

HUMAN DEVELOPMENT IN CHILE We, the Chileans: a cultural challenge 2002

What's going on? What's going on? Who are we? Who are we HH 111 11L 0 s it all leading Where's it all leading? United Nations Development Programme



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United Nations Development Programme

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EYV d'S[VIE`V&YZICVà`œZITF]ef dVZ_4YZVZ EYZIT_TvàeVg`VdR_UZ_daZvdWWJZ_Xd`V&R_ł dIV_UV_TVR_USVRfej ŽeZihZJVj f dVUZ_VgVcj USj daWTYŽ:eZI`V&V_UVJ_VU gRXfVjiLY`hVgVL`c f dVU hZY ^f]eZiV^VR_Z_XLR_UZ_eVJ]VTefRjd R_U RIRU^ZId JZVhZV/UZRXCW RS`fe eYV dV_dV e`SVReeRIYVUe`eYVeVc^Ž:_d^VTRMdZddWWd e`RaVa]VdReeL]ZeVBEf dV`cTf]efd{}YVZERXVL Z_`eYVcdZeZifdVUe`^VR_eYVhFJ Rd TZ4j`cR Xc`fa hZEYZ_ZESVRgVdR_UT_UTTedZedT^^`__ JZWZ:eZiZ_eYZidV_dV`V&YVeVc^eYRehVdaVR\`W TZgZTTF]ef cVL`VAc`eVcHR_e`c4 ReY`]ZTTF]efcVL`c `VRaVa]VdTf]efcV`c]RI\`VZEZ

7 ceYZłdf U eYVekć YRJSW_f dJUZ_ZdSc RJ dV_dV R_ULW] hZ_X eYV VI R`a]V`WF? 6D4 @Ł If] ef cVYRJSW_ eR V_e`A_R_hBj d`VJZZZ ke ł XeYVZZ def TYŁZEV_T ^ aRdddVgVg ^ R_ZWERZ_ `Wi TZJ`cXR_ZREZ_ŁEYVZ RX&LZVRŁgRJf VdR_U adRIEZIVdUVgV] aVUSj Rd TZ/gi`cd^Vd/TEZ_ eYVEV VŽEYV CVa`cedW/de`R_dhVcd^Vbf Vd eZ_dRZZZXW/ eYZHT_TVaeZ_`VWF] ef cVZH Y` RVh VLEYV 4 YZVR_dDH YVEVU hVT ^ VW7 ^ 0 H YRERVEYV hBj d`VJZWR_Ud TZBJ adRIEZIVd`Wf c yH V/GH YVEVZI`f cT]]VIEZV[`f c_Y YVRUZX0._ `eYVch`dULZe^ZXYeSVdZUE/Re[f deRLeYVCVIV_e a`af]ReZ_TV_d`dRN/WY`h ^ R_j 4 YZVR_dEYVEV hV&VLEYZICVa`ceLZ_R] ^`UVdgi LZIRNZ_XhY` eYV4 YZVR_dRNZ

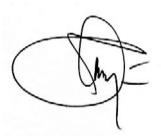
EYV&VbfV&BZ_ddW e SVR_Raac acZReVhR `WeWah`_UZ_Xe`eYVZ_gZEReZ_ VieV_UVUSjeYV AcVALV_e`V&YVCVafS]ZILCZIRU`=RX dthYV_YV Z_RfXfdReVUeYV4`^ ^ ZdZ_ WceYV3ZIV_eV_Rg `W_UAV_UV_TVŽyEYZ:1Z:leYV`TTRdZ_E%dRZJeYV AcVdZUV_eLye` ^ Rc\ eYVj VRcdV&/ #!!! e` #!"! RdRUVIRUVZ_hYZIYhVR]dV-VTe`_eYVYZte`q`W YRgvZzEYVF?5AYf^R_UvgVj`a^V_eeWR^ŁhZeY eYVV_eYf diaa`ce`WeYzd`W/TVLdve Zed/We $UdRAARV are? ReZ_R CVa`ce`_9f^R_5VeV!$ `a^ V_e R_U 4 f]ef cVLhZeYZ_ R]] eVV cVa` ced eVRe F?5AadvaRdvdZ_^`dveYR_"\$&Tf_ecZkoŽEYV acVdV_eCVa` ceRULEVddVdRdfS[VTeeYReYRd_VgVc jVeSW_a]RIVUReeYVTV_eeV`WRh`dJU9f^R_ 5 \gv]`a^ V_eCVa`ceLRdvZdeYReUReVdVd/^ "**!Ž 2d: ^ j dyWRgVdW_ŁZeYRdSW_ R_ VITZEZ_XSf e T^a]VíeRd∖Ž

 $\begin{array}{l} & \hbox{EYZlCVa`ce YRdSW_ ac`Uf`TUf dZ_XeYV^`ce} \\ & \hbox{C}Uc_ bf R] \end{tabular} \\ & \hbox{C}Uc_ bf R] \end{tabular} \\ & \end{tabular} \\ &$

CVIV_eUV§V]`a^V_edZ_eVh`dUYR§VUV``_ł dedR&UeVVZ`a`ceR_TV`Wff]ef cVWceYVZJV_e652d `WeYVh`dUddVXZ_dTf_e62XdR_UaVa]VďE`ZM _`cVZeh`f]USVhZMJSJZ_U_VdĎEYVXJ`SRJZREZ_ `WeRUVEVTY_`]`XJE}_R_TVR_UT^^f_ZREZ_d Zd_`eScVR\Z_XU`h_ZJV_6652XdEZeZITVR]V_XZ_X eYV`ES`eYSj eYVeYcMedZeZITcVREZ_XR_USj eVV `aa`cef_Z52dZeZl`aV_Z_XfaŽHVYR§VdV/_eVV edRXTWWWIcd`WV/UR`V_edZzh`R_U_REZ_RJZh`Ž ?`_VeYVJVdELhVR]d _`h eYRe aVa]Vd_WUR dV_dV`VSVJ`_XZ_XR_U d`]ZJREZjES`eY hZeYZ eYV`dJgVdR_UhZeY`eYVcEZVUV§V]`a^V_eZle` ac`daVELU^`TCRIj SVcfdEZZ_VUV§V]`a^V_eZle` ac`daVELU^`TCRIj SVcfdERZ_VUR_U_REZ_dZeVI 7 c eVZl cVRd _ LRd h V af SJZY eVZl WWW `VeVV F? 5 A Yf ^ R_ UVgVJ` a ^ V_ eeVR $LhV _ h eVRe$ h YRe h VRV `WWZ_XZl RacVaRRe` g_ VI VCIZV V Vc eVV 3ZIV_ eV_ Rg + R UVSReV RS` f e R d S[VIe eVRe Zl gZeJ] e` 4 YZV dVW f cVZ

EYZITVJVSCREZ_`W_UVAV_UV_TVZI eYV eZ V hYV_4YZJVR_^V_R_Uh`^V_VMR] RXdR_dhVc eYVTR]`WYZIE`g`e`eR_VEVZ_ZZREZEVZ_eYVZcZI UZEZIFR]R_UT]]VIEZEV[ZEVZ`EZIRTR]]VicUZR`XFV R_UUVSREVTS`feeYVZ`RX/hVYREV`WfcyHV%Lo RS`fe hYRe hVhZhYe`\Wa`WR] eYRe YRdSW_ SfZe YZEVVce`ER_UhYRe hZ]_WUe`SVREVCVZ SfZe YZEVVce`ER_UhYRe hZ]_WUe`SVREVCVZ VME oZE YVR_dhVcde`eYVdNbfVieZ_dRVZ_Vc^VU Sj eYV]Vctl_d`WEYVaRceR_UeYVUZZj VIaVZZ_TV`W Z_UZEZIFRJOZZ deYVCVa`ceaf edzeLTF]efcVZ_4YZ/V YRdeYVeRd、`WVTcVReZ_XR.de`_X]ZZZXZ`RXV`W eYVyHV%R_ULSjUZXdL`WYVjaZXaVa]Ve SVT^VeYVdyWAVjZR_eRTe`cdeYReRWchRdU]``\} ZXdTZ4jcNbfZXdŽ

ARœZIZaReZ_XZ_YZê' çi RiddjWedjZe e Rie cdZ d TZêjERdycf S[VTed‰eYReZIYf ^ R_Uêği]`a^ V_eŽ : eYZ_\eYVCVa`cehV_`h a]RIVSWWeYVeVVeVVeVUc ZIRcMI] T_ecZsf eZ_ e` eYVacVaReZ_dWc eYZd XWReVêjV_dEeYV3ZIV_eV_RojEeYReeYVAcVEV_eYRd TR]]WUWZ7 c F ? 5 ALeYZIZ_gZEReZ_ ZIR]d eYV `aa`cef_Zj Wc Yf ^ R_UŵjN`a^ V_ee` SVT ^ H acWY_UVUZ_R]]ZeddZz_Z TR_TVR_UUAeNEcZ_TV Ze ZIR TVJVScReZ_ `WWWU ^ Wc VRIY R_U Vêvcj `_V`WeYV4 YZJR_aV a]VŽ@_]j hZeYV&WU ^ TR_ Rd]ZUTf]ef ch] SREZIWc Yf ^ R_UŵjN`a^ V_eSV RIYZêJUŽ



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9i [Yb]c C ffY[UF" ; YbYfU``7ccfX]bUhcf

DYXfc '9"'; ~Y``'J" 9lYWihjjY'7ccfX]bUhcf

BcfVYfh@YWkbYf`6" FcXf][c`AzfeiYn`5" GcYXUX`;cXcmA"

-BGHHHHCB5@7CBGI@H5BHG[·]

G7 < C C @C : DGM7 < C @C ; M! I B = J 9FG=858 75He @=75 89 7 < =@9 fA Uf]UbbY ?fUi gYžFc VYfhc ; c bnz YnžGc YXUX Fi]ržG gUbU A YbX]j YžA UWUfYbU 8 ca b[i YnL

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F?5AhZMVde`eYR_\eYVZUZgZLFRJdR_U ZdeZefeZ_dhY`dVYRUh`c\ŁZWc^ReZ_R_U T^^V_edT_eczSfeWe`eYZECVa`œŽ

 $HVh^{f}UZVe^{e}e^{R} \times e^{V8}VZE$ $WeYVACKOUV_T_iL> Z_ZOKC> RcZ 7Vc_ï_UVkLYZCI$ acVUNIVATIC2]gRc 8 RCTFAR_UeVVVC^ VCF_UVA DVTcVeRg 6Uf RU 5 T V U cVV/c eV/2cT eZ f `fddfaa`ceZeYVT_UfTe`WeYVcWARcTY`_hYZTY eYZdCVa`œZdSRdMŽ=ZVhZMLhVhZMYe`eYR_\ 2 [V[R U:R< cR dt] Wc^ V:> Z Zt=V: VM[R Z XR U S`Z' $R_U: cZl 5 V/XRU$ `WeYV $dR^ V^ Z_Z Zeq$ Wc XZZZXfdRTVdde eYV42D6? #!!! df cgyj URERŽ HVRCVRd XReWN e 2Xfde 4DbfV]RLACVALV_1 eZE 2UgZNc`_ 4f]ef cVLWcYZTT ^ ^ V_edLR_Ue` eYV5 ZVTe c`WeYV? ReZ_R]:_deZef eV`WDeReZebZtdL > ii Z $\sim 2XfZVcRLRUYZIT$]]VRXfVdEVcVcRGR $9 \underline{Z}$ ekVV/ceV/gRJf RS]VdRezdeZIR] \underline{Z} V/c^ ReZ_ eV/ ac`gZMŽ

EYVCVa`cehRdX&VReji V_YR_TVUSj eVVT ^ 1^ V_edR_UdfX&ddZ_d`V&UFRU? Ze_LCZRU =RcR&42> Rce49`aV_YR_L;`cXV> R_kZ6^ZZ <]VZ_LD_ZR>`_eVIZ_`d:c^ R2ccZX&R_RCRAWJ GZ]V_RLC`UZX 4ï_`gReL; fR_RAfXR_T&CRAWJ GZIRZLARS]` DRJgReL> Rce44 C`Uc346 VkL;`d/2 8c`ddZ; fR_6deRSR_ARUL44 Rc]`d4 ReVi_L; fR_ $6 _ cZbf V GVXHL 8 V cXV 4 `f WX_RL; f R_ 4 RdRd df d_> RcFa6deVc 7 VeVd.; `d/2_e`_Z GZ6R8 R]]`L; f R_ZR8 R_RL> `_d/cdreAR]^ VeL; f R_; `d/F Xrce/L 9 R_d> í Yd=V_RU > `cV_`L3VcREVZeVJS`Z L G% c E` \^ R_L8`_kR]` 7RJSVJ[RL8 RScZJ] GR] U/cdDf SVCIRMAT i L@cZR_R3Vc_RdT_ZI:X_RIZ; RdRL CR42 ceZd; VR_=VIRL> RcFaEVeVdR> RcdrR]L; `cXV = Rcdr2/L> RcZR_R2j]hZL4]Rf UZ 5 Z8 Z`]R``L; `d/2H VZ_deVZ_L> Rc\ D' ZeYL6UF RU 3cVCIZR_ZI > RcZR H VZ_deVZ_L; `cXV GVCXRcHL=`cVe` = ^aVkL G% c 7R[_kj]SVL> R_f V] < df d.`aVV4 cZdeSR] C`gZcH.4 cZdeSR] 8 RCFFAL<]Rf dDIY^ ZdH9 VSSVL 7Vc_R_U 7]` cVd 4` W/L> ZcR 4 c`gVec LCR/4 @]Zc`dL8`_kR]` 4` ccVrL; f]Z Ec`_T d R_U CR/4 4f Vz/deVZ$

 $EYV > Ra W4f ef dVZ 4YZVT f U_eYReV$ SW_T^aZWhZeYfeeYVRddZeRTV`W+9fX $CZRL > RCR; Vd/dDZgRL; d/C CRVL6]ZR_R > 1$ $]Z_RR_U > RcXRcZRA464k WeYV? ReZ_R]: deZfeV$ `WDeRezcheZicht:? 6/, ARF 12_RD`e`Ł612R_RKVzchlR_U $7RSZ = VZR VZV4 f = CV5 ZZZ_ VZV> Z1$ $Zecj \ Vold Trez_, 4 Rr 3f U_Z k ^ k ^ k ^ 4 Rer _ k ^ 2$ R_UARezZZR4YZR_X`VeYV=Z5cRcZcH2cTYZgVdR_U $> f dM^{\circ} dD dg ZIV_{15}: 32 > /, eYVC V dWRCIYF_Ze^W$ eYV? ReZ_R]:_deZef eV`VDa`ce; RezZc6eTYVSVcjŁ We^ Ve UZEVTe c `WeYV:_eVe_R] CVgV_f V DVegZIV $1D: \frac{1}{2}R U > ZYRV$; cRee R U 4 R UZR > cRVd $1D:/, ;RZ VC UCM Vk WeYV 9 ZAVC 4 f_TZ$ We 6Uf TReZ _ 14 D6/, CRbf V/ E c_RU R_U ; RZ V AZKRCč 14 YZVR_ 3``\ 4 YR^ SV6/, ARecZI $TZ A^{S}_{V2} = 4 4 YZV, eYV? ReZ_R E^{T}_{A} = 6 ZC^{A}$ DVcgZIV1D6C? 2EFC/, eV? ReZ_R] DIZ/_TVR_U $C^{M}(R4^{A} \wedge Z \cup A R \cup R \cup R)$ R_UAVUE`CVjVd`WeYVF_UVdDVTeVeRcjdVZa`W $EVVT ^ f_ZReZ_d_1DF 3E6 = /, R_U > iiZ^$ > ` cV_` ` WeYV 2 dd TZReZ_ ` W4 YZ` ½7`]\]` cV 6_d/\S]Val27@49:/ŽEYR_\dRdVR]d UfVe eYV

VierR`fd?]TV_ecVdR_U]ZSdRzZd`V&YVTf_ecj`d f_ZgVcd&ZdR_Ue`eVV^f_ZZZR]ZZAdZ_UZgZtRdd_ Tf]efd?]`cXR_ZZRZ_dR_UXgVc_^V_eZ_d&ZfeZ_d eYRed/R:WUZ_Wc^RZ_hZYfdŽ

$$\begin{split} HVh`f]UR]d ~~[ZVe`VacVd1`fcXRezefUVe`\\ eYVW]]`hZ_XWc eYVzc YV]aVd1_Vd1Z_ac gZLZ_X\\ R_Uac TVdtZ_XZ_Wc^ReZ_+8VcXV=VgVc`VeVV\\ DR_ezeX ~~4YR^SVc`Vd1`^^VcTVL4]RfUZR2]]V_UV`\\ VeYV? ReZ_R] H`^V_dDVcgZTV1D6C? 2> /Ł\\ 2U ~~]W2]Uf_ReV`VeYV=ReZ_2^VcZTR_7RIf]ej`\\ VVD TZR] DIZ/TVd17=24D@/LARf]Z_R7Vc_i_UVk`\\ VeYV? ReZ_R] J`feY:_dezefeV1:?;FG/L5R_Ze]V\\ 8fZ]V`e`VeYV? ReZ_R] :_dezefeV`VDeRezeZZd\\ R_U6T__^ ZTCVdNRCTY1:?D66/Z_AREZE> R_fV]\\ GRCMRdR_U2]gRc~DvcR_` WEG_VLZecVeLR_U\\ 6gR>`cV_~Z$$

EYV hY JV CVa`ce YRd SW_XXRej V_YR_TVU Sj eVVT ^ V ed R_U V a VZV_TVd`WeY dV hY aRceZIZREVUZ eVVUZWWEV_eWdf ^ d`cXR_ZXVLŽH V h`f JUeYf d]ZVe eYR_VeY dV hY`e`\aRceZ eVV 5 ZVTEZ_`WFRS`f cH`c\dr`a+ARS]`=VZFE> RX URJV_R6TTV&VcSRL9 Vc_i_C`^`E=f Zl8 f VcVc`E 2_e`_ZER > RURZXXE> RCFa D`JVLRU 9 f ceRU E > RCFA: dSVJ 2]ZEVL9 VJZR=VZFE> RCT d7 f V_eVEL 6gR 3RCRY`_RLI Z`V_R 8`_ki JV&L;`d/25 VJXU R_U9 ½ c > `ZŽ

$$\begin{split} HVR dt RaacVIZREV etVT ^ Ved^RUV Re etV \\ 4Zj H`c\dr`a Sj > ZxfV] = RS`dVL2]V&U C`l \\ UcMF VkL7 dr_TZT DSREZZLOUF RU Dr_ > Ree24L ;`cXV > `dTRe`L8fZ]Vc^` 8 VZdV R_U ARecZIZ \\ 8c`ddZE`XVeVc hZeY etV^LhVhZtY e`eVr_\ etV ARecZIZ R_edZ_eVV5ZT fdZ_dH`c\dr`a+ \\ ARS]`@jRdk!4L;f]Z @]R]RL4Rc^V_4`dVc \\ R_UHZd_2dtjRZ$$

$$\begin{split} & EYR_{dRV} [ZVhZWUFVe`eY`dVhY`de`_eVV \\ & h`c_ZXT^{^{}} ZeWd`WeV:_UZW_`fdH`c_dY`a \\ & YV[USj eVF?5AAfS]ZTA`]Zj Xc`faZ_?`l \\ & gV^SVc#!!!Z \end{split}$$

 $\label{eq:aready} \begin{array}{l} ARe \end{tilde{Z}I} Re \end{tilde{X}Re \end{tilde{Z}I} UFVe^{\circ} 8^_kR^{\circ}_{4} \end{tilde{X}} \\ VWX \end{tilde{Z}VR^{\circ}e^{\circ}_{7} c^{\circ}_{V} Ve \end{tilde{X}} VaR \end{tilde{Z}} \end{tilde{Z}} \end{tilde{X}} \\ VWX \end{tilde{Z}} \end{tilde{X}} \\ eYZ \end{tilde{X}} CVa^{\circ}_{4} \end{tilde{X}} \end{tilde{X}} \\ eYZ \end{tilde{X}} CVa^{\circ}_{4} \end{tilde{X}} \\ eYZ \end{tilde{X}} CVa^{\circ}_{4} \end{tilde{X}} \end{tilde{X}} \\ eYZ \end{tilde{X}} CVa^{\circ}_{4} \end{tilde{X}} \\ eYZ \end{tilde{X}} CVa^{\circ}_{4} \end{tilde{X}} \\ eYZ \end{tilde{X}} \end{tilde{X}} \\ eYZ \end{tilde{X}} \\ eY$

:_ eVVT ^ aZRZ_ `VeYVCVa` ceLgRf RS]VRd dZeR_TVhRdRd ac`gZUUSj aV a]Vh`c\ZX`_R a]RIV V_eSRZZH Vh`f]UeYfd]ZVe`eYR_\6cZR C`UE%f Vk`WYVF_ZgVcdLRUUV4 YZVL; fR_4Rd`d CfZeEcZZRUGR]VL> 2 _ZR? 1 DNeL=fZl> f_ZRL =fZl2_URUM: X_RIZ 2c_`]UR_U; `d/@dR_U²_L R]`VeYVA`_eZTZRF_ZgVcdLRU4`ie`]ZIRUV4 YZVL R_U> RETUV7]VfcZef`VeYV:_deZfeV`WA`]ZZIR DefUZed`WARZEDIZZ_TVAA`Ž

HVRJd hZY e YZXYZXY e e YVX/VC f dT_ezzff eZ_^RUVSj R] e d V ZZXY dhY RXWU e h`c\ hZeyfdR_`_j^`fdj Sj XZZ X e YZC`aZ_dZ_ e YVZ_e k g Zh d UZIIf d Z_XC f a d TRV d f UZ d R_U d cg Y T_U T e VUVC e YVC d RC YZH V RC V X R e WY e R]`V e YV WC e YZC a Roz ZZ R Z_Ž

=Rtelj LhVVreV_U`fceYR_\de`R] eYVdeRWWe eYVF?5A`WIVZ_DR_eZRX L4YZV1CVOLV_e CVacVdV_eReZgVLac`XR^^VR_URU^ZZteReZ_ `WIVdcLdVTcVeReZdR_Udfaa`cedeRWWLaRceZff]Rc]j >Rc?R=fZRDZdcRR_UAR]R8fRdzZthY`dVac`ł WtdZ_RZt^ R_UV_VCY_T_ecZfeVUe`eVVdTTVdd `VeYZdCVa`ceŽ7Z_R]jLeVV^V^SVcd`WeYVeR^ eYReac`UfTVUeYVCVa`ceh`f]UaRceZff]Rc]j [ZV e`eYR_\eYVZcVR^ZZdLhY`dVf_deZ_eZ_Xdfaa`ce R_URWWEZ_f_VdgP_eYVecV^V_UfdVWWce`W T^aZZ_XZZ

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¡Gi VYhjj]\mUbX`a cXYfb]nUhcb. h\Y`dYfgdYWhjj Y`cZh\Y`\i a Ub`XYj Y`cda YbhifYdcfhg`]b`7\]Y

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D5 FH'

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7 \UdhYf& 7 i `h fYžk cf_`UbX`YWebca m j `7 i `h fY`UbX`YWebca JWXYj Y`cda Ybh	- &
; H.Y.fYg[[b]ÚWUh]cbcZkcf_ ; DYfWYdh]cbgcZh.Y.YWcbca]WgngelYaUbXkcf_]b[``]ZY	
7\UdhYf" H\Y`Webgi a Yf'Wi`hi fY	
; H.Y.flgY.cZWebgi a dhjeb ; 5 male e [meZWebgi a Yfg ; H.Y.UYgh.YhJVgeZXU]mi]ZY ; H.Y.a U```UgYa V'Ya ; G.edd]b['WYblfY.UbX.di V`]Wdfea YbUXY	
7 \UdhYf`(` <u>H\Y`dc`]h]WU``VUg</u> g`c <u>Z″KY″</u> ; KYU_`dc`]h]WU``]XYbh]ÚWUh]cb ; '9YWh]cb`hifbcih ; H\Y`fYhfYUhZca`dc`]h]Wg	<u>%\$,</u>
7 \UdhYf`) HY`Yj]g]cb`UbX`h\Y`diV`]WgdUVW ¡HY`Yj]glcb`]b`ZJa]m`]ZY ¡HY`fYWebÚ[ifUhjcbcZbUhjcbU``]XYbh]m ;HY`hfUbg&cfaUhjcbcZdiV`]WgdUWY	<u>%%(</u>
j h∖Y≟əhYfbYh Ubcddcfhib]lmiZcfh∖Ydi]V`]WgdUW¥3	

7 \UdHYf * <u>9Hb]WX]j Yfg]hmUbX h Y bYk</u> ¡H\Y]a dcffUbWY cZh\Y]bX][Ybci g ¡H\Y]bX][Ybci gdcdi Uhcb]b7 \] [*] ¡FYUggYff]cb UbX fYWc[b]hcb cZYh ¡5 bYk U[YbXU Zcfh\Y]bX][Ybci g ¡A cXYfb]nUhcbždcj YfhmUbX bUh]	Y Nb]W[fci dgUgdfcXi W/fgcZW/ h fY gdYcd Yg	<u>%&&</u>
7 \UdhYf+ <u>9Xi WUhcb UbX Wj</u> [WWY h f ; 7 \]Yg\ci XfYWc[b]nY [gUW]Yj Y ; 7 i h fU`WUb[YUbX WU`Yb[Yg ; H Y Wj [WUh]h XYgUbX VY\Uj]ci f ; Gi XYbhggWj [Wg_]`gUbX_bck YX[; 9Xi WUhcb UgU df]a Y U[YbhcZW ; 7 \U`Yb[YgZcfWj]WYXi WUhcb	∕a Ybłg ÆfYXi WUh¦cb gcZnoci b[™]YUbg Y	<u>%&;</u>
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7 \UdhYf & AUd cZh\Y WY `hifU` ÚY X`]b ; 8UhU gnghYa UhhUhcb a Uhf]	7\]Y	%(*
7\UdHYf" <u>7 i `hi fU``dfc ÚY`c Zh\Y`W\]`Y</u> _i 'H\Y`W`hi fU``XmbUa [ga]bXYl _i 'H\Y`W`hi fU``fYgc i fWYg]bXYl	Ub`fY[]cbg	<u>%*\$</u>

7\UdhYf (` <u>7 i `h fU` Webgi a dh</u>cb <u>]b 7 \]`Y</u> ; H.Y X]j Yfglmic ZW 'h fU` Webgi a dhcb ; H.Y j [geb Webgi a dhcb UbX Yj YfmXUmW 'h fY ; 7 i 'h fU` Webgi a dhcb Zea U \ci gY \c X'dYfgdYWhj Y'

; '7 i 'h fU``Webg a dheb'UbX']bWea Y. '`]b_gUbX'dehYbhJU`

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7\UdHYf% 6Y]b[_'Ub']bX]j_]Xi_U``]b'7\]`Y.`cddcfhi_b]h]YgžZ/Ufg'UbX'X]Z(W_`h]Y i_`=bX]j_Xi_U`hUhcb']b'7\]Y`hcXUm i_DUbb]b[_U``ZY`Ua_[XghWcbÛ]Whb[_XYa_UbXg i_`H\Y`X]Z(W_`h]YgcZ]bX]j_Xi_U`hUhcb i_`=bX]j_Xi_U`hUhcb'ghUhY[_]Yg	<u>% \$</u>
7\UdhYf`& <u>H Y W]`YUb ZJa]`m`VYhk YYb W `h fU``W Ub[Y`UbX`h Y`X]ZÓW``h]</u> ; : Ua]mhmdYgUbX`ZJa]mXYa c[fUd\]WgUfY`W Ub[]b[` ; H Y W Ub[Y`]b`ZJa]mfY`Uhcbg\]dg ; :=a U[YgcZh Y`ZJa]m ; H Y`dUfUXcl]WU``]a dcffUbWY`cZh Y`ZJa]m	gʻc Z]bX]j]Xi U`]nUh]c b &&(
7\UdhYf" <u>6Y]b[_'U'k ca Ubž'VY]b[_'U'a Ub"'H Y`]a dUWYicZWUb[Y</u> ; H Y`WUb[]b[_fcYcZk ca Yb ; H Y`<8=UbX`[YbXYf. h Y`cb[_fcUX`hck UfXgYei]mi ; H Y`WU`Yb[Y`hc`a UgW`]b]m	
7 \UdhYf`(H\Y`]a_dcfhbUVW`cZZYY`]b[_gžUZYVVjcb`UbX`Vvćbj_YfgUhjcb` ; `F\Y`bYk`g[[b]ÚvUhjcbgcZdf]jUhY``[ZYžgYliU`]mUbX`h\Y`Vvćid`Y ; `f]YbXg\]d ; `9a_chjcbU``UbX`VvćbjYfgUhjcbU``ghmYg	<u> </u>
7 \UdhYf`) <u>7 \Ub[Yg`]b`fY`][]cig`]XYbh]h]Yg`UbX`UZÚ]Uh]cbg</u> ; 7 \]YžU`WcibhfmcZdfcZvggYgVY`]YjYfg ; 14 Y`WUb[]b[`aUd`cZWifW`UZÛ]Uh]cbg ; 7 \ifW`aYaVYfg\]d ; 14 Y`g VYhj hUhcb`UbX`XY]bgh]hih]cbU`hUh]cb`cZfY`][]cigYldYf]YbWY	<u> </u>
7\UdlYf* 8]ZZYfYbhk Ung cZ`]ZY`]b`7\]`Y ¡`A Ud`cZW]YUb`k UngcZ`]ZY ; H\Y`WU``Yb[`Y`dcgYX`Vmk UngcZ`]ZY	<u>&(&</u>
7\UdhYf`+` <u>5`d`ifU`ÎKYÏ`fYei]fYg`hc`YfUbWY`UbX`UVWW/dhUbWY`cZh`Y`ch`Y</u> ¡He`YfUbWY`UbX`bcb!Xgw/ja]bUhjcb`jb`7\]Y ¡CcWjcW`h`fU`ZYUh`fYgcZhc`YfUbWY`UbX`bcb!Xgw/ja]bUhjcb ¡5a V];UYbWYgUbX`W;U`Yb[Yg	<u> </u>



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7 \UdHYf& DUHYfbgcZgcWUV]`]hm ; HndYgcZgcWUV]]hm	<u>&* (</u>
7 \UdHYf'' Dc`]HWU``]a U[]bUf]Yg ; G ddcfhZcfXYa cWUWn ; a [YgcZXYa cWUWn ; GJ UHhli XYgIc dc`]HWU`dUfHWdUhcb ; H.Y'dc`]HWU``Ja U[]bUf]YgcZW.]YUbg	<u>&*,</u>
7 \Udh¥f(=a U[Yg`c Zh\Y`Wc`i bhfm`U`ZU[a YbhYX`X]j Yfg]hm ; =a U[Yg`c Zh\Y`Wc`i bhfm	<u>& \$</u>

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D5 FH9 +	
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> `cVac`Wf_UR_UZ`ac\ddgveYR_Vfevc_RTYR_XVYRgvSW_eYVZ_vcTYR_X\dZ_aV a]\ZDZ_TVeY\dv RV_`e`SgZfdeYV/RV_`eVRUj dVTX_ZXUŽEYVdWdVLZzZL_`eVRd e`}_UeYVh`ddR_U_R^ Vde UNATEZSVEVNAVAVCA_RJVIAVZZ_TVEŽ?`_VEVVVALEVVTYR_XXdRcVeVVCVŽ2d]R_UATRAVLJZVVZEMJVR_UEVV hRidZ hYZYaVaVaVVZY&VCYReVTYR XULSVT^ZXR`SZERVeR_UT_WCZ_XČeZL_`ef_fdFR e`WWULKACZVEVURULREEZ`VELVEV a`hVEVUKZ?`CZARTVERZZEZERZZZCHEZZCHREZ doCoceZZXŽ 4YZVR_dRVSVhZUVEVUSVTRfdVUVabZeVSVZ_XZ_TEVREZ_XJj Tj`dve``_VR_`eVvEeVVj WVJ]ZVdeR_XvEVŽ

EYVAdvOLV_e`WeVVCVafS]ZLCZRU =RX dLcV Rc\UZ_dWWdV_TVe`eVV3ZIV_eV_Rg+yEYZLZIeVV `TTRAZ_____`` AR`_____` AR`______` ARUVIRUVZ_ hYZY hVR] CV-VTe`______ AVYZE q`_`______ `` W4 YZVL` R_U`_eYV\Z_U`WWefdveYVTf_eqjTR_YRgVZ%eeZdeZ Ve`dVT_dZUdeYVW/UR^V_eRjbfVdeZ_deHY` RVhVOHYV&VU hVT ^ VW ^ OHYV&VRVhVX ZX0EYVW &YT ^ ZX3ZV_eV_Rq` `W_UAAV_UV_TV Z 4YZVZIRX`U`TIRZ_ e`U`eYZŽ2eeYVeZ`V`W_UVaV_UV_TVL4YZVR_dUVIZUVL4VceYV`dMgVd R_UReeYVZc`h_cZhŁhYRe\Z_U`Wrf_eqieYVjhR_eVUe`SVT^VŽ?`hZHRX`UeZ'Ve`Rd\`fcdygvd RS`feyHVLeYV4YZVR_dYZEYZdTYR]V_XVZd_`e[fdeR^ReeVcWcZ_eV]]VTefRjdŽ:_eUBjd4YZVLZeZdeYV ^R[`&] hY`R&R{ZXeV^dMgvdevZlbfV&Z_R_UdMcTYZXWcR_R_dVZHYV_^`&VeYR_YR]W `VeYVSE!! aV a]Vcf ceyl VUSj F? 5 A Z ^ ZI #!!" Vi ac\ddwUU f SedRS`feeYVViZeV TV`VR jeYZ X f_ZofVjj y4YZVR_%LZZZIeZ Ve`deR_UZ_WY_e`WeYV^Zc`cR_URd\`fcdMgVd+U`hVWVJaRce`WRT^ł

^`_yHV%Q

(Åzlýz²æ) zÝÈ

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6gv; d TZ4j WURDWWZ RXZ4 YZVZI `VITVaeZŽ: ^R j hRj dL4 YZVdZ RXVYRI RocReWZzd dTTVdtMdR_UVAZfdvAZedWARdR_UUVdZvdŽeYRddYh_hYReZeYRdSW_R_UhYReZeTR_SVŽ7c^ eVV eZ VhYV_eYVaRXd`V¥R2dfTR_RhVdVhcZeV_L4YZVYRdSW_Z RXZ_VULdvac`UfTVUR_UeR_dVtc^VU RXZ_R_URXZ_ŽEYZIYZ_gY_eZ_`V4YZWeeYdVgRfKdR_UZWRddeYReYRgVd/RaWU`fc]ZWRdRdTZigL $YRgV^{a}V_{WeYVhR} e^{2}RZfd_RZ_{R}ZV_{e}ZV_{e}ZV_{a}V^{A}V_{e}V^{A}V_{e}V_{e}^{A}$ ezevz Rvz Rvz Rvzdz h YZIY 4 YZIVR_ddWeYV dvgvdRdaRceZZaR_edZ_RT^^f_zejŁRdYVzde`RYzeb`q

R_URdT IRfeY cd`WRT^^`_ eRd RVWcXUŽ9`hVgVdLZ_eYV^ZLde`WIYR_XLdR_UT_eZ_fZEXdLeYV Z_YVCZEVUcM/WZ_RXV`WIY`4YZJVR_dRVYRdeV_UVUe`S]fCZHYV_eYY_cVRJZEVY`h^fTYeYVTf_ecjYRd TYR_XVUR_UY`hUZWWCV_eeYVZcURZjj [ZgVdRcVe`URJLaVa]VeV_Ue`SVZ_TcVuf]`fdRS`feeYV_RccRezgV eYReYRdWc^VUeYVZJVR`W4YZVR_U_`ee`ZJV_eZjVhZeYZZ

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K < M8C 9G7I @H F9A 5H9F = B7 < = @93

 $\begin{array}{l} 4f \left[d \left(\sqrt{2} Z \right) Z a \left(\frac{1}{2} e S \right) V R \left(d \sqrt{2} Z \right) R_{2} Z e \left(\sqrt{2} e S \right) R_{2} e \left(\sqrt{2} e S$

 $EYV CV-VIEZ_RS`feTf] ef CVZ_4YZ Vd_eYVZ VZ_VARUUZ_aCVZ_fdCtá`ced+Yf^R_UVZ_VZ_i a$ $^ V_eZ_ea`dVS]VhZeY feRTf] ef CVeYRedeCV_XeYV_deYVZ_UZZ_FR] R_UT]]VIEZ_VTRARIZ; VCREZ_Ž$ $EYZta`dZ_TR_SVecRIWUSRI\ e` eYVT_T]fdZ_d`VeYV"**) 4YZ VR_CVà`ceŽ@_eYV`_VYR_UL$ $Z_UZZ_FR]dTR_dYRaVeYVZ_JZZ_XT_UZZ_d`_]; Z_d VACRdd TZ4; RdRhY`]VTR_XV_VREVRVAG`fdS]V$ $V_gZc`_^ V_eZ_YVCWCALRYf^R_UZZ_d`_]; Z_d VACRdd TZ4; RdRhY`]VTR_XV_VREVRVAG`fdS]V$ $V_gZc`_^ V_eZ_YVCWCALRYf^R_UZZ_d`_]; Z_d VACRDA'; fdeSVRUUCADUe`deV_XeYV_d TZ4; TRARIZ$ $eZdeYReSc`RUV_aVa]VdTY`ZVdR_U`aa`cef_ZZCZ@_eYV`eYVc`YR_ULeYVZcd`S[VIEZZ_iE4VVC:RSZZ;$ $e` }_U^ VR_ZXUVCeYVZ:REZ_dhZeYZ_eYV_dMgVdZIRIZ`a`ceR_eRddefTefd?] ecR_dVC^RZ_WCeYV$ $TCVReZ_`VeYZIVAG`fdS]VdTZ4; V_gZc`_^ V_eZEYVTf_ecj`da`eV_eA2] e` ^ R_VYf^R_UVgY`a^VeR$ $CVRZ4; ^ fdeSVdfXYeZ_aVa]VddfS[VIEZZ4;Ž$ $EYV\#! !! CVa` ceRaac`RIYVdeYZIZtf VhYV_ZeVdeYS[ZhVdeYRed TZ4] TRaZeY hZ] SVdeV_XeYV_UU`_]j ZWaV a]VdYRVyd^VeYZ_X&Z_T^^^`_ZEYY WeXV]Z_\d`Vedf de R_UT`aVReZ_Zd WC RdeYY WM] eYY Wc^ aRce`WR yH WZZEYVEVLEYV VIZEV_TV`VWR yH W6hRd R_Z RXV R_U RadREZTV dr`f]USV T_dZUEVURTcf TZ4] V/V_Ve`Wff^ R_Ugy]`a^ V_eZ_4YZVZEYVZ`a`ceR_TV`VWR T]]VIEgVZ`RXZ Rg WcYf^ R_Ugy]`a^ V_eUY_VEZXa`Z_EZ$

Î < i a Ub XYj Y`cda Ybh'bYWYggUf]`m]bj c j Yg`U`WcbWYfb`k]h`Wi`hi fY`!h`Y` k Ung dYcd Y`W\ccgY`hc``j Y`hc[Yh\Yf!` Zcf`]h g`h\Y`gYbgY`cZgcWU``Wc\Yg]cb` VUgYX`cb`W`hi fY`UbX`g\UfYX`j U`i Yg` UbX`VY`]YZg`h\Uh`g\UdYg`]bX]j]Xi U`` \i a Ub`XYj Y`cda Ybh'`ZdYcd`Y``j Y

hc [Yh Yf k Y ž Zh Ym Wc dYfUhY]b U a i hi U miYbf]W]b['k Unž h]g Yb Uf[Yg h Y]f]bX]j]Xi U Wc]Wg Gc ž \i a Ub XYj Y c da Ybh]g Wc bWfbYX bc h i gh k]h 'dYc d Y Ug]bX]j]Xi U g Vi h U gc ' k]h \ck h Ym]bhYfUWiUbX Wc dYfUhY] b Wc a a i b]hYgÏ

I B8D% - *ž))

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]b`]lgVfcUXYghgYbgYž]g``]b_YX`lc`h\YXY!	UbX`cdYb`hc`W¶hjW[ga"Ï
j Y`cda YbhcZU'W 'h fU``dc`]Wn	F]WUfXc`@U[cg DfYg]XYbhcZh\Y`FYdi V`]WzAUm&\$\$\$

EYVZ a` cdZ_TV`Wf]cf cVZdS`c_V`feSj eYVdTRV`WYYR_XZŐBi R` a]Vd`Wf]cf cd] TYR_XdRvZ_TcVRdU Z_UZZLFR] VXWU^ LeYV]VALZ_Xc`]V_`h SVZ_Xa]BJ VUSj eVVZZ_ R_U eYVZ_`gReZ_d`VWUFTReZ_ cWc^ Ž2]]`VeYZLRWWIcd_`e`_]j eVVhBj aV a]V[ZgVe`XeYVcZ_d TZcjESfeeYVZ_Z_UZZLFR] hBj d`W [ZWRdhV]Ž:_ d^ LTf]cf cV^ ReeVcdSVTRf dVZe ZLRS`fe aV a]Vdcf S[VTeZgVVI aVcZ/TVŽEYVZ URZj]ZW V_T f_eVcd_Vh VI aVcZ/TVdR_U eYVj ^ fce}_UR^ VR_Z_XVVc eYV`ŽAV a]V^ Bj _`eSVRhRv`VeYZL dRcTYŽAVcYRadeYy hZ]_`eSVRS]Ve`RceZff]ReVeYVbf Vdz_deYV aVcZ/TVR_U eYVZ/MgVd2Sf eeYVj hZ] aVcTVZgVeYVRa eYRe YRd`aV_Uf a SVANW_eYZcdS[VTeZgVVI aVcZ/TVR_U eYVUZWTf]cj eVy YRgVZ eR]\Z_XRS`feZeLR_URdZx_ZeR^ VR_Z_XeYPeeYVj TR_dYRvhZeY`eYvcŽ H:9C9GCB7I@HF5@7<5B;9G5B87<5@9B;9G=B7<=@9

"Ž4YZVZtf_UXXZ_XRac`Wf_UTf]efd?]TYR_XXŽ_eYZtac`TVtHeYVUj_R`Zd`WtTZR]X;SRZR&Z_ R_UaVcd_R]Z_UZZTRZR&Z_R_UeYVTV_eR?Zj`WAVV^Rc\VeR_U_Vh_eVTY_`]`Xj_RVa]RjZ_XRTV_eR? c`]VZ4f]efd?]TYR_XVT2VR&d`aa`cef_ZZXdSfeR]d_UZ/Vff]eZdWcVgXgUB;JZWZ_d`TZKjŽ

#ŽEYVZ_YVZENUZ: RXV^ VMYREZHY4YZNR_%MRdSVT ^ VS]f ccNUR_UZd_`egVcj TcNUZS]VVkc^ `deaV a]VŽ EYV dv_dv' `VSV}`_XZ_Xe` 4YZVYRdR]d hVR\V_VUŽE`URJŁ4YZNR_d TZkej U`Vd_`edW^ e` YRgVR_ Z`RXV` VMEdM/WeYReV_RS]VdZee` SVR dv/VkMZR_eRTe`d.`cydf S[VTe%Ž2 T_~ZTeZ_XZ'RXV` VMEdaRdeR_UR hVR\UNZX_`VMEdVMef cVT_ec2Sf eVe` eYZŽ

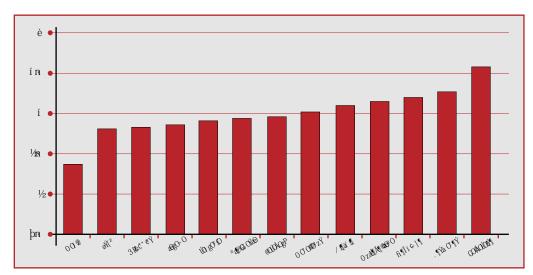
$$\label{eq:constraint} \begin{split} & \mathcal{Z} XUZ ITRREPORTED XIVUS is eVUVgV1 a^ V_e `VZ_UZgZUFRJZRZ_Z > `dVR_U ^ `dVL aV a] VR:VYRgZ_X e` UV_VGVZc `S[VEgV2LgRfVdR_Uac` [VIed` _ eVZc `h_ZEYZdac` TVdHYRd_` eSW_T fa] VUhZeY R^ ReIYZ_XUVgV1 a^ V_e `VeYVd` TZR] dd fcTVd_WUVUe` VM]] ZZEYZdTRFdvdR_i Zej R_U d` TZR] hZeYURR RJ Z_aV a] VZ$$

&ŽHŖJd`W/ZWYRgVUZgVczZfUZ_4YZ/VLSfeZ_^R_jTRdvde/ZdZtRUZdtTZReVUUZgVczEjŽEYV]RT\`W]Z_\dSVehW_eYVgRcZfdhRjd`W/ZgZ_XcVcf]edZ_R]RT\`W^^^f_ZTRzZ_R_UYZ_UVcde/VT_decfTeZ_ `WickRzgVUZgVczEjŽ

'Ž4 YZVYRdRTf]efd?JUV;TZŽ5 ValzEVeYVZ: a`ceR_TV`Wf]efd?Ja`]ZTZdZ_dVTV_ejVRcd_JValReeV_eZ_ YRdSW_XZgV_e`Tf]efd?Jac`TVabVdeYReh`f]UYVJaZ_TdVRdVdTZ4g`dTRaRIZeje`RTeV6ZedVJVZ

7I @HF5@7<5B; 9G5@H9F9J9FM85M9LD9F=9B79

 $\begin{array}{l} effective for the the test of test$



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 $@ _ VeYZU`WaVa]VViYZZeyacZVZ_4YZWZO`hVgVLeh`eYZUd`VeY`dVd`cgY_VUa]RIVeYV`dMgVd ReRUZHR_TVR_U]``\ ReeYVTf_eqj_VW'^ eYV`fedZWZ$

 $3 \hat{U}^2 \hat{Z}^2 \hat{Z}^4$

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>¶ïlýznani VźÅO (źqä), øä B1 Ł;maii þþ½ Ê

⁸C9G5B = A5; = B5FMC: H * 9ÎK9Ï CH #@9L=CHB

Î 5 bX k \]Y =k Ug k U__lb[VUW =gU|Xžk |h gc a i W k YU'h c b a mif] \ h\ UbXž\i [Y a]bYfU` XYdcg|hgžUbX c b h Y c h Yf g|XY U [fYUhVci bX Ygg gYUžUbX]hĝ bc hYbci [\ Å =gUnžk \ mXc 7 \]YUbgžk \ mXc =Ug U 7 \]YUbž \ Uj Y hc [c \ i b[fn8l fA UYži fVUbž \ C9, Ł

 $\begin{array}{l} 4 YZNR_dU _ eWM f_UK^ Z_VU Sj Xj SRZREZ_LSfeden Vc Sj eV dS[VTegV V a V ZV_TVd ` Ve V T f_eej dZ_YRSZER_eeZH YV_ a V a] VU _ `ea v CT V gV eV v a V dV_TV ` Ve TZ ej Z_eV Z_VgV jU j] ZW Z Z Z UZV If]eV c eV V e` YR VR_ZNR ` W R Z_Z Z \\ \end{array}$

< C K 75B = 697 C A 9 A MC9@ 3

 $> R[`cerR_dNc^ReZ_d_`e`_]j RWW ReV^RicdTZA] da Y do V do WZWZ_dTZA ji SfeRid Z_UZ ji Rid Vojo U ji JZWZA kon Rez_dNc^ReR^`dva V do Rij JV ji JZWZA kon Reveal a Riež do V kon V do Reveal a Riež do V kon V$

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k UgʻUʻfYU`mXUb[Yfci gži bWcbj Yb!	bchYUgn"AcghdYcdYXcbchZYY`h\Uh
h]cbU``dUh∖"`5bX`amidUfYbhg`kYfY`]bbYfZYYXca UbX=ZYh]hUkUngUbX=
Yj Yb⁺VfUj Yf⁺hc ⁺UVWWdh]h"=k Ug UV`Y	X]X`]lıž≓a UXY`a mgYZÏ
	; `cf]U'A ~ bW\a YmYfz'UWfYggz'&\$\$&"

. ¶¶ " ¢ " වෙස්පෙz ඊට ටැස්න¶ i Ú®ේක්ටෙරෝස් ¶² z ස්q¶ස්න¶ i සිසෙ¢ " සිසෙරෝස්ටරෝස්] zz² සි- ටදී ඉස්සෙz ස්ථා Yi @8¶‰ ස්ථා Z Ýz A67 z Ýz	

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>¶ï ÚgznaB1Ł; äl Ox¶²O@e∗ï Údzonai þþ½Ê

7 cgRzfddVRd_dL^ R_j 4 YZVR_dT_deZefeVeYVZcZUZgZUFRJZV_eZej `_ eYVVLXV`WcZ_`aa`deZ_ e`d TZKejŽEYZdyRd TZRJZUZgZUFRJZReZ_%dV-VTedRaRcRU i ŽH YZVL`_ eYV`_VYR_ULd TZKejZTdVRd Z_XIj V_T fdXXdZUZgZUFRJde`SfZUeYVZc`h_ |ZWac`[VTedLeYVZcVgVcjURj TZETF^ deR_TVdT_decZteeYVZc TRaRTZej WceYVZ_UZgZUFR]dd/WcVRJZReZ_ hYZY eYRedR`Vd TZKejac`TJRZ`dŽ

Î=ĨYY[] Y Yb]bžVi h]b th Y`\cdY th UhdYf\UdgÅ /a UniVY VYWUi gY cZh UhÅ 'H Y th]b[']g h\UhÅ]hỹ U``WebbYWYXžVYWUi gY =WUblÅi[Yha Uff]YX UbX`\Uj Y W\]XfYb ']Z=Ĩj`Y [chbch !]b[ž=a YUbžnci _bck 3 =WUblÅiXc]]žgc]hỹgcficZX]Z(Wi thÅ ž=a YUb]hỹU```]_Y U WfWY th Uh bYj Yf YbXg'I

H YfYlý bc k Umci h

ÎBcž=h]b_ h YfY]g U k Umci hž]hý gca Yh]b[]b h Ya]bX'Ï

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fAUYžUXi Yži fVUbž]bhYfaYX]UhYG9; Ł

 $\label{eq:constraint} \begin{array}{l} 3j \ W_{i} h_{Z} X Rad_TY^{\circ} d_TZR_Raac^{RYLeVCVa^{\circ}ce} - Ude^{ReeA^{\circ}} dvhY^{\circ} U_{a}^{e} PR_{e}^{O} dvhY^{\circ} Z_{a}^{e} RYZ_{a}^{e} PV_{e}^{O} Ue^{O} Va_{e}^{O} Z_{a}^{e} PV_{e}^{O} Va_{e}^{O} Z_{a}^{e} PV_{e}^{O} Va_{e}^{O} Z_{a}^{e} PV_{e}^{O} Va_{e}^{O} PV_{e}^{O} PV_{e}^{$

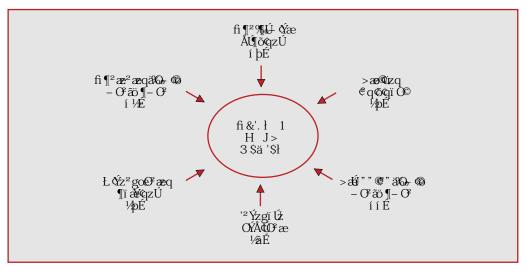
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8C CIFK 5MGC: @ 9<5J95BM + B; -B 7CAACB3

D TZR UZgVczej ZIR_ V ackdz_ `WalfcRzej, VRIY akcd_ YRIYZI`c YVc`h_ V akc2/ TvdR_UgZvhd`W d TZGjŽ3fe_`eVgVcj \Z_U`WUZgVczej VRg'fcdYf^R_UvgVj`a^V_eŽ2TT dZ_Xe`F? 6D4@ŁeYVVM] UvgVj`a^V_e`VvaV a]VdTRaRSZZEZdcVbfZvdyTcNrzgVUZgVczej %ZEYReZle`d3LRUZgVczej eYReScZ_Xd WceY Z_UZgZuFR] R_UT]]VIzgVVfacVcdZ_d`WYf^R_TcNrzgZejLhYZVac`^`eZ_XeYVT_dcfTeZ_`VR T^^`_`cUVčZ_4YZVLY`hVgVLUZgVczej ZdcPeVcVW7X`V_eVUŽ 0 0Åä[[%afa 0.002 0° äö 0.00Ýä[[%a6%20

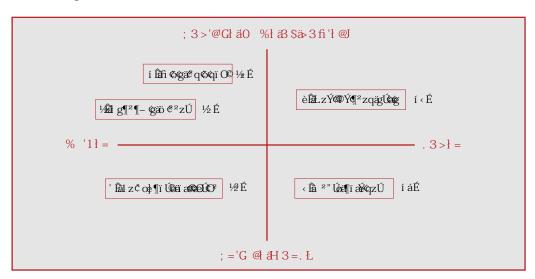


> ¶ĩ lýz näľu ž ÅO źqa 2 ä eza ä O Ý Ýa 3 a se za b 1 ½; äl O a 2 2 Va z a t b 1/2

 $\begin{array}{l} & \hbox{EYK} \end{tikz} \\ & \hbox{EYK} \\ & \hbox$

 $\begin{array}{l} {} EYV^{Aa} & W4 YZVR_{h} d` VIZVZd^{ & OVER_{eff} (feeR_VfeeR_vfeeR_VfeeR_v$

 $K \le 7 \le 5F9CIF = A5; 9GC: 0C7=9HMB$



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> ¶ĩ lắz nă lź Å Oź qä [² äcez ä] Oź
Ýá [%äcez ä B 1 Ł; äl Oct
[² O&> ĩ lắz orai þþ ½ Ê

:_ARe' ŁeYVCVa` œdr`hdeYVUZgVdZġ` `WaV a]VdZ`RXd` W4YZjVZ2TT d.Z_Xe`eYVF? 5 A_ReZ_R] d` cgy R_Rj dZLeYdVgZhdRvd`UZgVcdVe?ReeYvCVZd]ZedVe`T__VTeeYV`ŽeZd_`eVRd`e`ScZLXVeYVXRa SVehW_XZ_VcdR_U]`dvcL`cSVehW_aV a]VhY`YRgVR_ZJNR`W1TZdġ R_UeY`dvhY`YRgVc4ceVReW Z_e`RacZgReVh`c]UŽEYVa`dZzgVZ`RXd`VeYVT`f_eg`Wf_UR^`_XaV a]V`VeYVyTZgZTZ_UZgZLFR}%c yVT_`^ZThZ_Vc%g`aVReVgVg`VgVgVg`VccV``gVUVd^`eVVUvd`]ReVgZhd`VeYVyR_Xg``fedZUVcZa

 $\label{eq:constraint} EYVTYRcedn`hdR_Rcdy``WolTZRJCVacVdV_eReZ_dR_UV1aVdZ/TVdhZeYWhScZUXVde`[`Z_eYV^ŽEYZdyUZdYCdZeJ%dV-VTedRUV]TZeZ_TF]efcd?J_ZeVXCReZ_Ž$

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 $4 YZV acVdV_edRTf]ef cR] UV, TZeeYReh VR_V_dZedYf^ R_UVgV] a^ V_eZEYVCVa`cech`hdTVceRZ_eV_l UV_TZdeYReh VR_V_4 YZVR_d TZGj`dRSZZEj e`UVeVc^Z_dVVVcZedVJV&VVT fcdVR_UVvc^ZedT^^`_]ZVV cPvVVL VR_VVL 4 YZVR_d TZGj`dRSZZEj e`UVeVc^Z_dVVvcZedVJV&VVT fcdVR_UVvc^ZedT^^`_]ZVV cPvVL 4 YZVR_V d`YeVVVH V%TR]]dReeV_eZ_e`_V`VVeVVT f_eej`dfcXV_eeRche+Y`h TR_R UZdt TZRAUUZgVcdEjL`V&V_dt`eeYccfXYSj Vvc^d`VvcZgReZt`LSVURh_e`XVeVce`SfZURa]fcRZzEZT` dVceYReTR_XV_VReVRdV_dV`VSVJ`_XZ_XR_Ud]ZLRZEjO$

7 c 4 YZWR de` SVRSJVe` eRJ\ R_URXeWLeYVEV_WULde` SVR dRaac` TYV V_eR^`__XeYVd'S[VI362V VI a VZY_TVdf_UVdj Z_XeVVC UZWWCV_TVLWc VI R^ a]VZ_d TZSZZG R_U]RS`fc cV[RZ_d.`cZ_eYVhB] eYY]``\ ReeYVWef cV` cc/V V SVceYVaRtěŽE YVhB] e` RIYZgVd'TYR dRaac` TYV V_eZd_`ee` Y^ `X V_ZKVeYVAVVI a VZY_TVLSVIRF dVZ_UZZLF RZREZ_ R_UUZgVcZG REV_`h RWREŽH YV_eYVAVeV_UV_TZd RVRTVaeULZZ ZI`SgZ f dh YRe Zl^ ZHZ_X-cWWV_TVde` dYRVU VI a VZY_TVd` Wt TZG Ž: eZl`_ eYVSRZG `Wf TY VI a VZZ/TVdeYReRyT`^^`_h` dU% R_SVUYZ_VREVLZ_h YZY UZWWCV_TVdTR_SVZ_eVCTYR_XUU R_U_WC ZREVUŽE YZDZRERA Wcd TZG RdRhY`]VR_UWcVgVg Z_UZZLF R] 4 YZ/NZ Ž3f eLS`gVR]LZZZI RTZgZT eRAŽF JeZ_RMJ L^ RZ_XRT`^^`_Y^ V` fe` VVZgVcZg ZLEYV^ZDZ_ eYReUV^`TRTj_ZLEYVV e` a V&W^ Ž7f ceVVc^`cVLUV^`TRTj_TR_YRUJj_SVT^Vyf cd%Z_eVVRSd/_TV`VRyH VŽa

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ä ² ඩට සෙ¶ රෑවෙරි ව ä ¶ ඊ z ੯ − z² සමු C ස් ¶− z ස€ z Ý ් j z aj z anz Ú	1∕€
ä; z¶Å&äq¶²xägOŹäöoDäaaÅzä¶%äo¶õzÉ-z²ääeezøäoDĭzä	èí
äŁ-jŁä	<
ä @[aða	¹∕≱pþ

>¶ï ÚgznaB1Ł; äl One¶²O®a⊳ï Údzonaĭ þþ½Ê

 $\begin{array}{l} 4 YZVdTf [ef d] UV TZe YRdR]`_XYZE g ZAVEYRadZed` cZZ_TR_SVerRIVUSRI\e` eYV`]UWRc` WZW \\ WEV_TVEZ:_ cVTV_e eZ VeLeYVUZERE cdYZa cVacVdHUT]]VEZEVREZ_LZ_dEZE eZ_RZWUTVCHZ_\Z_Ud`W \\ WEX^ V_eRZ_R_Ua]RIWUCEVT_dedZed`_ d`TZG dCMWUVEC^ZRZ_Z`_ eYVUV` TREETerR_dEZ_ \\ ac`TVdLZ_eV_dVWWCedYRgVSW_^ RUVe` XGV4 YZVR_dSRI\ eYVZc cZXee`UVIZUVVceYV` dAgvdh YCV \\ eYV hR_ee` X_R_UY`h eYy hR_ee` XAeeYVCZ3f eeYVCVRV6EZ] f_}ZHVUERCAZEYV^ RZ_`_VYRd \\ RJCARU SW_^ V_eZ_VL+UERCZXe`XeeYVcUZEVCEZ Ze` R_REZ_ISFZLZ_Xac`[VEZY4 cREZVUZEVCEZ] % hZ] YRgVaf eU h_c` ed`_TVUV` TREJLAFS]ZTUSREVR_UTZZT aRceZZARZ_ RcVaRe` W4 YZVR_d \\ d'S[VEZEVV1 aVEZ/TVR_U` WAVZCZVR] Z RXV` VeYVyH WZ$



$H_{2}9 = ADCFH_{2}B79C: 7I = 7I$



7I@HF5@7<5B;9G



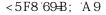
G7 9B 9G: FC A '85=@M@# 9

H YReZI4 YZWZZ RXWe UR OE YWZZL` d TZA eYReU Vd`eYRgVRdMWZ RXXŽ_R] d ced` VhiRj d. eYZiZ RXVV S`UZdZdd TTVdhdR_Udvývdd Zd WRcdR_U]`_XZ_XŽ eT ^ SZ_VdeYVWcd Zd f dR_U eYVZ_XRZ_WLackdV_eR_UaRtHLZZZZ_R_Uf_ZjŽ 2]]`VeYZIX Vde` ^ R.Vf a RaRczIf]Rc yZJW66 W eYVT f_eqjŽEYVdV a`cedJ RJddvgV e`Z_eVacvé eYV VIZtZ_X`dUALhYZV dY`hZ_XY`h Zd TR_SV f dkUR_U ViaVZZ_TVLŽE YZIZIhYRe Zlekć^ VUeYV yZ_RZ_Rj %6VRd TZAj`dUchYV&Sj Z_UZZLFRJd TR_cVT X_ZXVeVV dMgVdRdaRce`VRT ^ f_ZjŽ 6gvcj d TZ4j_T&RevdVvCZcMJWeYZ\Z_U`WJ_eYV&ZT aZtefcV`Wn/YReZeZth/YReZedYZde`g`YRdSW_ŁR_U hYRe\Z_U`WT`f_egiZehR_ede`SVT`^ VŽ

5B = A5; = B5FMC: 7 < = 29

HVh`_ EYV4YZVR_ WeSR] eVR YRdezZ f^aYURe]RetLR_UZ_DR_eZX aVa]V~`T\e` eYVA]RdR:eRZRWc[fde`_Vafca`dv4e`TV]VSdReV 4YZVdgZTe`gİZEYVTc`hUZI`gVd`j VLaV_dfa aRctZ_dVfa]`Uv4y=`_X]ZgV4YZV%aYVj TgHLizZd Z_XeYVaYdCVY`^VhZeYR_Vfa]VeZgVZ2dR`W 4YZVR_~RXdd'cXdZ_e`eYVdbfRcVR_UeVV`UU detWeJR`aZldYReeVCVLI]VRLZ_XcVdZV_ede`WRceYRe eYVTV/VScReZ_d^ZXYeUXX/_VCRVZ_e`R_RcTYjŁRd eYVjYRgVSWK&Ž2_U_`h eYVa`]ZVRcVXR]`aZ_X faŁecjZ_Xe`ckde`cV`dWŽCZXYeRhBjŁeYVdr´fed `WaRecZeZTacZUVR_UV_eYfdZrd`efc_e`Z_df]edŽ EYZTTf_ecj 5`Vd_`eYZ_XVgVcTYR_XOEYVcVZd RWZ_`V&YVyCVU2MahcRaaWUZ_R~RXLVackdZ_X dZ`f]eR_VfdjYZlacZUVReSVZ_X4YZJVR_R_UYZd ZVRehYReeYVTf_ecj deR_UdWZ

=``\Z_XRe eYVaZlef ckLeYVcVTR_SV_`UfSe eYVcVZlj`fc_Rz_RJZV_ezjŽEYVW_h`f]Ud3 d hZeY feYVdZReZ_+4YZVdR_UdWcd^VeYZAL R_Uj`f`]]_`h RS`feZeZWeYZ_XdX&ccfXYŽEYV 4YZVR_ZlR}XYeVdLYVh`f]Ud3LR_UR_jS`U hY`UVd_`edYRcVeYReT]]VTeZeVWJZXZL_` aRecZ eŽEYVT_ecRehZeY eYVyVcVZX_%bY`hVgVdL UVd_`eXfRR_eWRdec`_X_ReZ_R]ZV_ezjŽEYV V@ hY``SdvdZgVJjW]`hdeYVTYR_XZ_XVcef_Vd `WeYVW eSR] eVR^ RJ_`e}_UR_jeYZXe` ZV_eZjVhZeYVcZ_eYVTf_ecj`dYZb`cj`cZ_ Zed_ReZ_R] d^S`]eŽ



> j _R' VZt; VR_VéV> `_dR]gVR_UéVZtaZté dV hRdeR V_ hYV_: hRd`_ ^ j hBj é h` chŽ R]hBj d eg é]``\ ^ j SVdeSVIRf dV: UVR] hZeY éVVaf S]ZT R_USVIRf dV: gVR]hBj d]Z VUUckddZ XhV]]Ž h` ch W^ "! Z_ éVV^ `c_ZXé (Re_ZXYeZ R]RXV de` chZ_ eYVIV_eCVŽ `` #) R_U: YRgVRTYZJU` WŽ dAARREVUVØ' ^ j Yf dSR_UeVcWj VRcdRX, YVhRd e` ^ f TY` VR^ R]VTYRf gZ ZdeR_U: hR1 eX Z_X e` af ef a hZeY ZĚZ]ZgVZ_ R~ReZ_ > RZa ½ h YZTYZI d' R]] Sf ed&WR_UT]` dVe` ^ j a RV_ed Y`f ddŽ

: [ZV^ j h`c\SVIR dvZedr`hd: TR_ed\VTRV `W`jd\JXEYYJ dvdaVTe^VSVIR dveYJ _`h: U^j [`S R_UeYRe: ``RUVIV_eh`^R_Z`ed_`e VRd +d^VZ? Vdj`f`dVYR RdMUR_U`eYvch`^V_ U_edJ R_jeYZ_Xd Rd_`ee`]`dveYVZc[`SŽ3fe: h`_eSVaf drVURc`f_UZ: ^RvG dv: ``evVReVU ac`aVdj R_U_`S`Uj`dX Z_Xe`eR]\RS`fe^VeVV hc`_XhBjZ: ^ZXe defUj d^VeYZAd^VZ? VL ZW TR_VRc_^`dveYRehBjŽ7`c_`hZed^j d_ :``eYZ_VZ_XRS`feZ:`gVX eYZ`Z_R_fcdvgLSfe : TR_eaZI\YZ`faZ_eYVRAKc_``_dd YVdaV_Ud R]`e`V&Z`VRe^j aRv_edZ: hR_ee`XeYZ`R ?ZeV_U`__^j de`dVRULd`YVU Vd`eXeS`dVLZ



:_ Whef cMLR_j`_VhY` U`Vd_ĕ_`h 6_XJZHY R_U T ^ af eZ_XhZJ SVdef T\Ž

: $hV_e\dot{e} e\dot{e}V \wedge f_ZZaR_dY^{1}_RUR_hR_dUZJ$ $hV_{j}] e\dot{V}cVZ$: $YRUhYReZe\dot{e} \land R_U$: $hRdR_hR_jd$ $dMVT_{V}eZZTefR_jL_{X}^{2} ac fU `WhYRe:gV$ RYZ_gVZ : $ehR_deVR_j e XeR deVR_j [`SRAWC dARCRZ_XLhYRehZeYYR_ZXR \ZZ3fe: UZJZZ$ $: <math>^{7} cXR_ZVUR_U: \ `hYhe XeX `UT]`eVdd$ $Z_eVVd_VZZ_DRefdLgd: X e eVV Rc\eR_U d ^ VeZ Vd: X `fehZ_U hdd`aaZ_XhZeY ^j d Z_ eVV > RZaV4^R_jR_U hVYR_gV]f_TY Re > T5 `_RUCZ$

: eYZ \: ^ RcVRZdeSVIRf dV: _`h hYRe JZWZd R_U hYRe aV a]VRV JZVŽJ`f TR_`e ecf de eYV , eYY j`]] RhRj degi R_U eR VRLgR_eRXŽ: U_`e Xké Z_g`]gVUhZeY^j_VZXS`f cd R_U: `gV`_]j X e`_V VZV_UZ_ eYV dr`aŽH VeR]\ R_U d^ VeZ_Vdh VX `fee`X&Y c`_ Df_URJ dŽDYV dR_VgR_XJZRJ R_U dYV deR V_^ Ve`YVcTYf cTYŽE YY dW` e`SVX`U aV a]V hY`U_`e egi e` eR Vj`f Z_Ž: ed ekcZS]V eYV hRJ aV a]V ac eV_U e`SV d^ VeYZ_X eYY čV _`eŽ: ^ _`e cNZZZ f d.: ^ RSVZgVZŽ: SNZgVZ 8`USfe: U_`eX e`TYf cTYFf_]VcHeYVcVdRh VLI UZ_XŽ: YRCUJ X`fe_`hLaVcYRadVVc RT f dZ`d SZeYURJŽZTEF R]jL: YRV_`eZ Ve`^j dM`ZeeVV



^`de: hReIY RSZe`WAJ]j Reh W.V_UZD`^ VE`Vd : hReIY eYV_Vhdh YV_ eYVeVdSW_ RSZXc`SSVj `cd^VeYZ_XZ3fe: ^`_`eZ_eVeVdEWUZ_a`]ZZDZ : U_`ef_UVdeR_UZeR_U: U_`eTRVZ2e^`de: cVRUeYVDf_UBj aRaVcRe^j aRV_edZ JZ:VeVRUZ_X ^j Y`c`dT aVSVIRf d/ZeXVed^VeYZ_VZ_XRS`fe ^j dJVZV U_`eSVJZgVh YReZedBj dLSf eZeYVJadj`f dWh YRej`f RVZ

EYV^`decVhRdZ_XeYZ_XZ_^j]ZWZd^j d_Ž : * d`cqi : YRgV_`eX`e^ `dVeZ`Ve` daV_UhZeY YZ Ž h` ccj eYRed ^ VeYZ X^ ZXYeYRaaV_ e` YZ hYV_: ^ RhRjŽEYRedhYj : S`fXYeR^`SZJV aY_VLd eVV TR_XVe^ VdeRXXYeRhR ZVeYVCVd R_RTIZIV_eŽD^VUR; :U]ZVe`]VRgV^j[`S $R_U deR_V Re Y^{V} V d : TR_T_TV_ecReV^{V}$ YZdfaScZ_XZ_XŽ: U_ěhR_e^j ^`eYVc^ZVU faZ_eYReŽDYVdRSZe`]UVRAYZ_VUR_UUVd_e f_UkddR_UhYReeYVh`dJUdJZ.Ve`URJŽDYVU`Vd_`e ckR]ZkVeYkVRcVUfXdVgVjhYkVŽ2]]eVdVUfX RULZTedVZXYeV_^VŽEYVRVRd_`edRWR_j^`cVL eYRečdhYj:UdReYVcX`fee`eYV^R]]Ž:ečddRWL ZĕdRZfT_UZeZ_VUŁR_UZečdX e VgVg eYZ_X+dY adŁ ckdeRf cR_edLTZ_V RdR_UXR VdWc eYVTYZUcV_Ž : YRgVRX`UeZVeYV&Ž: cVRJZKVeYRe^V_RcV]``\Z_XRe^VŽEYV_d^V&?Vd: eeVRe^jd/]V&

d^VeYZ_XŽ: eYZ_\:UVdWcgVZZŽ:XVe^jdVJWd^V eYZ_X_ZIVŁVgV_ZVZe^VR_dchV_UZ_XRSZe^`CdŽ EYVR^`f_e:h`c\Ł:^_`eX_Z_Xe`SV`fdU_V Sj_eVV_VZXYS`fcdŽ:Wj`f_U_ě]``\X`UeYVdV UR_dtj`fčV_`S`UJŽ

: XXé SjŽ=ZWZd R ^ RIYZ VeYRe dr R]`hdj`f hY`]VZUY`f TR_e]``\RAKcj`f cd/]VŽ3fe: YRgV_`e X_Vf_UXdLXdaZeVQkuj eYZ_XŽ h`_edlj ZedSW_ VRJŽedYRdJe`X`_ZD ^ VeZ VdeYZdaRIV`VJZW Xkd^ VU h_Ž@_TV: hV_ee`eYVU Te`cSVIRfdV `W`j_VgVd: hRdd[VaZ_XdvR]j SRJjŽ9 Ve`]U ^ VZehRddedXdIR_U: hRde`d&VZeVRdJŽ3feY`h R`:XZXe`eR\VZeVRd]0

H × 9 7 I @H F 9 C : K C F?

EYV WeYV čYRd SW_RhREIY^R \K R] YZE JZWŽ 2 GRJaRORBA hREIY^R \KŽ9 Vd_\GYC^`g\UL_`e W^ GRJaRORBA L_`e\GY_W/ &Y_\ZXXS`f cY``U hY\&V eYV 4 R[R UV 4`^ a_dRIZ__1R_`_lac`}d ^RZ_Xd TZB d\Tf ZG R_UT&\UZE`cXR_ZARZ_/]\/e YZ_eYV^`_JY_WC R^`UV& Y`f d\Z9 Zl JZWYRd _`eSW_\Rd ZJ\RcdRX_YV]`&YZhZWhY_dVV WJ ZJ R_UeYY_T f]U_`exRe YVC bf Zl\]j_V_`f XY Re eYVY`daZRJŽE YReh`f]U_`e YRGVYRaa_WZ_ IR_&ZX LYVeYZ_\d eYY gVX e \GYG eYZ_XeV&Z 3f eYVIR_`edR_UeYVSf deJVR_UYRdV`V&YVIRaZ eRJŽE YVIZj_Zle``deXdWJ R_URXXVdZg\ZDZJLYV UZUX&YZld_Ze`R DR_&ZX f_Zg\dZjZ

EYVd_XRUFReVUZ_6T_`^ZtdR_UZd_`h R $^{\text{R}}$ R RXAC Z_ R $^{\text{VLZ}}$ $^{\text{Id}}$ dXAVU T $^{\text{A}}$ aR_jŽ9 V VRc_d dvgvdRJ eZ Vd^ `cVeYR_ YZH VREYVCU VeLR_U YZH WWW.dedYRgVV_RS[VUYZ' e` deRceRWR'Zj; R_USfj $RY f dVZ RCV2LV_eZR VZXYS f cY UZ9 Vh f U$]`gVe`X SRI\e`GRaRcRedtLSfeeYVcVRZejZd eYRe YVdZ_DR_eARX e`deRjŽ7`c YZ`ŁeYVTRaZeRj Zd]ZVRYfXVdfaVc^Rc\VehYVcVYV}_UdeyVSVde eYVT f_eqi YRde``WWZZ3V2ZV2LYVZdac`fU`W Y`h YVdT aWhZeY eYVf adR UU h_d`WeYV[`S ^ Rc\VeŽezlecfVeYReYVZl^ fTYSVeeVca|RIVUeYR_ YZdaReV_edR_UXrR_UaReV_edhV&VZ2]]eYVdR^VLYV RU^AZede`RWWZX`WZdVIfcZejŽEYVUV^R_Ud`_ YZ Reh`c\RVZTCVRdZXR]eYVeZ VŽ9VY aVd YVh`_`e]`dVYZd[`SSVTRfdVYV_`hdeYReeYVhR eYZ_XdRcVZeh`f]USVYRcUWcYZ'e`}_U`_VRd X`UŽ2]d ŁYZURY Zji cVda`_dSZZZZdRcVXc`hZ_XŽ

2) e`WYZdRRgi X\d`_YVR]eYZdrR_TVLdTZR dVffcZej aRj^V_edR_UeVV^`ϴRX\Ž2e]\RdeeYV TYZU&V_RV_`eRef_Zg\dzEj j\&Ž

EYVd_R/`ZVdYZIVNEYVCVCeYVUVUZNEZ_R_U aREZV_TVYVScZ_Xde`YZdTR]Z_XRdRhRETY^ R_VČ 2]eY f XY YVT f]U YRgVX e SVEeVc aRZUh`c\ŁYV R]hBj ddv RZ_VU eef Ve`YZdTYZUY`UU&R'``W a]Fj Z_XhZey & VŽAVCYRadVCeYZdCVRd_eYVd_ ZddZXYejj V_gZ f dRdhV]Ž9 ZUNNEYVCd]ZVYRdSW_ YRULSf eZEYRdRTJVRCjj UVj_VUZV/& gj ŽE YVd_Ł `_ eYV`eYVc YR_UŁYRd YRU e`TYR_XVV`a]`j Vc dkgVcRj eZ_VČZj TRaZEJZZ_X`_YZd`aa`cef_ZZd YV YRdSW_RSJVe`^R_VR a]RIVVCc YZ`dJVZ_ d TZGj Ž3f e eYVUZWKEV_e Rda VRedR_Uc`]VdZ_YZd JZWU`_`eRUUf a e`RTJVRcUZVTEZ_ŽF]eZ_ReVJjŁ YVh`f]USVYRCU af ee`Zee`dFj hY`YVhRdR_U hYReYZd]ZWR^`f_eVUe`Ž

H YV_ eYV aY e XRaYd`WWEYVc R_U d_ RV a]RIVUdZNSj dZNLd ^ V`WEYVUZWWC/TVdSVehW_ eYV`]U 4 YZV R_U eYV 4 YZV`We UBj TR_SVUZH TVc_VUŽ@_V`VEYVXXREXde TYR_XXd YRd`TTF ccVU Z_ eYVh`dU`Wh`c\LR_UZeZdaRe`VRh`dUhZN eV_UV_TjŽE YVVZd VgZV/TV eYRe dYZedZ_IES`fc cVJReZ_dYRgVWWWIedeYReRV^ fTY VXceYVdcXRIYI Z_XLZ`aZ_XZ_X`_ dTZAj cVJReZ_dYZed XV_VRJ]jŽ :_ 4 YZVLVKceYVc^`cVL_Vh ecV_Ud1JRS`fc^Rc\Ve UVcVf]ReZ_LVVcZdRE_TVLRvXgZ_XcZN_`e`_Jj e`_Vh_IZWdej JVeLSfee`_Vh hRjd`WJ`\Z_XRe dTZKej RdhVJJŽ

5 K C F@8 C: = A 5; 9G

=ZVe? f dr_Ud`WeYvć 4 YZWr_d Re eYZdeZ V `WURJ ŁdwD dr.8 dr.1Z/JR.R_UYvć Yf ds R_UYRgV dre U h_e`WreR_Ue`hReIY eVVgV_Z.X_Vh dž EYVj S`f XYe eYV eVJVgZZ_Sj Z_dr.]^V_ed eYdWj Vrcd RX, SWWCVeYRŁ eYY YRURSJRI\R_UhYZV`_VŽ :eZd_`ed T ^ ^ `__`h WceYVdke` `TIF aj eYV TV_edV`WeYVZZZ Xc`^ ŁSf ed V/Z vdZee/Reh Rj SVIRF dV drVTR_hREIY YVc Vrg`f cZeVac`XR`^ Vd RddVh`c\dž EYRe`_VZ_eYVR&Kc_``_ŁWc Zł drR_TVLhYZIY RJh Rj dYRdd ^ VcVR]jj f dvMj eZa dŽ 2]d ŁhREIYZ_XZe^ R.Vd YVc RaacVIZReV`eYVc aV a]Vdac`SJV`dŽDYVhREIYVd eYRe ac`XR`^ V `fe`WIF cZ dZj Ł`WI`f cdMLSf eRJd SVIRF dVZ=TR]Jd R drLVR drR.VŽ 2]d ŁZe ZIR T ^ Wce e`Yvc e`



eYZ_\eYRe^Z6Wcef_VTR_SWRJ]R_jS`UjŽ2_U`W TfcdMLdYV_VgVc^ZdMdYVcdRa`aVdRŽDYVXVed bfZeVh`c\Uufa [fdedWZ_XY`h eYVS`ddeeWed eYRej`f_Xh`^R_Ž9VcYfdSR_URccZeVdY^V RevLhYV_eYVd Ra`aVRZdR^`de`gVZEYVj de Uh_c2XYeRhRje`VReR_Ue`eR∖eYV_Vhd`gVZ :eZdaRce`WeYVZcc`feZ_Ve`XVeYVZ9VZd^`deZ_ł eVEV&EVUZ_eYVWeSR||LSfeeYV_VhdZlX`Ue`` Wc} UZX`fehYReZlYRaaVZXZ eYVTf eqiL eVVY]Uf a ZXYeZ $eV^{ZU}V WR eXX RU$ eYV dê c^dZ eYV difeYŽEY dV aZTefeVdeV ZU YZ `WYZELRF_e6]gZCRLhY`^ eYy gZZEVU eYV $d^{\wedge} CeYV Xe^{RcZUZEYV} eYV Xee^{XZX}$ RS`feeYVdZefReZ_`WeYV>RafTYVdŽHYjUZU_ĕ eYY Sf ZUaj d? Zd ZVeYV _ VdeYY d' hW _ $eV_V \notin ZZ_$]Rel DRef d.R OEY dV h V eV > R Rel. RaaReV_ejjŽD^ VeZ VdeVV hReIY U Tf^ V_eReZd `__RTf]efdR]TYR__V]+j `f]VRc_R]`eSj_dWZ_XY`h `eYVcTf_ecZkd]ZgVŽ

H ± 9 > C MG C : 7 C B G A DH€ B

@VK] $eYVecR_dVc^ ReZ_dZ_4YZVR_dTZkj Z_$ $eYV]Ret UVIRUA` VeYV ehV_eZeY TV_ef gLZe hRd$ $df cVj T_d^ aeZ_ eYRe TYR_XVU ^` deŽ4`_ł$ $df ^VzZf + Y`h RhVK] 3f e VgVg S`Uj hR_ed <math>e$





T_d^VLe`V_[`jeYVfdWM]R_Ua]VRR_eeYZ_Xd RgRZIRS]V`_eYV^Rc\VEZ@WTfdWL^R_j4YZVR_d dIRCTVjXkESjR_UYRgVec`fS]VVgV_RWXdLZ_XeYV SRZICŽ?`_VEYV[VdLeVVje`h`f]U]ZVe`SVZ_ Ra`dÆZ_e`dæZdyVeVZc_WUdR_UUVÆXVŽEYVAV Zdf_U`fSeVUjjR]`e`WT_daZff`fdT_df^aeZ_ hY`dV`_jjRZ`ZdUZWWAV_eZReZ_WV^eVAVde`W d`TZKġŽEYVAVZd_`eYZ_X_VhZ_eYZĚDZ_TVeYV ^Zd1_Z_VEW_eY`TV_efgLeYVDR_eZRX_VJZeVYRd SW_fdZ_XT_df^aeZ_EVREYZ_ERdRhBj`VAVd eZ_XZedNJVBaReWV^eYV@eYVdLeYVa``cR_UBJd eYVfahRdUjj^`SZVŽDZ_TVeYV_EUZWWAV_eZReZ_ deCREVXZdYRgVT^aV&UVceYVTRIYVe`WdejJV RUX`UeRDEXZ

4 c z z z h `WT_d h acZ_ R_UT_d h Vcd Zd cVR]j RZ VU ReeYVZ dfaa`dvU aRddZgZejŁeR\Z_X hYReZd`_`WWChZeY`feac`Uf`TZ_XR_jeYZ_X_VhŽ 2TT dZXe eYZdgZhLZUZgZfRIT_d^ Vd`c TZEZKY_łT_df^ Vcd TVRdV e` SV dy[VkVjZR_e RTe`cdL RXV_ed`WIYR_XXLTRaRS|V`WIY``dZ_XVXWj hYRe eYV hR_ee SVR_UUŽEYVTæZZZA ZdRolgveV `_VLSVIRFdVeYVeVTR_SV_`UV``TeRIj`cYfł ^ R_ UvgVj`a^ V_e h YvcV aV a]V YRgV]`de eYZd Z_WaV_W_TVR_UeYZIRSZZ; e` UVIZWhYReqiaV `W/ZWeYY hR_ee`]VRLŽ3feac`aVdj daVR\Z_XLZe Zdhc`_Xe`dVaRCReVac`UFTeZ_WV^ T_d*ał $eZ_{Z4} = d^{Z}ZdRaReeZfRchR, Watch UFTZZZ$? ` RTef R] `S[VTeZtac` Uf TVLLSf ecVacVdV_eReZ_d RS`fe`S[VTedReVTeVReVLŽAVa]VhY`gZZe^R]]d RVU ZX^` dveYR_ vX ZXdr aaZ XZZ YV Rdv $f dZ_X ac^{U} f Ted Rd d ^ S^]dL VZEYVc e^ cVacVdV_e$ eYV dygvde``eYVcdıy. YRgVX`UeRdeV‰`ce` S`]deVceYVZc`h_ZLVeZej 1y. UVdVcgVZe%Ž3jfd Z_XeVVac`UfTedRgRZRS]VZ_eYZdhRjLT_d^ Vcd X&VeYV^ R_Z_eVacVeReZ_R_UR^ VR_Z_XeYReReV _VgVcViRTelj hYReeYVac`UfTVcZ_eV_UVUŽ4`_dVi bfV_ejjŁT_df^ aeZ_ dr^ f]USVdW_ RdRhRj `W yac`UfTZX^VR_ZX0%eYRedvogVeLZ_ZedhRjŁe` XgVdX_ZTR_TVe`aVa]VdURZjj ZgVdŽ

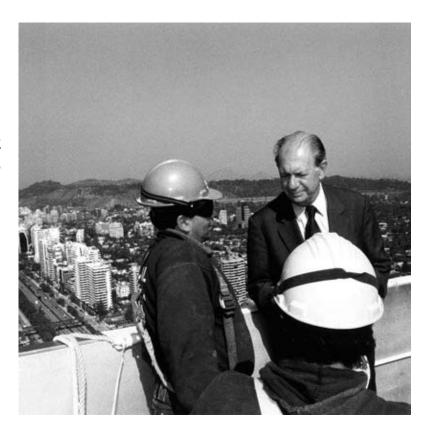
; @C 65 @A5 HC B. H 9 - 8 9B H HM-B HFC I 6@9

H YR&V& K YRaaV_VU e` & U h Z V R_U V` aR_R URD: d`fc Z J V_&Z j Z_ ec`fS]VOE YV a Z lef dV` WR YR` SfcX & U` V d_` eR] f U V`_] j e` eY V eY d Ree YRe Xj` SR Z R Z_ Z l d` aa` d U e` d a d V e W c_R Z_ R Tf] ef d V R_U Z J V_ & Z j Ž: e R] d` dY` h d eY V` Sg V d A eY V y_R Z_ R Z R Z _ % W J` SR Z R Z_ Sj` Z_U Z g Z f R] T f_ e Z d Ž: e Z l e f V eY R e Y V d Y V S d L U` W d` W U Z_ \ d R_U e d Z Z_ X d Y` V L e Y V d Y \)^ d R_U $\begin{aligned} & e^{V} dR^{V} V^{f} dZ LT R_SVWf_U gZ ef R | j R R c d e^{V} V \\ & a | R_VZ E YZ d U V _ e^{V} R_LY h V gV _ e^{V} R_Z & R V d \\ & d_{d} e^{V} e^{R} V R V _ A | S R T | e^{T} d^{W} Y^{A} S R V _ Z Z X \\ & V _ gV _ g W ^{A} & W R Z_R | V a d d Z _ Z E YVY R^{S} S f c X c \\ & Z | f d e R V d e^{V} V a c TV d V Z e^{V} Z d Z R Z_h H V d X _ J \\ & V _ e^{V} R Z _ R | V a d d Z _ Z E YVY R^{S} S f c X c \\ & Z | f d e R V d e^{V} V a c TV d V Z e^{V} Z d Z R Z_h H V d X _ J \\ & V _ e^{V} R Z _ R | T | e^{T} c V _ e^{V} Z d Z R Z _ h V d X _ J \\ & V _ e^{V} R Z _ R | T | e^{T} c V _ A R Z & V R | Z V \\ & S | R Z _ R | T | e^{T} c V _ d A Z & V \\ & S | R Z _ R | T | e^{T} c V _ d A Z & V \\ & A V e^{V} Z X e^{N} e Z | f c y h _ Z & V \\ & A V e^{V} Z X e^{N} e Z | f c y h _ Z & V \\ & Z | A R Z & V \\ & A R Z & V \\ & A V e^{V} U Z & e^{V} V - V & R Z & V \\ & A C U T e^{V} | f _ V W & Z \\ & A V e^{V} Z & V \\ & A C U T e^{V} | f _ V W & R U Z e^{V} e^{V} e^{T} Z & R T V \\ & V & X e d f d Z \\ \end{aligned}$

DVT_UJJ LeYV aZTET cV`VEYV YR`ST cXAC R]d dYULIR XAVRE UVR] `WJZXYE`_ eYV XRa SVAh W_ UZTT f cd/R_U acREZTVŽ@_ eYV`_VYR_ULaV a]V eV_Ue`ReeZTF]REVEYVZCUARIY^ V_eVA'^ `c cA[VII eZ_ `WhYRe eYVJ aVCTVZcVRTY^ V_eVA'^ `c cA[VII [VdtŽ@_ eYV` eYVL eYVJ RU'^ Ze eYRe YR`ST cXAdd RCVRTeT R]J aRe `V&YVZcURZJ [ZgVdŽ? `hLe` U `_VeYZ_XhYZ/VI]RZ Z_Xe` acWWCR_` eYVcZtIf dT R]J dW_ RdYJ a`TCZZTRZZ:_ eYZdTRALY` hVgVLZe ^ ZXYeSV^` cVZ_UZTRZZV VR]RI\`VJR_XFRXZE YV UZJVIFJej `Waf eeZ_X R_R` Ve` _Vh_VaVZZ_TVd TRF dAdaV a]Ve` cARZ_R_` c^ RezgVUZTT f cd/eYRe YRd_` acREZTR] WWWAL hYZVVVJ]`hZ_XR acREZTV hZeY_` UZTT f cdVŽ

Hk9'=A5; =B5FMC: 'Hk9'89AC7F5H≠7' GF5H9

EYV AcVOLIV e`WeYV CVaf S]ZT eR\\de` d^ V TZERKY_CZEYYZ RXVTR]dWceYUZWWCY_eCVRUZ_XCZ 7ZdejjŁeYVcVZleYVYZe cZR SRI\Xc f_UeYReRd d TZREVdeYVZ'RXV`W4YZVhZeYeVDeReVŽDZ_TV :_UVaV_UV_TVLeYV d`gVcVZX_ej``WeYV_ReZ_R DeRevYRdSW_ZeVch`gV_hZeYeYVac`UfTeZ_ $R_U \operatorname{CVac} Uf TeZ_ WR_ReZ_R$ Tf]ef $\operatorname{CVZ}:e Zd$ eYc`fXY^`cV`c]VddRdNceZgVDeReVRTeZ_eYReR_ RhRcV_Vdd`VwyHVLeYV4Y2JVR_d%YRdXc`h_faŽ 2_UeYV}XfcV`WeYVAcVdZV_edeZ]Z_g`\VdeYV $YZde q ~ WReZ_R ZWZE ~ UR Ley VZZZX^ V ~ q$ `W4YZVdeZ]dW^de`_`fcZfYZedN/W6V^ eYVDeReV RTéZ_ eYRe ac`XcVddZgVjj Z_eVXcReVU eYV UZVWCV_e d TZR Xc f adUf cZ_XeYVehV_eZeYTV_ef q Ž_eYZŁ $eYVYZde^{TR} ^{V} q^{Z}WTf dZ X^ R_R da VTe^{W}$ eYVDeReVeYRezd`VeW_f_UV&VdeZ'ReVU+zedd ^ S` [ZT



UZ: V_dZ_ŽEYVDEREVOJ^S`]ZKUCEYVF_Zj`WI TZR VIZEV_TVŽ7fceYVC^`CVLZEV^S`UZCEYVZ RXZ_Rj `WEYVYH W&XC`fXYhYZYY]]4YZVR_dTR_CVTXI _ZKVEYV^CMgVdRd^V^SVcd`VRT^^f_ZjLR_U EYV_TVZV_EXJVhZEYd^VEYZTR]JVU4YZVŽ

4`_dLWZ_XeVVc`]V`Wi`]ZZTdR_UeVVDReVZ T_def TeZ_XeVVT f_egiLZeYRde`SVRd\WhYVeVvc eVVL2`ZfeZ_`WeVVDReVdc`]VZ_dVTV_ejVRdYRd _`eSW_TYR_XZ_XeVVClackdV_eReZ_`W4YZVR d`TZIgiZ2deYVZ`RX/WeVVDReVSVT ^ Vd]VdTI]VRL eYVT`]]VTeZeVZ`RXZ_RCZdfdUUe`f_UkadR_UhYRe 4YZVZd^ZEVeSVhVR.V_Z_XRdhV]Z4R_^Rc\Ve ViaVeZy_TVdac`gZVRSREEWcclackdV_eZ_Xd`TZig R_UeYVZJNR`Wff_egiO

EYVaZlef cVR]d Vg`\VdR_Z`RW^VVV^`TdRIjŽ EYVAcV3LV_eZleR]\ZXe`h`c\Vcd_]ZdeV_ZXe` eYVZ:ac`S]V`dR_UVia]RZ_ZXeVV8`gVc_V_ečd a]R_dthYZVeYVj XgVeYVZ:`aZ_Z_KS`feeYVhRj eYVT f_egi ZdXZ_XZEYZdZ RXVVg`\VdR4YZV _`h_e`eYVh`dJUVcZed]`_XecRUZZ_`VVVi ^`TdRIjŽ=VdleYR_YRJVVVR]4YZVR_dY`hVgVL ViacVdt}c^ dfaa`ce VcUv^`TdRIjŽEYZdZl_`e eYVa]RIVe`Rd\hYReeYVIRfd/`VeYZdUZA/TYR_d ^V_e^ZXYeSVŽ.e^ZXYeSVUZRaa`Z_e^V_eReeYV $\label{eq:constraint} \begin{array}{l} VV2f cV^{V} VVV^{\ TCRIj} e^{VVa} Zdac^{\ A}ZM2L^{c} VVj \\ Z UZWWCV_TVŽH YRe Zl^{SgZ} f deeY^{f} XY2LeVVXa \\ dvaRReZ Xd^{TZkj} W^{\ A} a^{JZZDŽ} \end{array}$

 $5 V^{\ TCREZTZ_deZefeZ_dU^{Z}UWU^{a}VReVSj R$ T UVeYReZel_`egVcj cVda`_dZgVe`TZZKV_UV^ R_UDZ EYZclZel_`ed^ftY eVVTRUV hZeY aV aJVdycVR] ac`SJV^ dZz^defVd`VW^ a]`j^ V_eLYVRJeY R_UdV TfcZej U^XVeRYVRcZ_XVV^ eVVafSJZTRU^ Z_ZdecR $\begin{aligned} & \in \mathbb{Z}_{A} YRe \mathbb{Z}^{\wedge} (\mathbb{Z}^{\mathbb{Z}}) \\ & e \ ac \ S V \ de (\mathbb{Z}^{\vee}) \\ & de (\mathbb{Z}^{\vee}) \\ & (\mathbb{Z}^{\vee}) \\$

7 I @H F9 = B GI 6>97 H J 9 9 L D9 F = 9 B 7 9

EYVÓV ÓYZÁZIRCV]VR<u>ez</u>XSVYZUR WRYZZRC a Role $R_U f dV dZ XZ R_f T de Z We f dZ b de Z Ve V$ f_TVceRZ_ejL^R_j 4YZVR_dRcVZ_daZVUSj eYV `aa`cef_ZeZdeYReRcV`aV_Z_XfaŽEYVdVRcV aVa[VhY YRgVSVT ^ VW] aRceZZaR_edZ_eYV T f_eq dUvgV a^ V_eR_U_ h WW eYV dvgvde SVhZ_VcdŽEYZclZdeYVT f_eqi dyV_ecVacV_Vf cZR a` eV_{eZ} %Z3f e ^ R_j `eYVc 4 YZVR_dLaVcYRad eYV^R[`cZejŁWW]f_T^WceRS]VŽARcejjŁeYV/RCV T_WAANUŽEYVJTR_^fUUJVeYc`fXYZ_URZjj JZWL SfeeYV RCVSRAWUSj hYReZdX Z_X`_Z d TZAjŽ EYV/ cVR]ZkVeYReedRLZeZ_R]V3R^Vd`WcWWcV_TV RCV `WZEEVYMaZ_f_UkodeRUZXRWkefcVeYRe $Zd^{f}(x) = \frac{1}{2} $Z_Xf_T \wedge WeaRS$]VLd $\wedge VRVR_XjZ9jYb'k \setminus Yb'$ h\Y|f`|ff|lUhcb |gbchUfhW UhYXž|h|gghf_|b[

\ck Yl Wi XYX'a Ubm7\]YUbg2YY`2fca 1\Y` We'i blfmYgXYj Y`cda Ybh"=b Vch, WUgYgzï b! YUgYUbXUb[Yfz7\]Y]ggca Yh]b[fYa chY` 2fca ih.Ya "

AV a]VWW] Tf e`WWW)^ 4 YZ/VWc^ R_j c/Rd _d. S`eY^ Rev/ZR] R_UV`éZ_RJESf eeY/CVZl`_VeYRe dR_Ud`f eŽE YVWWJZ X`WQZ/ReZ_ dW^ de`SV Rdt TZRevU h ZeY UZ/VIF] ej Z_ ^ R.Z_X dV_dV`VeYV d TZRJ TYR_XdZ_ ac`XvdtŽ2_U eYZl YRd T_dA bf V_TVČŽ: WaV a]VTR_`e dW eYVa`Z e`VeYVdvL eYV_`_] eYVaRdedW^ de`SV}]]VU h ZeY^ VR_Z_XL h YZ/VeYVac/dV_e eV_Ud e`SV]]VU h ZeY^ VR_Z_XL h YZ/VeYVac/dV_e eV_Ud e`SV]ZeVU Rd ^ VeYZ_X bf ZeV^ VR_Z_XVdtLeZ_VdezZa/U`Va/vda/Tegy/ŽD Y`h TR_ dV_dVSV^ RU^`V/ZWOH YV_ eY/CVZL_` T^ aRdde`XfZ/JV kgV_edLXZ_X_`h YvC/Z2_U eYZlZ_UZeZLFR] VI a VZ/TV f] eZ_ReVj a`]]f e/d e/V XV_VRJ Re^ `da YvC/Z

EYVZ RXddf XXded ^ V`WrVbf Vdz_daV a]V `V&V_RA eYV dvgvdžEYVj eg e`UVj_VeYV dvgvd R_U }_U `fehY eYVjLeYV 4 YZVR_d.RvŽEYVj dRvjj RezIf]ReVR_j `WrYZLSf eeYVj_VgvCTVRdve af klyV `gvc eYVR_dh Vdž2d VUR UZvTebf Vdz_L aV a]VeV_Ue`daVR. `VgZdf Vd`c V&F jederYy dvRvV hZeY `eYVcd.`V&V_daVR_Z.X `WY`h UVAc^ Z_VLL `c]RijL4 YZVR_dRvŽEYVbf Vdz_ `VyhY`hVRv%uo `_eYV`eYVcYR_ULcVjRevde`eYVhVS `VVAJRZ_l dvZadeYRe4 YZVR_dTcVRevR` `_XeYV dvgvdŽ:eZd RS`feeYVd TZR] eZdR` `_XaV a]VR_U eYVT]ł]VTeZVCAcVd/_deZ_ `VeVVdvZ2_UZ:ZteYZteYRe d₩ de` SV<u>Z</u> U f SeŽ

 $@_V`WeVbfVdz_d^`de`V&V_RdvUzdhYRe$ dked 4 YZVRaRoeŽ2dS`dUkdT ^ VU`h_ R_U Vgi Vgi eYZXSVT ^ Vdd'S[VTee`TYR_XkL_`e`_]j eVV X`UdZ_eVVd^adSfeeYV^`deoZ Vh`c_YRSZedL ZeZlYRdUk R_U YRUVc'e`dsj hYReZdaVff]Zc e` 4 YZVŽ@_Vd ^ S`]`VZ_ecfdgVV&VZX_VdtZleYV YR`SfcXkZAKETVgVURd ^ VeYZXRJZ/_R_UZ_gR dgvLZeZd_`_VeVVkdR_Ze&XcR] aRe`VVR2j JZVŽ EYVR`SZgR]V_TVZHIJVRŽH YZVZeZdUV_`f_TVURd [f_\W ULZeWc^daRe`W R_j 4 YZVR_d_`c^ R] UZ&ZEYZdeReV`VRWZdZd_VhLSfeeYVIRd/ VeYV YR`SfcXkZZNRCW^ VITVacZ_RJZ.eUV``_dedRekdL Z_aRoeZff]RLeYReXj`SRJZREZ_T_dZbd_`e`_]j Z_VeVc_R] ac`TVdtkdLSfeZ_eYVZeVZcXZrZ_`W eYVdVSj 4 YZVR_d TZ6jŽ

EYVWZ Z_A]RkR:eR]ZReYcZ]de`eYVVia]`Zed`W eYV4 YZVR_ eVR^ R_UhdRadYZ dMVZ_ eYV_ReZ_R $\sim RXZB f VdeZ _ZX` VbiYReZdy4 YZVR_%decZVdYZ`$ Rd`UUŽ7`cYZ`ŁeYV_ReZ_RJobaZZe`SgZfdjViZtedŽ 9 VZdZ__`UfSeeYReYVZd4 YZvR_R_USVj`_Xde` $RT^{\uparrow} f_Z = Z = Z = Z = Z = R = Z =$ _ZejeV_Ude`hRdudgRXfV_VddLY`hVgVvZEYVVRY_d d'TZRJWRScZTS`ZJdU'h_e`YZclcVJReZ_dYZadhZeY W] h df aa celved Z eYVW eSR] deRLZ ^ ŽEYZd eczsvzewdyz Ra`hvewnjwwyz_X`Wervevsvz_X RyHWZA`]]VIezeVZV_ezejdW^de`SVRIezePeVU Sj Rac`TVdd`VW^`eZ_RJVKdZ_ReViedRdJZ_Rdj ^`^V_edŽ3feeYZdZ'RXZ_Rcj`VRxyHV%bJ'Vd_`e Z`a]j eYVZNR`WRydfS[VTe%LaRdy]WeVjZR_eRTe`c \underline{Z} d \underline{TZ} U]b`mž Vi hcbY h UhgYYa g`hc 'VY XfU]bYX' cZUbmiYl dYf]YbWY cZgcWYhm' EYVWZŁ]ZV $^{R}_{II}$ 4 YZVR_dLU Vd_`e}_UZ_YZdURZji c`f eZV eYVejaV`WaTZRJS`_UeYReh`f]UV_RSJVYZ'e` T_TVZeV`WalTZAGi RolRT]]VTeZeVofS[VTeŽHZeV`fe eYRe Via VZZ/TV` VR_ REZEV d TZAjŁeY VZNR` VR Sc`RUAC4YZWR_ZUV_eZejZelhVR\V_VUŽ

:eZL_`e[fdeeYVUY R_Ud`WY\c[`S eYRe`g\d hYV]^ ;\R__VeeV> `_dRg\Z6gV_^`cVeYR_eYZE ZcZleYVUZ/VIF]ej `W_UZ_XR^ \R_Z_XZ_Y\cURZj \{ZeV_T\ZJ\edYVIR__`ede`a eg Z_Xe`^ R_VdV_dV `\YZWZ:eZL_`eV_`fXY\VcY\ce`U`Y\c[`S hV]]E `cSVRX`UTZZKV_hY``SVjdeYVd`]\EL`c\gV_R X`U^`eY\chY`afedY\c\R^Zj } ddŽ@g\cR_U RS`gVeYVUZXWWEV_ec`]VdeYReVRIYaVcd_aVcVc^d. eYVcVZIRUV^R_UWc^VR_ZXŽ9f^R_SVZ_XdYRgV e`XgV^VR_ZXe`eYVZcVIZEV_TVe`T_deZfeV eYV^dvJgVdRdR_ZUZgZtfR]y.%Z_cVJREZ_e`eYV @eYVčZ_UeYVjTR_`e^R_Vdv_dv`VJZW`fedZV RdTZEJT_eVieŽ

9 `h ZdeYV Via VoZ/_TV `WURZj [ZW}]]VU hZeY ^ VR Z XOEYV&V ReV a VZ Ud h YV_eYZd ^ VR Z X ZdeR\V_WcXxR_eVUŽ2_UeYVcVRcVeZ_VdhYV_ \mathbb{Z} SVT ^ Vd R ac SJV Ž; $\mathbb{V}_{\mathcal{L}}$ VeV > $\mathcal{L}_{\mathcal{R}}$ UZicZV_eVUR_Ua`hVcfVcdle`R_chVcTVceRZ_VV_UR ^ V_eR| bf VdeZ_dRS`feYf^ R_ ViZdeV_TVŽE` deRce hZeyŁhYRedY`f]UdVU`0:eZdRh`ccjdV`WW WM/dŽC`feZ_VRdYVcUR;łe`łUR; |ZWZŁdYV_VgVc de`adh`_UVcZXhYVeYVcdVVZlUZXeYVcZXYe eYZ_XŽH YRedY f |U: U 02_UeYVydY f |U%bf Vd eZ_Z`a]ZdeYVyhR_e%bofVdeZ_Ž:deYZdcVR]j hYRe : hR_ee`UOHYjŁdVeYZ\dLTR_eYVch`c\ZX Y f cdSVTYR_XUd eYRedYVTR_X\eY ^ VZ eZ V e X R UalR Z eYVdof RcVhZeY YVcd_0; VR ł _VeeV>`_dRgVhR_edTYR_XVLSfedYVdV_dVdeYRe eYZdZdSVj`_UYVca`hVcZDYVaVcTVZgVdeYReZeZd eYVhR, d'TZkáj Zd`cXR_ZkVUeYReUVéVc^Z_VdhYRe Zdya`ddS]VZZ_UdYVX|Z'advdY`hR]Z/_dvR]Z;jZd e`YV&LR_UY`h a`hVc]VcdddYVZZŽ

 $EYV_j f_X R_RX_c R_d Z RX_V R UZXXCV_e$ $hRj \ WZWZ:eZdXWReVc~ViZSZZej \ WVa]j^Ve$ YVhR_edLY`hVgVdLcReYVc.eYR_`Vhi`c\Z_XY`f cdŽ 9 VZdeZVU`WeYVT_deR_eYfccj_R_UZ_dVTfcZejŽ 9 Vh`f]U]Z.Ve`X\\eRhRj W/^ eYVa`]]feZ_R_U devldd`WDR_026XXŽ2dYVT_dZUlddhYRee`ULYV eYZ_\d_`e`_]j RS`feVT_`^ZTT dedR_USV_VjeeL SfeRjd RS`feeYV\Z_U`W/ZWYVh`f]U]ZVe` $VRUŽF]eZ ReV_j LYVZlecj Z_Xe h`c\`feyhY`:$ R^ %ZEYVac`TVdd`VZ_UZeZLFRJZReZ_ ^ VR_deYRe √g√g S`Uj YRde`h`c\eYZd`feWceYV^ dyg√dŽEYZd \underline{Z} g`]gVdR_V_`c^`fdWWW.deZ_RdTZXej]ZV4YZVdŽ H\Y`Zcfa Uhcb`cZh\Y`gY`ZWUb`VY`YI Wi W! Uhlb["'GYZXYÚb]hcb'UbX'gYZfYU`]nUhlcb' \UjY`bYjYf`VYYb`YUgm":_UZgZfRjd_WUe` dR_URIZVW/^ eYV dMgvdR_U]``\ ReeVZc]Zgvd hZeYZ_eYVZcdTZR|T_eViee`dWhYRe`aeZ_dRcV Reprziks [VŽH YVeYVceYVj RcVRh RcV` Vze` c_` eh YV_ eYV/R_Rj dveYVZcgRf VdR_UUv2Zv2LeYV`aa`cef_Z eZdReRZRS [VR_UeYV]ZVjj cZhdZ_UZeZJFRddvARU

eYV dygväRd[^] V[°]SVa[°]WiTZkjŽEYVZ:Rdväd[^]V_e [°]WiYReZda[°]ddZjVR_UjZ:VjiL[°]WiYReeYVjhR_e e[°]U R_UhYReeYVjTR_R_Uda[°]fjUULR:VaRae [°]WeYVdTZRjh[°]dUeVyjZzVZŽ

 $\label{eq:starting} \begin{aligned} &3fehYRe ckl fcTkl^ ZXYe SVR9R4RS]VZ_eYRe \\ &d TZkj_Wc T_W_eZ_X eYVTYR]V_Xkl^WZ_UZ \\ &gZIFRJZREZ_OAV a]VakCIVZgV eYRe eYVacklif ckl \\ `Wh`c\ R_UT_df^aeZ_LeYVZ ckla`_dSZZj \\ &Wc ScZ_XZ_Xfa eYVZ TYZUV_ R_UeYVZ WRckWc \\ &eYVZ `h_YKR]eYX e`^R_Vfa R_R]]T_d^ZX \\ &y^RIYZ_WZe_]j_hYV_eYJ_RV cklift UW hZY \\ &eYVZ `h_W^ZZdU eYJ_WJ eYJ_YRgVWf_UR \\ &cWkXZ3feZZRacXIR:Zfd`_VZHZYURhZXZe` \\ &RacZgReVh`d]UZl_`ac`eYRZ_Ze_ eYVT_eRgiL \\ &Ze^VR_dXZZj `WI_2eRiZ_Z$

EYV&VaY e`X&PaYd dr`h eYRe eYV bf V&E_`W eYVydy]V&&W&dSRT\e`eYV bf V&E_`WyhY`hV RV%&R_U eYRe eYVZ:RXV`V&YVyH V&acV&f aa`dd R_VfaVZ_TV`V&TZ&jZJVRcdRX`L eYV yf_Zj‰ `W4YZJVR_d TZ&jhRdR&S``d'S[VT&T]`dvU e` UVSReVLdZ_TVUZgVcdZjhRdT_~ReVUhZeYUZd dvZ ?`hŁ`_ eV eYkYŁ Ud TZ Uźykt j dW d_`d ^ R] R_U_Rf dZ YVh VR V Z X`Wkt Z f_Z X WEIVL d'TY RdeYV_RZ_R] DREVR_UeVV4 RY´]ZT 4 Yf cIYL YR d' ^ SZ_W hZY R_ f ad cXV Z_UZW WEV eZ Z_ ac`Tktkkle`d/ReeVceYVYRSZ LZW WEV eZ Z_ ac`Tktkkle`d/ReeVceYVYRSZ LZW R_US`_LtdeYReeYkWkEIKdYRUZ_dE f eZ_RZ kUZ_ eYVyf_Z j %%W4 YZ VR_d TZ ij Z 5 g bY j Yf VYZ fY ż h Y a i 'hd`]WImc Z]bhYf Yg g UbX 'VY`]YZ j c Z c d]b]c bg`UbX`dfYZ yf YbW g z`]g`VYW ca]b[` WYUf''Cc WU`X]j Yf g]mi`Ug VYW ca Y`Vch`U` XYa c bg fUVY'Z WhUbX`Ub`Ug d]fUhjc b"

9 `h TR_ RdYRVU `dVcSVSc`f XYe`f e` V&ZD 7 cRa]f dZ&ZT`dVce`SVT&V&VU`f e` V&RZG IeYVV_WUde`SVd ^ VhYVVHYVVAVVUZWV/TI VdTR_ SV_VX eZ&VUR_URXW V_eCVRTYVUŽE YV ^ f]eZa]ZZg` `Wd TZG ZIRezTf]ReVLUV&Y`aVUR_U X&V_T YVV_TVhYV_RYT ^ ^ `_h`dU%vIZ&HR T_eVIed/RVU_`e[fdehZeY`f cT_eV`a`dRZdL Sf ehZeY eY`dVhY`TR`VSWVVf dR_UeY`dVhY` hZ] T ^ VRAVČZE YZI yT ^ ^ f_Zg`%ZI XV_VReVU acZ`RZJ; Z_eh`daYV&VZ 3f e S`eY YRgV f_UVX_V V_`c^`f dTYR_XXZ

 $\hat{I} = Zh_b[b_b[UVci hW h fU^{Y}]XYbhhmX]X'bchdfc!$ $j [XY'i gk]h^UmUfXghW_Zcf'Xc]b['h}b[gk Y^{V}YfY$ ʿUbXˈbck ž]hk ci ʿXʿU`k UngʻVY UʻgYWcbXUfma Ułł¥fž cZa]bcf`]bh¥fYgh'İ

DYXfc 'A c fUbXfž% - \$"



< I A 5 B 89J 90 DA 98 H5 B 8 7 I 0 H F9



H 9.7 < 5 @ 9B; 9C: 7I @ HF9

 $2 XJR_TVRe 4 YZVR_d TZRJ acRE6ZIVdcVgVRJdeh`$ $eV_UV_TZVCZ 7Zcdejj ŁeYVZ RXV`WeYV yH V%eYRe$ $V_RSJVd a V aJV e` WWJ aRce`WR T]]VI6ZgV RIe`c$ $dW^ de` SV h VR.ŽDVT_Uj ŁeYZd Raa VRcd e` SV$ $T__VI6VU hZEY eYV UZAVIF Jej ^ R_j Z_UZGZUF RJd$ $YRgVZ_VI a VCZV_TZ_X d TZZGj Z_R T_TCVEV hBJŁ$ $ZZZLZ_VI a VCZV_TZ_X eYV ecf de R_U VCZV_U2AZŁeYV$ $cVT X_ZZ_ R_U RWWREZ_ eYRe X e` ^ R.Vf a eYV$ d TZRJ VRScZIŽ

 $\label{eq:states} \begin{aligned} & \text{SVIR}^{\text{C}} dV^{\text{VeV}} dV & \text{VZ}$

`TTFcdhYV_eYVZdR^Zf`ReTYSVehW_eYVdV eh`UZ`V_dZ_d`WdTZR]VJaVGZ/TVŽAVa]VU _`eVJaVGZ/TV]ZWZ_dTZKejhZeY`fecWWCV_TVe RckácVdV_eReZ_`WdTZKejŽ4`_gVcdVjLeYVjhZ] _`eUVgVj`aR_jZ`RXZ_Rej`V&YVyHV‰fecZLV`W eYVZcdTZR]VJaVGZ/TVČZ

:_ eYVIRd/`W4YZ/JeYZlac`UFTeZ_R_Uc/ac`ł UFTeZ_`Wd TZAj ZleYhReWZ6gV_hYV_4YZ/W_d ReV_`eRhReV`WZELTF]efd?]TYR_XXdReVYRgZ_XR UZEVTeZ`aRTe`_ eYVZ:URZj [Zg/dZ6gVj`_VRXWEL hYVeYVceYVj Raac`gV`cUZRaac`g/LeYReeYVdj [V `Wd TZE]Z_eVRTeZ_YRdf_UVX_VR^R[`cd/ZGZ 7Zchelj Ł_Vh of S[VISZgV Via VSZ/TVd YRgV TR]]VU ZYVSZENU Z RXVd`Ven VyH V%Z e`bf Vatz _ŽEYZd hVR_Vdd Z erVVT]]VISZgV Z RXZ Roj ol W de`SV ^ R.Z.X Ze YRCU & Wc 4 YZVR_de`WV] erVj RcV aRceZTZa Rez X.Z_ erV d`TZd] TYR_XVd f_U/c h IgŽ DVT _U]jŁ^ R_j aV a]Vd RTef R] Via VSZ/TV`W d`TZdj ol W de`YRgV SW_ f_U/c^ Z VU Rdh V]Ž 2dR cvf]eL Ze ZISVT ^ Z XYRCU ce`c XR_ZEV erV UZgvozej `WZ RYZ RZDARc f_URT]]VISZgV yH V Zo EYRe Zdh Yj Tf]ef cV^ Revoz

EYZELR_RJj dZela`Z_ede`RW_UR^V_eRJ eRd\Wc eYVT ^ Z_Xj VRodŽ2dZeRaac`RIYVdZed3ZIV_eV_RcjŁ 4 YZJV ZelWRIVU hZeY R_ReZ_lSf ZLZ_XTYR]V_XIŽ > WeZ_XeYZELhZ] ^ VR_T_decf TeZ_XRyH WeeYRe YRdeYVa`eV_e2R]e`XgVc_eYVVfVefcVŽ

E` TEVREV EYZI YH V%Rd R UCZEVE `WYF ^ R_ UVGV]`a^ V_eL4YZJVR_dhZ]_WU e` aVEWE^ R eh`WJUeRENŽ7ZdeljLeYVJ hZ]_WU e` aVEWE^ R eh`WJUERENŽ7ZdeljLeYVJ hZ]_WU e` XV_VEREVR_ Z` RXZ_Rg` `WiTZIG RdRT]]VIEZEVRIE dLEYC f XY hYZY 4YZJVR_d TZIG TR_CVT X_ZXZedN/McHRyH V‰ TRARS]V`WMRAZ_XZedUVEZ_jŽDVT_UJjLac UTZ_X Rdec`_XZ_RX/`WYZJVH V‰ VR_d4YZJVR_dSVZ_X RS]V e` UVGV]`a R_ VIaVZJ_TV`WiTZIG Z_ eYZc URJ le`lURJ d'TZI] CVJRZ_dZZeŽ7` ceYZle` YRaaV_L aV a]V_WU e` cXR_ZXVEVVZcUZWWEV_eVIaVZZ_TVd Rc`f_URT ^ `_ h`dJUReeVVd? Ve2' VRdeYVJ Z_TEVREVEVZcZ_UZgZIFRJ VXVU ^ Ž

7 I @H F9 5 G 5 DFC 6@A

2 XRa YRd`aV_Wf a SV:hW_ 4 YZ, W da V:d_[]]Z; V:dR_UeYVd TZG eYY]Z; VZ LR_UZ :hZ] SVUZW } Tf]ee T]`dZ:eZiZ_UZREZ; VVRTf]ef dR_UV TZL SVIRf d/Tf]ef dVZ:h YRe T&RevdeYVT _UZZ_dWc T_eRIehZeY@eYVdR_UScZ_XdaV a]Ve X&YVcZ Rd/R:VUhB;`V/ZWZE YVhB; dZ_hYZIY Yf^ R_SV Z X:l]Z; Ve X&YvcZ_Xc f adZl_`eacUV&c^Z_US; _Ref dV eYY YR; Ve Z.gV_eR_UU&; a eYV hZY eYVZ:aVddZE`d c; Z; dR_UX; hYReeYY RdzZV e Le`V V:TZVeYVZ:V`eZ_dR_UX; X; Zi]R:Z_L Yf^ R_ JZW]RI\d^ VR_Z X R_U T_dR_ej RLRaeZ, X RT^^`_ hB;`WZWZ: eYV^`de TYR:RIe&Z; Zi Yf^ R_ RIZZ; Z

EYVV&^ deR.V_Sj d TZG dyReZ_dvZadRv/ fTY ^`dveYR_RadRieZIR] WRIe ^`dveYR_Rdve`VkXdWI ^V_edR_Uac`TWLF dvdWcV_df dZ XeYVf dvgZgR]`W VRIYZ_UZgZLF RŽŽ3j`dXR_ZKZ_XeYV^dvlgVdLYf^ R_ SVZ_Xd drezdyVeYVZc^`de adddZ_X dvbf ZV^V_e+R ^VR_Z_X e`]ZgV WdLR_ZJV_eZej e`dVT X_ZkV eYV^dvlgVd SjLR_U UZX_Zej e`dVJReV e`@eYVdŽ 7`c eYZd dVRd_LeYV dX_Z; TReZ_ R_U adRieZTV`W d TZRJ dvJReZ_dvZad YRgVSW_ReeYVTV_etV`WeYV daZzef R] R_UZ_eVJ[VIEF R] WWked`WYf^ R_Xcf ad W^ eYVeZ VI WAYVROJI Yf_eVIXReYV&VadhY Wf_U^ VR_ZXde` cXR_ZWeYVZ JZvdSj Z_Z RXd `WRf cVLfae` eYVacdV_eUJthZY ZdUNSRAd RS`feeYV^ VR_ZX`WZZXV_dZaR_UUV^ `TRTJ Re ReZ V`WA`SRJZREZ_ŽEYVcVf]eL`gvceYVT fodv `WYZde`gLYRdSW_ XcVReUZgvcdZj R_U^fdSZJ Zg`Z_d TZA`cVJReZ_dZadŽH.Uh`Jg`W`h`fY.h`Y` dUffJW`Uf`k UmJb`k \JW.U`gcWJYhmYI dYf]! YbWYg`Jg`gcWJU`YI JghYbWYZUbX`h`Y`k UmJh WebWYJj Yg`cZUbX`fYdfYgYblg`Jh

H ZY IF JET CALAV A JVT J VIEZYJ ST ZUEVN' OU eYJ JZVZ ŁVI A VZV_TZ_XEVV OLGYORIST ZUVCI W eYREN' C UŽCVT X_ZZ_ `VEYVGZET_WUVCIF JET CV ZIZ dARCES VVV ^ EYVCVT X_ZZ_ eYREZ UZGZIF J RJdRVCT S [VIEČCI V YWg UFY 'N c gY 'k \ c `cc_` k]h]b h Ya gY j YgZ f h Y c f][]b UbX a YUb!]b[`cZh Y]f`UWJc bg`i dcb 'h Y 'k c f XZ UbX' k \c`\Uj Y 'h Y 'VC `YWJ Y 'VC bX]Jc bg`h Ym bYYX hc 'VC bWY J Y 'UbX YI YW HY 'h YgY'' 2_U h YREZI' VR_ESj d'S [VIEZZEJ ZLEYVCH YCVZ h YZY d'S [VIEd ReVT_dEZ dcV-VIZ_dUVZVZ

H YRe eYV F_ZeW ? ReZ_d.R_U da VIZXXIR]j eYV F_ZeW ? ReZ_d 6Uf TReZ_R]LDIZ/eZ T R_U 4f]ef cR] @cXR_ZERZ_ 1F ? 6D4 @/Lf_UkdeR_U Sj Tf]ef $dVZ_RSc RU dV_dV RV eVV Wc^{A} deRVV$ $Sj JZWZ_d TZ4jZE YVRZ `VeVZIRaac RIY ZIacVi$ $dTcZa62gVdRYVceYR_R_Rj eZRJŽ2_j Tf]ef dR] Vi acVd$ $dZ_UVdVgVdcVdaVTeRdRYf^R_TcVReZ_R_URdR$ $T_ecZSf eZ_e UZgVdZjESf eZeRd TR_R_U^f de$ SV def UZU e`dWY`h VRc Ze UvgVj`ad R d TZ4j`d $d S[VT62gZej R_U^R_Vdfd S[VTed`VVZed^V SVdŽ$ $EYZIZIhYj Yf^R_UvgVj`a^VeZII]`dVj JZ_VUe`$ $Tf]ef cVZ9 f^R_UvgVj`a^Ve^VR_deYVI eV_dZ_$ $`VZ_UZgZIFR]dR_UeYVZcT^^f_ZZdT`aa`cef_Z$ $eZdR_URSZZej e`SVT^VdfS[VTedR_USV_VjeVV'$ $eYVZc`h_UvgVj`a^VeZ$

AV a VSVT ^ Vdf S VTedRdeYVdvdf le`VRT ^ a VI Z_ek/a]RJ_SVehW_eYVZcaVcd_RJ_YZde`cZkdR_UeYVZc ViaVEZ/TV`VolTZ6jŽ2]]Z_UZ6ZLFRjdReVS`c_R_U Uvgy a hzeyz Vizez Xd Tzezdze Yvzc aa ceft _ZZZdWcSVT^Z_XdfS[VTeeLR_UeYVT_deeRZ_ed eYV/WAVZ_eYZdcVdaVIdLhZ]eYVCWVCVU/aV_U`_ eYV giaV`Wd TZkgŽ:e ZdeYc fXY eYVZ RXZ_Rgi `WalTZAG eYReaVa]VdVTX_ZAVR_UdvR]ZAVeYV ł dygvdRdaRce`VRdTZkjŽ4`_gvdyjŁZeZleYR_\d e`eYVZcViaVZZ_TV`WdTZKejeYReZ_UZeZLfRjdTeVReV $RcVacVdV_{eReZ}$ `VeVV $dMgVdRdRT ^ f_ZjZ5$ ` We YWH Y a U bUfm g h Y gYhc Z XYU cf gna Vc`]WfYdfYgYbhUhcbgk \YfYVmh\YVU! g]gžX]fYW]cbUbXaYUb]b[cZhYfYUh]cb! g\]dg'Ua cb['h\Y'a Ya VYfg'cZU'[fci d'cf' gc WYhmUfY XYÚbYX" EYVT]]VTégVZ RXZ Roj Zd _VZeYVcR_Z]fdZ__`cRW2_eRdŽ@_eVVT_ecRcjŁ ZeZdRoW] aYV_`^V_`_Ž6gVgi d'TZVgi ac`[VTedR_ Z'RW^`WZeM/WR_UZeZdeYc`fXYeYZIZ'RVZ_Rgi eYRe ZeoVT X_ZXUZZeM/WRdRT YVoV_eXc`faŽ

4 `][VIEZEVZ RZZ RZZGEV_Ue SVT ^ Vd ^ Vh YRe UVERTYUV& ^ eVgRRZG WRZ J ZWETG dR]ZZZ X Z `dl `ch ZEV_ edl ZZ _d. ZEF RJdR_Uh `cd `W Red Z dEF eZ _dR_U]R_XFRXZ; f de RdZeZdV S`U ZUZ_ eVV& d`VRTZ j LeVT]]VIEZEVZ RZ_Rj dkd Zd dR] `_ VgVg acReZIR] Rd VIe `Wd TZR `cXR_ZREZ_ŽF JeZ REVJ LY h VgVL eV gZRZ j `W T]]VIEZEVZ RZ RZ d ZdZ eVVC RSZZ e`XgV ^ VR_Z Xe aV a]VdRIef R] V a VZ/TVdZ_UZ J ZWŽ E YF d SVh W_ aVd_R] d'S[VIEZE RZ RJ e' XgV Z RZ Rj eYVVRV]Z d`W f ef R] U a V_U TVL T _T dR_TV `c T _eRUZIEZ_ŽE YZd c/ReZ_dYZ UZZVdeVIF Jef cR] U_R ZT `VRd TZG Z

GI 6>97 HJ ≠M5B8 A C 89FB + 5 H€ B. H 9 D9FGD97 HJ 9 C : H 9 < I A 5B 89J 9@ DA 9B HF9DC FHG = B 7 < =@

EYVTF]ef dl hVR_Vdl `W4 YZV YRd]Vdl e`U hZey eYVUZRaaVRR_TV`c_W3VTe`W1^V`VZed ed UZZ_deYR_hZey eYVUZIVTF]ej `WVdeVZ_XT]]VTeZgVZ RZZRZdeYReeR]j hZey VgVg U3_VaV cZ/TVŽ:eZl_`eeYRe^`U\c_ZRZZ_ZUVde`j Z_X TF]ef cV_deYVdLeYVdaVTZ_TVc^Ze YRd eRV_Z 4 YZVR_U eYVCAcVdV_deZ_deYRe RTT^aR_j Ze RVRYZ_UR_TVe`eYVT_deZef eZ_`V&Vcd_R] R_U T]]VTeZgVd S[VTedZeZ VR_U RXRZ_L9 f^R_5 V gV]`a^V_eCVa`cedZ_4 YZVYRgV^RUVeYZTeYVZ TV_ecR]T_TVc_Ž :_ "**' ŁéVV) cceCVá` cedEeVUé/ReyeYVTYR_Xdd `V&VTV_ej VRcdYRgVaRceZff [Rc]j RWWTEVU VgVcj URj [ZW R_U d TZSSZZcj Ł R]`_X h ZeY eYV W? Zj R_U T ^ f_zj WScZT R_U aV a]Vd gRff Vd R_U Z.V.} $eZXVZEYV CVá` ce Wf_U eYReL Rd eYV W? Zj R_V$ $YRU eRV_ a]RTVL yeYV 4 YZ VR_ d TZAJ WScZTL YRgł$ $Z_XUVgV]` a VUZ_bf R_eZEREZGV eVc^ dL_`h cVbf ZVd$ $bf RZEREZGVZ' ac` gV V_eZEYV cf XXX deVU cV VUj$ $h Rde` yT ^ a]V^ V_e eYV QBR_URU` WZZZ_X]` XZT$ $h ZeY R Q;Rj `WZW]` XZ% Rd R acVT_UZZ_ Vc$ $^` cVUj_R` ZT R_U cf cd RZ_RS]V Yf ^ R_ UVgV]` ał$ ^ V_eŽEYVdVa`d&Z_dV^ S`Uj eYVgZha`Z_eeYRe aVc^ VReVd9 f^ R_5 VgVj a^ V_eCVa` cedZ_4 YZJVŽ EYVZc^ VdRXVZde/ReeYVT f_eqj 'd^ `UVc_ZReZ_ YRdR_RchVTeeYReTR__`eSVZX_`dVLh YZY ZdeYV d'S[VTegZej `VZ_UZgZuf R]dŽ

7`]]`hZXeYZlRaac`RIYŁeYVdVT_UCVa`œ 1"**)/ŁV_6ZEWUEYVARCRU'i `W& `UVc_ZKReZ_Ł $ZV \in ZV \in VT \quad dvbf V Tvd W VXVT \in X d TZR$ dfS[VTezzzijŽEYVaRcRUiT_dzedZ_RhZUkacVRU WWZX`WZdVTFcZejR`ZbeeYVdeVRUjZTcVRdVZ eYVT f_eqičdVT_`^ZTac`daVzZijŽ:_RgRzZkij`W RVRdeYVCVa`œUZX_`dVURd'S[VIezzi eYReYRU SW_YRc^WSj_eVV`gVchYVj^ZXRLgR_TV`WR ^`UVc_ZKReZ_UCZęV_`_]j Sj Zed`h_Z_eVc_R]`XZIŽ3fed`TZR]d`S[VTezezej Zel_`eRyd`Ve%eeRcZl RS[VeYRe^VeVjj eVda`_UdaRddZeVjj e` eYVWeTVd XV_VCReVUSj_eYVyYRU%h`dJU`WeYVVT_`^jŁ a`]ZEZTd`ceYV]Rh, ZeRJd Z_~fV_TVdeYV`S[VTEZeV cVR]Zej `Wd TZVejŽHYV_aVa]VdUV^R_UdWc $dMF cZe_{i} R_U dMT X_ZE_R CV_eT_dZ M CVU R_U$ cVda`_UVU e`Łd`TZR|dfS|VTeZeZej eV_Ud e` efc_ SRI\Z fa` Zech/WZEYZdh-VR\V dd TZR eef de R U $T `aVcReZ_kRWWW1eZ_XeVVh`c\Z_Xd`W1_deV^ dR_U$ ZedNVŽ4`_dVbfV_ejjLeYVCVa`ce^RZ_eRZ_deYReeYV df deRZ_RSZZej `WW^ `TcRIj ŁVT _`^ ZTXc`heY R_U Yf^R_UAW a^VeZed WUAV Ud`_eYVUXeW `WT^a]V^V_eRoze; SVehW_eYV_WUd`We1TzR $d^{T}S[VI\partial z z z R_UeY dV W deV dR_UZ de z z dZ]$ 2 UeYVEVTR SV `T ^ a]V V eRg cVRez dYZa hZeY feRdec`_Xd TZR] df S[VTeZezej Ž

EYV#!!! CVà`ceLV_eZJVUE`hRtURDec`_X\c D TZAj e` 8`g\c_ZXeVV7f ef c\LVi a]`c\UeYVa`ł e_eX]`Wi TZJ d`S[VIEZZj Z_4YZ/ŽEYZIZ_bf Zj T_cLV&UeYcWUj_R`Zd+eVVISZZj e` RoeZIf]RV R_Uac`T\dIT]]VIEZZVRbZREZ_deYVIZEV_TVR_U VieV_e`Wi TZJ TRaZEJLR_UTZZV_d`c\RUZ_\dde eR\VT]]VIEZZVRIEZ_ŽEYV R_Rj dZi du` h\U eYRe



4 YZVR d'TZKej UZU a`ddxdd eYVdV cVd f cTVdLSf e eYReeYVLIZaVcdNUR_UVXRX^V_eRcj_RefcV^WeYVdV Uj_R^ Zīd^ RUVZeUZIŅTF]ee`UVa]`j eYV^ ŽEYVCVI a`ceT TIFUVdeYRe` VZUZaV dS]VdVdfcTVV/c $Yf \land R_Ugy \land V_eZRyT \land \land \ h \ dUUUUZgZX$ W/^ R UVIZHZ XWcaVcd_RR Ud TZR of S[VTHE ZejŽEYVbfVdeZ_Rd\VLLeYV_ŁZdyY`h TR_RT^ł ^`_h`dJUSVac`UfTVUReReZ`V`VXJ`SRJZReZ_ R_UZ_TOURDZ_XZ_UZ6ZLF RZZR6Z_ŁZ_ Rd TZK6jeYRe ZIA ` OVR UA ` OVUZOVOZZ VUR U RIVZ XZ d ZU ZV_ ÆZKOV HAYÎK YÎ ei Yehcberi [Yehech Wh \i a Ub XYj Y`cda Ybh]b 7 \]Y]bj c `j Yg U W/h fU`WU`Yb Y":_dY cet ZezleYVT _ Tvaef R R_UV aZZIR h`c\U_VSj eYVacVgZfdCVa`ced eYRe_`h d'XXVdedeYV_WUe`dV-VTe`_eYVTf |ef dR dÆfReZ_`₩eYVTf_eejŽ

DYZ&J Z eYVT]]VIðgVZ RXZ RJ RVR `C'R aYV `^V `_ŁRIRVTYR_XIdZ eYVWC^ `WJTZJ V aVZJ TVŽH YReeYVaCdV eCVá`œa`d&JZleYRe eYVCVZIR^Zh REIYSV6hW_eYV6h`ac`TVdMŽZ ARce #LRAKC`f eJZ Z Xd ^ VZ RYZ RZd`W4 YZYL eYVCVá`œUXIZSVIY`h eYVT f_egidZ YVZAU dJWZ RXVYRJSW_VC`UVLŽ4 YZYR_dU`_`edW^ e`YRgVRd/RXUZ RYZ_Rg e`daalj T_eV_eWc eYV_RZ_RJZV & gZ Rg e`daalj T_eV_eWc eYV_RZ_RJZV & gZ RZ d'bf V_eljLaV aJV}_UZe UZWIF Jee`dWc eYVZ Z UZgZFR] V aVZZ/TVde`R Z RXV VeYVyH V@YReV_RSJVdeYV`e`eR_dIV_U eYVZ Z ^ VUZIJŽ+i Jg bchih Y Yfcglcb c Zh Y' c XWc`YWJj Y Ja U[_bUfJYgcZh Y ÎK YÏ h Uh We bgJh Hygh Y dfc V Ya c ZW 'h fY Jb 7 \]YZ Vi hih Y k YU_bYgg cZh Y bYk cbYg'

$$\begin{split} & EYVh VR. VZX `W'_XYVUZ RXd` V4 YZVR_\\ & ZV_& & efg ZIR]` XZIR] T_dbf V_TV` V& VXCVReTYR_X \\ & VdeYRe YRgV` TIF ccVUZ_4 YZVR_d VgVg UB_d TZR] \\ & VREZ_dYZ dZAReS UVIEZSVdd ^ VTYR_XdZ_eVZC \\ & hB_d` VVZVVZE YVCVIV_eZ a` ceR_TV` VT_d^ al \\ & eZ_R_U eVVZVZE YVCVIV_eZ a` ceR_TV` VT_d^ al \\ & eZ_R_U eVVZVZE Z_L VC VIR^ a]VLhV]] Z]f deRevd \\ & Y h cRaZUJ_J R_U cRUZIR]J eVVZVREZ_dYZdYRgV \\ & TYR_XUZ2_U_Vh VC^ d` VdTZE] cVREZ_dYZa \\ & Z_VZERSJ_J RWWAR_J T]]VIEZVZ RYZ RZZZ$$

ARce % ZEIR_f_acVIVV_eVU WWW.ce bfR_eZGV eYVT f_ecj dTf]efcR] cVd fcTVd R_U Uj_R^ Ztd R_U e`dr`h eYVZ: UV_dZj Sj cVXZ_Ž2 XJR_TVRe eYVdV ^ Radc\g\VR]dh YRe R cR_XV`Waa`cef_ZZXd YRd`aV_UU faŽ3feaV a]VTR_`_]j a\CTVZgVR_U ^ R.VfdV`WeYVdV`aa`cef_ZZXdZVeYVj dWeYV` RdSVZ_XhZeYZ_eYVcVR]^ `WeYVa`ddZS]V/R_UeVV S`f_URZXd`WhYReZtlya`ddZS]V/BcVUdRh_Sj T]}]VTeZgVZ: RXZ_RZCKŽ

ARce&UNRJdhZEY eYVhBj Tf]ef dRJ TYR_XVTcVReAd TY`ZVdR_UcZhdWcZ_UZgZLFRJdŽ@_VTYRCRIeAcZeZT `WIYZVZ cVTV_ej WRcdYRdSW_eYVXc heY`WZ UZ gZLFRJZREZ_Ž2decRUZZ_dhVR\V_Ł4YZ/WZ dYRgV e`UVTZUVeYVZ gRF VdR_UX RJdZ_JZWLeYVZ dYRgV e`UVTZUVeYVZ gRF VdR_UX RJdZ_JZWLeYVZ dYRgV EYZCIYVJadeVV e`ScVR_VXW`W]UT_decRZ cd R_UXZgVdeVV XCVReVC VXWU ^ RdZ UZgZLFRJde` TY`dVY heYy JZgVZ3fe_`eVgVg S`U RIYZ/gVd Z UZgZLFRJZREZ_dEcZNNTE cZjZ._ ^ R_j TRA/LEYV hVR_Vd1 `WT]JVTezgV cVWEV_ed JVRUde`Rd TZRJ Z UZgZLFRJZREZ_Ž2_U eYZCIF_dRecZNNTE cj ej aV `VaVvd_RJZV_eZej TR_RJeVC dTZRJ cVREZ_dVZad SVTRFdVZeeV_Ude`ac`UFTV ^ Zhef deL`aa`cef_1 Z' R_U UZRVMNTEZ_ R_U a]RIV R_VTVdEgV]`RU `_eVVW?ZjZ

; f de Rd II f Jef dRJ TYR_XXdRXWW leeY VacZgReVh`dU eYVec_dWc^ ReZ_`W4 YZJ VR_d a Vcd_RJ JZg vdZ JRW WIEZ_XJZWZ_d TZ kj Ź2 JR XV ac`a`ceZ_`WaV a JV U_`ecf TTWUZ_Z eW KR Z_X CREZUNI le`cZj Z_e`eYV d TZKJL VT_`^ZT R_U a`JZZTR] ac`TV ktL R_U eYZ ^ R_V kleYV UZg vcd kj`W4 YZJ VR_d TZ kj JV ktT KR Zg V eYR_Ze^ZXY e SVZ ARce' dr`h dY`h dX^`V_eVU d TZKJ UZg vcd kj Raa VR cde`SVZ_R_f^SVc`VR VR L eYVTF Jef dRJ XRa SVkh W_d TZ KJ Xc`f ad Raa VR cdd X Kreey Re Zeh`f JUSV UZJ VTF Jee`T_dccf Te RyH WZ E YZ LJ _UZ_X f_U cJ Z_V de YVa`eV_eXJ Z a`ceR_TV `VR_ReZ_LSF Z UZ_XVI VETZ Ve`CR_Z V UZW KV_e V a V cZ_TV dR_U cha vdV_eR Z_dRc`f_URT ^^`_ h`dJUŽ

3j hBj `Wr_TlfdZ_ŁARe(Uthd`_eV}_U Z_Xd`WYVdfUje`fdZ_Vd^VTcZWZRWcRdWdd Z_XeYVTfjefdRJUZ V_dZ_`WafS]ZTa`]ZZdŽBch cb`mWi hi fU``dc`]WYg`Ugʻgi WižVi hU```dc`]! WYgʻg\ci `X`VY UggYggYXZcfUbmidcg[hj Y`cf` bY[Uhj Y`]a d`]WUhcbg'h\Yma Umi\Uj Y`Zcf` h\YZcfa Uhcb`cZh\YÎK YÏ h\Uh\Ughc`VYh\Y` gi V'YWicZUbmibUhcb!Vi]`X]b[`YZcfh'

9L7IFGIG < IA5B89J9@CDA9BH5B87I@HF9=BIB8D KCF@8F9DCFHG

H ZEY eYV VZde H`c]U 9 f ^ R_ 5 \g\]`a^ V_e C\\actia`ceZ_ "**! \pm F ? 5 A S\\AR_ Rac`T\\dti`\\AV\-VI! eZ_`_ IF]ef c\'\\AV^ eYV deR_Ua`Ze`\\AVF^ R_ U\\g\]`a^ V_eZH YRe eY\\d\/C\\actia`ced WIf d`_ \pm Z X_\\AR}LRc\'eY\'IF]ef dR] \I ac\\dZ_d`\\AVF^ R_ U\\g\]`a^ V_eR_UeY\\hIJ`eY\]Ree\\cZIT_dcdZ_\U Sj IF]ef dR] ac`S]\^ dZEY\\U]`hZ_XZIRScZ\\AVI! T f_e`\\AV\C\]ReZ_d\Za S\\dh_Yf^ R_U\\g\]`ał ^ V_eR_UIF]ef c\LRdd_Sj eY\H`dUC\\a`ced Z`:eU \\d_`ed\\A`e`S\\dd\^ R\zT`c \I YR d\z\g\L`c e` d\`h Y`h eY\Raac`RIY ^ IJ`YRg\U\\g\]`a\U `g\\ceY\\dh\\g\C\\a`ced af S]\Zh\Ue` UR\\ZEY\ZI S\\Z_X eY\'IR\\LeY\C\]ReZ_d\Za S\\dh_Yf^ R_ U\\g\]`a^ V_eR_UIF]ef c\\IR_S\U\\d\[Z\XU]`LC \g\^ RZ_d`S[\TeY\RLZ_XZ

A 5-B H≮ 9A 9G

"Ž_ Zed` cZXZ_dR_UZ` a]ZReZ_dePVVT_Tae `WYf^R_UVgV]` a^V_eZel]Z_VU hZeY Tf]ef cVŽ :_` cZXZ_LyeYVc`` ed` WeYVT_TVae` WYf^R_UV gV]` a^V_eTR_` V&V_SVecRIVUe` VRc]j aVcZ UdZ_ Yf^R_YZef cj R_UTR_SVWf_UZ_^ R_j Tf]ef cVd R_UcVZXZ_d%b"**%L"%Z2dcVARd.deYVZ` a]ZR eZ_dy9f^R_UVgVcVT_`^ ZTXc`heYtecRUVLV` a]` j1 ^V_eta`]ZEZR] V&VU^^ ` cTf]ef cR]gRfVd V/^ eYV aVcdeVEZeV`VgVa]V%b"**&L" #/Ž

$$\begin{split} & \# \breve{Z}9 f^{\land} \underline{R}_{U}(\breve{g}V) a^{\land} \underline{V} = \underline{V}_{e} e V_{e} da Rec \breve{Z} a Re Z_{z} \\ & Z_{z} Tf] ef c \breve{V} \breve{Z} : e ~ \breve{Z} I RS `f e^{\land} W \breve{Z}_{z} X e V _ W U d e Y Re \\ & a V a] V W W R V Z a `ce \underline{R}_{e} e L Z_{z} a Rec \breve{Z} I f Rc ya `af] Rc \\ & a Rec \breve{Z} \breve{Z} Re Z_{z} Z_{z} T^{\land} f_{z} \tilde{g} R W W d V T_{z} `af] Rc \\ & a Rec \breve{Z} \breve{Z} Re Z_{z} Z_{z} T^{\land} f_{z} \tilde{g} R W W d V T_{z} `af] Rc \\ & a Rec \breve{Z} Z Re Z_{z} Z_{z} T^{\land} f_{z} \tilde{g} R W W d V T_{z} `af] Rc \\ & a Rec \breve{Z} Z Re Z_{z} Z_{z} T^{\land} f_{z} \tilde{g} R W W d V T_{z} `af] Rc \\ & \breve{Z} Re Z_{z} Re Z_{z} Re Z_{z} Re V R A C \\ & \breve{Z} Re V V M T^{\land} a `_V e ` W f^{\land} R_{z} U g M `a^{\land} V e L R Z \\ & V RS] V da V a] V e` a Rec \breve{Z} Z Re V R_{z} V g Z_{z} f V_{z} V e M Z \\ & Tf] ef ~ d] V_{z} \breve{Z} `_{z} ^{\lor} V e \% " **! L) \% Z \\ \end{split}$$

 `\&Wa1Vd1RaRSZZZZZZ_eYV1f]efd3}}VJUR``_X `eWcdu"**%L&Z

ARceZIZARZ_Z IT]cf cVZIRWc^ WURDRCXYdrZ RTT d.R_TV h Zey eYV:_ekc_ReZ_R] 4`gV_R_e`_ 6T_`^ZILD TZR] R_U4f]cf dR] CZXYcdac`TJRZ WU Z_"*('ŽE YVCVà`ccd YRgV`V&V_TZAU eYZLRdZe V_drZ_VdeYVcZXYee`aRceZIZARZ_Z IT]cf cVZEYV CVà`ccdV eV_UeYVdT aV`VeYZlcZXYdrY`hVgVŽ:e ZldR.V_e`^VR__`e[f deRTTVdle`Tf]cf cVLSf eeYV acRieZIRSZZġ`VKWc^Z_XR_UUWV_UZ_X`_Vd`h_ ZV_e&j +y2]] aV a]VLR_UR] T ^ f_ZZVdLYRgVR cZXYee`TXReVeYVZcTf]cf cVZ_hYReVgVchBj eYY hZh'hYVeYvc eYc f XY]R_XFRXLeYc f XY cZf RL Rcd_^f dZTR_UUR_TV`ceYc f XY]ZeVRef cV`cce`H g eV][Z_XI_Z_R_j`VeYV^j cZU Vc^d`VVff]cf cV eYc f XY hYZY Yf ^ R_SVZ_Xd eYV h`c]U`gVc

EYZdRjd Raa]Zdde WWkteelffccV_ejjSVZ_X^RU/ SjZ_UZ&V_`fdaVa]Vde cVRV/c^ eYVZ:ZU/_eEZd+ y&RWc^ `Wff]efcR]aRceZIZaReZ_e hYZIYeYV YRgVRcZ&YeÛR_UW/^ hYZIYeYVhY`]Vh`cJU XRZ_d%="**SL#S/Ž

 $\begin{array}{l} & \hbox{EYV} V \end{tidely} F \end{tidel} F \end{tidely} F \end{tidely} F \end{tidely} F \end{tidely} F \end{tidel} F \end{tidely} F \end{tidely} F \end{tidely} F \end{tidel} F \end{tidel} F \end{tidel} F \end{tidel} F \end{tidel} F \end{tidely} F \end{tidel}

DLV Sj dLV hZY eYRe UY ZZ_ŁeYVV ZI eYV ZNR`WF]ef cVRtyIF]ef cR cZYVC%" ** SL#S/ŽE YZł eR\VdRhZNc gZh `WF]ef cR aRceZIZRZ_+Vbf Z eRS]VRTVctle`_`h]VLXLd Z]dLeVTY_`]`Xj R_U Z_Wc^ ReZ_ŽZTT d.Z_Xe eYZlgZhLd TZA_`c^ d R_U gRJf VdLZ_TJf UZ_XecRLZZ_R]`_VdLTR_SVR_ Z`aVLZ'V_ee`RTTVctle`TF]ef cR cZYVCŽ

EYVUZXWWCV_eZUNRd`WWF]efcVfdNUZ_eYVCVa`œd R]hRjddV]ReVe`Z_eR_XS]VVNCNedR_UcZXYeeLhYZY



RVR_Z'a`œR_eaRce`V&V a]Vd_WLdR_UUV&XVŽ EYZIRaac`RIYeYfdUVaRcedW/^^ReVZRJZ&ZTeYVł cZd`V\$RcIT_WLdn"**'Ł&!/Ž

y>`deaVa]VUX2gVd/TfcZejW^ eYVZc^V} SVcd/Za Z_RXc`faLRWY ZjLRT^^f_ZjLR_ `cXR_ZARZ_LRCRIZE]`cVEY_ZTXc`fa eYReTR_ ac`gZU/RTf]efcR]ZUV_eZejR_URcVRdtfcZ_XdvE`W gRffV8%6"**%LS"/Ž

?f cef cZ_XTF]ef cW_ESVT ^ VdR \Y_U&y] `a^ V_e`S[VI&&ZZ] "**' LeYZIhRdV aYRZTR]j cdReW+Î < i a Ub`XYj Y`cda YbhbYWYggUf]`mi]bj c`j YgU`WcbWYfb`k]h`W`hifY`!h`Y`k Umg` dYcd`Y`W.ccgY`hc``]j Y`hc[Yh`Yf! Zcf]hjg'h.Y` gYbgY`cZgcWJU`Wc\Yg]cb`VUgYX`cb`W`hifY` UbX'g\UfYX'j U`i YgUbX`VY`]YZg'hUhg\UdYg`]bX]j [Xi U``\i a Ub`XYj Y`cda Ybh':WaV a]VJZV $e X keY kch V [LZVeY y T`a V ReV Z R^f f f R] j V_{1} \\ c Z Y Z X h R LeYZ V] R X de Y Z Z U Z L f R T Y Z V Z \\ D L Y f^ R_ U g V a^ V e Z T_T kc_V e [f de h Z Y$ a V a] V R d Z U Z Z I f R d S f e R d h Z Y Y h e Y y Z e k d $R le R_U T`a V R V Z T^ f_Z X C w "**' L & X Z \\$

 $9 \text{ VALTF} = \frac{1}{6} \text{ VALZ}

EYVXcheY`VZ_UZZIFRIVXWU^de eVVVd cZ`V_e`WT`]]VEZV_`c^dR_UgRfVdLZITZAURd `_V`WeVTRfdd`WR_`^ZZEYZIT_dLVRZ_ YJadfdRaacVIZZEVeYVa`dZZYUTT_dLVRZ_ eRUZZ_RJ acZ_TZIJVdYRVVkcdTZAZ_eVXRZ_Ž 2TEZZZIdeYRe\Wa eRUZZ_dWg`fdS]Ve`ZeVI XRZ_RZVYVJaZ`ac`gVYf^R_UgY`a^VeŽ @gvcR_URS`gVeYVZ:VT_`^ZTVWWRLeYVJ_YJa e`ycVac`UFTVadTZAjŽEYVJeYfdYRzVR_ZeZ_dZT Yf^R_gRJfVeYReTR_`eSVcVUFTVUe`f_Zd`W ^`_VJ`c`WZVI"**'L&#/Ž

EYV TJRZ eYRe TF]ef cV Ztl_`_łVT_`^ ZT Z_ _Ref cV U Vd_`e T_~ZteLY h VgVLh ZeY Ra`]Ztj `VWT_`^ ZT Xc heYZ 6g Vcj eYZ_X U/aV_Ud`_ eYV U/gV]`a^ V_e decReVzJ + y2 aReeVc_` VWc heY eYRe ZtlZ_TJf dzgVR_U aRceZtZaRe`cj_TR__f cef cVR_UV_ł YR_TVTf]ef cR] ceRUZZ_CMu" **' Ł' "/Ž

EYVCVa`cedRcVV`aYR2TZ_dR2ZXeYRecZZZX ZT^VdU`_`eZ_eYV`dv]gvdhRdU`W&V_UV_TZdd e`hRtudff]efd?JUZZeXxR2_ŽEYZdh`f]UVia]R2 hYj_eYVR_RjjdZdUVR]d`_]j_hZeYeYVUj_R^ZT`W UZZeXxR2Z_ZYZX1ZT^VTf_ecZdR_U^Rvd _`^V_eZ_`Va``c`cUvgV]`aZ_XTf_ecZdŽ

4f]efcV_`e`_]j ac`gZJVdZ_eVXdReZ_R_U

EYVCZXYee`TF]efCt] aRczZZARZ_UKURZSWUZ_ a`Z_e#Ztlf_VbfZg`TR]j RcZXYee`aRczZZARWZ_ `_Vd`h_TF]efCkLR_UeYfdRcZXYee`UZgktzEj 1"**SL#SYŽ7fceYkt^`CkLacktktgZ_X`_Vd`h_ TF]efCvZ`a]ZdeYVa`hVce`RURaeeYVCktf]edR_U eV_UV_TZkd`Wh`c]UU\gy]`a^V_ee``_Vd`h_ _WkdR_UgRJfKŽ

 $\label{eq:second} \begin{array}{l} & \label{eq:second} & \label{eq:second} & \label{eq:second} \\ & \label{eq:second}$

 $\begin{aligned} & 2aac`acZeZ_`WeYZI\Z_UZI_`e[fdeRgR]fVLSfe\\ & R_Z_VgZeRS]VVRIeZHYZIVX]`SRJZReZ_^ZXVeSVR\\ & a`hVcM] V_XZ_VVCFIF]efdQ] Z_eVcTfcdVR_UeVV\\ & ac`UfTeZ_`WA]`SR]TF]efdQ] X_ULaVa]VcVIVZgV\\ & R_UfdVeYVdVZ_UZWEV_ehR]dUVAV_UZ_X_eVXE\\ & Tf]efdQ] aVIFJZRZEZd1"***LS%ZEYZIT_dXNd\\ & ReZ_dr`f]UXFZVer`dVhY_UVdZ_R_UVgR]fReV\\ & VT_`^ZIXc`heYa`]ZZCZEYfdLeYVbfVdz_yZd\\ & ZeVch`_dZgVe`TF]efdQ] UZgVcdEj0%a"**'LS'/TR_\\ & ac`gZVRTZEVZ_VCURZ_XEVCV_dAPY`CVeVd_Z_\\ & SVehW_yc``e]VdUXc`heY`cV_ZTYZ_XIF]efd%aPRe\\ & f_UVcJZdd^ VZURd`VVVgY]`a^Ven"**'L'"/Z$

 $F ? 5 A h R_{c} det Re eYVTYR_Xd_`h X Z X`_L h YVeYVc eYY ReV TYR REVZAU Rd X]`SRZREZ_L eYVdet VU`W Rc\Ve']`XZT`c eYVU&Y'a^V_e`W Z Wc^REZ_eVTY_`]`XJ 1: E/LTR_RWWTe'Tf]ef det UZ gVdZg +y4f]ef cVLT^^f_Zg R_UYf^R_d/Tf cZg RVZ_eVchZ_VLLSf ee``V&V_f_UVc^Z_VUSj eYV Z gRZ_d`VW]`SRZREZ_\mathcal{B} ****L"! \sc{Z}

EYVEVOLV de`SVRUR_XVC`VYIF]efoR]Y^`X V_ZREZ_%eXREZX_`COL`cUVAEC`jdUZgVoZgLEOVF]ef Z_XZ_TF]efoR]Z`a`gVZEV^V_eZ8]`SRJZREZ_ZL ZVV_eZVURDEYVdfCUV`V&ZEVCVREŽ

y>`cVZ`a` cR_eeYR_X gVc_^V_ecVaCVdZ_`W If]ef cVde`UB_ZleYVWWWTe`W`Rc\VeWcTVdZS]`S} R]j ^ Rc\VeVUT_d`^Vcac`Uf TedR_UeVV^VUZR RVdf aVcZ`a` $dZ_XRf_ZVc^{R_U}def$]eZyVZ_XgZh `VeYVh`c]U‰"**'L'#/Z

 $EYVZ_TCARCHUZ_eVCT___VTeZ_R^{^{-}}_X aV a]V$ $TCAREVUSj X_j SR_ZREZ_ZL_eT_}_Ue eVV$ $VT_^{^{-}}ZTR_Ua]ZEZR_dAVVCVZ4f]ef cVZdZM$ $Z_TR_ejj RWWTEVURdhV]_1"**'L"!#, "***L"/+$ $y? REZ_R_S CUVCREVSCVRZ_XUh_L_e)j VC$ $eRUVLTRaZER_R_UZ_VC^{^{-}}REZ_SfeR_dVCZVREL$ $C^{^{-}}C^{^{-}}LTf]ef cVdR_UgR_fVCVCm"***L#*/Z$

DZ_TVeYV`fedkeLeYVCVa`cedYRgVV`aYReXKU eYReXj`SR[ZReZ_ScZ_XdS`eYeYcVRedR_U`aa`d ef_ZeZdŁZ_S`eYTRdwdhZeYa`eV_eZe]Z`a]ZReZ_d WcTf]efcVŽ

 $yE^UB_L^{+} CVeYR_VGVLR_Vh_X^{SR}TF]efdV$ ZIV^VZZZZ7C^^fdZTe^^gZdeS``\dLZI ekc_RZ_RJZMRdR_UGRIFVGRVSVZX^ZVUhZYL R_UdfaVZ2a`dVU`_L_RZ_RJZV_eEZdZDfTY T^^`_ZVK^REZ_~`hdRVR_RIYZGV^VeL SfeeYY_TRoj RcZLEAV]`dl`VVIf]efdZZV_EE R_UUZGVCEjZ3feeYY_RdR]`heVh`dUe`VRV falRdRT^^f_ZjIe`ZdFVd`VVT^^`_T_Tkc_ R_UT^^`_drgZR3%b"**#L(%Z

 $2^{\ }X$ eVVTf]ef cR] `aa` cef_ZZd` WWAVU Sj X]`SR]ZRZ_ZleYVa`eV_eZ] Wc TARZXRS`U `Wh`d[UafS]ZT`aZZ_Wg`f cRS]Ve`eYVUWV_TV R_U f_UAdR_UZX`WZdf Vd`Wh`d[UhZWZ_eAd VdLR_UWcT_gYZXR_`h]VUXV`W_Vd`h_ Tf]ef cR] aVTf]ZrZZZAŽE`TR] Tf]ef cATR_R_Udr`f]U SVchRvU1"**'L' "/ŽEYVZ_TARAVURGZJRSZZEj`W Tf]ef cR] T_eV_e`_eYVH VS dr`f]USVVAg`f drS]V e`eYZh1"***L'&+y2_UhYZV_Vh eVTY_`]`XXd TR_`V&V_UZ`Z_ZY]`TR] Tf]ef cVdLf dVUTcNezgVj eYVj TR_R]d ^ R.VeYV RgRZJRS]Ve`^f TY hZ.Vc RFUZ/_TV2%b"**SL#S/Ž

:_ eYZI h BJ Ł X]`SRJZREZ_ TR_ `aV_ aV a]Vd]Zgvde` Tf] ef dVR_UR] Zd TdVRZZG $LR_Ue eVV$ ~`h`VZURdR_U_`h]VLVv1"***L%ZDZ`ZRdj Ł eYVX]`SRJZRZ_ `VUF] ef dR] ~`hdZd X/_VRZ_XR Tf] ef dR] VWU ^ eYRe TR_RER dR_R_ZDU eVe eVV V/_UR`V_eRZT ddVREZ_XRXZ_de Tf] ef dR] TYR_XV 1"***LS%Z

$$\begin{split} & \& \tilde{Z} \in VVCZhd`VWF] efcR [X]`SR]ZREZ _ \tilde{Z}8]`SR]! \\ & ZREZ _ ZlecZXX&Z Xa`d& gVeV_UV_TZALSfeZeR]d \\ & ScZ_XdUJ _ R`ZdeYReRVf_Wg'fdS]Ve`Yf^R_UVgV]`a^V_e\tilde{Z} VVCVa`cedYRgVYZXY[ZXYeVUR_f^{} SVC`VVR_XACLeYV] cd`WeYV^SVZ_XeV]`dd`W \\ & CRUZZ _ R] ZV_e & gVRIe cd_Wi^] R_X RXVe`UXdL \\ & R_UWV^ _`c^ de`ZeVXRZ_ac`TVdWh"**SL##, \\ "**%LS", "**'L'#, "**(L*', "***L'! <math>SZ$$

$$\begin{split} & EYV dVT _ U UR_X & Zl eYRe `Wylf] ef dR U ^ Z \\ _ReZ _%a'' **' L' #/ eYc f XY eYV Z a `dEZ _ `W \\ & TVeEZ Wc^ d `VUf] ef dV`_ `eYVcZe_VaVgVcdV \\ ^ R_ZWERZ _ `WeYZlcf acV RIJ ZleYVUVCRZeZ _ \\ `WZ UZX_`f dXc f adRdyZ aVUZ V_ede`UVgY] al \\ ^ V_e%a'' **' L' #/ZD ^ VeYZ X`WeYV d ce YRaaV_d \\ & hZeY 2VZIR_TF] ef cV R_U ZV_eEj LWc VR`a]VL \\ & hYV_eYY RcVSVZeJVUR_UUZa]RIVUSj H VEVc_ \\ gRJf Vdn'' ** (L*' /Z2_`eYvc ej aV`VZ a`dEZ _ Zl \\ R_ZUR` WZ eJ]VIef R] ac aVcg`eYReZX` cVdIf] ef dR \\ \end{split}$$

EYVeYZU_VR&ZgVR&VTeZthYReYRaaV_dhYV_ If]ef cVZdT ^ VCIZGZ&VU`_ Rh`cJU dIRVŽEYZd Z_TCVR&deYVZ' a`ceR_TV`WIF]ef cVRdR_VT_`^ZT X`ULd eYReZeeV_Ude`SVZJV_eZ VUhZEYT ^ ł ^`UZZdeYReTR_SVd JUR_U ecRUVLŽ> fTY`W eYZdecRUVZ_TF]ef cR] X`UdZTT_UFTeVUeYc`f XY eYV_VhZ_Wc^ReZ_eVTY_`]`XXd+y2]eY`f XY eYV dacVrU`VZUVRdR_UZ RXdV_cZYVdeYVh`cJULeYCV ZIRcZh`WAUFTZ_XTF]ef cR] T_TVc_de`ac`eVTeZ_X hYReTR_SVS`f XYeR_Ud JUL_WYVTeZ_XT ^ fł _ZjLTf de`^ R_UecRUZZ_%b"***LSSYZ

 $\begin{array}{l} & \hbox{EYV^ R: Ve Wc TF] ef cVZlSVT ^ ZX^ ` cVT _ l \\ \hline \end{tabular} \\ & \hbox{TV_ecReWLe evVVT] f dZ_ ` Vd^ R] l] ^ TR Z Uf d \\ & eZdZ > ` cVReeV_eZ_ _ Wude SVaRZJe ` yff] ef cR \\ & \hbox{VTVaeZ_dWaJZVer dVUZI f dWJS j H E@ Z erV \\ & F d Xf R C ` f_UZ \\ \end{array}$

 $\label{eq:second} \begin{array}{l} & \label{eq:second} & \label{eq:second} \\ & \label{eq:second} & \label{eq:second} \\ & \label{eq:second} & \label{eq:second} & \label{eq:second} & \label{eq:second} \\ & \label{eq:second} & \label{eq:second} & \label{eq:second} & \label{eq:second} & \label{eq:second} \\ & \label{eq:second} & \label{eq:s$

 $2 \wedge R[`cTRfd/`VZ_VofRZj Zl^ Rc\VeT_TV_edl$ $eZ_Z_eVVSc`RUTRdZ_X`Wff]efdlLZ_Wc^ ReZ_$ $R_UV_eVedlZ_^ VeT_eV_eZ5VdaZVeVVVaR_dZ_$ $`WT ^ ^ f_ZTRZ_dR_UecRULT_TV_ecReZ_ R_U$ $VTTfdZ_ RcV_JVRUZ_Xe` eVVa``cVdeUVgV]`al$ $Z_XTf_ecZddSVT ^ Z_XyTf]efdl]j Zt]ReVU‰$ 1"**)RL&"/Ž

'ŽF_ZgVcdR] cVTZaVdWca`]ZfjZ`a]V^V_eN eZ_RcVZ_T^aRezS]VhZeYcVdaVTeWcTf]efcR] UZgVcdZejŽ5VgVj`a^V_eZtRf_ZgVcdR] `S[VTezgVŽ

$$\label{eq:linear} \begin{split} & \text{TY } ZV de` h YZY Ze Xz V deZV n'' ** & \text{L} \# ZE Y f d W c \\ & \text{V } R`a] V + y E Y V c V d`f] USV_` ReeV`aee` `WW c R \\ & f_Z v d R'a] V + y E Y V c V d`f] USV_` ReeV`aee` `WW c R \\ & f_Z v d R'ae' `UV]` V & V c V c V b f R Z i ZE Y V Z eV c a c A R \\ & eZ_` `W a' V c Z Y c h Z i U W c Z U W c V e d T Z e Z c A R \\ & eZ_` `W a' V c Z Y c h Z i U W c Z U W c V e d T Z e Z c A R \\ & U a V_U Z X`_ c V Z Z _ d`c T f] e f c d`c e R U E Z _ c & o \\ & n'' ** & \text{L'' } ! \# Z \end{split}$$



7<=@NG9@ = A 5; 9.5.8CI6HI@<9F=H5; 9

EYc`fXYZedYZeb`qL4YZVYRdaVcZtYVUR_U $SW_ CVS^{-} C_ ^Rj eZ^{-} VdZ^{-} VdZ^{-} d$ $UV6cTZ]RdVaZT=R2cRTR_RZd_`eeYVcR^VRdeYV$ 4 YZVeYReh`_ZedZ_WaV_UV_TVŽEYV` |ZARCTYZT `dVceYReV`VcXVUReWceYVSReeJV`V¥ZEIRjhRde` $f_UXX R^{T}_XURh_1 fe^{VR^{-1}} caY dZ df_UXc$ eYVZ aRTe`VZ Uf dezRZReZ_R Uf cSR ZReZ_Ž EYV^ZUJVT]Rd14YZVWdeVCVUSj DeRev RI62226j $R_UeYVUV^ TORESCREZ_ W fTY WeYVehV_eSCEY$ TV_efg_UXUZ_ "*(\$Ž3feeYVRfeY_cZRcZR_4YZV eYReTR' VZ_e` SVZ_XeVV_ YRd_VZeYVcdV' RZ_VURdZe hRd_`cUZRaaVReVUT ^ a]VeVjj Uf cZ_XeVVIf ccV_e ecR_dZEZ_e`UV`TcRUjŽ=``\Z_XReeYVTf_ecj W/^ RYZE cZR a Vca VTezev ZeSVT ^ VdT WRceYRe eYV&VZd_`e[fde`_V4YZVL[fdeRdeYV&VZd_``_V y ReZ R ZV \mathcal{A} % i VU TVR U V \mathcal{A} R \mathbb{Z} \mathbb{Z}]g[·]U[·]\]ghc f]WU^{··}dfc WYggžiU[·]gc WJU^{··}Wc bghi Whži U'W' `hi fU``dfc Xi Whc b"

 $EYVZNR`W4YZVZd^RVVfa`VRRVJUdTaZT$ RccRj `WZ`RXX&Ld`^V`W&YV` `]U R_U SRcVjj CVT X ZERS VL ` eYVcd VR ZZRc R U TYRCXVU hZeY _`deR]XZT]`_XZ_XŽEYVćVRcVZ'RXVćIRdV&VćYRdR eV/VeZZ__RUgVceZV^_V_eR_U`eVvccV^ `eVc`_Vd`W WeVelet ^ Z Vel R U T gVel Y VeV ReV Z RXvel | RUV hZeYd^S`]dR_UYZe`gŁdZVSjdZVhZeYZ RXVd `WLRZjj]ZWŽ:^RXVdeYReRc`fdV]`gVR_UYRecVLL ReedRIeZ_R_UcVaf dZ_ŽEYVj cVacVdV_eeVVUZgVd dZej `VWa`TYdR_URTe`ccL^ ReVZR] ded Tef cVdR_U $d'S[VI \partial z \partial V_I a \partial z \partial Z_I V \partial Z_i e Z \partial Z_i e RehV]^ \ Z_i$ eYV^ZcccRURd\hY`hVRcVf_[VddhVRcVRhRcV `WhYReYRd XReYVCVU Z_ eYV T]]VTezeV ^ V `qŽ :_VgVg aVzUL4YZVR_d`VR]\ZUdYRgVUhVje fa`_ŁVġ`\WR_UZ`RXZ_WeYVZcTf_eqiŁ]VRgł \underline{Z} XR a \underline{R} \underline{Z} adv $\underline{d}e$ `W' V' ` \underline{d} $\underline{d}e$ YRe T ^ Ve` ^ \underline{Z} U hYV_VgVchVeYZ_\`VeYVTf_eqiRdZeZd_`hŁR_U RdZehZ SVZ eYVWef dŽ

3 VALVICVT X_2KZ_XeYVIF] of dR UZgVidkig ` VALYZI

 $:eZd_{h} \ \ h \ \ h \ eYReS \ eY \ REZ \ R U d TZkj$ RVIF]ef d?] d\adddV eREZ_d c d ^ S`]ZREZ_deYRe aV a]VId/ReVe` WW] R_USVd/T X_ZAVURdaRe ` VR T ^ f Zj ŽEYVd/Zd_` d TZkj eYReU Vd_` eYRgV R_RcReZg/VS` f eZd/JŽZ_UT]]VIEZVZ.V_eEZdRV RhBj ` WRCREZ XL` VRezTf]ReZ Xh YReRd TZkj Zl R_URdrZvde` SVŽ4`]]VIEZVZ RZ_RZdRVaRe` W eYZd_RcReZg/VS` f eeYVd/JAd TZA d\adddV_eReZ_d eYRELhZeY f ed/RIYZ_XeYV]\gy]` WAhReV_VdIR_U T_dTZf deY f XYeLYJa e` Via]RZ_eYV dEf ReZ_ ` Va TZkj R_Ue` T_gY R_Ud/ReVT_TVaeZ_d` W eYVh` dJUR_U]ZWZAZTef cZ_Xd TZkj ZlR]hBj dR_ RTe` VZ RXZ_REZ_Ž

4YZVZIR_ZgV.eZ_Ž:_ `eYvch`ddLeYvhBj aV a]VgZh R_Uf_UvdeR_UZLeYvhBj eVvj WVj eYv dv]gvde`SV4YZVR_R_UdVT X_ZAvd ^ veYZ_X Rdyej aZIR]j 4YZVR_%LZIR IF]ef dR] T_def TeŽE YV T]]VIEZV Z`RXZ_Rcj `WhYRe 4YZVZLhRd R_U dr`f]USVYRdR]`_XYZE cjŽA`vedR_Ua`]ZEZZR_dL aRZ_evcdR_U^ZdevJddIY`]eVRIYvcdR_UdIZV_eZded YRgVYVJaVUe`TeVREVR_UcWvc^f]RevLeZ`VR_U RXRZ_LeYVZ`RXVeYRe 4YZVYRd`VZEdRJ RdsVTe R_UeYVa`]ZEZIR`_VŽ

EYVa`hVc`WZeVcRcjZ`RXVdR_U_RccRezeVdZd _`eUcRh_WV^ RcVR]Zej UZWWCV_eWV^ `S[VTezeV cVR]ZejŽeh`f]USVR^ZeR\Ve`T_ecRebeYV`S[VI] ezezei `Water Tef eVdR_UeYVdf S[VTezezei `WZETF f cold R_UZ^ RXZ_RZX&LRdeY^f XY eVy hVeV^_ UZXXXeV_e]VgYJČŽ:_ VRTELEYVEVTR_ SV_`ZUR`WEVRZEj eYRe U`Vd_`eT^VSjhRj`VRcVacVdV_eReZ_Ž2deYV 7cV_TYYZE cZR_C`Xkć4YRceZkća`Z_ed`feLyeYVcV Zd_` adRIeZIV`c def Tef cVeYReZd_`eac`Uf TVUSj eYVcVácVáV_eReZ_dL`aa`dVUR_UT_ecRUZTe`q`Rd eYV RevLeyReZUZeZUFRdR_UXcfadfdVe`^R.V $dV_dV W Y h = dU e Y Z Y S Z = ka c A R$ eZ_d `WeYVh`dURcVTcVReVUZ_eYVcVR|^ `WeYV a]Rfd&]VL_`eeYVecfVŽ4`_dVbfV_ejjLeYVjYRgVe` SVVeRIFREVUVIca`eV_eZRIVWWIEZEV_VollRdWRodSIV RU/VXZZ REVUZET fochdRS`feeYVd TZR `dVVŽ

EYVac`UTTZ_``Wff] $dcVZUV Z_V dj a`]ZZUZZ$ $:eZUV_`fXY e` `Sdv&yVY`h eYVT_} Xf dRz_d`W$ $a`hVcReX&yV_aVZUd`VWZ& g Z_Wc^ eYVhfy$ $aV a]V]ZeVR_UcVacAUV_eeYVZcdTZAJ Vf aVZV_TVZŽ_$ $ef c_LdTZA] Z_RYZ dh^ `f]UeYVa`]ZEZUJ d deV^ L$ $Zed` cZV_eRzZ_LeYVhfy dZ_ hYZIY a`hVcZI]VXEZ$ $^ Z&UR_UeYVTZEVCZAF dVUe`V&RJ ReVZZAF] ef cV$ $Zd R]hFy dT_W_eRzZ_Z6gV_ZVZe Zd Vf acVdtMU$ $RvdeYVEZR]] LZe Zd eYV ac`UFTe` Ve1TZAJ RXV_edZ_$ $T_~ZTeZ:_ Y`h ^ R_j TRACZ LeYV d TUAJ RXV_edZ_$ $T_~ZTeZ:_ Y`h ^ R_j TRACZ LeYV d TUAJ RXV_edZ_$ $A` cZ g %XV]Uf a RdaRe`VeYV_Ref cR]`dUVOEYV$ $a`]ZEZUR] UZ_V dZ_`VWF] ef cVT_dZd Zd ef XXVE.$ `gVce`cT gVceLe`TcVReVLZ'a`dVR_UcR_\aRce2Tf}]RccVacVdV_eReZ_d`WeVVdTZR]`dUVLR_Ue`cV[VTe `caVcdVTfeV`eYVcdZ4f]efcR]UZWWCV_TVLLY`h VgVL U`_`e^VCVjj^Zc`cdTZR]UZgZZ_dZ2]eY`fXY eYVj^RJ;SVac`UFTVU}fdTR]jj_`eUVJZSVReVJj`c T_dTZfdj}SjdTZR]RXV_edhZeYa]R_dcdcReVXZd R_UZ_dEZefeZ_R]djdeV^dceYVjR]d_CV-VTeeYVZ} eVc_R]Uj_R^ZT`WeYVZ'RXVdR_UCVacVdV_eReZ_d eYV^dv]gVdŽ

2 TV_eR] eVV V`WARce # ZleYV\c´dZ_`V&YZ VR_ZV_eZjŽEYVV aZZR] \gZV_TVd\eV\eYZ_eYV TYRae\cdeYRe W]`h ac`gZV\deYVSREK!\\c`_V`W eYVC\a`ced^`dea`h\c\V]T_TJf dZ_d+Z f`a c ghi dYcd`Y`]b`7\]`YZ`\V`YVYj Y`fYZYfYblg`!hY` a YUb]b[g`UbX`gma Vc`g`h\Uh\\cadf]gYX` k \Uhk Ug`Î7\]`YUbÏ!`\Uj Y`\VYUgYX`hc`VY` d`Ui g]V`Y":_`eY\ch`dELeY\J`YR\$V]`degR[ZLEj Z_eYV\RVV`WIYR_X\dS`eYZ_eYVLR2j_\fa\\ZV_TV `\V4YZ\R_dŽ

4 YRaekć" UKITEZS V. dd ^ VWRef C. di VerV 4 YZyR_ Z RZ_Rg RdT _def TeVUSj]ZeV. Ref C. Ž4 YRaekć # d deV ReZ. V. dd ^ V `WeYV UWA TF]ef cR] f_UVd aZ_Z_Xd `WeYV DeReV R_U a`]ZeZTR] T_def Te `W a`del:_UVAV_UV_TV 4 YZyNZ 4 YRaekć \$ TYRced Y`h eYVZ_YVEZEVUZ' RZZ_Rg YRdSW_Vć UVUSj d TZR] TYR_XVR_U_Vh V aVEZJ_TVd`VURZj]ZNNZ

7 < 5 DHPF %

H 97 < 5 @ 9B; 9C: 69-B; CBH 9CCIH 9FB 98; 9



: _ RX]`SRJZ&Uh`dUhYV&V&_eXdRVeV_UZX e`UZd]]gVL`_V&RA Wc_RZ_dZdZ`a]j e`VIZe UXdrZeVVgVj eVZ_XZ4YZVL`_ eYVVLXV`V&YV^ RaLZd V&VUhZeY eVVTYR]V_XV`W RZ_eRZ_Z_XRhRV_Vdd `VZedNWd eYReZdaV a]V_`h hY` eYVj RVLhYV&V eYVj T ^ VW^ R_UhYV&VeVVj RVX Z_XZ

CfS½ 5 Rc34hRd_`eeYV} cdHR_UYVhZJ_`eSV eYV]RdHe`Rc2Zff]ReVeYVR_XfZYeYReT^VdW^ _`e_`hZ_XhYV&V^R_\Z_UTR^VV&/^`chY&V ZeZdS`f_UŽHV_WUe`X_SRI\e`fcc`edd eYRehVTR_ddRceW^ eYVSVZ_Z_XdcVVbZ_XeYV VQJRJj eYRe`fcSVZ_Z_XdhV&VhZeY`fcdMg&Z_ 4 YZVLeYZI[`fc_Y_YRdSW_^RUVhZeYeYVYVJa`W hcZeVdR_Ua`VeZ

$C\,F8\,9\!F\,C\,I\,H\!C:\,8\!=\!\!G\!C\,F8\,9\!F$

 $EYV4YZNR_RZ_hRd `VeYVdZeVV VCI deV eV VCI de$ $`VeYV2^ VCIR_hRd `VeYVdZeV_eY TV_ef djZ$ $7f ceYVc^ `cVLeYV gZ]V_TVhRd_`eT_}UVe$ $eYV j VRd `VIT_bf Vde R_U eYVT]`_ZR] aVCZ UZ$ $:eT_eZ f VU`_R_U`WWF_eZ eYV]ReV_Z VeV_eY$ $TV_ef djLR_U daZ]VU `gVc Ze` eYV_V eZH ZeY$ $]`_XVc`c dr`ceVc ZeVcf aeZ_d_R_U UVdaZeV eYV$ $aRdZr`V_eRdj ZeVcf IVdTRf duUSj > Raf TYVdR_U$ $9 fZ_TRdR_U eVVcef TVd`VeYVcAaf S]ZIR_aVCZ UL$ $eYVTEVReZ_`WdVc`fe`VUZd dVcZlRceRzeeYRe$ $T_eZ f VdVgV_e`UBJŽAcVdV_eReeYV`f ceVeLZeYRd$ $cVRaaVRcVURe^R_j a`ZedZ_YZde`dj R_UaJBJ VU$ $Zed aRce Z_TEVReZ_XTYRCREVCZBEZdeVRe cVf cVRV$

hYV_VgVcRTc`ddc`RLdZdcVRIYVUR`_XeYVhRJŽ

7 c eYVT _bf ZHU cd_eYV eRd h Rd UZWIF]e W^ eYV f edkë Z:e h Rd WkeYVc^ cdL V eV Vj T dej Z 8 RTZRd UV]R GVRT _} c^ d eYZ I Z_ YZ $4 ^ V eRCZ eVY$ cd DaR_ZRU e UZIT gkc 4 YZV h Rd 5 ZX_UV2]^ RXc Ž3f eR] YVUZUh Rd]`` Re Ze R_UX_SRI\ e AV6 Lh ZeY f_e JU]RS f c S`eY `_ eVV[`f c_V] eVVVR_U`_ YZ dvf c_މ

9F7=@25.Ht9@H9F5FM6=FHtC:7<=@9

 $= \mathbb{Z} \times \mathbb{Z} + \mathbb{Z} + \mathbb{Z} \times \mathbb{Z} + \mathbb{Z} \times \mathbb{Z} + \mathbb{Z} \times \mathbb{Z}$

EYZER SVAR hZey 6ct ZIRLhY ^ ? Ver URTR VU yeYVZ_gV_e`c`W4YZWZb'hY'dU[YgcZ@U'5f! Ui WUbU k Y ÚbX h Y Úfghc i h]bYgc ZUb JXYb! hlmh UhgdfUb [Zica h Y WUa cifcZVUh Yž h\Y`gd]``]b[UbXa]b[`]b[cZV`ccX":ehRdeYV T]RdY`Veh`T_TVaeZ_d`VW1ZdeV_TVL`VSVZ_XL`W eYVh`dULRT ||ZZ_SVehW_eh`Tf|efdveLeh` cVRJZZALeh`^jeY`]`XZAŽ7c`^ > VIZT`e`4YZVL eYVT_bfZteRU cdUZU_`e^ VEVjj dW\ e` dfSUfV eYVT_eZ_V_edZ_YRSZER_edŽEYVj Rjd hR_eVUe Z'a`dV`_eYVdV |R_LtdeYVZc UZeZ ZejŁ |R_Xf RXVL RfeY`cZej R_UVT_`^ jŁRUZWWCV_ed TZAjŁRdIRJV `Werlf Vel.acZ_TZa]Vd R_U UZXWKCV_TVd eYRe TR^ V $WV^{\wedge} RWRd^{W}R_Uf_{h_T}e_ZV_eZE^{\circ}d^{\vee}V$ RfeY`cdLeYV ac`TVdd h Rd`_V`WH VdeVc_ZReZ_ eYReT_deR_elj_cVRUf deVUZedX Rde` eYVaRIV`W eYV^ Vec`a` ZeLcReYVceYR_e`]`TR|UVgV[`a^ V eeŽ y9 V_TVeYZUZTCVaR_TjLeYVdVf_T)`dZ_XXRadeYRe Via]RZ_hYj:_UZR_ddVIV_ejjh`_`gVce`RSRc`bfV 4YcZdeZR_Zej dY`f]UdfUUV_]j SV`dVcVUe`V`ł Scrivervouzzzzrez_~~Werv6_jzzrev_^ V_d.SWKV ZVRZA `c; RT SZZA ac gZNUeVV hZeY eVc $^{\text{UM}}$ UZal]R, VUZadh Revde`eYV^Ž?`eeyReeYVj h vévvévé XZeV_eYV^ VR_dL`WT f colle` ReeRZ_eYVaRcRUZANd

 $eYRe \sim Ref VU`_VRAK eYV`eYVcSWkVeYVZcYVcMacYVc$

:_UZXV_`fdaVa]V&XZEWUeYVUZRaaVRC_TV `WeYVZ: VXWU^ŁTF]ef&VR_Uh`dJUgZhŽEYYj YYJU`feRXZ_de@YVZ_gRUXdWc`gV:eY&WTV_ł efcZdŽEYVdecfXXJVZddeZ]f_dXd]gVUŽ?`eR]hRd gZ]V_TVLY`hVgVŽEYV&VhV&VdTV_Vd`WYRe&VU hZEYZ_eXgR]d`Wj`gVSVTRfdkLUXdaZeVeYVT]RdML Z_eXS&WUZ_XhV_e`_cZXYeW/^ eYVSVXZ_Z_XL W/^ eYVgVcjURjZ_UWUL`ceYVgVcj_ZXYdLeYRe eYVZ_gRUXdRczgVUŽEYfdLR_VhZUV_eGjSVXR_ e`V^ VXXŽ

EYZIh RdeYVTRW eYc`fXY`fe = ReZ_2^ VZTRŽ 3`]3gRc UWZ[VULhZeY R]^`de R_eYc`a`]`XZTR] acVTZZ_LeYV Yf^ R_ac`UFTe`WeYZIf_Z_`W `aa`dZeVd+

 $y=Vef det V SVEWAVALLyeYRe fcQfVS]^Zd$ $= Vef det V SVEWAVALLyeYRe fcQfVs fc aVR_L c? ` ceY 2^ VeZIR_LeYReZeZdePeYVc RT ^ a` dEV` V2 VZIRR_U2^ VeZIReYR_ Rac`Uf`Te` Vef c` aVL dZ_TVVgV_DaRZ_ZeM/WRdTVRdVUe` SV 6fc` aVL Z_SVIRfd/`VEd2VEZIR_S]``UR_UZedZ deZ def eZ_dŽ:eZdZ a` ddS]Ve`dJ hZeYRTIfdTJ hYRe VR^ZJ hVSV]`_Xe`Z> ` ce` VMYRehRdZ_UZ&V_`fd YRdSW_R_ZZZRAVLeYV6fc` aVR_aReYRd^ ZVU hZeY eYV2^ VeZIR_R_UeYV2VEZIR_LR_UeYZHYRd ^ Z/VUhZeY eYV:_UZR_R_UeYV6fc` aVR_Z`S` c_R] VeY^ RedZ X/V^ ` eYVL` fc VeXVEYVcdLUZWEZ_XZ_` cZZZ_R_UZ_S]``ULReVVeVEZ_VeZIR_URJ_UZWE gZdS]j Z_eYVVaZXc^ZE2^{0}$

BCH5 D@95G5BHGHCFM

EYVT_bfZHRU c6clZ]RhRdYZ dyWr_bfV&U Z_RhRjŁd ^ VéZ VdcVa`ceZ_X`S[VléZeVjjŁd ^ V eZ VddVLFTVUSj YZdfS[VlěZ?`eR] YZdT ^ aR_ł Z_dZ_R^ dR_U]ZeVRefcVRXWUhZeY YZ Ž3fe eYV&VhV&a]V_g` `WYc`_Z]VdR_U^ V_ `VWeVxd hY`drRwUYZIRU^ ZREZ_WceYVZ:RUgVcRjŽ

7\&Z_VLZ]f deZf dac`gZ_TVZZ_eYVW^ W2_e&I &Tk`_VLZ V&W^ WSj_WC `WW_R&Z_dZ WCZd_`S]V deV_XY_R_Ua`hVc+ZZdaVa]Vd_UZ&ZXYULZd hRdZ_VLSdgV_R_Uac`f ULZ_`\Z_XYRdVgVccf]VU eYV_Z_`V&VZX_a`hVcdSUF VZ

 $6cTZ_]R de Revid Z_eYV Z_ec`Uf TeZ_e`YZd a ce$

 $\label{eq:linear} \begin{array}{l} 4R_e \stackrel{?}{e} e^{Y} e^{Y} VZeY \stackrel{?}{VeV} Tf_eq TR] U4 YZV \\ hRdTYRRIEVZEVUS j e^{Y} e^{T}_eRUZEZ \stackrel{?}{VT}_eqR \\ UZEZ_d \stackrel{?}{h} RdyhR^2ZeY \stackrel{?}{E} UT] e^{Y} CERZER \\ e^{Y} CDaR_ZEY RczzeR R_UT _ bf Vebf_eZeCR TR_ZR \\ SVAR_Zed \\ SVAR_Zed \\ SVAR_Zed \\ VZeZ \\ \end{array}$

EYZIVÁZI ^ BJ SVSVAť EXNJ R_UYVČ ZIŁSTEZEZI cRVJj a]VRR_EŽ7 ceYZICARI_ŁYVU VI_` eV_gZI RXVRa`V Z_ eVVdj]V`V&RCIZRI Ž9 VdRAVCIEYRE YVhZ]_` ehcZEVR_VI]`XfV` cT fcelj a`V Ž*i?`e JRUZAL]`gV_` eeVVT fceldZICZ`VV_ZXIcL]`gV`c_* $d_XIZ_` ceYVE`V_CAZICAR_U\Z_Uh`CCE`VAH_VA$ $YVRceLeV_Uć_VAH_URWWZZ_< /7 cYZIh`CLRW$ $eVcR] YVYRICK_R_UVWCLR] eYVCT VWZZ XR_U$ $} XY6Z_XLUXICZSVI_` eR_ZJ]JZTRLEV_fcVSfeR$ $JZWR_UUVRY V_T f_eVZ7c` eYV`fceleYLŁ$ $YVhZMVCE` hRc_ eYVCKUXceYREYZIa`V hZJ SV$ $Z`SfVUhZY eYVYRCY_VCL`VRCER_ZTT_~ZEŽ$

B9FI 8=5B I HC D=5G

E`T^Ve`^`Ukc_eZ`V&L? V&FURTR_SV&AU RdeYVT_eZ_fReZ_`V&GCIZJRŽ9V`V&V_bf`eVdYZ` e`d^^`_ fa YZdf_Z&VcRLCV_RZdR_TVgZZ_Ł hYZTYZ_eYVdZeW_eYTV_efg hRdRJcVRUj XZgZ_X a`VeZTWc^ e`eYVZJNR`VR_RCTV_e4YZVŽ9V h`f]U`V&V_bf`eVdeZcZ_XLVaZT]Z_Vd`V6CIZJRdL eYV\ZU`WJZ_VdcVIZeVUSj dTY``JTYZUEV_LeYRe ^Z_XJV]jcZIZt'LXV_XdRaYjLYZde`q R_Ua`]ZEZCŽ

9 V RI_`h]VLXvd eYV 2 dFTR_ZR_ hRc Rd eVV } ade XXvRe RIe Z_ R UCR` R hY`d/VáZ, Xf V YRdj Vé e`SV h azev_ŽE YV ded XXJVU`Vd_`eR]hRj dT ^ V e` eYV d`d/RIVLSf e Ze cVIV`VXXd VgV_ e`URj_SVI TRF d/TV_ef aZd`]U T_~ZTed cV`RZ_ RJZgvL]ReV_e R_U f_d/d]gVLŽ

EYV? VÍ UZ_ fé aZ dacZ_XdW'^ RYZÉ cZR R_U [ZEVARj ecRUZZ_Ž2]eY fXY YVZIRa`]ZZZR] $T ^ ZEVUh cZVL? VÍ URZIRI TCZZIR] R_UdyW$ $TCZZIR] RdYVV R` Z_VdYZÉ cj R_UZdUVýY`a^ V.e$ $Z_ R^ `UV_ [ZXYČZ dyWT_WEWUaRez d_YVYRd$ $_` cZ VWc UZb]R] d`WIYRf gZ_Zh`Ž9 VU Vd_`e$ $RTIVáceYVW[R]] `VR4 YZVR_dRIVŽ9 VZIaRtiZ_ł$ $ReVIhZY a`dZgVZVN]dŽ9 VhR_cdRT f_cj eYReZI$ $`aV_ e` eY`c`fXYUV` TCRZKEZ_łh YVCVýVj`_V$ $YRdeYVcZXYee` R^ ZUJ ^ VR] R_URa]RIVReeYV$ $TZTF]RceKS]VeYREZIE`X Rc`f_UeYVh`c]UŽ$? VfUR YRU Y`aVKŽ9 VU Vd_`edW` e`YRgV YRU e` ^ R_j Z]f dZ_d.Y`h VgVKŽ9 V_Vh eYRe YZI T` aRecZ ed YRU UZWWCV_e gZh d. eYRe_`e R] `VVeYV` dYR:VU YZI` aZ_Z_d` c YZI ZUNRI VIC eYV T f_egi d VKef cVŽ 2S c`RUL eYV a` Ve dacVRU R_ Z` RXV` VVI YZVRIR JZXYe dYZ_Z XZ_ eYV d f eY` W eYV T_6Z_V_eŽ9 V YRS` f cVU eYV UCVR` Lh YZIY YV eY` f XYe RIYZ&GRS]VL` VR_REZ_ hZeY R JZeVj UV` `TCREZTRh REV_VHLCER REVURE eYV_U` VR=REZ 2^ VCZIR eYReh RIRD, VAL CE REVURE eYV UCV KR Lh YZIY IVEN` TCREZTRH REV_VHLCER REVURE eYV UCV KR=REZ 2^ VCZIR eYREH RIRD, VAL CE REVURE eYV UCV KR Lh YZIY RYf^` c` f dda ZZELZ_ VL eCRER XR_e T` a VEEZ_de` ac` gVLVc' VR` a]VL eYV df a VZ CE j` VVZIT f_egi d hZ VR U ac` UTVŽ

8=CH F698 H=A 9CZFCI; < C95G

CVRJZj ZL_V&VCRa`V Ł`cRJ^ `de_V&ZGZZ_d `W4YZJV WZ_SVT ^ VUZdf cSZ_XR_URU^ Ze`V&Vg UZ&VdVdVRLZ_XZŽ eZIRT f_egi hZY RIF eVa` JZZTRJŁ VT_`^ ZH:d TZRJ R_UTF Jef cRJ T_eeRdeZ 5 ZWWZV_TVd TR_SVT ^ VTYRch dLJVRLZ_Xe` TZZJ hRtL^ RdJZgV ReeV aedReRc^ VUcf aad/dtZ_`V&Y dVhY` eYZ_\ UZWWZV_ejjZ

 $EYVT f_eqj Zl_`eh RHVUSj ZdXVRebf ZdedvRL$ $RdeV_ReZ_R] R_eVV YRdZdL_`cTR_ZeS`RdeeYRe$ $ZdaReYYRdSW_d'``eYZ2]]`V&YZh R_VdZeYRdVć$ $e`ecRIVeYV]Z_VR^V_ed`V&YVyej aZR] 4 YZVR_%Ze$ $ZIYRRRU f de``SVIRf d/V&Ycj`_VZIUZWWCV_eZ:W$ $d^VcXdV^S]R_TVTR_SVWf_UFZeZleYVcVff]e`VR$ $YV&C`XV_V f dT`]]VTeZ_`V&Zdf VdR_UWF]ed:d^V$ $`VMYZTYT^VW^R]`_XhRJ SRT\Ž$

=89BHHM5G'7CBGH5BH7<5B; 9

 $\begin{array}{c} EZ^{*} VYRdh`c_Rh Rj eVTJZIY½`VR UFSZ fd\\ yZ V_eZ j %VdHS JZhVU`_TVR_UVC RJŽE YVac`Sł\\ V^{*} VZ V_eZ j hZJ_VGVc SV VM jj cVd gVL R_f TYR_XZ_X V_eVJVT jLaVcZ VU Z_eV eHet V`W\\ eYV4 YZ NR_C`e`Z_AJR RJ f_XB JZE YZ lbf V dEZ_hZJ hZJ RJ hB dYR gVZ T ^ aJVVR_dh V de YR RVd f XYe\\ ^`cV f cXV_eJ ReeZ Vd`VT cZZL`WT_VCZ_R_U\\ Xc`hZ X UZ cZ_EZZ$

EYVZ'a`œR_TV`WZXWZV_TVdZ_`fej``\hRdRe ZdfVV&/^eVV`fedvěŽH,Y`]bX][Ybcig]b\UV]h UbhUbX'h\YV&bei]gtUXcfibXYfgrccX'h\Y]f` ck b UbX h Y ch Yfŷ [XYbh]mi]b h Y ``][\hcZ h Y]f ck b dUfUa YhYfġ gc h UhWcbhfUg]]b[`]bhYfdfYhU]c bg WUb VY HUWYX hc h Y XUk b cZh Y Wei bhmŷ \]ghcfm' @_TV eYV DaR_ZhY Rozg WLgVg UZWWCY_eT_TVácZ_dSVAR_e SV Wc^ W` VeYV_Vh_ReZ_RZj eYRehRdV^ VSZ_XŽ EYVUZWWCY_TVdeV^ VUW7^ gZha`ZedR_UaVd d VTæg VdeYReh VcVd&f ReVURe`aa`d&Va`]Vd`VR d TZAj UVA]j UZZUVUSj hReLSj eYVT_dTZ fd_Vdd `VSVZ_Xf a RAZ_deeYVyV_V^ j%Zaf ea`]RdZRZ_ R'd _f cef cVU ^ fef R] T_dUVReZ_LcVT X_ZZ_ R' ZUedy[VTeZ_Ž

Hs 9'D9FG=GH9B 7 9'C : '7 9FH5=B'<=GHC F=7 5@ @9, 57=9G

EYV`aV_bfVdZ_KS`feZV_dejh`fJUSdZX WaeYdARCTYVdWceYV^VR_ZX`WIZdeV_TVL^Rj UZMUV_dLd^V^`dVTReXX dZRJKS`feeYVZc`h_ cVRLZX`WeYVTf_eqjL`W1TZdjL`WeYV^dMgVdŽ :_d^VTReVd deYVdVd^ZReZ_dJVUe`eYVTeVI ReZ_`WjeYdLeYVdVeZXfa`VZUJdUe`eYVTeVI ReZ_`WjeYdLeYVdVeZXfa`VZUJdWeZhVd`c ^`_deVddDfTTVdDgVT_defTeZ_d`WeYVT]JVTegV Z RYZRjhVcVac`UFTVLLT_ec`gVdZdRS`feeYV yH W&hYZTYeV_UVUe`T_d]ZLReVZYVdZeVUZVRd R_URgVdZ_dŽ

EYVEVZIRTJVRCZdGeV_TV`_ aRceZIF [RCYZGe CZIR] [VARIZKEŽAV a]V]``\ SRT\hRtUde`R_dhVetZ_eYVZc `h_hRjHrgzer] bfVetZ_+hYVEVU hVT ^ VVE/ 0 EYV`VVIZZ] R_dhVcZel_`e6CIZJ[Ret.SfecReYVcAVI Uc`UVCRJUZZZeVV^ eYV*LT ^ LUC*deeVV2CVRe]R_U`h_VcdhY` aVCIVZEVUR_`gVchYV^ Z_XUZW WEV_TVSVehW_eYV`dv]gVdR_UeYV_RezgVetd`_e` SVecR_dVC^VUZ_e`VVC^YR_UETR_f_ecfdeh`ceYj ^`SZEYVEVZER_V_ecV_TYVU`SdvetZ_hZeYCdePet Z_XeYVcfaVZ_cZej`VVeYVDaR_ZYY`ceYVVCXZ_RdR acZ_TZa]V`WRefdE]]RhEUfSeZ_X`cf_eYZ_VZ_Nj UV_jZ_XeYRe_eVVdvgR_eL]ZVeYV^ RetVeL^ZYE SV[`_Xe`RYf^R_T_UZEZ_h`ceY)`VVCaVZE

@eYVdhR_ee`T&ReVeYV^jeY`W&RIVŽ:_ eVV VRcjjehV_eZeYTV_efgL?ZT jid ARJRIZ eLZ_YZd S``\ *CR&R TYZV_RL*`WW&UfaeYVyc'e`%&eYVVgd Vg'^R_`WeYV4YZVR_]`hVcTJRetLRdeYVVeY_ZT d^S `]`WeYV_RZ_ŽZTT dZ_Xe`YZdViaJR_RZ_L eYVyc'e`%ZdR yaYV_`ejaW&oR dfaVZc \Z_U`W ^ Væk ES`c_`Wh`af CVcRIV&+eVV8`eVdR_UeVV 2chFTR_2R_cZARJRIZ dRaac`gVU`VZ ^ ZKReZ_Sj 8 Vc^ R_dSVTRFcV`WeVZc8`eVZTYV&ERXIŽ

?`_VeYVVdH.RaR`aYJVeafSJZHVUSjeYV4YZi VR_8`gVc_^VeZ_=VZakZXZ_eYVVRdjehV_eZeY TV_efcjhZeYRgZhhe`ReceRTeZ_X8Vc^R_T]`_Zded Via]RZ_VUeYReyeYVdfeY`WeYVTf_ecjZd]R_U W^ hYZIY eYV2dfTR_Z2_dLR_QZ_WZccRIV`W dPgRW:_UZR_dhY`fdVUe`Z_YRSZegRebf_Tf]eZ gReVUerRiedLhV2VViaVJJVUZ_"))#%Z

A5B=7<59€A

EYVRU^ ZZ_XUXIIZaeZ_d`VeY d/Re eYVe`a `Wi TZG RV^ REIYUUSj UZY ZUGV`_Vd`VeY`d/ Re eYVS`ee`^ ŁaVcd_Z W Z_ yeYV:_UZR_%R_U a]RIVURER]`hVc]VgY]`VeYVchVIZcZ@eYVcWRVY] V acXdZ_dRVRUVLLcf TY RdeYVcf cR ySR_UZ% R_UeYVf cSR_yc`e`%Z=ReVELhYV_eYVa`af]RIVYRU SW_`cXR_ZXUSj f_Z_dR_Ua`]ZZIR] aRceZdR_U hRdaf ceZ_XWchRtU ReVc_REGVZVRIVC d`TZGL eYVcVhRdRRc^ ReeYVf ad cXV`VeYVyLR_Xc`f d T]RtV%Z7 \]`YZIN YbZK Ug`[f]ddYX`VmZ/Uf`c Z h`Y`C h`Yf"

:_RdfST_&Z_V_eRdf_VbfR]Rd=R&Z_2^V&ZRL eYVLXWW/TVSVehW_eYVI]RdtkdZ_4YZ/vacUfTVd RTYRch eYReecR_dRevdZ_e R_RaaRV_ejjZcV^VLZ RS]V/decR_XA^V_eZEYZeff_ScZLXARS]Vd/aRR&Z_Zd Wf_UZ_VgVgRVR_VJZWZe^^T/Vd/IYV^VdWceYV \Z_U`Wj_R&Z_R]f_Zgj%LR_ZeVXRevUZV_eZgj`c ZAR`W4YZ/VE/Re^ZXYeSVRIYZgJSS]VZ_R^`cV `c]VdtY^`X/_fddTZkjZD^VReeRIYRUVAVc ^VR_ZXe`dTZR]UZWWCV_TVR_Ua`J&ZIR]UZgVcZgjŁ f_UVcder_UZ_XeYV_RdRd`ce`V&ZTRc_ReZ_`W eYVcdef XXVSVehW_8``UR_U6gZŽ

@VVF f colle/Zd> R_ZYRXZf Zd_`eR|hB, dVl ac\db\Ud d\RaljLSfeRT_dR_eUZ/ZZX]Z_VZd Udh_ŽEY\&\R\&Z \LY h\g\dbY_ef d\hY Rdh\ceZeV_e\cRXCy_R\Ad \&V_eY\Zc]R_XFR\R_U eV a\ceY\gZ]V_TV`\\AqVIZ_Ž

H 9 < 5 J 9 G 5 B 8 H 9 < 5 J 9 B C H G

DZ_TVT]`_ZEJEZ VELEYVEVYREISW_R_RTNAER_TV `WWf_UREZ_R]^j eYdeYREVN/BREVEVVgZef Vel`VBYV faaVcTRdWŽEYY RVReeYVe a`WAVaj dX ZŽ EYY Z a`dU`SVUZ/TV`_ eYVa`af]RIVŽEYVZ ZJR`WdVchRdf_eYZ \ZXT ^ a]Z TVhZY eYV]Rh Sj eY dV eYY U ^ ZRAU RAKć eYV SReeJV`W =ZTRJŽ5 k \c'Y']XYc'c[nžVYVc'a Y'gYVc'bX' bUh fYžk Ughc YbhYbW Ub fcb X]gW[d']bYž U'XU]'mfYbYk YX ZYUf cZUi h cf]mUbX cZ di b]g\a YbhZ fh Y'g'][\hYghfUbg fYgg]cb":e h`f]UR]d d\cyVe Rg\ceeYVcZh`\K_j dX_Z TR_e a`af]RcUZd dVZ2 d'TZkj `WcZIY R_Ua``chRd eYfd\cHS]ZhVURdR_Z ^ fdS]V]RhŽ

3feeYVdARCTYWceYVcVacVdV_dReZeV4YZVR_ h`f]UT_eZfVZ]ZEVcRcjh`c\Ž>RcZR_`=Re`ccVL eYV [VRU/c ` WeV TZ] ZHR dIY `] Z 4 YZVL^ RZ] eRZ_VU Wc Vi R^ a]VLygVcj } c^]jLeYRe RV6Wc eYV YVć``WYZE`qiLeYVd`]UZC`WeYV:_UVaV_UV_TV ^`gV^V_eLZehRd_`heYVY`fc`WeYVXRfTY`Z_ 2cXV_6Z_RR_UF d XFR R_U`WeYVQYFRd`LaVRd $R_eVZ_4 YZVLTR]VUeVVQVc^ VaVRTVZ2 decR_XVj$ ď XXV dezev ZVRLSRCV j `Sdlf cVU Sj eVV VRIe eVRe eYV4YZVR_QYFRd~YRd_VgVcRIbfZVUeYVdeRefd ReVZ eYZddvdaVTeeYR YZdT ^ aR Z ` cT f dZ > Ree³/₄ 7Z/dc``cU_DVAf_UD^SdR, eYR_eYV $GV_V f V R_a RZ_d R_c ceVV4]^ SZR_d SSVc$ h`c\Vc,eYR_eYV:_UZR_`cQYY`]```W6TfRU`c`c AVcf, eYR_ eYV3cRkZZR_ TRIR h`c\Vcd`cDkce²_ TRee[VorR_TYVorL`ceYVh`c\Vod`_eYVofXRcR_U SR R R a R e Rez d`WeyV 4 Rezs SVR ŽE Yzd Zd R WRTELVeV_ZWZEZIYfceWN/e``fcacZUNŽ2_UhYRe Zel^`cVLeYReY`fc`VeYVQyfRd``VeYVT]`fcVM `]UdeR^ a YRdac`SRS]j aRdtVLL`cZl_`h aRdtZX‰ 1EVZeVJS`Z'Ł"*(\$⁄Ž

I F65 B I DCH5 FHC

:_ =ReZ_ 2^ \{ZR e`UB}LeYVef eY ZleYRe eYV TZġ ZlUGZZX eYVT f_eġ dZNŽE YVWCIZ ReZ_ `\VeYV]R_UCIRa\LhYZVZe ZldeZ] R_ Z_\V YR deS]V d fcIV` \VZ_daZReZ_ RdR d\eeZ_X`c SRI\Uc`aLZl _`eV_`fXYe`ac`gZVeYVSRdZl\\cR_ RcIY\&j a\Z :_ 4 YZ\LTZġ lUh V]]\cdReVZ_ eYV^ R[`cZġ LR_URV SVT ^ Z_XeYV_\h deR_URUŽE YVJ R\\deeZ_XeVV aRIVZ_ R] d ced` \MB dŽE YVJ T g\\ceYV_eZVdIR\L \W^ eYVfcSR_y]f^ a\Z\@o`eYV_`fg\Rf cZIYVR_U eYV^ R_RX\ch`c\Z_X\\cR^ f]eZ_REZ_RJŽ $8 \vee VReZ_R RCTV g a Vd R d Raa VRŽ:_ > RR$ `_URL2]SVæ 7f Xf Vé UVCTCZSV de VV ^ R__Vcd R_U ZZ ^ d`WeYV]Rde XV_VCREZ_ `Wy`f_XaV a]VZ eYVeh V_eZeY TV_ef g LRd2]SVæ 3]Vde 8 R_RUZU Z_ > Rce3/4 CZgRctZ_ eYV ^ ZJ_Z VeW_eY TV_ef g Ž AVUc` =V^ VSV] h Rde`Rh RcU R TYRceVc` V/ZeVcRg TZEXV_dYZa e` eYV af S]ZT T ^ Z_X`fe`VeYV XG dTV_VLRd1/ceZ_X eYVT]RZ` e`]VXEZ RIj` VeM f R] UZEVcRg Ž

3fe> Rce1/4CZeRcIZcleYV_`gV]`VV R__VcdeYReYRd Tc dt UeVXV_VReZ_dtRaaVR[Z_Xe R_V_c^ fd af SZZZ: e YRdZ_daZVU}]^ dLa R dR_U eVVgZZ_ dvZdLR UYRdSW_gZefR]j cVbfZVUcVRLZXZ dTY``]dŽ:edeZ`V[Vdda`af]RcZej Tf]USVUFVe` $Zed dYZeVW^{\wedge} hReeZ^{\vee} VWRed l > Ree\frac{3}{4}Zdc^{\circ} feVU Z$ eYV cVg`]f eZ_Rq``f eScVR\`W) &" LT_UV_VU è UNReY R_U VIZIVUI è eYV XKNRe WNRe `W^ `U\ć_ eZ Vd+d TZR] RUgR_TV V_e R_U ^ _ Vj ł^ R_Z XŽ EYZIZIeYVXCVReRIYZIgV V_e`Vkac`gZ_TZRjj`feYL $dY_{L^{\circ}} dR_{J} = dV_{L^{\circ}} VR dZ_{V^{\circ}} ZZ_{XV_{L^{\circ}}}$ ecVacV_VfdLhY_ZdRS]Ve`defUj]RheYR_\de`eYV dfaa`ce`VRhVReYjDR eZRX dTZRZEVŁRVOZVU`W YZI WREYVČOŽ > Rce³/₄ ZI CVT X_ZKU SjeYVa`hVd $MZ9 VZIRITVAeVUSVIRF dV^ WZI^ UVReZ_ R_U$ df_U[fUXV^V_eLYZthZ]Z_X_Vdde`dv/gVeYdV hY`Zec`UfTVYZ`e`eYVdV{_V`V_ed`V02Re2RX`Ž EYV_`gVjdY`hdyR_RSd`]feVT]RcZgiRS`fehYRe RdTZkjdYf]UR_UdYf]U_`eSWaaR_UReeYV dR^ VeZ VyRa]ZRS]V^ `dR]Zej Z_ ^ ReeVed`V&`]ZeZId R_USf dZ_Vdd%@dvdL" ***/ŽecVgVRjdRTf]ef cV`Sł dadauhzeyd Tzr, Rubr, TV Ver, URWARc Wdz X a`dEZ_Ž:eUvdTcZSVdeYVZc`_ZTR|R_UYf^ZZReZ_X ecVRe^V_e^VeVU`feSjfaaVdT]Rddj`feYde`eY`dV `W` d`TZR` deR_UZ_XŽ*A Ufht*b`F*jj Ug*`gYYa g`hc` i bfUj Y``U`ghYfYchndY`cZ7\]`YUb`gcWyYhnž]``i ghfUhjb['h\Y'hfUbgZcfa Uhjcb'cZh\Y'Yd]W UbX [XYU`]ghW\Yfc []bhc U Wc bZ fa]ghž gc ! WU!WaVb[\Yfck\c^cbghYXca]bUbh ₩`'n fY"

$H_{c}9G58B9GGC: H_{c}97 < = @95B$

:e YRd SW_ dRU eYRe h cEvcd RcVL`c TR_ SVL h VReYVcgR_VdWcYf^ R_V a Vc2/_TVLeYVec2f^ a Yd R_U erRef2dd`W' R_\Z_UŽ

7dR_\]Z_BfVgVU 1#!!!/UVTZUVUe`Sfg YZ`ł

 $\label{eq:constraint} \begin{array}{l} dMVZ eYV[f_X]V^{*}W4YZWR_a^{*}Weg^{*$

5 GMBH + 9G+GC: H + 9 D@5 B 9H

7 Ufcg DYnc U'J f`]n'gd YU_g cZÎ U'_]bX cZ]b\Yf]hYX gUXbYgg h UhgYYa YX hc k YYd Z f U``h Y gcffck g cZa Ub_]bXÏ ": V&YV2j ł ^ RRdda`\V`W4 YZ]ZRdeYVa]RIVyh Y&VeYV]R_U V_UY42 Vf URdUVIRZaeZ_SVZ_dh ZY eYV_`ceY+ y EYV&VhV}_Už af dVXV XRaYj ŁUV&C^ Z W Z ZddeR_XVZ R_U RSdeRIe]R_UIRaVLVReY R_U RZŽE YV_TVe``eYVaf dVR_UaRZ_W] aReYd`W R_ UXIV_Uމ

9 f Z) SC ^ RZ_dZ_dZ_2 2 JeRK d.eNRe < Z eZd UNICE VRIY dRCZZEEV/ ZXVCR_ `RZZZ@C~RXd `WWSS`UZ_XR_UUREYZ

7`c8RScZJR>ZteRJLeYZt]_`ceYZt]yRTVceHZ_ a]RIVZ_eYVh`c]UhY`dVa`ceZ_hRtlR]R_UTRde dY`c_`WgVcjXcRIV`WgVXdReZ_R_UVgVcj\Z_U _Vdt`WhReVcZ $\begin{array}{l} 6^{a} XRCHZZ XeYVYRUVXIV`VeYV2_UR_]R_U \\ dIRaVL3V_ [R^ {3/4} Df SVCIRCHAFT aZI\d`fed^V \\ d`XXCHZZVa]RIV_ R^ {4/4} f TYRd> f VeVcluy> R_j \\ 5 VReYCHLARCH 4`^ VL4 RSR]`duyDhR]`hl9`cdV \\ ARCHML>`_eVUV]RAV_ Ruy>`f_eD cc`hMZZ \\ \end{array}$

8 RSCZ/R> ZherR ecRVdeYV_Rcc hET_ecRUZie g [Z_VR^ V_ed`VWVcY^ V/R_U+yEYVXV XRaYj`W 4 YZ/VRIYZ&gVdR\Z_U`WJ_eYVdE'V&Va/R_VŽ:e dRccdZ_eYVUVA/deLhYZIY ZddRceZ_XhZeY RdeVCZI Zj_eYVgR][V] d`V&YRek`_VhYVcVWc^ Z_XZdR], Ze eR\d`_ RYVc`ZI`WCVESVRf gi_Z_eYV]Rde dcvEIY `V&YVT_eZ_V_eLRdeY`fXY e`V_Uh`ceYZjER_U Ze da]Z_eVcdReeYVeZeL`WWZ_X]ZWR_UUVReY YR]W R_UYR/WZ_RdvReYReacVgRZReVCSVchW_Zd]Zbf ZJ S]ZdIR_UeVVa]B_Vb] S]ZdI`Wevc_R]ZVZ/EEYVeYZT/E V&YVC4: WXC2_VZEYV/R_U: TR^Ve`YRL^ DacZ_Xe Zz_YRdZd]'_X_ZXEeRReYZ/VCA^VZ/VR^^ eVCZ

7 < FC B = 7 @ C: 7 C @ 7 H 9: 95 FG

EYV&VRVRFeY cdhY JZE eYVETRFdddWceYV f_VRdV`WeY dVhY JZeVZ eYZdJR_ULRaRceW'^ eYV VRceYbfR\VdR_U g`JTR_ZT VcfaeZ_dhY dV YZEF g`Z_4YZVZdReVcZfyZ_X`_VŽEYVj dWVce` `eYvETRJR^ZZXdLeYVdfCtV W__VgZ_XdReZbZtZ EYV&VZdR_VRdj dWVV_TVe`dYZhdVT\dLhYZTY RVTRJJVUeYVYUZJj SCVRU`Wd cc`h%ZeYRdSW_ eYfddZ_TVeYVSVXZ_Z_XLZ_eYZdgZ JV_edfeYVc dMZ:_4R_e`dI G R_UI G:`V&R2dFTR_R6cTZJR UVCRZSVdZe+EYVdj`aV_deVVdRc`RcdR_XZj< :e cfdrWfa`_eYVRJ/V_RSVR`< HZEYeVSRTVhRd/L eYVVaVRWUURAYZ

3Véh W_ "&#! R_U" *!! ŁeYVC/h VC/" Ł\$#(dYZał hcVT/d`WWYV4 YZ/WR_T RebŽ6_`f XY e`decZ/VWRČ 7c`^ eYV dWLe`LTR`VeYV ya ZReW&R h`dJeYRe h`f]UR]Rc^ 4 YZ/WR_dWc`gVceh`TV_ef cZCŽ

+b h Y W fcb JWY c ZWć `YWj Y Z/Ufgk \cgY]bû YbW/k Ugbc hWc bÚbYX hc h Y a YbhU]mi cZh Y `ck Yf WUggYgźk Y U `gc ÚbX k \Uhk Ug _bck b `Ug Î VUbX]Ifmi `h Zey Zed & VY _ `f d d & `Ukc_ JWRJ Zh Z.MacARUTAZ VLRX `U`cSRU aRe `Wh YZY UKZgkł W/ a `gkiej R_U W/ R



T_WAAU (A)g`]e Sj eYV ^ REXZ RJZAVU RARZ de eYV dj deV eYRe VIT]fUAI eYV Ž:W_TV Ze h Rd T ^ ł ^`_ e` eR]\`VVd TZRJ ScZAR_URXVA Zed c``ed_` h X VgV_UVAAVc R_U h ZUACZ_R d'TZA gi eYRe Zda`` c Z_Vbf Zgi R_U [f deZTVŽ

 $4 \mathbb{R}^{(1)} dAWc \mathbb{R}G^{1/2} W^{(1)} hdZdUVgV^{(1)} a^ V_e Z_{d}^{(1)} (AWc^{(1)} WC^{(1)}

H 9 A 9 0 5 B 7 < C OMC : 8 - G = O G C B 3

 $\label{eq:approx_appr$

4 Rc]`d AVk`R G ¼Zk_`eVd+y@_V`Wê URj`d _VhobRaVcd TRocZki R gVcj_decRZXYeVkh RcU]Zee]V ZeV Ž:eZcIRS`f e RUcZANc_`h_Sj_eVV_ZT_R`V > Rf dZRj`f_XRaaRV_ejj R_Uf_a]VRR_e]``\ Z_XLhY`UZUd`UUV_lj Z_eYVIR]VUV]RGZR`dZZ EYVU`Te`chY`TRcdZU`feeYVRfe`adj deReWeYRe YVYRUdeRcgVUe`UNReYZ‰

9f_X&+y2_U: YVR:9f_X&VR2_X&rd3 d8 Rsc2 VR> Zber3Ž2 S`YV ZR_ R_UVcdh YZVUR_UJLeYV a`VeEV}]` 4 ZLLaYZ`d aYZ&dRS`f eYZUU h_V9]+ : YRgVX_Ve`VReh Y&VeYVa``c VRežR_U: YRgVVV eYRe eYVcHRUh Zl`gVc R]] žeYRe aRZ_ JZVeYZIZIR JR_X RXVZd`caRdZ_XeYVd_Ld`caRdZ_X^`eYvcŽ

$$\label{eq:linear} \begin{split} & Dc `]HWU`X]gUddc]bha Ybh]g U`gc `U`Wca !\\ & dc bYbh c Zh Y`7 \]`YUb `gUXbYgg `bUffUhYX`\\ & [b ``]HYfUh fY'' > Z]Z_d`WaV a]VYRgV`c YRU R\\ & UCR` LRY`aV, eYVac`^ZhV`VRd `TZej eYRe_VgCC'$$
 $TR` VZ4f dZ > R]RaReVgZEEU 4 YZVR_UXRgVR SR]R_TUU`aZ_2_+ \end{split}$

yEYYZ WIVARVAUR_UéYZcd_XAR_UUR_TVAL RJeY f XY dée [ZgV] cY eY d RVAUR dh V][Ž2_U S` eY eYYZ d a` Vej R_UeYYZ ff JeZgReVUa` Vej RVALŽEYYZ d R_UEYZ d RTZ/ d Wd` WW dU_VAL_`e`_] Z_ eYZch BJ `WAR\ZXL`cXd eZf]RZ XL`ceR\ZXL`c]ZkL`c]``\ZXL`c WJ[Z_X dV/d h YZY d ^ VR eY d YRgV]RSV][W ^ Zhef de`cd daZZ_LSf eh YZY: eYZ \ Zd^`cV eYR_ eYR+RT_dR_e^ VLZRZ_`_ Yf^ R_ RWXCd R^ VR_TY`] `WUZZ][f dZ_ 1< / eYY RV} VETVL bf RacVd ^ VLYZY] SAgVR_UZ_UZWWEV_ee`UVReYL bf RZZdeYRERVSVevCd ZWUe`RAU_Rf cVerR_ R^ Vaj`_VaB f VgVU L#!!!/Ž

EYY YR YVI a]` CUEYVAU_VA` WZTER` CAZAL V ZVL^ RARCUAR RALVREY, UNREY hY`^ 8 RScZ VR> ZHCR TR]deYVy@]UCVXZHCR%LeYVy4`f_eVd > `eYV%LeYVy4`^ VAV a]VAZ

H\Y`]HYfUfmWei bHYfdc]bhcZU```h\]gʻgcffck k Ugʻhc`VYʻdfcj]XYX`aU]b`mVmH\YʻBYfiXU` cZhYʻgYWebXʻdYf]cXžk\Yb`\Y`X]gWejYfYX` 'cm'

? VcfURLhY`hRd^V[R_TY`]j Z_YZdj`feYL afS]ZEYZ_XRd_X`WUXbaRZ: ReeYVRW`W#! R_U ac`T]RZ`Z_X+: *Tf]UhcZeVeYVRUXde]Z_Vde_ZXfe_L* hc`eVZ_YZd^RefcVjVRcdR_y@UVe`cRU_Vd91400 hYZIY ZIR_R_&U eVe dU_VdHR_RSd |f eVeV[VI eZ_`Wat cc`h f eeVeVUSj R^R_hY`hZhVde`SV YRaaj ŽDRU_VdHSWEVZhZeY dgV_Sc`\V_JVHZVXA `WabZNedhVSHZ^RZ`VU dHZSZEIYdd V[Ve_+zJ`f hZ]_`e V_eVeYVeVZz< Via`f eZ5 VaRezZ

? VcfURh`f]URd hcZeVYZdy@UVe`eVVYRaaj UR WŽEYZLOZ V Ve ^ Vž SVYRaaj < 7 c X U ^VRcfcVLYVhVe` e`hcZeVR y@UVe`[`j‰: dľc_VUj`fŁ[`jŽź: hRdZ]]łRUźZWŽžEYV^``_ž]VU ^ VR]`_XYVchRj dŽžEYV` [Ua`Vedž]V_e^ VedvIeRI[Vd žR U Viee`VevjeYZXž: a|RIVUR URc\ YR|`Lž Tc`h_WeyV~`h\chZeyS]RT\ŁždeRdRU\Zdžfa`_ eYVSV gVU^ `f eYŽE YVCVZddZ] eZ Vž [Ve^ VTYR XV _`h: TR]]fa`_j`fL[`jŽžz=Z\VeYVRceYžj`f RcV ž_VIVáRcjŽž=ZVScVRUžj`f RcVafcVŽž=ZVeVV hRevć Z_R częvć žj`f RcVcvd_R_ežz=ZvRSW žj`f a`ccZ_`feY_V/Rdj`f~jŽž;`jŁž: hRdRdf]]V_ j`feYLž: Wf_Uj`fcYKUždYTVZX : R^ XZX e` cláRj \ģ\ģ`_VžSVIRfdV: `hVž^j [`j e` R]|Žž ?`S`U dr`f]Uh`_UcZWhR_eže`X&V^ V_žeW XXXX WeYV ReeYLŽSVIRF dVZ_ eVV def XXV:]VRc_ež eYReZeZd^ j VRceYj Uf ej že` decVRU[`jŽž2_UhZeY $^{j} d_X W] ^{j} U d Z j Z$

GVġUZWWEV_eZtyEYVUZET gVġ`VVjj‰jARS]` UVC`\YRLR_R_eYV`ê 4 dV]VVfaY`cZeLdf_XL`c ^ R_XJVULSj eYVyc`ê TY`c`%ueYVa]fT\jc`ê/Ž

:_ T^ VeYVXfZRZHdR_URSZXCR_TRXfRhZ_Vž hVládeVhVláZXTfVTR`VeYVc`e`TY`c` hVládESfe žh WádZed TYWCW[]j RhZUh YZ] `W^ aR_RLRR_U ž`]ZeVR_UCRZ`f_U 4`_ecV&RdacZT\ždY`f eZ_XR_U dZ_XZ_X]Z\VR daZJj a`c\c`]] žj`f dafc_ eVVhZ_eVc af_TYžeVVj`f eVd]Ra fa<

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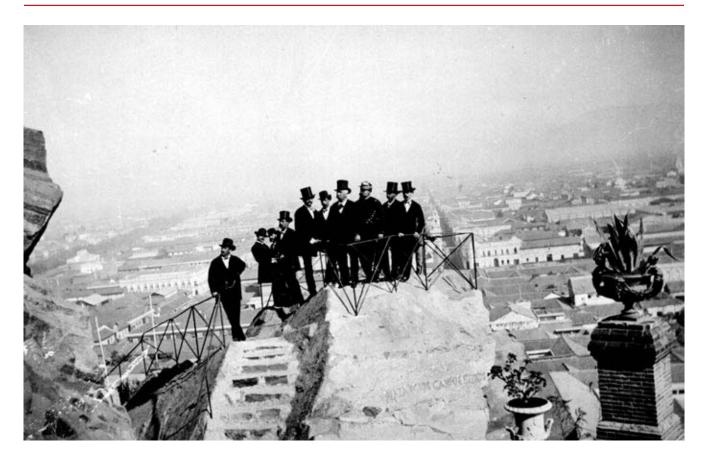
y? ReZ_RJ ZU/eZej%Zcl^`cVeYR_eVVef^`W dVTe`dRJ ZU/eZeJ&LR_Ud^VeYZ_XUZWWEV_eV0'^ acVT_deZefeVUVdbV_TVCŽ?`cUVdZeRZEV`_Jj V&V^da`_eR_VfdZ_UZgZfRJeYfXveZ:e_WUdR T^^f_ZejZ:eZITCVReVUZ_eYVY^VERedTY`], ZeZlecR_d^ZeVUEVCSVeeVc`ch`cdMEZ_eYV^Rdd ^VUZELeYcfXYS``\deYVh`dJU`V&T]ZeZTeLy`aZ_ł Z_Wc^Vcd%Z

E`UMZ_WREVZELZEZL_VIVdRg e`UFde`WWZde`djŁ }_U`feZedecRUZEZ_dR_UTfde`^dLXde`_`h ZedYVc`VdR_UR_e2LYVc`VdLeYV]ZgZ_XaRdeLdr`hł Z_XeYReeYZdZlR_RIEzgVaRdeL_`eR_`ddRJXZTTf]e `WhYRefdWUe`SVŽEYVeRd\Zde`SJV_UhYRehRd hZeYhYReZdR_UhYRe`fXYee`SVŽ

=XYbł]mžł\Y'gY'Z dc flfU]hbUffUłłYX']b'\\Y' Wa a cb'\ca Yžg\ci 'X'bch'i ghfYdfYgYbh \\Y'W UfUWłYf]gł]WZYUh fYg cZgcWJYmžVi h g\ci 'X'U`gc'cZzYf'U'XfYUa 'cZh\Y'Wci blfmi k Y'k Ubhłc 'VY''E` daVR\`W&YV_REZ_ WJ}]]Z_X Zda`eV_eZg]U Vd_`e^ VR_eYVX R]ZIZ`^`SZZGŽ CReYVcZeZIRTR]] e` RIeLe` h`c\e`h RtUdRd TZG eYReZlh`ceYj`VZedJ]WZ

$7 < 5 \text{ DHPF}^{-}$ &

H≰9[·]DC @H¥75@7CBGHFI7H€B[·]C: [·]7C @@97HJ9^{···} → 5; [·]B5F=9G



CVT X_ZKZ_X eYV YZte cZTR f_UkaZ_Z_Xd `W4 YZV ^ VR_d cVT X_ZKZ_X eYRe Zd Z.V_éZj Zd R T_ded TtE_R T_éZ f `f d ac `Tkd ` WIckReZ_Ł ckac`Uf TteZ_ R_U ecR_dNc^ ReZ_Ž:e Zd Z_ eYZd ^ VeR^ `caY`dZ ` WWc^ d R_U ^ VR_Z Xd eYRe Ze hZJ SV_VTkdRg e` UZHT gkceYVIF]ef cR ^ Rez `W 4 YZNR_UkgY`a^ V_éZEYVVI a]`dEZ_ `WYR_XL Y`h VgkLdY`f]U_`e]VRUf de` gkd`` \ etV]VKRJ `WeRLZEZ_ R_U VI a kZV_TKŽEY kdv Sf cZU]R kd RcV aRe `WEYVTF ccV_e yH WZZ2XZŁ RTVacZ X

eYRe TVæRZ_WR&f cVd`W4 YZNR_d TZAġ R:VZ_R_ `]UVc ecRLZ&Z_U`Vd_`e^VR_ecVReZ_XYZde`g`Rd d^VeYZ_XARCVUŽF_UVdjZ_XeYVý WTZRJYZde`g`% h YZIYY`^`XV_ZAVdeYVUZgVcdZg``Vvac`TVdbVdZ_e` R cZ_XJVTf ccV_eLeYVEVRV`eYVc YZde`cZvdL_`e R} h Bj de`]UŽEYVEVZd_``_VUVJ_ZZgVYZde`g`ZH_Y` a YUDbjb[`cZhYdUghXYdYbXgzhYbžcb\ck` 7 \]YUbg`hc XUmUddfc df]UhY`UbX`jbhYfdfYhi h,Yjf`\]gtc fm"

:W4YZWR YZ6e`qi ZdcWRUW/^ eYVdeR Ua`Ze `WeYVacVdV_eLeYVcVZd`_VZ`RXZ_Roj eYReT[VRc]j df_dd2XYeeYc`fXY22LW3^ :_UVaV_UV_TVe`eYV acvál/_eUR;+eYVZ'RXZ_Rg``WdUkž:eZdReYcVRU `WT_eZfZejeYRe]Z \deYVTf_eqj`d`cZxZde`eYV dzf Rez__`hŽH,Y'gd YWJÚWJmic Zh,Y'7 \]`YUb']a U[]bUfmgYYa g hc ``]Y]b h Y Wc bgY₩U! hcbcZcfXYfUgUib]mibVfc_YbZca hY VY[]bb]b[žmYhWcbgHJbhmh.fYUhYbYX[·]Vm X]gcfXYf"EYZdZ RXZ_Rcj UdRhdZeddecV_XeYW^^ eYV`aa`dZ_XZ'RXZ_Rg'+eYV`^_Zac\dV_TV`WVRc\Ł fc\ZXWETVEŽ:eZleYVWRc`WeYVy@eYVe%bo`WeYV $UZWWCV_eR_Uf_^ h_ eYVZ2_U_e[fde WeYV$ a`af]RIVŽ:eZdRWRdLf]eZ`ReVjjL`WeYV`feScVR `WRdfS[VIezzei SV/ZkgVUe`SVZcVdZezS]VŽ:eZd `___eYZdWARceYReeYV`SolvatZ__hZeY`d.Vat.f_Zejt. Z_deZefeZ_RZejŁ]VXRZejŁZISROWZEYZIZ RXZ_Rcj $Zd_{h} V S UZUZ eVacZ UZa V WX gVc_R V$ eYRe a VcgRUVd eYV yeoR_d&Z_%Zied acZ RIj ZlUFV e`Reh`WJUf_VRdV+eYVWRc`VVJYRdLZV_eZVU hZey 2] V UVR UeVVF ZIRUA` af]R&R UeVVWRc `Waf_ZtY^ V e Z TF TRevU Sj eYV UZTeRe` cdYZa `W $AZ_{TV} = TVZ RhR \ TVZ$ Z_XeVVWRc`WIYR dR_Ua]RIZ_X]Z Zed`_ hYRe ZłUWZERS [VR_Ua`dzs [VŽJ ve eYZdf_Uvdj Z_XWRc \underline{Z} TeVReWdU f SeedRS` f eeYVeVR] d] \overline{Z} . \overline{Z} ` V4 Y \overline{Z} VR_ \underline{Z} de \underline{Z} de \underline{Z} d 1; TV j \underline{I} 9 \underline{I} 9 \underline{I} (\underline{K} R, DR R R R R U AZ_e`Ł"***/Ž

 $EYVR]^{\ \ deT} af]dgVj VRc_ZXVC \ dVc R_U$ WRc `WIYR dUReVSRI\ R]`_XhBjZEYVdVh VV eYVaRdZ_deYReUZBREVUeYV") S! 4`_deZf eZ_Ł hYZIY ef c_WZ dSRI\ `__]ZSVRJ R_U c` ^ R_eZI eYZ_VZXCVa]RIZ_XeVV `_RTYj hZeY Rckaf Sł]ZIR_d deV LeYV_Vh DeReVhRdSRMU`_ eYVT_ł eZ f ReZ_ `WeVVT]`_ZR] d TZI `dVZEYZdZh YRe A` aeRJVdhV]]!_`h_dV Rc\R]f Ude` +yEYVd TZI `dUc Zl^ RZ_eZZ WZ_4YZVSj eYVhVZYe`VeVV _ZXYeZA YZVhRdeYf d`_V`VeYV} adeT f_ezZdZ eYVeXZ_e` RIYZgVdFSZZi hZeY Rc^ VUVcTVdeYRe hVcVf_UceYVT_ec`]`VeYVTZZI REY CigZA`_ł eRieZ_XeYVd TIVdMN]T_def TeZ_`WYVCVaf S]ZT hZeY eYVR_RCTYj eYReadvgRZWZ_`eVcT f_ecZd ac`gZNUR_VeY`d`_hYZY_ReZ_R\ZV_eZej Tf\U SVSRcMUŽ2 UeYVhR, YZDe cj hRdeRf XYe W/^ ")%`_hReUhRdTRJTF]RevUe`TevRevR_ReZ_RJ WWZXRdeYVWf_UReZ_R_U VXEZ ZkZ_XacZ_TZa V `WAY_Vh `dVc1DRXXVU`RUDVccR`L"**%Ž EYZdd TZRZREZ_hRdfaYVJUSjZ_deZfeZ_ddfTY $RdeYV? ReZ_R = ZSdR (1") " S/LeYVF_ZSVdZ (V) W$ 4 YZV1") %#/ R_UeYVAVLRX XZR: _deZef eV1")) */Ł SWKVSVZXZ a]V V_eVU `_ R ^ RdddIR]V `_TV T^af]d`qi acZ`Rqi dTY`]Z_XhRdZ_ec`UfTVU ı" * #! /ŽEYc`fXY`feeYV_ZV&W_eYTV_efqLeYV _ReZ_h`f]USVZIV_eZ;WhZeYeYVViZeV_TV`VR_ Z'aVcd_R|XgVc_^V_eLRDeReVyZ_Wc^%Lee fdV DaV XVcdaYcRdH_RS[Ve) T_eRZ_TYR dŽCVafS]Z TR_RfeY`cZERCZR_Zd`h`gVeYZdZ`RXZ_RcjhZeYZd aR eVV_`WVc`VelZedcRIcVUVaZILZedcZef RdŽ@dU/c hRd XgV_R dRIckU TYRCRIekć eYRe dkgVU e` ^ Rd. d TZR T_~ZTe R_U TYR_V eYVZ_eVc_R UZRXcW ^Ved`WeYVV/ZEWŽ2_UeYZd^jeY`WvcZ&Z_hRd e`dV`RZ_RZzVLVgV_hYV_YZde`dZP_du6_TZ_RL6U hRUd/Z_eVVRcjjehV_eZeYTV_efgia`af]ReZkVUZe RdR/VXV_U`WReZ_R/UVIRUV_TVŽEYZdeV_UV_Tje` Zevlade ey v Z Tol Roz XUZevlod Z TRez ` VA YZVR d TZAG RdUVIRUV_TVdY hdY h UZJVIF]eZehZ] SV e`UVR]hZeYdTZR]UZWWCV_TVdZ_VKefcVŽ

 $3 c_V R_V WSj^2 ZZR_j dTIVdWLeVV_RZ_R_$ $DeREVV_U hWZeM/WiZeY Ry_RZ_R_ZV_ZV_ZZ_WI$ $aRSJV WZ eWARZ_XL cReJVRe UWZV čZ_VLRJ dTZJ$ $Xc fadŽ@dUc^ VR_dUZIZaJZ_V} cdeR_UWZV^ čdL$ $R_UeYZI^ VR_eVITJfUZ_Xa^eV_ZZJ dfcTVd^ WZd$ $`dUZZ2eeYVR^ VeZ VLeYV^ jeY WYVY4 YZVR_$ $c`e`%h`fJUSVT^ VeYV\Vc_V] WYVZ_eWARZ_$ $UZIT fcdM_eYVyc`e`7%MTJfdZ_SVZ_XT_TVRJW$ $SV_VReYeYVI]`R_ WRZ_RJf_Zg ZE YZUZIT fcdV$ $hRdfaaJV^ V_eVUSJ R_ eVc`_VLeYRe`WYVSRd$ $SRZg `VeYV:_UZR_d13V_X R_"*) &ZH YRe hRd$ $WHSJZHVURdRcVd JehRdRTZZZXWUdJWZ RXV^ W$ $eYVyH WLhYZY^ Rd\VUeYVWRc`WEVVdJWZ$

EYZLac`TVdLYRUeh` WodeYVcTYRCRIeVZdzZdZ @_VhRdeYVacVU^Z_R_TV`WeVVcfcR]h`dJUŽ 4YZVhRdS`c_R_UX&h fa Z_eYVT]`dU`cSZe `WeYVYRIZV_URL`c]RcXVR%ZIf]efcR]VdHReVŽEYZL daReZR]_Rcc`h_VddhRdVWg`fdSS]Ve`Tf]efcR]Y`ł



^ `XV_ZREZ_ŽEYVAV d R] c``edh VAV ARAVC' VU Z_ eVV Rdj eh V_eZeY TV_ef g Z_ cVa`_dVe` eVV Z_Uf de ZR]ZREZ_ R_Uf cSR_ZREZ_ `VeYVT f_egiŁ R_UeYY YRgV]We eVZc ^ Rc\`_ eVVZVR`W4 YZV eVRe dz] ac vgRZde`UB Ž2]eY f XY eVV d R] [ZWZd _`h RWc^ `VW]\]`cVL_f]]Z VUSj eVV V UZRał ac`acZeZ_ `VVIf]ef cVLZe dz] ac`gZVd R y^ `dP] cVd kgW W kc eVV (ZeVe`]VXEZ_ZV eVVZ d TZA a`dZ eZ_Ž2]d TYRRIE kCZET ZI eVV a RecZIZL_]`XZT eVRe Z_daZ kd eVVZ RZ_Rg` VeYVyH VZe Zb cR_df TY Rd2_R> RC RD e gV_R_U> R_f V [CZIF DRU k116ZSV eYV d TZAJ actieZIV d`VWR_VJZV hY dVYVXV^`_j ckded`_WA^Zj eZkdR_U]Z_\dR^`_XXc`f acŽEYkdV U^ kdzT_Vah`c\dhVčVVie`]]VLLR_UZzhRdcZU`W DR_eZX eYReZzhRdRTZj`VkM]ReZgVdLcReYVceYR_ Z_UZgZLfRJcŽEYVT_eZ_fZj`VeYRe ecRLZZ_TR_ SVdW_Z_eYV d TZAJ YZcRCTYj R_UyI]RctZi %eYRe X gkc_aV a]VdURJ ie iURJ UNRJZ XZZ eX wRef ckd XZgVRchvTZ TchRaVe`eYVZ RZ_Rj`WcLvZ eZi eYVcfcRjzf aaVdT]RctRfcR`Wd TZAJ `cUv4LR_Z'RXV eYRedW^ de`d cgzgVZ_d^V V`WeYVcd TZAJ UZAVIF]i eXdeYRehZJ SVUZIIF dbUJRekc`_Ž

:_eYV"*'!df_UceYVZ~fV_TV`WeYV4fSR_ CVg`]feZ_R_URdRcVRTeZ_e`VT_`^ZTdeRX _ReZ_ŁR_Z`RXZ_Rcj`Wc1TZR]TYR_XVSWR_e` ~`fcZtYŽ5VabZeVZedcVg`]feZ_Rgi_]R_XfRXvLeYZd ^`gV^V_eUZU_`eScVR\hZeY4YZ[VdTf]efcR] ^ ReeZL `caReeVc_Ž:ehRdeYVZ'RXV`WRyTYR_XV Z_`dVC%ZEYVV`aYRCZdVaVReVUjj a]RIVU`_ eYV 4 YZVR_ TYRRIEVC ` WEVV dyg` | f eZ_ Z_UZIREVd R_ f_UVcdeR_UZ_X`WeYVZ_deZefeZ_R]ecRUZeZ_ŽEYV a`]ZEZIR] Uj_R^ZILY`hVgVLCRUZIR]ZKU ViaVIeR eZ_d`WRTYR_XVeYReeV_UVUe`SVViaVcZV_TVU Rde/VcWRZKReZ_`WRfe`aZR`dLReVc_RezeVjLRd R^`ceR] eYcVReŽ:_ S`eY TROMELeYV d'TZR]`dUkc hRdTR]]VUZ_e`bfVdeZ_R_UeYVdTZR]eV`a` RITY/VREVUŽ3VIRF dV ` WEYVOV dYRCVU VI a VOZV_TVOL ZUV_eZejeV_UUUe`SVf_UVcde``U^`cVRdRh`c\ Z_ac`XcVdlR_U]VdlRdRecRUZZ_Ž3feeYVVVefcV hRdf_TVceRZ_ŁeYcVReV_Z_XR_UTYR eZH]``\Z_XŽ EYZdWRce/ReZV_6Zjh`f]USVd?aaWac`gZVU eVV[fde2/TReZ_WceYV^2ZERcjTfaRdRhRj`W dvIvdeRS ZHZ_X`dvZŽ

H + 9 G + 5 H 9 G C I @

Bc '@Uhlb 5a Yf]WUb Wc i blfm gYYa g hc ' \Uj Y VYYb a Uf_YX Ug a i W 'Ug 7 \]'Y' Vmk \UhA Ubi Y `5bhcb]c '; UffYhOB WU `g]hg Î GUhY! WYbhf]Wa Uhf]I Ï " EYZI TV_eRZi `W eYVDReVZ_ VRIY `WAVd TIVdEVVAc' deR.V_Sj 4 YZJR_d TZAġ ZII]` dJj]Z \UhZeYeYVZ RZ_Rġ `Wd.VXŽ: e YRdSW_dZLZ: _ZIR]jLeYRevYZe` q Zdeff X/ecZX/eV&^ acZ Rg dIY^`] Rd9 Zè g R_U 8 V XRaYj ESVIRF dVeYVXF ZIZ_XZJRZdd gVcVZ*.g `gVcRe4cz@ gHh YZY ZIV VcIZMUSj eYVDRe4/R_U _`ea`af]Rcd gVcVZ*.gHh YZY ZIV VcIZMUZ_acZ H TZa]VSj eYVV_eCV_ReZ_%b8 RcT%LUV]R 9 f VcRt. "****E#"'/Ž@_ e`eYVUV^R_UVca`af]Rcd gVd VZ*.gi }eYVRie`W`UVc_Zij Z_hYZY 4 YZV hRd S`c_lhRdfaVcZ`a`dVUeYVRVkC^RzZ_`VVRZ_R d`gVcVZX_giLR_U eYVZ`a`ceR_TV`VeYVeVcZe`g R_UZedVV_eZkdeV_UVUe`eR\VacVTVUV_TV`gvceYV hZhVd`WZEXV_dŽEYZtacVjXfcVdeYVdTZRjgRtff^ eYReDeReVRTeggZt`YRdd`V&V_T_TVRJVLŽ

:_ [fdeRWh jVRdLSVXZ_Z_XhZeYeYVV]VTeZ_ `W2]VdR_U2R_UeVV" * #%1" * #&cWVc^ dR_UeVV_ $T_eZ_fZ_XhZeYeVV$ and $X_gVc_Ve^WSi$ WSi WALf_eZieVA`af]Rc7c`_eLeVVDeReVZ`RXZ_RgieVRe hRde`acVgR2jeYc`fXY`feeYVehV_e2XeYTV_efg YRUSVT ^ VV_eeV_TYVLŽ: _ eYZthY` [VaVZ ULeYV TYZWOWWOV_TVa`ZeWcdTZAjihRdeYVDeReVZ ZedUZXWKV_eXfZktŽ:ehRdeYVV_XZ_V`VZ_UfderZR} $\mathbb{Z}R=\mathbb{Z}_{\mathbb{Z}}\mathbb{Z}$ eYVZ ZERe`c`Wa'TZR cWWc^Ž:ehRdeYVDeReVRd eVRIYV&Lf_ZfvZ_XR_UY^^`XV_ZkZ_XeYVTf_eqj eYc`fXYdIY``]Z_X1R_U^ZZERcj_dkgZIVŁR_UeYV 7ZET ŁEYVVI TYVbf VŁCVACKU Z XEYV^ VI TOREZ T f_eqŽ2S`gVR]]LeYVDeReVd ^ S`]ZkVUVkcd TZkj eYVV XRXV V e`WITZR TIRdhdR Ua` ZZZIR WETVEZ EYZdd ^ S` [ZT łZ' RXZ_Rcj h`c[UR]]`hVUT _~ZTed e`SVZ_deZefeZ_RZXVLLhYZdecVacVdV_eZ_XeYV ac`XcVdbgVViaR_dZ_`WUV``TcRIjZ4`^SZ_ZX deRSZZEj R_U~VIZSZZEjŁeYV4YZVR_DEREV^ R_RXVU e`ac\d\cgVeYV`[UV]Z\dhYZ\deScZ_XZ_XeYV]\\dV $hZ_X aRee ZdZ_e e VV^RZ_de VR^ZE YZda^ZE ZZR$ \underline{Z} eVXReZ_ \underline{k} UeVVd \underline{T} \underline{Z} eVXReZ_ eVReW] hU ZŁWć^ WeYVa` ZZIR T cV WYVDEREVZ RXZ RjŽ E` af eZeR_`eYVchR +h YÎCHUhY gc i \ddot{l} cZ7 \]Y WUbVYHU_YbUgUaYHUd\cfZfh\YYldYfl! YbWY'cZgcWU`'bhY[fUhcb"

 $EYV VI eV_dZ_ `WeV DReVZ RZ_Rj hRd RII$ $T^aR_ZUSj R_VI aR_dZ_ `WeVV af S]ZT da YV&Z$ $D TZ ej eYC hZ eM WZ_e Raf S]ZT da RIV^ VL REVUSj$ $eYV DREVLV S dRIZ_X_ `e`_]j eVVa`]Z ZIR a ReZd$ $R_U eVV af S]ZT RU^Z_Z te ReZ_ Sf e Rd VL T REZ_L$:_ eYV |Rde UVIRUVd `WeYV eh V_eZleY TV_ef g eYVcVhRdRScVR\hZeYeYVa`]ZeZIR]T_decfTeZ_ `WRafS]ZTZ`RXZ_RcjŁhYZTYhRdUZda]RTVUSjR acZeReVZ RXZ_RgŽEYZdyacZeReXkReZ_%hRdRjd R a` [ZEZIR] T_decf TeŽ: WWAC^ Vc]j eYVV^ aYRCZ: YRU SW_`_ DeReVZ_eVcgV_eZ_ e` ViaR_UeVVafS]ZT daYV&VL_`h ZehRdeYV^Rc\VeViaV&Z/_TVeYRe SVIR^ V V_eeV_TYVLL^ R\Z_X eYV Z_UZeZLF R eYV TV_eeR|}Xf_eVZ_eYV_Vh_Z^RZZ_RcjŽ2_aRcRU_iZR ac`TVdLcVR]]jLSVTRfdVZeUVacZgVUa`]ZEZTd`WeYV $Z^{*}RXZ_R_{j}f_U/caZ_Z_X_{d}^{*}W_{ed}R_{e}Z_Z_{e}VafS]Z_{f}$ cVR^ UZU_`eUZRaaVRŁ`WY`fcdV,Zee``\`_ UZVWZł V_eWc^ dŽ2dARce\$`WeYZdCVa`cedY`hdŁY`hVefv&L eYZlecR dWc^ ReZ___`WeYVafS]ZTdaYVcVZlRWWWeZX aVa]VdViaV2ZTV`W22WZ_dTZ4jŽ2 \ZU`W y^ Rc\VeZ RXZ Rg %&Rd SW_ Z de Ef eVULac gZl $Z_Xa^{h}WWI^{h} = 2 dWc Z_UZZIFRWWU^{h}$ UVIZZZZ ł^ R.Z.X.R. Uckła` dzszzej Ż2 jey`f Xy eyzd deZ`f]fdWcZ_UZeZLfRJZReZ_ZIXV_VReZ_XRhVRJeY `WUZEVICIZE; Z_d`TZR;]ZWLY`hVgVeLeYVU^Z_R_e Z RXZ Rcj XZgVdWh Tlf VdRde`Y`h d`TZVej dY`f]U SVaVcTVZevUR_UViaVcZV_TVUŽ: WevVcVeV_UV_TZVcl SVIR^ VV & TYULEY&VT f USVRUEV&VT dl bfV_TVdWcYf^R_UvgVj`a^V_eZAczeReVZ_UzgZuf} R]dh`f]U_`e`_]j SVU\acZevU`WeyReafS]ZTc\R]^ eYReac`gZNdRWdf^ V\cdvelZ_XUZWWcV_TVdR_UR WTR] a`Z_eWceW_Vh UZgVcdZjŁSfeeYVj h`f]U R]d SVZ]]{Vbf ZaaVUe`TY``dVR_UcVR]ZkVeYVej aV `W/ZW/eYV/hZYVUe`]VRUŽ

I BF9CC @ 98 8=@A A 5 G

EYVaReeVc_`VUT_eZ_fZej R_U dfaefdvZ_eVV S 4YZJVR_a`]ZEZIR] Z RVZ_Rcj dRZMdR_f^SVc`W Y UZJV^RELR``_XeVV eVVT^a]Vi dV[ReZ_dVZa Z

$$\begin{split} & YZte j eYReYZ_Xtdfa`_eYVa`dtSZZej`VWZtdUtchYZte j eYReYZ_Xtdfa`_eYVa`dtSZZej`WZtdUtch$$
 $SVZ_ektZ_dXtURdWRc`VT_~Ztež:_S`eYTRdtL$ $f_T_dcdrZ_VUdS[VTeZzej h`f]UTEVReVeYV~``U$ $eYRedS^ VEXUVgVg'eYZ_XZ_TYR dR_UR_RETYjŽ$ $2TT dtZ_XjLdyWT_VETZ_R_UdvjWTV_d cdrZedW^$ e`SVeYVacZTVe`SVaRZUVceYVdVTfdzj`WdUteŽ $EYZtYZte cZIR]SRT\Xc`f_UZtdvZ_WETVUSj_eYV$ $gVj_cVbfZV^V_eti`VtdyWT_ec`]eYReZ_UZzTRj$ $ZReZ_LfcSR_JZWR_U eYVUZTZaJZ_ZX`WJRS`fc$ $R_Ua`]ZeZtdZ`a`dULZ_eYVetV_eXeYTV_efgL`_$ $aVcd_R]dS[VTeZzejZ$

@_VUZIV^ ^ RR-ZANdhZey eyVdacVRU`VRd TZR Z'RXZ_Rg eYReXgVdXcVReVchVZXYee`eYVUVdZCVe` ySV`_VdyVXZEYVcZV`VerVacZeReVh`dU^R\Vd aVa[VWW]RXCVReVc_WUVCRXV_fZ_Vy.%LRUVCRXV eYReZddáddUSf eReeYVdR^ VeZ VYVZXYeV USj eYVa`hVc]Vdd_VddZ_UZc;ZLfR]dWWJZ_eYVWAV^WeYV yd TZR] ^ RIYZ_VZi_ dWXZ_Xe` RV/kc^ eYV dv/gVdL eYV/T^VZ_e`T_~ZTeRXRZ_R_URXRZ_hZeYeYV y_RefcR]]Rhd‰WdVkŽEYVj hR_ee`y]VeeYVZc YRZCU h_%LSfeeYVj RCVTYVT\VUSj eYVecRf^ ReZT ^ V^ ` qi ` WeYVaRdeŽ2e eYVj dR^ VeZ VRd eYVj h`f]U]ZVe`y]ZvevZc`h_]ZvevZc`h_KvevVj cv V SVc $eYReeYVUV2ZVVVcVXVU^{f_UVc^{T_U}} f_UVc^{T_U}dVcR_U$ WRUde T_~ZTeŽC i hc ZZYUf c Zh Ya gY j Ygžc Z h\Y`X]gcfXYf`h\Y]f`gi V'YWjj]hma][\h[]j Y` f]gY⁻hcž]bX]j]Xi U`g⁻X]gWd`]bY⁻h Ya gY`j Yg⁻ $UbX^{*}[i Y^{U}[U]bghh Y^{I}[fU]b^{*}cZh Y]f^{*}ck b^{*}$ XYg]fYg"

2 dvT_UUZW^ RT_Tkc_deYVakdZeV_eWkc `WIYR dŽEYZIZIR_Z a` ceR_eckil fcTVkk ^ RZ i eRZ_Z X`dv&LSfeRid R_Z aVUZ V_ee` cvT ^ i a` dEZ_ `WeYVyH WŽEYVeER ^ RET VI aVZV/TV `Wil TZ ia`]ZZIR] T_~ZTe]VU 4 YZWR_de`]`hkc RgVZ `WEZV/TV`gkc eYVUZZZ_dZ_eYVZc d`TZR] `dvZEYVWRc`WMZZZ ARTET_~ZTed^ RUVEYVZ `h_ YZTe` g` RyWr Zj_dvTkV94cd ^ VeYZ X_` ee` SVeR]\UURS` feŽEYZI deReVZj_ ^ RUVZea` dES]Ve` ackikgVeYVZ YVZEUUZ RX/`WH VLeYV4 YZWR_d4c SfeReeYVacZIV`W_VfecRIZIREZ_, Z_`eYvCh`dtiL Sj_V^ aej Z_XeYVyH V6Z RX/`WEdT_eV_eZEYZI dW^ de` SVeYVckdF]e`WgeYVacUZTa`dEZ_`W a`]ZZIR] RTe`cde` RXCWLhZeY`feR_j acZ c RZZ_X `WUZWEV_ea`Z_ed`WgZh%b4`ccWRL#!!''LS%/Ž H ZeY feRU fSeLeYVyUV `TdRIj` `WRXW V_6‰ YRISW_ R \Y WREFdV `WeYVecR_dZ_ ac TVdŽ BcbYh Y Yggž]Zh Y ZYUF c ZVc bÛJWi]g dfc! YWYX]bhc h Y Z hi fYž]hWci `X fc V XYa c W fUWnc Z[hgj]HU`]mvYWUi gY]hbYWYgg]IUHYgU bUffck fl bWc blfcj Yfg]U*LXYÚb]hc b c Zk \Uh]g Î dc gg]V'YÏ "

2 eYZUUZV ^ RZleyReeYVacU ^ Z R_TV` VR acZeReVZ RXZ_RcjeV_Ude ViRjeZ_UZeZUFRjRfe_ł `^j hYZVf_UVc^Z_ZXT]]VTeZeVRTeZ_ŽHYVcVRd eYVafS|ZTZ RXZ Rg hRdSRdVLVgV_ZVV_)j eRI ZejjŁ`_ eYVZUR`Wa`af]RcdgVeVZX_ej R_UeYV UNZSVOREV ac`UFTeZ_`WolTZR]`dUVeLeyVacZeReV Z RXZ Roj ZdCVA RIZ XT ||VT&ZVCM/WUV&VC^ Z ReZ_ Sj dj dev^ZT dyWeVXf]ReZ_ŽH, Y`a Uf_Yhž; Ug`U We YWH Y a U bUfnž a U Yg h YUg Yf h dYfWY]j Y h Y W U`Yb[Yg c Z]bX]j]Xi U`]nU! h¦cbžVi hk]h ci hdfcj]X]b[]bX]j]Xi U`g'k]h Ub]a U[Y c Zgc WYhn' E YVd TZR] h`dURaa VRd e`SVR^V&Vdvez_XVcz_UzezLfR]RTez_Ž@cdreYV&L R_RefoR]`dUkće`hYZIYZeZi_VTVdRgie`RURaeŽ :_UZeZLFR]dTR_UWW_UeYVZcZ_eVcVdedWkgV_ejjR_U VARS ZEY RIZE_TVAL A EY `eYVadeYVSVeeVace` Radiva eVV Ž3feeYZlRXXXVReZ_`V&cZgReVZ_eVCVdedU Vd _`eRUUfae`RafS]ZT^ReeWZ>`deZ'a`ceR_e|jŁ ZeU Vd_`eRUUfae` RT ||VTeZeVRTe`c`cyd'S|VTe‰ hZey eyvRSZZzje`aRceZIZaReVZ_eYVT_decfTeZ_ `WeyVol TZR]`d.WZ

:_gZth`WeYVeV_UV_TZkdcWWkcVUe`ŁZeYRde` SVRd/WhYVEYVC4YZVR_dTZKejYRdRgRZJdVał $dd_eReZ_ WZdMVZd_eReZ_ WZdMVZd_eReZ_ W$ d TZK RTEFR] j a VC^ VREVUS j eYVRSdV_TV VRd TZR UZ V_dZ_OEYVEVZdVgZV_TVeYReyTZgZ d TZkj % $RdR_Rfe_^^ fdRIec_ZeYVdTZR_acTVdtLYRd$ SW_ drefVch VR Z_ 4 YZVŽE YZ d Z d XXdeVU Sj eYVa`hVc`WeYVyhVZXYe`WeYV_ZXYe%R_UeYV ZJV_eZ;TReZ_`WeYVafS]ZTdaYVeVhZeYeYVDeReVŽ EYc`fXY`feZedYZde`qL4YZ[WR_d`TZAkj dW`de` YRgVSW_T_deZefeVU^`cVRdRac`UfTe`VDeReV RTéZ_eYR_Rdd^VeYZ_XZ_Zed`h_cZXYeŽ?`c UVdeYVTf_eqjdcVTV_eUVgVj`a^V_edW^e YRgV decV_XeYV_VU ZeŽE YZd T f [U h V] SV`hZ_X e`RTcZCZL`WeYVZ`RXZ_RcjcZZ_TReZ_deYc`fXY hYZIY Rol TZAGI JVRc_de` cVT X_ZAV ZechJVŽAH YRe 4 Rde ozruzeluzex_`dvuRdRXV_VcRjeV_UV_Tj^ R\Vd

 :e`_]j cV^ RZ_de`_`eVeYReeYZIVc`dZ_`WT`]]VTeZgVZ RXZ_RXd YRd WWWTed`_ eYVUV^`TcReZT `d.VcŽ: WeYVcVhVcV_`Z RXV`WyhVLeYVaV a]V%u hYReacZ_TZa]V^WT]]VTeZgVd [ZLRzZg R_UhZ]T f]U SVZ_g`\Ue ScZ_XTZZKV_de XVeYVcV:WeYVd TZZ] `d.Vch`c\d]Z.VR_Rfe^ReZT^RIYZ_VLZcVdaVI eZgV^Wa`]ZZTR]UVTZZ_dLeYV_hYReU`hVhR_e UV^`TcRIj_WcO

7 < 5 DH9F'

K 9žH≰ 9'7 < =@95 B G 'H≰ 9'9A DHMB; 'C : '5 '7 C @@97 HJ 9' =89B HHM



:e YRd SVT ^ VUZIVIF Je e` daVR ` WR 4 YZJVE ZUV_& g` Rd d ^ VeYZ X dyJVWgZUV_eŽE YZI TC\Re\d ac`S]V` dWc eYVZ RXd eYRe Vg\g`_V^ R.\d`W eYV` dyg\dR_U` VeYVZ: cVJReZ_drZadh ZeY ` eY\cdŽ :_VgZES]jHUWa V^ ` eZ_dRVdzCvUŽ2dUZIF dZ_ RS` f e4 YZJVR_URS` f eyH VLeYV4 YZJVR_d6SVT ^ \d T ^ a]ZIR&U R_U a\cd_RZ&VLLZE SVZ_d e` Xc`h YVRe\UŽAV a]V da\R.` W4 YZJVRd ^ VeYZ X.eYRe ^ R.\deYV` f_T ^ WceS]VR_UZcZES]VŽ

EYVRZ `WYZITYRaekćZle`UKITCSVeYVUj_R`ł ZtłakćtkácZ_dR_URackVIZKeZ_deYReUVj_VhYRe Ze^VR_de`SVR4YZWR_e`UJjŽEYVd`S[VTeYRd e`SVRUUCKHKUWV^^ ^ R_j R_X]VZZTT d.Z_XJjŁ UZWWCV_eV^aZZIR]^VeY`UŁS`eY bf RJZKEZEVR_U bf R_cZREZEVLYREVSW_ Raa]ZUČEYV^ RZ_RZ^ZI e`RdTVceRZ_eYVZ`RXVdaVa]VYRgV`W4YZVLeYV V`eZ_deYVdVRc`fdvLR_UeYVdg]VR_UT_eV_e`W UZATFdvZ_RS`feeVVTf_eg_R_UZedTYRcRTeVZ

E` eYZIV_ULR_ZZER] 5 ZIIF dtZ_8 c`faddefUj hRdTRocZU`fe[`Z_ejj hZey eYV7RIF]ej`VD`TZ]! `Xj`VVAVVF_ZejvCoEj`VV4YZJvZ8 c`fa UZIIF dtZ_d hVCVZZEREVULdRocZX`WMiZEY eVVbfVdtZ_yHYRe U VCZe^VR_e`SV4YZJvR_O%adWRaaV_UZ"/ZEYV defUj hRdT_UFTEVU`_RSR2TdR`a]VdvX`V_eVU Sj d TZIVT_`^ZTdecRetR_R_UZeYVJaVUVACC^ZV eYVRXRd`WZJVIF]ejZ_eYVUZIIF dtZ_RS`fe4YZJv ZeRd cVgVRJVUVVA UZWWCV_TVdZ_eYVRetRIY^V_ed V acVdtVZ

EYVÁVZ_UZIREZ_dac`gZUVUEVVSRHZIVVCRdvT_U

aYRW WYVbfRJÆREZVÆL UŽ_T]]FS`&RZ_hÆY eYV&&MRETYUVaRee V_e WYV> T4R_627\d RW_TJEh`c\hRdU_V`_Xc`faZ&&a&ReZ_`W aY`e`XRaYdfdZXeYVXfZWUXc`faUZIFdZ_`c WIFdXc`fa ^ VeY`U]`XJŽDR`aJZXWceYZdhRd Sj deRef ^ ŁRXVR_UdvIŁd`aaJV`V_eVUSj Xc`fad Z_dXZ_d`WYV_`œYR_UdfeYŽEYVT_eV_e`W eYVUZIFdZ_dhRddefTefdVURc`f_UeYVdaVIZJT }VJUdZ_hYZY4YZJNR_JZWZdVaVZZ_TVLŁdTYRd h`c\LeYVWY`ZJŁa`JZZTeLJVZFcLeVJVZZZ_R_U cMZZ_1dWRaaV_UZI#Z

 $EYV eYZU deVa h Rde`gR]Z.ReV eYVdV ej a`]`XXd R_U eYVZ UZWWEV_eFReZ_dZ_RcVacVd`egVf a]V`WeYVa`af]ReZ_Lf dZ_XeVVd`egVj ^ VeY`U]`XjZ EYVZ`a`erR_e_R_UT_ec`gVcdFr]Ztf Vdh VeVZ_l T ca`dreVUZ_e`Rdj deV^ReZTdVZd`WefVdEZ_dVVc eYV_ReZ_R] d`egVj T_UFTeVUSj F? 5 ALhY`dV } VJLh`c\hRdTrczZU`feSj EZ`VCVdRcTY1dW RaaV_UZIVd&R_U'/Ž$

:_ eVVddV_eZdLeYVUZWWCV_edefUZdac`UfTVU ^fefR]jjT_dZdeV_ecVdf]edŽEYZdTYRaeVchZj_`e UVdTcZSVeYVcVdf]ed`WWRIY`_VLSfehZj]dvEVVeY eYVZ:T^^`_}_UZ_XZĔYZI^VR_deYReUReRW/^ UZWWEV_edfcTVeLS`eYbfR]ZERezgVR_UbfR_eZERezgV R_USReNU`_dR`a]Vd`WZWWEV_e\Z_U4LYReVSW_ Z_eXXReNUZ_e`RdZ_X]VR_RjjdEZEYVU2gVcdEj`W dfcTVdXZgVdUVaeYe`eYV}_UZ_XZZ:eRjd`^VR_dL Y`hVgVaLeYReeYVj_WUe`SVRaac`RTYVU hZeY TRfeZ_Ž

EYVT_TJfdZ_dR:VSR:MU`_R_Rjd&:VWgVdjł eYZ_XeYReTR:V`fe`V&YVUZTfdZ_dR_U_`e`_ R_j aRceZIF]Rc`aZ_Z_ŽHYV:V`aZ_Z_dR:Vbf`eVUL eYZIZIVV:ch`cVRd_d+e`Z]fdc:ReVeYVZtfVdUVR]e hZEYLR_Ue`dr`hd^V`V&YVefc_d`V&YVR:VfdvU e`UZTIFdd:eYV:V^Re&VcdZ_VgVjURj]ZWZ

 $EYV_RcRezeverReW[]`hdZlUzeZUUZ_e`eYdW d&adŽ7ZdejjLeYVdVZlRUXCRZaeZ_`VeYVZ`a]RfdZ$ $SZZej RecRIYZ_Xe`eYVZ`RXV`VhYReZUy4YZNR_%$ $R_U e`Zed_RcRezevZZDVT_UjLVgVcjUBj ViaVcZ$ $V_TVclReVURh_fa`_Z_R_Reev`ae e`Via]RZ$ $eYZŽEYZUJjLeYVZ`RXVd`VV4YZNR_d`TZSSZZej$ $V_T f_eVcUURVUVCRZSVU hZeY dWXV_TVe`eYV$ $V`aejZ_X`WeYZET`^``_Xc`f_UŽ$

H ≤ 9 = 8 95 °C : '5 °7 < = @95 B = 8 9B H = M < 5 G 6 97 C A 9 = A D @5 I G = 6 @9

EYVEVZIR WWJZX`Wf_VRdVR_UWfdeReZ_ Z hYReaVa]Vdy RS`fe4YZVR_UZdZV/eGjŽ yHYRedYRaaVZXe 4YZVOKey9`h U hVdW `fcdMgvdDkey@fc^ZVUWWZXdRS`feeYV~RS%e y4YZVZ eYVda`eJZX6%key4YZVR_dT_VKdU%ReV R``_XcVTV_e_VhdaRaVcYVRUJZ vdR_UeEJvdZ S``\dY`a hZ_U hdŽK \Yb`dYcd`Y`gdYU_` UVci h7\]`Y`h Ym UfY`XJgWc bWffhYXž Ug` h\ci [\`h\Ymk YfY``cc_]b[`Uhih.Ya gY`j Yg`]b`U`a]ffcf`UbX`bchfYWc[b]n]b[`k \Uhih.Ym gUk "

 $2 det{S} V' d' h d' `deaV a] VU _`e}_UZe`SgI `f det{Ree}V&VZIR_j eYZ_XTYRRIE}VZEIR] j 4 YZVR et{ReuV}_VdVRIY a Vcd _`dZV_eZj L`cet{Re4}YZVRd RT f_eg ZletVVi a cvdtZ_`VRT]]VIEZVZV_eZj Ž 6RIY Z_UZZIF R'd cVIREZ_dYZa h ZEY etVT f_eg$

@/.}ä½

@oz ÚzäCÚzäq ‱lúz²æö OzÝä¶‱i²qz Ú∕æPq∉"ä¶Úqz‰&∉"äæzäfic®2O?äqz²æœÂa @oxÍd≀z∉"äݶmaq¶æ¶ïææ€"æœΩe áCÅzÚgz²æ9′zÝÈ

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>¶ïÚgznäB1Ł; älOas¶≊Oãa⊳ïÚnzonaĭþþ½Ê

 $\begin{array}{c} R \cup Z d Z \mathcal{V} \leftarrow \mathcal{E} g \quad Z d Z \cup f S \mathcal{E} Z H Y Re Z d Y Raa V_Z X \\ e \quad 4 Y Z \mathcal{V} O E Y Z d Z d R b f V \mathcal{E} Z d \mathcal{V} \mathcal{Z} X R \quad V f a] R \\ \mathcal{E} Z \quad W c \quad d \land V \mathcal{E} Y Z \end{pmatrix} \mathcal{E} Y Re Y R d S \mathcal{V} f \land V f _ W ? Z \mathcal{P} \mathcal{Z} \\ 3 f e \mathcal{E} Z d f \land V \uparrow _ f _ \mathcal{V} \mathcal{R} \mathcal{V} \land R d d \land R j U \mathcal{X} \mathcal{W} \mathcal{E} J \mathcal{V} \mathcal{E} \\ 3 f e \mathcal{E} Y \mathcal{E} d Z _ d R U U f S e d U \mathcal{X} \mathcal{W} \mathcal{E} v e a] \mathcal{V} c \mathcal{E} d f] R \\ \mathcal{E} \mathcal{V} \sim \mathcal{V} E \mathcal{E} \mathcal{V} \mathcal{Z} \mathcal{U} a \mathcal{V} \mathcal{Z} / T \mathcal{V} R U \mathcal{V} a \mathcal{V} \mathcal{E} \mathcal{Z} - d \land \mathcal{V} \mathcal{U} \mathcal{Y} \mathcal{V} \\ R U Z d Z \mathcal{V} \quad \mathcal{E} d Z \end{array}$

K<5H=GCIFJ5BH5; 9DC=BHB

H YReaV a]VdJ RS`f e4 YZVZIZ dáRcRS]VW' eYVZ RXdeYY YRgV`WYV dJgvdR_UeYVZ:a]RIV Z_4YZJR_d TZ4jŽ2_URdeYY]``\Re4YZVW' eYVdR_Ua`Z_e`WYVZ:UZWWV_ea`dZZ_dR_UVI aVZJ_TVdeYJ dW e`SVdWZ_XZeW' RUZHR_TVŽ H.Y.7 \]YUb [XYbH]mbc "cb[YfgYYa ghc VY' Ub`cVj]ci g`cbYž`VYWU gY`dYcd`Y`Xc`bch gdYU_`Ug`dcggYggcfg`cZh\Uh]XYbH]miVi hi Zca `h\Y`ci hgIXYž gYY]b[`]hUg`gca Yh,]b[` Zcf`ch\Yf`dYcd`Y`UbX`ch\Yf`Ha Yg" EYVEVRV eYCWgZha`Z_edW' hYZIY4YZVR_UZdZV_eZj RVUZIIF dMLŽ

†EYVVJZEVgZvha`Z_e+hYV_RdvURS`fe4YZvL aV a]VvO'^ eYVYZXVcdeRERZ ^VUZEVjj VdES]ZY]Z ZedR_Ua`dEZ_dŽ:eZdRa`Z_e`VgZvh eYRedvUd 4YZVVO'^ eVV`fe2UVR_UVO'^RS`gVŽ

Î=XYbh|migUj |hU`ği VYWžf|| \B`=Xcbhĭi h.]b_ h\YfY]ğUbm[XYbh]mi'=bU`chcZkUng` =`]_YVY]b[7\]YUb"=ĵiYVYYbUVYhc gdYbX'ha YUVfcUXUgkY``"=ši WeaZcfh UVY'k]h\VY]b[7\]YUb"=kci X'dfcVUV'm VY'WeaZcffUVYUg'kY``]Z=kYfY'9b[]g\cf >UdUbYgYžVi h]hỹchY'kUmh]b[g'kcf_ci hž mci kYfY'Vcfb'h\YfyÅ Ĭ flYaUYža]!YX'U[Y'[fci dži fVUbž\][\@, Ł

 $\begin{array}{c} 4 YZVZddW_W' \wedge eYVa`Z_e`WgZh`Wd \wedge V_V \\ hY` ^ ZXYeYRgVSW_W' ^ Rj Tf_eq ŽEYVVJZV \\ daVR ` W4 YZV W' ^ eYV gR_eXW a`Z_e`VEYVZ: \\ djWZ' RXVRdRT d` `a` JZR_TJRdŽ8]`SRJZRZ_ \\ ac`gZUVdeYV hZYRa`Z_e`VT ^ aRZd_ŽEYVJ \\ eYf ddWeYV ^ dMgvdRd dR_UZ_XRS`gV eYV`S[VTe SVZ_X[f UXUŽEYV4 YZVR_ZV_e6g HZ_d ^ VTRAAL ZlgZh VURdR\ZU`W_eR_XV ^ VeeYReZeZL_VIVd \\ dkj e` UV&RY`_VdMjW6/^ Ž \end{array}$

3f eeYZldfaVcZcZg U Vd_`edW^ W/^ RSV/ZWV eYReeYY _`h hYReZlSV&Wc4YZ/VZ._eYVa`dZ eZ_deYY dR/VLeYVYZXYVcdedRRU _`edW^ e`]B T]RZ' e` R]VRUVCdYZa c`]VŽH YReeYY dWXLcReYVL Zle` YZXY/ZXYe RUZWWCV_TVŽH YV_ eYY RUVCHEYV T_UZZ_d`WeYVZcURZj]ZgVLeYV YZXYVc decRefL RIT dLZ_Xe` eYVcf cgyi }_UZ_XUWW]aRe`WRT^ł ^ f_Zj ` WiZ_ Vdh YZIY eYY ZJV_eZjWh ZeY 4 YZV R_U ` Wh YZIY eYY WJ ac` f UŽH YV_ eYY T ^ V e` T_dZJ/ceYV4 YZV` VZ_YV& AUT ^ ^ `_ dV_dH_ eYY WJ RZ/_ R_URVT& ZRJŽE YVZ ZJV_eZ TREZ_ ZL_` eh ZeY VgV jS` Uj` d4 YZJVLSf eh ZeY eYRe` WeYV hZ_V dŽE YZ JXc` f a TR__` e` c U` Vd_` eh ZHY e`]VX EZ ZAV Zeda` ceRZe` VR T f_egi ` WhZ_V dS j ^ R.Z_XZE Raa]ZTS]Ve` R] ŽE YZ dV gVR da Ree` VZed dJWZ RXVR IR_V ZEVŽ: eU` Vd_` edWZed f a VZ cZj RIeYRe` VRX gVc_Z XT] ReH Sf e^ VeYj R IR UZ HZ_TI eZ_ R_UR IR YZXVc^ ` cR] bf RZ jŽ

† EYVgZha`Z_e`V&YVa``c+ReeYV`eYvcVi eV VLa``c Xc`fadcVT X_ZVR]Z ZeR_UdZfReV eV dJgvdfeZUZESfeSV/hŽEYYj TReeYV dJgvd RdgZTeZ d`WiT]fdZ_Ž@_eYReSREELeYVZUR`W RT ^ `_ZUV_eZj hZeY eYV`eYvdU`Vd_`eTRoj T_gZTeZ_WceYV`ŽEYYj dW4YZJVR_ZUV_eZjRd Sc`\V_U`h_Z_e`T]RdHVŽ

Î H. Uhiğ k \ Uhik YNY `]_Y 'b 7 \]Y" H.Y dccf glUmk]h h Y dccfÅ /h YfY UfY h fYY X]ZYf! Ybh7 \]Yg^T fA UYža]l YX'U[Y [fci dži fVUbž`ck 'Q9, Ł

EYVa``cdvR\`VSVZ_X4YZyR_RdRUVdZ_j eYRe YV deYV Z_ŽD TZG ZlaVETVZgVURddReZHR_UZd Wc^ d`WiTfdZ_RdZdeZf eZ_RJZAVUŽ2TT dZ_X e` eYVd gyJŁZ_WNELEYV^RZ_T^a]RZ_e`WeYV]`hVc deRRZdeYReLUVdbZeVR] eYVRaaVRcR_TV`W TYR_XVZ_4YZyLeYZ_XdYRgVTRczUU`_ [fde eYV d?`VŽ7`ceYZdARd_LhYV_eYJ_UV_j eYVViZeV_TV `VR_j 4YZyR_VdW_TVLeYY_RVVRc^`dVgWV^V_e eYR_^V SVcd`WeYVcXcfadŽ

Î=XcbŇi_bck k \Uhh\Y'dcg]hj Y'WUfUWWf[|gh]WgUfYžVYWUi gY'bch\]b[Iğ́ [c]b[f][\h Ufci bX`\YfY"=Ĩ)Y`\UZU'a]bX'hc [Yhci hhc Ubch\Yf We'i bhfm'Ï

fAU`Yža]] YX`U[Y`[fcidžifVUbžaYX]ia!`ck`C9; Ł

 $\label{eq:constraint} \begin{array}{l} & \left[EYVgZha`Z_e`WeYV^ZUJWZ_T^VUdverteed \\ :eZH^`__XeYVdveYReeYVYZXYVdeJVgVd`WIV_eZH \\ & TRZ_hZY4YZVREVe`SVWf_UŽEYV^ZUJVIJRdd \\ & VRVdW/eYY_ZUJVIJRdd \\ & VRVdW/eYY_SV_ZZ:ed^VV^SVdWWJeYY_SV_ZUJVIJRdd \\ & VRVdW/eYY_SUJ^Z:ed^VV^SVdWWJeYY_SV_ZU_VEV \\ & SfeeYVZ:h`ddU_`eU^fTYe`~VdY`feeYV \\ & YZW_ZVR_ZUV_eZJZ \\ \end{array}$

ÎK \ UhY`gYž`YhŷggYYÅ žk Y`7 \]`YUbg'UfY` [fYUh'c_ Yfg'Ï fl Ya U'Yža]l YX'U[Y`[fci dži fVUbž]bhYfa YX]UhY`

G9; Ł

 $EYV^{Z}U_{VZ}T^{V}VdVTe^{d}TR_{d}VR_{R}d4YZ_{I}$ $VR_{d}Sfee^{V}_{J}YR_{g}Vec^{T}S_{V}d_{J}Z_{Xh}YRee^{V}Re^{V}R_{d}Z_{Z}$ $2e^{A}d_{S}VZ_{X}4YZ_{VR}T^{V}U_{I}e^{e}RTR^{d}Z^{T}$ $d_{V}d^{V}WYf^{T}cR_{U}d^{V}V^{V}KCVda^{2}eZ_{X}eZ_{I}$ $f^{A}YZZ_{V}VW_{I}Z_{X}W_{J}T_{Z}Z_{Z}Z_{I}e^{R}dfCV^{V}W$ $acZ_{V}ZZ_{d}VeYReZ_{V}eZ_{J}e^{E}SVT^{V}U^{I}acC^{I}$ $d_{g}VZER_{Z}XRT^{A}aRReZ_{V}gZ_{h}LR_{U}d^{V}VZ^{V}U$ $RiV_{A}SZT^{V}W_{I}Z_{A}CR_{J}ZW^{I}e^{2}MCR_{V}N^{2}C^{I}$ $4^{A}e^{A}aeWcAVdgZ_{R}dR_{U}^{2}W_{L}^{2}Wc^{2}ML^{2}C^{I}W$

EYV^ZUJVTJRdUZdIF dZ_dckýkij RWWJZX`W UZd cZV_eReZ_ŽEYVJ TR_`eckácků/_eeVV dvjsků RdR_VJZeVESVIRF dvěrZdZtT_ddR_elj cVTVLZXVV^ eVV ESFe_`cU eVVJ hR_ee`SVVTJFUVLEd ^ VI eYZ XeYRedW^ dVZXVeV_ZXJj a`ddSJVZAV aJVZ_ eYZddcRef ^ TR_`eR_UU _`ehZtY e`SV`f cdLV JZV`eYVcXc`f adŽ3fehYReeYVJ hR_ee`SVJ`_X e`R_URIefRJj U SVJ`_Xe`LeVV4 YZVeYReY`JUd `f eeYVac`^ZU^`W`UVc_ZjEZdd ^ VeYZ XeYVJ }_UJvdtR_UJvdtaJRf dSJVZDVVCZZTZ*ZhPJ `f eŽEYVJ RecZSf eV eYVZc VKZZ Xd e`eYV`dvjsvE SVIRF dveYVJ TR_`eLZtBr_TVeYV`dvjsvE Ze eYV}_Xc ReRTFJacZZ:_eYV4 YZV`VT`^^`_ dv_dvETZZTYZ Zd`Zi`_jj a`ddSJVZVJV`f ReVcf aVZ.d. `c VTJFUVLŽ

=B < 9F=+98 7 C A A C B C9B C9

 $\begin{array}{c} 4 YZVZd_`e [fde`_VTf_eqjZ:e YRdf_W]UU\\ YZde`cZIR]j Z_^f]eZa]V_RccReZgVdcV]ReVUSjUZV\\ WEV_e RTe`cd_VRTYV`a YRZKZ_XaRceZIf]RcRatVTed`$ `gVc`eYVcd1=RccReZeL#!!"/ZEYVdefUZdTRccZUU` $`feVCeYZdCVa`cecVgVR]eYVacVd/_TV`WVfcUZV\\ WEV_eZRVU_RccReZgVdZ_aVa]VdURZj deWTY+eYV$ $_RZ_R]^ZeRcj_RccReZgVLeYVTZZT1_ReZ_R]_Rd$ $cReZgVLeYVa`af]RcVT1fcZ__RccReZgVR_UeYVV_1$



ecvacy_vfcZR] [RXfRc_RccRe2gvlZ_afS]ZTUZEIFdZ_ RS`fe4YZVe`UR] eXv3VgvcZ_dRcVcV7cVReVUL`_]j e`YRgVeYVZ:TcVUZSZZEj bfVdz_VUZ_dR_ejjZEYV3V _RccRe2gvdRcVefc_Z_XZ_e`4YZ/VR_y^ jeYc1/Z

EYV_RcRezgydSVZ_Xbf V&Z_VUclyReVe eYVYZł e cZIR] R_Ua`]ZZIR] 4 YZIVŽE YVT f_ecj cłackół/ekU Z_ eYV ZdR]^`de R]h Bj dRT^^ f_Zij X g%c_VU R_UXf ZJVU e h Rdd`d.VcSj VZEVČK \Uh]g'VY!]b[`\Y`X`i d`hc`ei Ygf]c bž h Ybž]g`H c Z: X.` k \Yh Yf`h]g`c fXYf`]g`[c c Xž UbX`k \Yh Yf` h Y`Y`]h g` UfY`WUdUV`Y`c Z dfc Xi W[b[`]h' E YVdV U f Sed RWWE R] Wf c g\cdZ_d`V4 YZVR_ ZJV_ezj UkfIcZSVLId^ & VZ VdZ_T^SZ_RZ_R_U d^ VeZ VdZ_ZI]ReZ_LR_U eYY_R]h Bj dV_eVZ, R d SedR_ezi]`cd`WC4VZSZejZ

H,Y`bUHcbU`!a]`]HJfmbUffUHj Y EYZI^ R_ZWHdZeM/WRdR_RecRegV`WcZZ_dŽ:e R:ZN:HRdd ^ VeYZ_XcM/WgZU/eLZ_R_j UZIIFdZ_

ÎKY'UfY'U'ge WyYhmik ∥h∖ ZYk 'VcbXg'cZWe'a a i b]hm' =Zmci 'Xc'VUX'm]b'h∖Y'a Uf_Yhž mci 'UfY'gff]ddYX' j]fhi U`m'VUfY''':U]`i fYg'UfY'Yl dYf]YbWYX'Ug ZUi 'hgž UbX`bchUgʻZU]]b[gʻ]b`h\Y`gnghYa"`: cf`h\gʻfYUgcbž ZU]ifYgʻHU_Y`hc`h\Y`dgnW\c`c[]ghỹg`UbX`bchhc`h\Y` gfYYhï

9i [Yb]c 'H͡fcb]ž&\$\$%"

`WAYVRITVAAURIT f_e`WAYRe4YZVZZEAUT f_ed eYVRIZ_ddR\V_Sj eYVT f_eg dWf_UVdRXZ_de eYVDaR_ZY^`_RTYjZEYZIZIH YV&VAYV`CZZ_R_U ^ VRf cV`WARez eZA REVe`SVWf_UZ7c`^ eYZd dRczZ_Xa`Z_dLeYV_ReZ_R]AZERg _RcRezgVX Vd `_e`eR\VZ_eYV`eYVchRdWfXYeSj eYVT f_eg hZeYZed_VZXS`f cdŽ

H YRe Zibf VátZ_VUZ_eYZi_RcRezgVZiZclgVá SR2Zi+eVVV&Zi^ R_UaRez eZi^ `WeVVWf_UVcd Zi_`eTcVUZS]VŽ

ÎFYU`mj YfmcXXÅ k Yfj Y [ch6YfbUfXc CÑ][[]bgžUbX]hhi fbg`ci hik UhGUb A Ufff k Ug'lk Y Zci bXYf"6YfbUfXc CÑ][[]bg`k Ug hcc``UhY'''<Y`k Ug'bYj Yf'lk YfY'' =1k]b_ ik Uh\]g` VY]b[Vcfb`ci hg]XY k YX`c W_žg\U``k Y`gUnž]g`U'j Yfm7 \]YUb W UfUWhf[g]JWÅ Ï

fl Ya U`Yža]| YX`U[Y`[fci dži fVUbž\][\`C9; Ł

$$\label{eq:constraint} \begin{split} & EYV_ReZ_R_{1}^{1} \wedge ZZER_{2}^{2} = RcReSgVYRdVR_{1}V_Zee \\ & UZICVLZeSVIRTOVEYVCVZd_` ecfodeh` ceV_{1} V_{2}Z_V_TV \\ & VcZZEYZCUZCIIFOUZ_T_1FUVChZEVEVVCFOLZZ_eVReZehRcdZ_gV_eVUVcCM_VZ_eVcVdeVU^` ezgVZZ \\ & eYReZehRcdZ_gV_eVUVcCM_VZ_eVcVdeVU^` ezgVZZ \end{split}$$

Î < [ġrc fmgUng k Y UfY VfUj YžÚ \ hYfgÅ h\Uh k Yfj Y VYYb k]bbYfgÅ Vi h=Xc blki_bc k ž gca Yfja Yg mci k cbXYf UVci hk \Uhğ VYYb k f]fhYb" Mci ñY fYUX]b[UbX ZJVVg UfY X[gdi hYX UbX h\YmgUnic bY h\]b[h\Yb Ubc h\YfÅ h\Uhğ k \Yb h\YXci Vfg gfUffÅ 6YVUi gY h\YfYfg gi ddc gYX hc VY h\]g \Yfcž 6YfbUfXc C Ñ][[]bgÅ Vi h=XcbNii_bc k Å =ĵÑ Y fYUX gYj YfU`c h\Yf h\]b[g'h\UhgUm\Y k UgbNiu\Yfc Ï fA]| YXU[Y [fci dži fVUbža YX]i a ! ck @; Ł

EYV_REZ_R]ZU/e2;TReZ_eYReeAZcl_RecRezgeV dW\de`ac`gZU/ZclSVT ^ Z_X\MRX2J\ZEYVf_c\]Z RSZZEj `\V&YV ^ ZZERcj RTT f_e ^ R.\diZe YRdU e` ZU/e23J\hzeYZ

 $\hat{I} = \langle Uj Y b N \hat{N} i [c h U b m \rangle]ghc finc Z7 \rangle] Y h U h = U b X h U h a U_Y g a Y g U m H U_Y a m \ U h c Z$

Ic '5 fhi fc DfUhcf'6YfbUfXc 'C Ñ'][[]bgÑÅ VY!
WUi gY h YmÑY i bfYU'Å h YmÑY a UXY! i d '
ghcf]Yg'h YmÚ``nci i d k]h k \Yb nci ÑY'
ga U```UbX'HU_Y'nci ']b k]h Å UbX'h UhỹthY'
fhi h 'Ï

fAUYža]] YX'U[Y'[fcidžifVUbž`ck'Q9; Ł

4 czezzań `WeyV yzde`czn`ł^Żącegi _Rocłeżgy zdł _`eV_eyf czładeżni ze zdreży RT_`h]VUXV^V_e`WR]RT\+

ÎH,Y'dfcV'Ya ']g'hUhžVYVVUi gY kY`\Uj YbŇi [chUbni\]ghcfnžkY`\Uj YbŇiå kY'UfYbŇiå kYÑJY'[chbch]b['hc']XYbhZnik]h`Ug'cif ckb'Ï

fl Ya U'Yža]] YX'U[Y'[fci dži fVUbž\][\'C9; Ł

H_iY'Wj JWbUhcbU`bUffUhj Y

 $\begin{array}{l} & \hbox{EYZI}_RcRegVZITfccV_e`_j Z_RVRX^V_eVUL\\ Z_T_TjfdgVVC^Ž:edVd4YZVR_YZb`cjRdeYRe `VRaVa]VhYZYYRdSfZeRTzgZXVUdTZcjR_U VS`UZUeYZIZ_eVZ_deZfcZ_d`VeYVCVafS]ZIŽ 2dR_RcRegVZeT_VTcdhZeYRa`]ZZTR]Z_eVcacVieRZ_`V_UVAV_UV_TVŽ \\ \end{array}$

Î=ZYY îh Uh7 \]Y jb îh UhdUfhcZ \]glv fmk Ug Z ```cZdYcdYk \c k YfYk ck °Q Ygli fY cZUXa]fUlfcbQÅ k]h [Yhi d UbX [cžk]h Xfj Y" Hi [\ dYcdY" HYFYdi V]WWUaY Ucb[UbX [fUXi U``mîh YmglUfhYXhcVY! WeaY gli d]XÅ žg]``nž`]_Y gebg cZÅ žîh cgY ZJh Yf Ú[i fYg îh Uhîh Y dfYg]XYblg UfY'Ï fl Ya UYža] YXU[Y] fci dži fVUbž]bhYfa YXJUhY Q9. L

EYVTZgZI_RZ_RJ_RCREZVZIV_T f_eVURI ^`deViTJfdZyJjZ_eYVUZIIfdZ_d`VAYV^ZUJV R_UfaaVcdeRHZZeZIRd ce`VJVRc_VUJVXV_URS`fe eYVT f_egiLhYZYYRdeYVU^`TCREZThVJVRCVDREV Rd`_V`VZed\Vjce`_VZEYZL_RccREZVCf^dfaeYV Z`RXvcj`VVAV^ViTCREZTZgZZREZ_`VVAVehV_ł eZeYTV_efcj+TZg1Z_Ufdeg1UV^`TCRIjŽ

 $\hat{I}H_{Y}YUfY'[ccXh_b[g']b'7]YUb']ghcfm$

UgʻVY]b['UʻXYgʻfYžUʻWć `YWfj Yʻ\cdY'h\Uhi]gʻU`acghi

U`k Ungʻh∖k UfhYX''Ï

ÎKYNj̃Y`bYjYf`aUXY`]hžUbX`h\g`a][\h`YUX`ig hc`gigdYWhih\UhÎ]hï`]gU`amh\žUb`]bjYbh|cbžUgkY``

>cf[Y'9XkUfXgž%--"

hccÅHU_YihYidYf]cXicZfUX]WU``[cjYfb! a YbhgžZcf]bgHUbWY'Ï flYaUYža]IYXU[Y`[fcidžifVUbž]bhYfaYX]UhY` G9; Ł

$$\begin{split} & \text{EYZ}[_\text{RcRegVYRdSVT} \land VZ a] \text{R} dS] VLY h VgVd.\\ & \text{SVIR} dV eV YZe g Z SRMU `_ h \text{R} d \text{T} f e d ` e \tilde{Z} \\ & :e U Vd_`e R]`h RT _eZ f`f dac XVddZ_e SV \\ & e RIVUW \land e V`cZ Z d U h_e e e V ac VdV e \tilde{Z} F YRe \\ & \text{TZ} _ `]`_X k V Z e d R_R U_` c U e ` d V TZ K V d \\ & `c e YRe Z U f d c Z h h`c `Z F YZ l_R c R Z V Z l [f de R$$
 $<math>\land V` g \tilde{Z} \end{split}$

EYVdf UZdd^ h eYReeYV] d' WRUZSZZG d' W WRUSj _RcRzzydSRdU`_ YZE g ZIRd TZEVL Z d^VTRML hZY R aVCIVá $Z_$ `WYV^ZZER X gVc_^V_e aVZU1"*(Sł"*)*/RdeYVV_U`W TZZT4YZŽ

ÎK \ Yb =k Ug U []f žVYZc fY D]bc W Ylžth YfY fYU`mk Ug U ZYY]b[cZ]XYbl]lmt Mc i b[dYcd Y \ UX`a i W`a cfY]XYU]ga žhccžUbX` [XYbl]ÚYX`a i W`a cfY k]h 'h Y We i bhfm UbX'h Y '7 \]YUb ÛU["'7 \]Y 'k Ug '7 \]YZUbX` h YfY k Ug U`chcZdf]XY'Ï fl Ya UYža]l YX`U[Y [fci dži fVUbž\][\ `Q9, L

H\Y`bUffUhj Y`cZdcdi`Uf`Yl Wiglcb

Î A mXUX la X a Y l\ Uh7 Uf c g = Vz < Yn k Ug cbY cZh Y V][[Yghgk]bY mci WUb]a U[]bY 'Ï fA UYža]l YX U[Y] fci dži fVUbž ck C9; Ł

$$\begin{split} & EYZ [_RcR & EZV \ S`UZ(d_`eRYZ) cZR \ ZV) e E \\ & Sf eRT [RZ' Ž YV_R & Z_R]Z' `We Va`af]Rc_R \\ & e \\ & E \\ & V \ R_Z W \\ & E \\ & Z \\ & M \\ & E \\ & M \\ & E \\ & M \\ & E \\ & M \\ & E \\ & M \\ & M \\ & E \\ & M$$

 $\hat{I}5bXk \setminus Y = k Ugk U_b[VUW = gUXzk]h$



gc a i W k YU'h cb a mf[[\h\UbXž\i [Y a]bYfU`XYdcg][gžUbX cb h Y ch Yfg]XYU [fYUhVci bX`Ygg gYUžUbX]hg bchYbci [\Å =gUnžk \mXc 7 \]YUbgžk \mXc =UgU7 \]! YUbž\Uj Y lc [c \i b[fn8l fA UYža]] YXU[Y [fci dži fVUbž ck 'Q9, Ł

H, Y [·] bUffUhj Y [·] c Z h Y [·] YbhYdfYbYi f]U^{··} ′U[i Uf

EYZIZIeVV^`decVIV_e_RcRezgVLR_UZeZiecVReVU Z`_ZIR]jj RdR_Rcc`XR_e}TeZ_`cRdRhZfYeYRe _VgVcTR`VeefVŽ

EYV^ j eY`WeYV[RXFRcZdUVdRZSVURdeYV1]RZ eYRe 4 YZJVh RdeYV=ReZ_2^ VZIR_RgR_eXRdV`W ^`UVc_ZejŽEYZdXRgVeYVT f_eej]VRUVcdYZadeRefd R_U dveZeRaRceW/^Zed_VZXYS`f cdŽ

ÎHY k Umh Y VUb_]b[gYWc f XYj Y c dYXž mc i _bc k 3 =hc c_ =bhYfbYhWUggYg]b B Yi ! ei fbÅ K Y 7 \]YUbg UfY Ua Un|b[mk Y^{***} fY[UfXYX UVfc UX" FYU`nžh Y `Yj Y`c ZYXi ! WUhc b]b 7 \]Y]g Yl hYa Ym\][\ 'Ï fA UYža]] YX U[Y:[fci dži fVUbž\][\ Q9, Ł

EYVUZETF dZ_eR\VdR_Z^__ZTUZER_TVW/^ eYV

_RcRozgVLY h VgVc+

Î MYUfg'U[c k Y k YfY'g' ddcgYX'hc 'VY'h][Yfg']b h]g'Wé'i bHînž ']cbgžk \UhYj Yf''5 'WUhk ci 'X' `cc_']a dfYgg]j Y'VYg]XY'i g'Ï fA U'Yža]I YX'U[Y'[fci dži fVUbž`ck '09; Ł

2_UUZZZ]fdZ_^ V_ecVd_ReVdeYc`fXYaVa]Vd cV^ Rc\d+

Î =Xc blìth]b_ UbnVc Xmlv c_ th Ya 'gYf]ci g`ni' =ĨX``cj Y lv 'VY`]Yj Y]lž=a i ghgUn'l fA UYža]l YX'U[Y`[fci dži fVUbž]bhYfa YX]UHY CQ; Ł

2]] Wfc_RockezgVdYRgVSW_UZERCUZeVULSfe

h` cdeRWWIEW ZIEVZ RW` W4 YZ/RdRYZE cZIR R_UZ_deZf eZ_R] Wc^ ` WZgZT` dWŽ2]d RWWIEW RVeYVd TZI Xc f adh YZIY eVdV_RcReZeVdIcW ZAU hZeY TcNeZ_X eYZI` dVc+d]UZcdLa`]ZZZ2_dR_U Sf dZ_Vdf` V_Ž3` eY eYVT f_eqj decRf ^ ReZTa`]ZZ TR] M aVZ/TVdR_U eYVTYR_Xd eYRe YRgV eR.V_ a]RIVZ_URZj [ZWYRgVf_Uc^ Z_W eYV_RcReZeV eYRe dWd eYV 4 YZ/R_aVIf [ZcZgj Z_ eYVYZE cZIR] R_U Z_deZef eZ_R] T_eZ_f Zej ` WyX` U` dWc%Z K \Uhig]b`Xci Vhzh Ybz]gth Y [XYU'h Uhh Y` Wc i blfmig]b`UV]Hblg`Uj Y U dYW`]Uf UV]`!]mžUa ci bHb[1c U bUh]c bU`W UfUWHf [g]/Vz Ic WYUhY U`\Ufa cb]ci gʻgc WYmi'

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EYVZUR`W4YZYL`WW&^Z_XaRe`WR_`dU& T_UFTZEV@Z_eVXReZ_`_RW@Z_X`WWbfRZEj R_Ud]ZLRZEjŁYRd]`deT&UZSZZEjŁR_UaVa]V&/U e`dRTe_WREZEVJj hYV_d^Z_UVU`WEZHYj YRd eYZIZURSVT`^VZa]RfdS]VO

H{ F99 9L D9F=9B 7 9G C : 7 < =@

EYVCMEL_dWCeYVZ a]Rf dSZZEj R_UTGEZZE `WeYZEL4YZWR_ZV_6Ej TR_SVVEa]`CUZ_UZW WEV_ehBj dŽ@_VZELe`CVT_decf Te eYV`S[VTEEV R_U d`S[VTEEVTYRCRIek/ZEEZId`WeY`dVhY`dW eYV_REZ_R] ZV_6Ej a`dEEgMjER_UeY`dVhY` eR_VRdTA6ZTR] gZh`WEZ:WEYVbfVdEZ_dZ_eYV F?5A#!!" d`cgY RS`feY`h 4YZWR_ZV_6Ej ZELaVCTVZgVUEd^VVMYZTYYRgVSW_aCdV_eVU YC&I RCVeR_V_R] e`XeYVEZEZELa`dES[Ve`}_U XC`fad`WCAL_UV_edhY`dVR_dVCL'e`ZEYCWXC`fad hZEYT_dZEV_egZhd`W4YZWR_ZV_6Ej TR_SV UZEZ_XEZMVUZE YZETYRCRIek/ZEEZIERUVAC^Z_VU Sj R_f^SVC`WeYCEbfVdeZ_dZ_eYVd`cgYERV RUW]`hdŽ

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AV a]VhY ReVac`fU`W4YZVSVZ&Ve?ReR 4YZVR_ZUV_e2ej ViZtedR_Ue?ReZecto?ZUteZ_e?V Tf_eej`dYZte`cj_R_UTfde`^dŽ4YR_XtdZ_e?V hBj 4 YZWR_d dVJReV e`eYZIZUV_eZej YRgV SW_ a`deZegvZAGZUVR_UT_}UV_TVR:VeYVV``eZ_d eYVdV aV a]VWWJ e`hRdd 4 YZVZEYYJ ZUV_eZeJV hZeY e`URj`d 4 YZVZEYZIXc`fa ^ R\vdfa \$#" `VVeYVdR`a]VZ

EYY eV_U e`SV`gVc&&R_U^RVŽEYY RV YRgZ dackdV_eVUR^`_XeYVYZXVcVLTReZ_R]VgVdR_UeV_Ue`SV]`_Xe`eYVYZXVcdeRef^Ž EYY RVVVf_UhZeYd^VhYReXXReVcVXbfV_Tj R``_X^`cVRTegV4ReY`]ZOŽEYY RV/ZVj e`SV ac`WdtZ_R]d`cd/WV^a]`jVVŽEYY YRgVRYZXY `aZ_Z`VWYZc`h_TRARSZZZCHR_UeYY RVT_ł }UV_eeYReeYV hZ]_`e]`dVeYVZcV`a]`j^V_eR_U eYReeYVZc}_R_TZEJ dEFREZ_hZ]SVSVevcZ_VGFcVZ EYVZc`a`[ZEJR] ResEFUVZTZEZTZ_REFcVR_UeYV VacVddfaa`ceWcUV^`TRIJŽ

EYZLX: fa SV/ZLÓV EYRELSJ R_U JRXVL EYV TYR_XLOEYREYREVGR.V_a]RIVZ_4YZV`GVCVIV_e j VRcd YRgVSW_SV_VJ TZA] R_U YRGV YRU R TJVR: UZEVTEZ_ŽH YV_ EYY T_dZLVC EYV VT_`^jL EYY WY EYY YRGVU_VHVJ] `fe `VZE R_U RV hVJ] UZA` dVUE hRLUEYVVT_`^ ZTd EV^ ŽE YY REVYZXYJ d TZSSJVZ_XV_VRJLR_U HVJ] UZA` dVU e hRLUE`EYVGŽE YY EYZ \ aV aJVTR_SVEET EVZ AV aJVHY` REVac` fUE`SV4 YZVR_WJ EYY REV aRe`VRGVG JRXV^`CJ XC` faLRDEYY EYZ \ eYRE ^`deaVa]VTYVZZYgRffVddZ'ZRce`eYVZc`h_Ž EYYjeV_Ue`YRgVR]`_XeZ`VY`dZc_R_UeYY UVj_VeYV`dvjgVdSjeYVZca]R_dŽ

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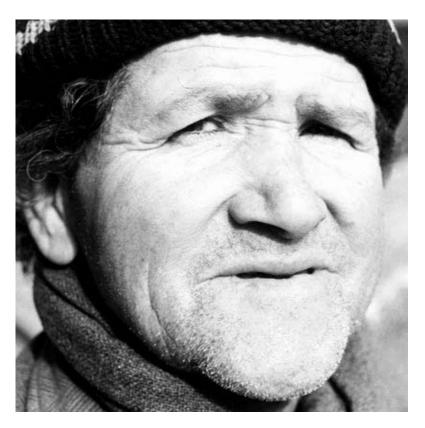
AV a]VhY`RVf_dCVRS`fe4YZVeYZ\eYReZe ZUZWIF]ee`d3 hYReeYV4YZVZ`LV`eZj Zle`U3jŽ EYVZ:ReeZfUVe`hRtU14YZVZI`_V`VVF_VKZ_ R_UUZZJfdZ_^V_eZEYYJ RVZTJZWE`eR\VR _VReeZfVgZh`WYR_XKdZ_eVVhBj 4YZVR_d_`h WWJRS`feeYVZ:ZV_eZjZ3j R_U]RXVLeYY eYZ\ eYRe^`CVYRdSW_]`deYR_XZZUSj eYVTYR_XKd eYReYRgVd/R\V_4YZVZ_cVTV_ejVRcdZEYZdXc`fa ^R\VdfaS)´´`WAYVR`a]VŽ

AV a]V \underline{Z} eYZLXc fa R $\underline{V} \wedge R\underline{Z}$]j W R]VLhZY eVTY_ZIR]Lac WdZ_R] R_Uf_ZgVdZj VLFTRZ_Ž EYY eV_U e SV]_X e eYVZ eV VLReV d TZ ł VT_`^ZT de Ref ^ R_U e]ZgVZ_DR_eZX ŽEYY WJ eYJ YRgV]`de fe`_SR]R_TVW'^ eVVT_`^ZT d deV ŽEYY R \underline{V} UZHRZJ W hZY eVZc }_R_TZR] ac deVTedR_UTF cv_eVRc_ZXLVgV_e' f XY eVJ RV_`eR``_XeVVh`cde aRZLŽEYY R \underline{V} eT_ł } UV_eRS`fe \WaZ_XeVZc V a]`j^V_eŽEYY R \underline{V} 4 ReY [ZT`_]j Z_R`VLR deYJ U_`edR\VaRceZ `cXR_ZXUh`cdYZČ

D TZEJ j cláz Z XLEYY U _`eYREVR_ RIEGOVAR I Zj JZW ZEYVER deYZIZL_`eR_Z a`ceR_ecWWV_TV a`Z_e Vic eYV ŽEYY RV glvj T_glvdR_e hZEY ^`Ulc_e``]dŽEYY eYZ\ eYRe eYVTYR_Xld_`h X Z_X`_Z eYVT f_eg RVJWLZ_X_`hYklžEYY U _`eWW] aRe`VWRSc`RUT ^ ^ f_Zj `VGRIf VE RdeYY SVJZGVeYRe eYVZdRV_`ehZMj dYRVLŽ EYY eYZ\ eYRe`eYVcaV aJVRV_`eX/_VRJ]j e` SV ecf deVLŽEYVZ: a`JZZIR] gZhdT glc eYVhY`JV daVRef ^ ESfeeYY YRgVRdZXYeeV_UV_Tj e`ZV_I eZJVhZY eYVTV_eXIcZXYeŽ

; fcid". 8 kgWcbhYbhYX:#5 b[fmWk]`YUb AV a]VhY`RVR_Xj RS`fe4YZ/VeYZ_\Ze^R.Vd _`dV_dVe`eR\ RS`feeYV4YZ/VR_ZLV_eZjŽEYVj T]VRcjj U_`eWW]aRce`WcUB; d4YZ/VZHYV_eYVj eYZ_\RS`fe4YZ/VeYVj WWJR_XgjŽEYVZCZ RXV`W 4YZ/VR_ZLV_eZg ZLRdt TZEVUhZeYTYRRREVcdReYVc eYR_hZeYYZde`g`cZ_dEGfeZ_dZEYZdXc`fa^R.Vd fa S! ~`VWEVCR`a]VZ

AVa]VhY`RVR_Xg`RS`fe4YZVSV]`_Xe`



eYV]`hVcdTZłVT_`^ZTdecRef^ŽEYVdVRcV YfdMhZgVdR_Uh`c\VcdReeYVS`ee`^``WeYV Z_T^VdIR]VŽEYVjRcVYVRgZjcdacddV_eVUZ_eYV Tf_ecjdZUŽEYVjWRJ]SVchW_VgR_XVjZR]dR_U _`_łSVJZgVcdŽEYVjYRgV]ZeqVVUfTReZ_RJTRaZER] `cWR^ZZRcZejhZeY^`UVc_e``]dŽ

:_ XV_VAP,LeYY SV/Z&VeYVTf_eg YRd_`e TYR_XU R_U eYR&UVAZEV RaaVRR_TV&VgVj ł eYZ_XYRdeBJ VU eYV dR VŽDFTY TYR_XdRdeVJ U aVCTVZgVeYJ UZRaac`gV`VŽEYJ WVJeYJ YRgV TJVRdj]`de`feW/^ U&JT a^ V_edZ eYVVT_`^ZT d deV^ŽEYY RV_`e Re R] T_}UV_e`WWAZX eYVZ [`SdŽEYVZ: UVIZZ_ł^RZ_XU Vd_`e]``\ SY`_UeYVaVdV_eŽEYJ RVf_d TZSJVR_UeV_U e`hZeYURh Z_e`eYVW^ ZjŽEYJ REVZ_e`JVR_e R_U]ZeqVZ_eVCVEVZ aRczZARcZ_XZ_d TZGjŽ EYY eYZ_\aV aJVRV_`ee`SVecfdeVZEYJ U _`eSVZ&VeReeYJ SV`_Xe`R]RXV^`d]T^ł ^f_ZjLR_UWNJ dReYVCZI]REVZ

AV a]VZ_eYZIX: faeYZ_\eUJ; dh`d]UZIYRUV. e`f_UV.deR_UeYR_eYVZ:XR_UNAEYV.dZEYVj WWJ eYReVgV_edR:VaR.dzZ.XeV^ Sj R_UeYReeY`dVhZeY a`hVceR_VRLgR_eRXV`V&YV^Z_a`]ZZI:deYVj R:V UZRWWRAU R_UR:VVZEYV.cf_dXZeVC:U`cU_`e S`eYV.ce`g`eVZEYVj U_`efd`R]jj ZJV_eZiVhZeY

ÎK \Uh Xc Ygʻ]ha YUbži]bʻWi hi fU`hYfa gžhcʻVYʻ $7 \ VUb Uh h Y VY[b]b[cZh Y h Ybm Ufgh Wb!$ hifn8°K \Uhigh\YfY°b Wcaacb'Uacb[WUfUWfYfg $\sum Y h Y c Z W k c f Y h k c h f g h h Y U b i U Y$ cZFiad]/h\Y`UXmik \c`eiYiYg`id`hc`VimUb` CaUfWhc VfUWYYh'h Y ghi XYbhUhh Y I bli YfgXUX $XY^{-}U^{-}$: fc bhYfU⁻k \c |XYbh|UYg'k|h h $Y^{-}A$ Udi W.Y⁻ dYcd Y/h\Y`\]d!\cddYf`]b`h\Y`dccf`bYk `g Vi fV/ h\Y`XYX]WUhYX`ZcchVU```ZJb/h\Y`mcib[`Xch'Wca` VigbYggaUb`k \c`fYUXg`7*Ud]HU*``aU[Un]bY`cf`h\Y

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:eZURZj]ZWeYReXgVd^ VR_Z_XR_Ua]Rf dSZZj

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^ R[`c } V]Ud`VW1 a V2Z_UR2jj]ZWhYVEVeYV

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4 YZV ZITYR XZ XZ 2 dhZ SV dW eYc f XY fe eYZICVa`ceLeYVaRjaRS]VdIRV`WeYVecR dWc^ R eZ_aVc^VReVd[fUXV^V_edRS`feeYVTf_eqŽ:e Rod RWWTedaVcTVaeZ dRS`feZUV eZEXcZAV a]Vd `aZZ_dRS`feeYVViZeV_TVR_U^VR_ZX`WR 4YZWR_ZUV_ezej UVaV_U`_Y`h eYVj dW eYVZc `h_a`d&Z_Z_eYZ:lac`TVddŽ

9 RdeYVT f_eq XRZ_VU^ `cVeYR_ZeYRd]`deSj eYVdVTYR_XVdL`cgZVgVdROEYVR_dhVcZdS]f_eŽ 2c`f_Ueh` eYZLd`W&da`_UV_edSVJZgVeYReeYV Tf_eqiZdh`cdV`WXXEYZdRaacVIZReZ_RWWTedeYV TeVUZSZZEj `VRT ^ ^ `_ZUV_6ZEjERdeRS]V#dY`hdŽ EYVZ a R d SZZ RERIYZ Xe eYV4 YZVR Z.V. ł ezej Zd]Z_\WhZeYeYVWWJZ_XeYReTYR_X/YRdSW_ SRUWceYVT f_eqŽ

HYj U eY dV hY eYZ \ TYR_XV YRd SW_ UVecZ V_eR] e` eYVT f_eqj]`dVT _} UV_TVZ_ eYV ZNR`VR4YZVR_ZV_eZ; R_UWV]^``dVUVeRIYVU $V_{X}^{A} = U_{X}^{A} = U_{X$

gYUgcbU``ZJfa k c f_Yf k \c fi g\Yg hc Ub]g\ \Yf ZJfa ' k cf_gc Ug bchhc a gg \Yf ZJj ci f Y gc Ud cdYfU3 =b hYfa gcZ XYbhhmžUa cghbch b[/bch b[YhhYf $bhYfa gcZhYWca a cbdUWYgcZ7 \YUbbYggZ^{Y}Y$ VY]b[`X]ZÍXYbhcf`ibUggYfh]j Y"`H\Y`cb`mh\]b[`h\Ym \Uj Y`lb`Wca a cb`lg`U`bYk `W`hi fU``Ybj lfcba Ybh']b YUW cZh Ya žYj Yb HJ_b[*1 ghh Y ZYUh fYg gc * Vf]YûmbchYXžh\YfY'UfY'hfUWYg'cZh\Y'[fYUhWi'h fU`` WW.Ub[YgcZfYWYbhXYWUXYg'Ï

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> `de aV a]VSV/Z&VeRe eYVTYR_X&I YRV_` T]VRcUZVTeZ_L`ceYReeYY YRgV_` cVR] d`SdR_TV SVTR*dvf]eZ_ReVj V&vgV_` cVR] d`SdR_TV SVTR*dvf]eZ_ReVj V&vgV_` cVR] d`SdR_TV R_UeYZHRWWTedeYVZ:ReeZet UVe hRud4 YZVZEY dv hY`WVJf_d*cVR_UR_Xj RS`fe4 YZVeY`dvhY` U`fSeeYVV1ZEV_TV`VR_j T^^`_4YZVR_ZVV_1 eZg] RCVeYVgVgi aV a]VhY`SV/Z&VeRee2VeYcf de `WYR_XVYRd_`e`_]j SW_f_V&g`fdS]Ve`eYV`L SfeeYReZeYRd_`T]VRcUZVTeZ_`df]eZ_ReVjLYRd]V&VeYZ_XdRdeYV_hV&Z

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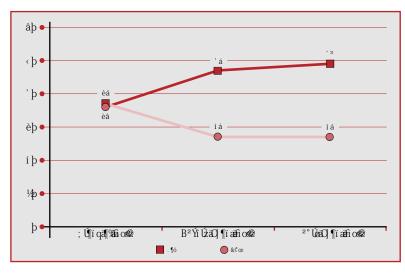
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R_UŁZ_ a RoeZIF] ReLeYV ej a V`Wa TZASZZZEj cWa] et $\underline{Z}XW^{\prime} = WW Reezer UWZ5^{-} bX^{-}cZWU i gU^{-}hm$ gYYa ghc UflgY. hig a dcggVYhc gUmh UhU WaacbbUhcbU`]XYbh]mYl]ghgžVYWUigY 7\]YUbUhhh XYgUbXfYUhcbg\]dggYYa hc dfcjY'h\Y'WcbhfUfm"

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C bY U[U]bghh Y c h Yf EYV4 YZW_Rozef UVZIUVIKSVURIh RJZVR_U RXXVIIZV4

Î 7 \ JYUbg UfY dfJW mUhih Y VYghc Zha Yg k \ Yb JhWea Yghc ``Jj Jb[``JZY YUW XUm a cghmÅ 5 ZJYbX glUflg [c]b[U[U]bghme i VY\]bX me i f VUW Å Ï fA UYza]I YX U[Y [fei dži fVUbž ck @, Ł

@_VdfcTV`WT_VZTeZ_dTZR]cVJReZ_dZd V_gjŁeYVUZWTfJej`WRT_`hJVLXZ_XeYVgRffV `WeYV`eYVchZeY`feWWJZ_XeYRehYRe`_VMJW YRdZdUvgRffVUŽEYV4YZVR_fcXVe`UZTRVUZeeYV `eYVcZlRhFj`VS`JdeVZ_XdMVWdeVVŽ3feeYZd ZdU_VZ_UZVTeJjŁeYc`fXY^`T\VcjŁYf^`fcRd RhVRa`_+

Î 5bX k \YbYj Yf îh YfYŷ U'a Įg\Udž ZU UXm h]dg cj Yfž Yj YfnVcXm Ui [\g Q i ZUk g]b h Y [fci dQH Ym]_Y U Ui [\U`f][\bž k \Yb]hŷ gca YVcXmY gYlŷ a ĮgZ fli bY'Ï fA]I YX U[Y [fci dži fVUbž ck îc]bhYfa YXJUH Q9, Ł

CbY'k]l\\cihi\Y'ch\Yf D1ZR]cMReZ_ddW^e SV^Rc\UUSjRcV[RezeV
$$\label{eq:starting} \begin{split} & |R| \land WXZac TZj L \land WXZgZ XR_U eR Z_XRdR \land Rd \\ & ekc \land WXV_Vc dzj R_UXRezef UZj 6] aRX UV4 YZJ & \\ & uy4 YZJ Vdch RcU% \land VR_Z XR \land VRXV `_V Z_YZd \\ & e g LR_U eYV WZf cVe ckef c_Wg f cdZ_UZj JZWL \\ & RVaRce `WYVCR` VTYRCREVCZEZ+cf S[VTezzzj TR_YRgV_` T_} UV_e V a VTEREZ_cZE YV cVT X_ZZ_UFV`c Y a VU & cdW dYRU e XzgZE YV JRT `W cVTZac TZj ZIV a VcZ/TWU RdRSVect RLeYV hZYA \\ & Y [UZ_X` VR[f de ch Rd +] \\ \end{split}$$

ÎKY`\UjY'h kU]hZtfgcaYVcXmhrX]Y` VYZtfY'kY'hY``'h YaÅk\UhU'[fYUhZY``ck` \Y'kUg"DUV`cBYfiXU'[ch`\]gfYVé[b]hcb` UVfcUXÅBck'9`JUg:][iYfcUÅ/kYÑY`Ub` ib[fUhYZ```chÏ fAUYZa][YX`U]Y'[fcidžifVUbž`ck'@, Ł

Ch\Yf ZJWYg

:_ $e^{V}UZIF dtZ_dRS`f e^{4}YZ_VR_d TZA] Reset UV-L$ $cWWCV_TVhRd^RUVe`WAJdvRaaVRdR_TV-dR_UT_l$ $TVR]^V_eZ_e^{V}VhR_j aV a]VacVdV_e^{V}Ue^{V}V_dM_gVdZ$ $2d R cVdF]eLUR_j le`lUR_VgV_ed R_U Reset UV-d RcV$ $dTdf eZ_Z&VU Vc e^{V}Z_e^{V}e^{Z}_`c eff e^{A}V_j T_l$ $TVR]ZCV[ReZ_dMZadRcVdZUe`SVVV]]`VVfj a`TcZjL$ $d e^{VRe}4YZ_VR_dRV`S]Z&VUe`SVTF_Z_XR_U$ $^Ztef deVM_RdeV_j dW_e`f_T gvch VRe YRdSW_$ $T_TVR]VU+$

Î Gc WU``nž=ł\]b_ k Y7 \]YUbg UfY \mdc! W]hYg" H Y k \c Y l\]b[cZWci d YgžcZk \Uh dYcd Y k]``gUnždi h]b[cb a Ug_g'Ï

fi Ya U'Yža]] YX'U[Y'[fci dži fVUbž\][\'C9; Ł

 $EYVeV_UV_Tj e`UZHZ`f]RevZidRZUe`ckf]eZ_cV]Rez_dVZideYReRcVSRdvU`_^Zf_UVcdeR_UZ_XZ`$ $EYVUZWTf]ej`VcVTX_ZKZ_X`_VcMJVR_U`SeRZ_H$ $Z_X cVTX_ZEZ_W/^`eYVcdckf]edZ_UZHE`ceVU$ $T^^f_ZRez_ŽEYZHAZ]SVV(a]`cVUWceYVc$ $Z_ARce &Ž$

@Yggh\Ub ch\Yfg

EYV deVcV giaZIR, 4 YZJVR_ZI^R \U`feSjR WWJZ_X`WZ_WCZ cZgjZEYV UZEIF deZ_d Vg`\VR_ f_cVRJZAUZU/cZgjR_URT_decRZ_VUR_UUZ^Z} ZhVUa`eV_cZg]+

Î K YMY U k Ung VY]hì]b[ˈlà Ya Å k YMJY U k Ung [ch Ygg UVci hi g là Ub Yj YfmVc Xmi YgY"K YUk Ungžnei _bck Å k YÑYUgc! fUbgUbX h Uhỹch Yhci VYk |h i gÅ H Y gUa YUg'k |h ZchVUžk YÑ U'k UngVY Ugc!fUbg'Ï fA || YXU[Y] fci dži fVUbža YX|i a !ck 'Q9; Ł

 $EYVWWJZ_X`VZ_WVZ_CZ6jZd_`eT_}_Uve`cM$ $]ReZ_dVZadR``_X4YZJVR_deYV`dMgVdŽ:e^RZ_j$ $RCZMdV0/^T^aRcZ1_dhZeYVC0ZX__VZXYS`fcdŽ$ $EYZdWWJZ_X`VZ_eAc_ReZ_RJZ_WCZC26jVdHS]ZdYVd$ $RYZdRCTYZIR]dIR]VZ2cXV_6Z_VdRVdVV_RdeYVcfaVi$ $cZc`eYV&LAVcfgZR_dR_U3`]ZgZR_dRdZ_WCZc24+$

ÎH Ymỹ Y [cha cfY W YY_ ih Ub i g" H Uhỹ k \mih YmVYUhi g" H Ymỹ Y [cha cfY dYfgcbU] m" K Y W[b[Y VYZcfY h Ya Å = WUbhñgUbX 5 f[Ybh]bYg" K \mVUbhi=gUbX h Ya 3 GYWU gY h YmgUmih]b[g=k cbħigUnž UbX k YñY h Y Î W] Yb]ncg ĭ Xa |bi hj Y cZ Î 7 \]YUbI i gYXX[ga [gg]j Ym\$Å =a YUbžk Y gYY ci fgY j Yg Ug h Y Î W]Yb]ncg Ĭ Å žUbX k Y cc_ Xck b cb h Y 6c]j [Ubgžk \c UfY Yj Yb k YYb]Yf h Ub i g'Ĭ

fAU'Yža]] YX'U[Y'[fcidžifVUbž]]bhYfaYX]UhY'C9; Ł

=bg][b]ÚWUbWY

$$\begin{split} & EYV eV{d} de`VeVV LZIIf dZ_hRdeYRe4YZ_VR_d\\ & W_{le} \ Z_dZ_Z_TR_eLf_UZdeZ_XfZHVU \ Z_Rj h`ceYl \\ & hYZV`c \ If \]ef \ cR]j \ Z_eVCVdEZ_XhRjZ:_UZWVCV_TV \\ & R_UR \]RIV`W \ R_VUTYRRIEVCZdeZdeT \]`f \ cdR_U \\ & ~Rg`f \ cdR_VhYReTYRRIEVCZVA YZ_VR_d+ \end{split}$$

Î=łh |b_ k Y Xc U```\Uj Y gca Yh |b[]b Wea ! a cbžUbX mci WUb gYY |hf]| \h\YfY. k YÑY [fYnî MYgžXUf_ We ci fg U``h Y łļa Yž |hĝ', Y h Y 7 \]YUb i b]Z fa žk Y XfYggXfUV mžYj ! YfnVcXm]b [fYnžXUf_ We ci fgžV UW Å h Uhĝ' k \mk YÑY [cca m]bghYUX cZW YYfZ 'Ï fl Ya UYža]I YX U[Y [fci dži fVUbž]bhYfa YX]UhY Q9, Ł

EYVWWJZ_X`W_`eSVZ_XUZWWCV_eZReVUZ_R_j h`œYhYZJVhBj YRd_f^Vc`fdT__`eReZ_dŽ:e cVJRevde`aVa]Vd`h_UZJVTF]ej Z_RTTvaeZ_XUZW WCV_TVAŽEYVZ_RXV`WT^^f_Zej dW_Rda`dEzegV V_eRZJdRY`^`XV_VZej eYReSR_ZEhVdUZWWCV_TVŽ7VRc `WT_~ZTea]BjdR_Z`a`œR_ec`JVYV&Ž



5::=FA=B; H 9'9L 7 9DH B

$$\begin{split} & EYVUZIIF dtZ_dUZUR d ckykr RUZWKV_e_` \\ & eZ_` `W4YZW_dY h VgVd.`_Ve/ReT_ecRUZ d e V ^ RZ_de VR` gZhŽ:eeM]d`WRa`d Z gVLT_ł \\ & eXV_eZU_eZJ_ERT^ ^ f_Zj Z_YRc^`_j hZY \\ & X`UdTZA ck/ReZ_dVZ d d]ZLRZ j LY chZRZ j LY chZZ j LY chZRZ j LY chZRZ j LY chZZ LY chZZ j LY chZZ$$

Gc`]XUf]hm

4 YZNR_ddR_USj eYVZc`h_ŽE YZIRtHveZ_hRd YVRU`_]j Z_eYVUZIIF dtZ_d`WeYVa``čZeZiT_ł }_VU e`ŁR_U bF VdzZ_VU SjŁeV/ Rj`_VŽEYVAV ZIR^V^`g`VVT^^f_Zj cVda`_dvde`UZRteV4Ł YRUeZ VdR_UT_eZ_XV_TZAŽ6gvdj S`Uj TR_cVIR] d^VZ_dR_TV`Wu V`a]Rdj d`]ZLRZdj Z_cVda`_dv e`R_VReeYbF R_VLRTTZU/e`cZ]_VdtZH YReZUh Vje `_^`deZleYReeYZIZIeYVd`]ZLRZdj`Vu Va]VhY` YRgV_`eYZ_XŽE YVgRJF V`WeYZHVja SVZ_XcVT Xi _ZXVLLh YReec`f S]VdaV a]VZIeYReZeZIRS_`c^RJL VieR_V fde`URZj`]ZW4



Î@_Y'h cgY`\i [Y'[fYUhfU]bg'k Y`\UX'Z:f]bgHUbWY/k Y U``fU`]YX fci bX h Yb"MYgžVi h h Uhỹtk \Uh=a YUbžgca Yh]b[V][`\Ug'hc` \UddYb VYZ:fY'dYcd YÅ ch Yfk]gY'k YÑY' bchÅ žch Yfk]gY'k Y WUbNtVY Vch YfYX'k]h` dYcd Y'k \c'UfY']b U VUX gdch'Gca Yh]b[Yl hfYa Y`\Ug'hc`\UddYb VYZ:fY'k YÑ`[Yh]bj c J YX'Ï

fA]] YX'U[Y'[fci dži fVUbža YX]ia !`ck 'C9; Ł

<cgd]hU`]hm

4 YZ/VR_dR:Vd*TZ7S]VLRWW16Z_ReVR_UhVjT^} Z_Xe`hR:UdgZEE`cd`cV&2X_Vcd+

Î K YÑY j YfmZ]YbX`nžYgdYWU``mk]h` dYcd Y k \c Wea Y \YfY Zca UVfcUX''5bX` [Zh`YmUg_gca Yh]b[k Y]]j Y h Ya U[ccX` Ubgk Yf''H Uhğgca Yh]b[k YÑ Y [ch j Yfm Z]YbX`nžUZYW]cbUhY'Ï fA]I YX`U[Y] fci dži fVUbža YX]i a !`ck @; Ł

$$\label{eq:linear} \begin{split} &2_f \left[\text{ekZ}\ c^{\ \ } \text{e}_{\text{Z}} \text{VZd}f \ d_V \text{TeVL}Y \ h \ \text{kyc}+\text{VZeY/c} \\ &d^{\ \ } VSV_V \ e^{\ \ } \text{E}_{\text{Z}} SV_Z \ Xd \ f \ \text{X'eL} \ c \ e^{\text{Y}Zd} \ \text{VZY}_U \ U_Z \ \text{Vd} \\ & \ \ \text{Rhd} \ d_{\text{V}} \ e^{\ \ } V_e \ \ \text{VeV} \ \text{VeV} \ \text{VeV} \ \text{XZ}_V \ \text{VZ}_Z \ \text{$$

<UfX[·]k c f_

:_ eYVUZEIF ddZ_d`WeYVa``ck Xc`f act_cNrUZ _VdtWcYRdUh`c\R_URaacVIZReZ_``WZed gRfV RVRTV_ecR] eYV^VZE` eYV^LeYV6VScZ_X^VR_ł Z_XLWdtVcZUV_eZej R_U^R_VZe'a`ddS]Ve`YRgVR UZEIF ddZ_Z_eKc^d`VyH WZEYVUZR]`XfVRS`f e 4 YZJVR_dR_Uh`c\cWXK6YVdR_Z`RYZ_Rej eYRedWd eYVd`TZRJZ_eXXReZ_``WeYVa``cRdSVZ_XWcXVU Sj YRCLLUZIZAJZ_VUJRS`f c+

Î H. YmÑY Ú () hY fgžih Ymk cf_ ih Y]f k Unici hcZ h]b[gÅ /bchU`žVi ha cghi fA]l YX U[Y] fci dži fVUbža YX]i a !ck C9; Ł

:_eYVZ RXZ_Rg`YWRUh`c\hV}_UeYVgRfKd `V&Vd_RJUZX_ZgLac`XXddR_U_RZ_RJT^^f _ZgŽEYVa``cdzJdVT X_ZXVeYV^dNgVdeYV&Z:_ eYV^ZUJVIJRdMLeYVZ RXZ_RgZdZ ZRŽ3feZ_ eYZTRVZzZL_`eRJJVT^aRdZ_X ZzZdeY`dVhY` cVRJj U`h`c\eYRedeR_U`fe+

Î 7 \ J'YUbg'UfY'hYff]V`m`Unn'lÏ fl Ya U'Yža]! YX'U[Y'[fci dži fVUbž]bhYfa YX]UhY' Q9; Ł

DUfhm

2_`eYVc R`SZGRIV_TV eYRe cf_d eYc f XY eYV UZEIF dZ_d`WaV a]VW/^ a``cR_UZ_eVc^ VUZEV dVTeZ_d`WaTZ(ej ZeleYV`_VSVehW_ ^Vcj ^ R.} Z_XR_UVi ecRogRAR_TVLTV/VSCReZ_R_UVI TVdŽ7RTVU hZey eYVCZX f c`WRZj JZWZ:eZdcRZLIA YZ/NR_ddXV `fe`aa`cef_ZZZde`]Ve X, eYV_eYZ:cVacVdDU ZV_eEg T ^ Vd`feŽE YZIVV_1]`gZ_XdLV`V&YVZcdZd _`eaRce`WRZj JZWLY`h VgV&R_UeYVI ecRogRAR_TV Ze V_eRZjd^ R_VdURj le iURj VIZEV_TVVgV_YRUVČZ ARcej Z_XdW^ dZ_dVaRCFSJVW/^ XfZe+

Î; YhXck b h 'h Y Z bXUg OH a dcfUfm ci hXccf fYglUi fUbhgk \YfY bUhcbU`XUm]g WY YVfUhYXQH YnÑ VY dUW YX°H]g cb[k YY_YbXzh Y fcUXgk]``VY 'Ua a YX° H YfYfg bc a cbYmUfci bXzVi h7 \]YUbgž h]g]g k \Uh=Ni [Yhh]b[Uhz`]_Y U [ccX ha Yz h Ym']_Y h Yb'cmh Ya gY j Ygzh YnÑ gdYbX h Y]f UghdYgcžU'k \c Y a cbh Ng k cfh]b U XUnÅ UbX h Yb h YnÑ [c Ufci bX a cUb]b[" K cbNih Yn8 H Uhg h Y ZUWz UZYfk UfXg h Ym

[c'UfcibX'Wcad'U]b]b['Ï flYaU'Yža]lYX'U[Y'[fcidžifVUbž]bhYfaYX]UhY' G9; Ł

 $:eYRdSW_dW_eYReeYVZUR`V4YZVRdRT^{1} ^{`}_dV_dV`V5V]^_XZX2gZXcZVe^RWWZX`W$ ZV_e2g_YRd]`deT&UZ5Z2gZEYVfd'R]V1a]R_REZ_ WceYZdZ1eYRe4YZVZ1_`eRT^^f_ZgLSVIRfdV eYReZ1_`eeYVhRJ4YZVR_dRVZ

EYZELOW de SVeef V`W4YZVe UBJŽERSJV* dr`hdeYRe aV aJVddyWWdeW eV_Ude SVbfZeV YZXY hYV_ eVJ T ^ aRtVeYV dygvdhZeY eYVZ_ł YRSZER_ed`W_VZXYS`fcZ_XT f_ecZdŽ

2TT d.Z_Xe`eYVF?5A#!!" Df cgyj£Y h Vgv& eYZIXV_VA] eV_UV_Tj ^ Rt\dT _dZ.VATS]VUZXWAV_TI VAŽH`^ V_ eV_Ue`T ^ aReVeYVZ:T ^ aRecZ ed]Vdd VAg`f dS]j hZEY`f cdZ.VadeYR_ ^ V_U Ž> V_ ^ R.V ^ `dVa`dZ52gVRdJAdt V_edhYV_Z:T ^ Vde`RdaVTed
$$\label{eq:response} \begin{split} & \text{TYRfgZZizT_RZ_RZi^+ScRgVcj} \ R_U \\ & \text{aRez ezt } \tilde{Z}_eVzlT^a \text{aRrezgVvgR} \ ReZ_LRUf \] ed \\ & \text{YRgVR^RC_VU} \ \tilde{Z}_eVzlT^a \text{aRrezgVvgR} \ ReZ_LRUf \] ed \\ & \text{YRgVR^RC_VU} \ \tilde{Z}_eVz \ RV^W \ YZVR_d \\ & \text{eYR_eV} \ \tilde{Z}_eVzlT \ RV^Z \ RV^W \ YZVR_d \\ & \text{eYR_eV} \ \tilde{Z}_eVzlT \ RV^Z \ RV^W \ YZVR_d \\ & \text{eYR_eV} \ ZVUgZh \ d \ YZVR_d \ RV \\ & \text{SvevcRdvWRUHTYRfgZZizT_RZ_RZETRaVTed.} \\ & \text{StevcRdvWRUHTYRfgZZizT_RZ_RZETRaVTed.} \\ & \text{StevCRdvWRUHTYRfgZZizT_RZETRaVTed.} \\ & \text{StevCRdvWRUHTYRfgZ} \ eYVZ_YRSZER_ed^W \\ & _VZXSS^f cZ_XT_f_eZiZE_VVYZXH^V \ VZA^F \ YZXY \\ & \underline{VZXSS^f cZ_XT_f_eZiZE_VVYZXH^V \ VZA^F \ YZXY \\ & \underline{VZ}eVT_f_eg \ ZIML^V \ VR_h \ YZMENT_2 \ eWed \ YZMC_d \\ & \text{RVSGgVc}R_U^- \ CVaRez \ eZZ \ Z \\ \end{aligned}$$

:WAYV`aZZ_dT_TVcZX4YZJVR_dfaVtZcZej `gVc_VZXYS`fcZXTf_ecZdZ_eYVeRS]V*bfVd eZ_dRcVeR\V_Ze`RTTf_etRd_eYVeZTZUV/TR_ SVT^aZJVLŽ

EY dhY RVac`fU`W4Y4VRV^`dVJZVJj eYR_ `eYvc`Xc`fade`RVvc^ eYRe4Y4JVR_dRvvcfavkZc e`eYVZ_VZXS`fcdZ_ eYVRvRdT_dZVvVZ3j T_eRHELeY`dVhY`RvVcVdaVTegyJj f_dfcVR_U R_Xgi RS`fe4Y4VLhY4VeYJ XV_VRJJj eV_Ue` dJ eYRe_VZXS`fcZ_XTf_ezZdRvvcfavkZd:YRgV UZWKV_eFReVUgZhd+4Y4VR_dRvVSvEevcZ_ eYV TYRfgZ_ZH2TRVRd1SdRgvcj R_UaRecZeZt`/ R_U h`cdvZ_eYvdTZA]RvRd1]Rj R_UdM}dv/Z

7 C B 7 @ G€ B

H YRe V V&Xd W^ R] eYVRS gVZI eYRELZ: f a cgłź h Y 7 \]YUb [XYbh]mi]g bc hWYX]VY UbX Xc Yg bc hdfc Xi WY U gYbgY c ZVY cb[!]b["AV a]V dRIY eYZIT _]If dZ_ `_ eYVSRdZi W eYVZ: If ccV_e V a VZZ TVL: Vh YZIY eh` ej aVdRV aRceZIF]Rc]j Z a` ceR_e+ eYVZ: a VCIVaeZ_d RS`fe eYV WWME R_U UZEVIEZ_ `VVVIV_e TYR_XddZ_ eYV T f_eqiLS` eY VC eYVT f_eqj RdRhY`]VR_U VC eYV` a Vcd_R]jLR_U eYVZ: a VCIVaeZ_dRS`fe eYV ej aV`Vd TZSZZej eYRe acVgRZdR` `_X4 YZ/VR_dŽ Gi a VZZ_TVdZ_ eYVV RVRdRV a VCIVZeVU RdT_ł } c^ Z_X eYV UVXcW` VZ_eVXReZ_` c VI T]f dZ_Z_ d TZkjŽH YRedW^ de` SVRedRV VZleVVa]Rf dSZZej

`WeYV4YZJWR_ZUV_eZejR_UeYfdhYReZe^VR_de` SVaRce`WZeŽ

8 [gVY`]YZ]b 7 \]`YUb`]XYbh]mi]gʻh YʻdfY! gYfj Yʻc Zh\c gYʻk \c 'Webg]XYfʻh Ya gYʻj Ygʻ Yl Wi XYX`c fʻdfYʻi X]WYX`Vmih YʻZefa 'c Z h Y]f`ge WJU`fY`Uhcbg\]dgʻʻ6mWebhfUghžh\c gY` k \c 'h]b_ 'h Uhih YʻZefa 'c Zh\Y]f`ge WJU`fY! `Uhcbg\]dgʻXc YgʻYbUV`Yʻh Ya 'hc ']bhY[fUhY` ge WJU`miUfY`U`ge 'VY`]Yj Yfgʻ]b'h Yʻ7 \]`YUb`]XYbh]mžUbX'dfci X`c Z]h'

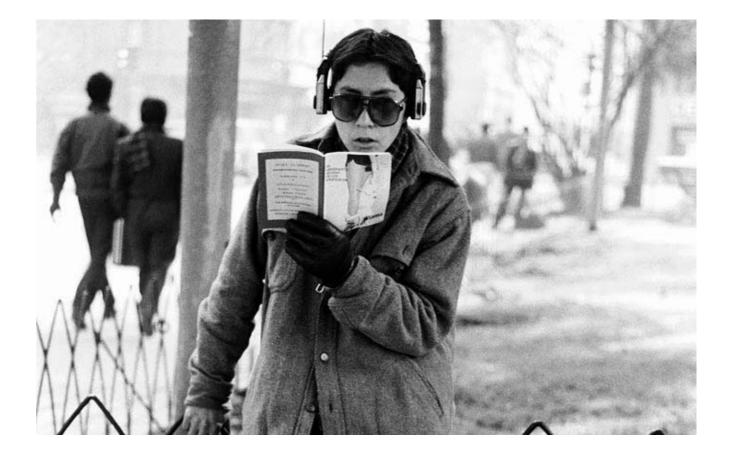
 $EYVZUMR `WR 4 YZWR_ZUV_eEg YRd_`eT^{1}$ a]VEVj UZERaa VRCVU VV^ eVV aCVU ^ZR_ed TZR

Z RZ_RjŽ2deVVRjZćUXđRžaZ_dYhULZZ V_T f_ekčURdR_ZVRjŽVZeUVd_`e^R_ZVVEZdVJW RdRcVRJZj Z_VgVjURjJZVLeVV_eYZdZVRJUVd_`e TVRdVe`SVUVđERSJVLSfeZddYZAVU`_e`RaJR_V hYVEVZeZL_`ed`S[VTee`eVVekde`WVIaVEZ/TVŽ

EYZITR_YRaaV_Z_dh`hBjdŽ2 aRde eYRe ZI eY`fXYee`SVX_VWcX`ULR_UZIeYfdf_gV231 RSJVL^Bj SVZLNRJZVUŽ@ceYV4YZVR_VdV_TV^Bj SVda`\V_`VM2EY acZUVRdd^Vh`_UXMJeYZ_X eYRe VIZdd`fedLWeYV_`c^BjdaRIVR_UeZ_V`W URZj JZNL`c`fedLWdTZRjcVReZ_dYZad RXRZ_L SYj`_UR_j gV23TREZ_Sj VIaVEZ/TVŽ

 $\begin{array}{l} & \label{eq:constraint} EYV URR U _`e ckgvR] R_j Wch RU]``\ZX \\ & \mbox{ZMRZ}_`W4 YZVŽEYVCVZI_`dX_`VR_Vh \\ & \mbox{4 YZVeYReh Z]} RczgV`_VUBLh YVeYVcda`_eR_V \\ & \mbox{1}fdj `c eYc f XY UVJSVReV d TZA] REZ _ZH YfY` \\ & \mbox{gbc `\cdY'Zc f'U'bYk 'Z hi fY'h UhWUb 'hfUb! \\ & \mbox{gWbX h} Y'a d'Ui gV]`[mic Z7 \]'YUb '[XYbH]mi \\ & \mbox{h} XUm' \\ \end{array}$

EYVTEZZEL WAYZVROR ZUREYRETR ZOLZVR $dV_dV W V_X X_X W de SVaf e Z T_e M e Z e Z d$ `eeYVdR^ VeYZ XRdR ZLV eZej gRIff^ŽUV eZeXd $R_U \operatorname{ReeRIY}^{\wedge} V_{ed} \operatorname{RVR} dY Z dZ X \setminus R V Z J d\Gamma a V Z E Y V$ T_}XfcReZ_ZflRjhRjdTYR_XZ_XVgV_hYV_eYV SROWIREV ders VZ2 e a Roezer f Rc ez VeLd ^ Vazziva SVT ^ V^ ` dVZ' a` ceR_e h YZV ` eVvcd UZRaa VRŽ :_4YZWLeYV\RWZUdTaV`WXU_eZZVdR_UReeRIYI ^ V_edZdTYR_XZ_XŽEYVZ_YV6ZeVUT_}XfcReZ_Zd _`ea]RfdZ5]VRdRT^^`_dWXeV_eŽ@eYVcdWXeV_ed dv RZ_Z_eRTeLR]eY fXY_`ef_RWWTeVLŽ2eReZ V hYV__ReZ_RJReeRIY^ V_edRcVhVR\V_Z_XLcVJZXZ_ $R_U eYVW 2j RVeVZX R_Vh^VZ_JXR_U$ W_TeZ_Ž2dhZ]SVdW_ŁY`hVgVŁeYVj YRgV_`e SW_RS|Ve`d`aa]j eYVejaV`VSV(`_XZ_XeYReeYV ZUNR `W4YZWUZUŽCVJZZZ_ R_UWR^Zjj RcV^ `cV Rdt TZREWUHZEYZ_UZEZLFRJZEREZ_aYV_`^ V_ReYR_ hZeY_VhWc^d`Wd TZR ZLV_eZejŽF_acVTVUV_eVU ejaVd`WdTZR] ReeRTY^V_eRcVR]d`V^VcXZ_XL Y`hVgVZEYVW]`hZ_XTYRaeVcdhZ]UvdTcZSVeYV dYRaVLdT aVR U Z ZRZ d`WeYVdVac`TVddVd`W ZV_ezj dvTdvReZ_Ž



7<5B; 9G⁻ B⁻7I @H F5@DFC 8I 7H€ B.⁻ bYk ⁻⁻Ub[i U[YgžbYk ⁻⁻UbXgWUdY



H≰9[·]B9K [·]7CB8+HCBG[·]C: [·]7I @HF5@DFC8I7HCB



6RcjZćTYRaekdokgZh UU ^ V VeYVhB, dT] [VTeZgVZ RZ_RZKIZ 4YZV YRgVTYR_XUŽEYV ^ `de dRZ/e }_UZ_XLR_Rj dU Z_UKRZLhRdeYRe eYVZJNR`VRT ^ ^ `_ 4YZVR_ZJV.eZj YRUSW_ UMalj Vc UUŽEYVeRLZZ_RJZJNR`VEYZIZJV.eZj dW de YRgVSVT ^ V Sd]VeVhYV_dkERKZ_deeYV dKRZj `WhYRe 4YZJNR_dViaVEZ/TVZ_URZj]ZWŽ ? VZEYVceYReT]]VTeZgVZ RZ_Rj _ `c`eYvcZYVd Z&U chackdV_REZ_dLdTY RdeY dV`VeYVIR*ZjL cMZZ_ R_UEYVDERELYRgVeYVa`h Vce'V S`Uj R yH VZZJVE eYY_RV_`e UZRaaVRZ_XŽEYV`]U Z RXdd cgZgVR_UZ_rV_TVE/VhB, aV a]VdW eYV_Vh]R_UEIRAVŽ

 $= \mathbb{Z}_{V} \setminus \mathbb{Q}_{dj} \stackrel{\text{def}}{=} \mathbb{Z}_{X} \mathbb{Z}_{2} \quad \mathbb{Z}_{2} \mathbb{Z}_{2} \quad \mathbb{Z}_{2} \stackrel{\text{def}}{=} \mathbb{Z}_{2} \stackrel$

a`h\&W] eeRLÆZ_d_SfeRjd Sj Z_Y&ÆAUSfdV_d R_UZ_VæÆŽ:_R_j \&V_d_eY\&VZd_` \dIRaV\&'^ eYVaRdeŽAV a]VSVRcRh\Z&Ye`\Wia\&Z/T\LeY\Z `h_`c`eY\dLeYReRWWWEdY`h eY\j d\\eYVa&d\/e R_U\WU\&YV\&E &ZEY\Zc&RLZ_X`\&YVdEFReZ_L Y`h\&V&LhZ]RhRidSVSRMU`_eYVa&d\/eŽ

 $4 YR_XVT^{VZ_UXWZ_X} dVdd^{VZ} a^{R}_TVZ_EYZITYRaeVchZ] UVITeZVeVVdvdef Tef cZ_X^{VVV} XV_VR_VR_Vh^{c} e^{PETf}]ef cVZIaRe^{Vef} fTYZ_X ^_ eYVZ^{aRTe}_e^{-}[j^{VZ}ARTe^{-}]j^{VZ}ARTE^{-}]j^{VZ}ARTE^$

dec`_XS`_UZ_XVJV`V_eZ_eYVT_dTZfd_Vdt`W yHVLeYV4YZJVR_d%ZEYVZ_V&^ReZ_acVdV_eVU YVCVdr`hdeYReeYVc`]V`Wa`]ZEZTdZ_eYVac`UFTi eZ_`VUF]efcVYRdTYR_XVUZEYVcVJReZ_dVZaSVi ehW_eYVa`]ZEZTRJZ`RXZ_Rcj_R_UaVaJVdURZjj]ZEVIZEUVeVJ`aZ_XZ__VhhRjdŽ

Df Schlof V_e TYRaekch dr'h Y'h eY actiezt vil $R_U Z' RXZ RZA' WJZWZ d'TZAj RV vg']gZ XL$ h YvéY véSVIRf dv_h } VJUA' VHF]ef cR] ac' UF TeZ_ d'TY Relev VgZZ_ RV' a V_Z Xf aL' cSVIRf dv'd ^ V _`c^ R] Rab Vied' Wi TZA] JZW d'TY RdT_d^ aeZ_ RV eR Z X`_ R_Vh Z'a' ceR_TVL' cSVIRf dv'eY_ZT U/ R_UdR vSVZ Xa'h včW Jj cV_vh VLL' cSVIRf dv' `WeY VZ_TC RCW udack RUR_UTV_eR JZj `WUF TReZ_L h YZTY ZI RIbf ZZ_XR_Vh c' JVZ_TF Jef cR] ac' UF TI eZ_Ž4 YRaekch kL' R_U(UKR hZY eV vkV/ véXZ X eV_UdZ_4 YZ/W_TF Jef cKŽ

; @C65@AN5HCB

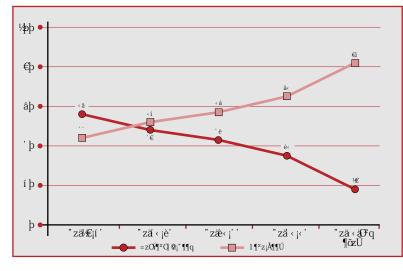
EYV} cdeR_U^ `de`SgZ f dTYRcRTeVcZbZT`WeYV $_Vh dEf ReZ_ZdX_SRZReZ_ZJVe eVVTf]ef dR$ $UZ^{\prime}V_{d}Z_{-}^{h}V^{\prime}V_{d}X_{Z}X^{f}e^{U}$ YRdSW_ ZeelVdefUZUŽD^ VT^ ^ V_eRe`cddWZed WWWTeRdRyY^^`XV ZZ X% _VLSfe`eYVcdRcXfV eYReeYVolVac`TVoldVdU _`eRUUfae`Rf_ZVvc^ yX|`SR|TF|efcV%LJVcR|eYReeYVfSZbfZij`V4`TR 4]R c > T5 _ R]UdRc f _ UeVh d]Ud XX/dedR $XV_VR_Y^*$ $XV_ZR_Z_ 18R_T_4R_T_ZZ_**!$, @ce2kL"***, > Rce3/4 3RcSVc`L"**)/Ž:_ WATEL VRIY d'TZK ac`TVdtVdLT ^ SZ_VdR_U dV dXR_ZKVd eYVIf]ef cR V/V V_ecITZEIf]ReZ_XRc`f_UeYVh`dJU \underline{Z} \underline{Z} $\underline{d}^{1}h_{d}$ $\underline{d}VIZ$ ThR \underline{Z} \underline{Z} $\underline{d}^{1}h_{d}$ $\underline{d}VIZ$ ThR \underline{Z} \underline{Z} $\underline{d}^{1}h_{d}$ $\underline{d}VIZ$ \underline{Z} $\underline{d}^{1}h_{d}$ $\underline{d}VIZ$ $\underline{d}V$ \underline{d} $\underline{d}VIZ$ $\underline{d}V$ `acZReVUR_Uy_ReZ_RJZKVU%Z2dF?5A1#!!"/ YRddr h_ŁeYZdeV_Ude YVZXYeV_ UZęvładzij hZeYZ_ VRIYT f_eg Ž@_VViR^ a]VZ_4YZVZleYVX/VR eZ_XRaZ_eYVfdV`V&RdZT^`UVc_ZkReZ_e``]d+ VcdL^`SZVeV[VaY_VdR_UeYV:_eVc_VeŽ2d} Xf cV # dY`hdL) #"``WeVda`_UV_ed RXVU`gVc && dePeV eYReeYVj RcVR]^`de`cT^a]VeVjj f_VR^ZZRchZeY eYVdV^`UVc_Z_decf^V_edŽEYVXRadR^`_XRXV Xc`fadRcVdezZZXLhZeY&' `Wj`f_XaVa]V RXVUSVehW_") RU#%TIRZZXe`SVVRZcji`c gvoj WRY ZZRICh ZEY eYV Ž

4 YZW₂ d TZkj Zł dzJ eV dkeZ₂X Wc ^ de aV a]Vd_`c^ R] JZWŽ3f e eVZc Vi aVZV_TVZł_`]`_XkT_}Ue eYZŽ7Z_R_TZR TZM dR_U`eVkc h`dlhZWf aYVRGR dRvRd aRe`W4V_RzZ_R dzf RzZ_Ž:_UWLŁ#(´´`W4^ dVZ ekgZhVU Sj F? 5 A dReWUeYRe eVV^`deZ a`ceR_eZ_fV_TV `_eVZc JZWdhRdyh YReZdX Z_X`_Z eVVh`dUXw hYZV% dZUZe hRd yh YReZdX Z_X`_Z eVVh`dUXw hYZV% dZUZe hRd yh YReZdX Z_X`_Z eVVh`dUXw h`dUSVZ_O.Wi YZWdac`S]V`hRd`_TVZddVI]fł dZ_W7^ eVVh`dL4eVV`aV_Z_X`WzdS`dVkd_`h dW^ de`SVTEVReZXEVV`aa`dZvUZWIf]ejŽ9`h TR_eYVJZ_Vd`WZ_TIf dZ_R_UVITIf dZ_eYRe^Rc\ eYVS`f_URZd`WI TZKj SVerRIVLO

F989:=B=B; H≰9B5H€B5@GH5H9

2 d/T_U^ VXRecV_UL`aa`d/Ue`e/V} cdeLZde/V dv `UMIZX`WeYV_ReZ_RI DeRevŽEYZdecR dVd ^ ReZ_Zdac`gZXR] eVV^ `dVhdV_TYZ_XSVIRf dV TF | of cVZ_4YZVYRdSW_Ra` | ZEZTR| RWRAC dZ_TV : UVAV UV TVŽEYZdh Rde`f TYVU fa`Z ARce# `WeYZICVa`ceŽ:_4YZJVLa`]ZeZTR]T_decfTeZ_`W R_ReZ_R|ZV_eE;ZdZ_eVachZ_VUhZeYRTf]efdR WWW.de+eYVT_dVTdReZ_`VRR_ReZ_RJYZde`qi R_U eYVecR_d^ZtbZ_`VR_Raac`gVU_ReZ_R]Tf]efcVŽ 5 fcZ_XeYV_Z_VeW_eY R_U ehV_eZeY TV_efcZkeL $DereV VUf TReZ_R R_U Tf] ef dR a`] ZZ dL R]` _X$ hZeY YZEE cZTR] VgV_ed d'TY Rd eYV ARIZZT HRc eYRe TeVReVU R y_ReZ_R]%7]Z' RevLh VeV eYV ^ RZ $^VIYR_Z^{T} dVcZ_dZ_{T} dZ_RZ_X^VIZR_dcdcdV_{1}$ eReZ_d`WeYV_ReZ_Ž_eYZdhRjŁeYVDeReVTeVReVU T]]VTezeVedRUZZ_dR_U^ V^ `cZdeYReYVJaVU_`e `_]j e`f_ZjVeYVaVa]V1RdRacZ_TZa]V`Wa`]ZZ TR] JVXZZ RIj / Sfee` Z_T ca`dReVZe1RdRya]VSd‰ \underline{Z} e eYVU ^ \underline{Z} Re \underline{Z} d deV \underline{Z} EYVUkeV a V e W eYZi yDeReViTV_ecZi%di TZkij YRd SW_ UcRcbZIR]jj ^`UZ; VU Sj_V]ZSVCR] Xc`heY decReVXZKŽD TZ ł VT_`^ZT^`UVc_ZREZ_YRdSW_RTT^aR_ZUUSj DeRevolution have uncoment of the traditional of th ac`UfTeZ_ŽEYV^R_RXk2R|c`|VRd2X_VUe`eYV $DeReVZdhVR (V_ZXZedVV_TeZ_RdeVVd^{S})/ZT$ chác với _ erezev ` Weyv d' TZR] ` d.Wž ARCRU' i ZIR] ji Ł eYZdyVT_`^ZIZd%gZdh`V&YVDeReVZddecV_XeYV_ł \underline{Z} X eYV UV \underline{R} U Wc d TZR \underline{Z} eVX \underline{R} \underline{Z} . ` eYVc h`ddLeYVUVIZV`WeYVDeReVR_UeYVdvff]eR_e

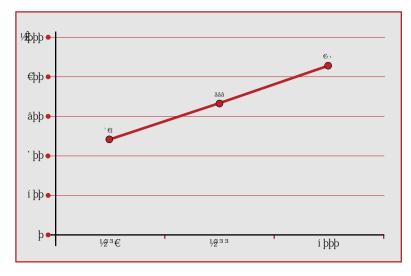




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fi¶ – Åï æ ÚžiÅz Úži⁄pnþþä? o@ 🕫 átáÇz Ýæ- OæqÈ



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f acf cXV^ WeVV^ Rc\VeVT _`^ j RcVX g_Z XTf]ef cV R_Vh Z a`ceR_TVŽ

5 ÎA 5 F? 9HCC 7 = 9H/I

H YV_ eVV ^ Rc\Ve SVT ^ Vd eYV ` cXR_ZkZ_X acZ_TZa]V` Vd TZA] $ZVLZeZd_` e`_]j eYVT f_ecj d$ VT_`^j eYRe TYR_XkdLSf e Zed Tf]ef cVRdh V][Ž: e Zd_` e R]h Bj d VM]j RaacVIZReVU eYRe eYVRU acZ_ ` VY^ Rc\Ve]` XZI%V_eRZdR Tf]ef cR] ac` [VIeRdh V][Ž E` eYV Vi eV_e eYRe Ze ccR_dWc^ d eYV acRIeZTVd R_U cVacVdV_eReZ_d` Wd TZAG LeVV ^ Rc\Ve]Bj d eYVXc`f_Uh`c\WcRyTF]efcR]^`UV}%Zied^RZ TYRERE&CZEZTOW^de`SVeYVTV_ecRZj`WeYVZ_UZ gZLFR]R_UL^`CVUZVTejjLRaReeZfF]RcT_TV&eZ_ `WeYVZ_UZgZLFR]RdR_Rfe`_`^`fcLcReZ_R]R_U Zi]RE&URTe`CZEYZZZAR`WaVa]VXfZUXdeYV^VeY1 `U`]`XZTR]Raac`RTY`W_VT]RedZTR]VT_`^ZEHR_U cWUY_VdhYReTR_SV^VR_eSj_eYVT^^`_]ZW `WdTZXejZ

 $:= eYZIT = eVIeLTf | ef dR | h^c < eR Vd^{-} T^a | VeVI$ $j_{\rm L} = 10^{-1} \, {\rm Mc}^{-1} \, {\rm d}^{-1} \, {\rm d}^{$ eZ_LLZEVcdZTReZ_R_UaV_VecReZ_`VXX`UdR_U dvgZIVdVcRdvdeYVT_ecRdeSVehW_yYZXYTf]efcv‰ RUV Roll TF lef cl/165 Veh WeYV} VRoed RU VZ dfcVR_UV_ekkeRZ_^Ve`WWKZ_XdŽ2 hZVdR_XV $WT = dR X UB RCV_ h T_d VU VRS Z X$ ZUZEZUFRIde TOUREVRTFIefor YRSZERe WC eYV 1 dMgVdRdeYVZcaVcd_RjeRdeVdUZteReVŽ6Rd RTTVdd e`eYVdV`aa`cef_ZZdUZ`Z_ZhVdeYVacVdTcZaeZeV Rf eY cZej `WaRcV_edR_UTYf cTYVdR_URjeVcdeYVZc ecRUZEZ_R|c`|VLW/^ VR^Z|i ITV_ecVUcVTcVReZ_e` dIY``] VUFTREZ_R_UdVTe`dR|TF]efdVa`[ZIZdLZ_ eYVTeVReZ_R_UeeR_d^ZebZ_`VRCT^^`_de`eV `WIF | ef cVŽEV | VezzZ_``WWkd R d'WIZV_e Vi R^ a | V `WeYZETT_eZ_f`fd~`h`WZ_`gRezgVLWARX^V_eRgi y~RchVcheyRezlchWazXRhR `]UecRUZZ_dR_U VRS]ZX4YZWR de`dYRCVZ f_WR^ZZRcViaVcZL V_TVdR_UZ`RXZ_VUZXWKV_eh`d]UdŽ

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 $2 \text{ Wf eeY eV_UV_TJ ZIWc d TZA T ^ f_ZReZ_$ e` eR_Va]RIVeYc f XY eYV^ WZEZ? Vh Z_Wc^ReZ_ eVTY_`]`XJ R_UeYVacU ^ Z_R_TV` WAYVR UZ I gZ d'R] h`dUYRgVTYR_XUeYVy^ V_eTJ ^ Rad%6dWSj 4 YZVR_de` T]RdZfVR_U`dVcd TZA cMZEjZ

@hZ_XaRczIf [Rc]j e`eV[VgZtZ_LeYVVZtRXc`hł Z_XdV_dReZ_`VgZtef R] cVR]ZejŁhZeY daRezR] [Z`Zed 1Z_dZU/z´f edZU/ dW^Z_X e` VRU/RhBj R_U eZ V Y`cZk`_d1RA8VcZSWV&V eV[VeT aZ_XZ@_ eYV`_V YR_ULeYVT ^ af eVcZkVUViaR_dZ_`VvdaRIVR]]`hd T ^ ^ f_ZIReZ_ hZeY aV a]VhY`ReV_`e aYj dZ IR]jj acdd/eŽEYZtZITYR_XZ_X_`e`_]j URj łe`łURj d`TZej T_eRIeSf eR]d eYVZUR`VeYVaf S]ZTdaRIVL hYZTYZEISVZ_Xd/a]RIVUSj`eYVcWc^d`W VUZA eZ_Ž> VR_hYZVLd`TZEj eZ`VZEISVZ_XVRX^V_eNU Z_e`dvJWT__eRZ_WU VaZdUVAŽEYV^f]eZaJZZaj`W Z_eVcackeZgVTUVdR_U eYV daWU hZeY hYZIYZł Wc^ReZ_R_Ud_^S`]dTZCTF]ReVReVYREV_Z_XeYV `Sd]VCTV_TV`WaRde Vra VCZ/TVdR_U VdeRSJZMZ_X Rd ce`WRFeZdeZTackdV_dERdvbfV_TV`WRTedf_T_ł __VTeVUSjR_j YZde`cZTR]cVJReZ_dYZaŽ

 $\label{eq:cvar} CVAf]RcT ^ af eVeL^ `SZVeV]VaY _VR_U: eVel$ $_Vef dRXVZ_UZIReVdR_RSZZ6j e` h` c\ Z_ ycVR] eZ_ VM_$ $eR_dIV_UZ_X_ReZ_R] VV _eXddŽ$

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AVCYRadeYV^ `dedecZZXWRefcV`W4YZVR_d ł TZAG e UR ZIZEdoRaZUZ UZEZUFRZAREZ _Ž4YZVR_d REVEV UZ Xei SCVR eYVd TZR Z \dR UeeRUZZ R YRSZECIEYRE YRGV S`EY T_decRZ_VU R_U ac`eVTeVU eYV^ŽEYZdyT^Z_X`fe%ZdaRce`WRac`TVdd`W V R_TZAREZ_ eYRe V_RS VdZ UZeZUFR de` Sc`RUV_ eYVZcY`cZk`_dLZ_TcVRdVeYVZcRSZZZj`e`aRceZIZaReV Z_d TZkg R_Uaf of VolyWolkRZ_RdeYy dW} eŽ :e^R, Z,g`]gVeYVcWVc^f]ReZ_`Wd TZR, S`_Ud `dŁRd`WaW_YRaaV_dŁZe^RjeR\VR_Rd17ZRjefc_Ž :_UZ&ZUFRZKReZ_RdRdTZRTT_Tvaedv^fTU_`eSV T_VKdNUhZeYeYV^`dR]TReVX`qj``VdM]}dY_Vdd`c eYVa` ZZR`_V`WZRWWEZ_Ž_dY` cetZeU`Vd_`e dW eVRed TZR Z UZeZLF R Z REZ Z Zed WZelh YRe ZELVECUZIXS`_UEL`WELTZRE dE |ZURGZEFR_UTRF6Z_X aV a]Ve` hZeYUdRh W/^ af S]ZTRWWKZdŽ> cVZ_{1} UVaV_UV_eR_Ud/W RUVZ_UZZIFRdTR_}_U_Vh $R_UUZWWCV_eVVc^{1} d Wd ZRZELZ_Vh T^{1} ^{1}$ daRIVČA`_dZNZ_XeYZŁeYVTZETf^deR_TVdeYRe d`WW_XZgVoZtVe`y_WRezgVZ_UZgZLfR]Zh%hZ] YRgVe SVR RjdU ReVZ

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:_UZ&UFRJZR&Z_ZIAVG`]F&Z_ZZX&VVdTZR] S`_USVIRFdV`VVEd]Z\ hZ&Y &VVdTZR]UZW&VZ &R&Z_ac`TVdŽ_d&RU`V&YVWhdTZR]UZW&VZ WETVdeYRefdVUe`VIZ&ERVRCXVR&VERdFJ`VRTe`cd R_U`V&RFfVR_USVJZVVJd&V`dTR__`hSVZ.V_&Z }VUŽEYV&VRVUZW&V_eyh`c]Ud`VVZVV&hYZY ^R\dZeYRdUV&ZUZ&UFRJde`}_Ud^VT^^`_ `dVcfa`_hYZIY`e`SRV@VVZ:VIZ&V_TVŽ

:_d`Wc`Rdd`TZR]yf_Zej%TR__`]`_X\cSVSRdvU `_ RdZ_XJVV&YZLeYVbfVdeZ_`WY`hd`TZR]Z_eVi \$'%B=1 ä @ @ ÕÝ(¶ ² ǎŹzáźå²z ĺ∄/źpþþä? o@) @ AÝ



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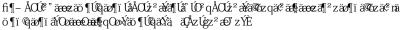
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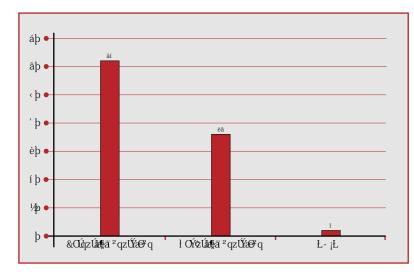


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XREZ_TR_SVSfZjeZdSVT ^ Z_X^` cVf cXV_& ŽEYV d TZR, WScZTh`f]U YRgV e`SVT_defTeVU W/^ dMcVU^` & gReZ_d.dZ'ZRc Via V ZZ_TVd`W/ VR_ł Z_XR_U dZ'ZRc Raac`RTYVde`RT&Z_ŽAJRZ_J j.ŁeYZd ^ f de Z_g`JgV WCd KRTYZ_XTFJef cR] ^ VR f cV Ž3f e eYV Z_UZGZ f RJZR Z_ R_U UZWWCV_& BEZ_ ac`TVdd Z1^ R.Z_XZe YR U/c e`cVda`_U e`eYV TYRJ V_XV `Wd TZR] Z_eVXR EZ_Ž7f ceYVc^` cVL eYV d ł TRJ VU yW_T&Z_R] UZWWCV_& BEZ_%ac`TVdd XGVd cZW e` ` eYVc UZWTFJ & ZKŽ

:_ eR_UV^ hZeY d TZR] UZWWEV_eZreZ_ŁeYVEVZd Z_TEVREZ_XUZWWEV_eZreZ__`WeYVeReZ f dyWV_TEZ_R] \$'%B=ł äâ





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d dev drå e Zel_`h hV] f_Ukde``U erre ervVT ł _`^ ZTd dev`YRdSVT ^ VcVR=ZVJ RF e`_`^ f dŽ D ^ VerZ X d2 ZRc Zel YRaaV_Z X Z_ erva`]ZEZRŁ]VAR R_UVUFTREZ_R d dev dŽE YVJ REVSVT ^ Z X ^ `cV dv/WerWerV_ERLVRIY`VerV^ `aVREZ X RI T d Z X e`Zed`h_Z ekc_R y]`XZI%Z4`_dLVAREZ_ `Vyd dev^]`XZI%ZerRe`VerVVT_`^j WcZ dR_TVL

+b h Y % + \$gž h Y 7 Uh c]W7 \ i fW k Ug U fYUXmi \][\][\][\][\]b W Ub[Yg]b W bhYa dc fUfmW h fY" H Y ; Ui X]i a Yhgd Yg DUg c fU~7 c bghh hc b c Zh Y GYW c bX J UhWUb 7 c i bW] dfc j]XYg Ub]bhYfd fYhJhc b c Z h YgY W Ub[Yg

Î H.Y. WIW a głUbW g c Z h Y. ZY c Z a c XYfb a Ub \Uj Y VYYb gc dfc Z i bXmW Ub[YX]b h Y]f gc WU UbX W h fU Ugd YW gz h Uhk Y WUb gd YU_c Z U bYk U[Y c Z i a Ub \gr fm BYk k Ung UfY c d Ybz h Yf?! Z fYz Z f h Y dYfZ Wic b UbX h Y Z fh Yf Yl hYbgc b c ZW h fY" H YgY k Ung \Uj Y VYYb dfYd UfYX Vmh Y Ybc fa c i g [fck h c Z bUh fU z i a Ub UbX gc WU gWYbW gz VmhYW b]WU dfc [fYggz UbX UXj UbWYg]b XYj Y c d]b[UbX c f[Ub]nb[a YUbg k \YfYVma Yb WUb Wc a a i b]WUhY k]h c bY Ubc h Yf" < YbWY h Y dr hdy h UZWIF je Ze ZdWca ` JZZ de` Rjekc` cTYR]]V_XVeYRe d deV R_UWcZe e` SV`aV_WJ fa e` aRceZIZaReZ_ Sj` eYkc of Sd deV d R_UUZWWeV_e d TZR] RIÈ coŽ 2 TT f_e YRde` SVeR.V_` VeYZ dUZW WEV_676; Z_LR_UZ_d ^ VTROM dAX V_eReZ_L`W ^ f]6Za]VyMV_TEZ_R]]` XZ d% eYRe TF e cZXYe RIc`dd 4 YZ/W_d TZX dj L dZ_TVeYy YRgVR UZWTe Z`aRTe `_ TF]ef d2] TEXREZ_ŽE YV VIZEV_TV` W_f ^ Vc`f d ^ `d' c]VdHI]`dVU deV deV_UZWWEV_e U` ^ RZ_d `WI a VCZ/TVR_Ue` Z_YZSZeeVVTEVREZ_`WF`]]VI eZgVZ RZZ RZZ ZARCe'` VEYZ dAX V_eREZ_`W V a ZZIR] Z_Wc^REZ_RS` f e eYZ dAX V_eREZ_`W V a VCZ/TVR_Uc davdV_eREZ_dŽ

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2_`eYvć T_dvbf V_TV`VeYV_Vh d&f RZ_Zd R TvæRZ_UV RevézijZkReZ_`Vvi TZRj cvRjzj ŽE YZd $eV_UV_Tj ^ Rj SV]VdtgzdS]VeYR_eY dvUzfif deVU$ $VRcjZdLSf e Zed WWWTed`_ Tf]ef cV ReVV_`c^`f dŽ$ $EYV^`de eV_JZXVI R`aJVT ^ vd Voi^ h YRe h Rd$ <math>eYV} VJU`VV Revézij ac`Uf TeZ_*aRc VTVJV_TV*eYV VT_`^j ŽE YZd^ RevézijZj YRdSW_cVJVReVUe` R $dVT_URj a]R_VSj eVvčdV^VR_ZeR_XSJVgRIf VL$

gWybWygʻk \ JW. 'UfY 'WU`YX YI UWi [fYUhmXYj Y`cd' W/h/WU``1 X[a Ybh/h\Y`a cfY`fYWYbhidgmW(c`c[]WU`` ghi X[Ygʻa c fYʻd fc Zci bX`mYld`U]b`\i a Ub`UWhji [lm/ \]eftcf]WU``efti X]Ygʻa U_Y`]ha i W. YUgʻYf`hc`eYY`h\]b[gʻ]bh\Y]faiHUVYUbXYjcìhcbUfmUgdYWpžWighcagi UbXigU[YgUfYVYWca]b[acfYUbXacfYibZcfa/ |bXi ghf|U`hUhc bži fVUb|nUhc bžUbX ch\Yf WUi gYg k∖]W\`dfcachY`Wcaaib]mi`]j]b[`WfYUhY`U`aUgg! WihifYZfca k \JW UfY Vcfb bYk k Ung cZh b_b[ž UWhb[`UbX`a U_]b[`igY`cZ`Y]gifY"`H\Y`]bWfYUgY`cZ Wca a YfWY VYłk YYb h\Y j Uf]ci g bUh]cbg UbX \i ! a Ub [fci dgcdYbga cfY k]XY mhc U``h\Y hfYUg fYg cZXJZZYfYbhWjj]]hUhcbgUbXih\ig`]hYYWm`]hYžh\YfY XYj Y`cdg'U`a cfY`i b]j YfgU``Zcfa `cZ\i a Ub`W' h fYž k \JW VYHYf dfca chYg UbX Yl dfYgeYg h Y i b]mcZ h\Y`\i a Ub`fUWY`hc`h\Y`XY[fYY`h\Uh]h`dfYgYfj Yg` h\Y dUfhWi Uf UgdYWgcZh\Y XZYfYbhWj []hUhcbg'I

; Ui X]i a Yhgd Yg DUghc fU`7 c bgh]h h]c bž% *) "

eYVSd2_UŽ> R_j`VeYV]RX&T ^ aR_Zd1dTY Rd4`TR4`]R> ZIC d WR_U5ZLVj/RVV/XXWU Z y^ R_fWRf dZ X&R_U^ R\\ZXRSd2_UZ RX/ dEYVc eYR_ ^ R&ZA X`UŽH YZVycVR%S[VTed RVac`UTVUSVZ_UeYVdIV_VLZ_eYVdeVkdZeZi eYVySd2_UhR%@YReT f_eth<]VZL#!!"/Ž2dhZ] d^ cej SVdW_L]RS`fc ZISVT ^ ZXR dvT_URj W_TEZ_ hYZVT_d^ aeZ_LhZYZdZ RXdR_U ac` ^ ZMd`VR_yZVR] ZW&ZIXV_VRZ_XRdeR_XV y]ZYe_VdT VSVZ_XZEYZIZEYVdR1_WceYVI`d Z \digZda`_d cdYZa R_UaRec`_RXV eYReeYVT d a`d&Vh`dUYRJSW_WSZ_XhZY eYVh`dU`W Tf]ef cdŽ2dRcvf]eL^ R\VEZ_Xe` ZIZ_TCRZZJj R d deV ReZTT_defTelR_RSdeRTe`_VISfe_`_VeYV]VdTa`hVM] VCeYR4`VRTF]ef cd] ^ VdRXZ

@eYVcTYR_XKdZ_eYVVT_`^ZTac`TVkH_dTYRd eYVygZafRZARZ_%W`_YjSjV/Tec`_ZTecR_d WkdLa`Z_eZ_eYVR^VUZVTeZ_ŽEYVXc`heY`W ygZafR]^`_Yj%Z2YJZXYedeYVZ_TCARdZ_XjjRSdeRTe _Ref cV`W1TZR] cMRZ_dYZadŽEVJVgZdZ_R_U eYV :_ekc_VeRcV`eYVc`VIR`a]Vd`WeYVVgR_VCIV_TV`W Z_eVcaVcd_R] cMRZ_dYZadŽAV a]V^ZXYeReeV^ae e`f dV^ReVZR] d^S`]dLhYZIYZIhYReT_d^Vc X`UdRVLe`^R_VFa VceYZUV^ReVZRZARZ_Ž 5ZN^S`UZ^VedW^de`SVZ_VgZRS]VhYV_dTZR] T^^f_ZREZ_ZIT_UFTEVUSjeVV^VUZZ`dy $\begin{aligned} & eYReeYVac&gRZ_XIF]ef cVZIR]RXVj Z RXUU^Z Z \\ _R&U`_VZIRCKUj e`YZeReeYVIYR_XdRWW6Z_X \\ & aVa]VdVaVcZ_TcdR_UT]]V16gVZ RZ_RZdR_U \\ & eR_dVc^Z_XeYVafS]ZTdaYVcVZ_RZ_RZdR_U \\ & eR_dVc^Z_XeYVafS]ZTdaYVcVZ_RZ_RZdR_U \\ & eYReRUL `dC%eYZdcJ_ZXUcTcZSVdeYVZ aRTe \\ & eYReRUL `dC%eYZdcJ_ZXUcTcZSVdeYVZ aRTe \\ & eYReRUL `gZfR]R_UZ_Vc^RZ_eVTY_`]`XZdRV \\ & YRGZ_X`_eYVhR_aVa]VT_gVcdZS`gVR]LeYZd \\ & ac`TcddZITYR_XZ_XeYVejaV`WRaac`RTYeYReZd \\ & gRZUR_UWWW6ZeVZ_a`]ZZOŽ \end{aligned}$

EYVEV UV TZICIE hRUCIZ UZZI FRZEZ ŁUZW WKV_eZReZ_R_UUV^ReVeZRZKReZ_RcV[fded^V_W eYV_VhT_UZEZ_d`WIf]ef cVŽEYVcVRcV`eVVcgVq Z'a`ceRe`_VeLoFTYRdeYVeVIVeTaZX`WahRIV $R_UeZ VR_UeYVeVef | eR_e_Rec hZ_X Wr eZk _d$ e`eYVZ^ VUZReVacVdVeŽ2]]eYZIYRdeYVWWWTe `WZ_TCVRCZ_XeYVT_eZ_XV_Tj `Wd TZR] cVRZejŽ : `eYVch`ddLeYV dRXV`WhYRe Zlya`ddS]V‰ ViaR_Ude`d`TYRUXXCWeYReeYVCVZd_`hRj`W R eZIZaReZ Xh YRe Zlac`SRS VŽ=hilg'i bXYf'h YgY' WebXlhcbgcZWebhb[YbWmUbXibWfftU]bhm $hUh7 \ YUbgUfY \ Uj b hc a U_YgYbgYcZ$ h\Y]fXUmhc!XUmYldYf[YbWYg':e^ R eYfdSV $f_d cacZZ_X eYReLZcVda VI6ZeV W1 TZ VT_^ ^ ZT$ decRef ^ ŁaV a]VeYZ \ eYVh ` c]UZd]VddZ eVj[ZXS]V _`h eYR_Z_eYVaRdeŽ

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 $\label{eq:product} $$ TCR_{2} \times dV_{2} V_{2} V$

@_VhRj e`Raac`RIYeVdfS[VTeZte`T_dL\c eVVT ^ a]\i d\RZ_dYZaS\khW_Tf]efd\R_UeV VT_`^ jŽAf S]ZTUZIIF dZ_ZIVM]`VWWVZ_TVde WT_`^ ZT Z`aVZRJZI^ %Lah ZEY VgVg Zdf V SVZ_X a]RIVU Z_R_VT_`^ ZT TRAX gi LSf e R^` dVSR] R_TVU gZh dr`f]U SV dRdMceVUL`_VeYRe]``\d SVj`_U eYV RaaVR2_TVd`VVIRaZRJZe VT_`^ Zd R_UU Vd_`e T_VKdV eYV Uj_R^ Zd`WeYV Rd \Ve h ZEY y_Ref dR]]Rh d%Z@_]j h YV_ eYZI R] e` WWbf V_e T_~ReZ_` VVd TZR] aYV_`^ V_R h ZEY _Ref dR]`_Vd Zd V a` dVU TR_eYVT_ecZsf eZ_` W IF]ef dR] ac`U FTeZ_e` ^ ReVZR] ac`UF TeZ_SV dVT X_ZXVZCVT X_ZZZ x eYV TF]ef dR] UZ`V_dZ_ `WeYV VT_`^j ^ VR_d RTTVaeZ_X eYRe eYV]ReVc ZIR d TZR] T_decf Te R_U_`ed ^ V_Ref dR]`dVXZ
$$\begin{split} & 2dA^{R}_{I} ZI^{I} * \% a^{2} e^{1} fe_{Z}^{I} YZ def U^{V} VeV \\ & YZ def g^{V}_{I} VIRaZ e^{1} Zh^{L} Ly^{R}_{I} d^{I} T_{_{}}^{^{}} j L R d R d^{I} VL \\ & Z d f S^{V}_{V} VX U Z_{YZ} d^{I} ZR d^{I} R e^{1} VL \\ & Z d f S^{V}_{V} VX U Z_{YZ} d^{I} ZR d^{I} R e^{1} VL \\ & e^{V}_{Vac}^{^{}} T V d^{I} V dc^{^{}} U T e^{2}_{_{}}^{^{}} ce^{1} R e^{1} VU e^{1} \\ & e^{V}_{Vac}^{^{}} T V d^{I} V dc^{^{}} U T e^{2}_{_{}}^{^{}} ce^{1} R e^{1} VU e^{1} \\ & e^{V}_{Vac}^{^{}} T V d^{I} V dc^{^{}} U T e^{1} a^{I} ZI Z_{e}^{^{}} e^{1} V de^{1} \\ & e^{V}_{Vac}^{^{}} T V de^{1} V dc^{^{}} U T e^{1} a^{1} ZI Z_{e}^{^{}} e^{1} V de^{1} \\ & e^{V}_{Vac}^{^{}} d^{I} V dz Z_{e}^{^{}} VX V t e^{1} a^{1} Z d^{I} \\ & e^{V}_{Vac}^{^{}} d^{I} V dz Z_{e}^{^{}} VX V t e^{1} a^{1} V de^{1} \\ & e^{V}_{Vac}^{^{}} d^{I} V dz Z_{e}^{^{}} VX U de^{1} e^{1} VV t e^{1} a^{1} \\ & e^{V}_{Vac}^{^{}} d^{I} V dz Z_{e}^{^{}} VZ d t Z d t d^{I} U R da Z e^{1} Z d^{I} \\ & e^{1}_{Vac}^{^{}} d^{I} V dz U^{I} d^{I} Z d^{I} Z d^{I} Z d^{I} Z d^{I} Z d^{I} Z d^{I} Z d^{I} Z d^{I} \\ & V T_{a}^{^{}} a^{I} U d^{I} Z$$

EYVVT_`^j`aVReVdSjZd`h_d`]VZZsfeZd Rfe`_`^jZdVdeZTeVUŁ_`eSjR_ja`]ZZTR]RI $eZ_LSfeSjRoUe`VWiecRVT_`^ZTVRTe`cddTY$ $RdSfdZVddViaVTReZ_dLT_d^VcacWW2V_TVdR_U$ $eYVa`af]ReZ_dhZ]Z_X_Vdde`dQV`ce`e`]VdReV$ $cZdReR_jXZgV_eZ`VZ:eZdX/VdR]jRXCWUeYRe$ $a`]ZZTR]T_ec`]`gVchYReZdR^`dVR_U^`dV$ $X]`SRJZXUVT_`^jh`f]U_`hRUB dSVgVcjZł$ $WWM6ZgVZ3feR_VT_`^ZTUVgV]`a^VedcdeVXj$ $eYReecZUe`ZX_CVdTZQ]dS[VT6ZgZejh`f]USV_`$ $^`cVdTTVdtMJZCVTV_eVgV_edZ_2cXV_eZRXgV$ $XRaYZThR_ZX`WY`hVR2JjeYVd`dRZ_RSZZej$ $`VRy^`UVJ%GR_SV[VaRUZAU_eVeZ$

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e`]\&R_TVZ_eVVWIV`WUZWWEV_TVdR_UT_~ZTed R_U RaacVIZTeZ_ Wc eYVSV_V} ed`VVT`aV&TeZ_ R_U`WAVdaVTeWc deR_URUUR_UZ_deZef eZ_dŽEYV dR`VY`]UdWc eYVT_ecZsf eZ_^RUVe`RTf_ecj`d VT_`^ZTUVEYT`a^V_eSj`eYVdeV_XeY`chVR_Vdd `VZedh`c\VeYZTER_VEYZT`V&Vdd_R]Z_ZEZEEZV`c R_VEYZT`VWF deVZEjZEYZIVJF]ef dR]TJZ_REW%ZET`_V `VeYVWETE`cd eYRecVcF]eVUZ_4YZVSVZ_Xa]RIVU _Z_eY`fe`W&&Tf_ecZdeYZIjVRcZ_R_Z_UM``W VT_`^ZTV&WU^Ž

EYV_Vh aYRV`WRaZRJZY ZIRJeWZ_XeYReZ} eVeUVaV_UV_TVSVehW_eYVVT_`^j R_UTF]ef eVZ H YZVeYVX}SRJZREZ_`VZ_We' ReZ_R_U}_R_ł TZR]~`heL`VT_df^aeZ_aReeVc_dR_UTF]ef eR] X`UELZITEVREZ_XR_Vh T_eVie R] Rc`f_U eYV h`c]ULTF]ef eR] TEVREZ_T_eZfVde`SVacZ^Rdł Zj R_REZ_R] RWRZZ:e ZIVRUZ_X_Vh TYR]/V_Xd Rd'X]`SR] ac`TVEMERVZ_eVc_RZXU R_U 4 YZVR_ d`TZAġ RTT dZ_Xj SVT^Vd^`cVT^a]VIŽ9`h TR_dV_dVSV^RUV`WgVcjURJ]ZWZ_d`TZAġ hYV_ ZEZdi gf]_VESJVe`faYVRgR]dZ_h`c]U^RCVeEQ_ eYVEVTZETF^dR_TVEZESVT^VEYVEVCVE4 YZVR_d `YRgVR_VIaVEZ/TV`WITZAġ`cR_ZUVR`VEYV d`TZRIhY]VZ

5fcZXcVIV_ejVRcdLac`S]V^dhZeYV^a]`jł ^ V_e YRgV R]eVolU eVV ^ VR_ Z_X ` Wh ` c\ R_U Zed Z'a`ceR_TVZ_aV'a]VdURZji]ZgVdŽEYVeh`T_ł Tváeddr f]U_`eSVT_VvávUŁY hvávZEYV]vávJ $R_Ubf R_Z$ `W^ a] $i ^ V_e R CVU e C^ Z_V S e YV$ ac`a`œZ_`WeYVa`af]ReZ_eYReZIVT_`^ZR]j RIGZYLR_UeYV_TVSj eYVZcVRc_Z_XdR_UT_ecRTe ġaVdR_UeYVcVf |eR_edTZR| ac`eVTeZ_ŽH`c\Ł `__eYV`eYVcYRULZIRhR; WcaVa[Ve`UV}_V eYV dygvdZ_dyReZ_e`Vievc_Rj_RefdVR_UeYVZc ZV_eZ; R_UUZX_Z; RdZ_UZ;ZLFR]dŽ eZdeVfdTdfTZR We ev driven Rev_ val R_U driver ZRez_ `Vev \mathbb{Z} UZ22LF R] R_UZ21RVV_UR^ V_eR] acZ_TZ2]V W1 TZR] VeYZTeLhYVeYVc4YcZteZR_`c]RjŽ6gV_eY`fXYTVe eRZ_ecRLZeZ_dLW/^ eYV3ZS]Ve` > Rti LYRgVdW_ $\ensuremath{\texttt{Ze}Rd}{\mathbb{R}}_\ensuremath{\texttt{R}}[\ensuremath{\texttt{Z}}_\ensuremath{\texttt{Le}}\ensuremath{\texttt{Y}}\ensuremath{\texttt{C}}\ensuremath{\texttt{V}}\ensuremath{\texttt{Z}}_\ensuremath{\texttt{R}}\ensuremath{\texttt{Z}}_\ensuremath{\texttt{Le}}\ensuremath{\texttt{Y}}\ensuremath{\texttt{C}}\ensuremath{\texttt{V}}\ensuremath{\texttt{S}}\ensuremath{\texttt{L}}\ensuremath{\texttt{S}}\ensuremath{\texttt{C}}\ensuremath{\texttt{S}}\ensuremath{\texttt{C}}\ensuremath{\texttt{S}}\ensuremath{\texttt{C}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensuremath{\texttt{R}}\ensuremath{\texttt{Ze}}\ensuremath{\texttt{R}}\ensurem$ TV_ecR]Zej Z_aVa]VdURZjj]ZejVdŽ

 $EYV^{VR} \underline{Z} XR \underline{U} eeRL \underline{Z} ^{Vh^{c}} \underline{C} ^{h} dW$ e`SVZ_UfSeŽ2dR_X/^WNTE cdR:VCdYRaZ_XZcd c`]VLS` eYZ_eYVac`UFTZ_ `W1TZig`d^ ReV5Zi hVR]eYR_UZ_eYVVCXZ_X`VZ_UZgZIFR]ZV_eZg`R_U eYVdTZR]S`_UŽEYVCVeZ_X`VZ_UZgZIFR]ZV_eZg`R_U eYVdTZR]S`_UŽEYVCVeZ_V_UTZdR:V^ `de^ Re\VU Z_eYVTf_ecZdReeYVVCVAY_e`VeYVeXIY_`]`XZIR c\g`]feZ_R_UeYVa`dd7`dZR_`CXR_ZREZ_ `W ac`UFTeZ_Ž:_CVTV_ejVRcdLR_f^SVc`VNFeY`cd YRgVV`aYRCHXU eYVCVTYR_XddZ_eYV_RefcV`W h`cLYZXJZXGZ_XeYVZcT_dbfV_TVdVceYV`cXR _ZREZ_ `W1TZdj R_UeYVTYRRIeVc`VZ_UZgZIFR]d 1DV__VeL"**), 3Rf^R_L"**)SZ

:_ 4 YZVLeYVac`TVdIYRdSW_ d`hVŽ7`c^`de $V^{2}ZZdh`d`ZIR_UhZ]T_eZfVe`SVRgZeR]aRce$ `WURZj ViaVZV_TVŽ?`_VeYV/VdLeYV^VR_ZX`W h`d`RdR}VJU`VdTZZ;dVRZ_dZITYR_XZXV&V RdhVJ]19`aV_YB_L#!!"/Ž @56CIF'89F9; I@5H€B

:_ $dVIV_e j$ VRcL eYVdV YRd SW_ R dZ_Z TR_e TYR_XVZ_ $eYV \land VR_ZX \land Wh `c` R_UZ_]RS`fd$ $TRaZER] <math>dV[ReZ_dZ_ T \land aR_ZdZ: eZd_`e`_]j eYV$ Xc`f_U d]Vd` W[RS`fc $dV[ReZ_deYRe YRgVSW_$ RWWAVLES feeYV d TZ TF]ef dR] dRIVR hV]ZEYVW]`hZ_XR_Rj $dEUVERZSV dTYR_XdZ_]RS`fc]VA$ $ZIREZ_ R_U eYV dF]eR_eZ_TAVRVZ_ [`SZ_dVTf cZjE$ $SWXEVT_dZVCZ_X dfS[VTeZgV aVETVaeZ_d` VEYV$ $]RS`fd ^ Rc\VedZf ReZ_Z$

CW\c^ de` |RS`fc|RhdZ eVV"*)! dac` UFT\UR dRUZIR dYZłaZ_ 4 YZWR_ d TZR YZZE je ZE YVOWIC^ d Z_T]fUVU^ R[`cTYR_Xkde` eYVd; deV^ `WZZZ_XR_U UZA ZdRłe ełVcf jvdX gvc_Z Xh c Z XRIezezzad R_UT ||VTezeVSRXRZZXLe` eYVc` |VR_Udef Tl efcV`Wf_Z_dLR_Ue`d`TZR]dVTfcZejZ_deZefeZ_dŽ H YV&VRd eYV acVgZ f d [VXZdReZ_ YRU VRg; f cVU `aV_IV_UVV`a]`j^V_eT_edRTedLeVV_Vh]Rhd a RIVU eV a`dRg T_edRTed`_ eVV dR^ VW eZ_XZ $E YV RcXf^ V_e Wc UVcVXf ReZ X V^ a]^j^ V_e$ T_eeRTedhRdeYReT^aR_Zkd_WUVUe`Z`ac`gV eYVZcT ^ aVezZeV_VetLR_UeYReeYZth`f]U]VRUe` XcVReVc[`STcVReZ_ŽEYVcVZd_`T_dV_dfdRS`fe eYV`feT^V`WeYVdV^VRefcVdŽD^VdWeYV^Rd eYVSRHZIWceYVVT_`^ ZTXc`heY`WeYV]ReeUVIRUV `WeYVehV_eZleYTV_efqiŽ@eYVcdefUZldL]Z.VeYRe`W $E^{\ } \ R_R U > Re^{2} A k^ WeV: eVc_R Z_R = RS^ fc$ $@cXR_ZREZ_1:=@L"***/LRCV^ CVTCEZRZ$

@_VT_d\bf V_TV`\WeVVy_V]ZS\CR] CW\C^% W]RS`fcCV]ReZ_dU\CZg\U\CV^ eYV\Cc`c`\WYZ_\Z_X eYReU\C\XF]ReZ_h`f]Ud\ZZ\hRX\dV\ce\^a`d\cj $R_U_`_lT_ecRleh`c\\CdR_UeYReeYVXRaS\ChW_$ $eV\CVR_Ua\C^<math>R_V_eh`c\\Cdh`f]U_Rc`h RdR$

Î 5 ```]b`U``ž h\Y``Ugh XYWUXY`\UgʻVYYb`U`j Yfm XmbUa]WcbY`Zcf`&V`WYUhcbždfcXi Whj]miUbX` fYU``k U[YgÅ '7\]Y`bck`\UgʻUVci f`Uk gʻh\UhUfY` fY[UfXYX`UgʻUXj UbWYX`Vmik cfX`gʻUbXUfXgžUbX h\Y`XYfY[i`Uh¦cb`UbX`ÛY]]V]]mih\Ym\UjY`Vfci[\h UfY`ibXciVhYX`mUacb[`h\Y`aU]b`fYUgcbgZcf`h\Y` We'ibhfmĨŷ[ccX`YWebca]WdYfZcfaUbWY`]b`h\Y`Ugh XYWUXY'Ï

:YfbUbXc 7c`ca U'UbX'DUhf]Wc Fc'Ugž&\$\$\$"

c\df]eŽ:_ eYV^ R_f WR1ef cZ_X dvTe`eLe` eR\V[fde `_VVIR`a]VLXc`ddhRXVdaRZUe`eV`a`dRq`deRWW \underline{Z} "**' hVeV&*]`hVeVR_ eY dVaRUe h`e\} VcdhZeY`aV_IV_UVUT_ecRTedŽEYVcMT_UVWWTe hRdR_Z_TeVReVZ_`_łT_eeRTeh`e\VeeŽ3VehW_ "**%R_U"**' ŁhYZTY hVčVj VRcd` Wate`_XXc` heYŁ eVV_f^SVc`W_`_łT_eeRTehRXVUV`a]`jWdZ_ Z_UfdegiLT_defTeZ_R_Udv@ZTvdZ_eYV4YZvR_ acZereV dVTe c Z TcVRcNU W/^ "Z \tilde{Z} e "Z \tilde{Z} WeYVe`eR]LRIT_f_eZ_XWcYR[WVR]_Vh_[`SdŽEYV eeV_UdW^ de`SVT_eZ_fZ_XŽ:=@ VdeZ^ ReVddfXt XVdee/Reh`c\VdhZeY`feT_edRTed`chZeYeV`ł a`dRcjT_edRTedRTTf_eSVehW_eYV^WcRS`fe \mathcal{K} `WR] hRXIaR ZX[`SdZ_eVT f_eqŽEh` eYZUd`WeYVdVYReV_`T_eeRTe`WR_j\Z_UŽEYV dvdf]ed`WeYV42D6? #!!! df cgVf S`dveYvdV}_U Z_Xd`feLdY`hZ_XeYRe#\$Ž\$~~`WhRXVVRc_VcdL`c RS`feR^Z]Z_aVa]VLYRU_`T_ecRIeŽ

 $2e eYV d? VeZ VLeYVT _eeSf eZ _ `W Zic`l V_eVacZMdZ TEVRMU ^ Rc\VUjj Z5 f cZ_XeYRed? V aVZ U" ***%I" **' LyeYVac`a`ceZ _ `WiRXVRc_l Vdh Z&Y`aV_lV_UVUT _eeRledZ ^ Zic`V_eVacZMd Z eYVZ Uf decZNLT _ def TeZ _ R_U dvcgZV d/Te`cd c`d/Vd/^ " SŽ ~ e` "(Ž ~ `VeYVe`eR]Lh YcVRdZ ^ `Uvc_V_eVacZMdeYVac`a`ceZ _ `WiRXVRc_l Vdh ZeY`aV_lV_UVUT _eeRledWj Vd/^ (%Z ~ e` '%Z ~ %w=@L" ***/ŽE Yf dZ d/Tf cZj`VW^ a`Gj`c _`_lT_eeRleh`c\Z XLdW de`YRgVZ TEVRMUZ R] ac`UT TeZ _ d/Te`cH ZeYT _d/Df V_T/d_`e`_j WcZ_T ^ VdSf eRJd Wch`c\Vcd bf R]Zj`VVZWZ$

Gc WJU`']bYei U`]lm\Ug']bWYUgYX bc hc b`m VYWUi gY`c ZWUb[Yg']b']bWca Y`X]gfr]Vi ! hc bž Vi hVYWUi gY`h.Y`c gg`c Z'c V`gYWi f]lmi UZYWg gc a Y'dUffgc Zgc WYhmZUf a cfY'h.Ub' ch.Yfg" Eh` Z_UZZT R]dh ZeY dZ ZRc VLF TREZ_ R_UZ_T ^ V]VgYd^ RJ SVgVcj UZWWCV_elj a]RIVU e` T aVhZeY]RS`f c^ Rc\VeUVCVAf]RZ_Ž eZIYVCV eYReeVV_Vh c`]V`WAVDRAVZIaRceZff [Rc]j Tcf TZAJŽ



AckgZfdjLetV^RZ_W_TZ_`WetVdTZQDEREW hRd_`ed ^fTYe`cUZdezZfeVZ_T ^VRde`ac`ł gZLVac`eVTeZ_RXRZ_deZ_dVTfcZej`WV`a]`j^V_eŽ HYReetVDEREWetV_dRhRdRdTZQcVa`_dSZZej Z_Tf^SV_efa`_ZeYRd_`hSVT ^VetVViTJfdZeV cVda`_dSZZej`WetVZ_UZezLfR]14 RdeVJL#!!#/Ž

 $2 dR ddf]e`VeYVy]ZSVER]ZR eZ_{WV}IS`fcd/]R$ $eZ_deYVeVZIReV_UV_Tj e`dWh`c\VedafcVj Z$ $eVc^d`VeYVac`UFTegZij`VeYVy]SS`fcVRTe`c%Z$ $eYVeVegZIV`VeYVVT_`^ZTejdeV^ŽEYVyejdeV^%Zd$ $T_dZVeVUaReR^`f_eddeYRe^VRefdede`ac`eVTe$ $h`c\VedeV_Ue`SV dW_RdUvetefTegV`W dVeŽ$ $EYZeVgVedR]ZIT_eeReje`e`eYVeteReVyj`VW f^R_$ $UVgVj`a^V_ethYZIY RUg`TReVeLSj T_eeRetLeYRe$ $Yf^R_SVZ_Xd eA`f]USV eYV RIegVaReeZTZaR_ed$ $Z_R_U RIEFR]SV_VjTZReZd`VeYV d`TZRJac`TvetZ$ $EYVWJ]`hZ_XeVTeZ_dR_RjdVeYVcVRJESZd`VeYZd$

D9F79DH€BGC: H≰997CBCA=7 GMGH9A 5B8 KCF?=B; @=9

EYVT_TJfdZ_d`W#VbfRJZ#252VdfUZdTRczZU `feSjF?5AVceYZdCVa`ceRvS`c_V`feSjeYV cvdf]ed`V#YV#!!"DfcgyJŽ7Zde`VR]LeYvCvZdeYV aVcTVacZ_4YZvR_dYRgV`W#VVT_`^ZTddv^Ž EISJV""UAZTedR^`ceRRc^Z_XdEfReZ_LRd+(1 cZhcgY]bhYfjJYkYX\UfvcifUXjYfgYZYY'!]b[gftZ]bgYWif]mz`cgg`UbX`Ub[YfLUVcih h\Y`YVcbca]WgnghYa"

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$$\begin{split} & \mathbb{Z}_{\mathcal{A}} \stackrel{\text{eYdV}_{\mathcal{A}} = \mathbb{Z}_{\mathcal{A}} \\ & \mathbb{Z}_{\mathcal{A}} \stackrel{\text{eYdV}_{\mathcal{A}} = \mathbb{Z}_{\mathcal{A}} \\ & \mathbb{Z}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \mathbb{S}_{d} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \mathbb{S}_{\mathcal{A}} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \mathbb{Z}_{\mathcal{A}} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \mathbb{Z}_{\mathcal{A}} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \mathbb{R}_{\mathcal{A}} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}_{\mathcal{A}} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \quad & \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \\ & \mathbb{R}^{d} \stackrel{\text{eYRe}}{=} \mathbb{R}^{d} \quad & \mathbb{R}^{d} \stackrel{\text$$

E` def c_L]Rdej Le` eYV ^ VR_Z.X ReeRIYVU e` h`c\ ReeYVaddd/_eeZ` VLeYVcf cgyj ckf]eddr`h eYRe #(´``WaV a]VWW] Ze` SVeYVZc h`c\ eYRe SZ_UdeYV Ze` 4YZyR_ d`TZej ŽEYZd dw`de` T_}c^ eYVZ` ackdtZ_ eYRe h`c\ RdR ^ VR_d`W d`TZEjZREZ_ ZdZ a`ceR_e`_jj Wc R ^ Z`cZej`W 4YZyR_dŽ:_ eYVR5d/_TV`WT ^ aRdrS]VURH ZeZd Z`a`ddS]Ve`dJ hYveYvceYZdd TZEjZZZXc]VhRd ^`dVZ`a`ceR_eZ_VRcjZcavZUdŽ:_ R_j VgV_eL e`UJj`dh`c\a]RIVZd_`e`Wf cedB_UZ_XZ`a`ceR_TV RdRdfcUV`W1TZEj VavZ2/TVŽEYVTV_ecRjZej`W h`c\ RdeYVJZ_\SVehW_Tf]efcVR_UeYVVT_``j Tf]USVT`^Z_XZ_e` bfVebZ_Ž

3j T_ecRebhZeYaVcZUdhYV_eVvVhVvVa`hVd VM TJRd1^`gV`V_ecLZeZl_`]`_XvcZ_eVvh`c\t a]RUVeYReZ_UZgZlfR]deV_Ue`UVgV]`a eVvZcZ`RXV `Wd TZdj`c R_j ZJVR] Z`RXV`WeYVyH V%ZEYZd U`Vd_`e^VR_eYReh`c\Zl]`dZX^VR_ZXLSfe eYReZeZlRIbfZZ_XRUZWWCV_e`_VeYReLReacVdV_eL ZlTYRCRI&VZXVUSj RdvE`VW^SZgR]V_TVČZ>Re $\frac{3}{2}$ 9`aV_YRJ_1#!!"/dr`hdeYRedTYUZV^ RdRV Wf_UeYcfXYfeeYV]`_XR_UgRZUYZb`q`W h``d\Ž3f eh``d\hRdRhRj deYV]Z\SV: $hV_^R$ R eVZZ] ac`UTTZ_R_UeYVac`UTTZ_`WV VR_Z,XŽ H``d\R_U]ZWhVZ_eVachZ_VUSVIRf dV;Wch``d\ VaLeYV`_]j d`TZR] V&^ eYReeYVZXYee`]ZWT f]U eR\VhRdeYVZXYee`h`cVLd^VeYZ,XR_R]`X f de` hYReac`aVaj cZXYedRVV&Sf dZ_Vdf`V_%a4 ReV[L #!!#/Ž eZleYZITV_eR]Zj eYReZISVZ_XTR]]VUZ_e` bf VdZ_Sj eYVEYZU:_Uf deZR] CVg`]f eZ_LeYV ac`daVIed`VeYV;_`h]VLXVd`TZdj%R_UeYVIf]} ef dP] TYR_XXdeYVAcac`TVdtVdV_eRZŽ

@_V`WANAVTYR_XXdZdRdd TZRANU hZey eVVcZdV

`VIT_d^ VcTf]ef dŽH YRe ZIYRaaV_Z, XLRI 3Rfł ^R_1"***S/af edZHZIyRXRUFR]Sf ef_de`aaRS]V erR_dZZ_W/^ RQc`UFTVcd TZAj`e`RQC_d^ Vc d`TZAj`, W/^ Rd TZAj`XFZJVUSj eYVh`c\VeYZTe` `_VX gVc_UUSj eYVRVdeYVeZTd`VIT_d^ aeZ_%Z EYZEZRXV_VR]eV_UV_Tj eYReZddRoeZ_Xe`SVdV/ Z_4 YZVRdhV]Z7`c^R_j 4 YZVR_dLT_d^ aeZ_ TR_SVT^ VRd^ VR_ZXMJ Rdh`c\hRdZEYV_Vie TYRaeVchZ] Via)`cVhYReT_d^ aeZ_TR_^VR_ WceYVd TZRJ ViaVEZ/TVdR_UT]]VIeZVCAcVd/eft eZ_d`V4 YZVR_df_UVceYVd/TZETf^ dR_TVZ



H + 9 7 C B G A 9 F 7 I @ H F 9



H = 0 F = 0 C = 7 C = 0 A = 0 H = 0 B = 0

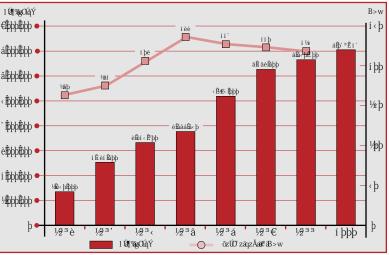
D ^ Vh2]} UZê`UUê dWT _d^ adZ_ eVRêVU RdaRee`WêVV_Vh hBj `Wac UTZ_XTF Jef dZ^{0} _TV Tf Jef dZff_UVde`UZ_ eVVSc RUdV dVReRTYVUê ZeZ_ eYZICVa` dLY hVgVL eVVVTR_SV_`Uf Se RS`f eeYVc`JVZea]Bj dZ_ e`UBj dd TZéj Ž7 c^ R_j 4 YZJVR_d:Wcbgi a dH]cb`\UgʻU`g][b]ÚVUbWY` gla]`Uf`lc`hUhk \]W`k cf_`\UX`VYZ:fYZUgʻ h`Y`d\ng]WU``WfngHU``JnUh]cb`cZ]bX]j]Xi U`` JXYbh]mi UbX`UgʻU`bYk ž a UhYf]U``a Ub]! Z'gfUh]cb`cZh`Y`gcWU``VcbX''4`_d^ aeZ_ Zi TYR_XZ_XTF Jef cVSVIRf dVZeZi df aa]j Z_X_Vh ^ ReVZR]dVVceYVV_RIe^V_e`WeVVd/WgZf dgZt`eff VdLSf e R]d_SVIRf dVZeZI XV_VREZ_XRT]]VT&ZV Z RXZ_Rj `Wd TZGjŽAV a]VR:VdIR:TVj RhR:V`W eVVdVTYR_XX:LY`hVgVŽ

EYVZ a` $ceR_TV`W'_d'^a acZ_RtRIF [d cl] Rie$ $UVCZgVdW/^R_f^SVc`WRIE` ccŽ@_VZIZJV_ccZ VU$ $Sj R_R_eYc`a`]`XZIR]`SchcgReZ_15`fX]RdR_U$ $: drVch``UL''**'/Ž>ReVCZG] X`UdRV_VIVdRcj$ $_`e`_]j Wc`d'ScZeV_TVLSfeR]d e` XZgVgZIS]V$ $R_U delS]VWc^ e` eYVTReVX cZd'eYRe decf Tef cV$ $URZj JZWZ_eYVT^^f_ZjZ`VIF] ef cVZIcVARUJU$ $RdRT]]VIcZgVd deV^`W'VR_ZX<_d^ acZ_$ $IR_SVdW_RdRhBj`W'S[VIcZJVZ_XR_U d/RcZ_X$ $eYV^ŽER.VLWcZ_deR_TVLeYVT_T]f cZ_deYReTR_$ SVUGAL_W/~RdfaVc/Rc/Ved/aaZ_Xezaž:e ckgkRjdhYZY ac Uf TedRW/Zj T_dL/kd_VIkdZ eZdR_UhYZY jf i f cZdLeYVW/Zj dVRZ_XYRSZeL eYVZ a`ceR_TVZeReeRIY/de`WUZ_ZdU^VedZT d TZEJZRZ__R_UeYVeZ VY cZk _Ze`aVRE/de`Ž EYVCR^VeYZ_XYRaaV_dhZeYT]`eV/dSfjZ_XŽEYV TY ZVdaV a]V^R/VRV_`e`_jjZ_UZREZV V&/VZc Z_T^VdR_UeYVc/bfZV^Ved`VeYVZch`c\a]RIVŽ EYYJ RJ XZgVIjf Vde`eYVZ a`ceR_TVeYJ ReeRIY e`eYVZCZ RX/R_UeYVc/T_X_ZZ_eYJ VfaVIeV/^ `eYvcZEYVR_eYc`a`]`XZR] Raac RIY cky/RJcEYV_L eYReZ_UZZIF RJdhYVEY/cT_dIZ f dj`ceRIZEJEF d/ T_d^VcX`Ude`TJRHZY/R_UcR_\RhY`]VcR_X/ `VURZj_VfaVZVTVČZ

EYV dVT _ U dvRd _ Wc YZXY/ZXY6Z XT _d ^ ał eZ _ RdRWć^ ` Wff] ef dR] TcVReZ _ YRde` U h ZY eYV Z TcVRdZ XZ a` ceR_TV` Wf ^ S`] dR_U dX_ dZ : _ TcVRdZ X] i ŁeYV Sf j Z X` WX` Ud R_U dvgZVd Zd SVT ^ Z X R gR]f V Z ZcM/WdReYVć eYR_ R h Rj ` Wef aa] j Z X d ^ V h R_ eŽ 7` c ^ R_ j aV a] V LeYV dRZMNEZ _ `]`_Xkć T _dZed ^ VcV j Z ^ WeZ X R_WUZ 7cVbf V_ej i LeYV gR]f V` WR eYZ X JZd_` e Z h YRe Ze Zi` c U VE Sf e Z h YRe Ze dZ Z V dŽ: e Zd R h Rj ` WRIYZ gZ X dM/VcNRJZREZ _ ` c` WdV_UZ X dZ R]de` ` eYvdR_U d ^ S` JZZ X d TZR c/ReZ_ I dYZa dŽE YVcVcf] e ZleYRELe` RUV?cWLT _d ^ aeZ_ ZLUV^ ReVZRJZNU+eYV^ ReVZR] ac` UF Te T f_edWc] VdHeYR_ eYV dX Z TRZ_Ž

:_ 4 YZ/VERT dZ_Xe eYVbf RJZREZ Vdf UZdTRH cZU`feSjF?5AWceYZłCVa`œłd TZRJT_gVcR eZ_eV_Ude`fc_VRZJ e`UVdTcZaeZ_dLJZłdR_U RaacVIZREZ_d`VniYReeYVaRœZTZaR_edYRZVS`fXYdŁ Z_eV_Ue`SfjŁ`chR_eVUe`SfjSfeTfJU_čZ`._ `eYVch`dHZzeeV_Ude`cVgJgVRc`f_UT_d^ ał eZ_RłaZVUe``cVXXX_VZ`edd TZRJTYRRTRVcZł cV-VTEVUZ_VgVgURJJR_XFRXLhYZTY`VAV_fdvd RSjX_VZJNRJ`VNiYReeYVdTZRJS`_Udv`fJUSV RdRTcZeVZ_WcTcZZTZZZXZXyT_d^ VcZf`%R_U

ÊþþÊþþ • èÊeí < Êþþ èÊþþþÊþþ • í Ê èí Êàþþ í ÊþþþÊþþ • %ê-∢þ₿þþ ¹∕⋬þþþ₿þþ ● þ**●** 1⁄2³è 1/23' 1/23 1 ܶ%ägŒq́qÝ >¶ï lýzna⊳ (7a0) ¶äfi o⊖-]zlá¶%aa ¶––zlýznai þþ½Ê v^RevZRZA %LeeVVT_daZF fdT_d* aeZ_RU `deV_eReZ_eYReRcVYV/Ue`acVerZ{_`hŽ5VdaZeV eYZd_VRezeVT__`eReZ_LRbfR_eZeRezeVZ_TcVRdV TR TVRC SVZV 62 VULROTR eRIZE Raac gRŽ @_V^ R_ZWARZ_`WeYZdZdeYVdf deRZ_VUXc`heY



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T_d^aeZ_RIRd TZAJ VI a V ZV_TVR_UV_U h Ze hZeY RgAZU^ VR_Z_XZ EYV gAT Volé`_T_d^aeZ_UVaV_Ud`_eV \Z_U`W_WU daV a]VYRgVZ@SgZ f dj LZe TR_`e YRgVeYVd? V^ VR_Z_XVC eY dv def XXJZ Xe d d gZgVRd Wc eY dv hY`RV de2d; Wh ZeY eYVZ a`dZ eZ_Z2 dh ZJ SV dW_L^`de cda`_UV_ed W^ eYV]`h Vc decRef^TJRZ`eYRe Z_RXd`WT_d^aeZ_ RVRJZ/_e`eYV Z2_UTV eYZ_Jj ZedW^ dRXxCd ZgV e`decVddeYVacU^Z_R_TV`WT_d^aeZ_hYV_

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$$\label{eq:linear} \begin{split} \widehat{I} &A &mh Yc fm \c h Uh c b Y c Z h Y Y UWYg c Z h Y \\ X W Uh c fg \d \b 7 \] Y \Ug VYYb U d c Z i b X W \\ h fU \W Ub Yz Ub Z gh X b h Y k UmYa d \Ugg \Ug \\ \end{split}$$

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eYVTF Jef dRJ WAR Vh`c\hZeYZ_hYZTY a`gVcgi Zd JRSVJJVU Rd dTYŽE Yc`f XY eVJVgZZ_LRUgVcsZZ_X R_U`eYVc^ VUZRUVgZTVdLZ TJf UZ_XeYVVI a VCZ/TV `WJZgZ_XZ_RSZXTZgiLeYVyT_d^ Vcd TZAgi %XRd RTCZEZTRIZ_fV_TV`_eYVhBj 4 YZJVR_dLR_UVdaVI TZRIJj eVVa``c eYV^dvJgVdLUVj_VhYReZe^ VR_d e`ySVa``CZZ

EYV bf $R_{ZR} = V df UZ d dY h eYR yT d^ Vd$ $Zh \% Zh V V V V \dot{e} g V h V / Z Xack df c V -$ \underline{Z} UZ \underline{Z} \underline{L} \underline{R} \underline{d} \underline{Z} \underline{e} \underline{V} \underline{Z} \underline{e} \underline{k} \hat{k} \UURS`feeYVejaV`WaReZURATeZ_eYVjXeW/^ SfjZ_XRac`UfTeL%\$~ `WeVda`_UV_eddeReVeYRe ZeZlRhFj`WyeeVFeZ_XeVV^dygVe7ZiWrFeZH74FeZ_ ReyXteZ_XeYVeYZ_Xd: hR_e%ZdRUUUe` eYZŁZe $\label{eq:linear} $$ TR_SVdR2UeYReWc) ! " `WeVda`_UV_edtT_d^ ! $$$ Z_XZdRhR `WeRezUVZ_XRUVOZEYZda`dezeV RaacVIZReZ_Raa]ZddZ_^fTYeYVdR^VhRje `eYVcdT_df^aeZ_ŽDZL`fe`W'!cVda`_UV_ed eYZ \ eYRe aV a]VSf j eYZ XdySVIRf dVeYVj _WU eYV %LaR_U`_]j eh`Z`RXZ_VeYRe eYVj U`Zeye` dr`h`WWZiWeYZdeV_UV_TjZdT_}c^WLhYjU aV a]V_`eWc^f]ReVR_UT ^ Ve`eVc^dhZeYeYZd dezantez_0

5 HMDC @C; MC: 7 C B GI A 9FG

 $EYV dYRaZ_X`YRYT_d^{A}VcdTZkj%ZdZ_UZIR$ $eZgV`YR dRaZJ dV cXR_ZREZ_`YkYVT_UZZ_d`W$ $T^^f_Zj]ZWŽ_eYZddTZkj`YkYZ_XT_d^a$ $eZ_Lh YRe ej aV`VYT_d^VcdRV4YZYR_dDEYV$ $d`cgYJT_eRZ_dR_f^SVc`YT_d^acZ_lcVJReVU$ $gRZSS]Vd1 dW RaaV_UZ_(/ eYRe ac`gZ, W^ReVZR]$ $VkCR ej a`]`XJŽ7fcXc`fad`VkVch`_UV_edTR_SV$ UZKZ XFZhVUŽ

H& 9 B 998M 7 C B GI A 9Fž C F Î = 7 C B GI A 9 HC GI FJ = J 9Ï

EYVEVZIR WYZEJ UZEVTE JZ \ SVEN W_ eYV hBj aV a]VT_d^VR_U eYVZcd TZ łVT_`^ZT JVEVJŽ EYV]REXXde Xcfa`VZ_UZEZLFR]d1%#″/REVVEV^ eYV]`hVcdecRef^LR_UeYVZcT_d^aeZ_ZUZEZV_ ViTJf dZEVJ Sj_WUŽ3j R_U]REXXLeYVJ_VEVCYREV ^`_VJ e`daREVLVEV_eY^f XY eYVJ h`c\`_Jj e`

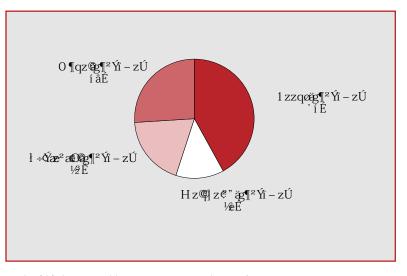
7 C B GI A -B; ∶ C F K 9@@ 69-B; žC F Î = 7 C B! GI A 9 HC A 5?9 @= 9 69 H9 FÏ

EYZIZdeYVď R]VdeXcfaL[fde" \$~`VK]dVah`_ł UV_edLR_UZed^V SVadh`c\YRUReT_d^ZX Z_bfVde`VRSVeeVc]ZWabjVŽEYVdVR-VZ_UZeZJFR]d W/^eYV]`hVcZ_T^VXcfadhY`ecjeZgVab eYVZ: ^ `UVde VR:_ZXdZ d'R] Z ac gV V_edł R cWVZXdRe d.R_Vh eV/VgZZ_łeYRe Z T&RdV eYVZ: WY ZXd'deR_URU`VJZgZXŽEYVJ hZ]RhRJ decj e `SeRZ R_VfecRZT ^ Ve dR]ZVeYVZ:RdzZReZ_d. hYZIY eYVJ af cdf VVR:_VdeJ Sfe_`e`Sdvd2gVJŽ D ^ VeZ VdLeYVdV decV_f `fdT_df VdX e`R dr`aaZXTV_ecVe`dWZVeYV&RVR.j SRXRZ_d. R_UeYVJ RCVYRaaj ZVeYVJ TR_Xkéd ^ VeYZXWc RX `UacZIVŽ2]RXVac`a`ceZ_`VeYZEVc`fa RcV ^ V_W7 eYV]`hVcdeRef ^ hZeYYVRgj WY Zj cV da`_dSZZEZCŽ=ZVeYV^ V SVcd`VeYV} cdeXc`faL eYVJ eV_Ue`WWJeYReeYVJ YRgVSW_JVASVZ_USj]ZWR_UYRgV_`TF]efcR]T_df aeZ_ŽEYVJ eV_U e`VR:_d ^ VhYRe^`cVeYR_eYV`LY`hVgV&R_U

H so 9L = CH9B H so @ 7 C B CI A 9F ž C F Î = 7 C B ! CI A 9 H C A 5 ? 9 A M C9@ 69H 9F Ï

@_VZ_}gV`WeYVcVda`_UV_edRcVZ_dVTfcVT_} $d^{A} V d Z E Y V R V f d R i a V a V W A e Y V Z U V$ decRef ^ hY RcVgVg T_TVc_WhZeY `SeRZZX af SZTOVT X_ZZ_ `WeYVZcd TZR deRef dŽ7` ceYV` Ł T_df^aeZ_ZlacZ'RzZj RhRj`Vstc[VTeZ_XeYV^ł dMg\dŽy9 RgZ_X%ZclaRce `WeYVZchRj `WySVZ_X%Z EYZdZhYjeYY TRVd ^ fTYRS`feeYVZcaYjdZ TR Raa VRcR_TV, eVVZchV]ISVZ_XUVaV_Ud`_ eYZd Viewc_RIZ RXXŽEYV/h`f]U]ZVe`hVRcScR_UVU T]`eYZ_XLegi`fe_VhWRAYZ_ac`UfTedR_UXV_Va $R_{i} de eYV dMgVd RaReeZ6i ZeV_eZR T_dr^ Vd$ `fXYee`SVZ_Ra`d&Z_e`WJ]`heYc`fXYeYVZc UVOZEV e` UZCHZ_XFZEY eYV dygVoZEYV fd R]j $VRc_hV]ERCVZ_RX`U\}_R_TZR] a`dEZ_ER_U$ WW/eYReeYV/ReVhZ_VcdŽ?`_VeYV/ddLeYV/`VeV_ TR_`eRWAUeYVAV]fifcZdR_URdVVATVUe`Sfj TYVRaljiŁhYZTY ^ R.VdeYV Z dVTf cV, eYVZc VX d dW^ e` e` eeWZEYVeVc^ yWZeV_eZR%T_df^ Vc Zdfd/Ue`f_U/d/ZVe/V/Z\SVehW_Z/VeZejRU $T_d^{aeZ} + yReZ_X$ SVT ^ VdRdZ_ eReZV_1 eZ; VdySVZ_XZZEY dVhY dVZV_eZej ZdSRdVU`_ $T_dR_eT^{A} = T^{A} = R_{Z_{1}}^{A} = dh_{Z_{1}}^{A} =$ $T_dIZ f d WhYRe aV a]V^ZXYe eYZ \ WeYV Ž$ 6ZeYVcRSVeeVd`WWVZXYS`fc`cRa``cY`fdVY`]U _VieU`chZ]dZCVUZefcSZ_XUfSedŽF_dfcV`W eYVZCZIV eZejŁT deR elj UVWV UZ XRXRZ de`fedZUV acVdfcVdLT_df^Vdc`VdYZdejaVIR_`eVgV_}_U CWAXZ eYVZC VR ZZCŽ

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2 WWK jj YZXY ac`a`ceZ_Ł# ~``WeYVe`eRJLSV]`_X e`eYVXcfa`WZ_UZeZLfR]dhY`^ZXYeSVeVc^U y^`UV|%T`_d`^Vcd`WeYVejaVWR^ZZRcW/^ RugVæZZ_XŽ:_`eVvch`dutaVa]VhZeYRdec`_X RkdeYkeZTeRdeVLgVcj T_Tkc_WhZeYeVVZcaYjdZR RaaVRcR TVIhY ZVe dec]] R UhZU hłdY a Z dr`aaZ_XTV_eeVdR_USfj_SdR_UVUT]`eYZ_XZ7c`^ eYZddR Ua`ZeLeYVj eYZ\eYReeYV`aa`cef_ZZdd WcT_d^ aeZ_ YRgVTYR XVU Wc eYVSVeeVZ3j R_U RXVLeYVaV a VZ eYZXC fa RV^ V SVcd W eYV^ VUZ ^ łYZXY decRef ^ hY TJVRcjj WW eYReeYVj RVhZ_VcdR_URVVMjjcvRjZvURdZ_UZeZUFRjdŽ EYVZcd/JVT_}UV_TVZfT^SZ_WhZeYR_Z_eVetvele Z_d'TZR|ZWZ@_|jZ_eYZdXc`faZdRYZ&Y[VgV]`W Tf |ef cR| T_d^ aeZ_Wf_UŽ2 |eY f XY eYVcVdf |ed Z_UZIREVRT_ddeV_eac`}]VLeY_fXYLeYVddkV_VeYV Xc`fad'XXkdedeYReeYVy^`UVjT_d^V& ZXYe RTef Riji UZeZLVZ e`eh`ejaVeZ@_VZdeYVRTef Ri T_d^{Λ} T_{M} T_{M} T_{M} V^S`UZUZ_eYVZ`RXZ_Rg``WeYZtT_d`^Vcd`TZL VájŽEYV eYVcej aVZV_eZ VdhZY eYZtyZVR[‰_]j $RdR_RdaZReZ_Z4`_df^ aeZ_Zd_`h_e`YRgVR$ dec`_XRdaZReZ_R]T__`eReZ_ŽAV a]Vh`f]U]ZV $\dot{e} dd S V dV \gamma^ UM T_d^ VLS fe Z dVZc$ RTef R Via VZ/TVeYY RV^`cV ZV/W ZEV_&R/% $T_d^{\Lambda} Vade c_SVeh W_eYVUVaZeRS V^{UV} R_U$ eYVCVRZZZA VEYVZC ZZVOŽ

EYVZ a` ceR_TVeYRe RkdeYkeZtdZdSVXZ_ZXe` eRV`_Z_4YZVR_dURZ; ZEVdYRdRjcVRU; SW_ ^ V_eZ_WŽERS]V"%dY`hdY`h V_`c^``fdj Z`ł a` ced` VRVdeYVeZTT_df^ VcX`UdYRgVZ TcVRdVU 1'% ~/`g\ceYVIRdeUVIRUŽ5ZaV dZXhZeygRlfV UV}_ZZ_dZ_UZeZLFRjddvZkVfa`_eYVViedReRXR_dL eYVT ^ ^ `_a]RIV`c eYV df SejV e` c\ac\dv_e eYV dMWeYc`fXYR_RdeYVeZTZ`RXVŽER\ZXeYZde` Zed) XZIR T_TIf dZ_LInWci X'VY'gUX'hUhU' dYfgcbÑg V]c [fUd\mhYbXg hc VY fYU`]nYX Ug U gminUhcb cZh Y Y c " 2e eYV V eV VL eYVZ_UZeZLFR] ZYZL`cYVc]ZWdej]VLeYVac`[VTeVU Z^{*} RXV ` WYZ1 ` c YVc dej]VŽ2_U eYZ1acVIV Z_{V} TV `VEYVZ' RXVLR RVdeYVEZT | R XF RXV dReYVc eVR R gVSR] $^{T}VLT f$]U Via]RZ hYj aV a]V}_UZed YRUe Roz Revh YRez YRaaV Z Xe evv +h Y Webgi a Yf W h fY lg U k c fX Ygg UYgh YhW Yl dYf]YbWY"

 $EYV dec`_X R deYV \& T T ^ a`_V e`VVT _ df ^ a \\ eZ _ Zl`_V`V eYV ^ RZ_ VM e` cdf_U c ^ ZZ X e YV \\ ZJR ` WYYZX' If] ef c % Z ac Zl_`h ac`Uf TUU`_ R$ $^ R dd dIR]VLZe Zl R_ ` d Z R g R le eYRe R_j`_V IR_$ $V VI f e Z 6 g X b R c % o 7 c_ï_U k L" ***/ ac`g ZJ d$

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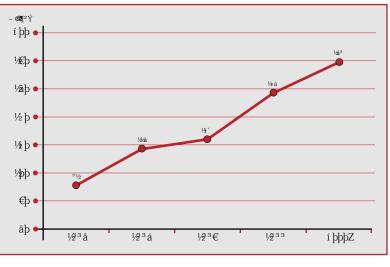
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 $\label{eq:started} \begin{array}{l} dW_{LSf} ehZeY feeYVUR_X& VSVZ_XS` eYVEVUSj\\ SVXXZ_XLRXXCVdIgVedRWIEa`]ZZIR] ac`aRXR_UR`c\\ d^Vj`feYVIJUZHfCSR_TVŽDW_Z_eYZI]ZXYeLeYV\\ ^R]] TeVRevdRafS]ZTdaRIVLSfeRdR^VEVa]RIV`W\\ aRdRXVŽ\\ \end{array}$

 $\label{eq:second} \begin{array}{l} 3 \ eV \ eV \ UV \ TZdZ \ alj \ ReR \ dVc^RZ \ VeV \ af \ S]Z \ dY \ VZZ \ Z \ Z \ Z \ VZZ \ Z \ VZZ$

> ZXYe _`e eYV ^ R] SV R cZef R] ac` TVdd eYRe T_dVTdRevdRUEVR^ `WeYVyHV%Q4VceRZ]jLT_ł d^{aeZ}_{aeZ} a VRev dRdR } VU W [] VI 28 V 2 V eZ j Ž 7RdYZ ŁhZey ZedUj R^ ZId` WUZWWEV OZROZ R U ZV_6Z_TReZ_ŁZteYVSVdt_`h_ VtR^a]V`WeYV ZWC^RLeV eREEVZW EREZCHEYREUKZEVW/^T_ł $d^{aeZ}_{Z3feeYW} \sim ZYeSV d^{VZ}X^{O}$ DY`aaZXTV_ecVd_`e`_]j cVacVdV_eRdVVTegVL YZKRETYZIR ` d.W.Z_X` WWKERZ_ d ^ S` [ZTX ` UdeYRe YV/a aVcaVef ReVR UcV Vh aRceZIF |RcacRTeZIVdR U cháchál_eReZ_d`Wa TZkéjŽEYVj RcVRjď R\ZU`W Webzev TVeV `_j eYRe V_RS]Vd Zed a ReeZIZaR_ed e` WWJ aRce `WRT^^f_ZijŽEYZdZdaVcYRadhYRe aVa[VLUWaUh_LdvR]j hR_e+e`eR\VaRceZ Rozef R eYRe [VedeYV UVA] j eYVZc Z UZez If RZejŁ hYZdeT^^V`deZXRT]]VTeZeVZV_eZejŽ:eZd eYVTYVScReZ_`WRyHV%LSfeRaRceZIf]RcyHV‰ eYReZL_`eSRdVU`_T]]VI6ZvRI6Z_Ž:eZlaVcYRad eYZdejaV~VafS]ZT1^ ~ CVdaVTeRe`ceYR_RTe`dL^ ~ CV TOZZT eYR_ a RoeZZaR_d eYRe Zt eYV d'S[VTe`WeYV yafS]ZT%ZNRe`URJŽ



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K 95? DC @++7 5@=89BH+ =7 5HC B

 $2dacVgZ fdTYRaeVcddr`hVLLT_dr`aeZ_ZdeV_UZ_Xe`dfaa]R_eh`c`RdeYVTV_edf]ViaVcZ_TV`WdTZf]Z_edcRieZ_Ž2 dZ`ZfRcTYR_XVTf]USV f_UVc`hF]Z_a`]ZZTdŽ9Zde`cZfR]]jLya`]ZZTdhRdeYVTf]efdf]TV`V_e`W4YZvR_dTZfg'%a8RcdvE_L #!!"'ZehRdeYc`fXYa`]ZZTdeYRe4YZvR_dVVcXU^V_Ue`VZ_XdWceYVZ_UZjVaVcZ_TVdR_UeYVZcdał cddV_eRz_d`VdTZfg'RdRhY`]VZYReTV_edfZjZfR] a`UZfZTCJPVREVVFfUZ łgZffR]^UZFAR_UdaVUZ_TR]jedf]ac`UFTeZ_ZEYVdVRV_`ecYaZTA`]ZZTdAVFedV~de`YRgVTYR_XVL cRYAZTA`]ZZTdAVFAU^ACAVAL$

af S]ZT daRIVŽ3WKVT_dZWZ_XY`h eYVaf S]ZT daYVKVYRdSW_TYR_XUSj eVJVgZZ_Ł`_Vdr`f]U Rd\e`hYReVieV_ea`]ZEZTdYRdT_eczSfeVUe`eYV Tf]efcR]T_decfTeZ_`W4YZWR_dTZkejŽ

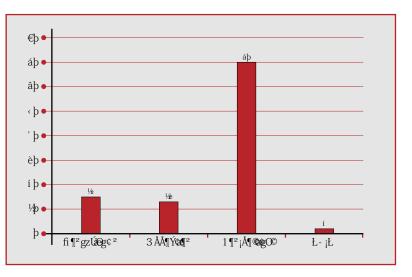
A`] $\mathbf{Z}\mathbf{Z}\mathbf{I}\mathbf{d}_{h}$ h dW de` SV]VdUZ a` ceR_eVc eVV acRI&ZVdR_U c/ac/dV_eReZ_d` V/ \mathbf{Z} d' TZ/ej Ž: ed UVI]Z_VTR_SVdW_Z_eVV]` h UV/cW` Va`] $\mathbf{Z}\mathbf{Z}\mathbf{R}$ $\mathbf{Z}V_{e}\mathbf{Z}_{h}$ TReZ_c/eVV]` h UV/cW` Va`] $\mathbf{Z}\mathbf{Z}\mathbf{R}$ $\mathbf{Z}V_{e}\mathbf{Z}_{h}$ TReZ_c/eVV]VUSj eYVc/dF]ed` VeYVF? 5 A #! ! " d' ceVjŽ; f de " # j VRcd RAKC UV` ` TCRIj h Rd c/de` c/UL TZZKV_d ReV c/` Rc\RS]j U/eRIYUU V0'^ a`] $\mathbf{Z}\mathbf{Z}\mathbf{C}\mathbf{Z}_{h}$ Y/ $\mathbf{Q}\mathbf{R}_{h}$ d ReV [Vd1 h Z]Z_X eYR_ SW/cVe a` $\mathbf{d}\mathbf{Z}_{h}$ eYV d/gvd1 R]`_X eVV]V46/cZY/e R $\mathbf{Z}\mathbf{L}\mathbf{R}_{h}$ U j`f_XaVa]VRV<VfTRLee`dXZdeVcWcg@ZX R_ULZ_XV_VRILe`aRceZIZaReVZ_ZdeZefeZ_R] a`]ZZZdŽ

E` eVde eYV} cde Yja`eYVdZLeYV]`h [VgV] `W a $\mathbb{Z} = \mathbb{Z} hRd^RUVe`ac`}[VeY`dVhY`dRha`]ZZZdRdR ZeVXOR a Roe` VeVVZcZV_oZjŽ3j ZUZeZU RjdhZeY Rol [ZU a`]ZEZTR ZUV eZej RolV^VR e olda` UV ed hY $ZV_{e}Z$ WhZ Ra dZ_{R} R Xe WW RIZER_UHY`S`eYg`eVUZ_eYVacVdRV_eZRJV/VII eZ_d`WR_fRq #!!! R_UZ_eV_UUe` g`eVZ_eYV aRc[ZR^ V_eRcj V[VIeZ_di5 VIV SVc#!!"/Ž@_eYZd UV ZZ ŁR^ ` CVUV R UZ X` _ VeYR eYV^ VCV RWAC^ REZ_ `WR a` ZEZIR] `c ZUV |`XZIR] deR_TVL Îdc`]hJWU'Ï fYgdcbXYbhg'UWWcibhYX'Zcf'bc' a cfYihUb & 1 cZhYgUa dY"@eYVccVa`_ł UV edley dvhy UZU `eS`ey UVIRCVRa` ZZZR a`dEZ_R_UdeReVeYV/YRUg`eVUR_UZ_eV_UVUe`Ł RV]RSV]]VUy_`_ła`]ZZR]%LR_URIT f_eWc(! " `WeWda`_UV_eeŽ

yA` JÆZIR%&Vda`_UV_ed R:V UZac`a` œZ_ReVj Wf_UR``_XaV a]VhZeY YZXVc]V&Vdf TR eZ_W^ eYVf aaVcdeRef^ R_ULaRœZIf]Rcj LeVV ^ VUZf^łYZXY deRef^, ^ V_RXU`gVc %& R_U aV a]VW^ DR_eZX ŽEYVdVT_UXc`f a T_eRZ_dR]RcXVac`a`œZ_`VZ_UZgZLf R]dW^ eVV]`h VcdeR ef^ hZeYZ_T^ a]VEVdVT_URg`VLf TReZ_Lh`^ V_ R_Uj`f_XaV a]VRXVUSVehW_") R_U S%LR_U aV a]V]ZZ_XZ_TZEXd`eYVceYR_DR_eZX Ž

 $EYV ya`] \textbf{ZZIR} \% \&c` fa TR_ SV U \textbf{ZZIVU SVEh W_} cVda`_UV_edZIV_e2JVZ_XhZeY AcVdZIV_e=RX dLeVV$ $4`_TVdeRIZ_ 1X gVc_ZXT R] \textbf{ZZ} _ / R_Ua` d \textbf{ZZ}_d$ $cR_XZ_X V o^ eVVTV_ecVe` eVV] W \textbf{Z}`_ eVV`_V$ $YR_ULR_U eV` dVZIV_e2JVZ_XhZeY; `Rof <math>\frac{3}{4}$ = Rg $\frac{3}{4}$ 1eVV^Rj`c` W LR_e JX 'LeV`aa` d \textbf{ZZ}_ R_U eVV cZXYe e` TV_ecVicZXY dL`_ eV` eVV ZH YV_ eYZ IZ U_VLZ: eR_daZVdeYReeYV y4`_TVdeRIZ_% c` fa ^ R_Vdfa " &` VVYV dR`a] VR_U eYV y` aa` d \textbf{ZZ}_ % " S` ŽEYV y_`_la`] \textbf{ZZIR} % c` fa L] VeZSV da VReVLL T^acZMd(! ~` VKR] 4 YZ VR_dZ_eV cZZMA VZ

 $\label{eq:constraint} 2ddVARLdeYVdVT_UYja`eYVdXLeYV]`h]VgVJ ``Wa`]ZEZIRJ aRceZIZaReZ_ R``_Xj`f_XaVa]VL eh` eV_UV_TZdTR_SVZLV_eZ_VLZEYV} cceZleYRe j`f_XaVa]VRXVUSVehW_") R_U#%U Z_UVU$



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UZA JB, R^ fTYh VR\Vca`JZZTRJZV_GZj eYR_`eYVc RXV Xc`fadŽEYVeV dW^ de`SVR ^ Rc\VU a`JZZ TRJ UVIZV_GZ TRZ_ R``_XeY`dV hY`T fJU SV T_dZVeVU aRce`VeYVyceR_dZZ_ XV_VCRZ_%Z3j T_ecReLeY`dV hY`_Vh eYV acVI"*(\$4YZ/VZ eYVZcj`feY`c RU`JVETV_TV dW^ e`YRgVR dec`_ł XXca`JZZTRJZV_GZjŽEYV dVT_UeV_UV_TjZLeYReL R``_XeYV ya`JZZTRJ%oVch`_UV_ecLj`f_XaV aJV ZVV_GZYV^`cVhZY eYV`aa`dZZ_Ž

ERSJV") SVJ`h dr`hdY`h Rezef Uvde`Uvi ^`Tortj UZWWCR``_XeYVeYeW Xc`fadŽH YZV eYV XcWre Sf]\`WeY`dVhY`ZUV_eZjVhZeY eYV 4`_TvoertZ'_ dfaa`ce eYV Uv^`ToreZt djdev`Ł Rj^`deYRJWWeY`dvT]`dve`eYV`aa`dEZ_eYZ_\ R_RfeY`cZERZR_CXZ'VTR_d^VEZ`VdSVSveeveZ 2XRZ_Łckda`_UV_edhY`ReVJZeJVT_Tvc_VhZeY a`JZZTdeV_Ue`SVJVdT ^^ZeeVUe`Uv^`TortJZ y?`_ła`JZZTR%okda`_UV_edTR__`eSVZUV_eZ VU hZeYy_`_łUv`TorezMaYa`hVgVZ__WaterVjdr`h XcWre4cT ^^Ze^V_ee`eYVUv`ToreZtcXZ_VeYR_ `aa`dZZ_daveVdZ

 $EYVAVUZWWAV_TVARAVT]VRAVE hYV_eYVATS[VTe$ $Ztla`]ZZTALSfeeYYJTR_SVAW_Z_`eYVARARE`Ž$ $2dRaVT_UVIR^a]VLeR_VReeZfUVAte eYVTYR_XAd$ $aW_Z_4YZIVŽEYVXARe^R[`cZgi1)(~/`Waa`dZ$ $eZ_R_Uy_`_la`]ZZTR%aVa`_UV_edSV]ZgVeYRe$ $eYVAVTYR_XADRAV]VRUZ_X_`hYVAVR_UeYReeYZ_Xd$ $YRgVcV^RZ_VURDEVY_hVAVZEYV dev_XeY`VAVV$ @/ }ä/á

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Z.V. & TREZ_RV_`e & Z&A] ^ RekktŽEYY ^ VR_ eYReeYVa`]ZZIR] T UVła`h \k RdeYVV a ktdZ_`W a`af]Rc d g\&ZX_ej ł Raa \Rade`SVZ_eV][ZXS]Ve` [f de eYcW`f e`VWgVg`"! TZXV_dŽ:e dW^ d c\R d_RS]Ve`d aa`dVeYRe`_]j eYZl^Z_`cZj c\&Rtd a`]ZZIdRdaRe`VhiYReXgVd^ VR_Z_Xe`VgVg`UB] V a \kZV_TVR_U RdeYV daYVkV h YkV eYVZ Z.VR`W 4 YZV Złe`SV dYRa VLŽC h Yfk [gYž]ha i gh VY` Uggi a YX`h Uhdc`]HVg`Xc Yg`]hhY`hc`g\UdY` h Y`]bX]j [Xi U``UbX`bUhcbU``]XYbh]micZh Y` ch\Yf`+Si`cZfYgdcbXYbIg"

EYVZcVJVgR_TV`Vva`]ZeZTdLf_UVcde``URdRUVi ZSVEREVT_defTeZ____WeYVdTZR___dVeLdW_de` SV Z_VU é TZERV ď Z_RSZZEj é RTeT [[VT6ZEV]jŽ EYVZ'a`ceR_TV`Wa`]ZZTdZdZdZ_gVcdVjj cVjReVUe` eYVy_Ref cRIZEREZ_%WA TZAGŽ WEYVVI ZEEZX d.V.c Zty Ref dR% R Uf TYR XARS Why YRe Zda` ZEZTOWO :_UWUŁCYÓWRCTYZ_e`eYVa`]ZEZIR] ReeZef UVd`WYZ}ł UCV_R_URU]VCIV_edZ_UZIReVcleyReeYVZc_VXReZeV WWZ_XdRS`fea`]ZEZTdRCVXV_VR]jj Rdd TZREVUhZEY RaVćTVáeZ_eYReeYVZc`h_RTeZ_dRcVZ_VWWTeZeV $12^{\text{Rd}RL''**}(, > R_kZL''**(/ZJ`f_XaV a]Vd'W$ WCW/^RTX_ZZZVUZZTdUSVTRfdVeYV/hZEYe` TYR_XVeYVVIZeZ_XdeReV`VRXWRZdSfeWWJa`hVdjVdd e`U`d`ŽHYV_eYVZcUVdZvd]\VRU_`hYV&VLeYVj eV Ue` dvRIeSj dv[VIeZ Xa` ZZZdŽ5 VdaZZ Xa` ZZZd ZdRhRj`W R\Z_XfaWceYVZcWfdedReZ_RehYRe eYVjdWRdeYVZ_WWWI6ZeV_Vdd`VeYVZc`h_RI6Z_dŽ $EYZISC RU = C^{d}R - UZX WeYV add Zfd$ CVa`œidYcd`Yk]``cb`mYlYfWgYWfhyYbg\]d k \Yb h Ym \Uj Y h Y gY ZW bÚXYbW UbX gYZYghYYa hc ZYY h\Uhh\Y|f UWhcbg WUb a U_Y'U'X]ZZYfYbWY"

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9 ZXY VJVTeZ_ efc_`fed RcV`VAV_ foNU Rd R_ RcXf^V_ee`oh`heYRe 4 YZjvR_UV^`TeRTj Zd Z_ d f_UYVRjeYŽ

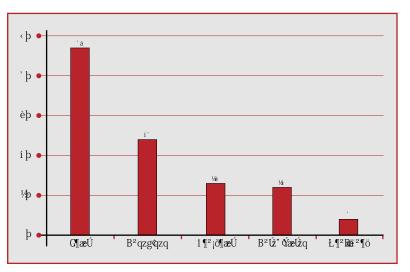
 $\begin{array}{l} 6] VIeZ_dTf] USV XZZX X CAREAC h VZXYee ``$ $yAXWU^ ``WIY`ZIV%Z eVVT]] VIeZeVZ RZZ RcjZ$ 2TT dZXe` eYV CAF] ed`V&YVF? 5 A #!!" dfd $gy[LR]^``de YR]WVR[] CAb`_UV_ed RCV h YRe hZ]$ SVTRAX cZAU YAVRdyg`eAdžE YAVZ_UZ9ZLFRd g`eAUZ_;R_fRg #!!! R_UhVAVZ_eV_e`_ efc_ZX `feRARZ_Z_5 VIV^ SVc#!!"Ž2eeAV`eYAVI eAV V RVy_`_łg`eAdMaeY`dVhY`UZU_`eg`eVR_UYRU _`Z_eV_eZ_`WUZ_XdŽ

HY`REVEVVIVIÈ dENCEYVZC^RZ_TYRETENCZEZT Zela`]ZZIR]ŽEYVyg`eVc%Zc`faZ_T]fUvd"!!!~`W eY dV hY ZV_eZJVa`]ZZTR]jL hY VeYvc hZY eV `aa`dZZ_`ceYV4`_TVeRTZ_Ž3jT_eRHL`_]j ##"`VY_`_ła`]ZZTR%dv&:_UV_edRvaRe`VeYv VJVTe`dRVZ:_`eYvc h`dULaRezTZREZ_Z_VJVII eZ_dZlaRe`VRa`]ZZTR]ZV_eZjLcVARUJV&I`VZed ZV]`XZTR]`cZV_eReZ_Ž@VeY`dV hY`drRvS`eY RecZSf eVd1a`]ZZTR]a`dZZ_ZXR_UVJVTe`dSJ aRd eZTZREZ_łZETR_SVdZUeYREUV^`TRTJZIRT^ł a`_V_e`VeYVZZV_eZjZ2_UZ_UVULeYY_XV_VRJ]j VJ acVdTRdec`_XT^^ZE^V ee`UV^`TRTJŽ

 $2 XchZXaca`a`ceZ_`VUZEXV_dH% ~ Z_eVV \\ \#! ! " aRc]ZR^ V_eRcj V/IeZ_d^R_ZXWEd^V_ZU \\ `VWAKcgReZ_ZD)^VU eYZISj_`eefc_ZX`feZ_ \\ V/VIeZ_dieh`^Z]Z_ 4 YZVR_dRVV_`eV_c`]/VIEZ_dieh`^Z]Z_ 8 CHZZ/E eVVcSj RIEESV jace eVcEZX i' & eV^fdR_U da`ZVUSR]`edR_U #$! eV`fdR_U \\ S]R_\`_VHZ_S`eVTRACHY RVVI acVCHZXEVZc RZZ_RZ_W'^eVV4 YZVR_a`ZEZR jd eV^Z$

2_`eYvcdZ_Z_TR_ecVcf]e_WUde`SV^V_eZ_VU+ eYV]Z_ZeVUZ_fV_TVeYReVT_`^ZTVRTe`cddW^ e` YRgV`_VJVTe`cR] Reczef UVdZH YZJV%&``Vg`eVcdRtV aV a]VhY`SVJZgVeYVj YRgV]`de`feSj eYVVT ł

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 $\label{eq:linear_line$

 $EYVZ_Wc^{A}RZ_R_R_i dWd^{A}WdedeYReUV^{T}I$ $dRij YRd^{}_j j Z ZWUZ a^{} cR_TVRdRT_dZf eZV$ $acZ_TZa_VVWeYVT j VEZVZ RZ_R_i Z2_UeYVVZi$ $WceYVc_VZI_VVc_eYZI_ReYZU^{V}WYV4YZ_VR_d$ $d^{} cgy WdZUeYy UZJ_{eTR}VhYRej aV^{VX}gi$ $Vc_^VeeYY YRULR_U'')^{''} dZUeYy h^{}j USV$ $T_eVeRZYR_RfeYcZRZ_dXZ^{VZA}^{A} aRZi_h$ $hZeY URERW^{2} 2cXV_eZ_R_VgV_Z eYV^{Z}ke^{V}W$ $eYReTf_ei dTZi faYVReR_i dZeR_i Z4V^{} i W j T^{2} ZeVUe^{V}$ $UV^{T}ZR_i J 0$

 $4ZEKV_d$ Receff Uvde h Rduda) Zezddw e SV Uvevc^ Z_W_ ed ^ f TYSj R_j RSderle ZURRdSj eYVZ: VgVg UB V a V ZV_TVŽ: e Raa V Rde SV Y V VL Z_ eYVZ: URZj d TZR] adrie ZV V LeYRea V a V f_UVX eYVZ: T X_ZEGV R_U RWWEG V y RaacV_e ZV V YZa‰ Z_ a) ZezTR] RWWZ Z 4 `_d ZU c Y h a V a V J V C_ hYReyWWU^``WIY`ZIV%6VR_dŽEYZtlacZ_TZa]V ZŁ`WI`f cdNLRaZjRc`WW^`TCRIj, TZENKV_dYZa Zd VIVETZHUSj TY`` dZ XR UUVTZLZ XR'` XUZWA V_e`aeZ_dŽAdRZVVC eYZdyVXVU^``VVIY`ZIV%Lo Y`hVgV£XV_VR]j`gVdj``\deYVVR1eeYRe^R_j`W eYV`aeZ_dYRgVSW_UVIZUUVRCZ_RL/gR_TVR_U R]`_XhR; RhR; W/^ eYVTZEZKVŽ:_TcVRdZXjjŁZe Zd_`_ła`]ZEZIR] WETVOłEYV]`TR|R UZ EVE REZ_R ya`hVcdeYReSV%iæYReUVeVc^Z_VeYVTY`ZVdWc d TZkáj d Uvýlj a ^ V_eŽ4ZEKV_d y]VRc_%eYRe eYV d TZR] dZef ReZ_dW^de`SVR_`dU/cVdeRS]ZM/USj $RWhL^{s}dh YZY eYY YRdV_{UVIZZ}^{h} R_ZX$ a`hVŽ:_`eYVch`dJdLeYVReeZefUVd`W1ZeZkV_d dW^ e` SVZ_~fV_TVUSj eYVaVcTVaeZ_ eYVj YRgV `WeYVZCRSZZEje`^R.VRUZWWCV_TVe`eYVhRjeYV Tf_eqiZdXZ_XŽ@_VZ_UZIRe`c`WeyZdZdeYVWW/Z_X `Wa`hVdVddVddŽ

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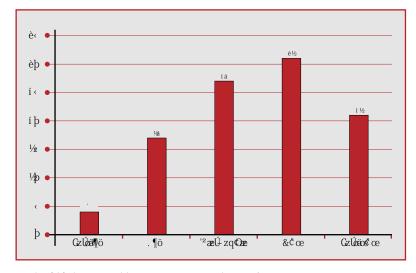
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>¶ï ÚgznaB1Ł; al Ove¶²O®≥ï Údzonai þþ½Ê

2_eZZARZ_XeVVT_TJfdZ_LZETR_SVdZUeYRe 4 YZJNR_deV_Ue`dYREVRdec`_XWWJZ_X`Wa`h VcJVdd _VdZE YZdcVdf]eZdUVcZgVUVG'^ R_RUUZEgVZ_UVi SRUU`_ WfcgRzZS]VdLRddr`h_Z_dCS]V#!Ž2d eYVWJ]`hZ_XTYRecCgVRJdL`_VZ_}gVcVda`_UV_ed WWJ^ REXZ_RJZKUR_UdT`c_VUZ_VgVcj`__V`VeYV Vfc`aeZ_d^ V_eZ_VLER_UYRJWVeYVR?`a]VWJJd Ze`eYVdh`faaVcSR_Ud`VeYVZ_UVIŽ

CVda`_UV_edhZeYRdec`_XVWJZ_X`Wa`hVdjVdd _VddeV_Ue`SVJ`_Xe`eYVJ`hVcdecRef^ŁhZeY`fe UZdeZ_TeZ_ `VVRXV`c dvfZA`hVdjVdd_VddZdeYV

\$'%B=1 ä/e '²qz÷ä¶%åŶözÚ@ÝÝäÇÅzÚgz²æÖ'zÝÈ



 $df S[VI52gVV aV22/TV`VeVVa``dLR_UZET_dZedd Z_WVJZ_X_`e[f deV a]`ZeVUR_UVIT]fUVUVT_`^ZI TR]jjLSf eR]d Yf^ZZEVUR_UdT c_VLZA`hVd/Vdd __VddZ` a]ZdR]RI\`Ved/VVT_}UV_TVR_U`Vedf de Z_`eVVcdZ2S`gVR]LZe^VR_dR]RI\`WT_}UV_TVR_U`Vedf de Z_`eVVcdZ2S`gVR]LZe^VR_dR]RI\`WT_}UV_TV Z_`_Vd RSZZej e`TYR_XV eVVUZVTeZ_`W_Vd`h_]ZW`c RWWTe UVgV]`a^V_edZ_eVVT f_ecjZ 4`_dVbf V_eljLaV a]V`VeYZlej aVeV_Ue`ckeVRe W/^ eVVa`]ZZIR daVVdZ$

2_Z a` cdR_eT_TJf dZ_etNeTR_SVUGh_W/ etZiZierNeh Y`a cfY`dck Yf Ygg dYcd Y ZYY`z h Y`a cfY``]_Ymh YmUfY hc h]b_h Uhdc`]fJWg` lg`dc]bhYgg`UbX`hc`dfcZ'gg`]bX[ZYfYbWY`hc` h Y`dc`]hJWU``fY[]a Y" EYZiZiS`c_V`feSj etV W]`hZ_XT cd/ReZ_+etV^`čVa`h Ve]VddaV a]V WJZ_etVZcUZj [ZgVdetV^`čVa`h Ve]VddaV a]V WJZ_etVZcUZj [ZgVdetV^`čVa`h Ve]VddaV a]V WJZ_etVZcUZj [ZgVdetV^`čVa`h Ve]VddaV a]V acVgZ f d CVa`ce 1F? 5 AL #! !! R/Z_cVReZ_e` yd TZA] TRaZEN?ZEYV cVdf]cd etV_Z_UZR&U etNe aV a]VhY`eV_Ue`ecf ceR_URdf TZRVhZeY`etVd XV_VGN]j aRceZIZR&V^`čVZ_af S]ZTRWR&cZEYV_ Rd_`hLZeTR_SV dZU etNe dTZA] ViaVZV_TVR_U a`]ZeZIR] RTeZ_RcVf df R]jj]Z_\UJZVeh`dZVd`W

2_j`Sdkgkck&ZhZ_XeYVURR`_eYVhVR_Vdd `Wa`]ZZIR] ZJV_&Z TREZ_ R_UeYVVieV_ee`hYZIY aV a]VWJ] a`hVc]Vdd ZlS`f_Ue`YRgV dec`_X UfSedRS`feeYVdX_Z TR_TVeYRea`]ZZIdTR_YRgV Wc^ R_j 4YZJVR_dŽ:eU`Vd_`edW^ e`SVZ_eYV a`]ZZIR] daYVcVeYReeYJ ^ ZXYe}_UeYVcvdffcTVd eYY_WUe``cXR_ZXVR_UXgV^ VR_ZXe`eYVZ cV]REZ_dYZa hZEY d`TZkjZEYVhZJVdacVRUWJZ_X `Wa`hVc]Vdtd XXVdedeYReeYJ U__`eaVcTVgV a`]ZZIR] a`hVcRdYVJaVAJZ_VYR_TZ_XeYVd`TZA TRaRSZZEZ/deYReaV a]V_WUe`SVT ^ VdxJVkVJZR_e RXV_ed`cyd`S[VTa%oVU/gJ]`a^ V_eZ_4YZJVŽ

EYVEVIR_SV_`UfSeeYRe4YZ/W_UV``TRIj YRdSW_g&g d'TIVdHM]Z_eYVh`c\`WZ_dEZfeZ_R] T_d]ZLRZ_ŽeYRdSW_[VddV_dEZgVLY`h\g&de eYVd'S[VIEZgVLIf]efd]UZ`V_dZ_`V&YVecR_dEZ_ ac`TVddŽ@_V^ZXYeVgV_R\hYVEYVcZeZdTZEZKV_d hY`YRgVSVT^VUVERIYVU &V^ a`]ZEZTZ9Rd eYVa`]ZEZIR]d_deV^_`e dReYVchZeYURh_ W^ TZEXV_dD>ZXYe_`eZddV/WKWVV_EZ]Uj_R^ZdSV XV_VCRZ_XeYVWVJZ_Xd`VZ`a`eV_TVR_UViTIfdZ_ UZda]RJVUSjd^R_j4YZ/WE_dD



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4 `f]UeYV Rdf VUZER_UeJ\&ZZ_aReZf]Rd]j Ld aa]j eVVZZ_Z TR_TVeYRea `ZZZZZ TARZZ Xj]RT\dDEV\&ZZ_RIETR]j dW de aVAVC d&AG `V&YVW_TEZ_d_`c^ R]j Rdf TZRAUhZEY a `ZZZŽ > `dVeYR_a`]ZZTR dAWTVALZEZL_`h eJ\&ZZ_ Z RXd eYRe ReZIF]ReV aV a]Vd URZj V aVZZ_TVŽ :^ RXddW^ e SV]Vdff_hZJUJ R_U^ `dVdUFTi eZgVeYR_h`dUhYV_ZET ^Vde UVCRZSZ XRWW1 eZgVVI aVZZ_TVdR_UT _gYZXaV a]VdV` eZ_dŽ 2]] WC^ d`Wf TZS] dJREZ_dZA RAV_`h aVC^ VRAU Sj R_ yZ RXVTF]ef d%hYZYZIXZZZ XcZV e R_ V_`c^ `fdLR]eY fXY ~WZZ XLRcdJ `VT]]VTEZV Z RXZZZH YReZIER\Z Xa]RIVZIRyZZF RJ T_ł def TEZ_`WARZEJ SVchW_eYVZ RXZRJ R_U eYV cNRJŽ=ZV eYV a` JÆZIRJ Z.W]`XZd` V&YV a Rett. eM/VgZZ__`h dW^ de` ac` gZLV4 YZJNR_dh ZeY eYV \Vj deYVj f dVe` Z_eVcackeeYVZc VI a VZZ/ TVŽEV/VgZ dZ_ZdeYf dSVT^ Z_XR Tcf TZGJ e``]` V&M/W Schd gReZ_ŽE Yc` f XY ZeL4 YZJNR_d TZGj TR_cV-VIe`_ Zed/VŽE YVCVZIR` a]VVgZLV_TVLeYV_LeYReeM/VgZZ_ Zda]R_Z_XR gZER] c`]VZ_eYV]ZW` WI TZG Ž

 $2_f^SVc^WRZ_2^VCZR_RfeY^CQYRZVI$ $]ZYeWeYV^aa^cef_ZZCR_UcZNCRthTZRWDhZY$ $eNVgZZ_Z_RZ_2^VCZR18RTFA4R_TJZ_Z"**!,$ $=R_UZ."**#, > Reg243RSVc~L"**)/R_UZ_4YZV$ $14ReRj_L#!!!, 7f_V_kRJZRL#!!!/Ž:eac`gZNct$ $4YZVR_dhZY^`cb`WAVZcTf]ef_cR]T_d^aeZ_Ž$ $EYZIRbVIehZ]SVRUCVdMUZ_ARce%Ž$ $EYVTV_ecR] a]RIV`TTf aZUSj eYVel/VgZZ_dvé$ $Z_^R_j 4YZ/VR_Y^VVdSVRcdhZe_Vdde ZedZ aRTe$ $`_ eYVhRj VgVcjURj d`TZSSZZcj Zl`cXR_Z&VUR_U$ $Vf aVCZ/TVUŽ4`_dvbf V_elj LeYVCVZIRT_Tvc_eYRe$ $eYVXc`hZ_Xdx^V_eReZ_`VVel/VgZZ_``WWCZ_Xd$ $R_UT_df^ aeZ_^ZXYe]VRU e`Vc`dZ_``Wd`TZRj$ $cV]ReZ_dYZad R_UZ`c eYVTf]ef cRj VMC^Vh`c\`W$ $_ReZ_R]ZWŽ$

HYVEVeYVa`eVeZRZ Z'aRTe`_aVcd_R_cVR eZ_dYZadZdT_TVc_VLŁeh`RdaVTed_WUe`SV $UZdeZ_XfZdYVU\check{Z}@=eYV`_VYR_ULZeZda`ddS]V$ $eYRe eYV oZV Z T_d^ aeZ_{L^{h}} Z ToVRoZ Xj$ Z_UZ&ZLFRJZKU R_U dXX^ V_eVUL ^ Rj YRgV SW_ UR^RXZ_Xe`aVcd_R]VXZ_UdYZad`caRceZIZaReZ_ $\underline{Z} \ CXR_{\underline{Z}} = \underline{Z} [VTeLeY`f XYŽ@_eYV`eYVELeYVEVZIZWE^ReZ_ e`d\`h hYReRdec`_Xad\dV_TVeYVeVVeZZZ_d\e ZdZ VR^Zj ZWZEYZdRIefR]j dW^d ZVj e YReV SW_RWATECZ_eYVTfccV_eeV_UV_Tj_WcaVa]V e`hZeyUdRhZ_e`eYVWR^ZjjŽ@_VaZ/TV`WUReR RgRZIRS]VT_TVc_deYV]`TReZ_`V&VVgZEZ_dvedZ_ eYVY^ VŽ3VehW "**' R U"*** eVVZcadvdV TV $\underline{Z} eVV]\underline{Z}\underline{Z}X\underline{Z}\underline{Z}X\underline{C}^{^{-}}UV1]\underline{Z}UUd\underline{X}\underline{Z}T\underline{R}ej$ eYVfaaVcdeRef^ R_UdjZXYejj Z_eYVZ_eVc^ VUZReV `__VLhYZdecV^RZZXdeRS[VZ_eVV]`hVcdecRef^Ž 5 fcZ_XeYReaVcZULeYVaVcTV_eRXV`WaaVcdcR ef ^ Y` ^ VdhZey Rev VgZZ_ Z ey V^ RZ SVLc`` ^ \underline{Z} TeVReMUV&*) ! " e` *! " , \underline{Z} \underline{Z} eVe* VUReVeV1 e`ceLeYVac`a`ceZ_Z_TeVReMUWY^'#" e`'*", $R_UZ_eV)^h c de Re Ze c d V W ^ & " e & " Z$:eTf]USVdRUeYReeYV]`Tfd`WLeZ`RIjRSdcSd eYV af S ZT Z' RXXŽ=ReV&LeY` f XYLeYV` aa` deV eV_UV_Tj hZ]SVdW_+Sj cVacVdV_eZ_XZ_eZ_RIjŁ ev/vgZZ__ac`XR^ ^ VdTcVReVR_Z]fdZ_ `WefeYZ 3feZe`_]j RTYZgVdeYZdyecfeYVWWT&%Sj ^ R\Z_X eYVacZeReVaf S ZŽ

 $EV_V [gzZ_ Zldz] R_ Z a `cR_ e V_V V_ e Z e V$ $d TZSZZ `VM YZNR_ VA ZZ ČZ E VVac` a `cz_ `W$ $aV a]VhReIYZ_Xac`XR^ \ VdhZY eVZ VA ZZ ČRe$ $TVcHZ_ eZ Vd`VVR YRdcV RZ VU dVRU ReRS`fe$ $)! " dZ_TV"**' ŽZTT dZ_Xe` eVV"*** 4? EG$ $a`]]L' ' " `WVch`_UV_edZ eVVf aa VcdeRef ^ R_U$ $) $" `VeY dVZ_eVZ_eC VUZeVR_U]`h VcdeReR$ dz]]U eYZŽ2 d2 ZPc eV_UV_Tj ZdcVgVR]VUSj eYV F?5Ad*cgVjŽ2dRVRY Zj REzzzgiŁhReIYZ_XeVVgZ dZ_e`XVeYVc1&! ~ `V4Xda`_UV_ed'T ^ VddVT_U `_]j e`eR]\Z_X`gVcVRY Zj ac`S]V^d1&! ~ Z

2dcVXRLdeYVdvT_UeYVdxLeyReRdZ_XIVafS|ZT $YRdUZZ_eVXdReVUZ_e^{-}_f^{C} ddVX^{V}eVU^{-}VdL$ eYVTV ecRZi `WVhdSf]]Vz dZ S`eY eYVd aa]j $R_UeYVT_d^{aeZ_{WeyVgZZ_{ac}} XdR^{A_ZX}$ dY f USV YZXY ZXYeVUŽE YV acZ cZej XZeV e eYV_VhdTf]UYRgVR_`c^RegeVVVVV_e1yZed d^VeYZ_Xj`f [fdeYRgVe`hReTY%LSfeeYZdUVd _`eacVgV_eZeSVZ_XRa`hVcVM d`TZRZ_eVXcReZ_ $^VIYR_Zh Z2 \ZU \WT ^ f_Zj \%Zh TevrevU+$ gZuh Vcd WWJ eYRe eYVj REVZ_T ^ aR_j hZeY eY fł dR_Ud`WeYVcdReeYVdR^VYfdLd/RcZ_XRdvé `W^VdRXVdŽ2_UeYVdYRvZX`WZ^RXVd]VRUde` $eVVTeVReZ_ WT^{^} ^ = eVVVeZ_ Za eR_e$ Where the the terms of terms of terms e`hYZIY aV a]VRœZIf]ReVhYRe eYVj YRgVdW_Ž BYkg'dfc[fUa a Yg'UfY'h\Y'a cghdcdi 'Uf' fl) 1 łžUbX h YmUfY U`gc h Y c bYg h Uhh Y `Uf[Yghidfcdcfh]cbicZfYgdcbXYbhgifl&uEi X]gW gg k]h ch Yf dYcd Y"

$$\begin{split} & E YV \text{We erre UZHF} dZ _ `\text{W} efc_d` _ yh \text{B}d \\ ` W \text{WZ} & \text{Werz} \text{X}dT f] U \underline{Z} \text{UZR} \text{Vere Z} \text{RX} dac \\ & U & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{F} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{F} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{RX} \\ & \underline{Z} \text{ReV} d & \text{Vh YRe `gkc } R & \text{X} \text{RX} \\ & \underline{Z} \text{R} \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} \\ & \underline{Z} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} \text{R} & \text{V} & \text{V} \text{R} & \text{V} \text{R} & \text{V}$$

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aV a]VRœZIF]Revh YReeYVJ YRgVdW_ŁY`h \g\&Rd Z_UZIRevdeYRe Z`RX\dRv_`eT_d^ \UaRdZgVjZ :_ \KUZRevdeYRe Z`RX\dRv_`eT_d^ \UaRdZgVjZ :_ \KUZRevdeYRe Z`RX\dRv_`eT_d^ \UaRdZgVjZ Z_UZgZIFR]dT_ccReeeYVZ.`h_gZh`V&YZ_Xd_`e `_]j hZeY`eYVc VI aVZZ/TVd dW_`_eYV_Vhd. SfeR]d hZeY eYV`aZ_Z_dRZvUSj`eYvc aV a]VŽ EYVd/UZIIF dZ_dRS`fe_ReZ_R]R_Uh`d[U_Vhd IR_dZ`f]RevdYRvUeYZ \Z_XRS`fehR]d`VVZZX e`XXeYvc, Z_`eYvch`dLLSS`fehReZIX`UR_U SRLEJVZZZ RevR_UZJVZZ RevLSVRFeZM\R_UfXjj Z_d TZeJ]ZWZ9`h \g\cSR_R]eVvUZIIF dZ_Ld^ V UX&W`WJRS`dReZ_ZX\ac UFTeZ_`VRyT^^`_ $dV_d\% dR Vda |RIVZ: eTR_ `eSVUZ' ZdZ | dZU eYReeV/VZZZ_ ^R_Zaf |ReVdafS|ZT`aZZ_ `ceYRe ZZUVdec`jZX4YZ/VE_dTf |ef dR YRSZREŽE YV/VL1 ZXc` |VZ ZdeR ZX` Z UZj |ZWZ UFV deYVc e`ZdRSZZ eT ^SZ VaVd _RZ VUUZWKV_6ZA eZ_ `VZ ed R UZ/TV hZY R_ Z eVX eZ VV/TeZ_Z 3j R]`hZ XaVd _RZ VU ac`XR^ ^ Vd/VEZ_ Ze T _eZS fevde`gZh Vd Z UZZ R RZ _ L hYZ V Re eYV dR VeZ VZ T __VTed eYV hZY RZ _R RUX SR T ^ f_ZRZ _ `hdŽEYZ HSZ R j dVU _`hZ$

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:eYRdSW_eYc`fXYeYVacVddLeYV_dRLZLR_U _`heVVgZZ_eYRe4YZVR_dW/^UZXWEV_ecVXZ_d R_Uac`gZ_TVdYRgVSW_RS]Ve`dYRcVViaVcZV_TVdL $f_{z}Z$ XeYVa` ZZR ZNR $WRZ _ Ze$ RWMZ X WSV/_XZ_XŽEV/VgZZ_Z_aRceZIf]RcYRdT_ecZSfeVUL $hZey ZedycVRZh % Zed^ RdlaV_VecReZ_R_UZedZ_{}$ TeVReZ_XTV_eeRJZA^ R_UXV XePaYZR T gVeRXVLe eYVy_ReZ_RZREZ_%W172R acREZIVZDZ TVeYV "*)! dLY` h \g\dLX]` SRZKPZ_ YRdSW_ USZZ_XR ^ R[`cecR_dWc^ ReZ_Z_eYVeVJVgZtZ_Z_UFdeqiŽ $EYVTeVReZ_ `VeeR_d_ReZ_R|T_X|`^ Verevel R_U$ eYVX)`SRJZReZ_`VRFUZ}gZfRJac`UFTeZ_ŁT^ł SZ_WhZeYRUXXW W^^ XK_ZREZ_ŁYREVXEV_ cZWe`eYWWRceYRe_ReZ_RJZW_eZejZdfTlf^SZ_X e`W&VZX_Z_~fV_TVdŽEYVacVdV_eCVa`cedR\VdR UZWWCV_egZh+eYVUZbZ_TcZ_SVehW_eYVY^V Xc`h_R_UeVVRZV_Zd_`eRUNbfReVe`UVdTcZSV e`URj`d`Tf]efcR] ac`Uf`TeZ_Ž2d_`eVU VRc]ZkŁ eYVeV_dZ_SVehW_eYVX)`SR]R_UeYV]`TR]Zd ddf | eZ_XZ_ eVRaac` acZeZ_ R_U ddZX_Z TReZ_ `Wo]^S`]ZTX`UdSj_]`TR] Tf]efcVoŽEV]VozZZ_Zd _`ViTVaeZ_Ž

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:_ eYV d'aa]j `WT ^ ^ f_ZReZ_ X `U2L eYV ac`a` eZ_ `W4 YZVR_ e` W6VZX_ ac`X6R^ ^ Z_X

 $\begin{array}{l} & \label{eq: constraints} & \label{$

 $:eZh`ceY^ R.Z_XchVIZA]^ V_eZ_ `WYZLCV_`d$ ac`XR`^ Z_XLRCHYZLY``UZIR_Z`a`ceR_eeZ`VZ eYVd TZRJZARZ_ `WAV_RZ_R]Z RZ_RjŽ_eXZl TRAVX`cjLeYVcVJRZ_dYZa`ZdckgVcdVU R_U WCVZX_ ac`XR`^ Z_XRTT f_edWceVVSf]\`WSc`RUTRAZ_X eZ`Vn)! ″/LW]`hVUSj]`TR] ac`XR`^ Z_XhZeY WCVZX_T_eV_eŽ

 $4 RS]Velvez _ `SgZfdj YRdRete`_Xj Welz _$ $Ret Z: _UWULeYZIZIeYVT _eczSfeZ _ Ze^ R_Vde`$ $eYVT f_ecj `dTf]efd?] UZvdzjZ: _ #! !! LX Z_XSj$ $eYV_f^ SVc` W`fcdSc` RUIRetUZjL(" ~ `WIS]V$ $ac` XR`^ Z_XhRd` Welz ` czzZZEYV_f^ SVc` W$ $TYR_VdctvIzZzZ Z_ Wc^ ReZ _ ac` XR`^ Vd$ $YRd Xc`h_ dPazUjLW^^ VZX'eZ_ "**(e` "S Z_$ #! !! 14? ECL"**) L#!!"/Z

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Y hVgVŽ5 ReRVIc" **(dr h eYReeYVcVhVcVeYV_)!]`TR|TRS|VdZX_R|dSc`RUTRdeSj_f_ZeVdZeZk4L^f} ZZARZEZICIR U`EYVC]`TR|`CXRZEREZ CŽ

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 $EYVT_d^{aeZ} X ddRdv^{CV} dVgR RS VeYR$ eYVdfaalj } XfcVdLRdeYVj dY h hYReaValVRcV RTef R]]j hReIYZ_XŽE YVj U _`edRj R_j eYZ_XLY`hł VgVLRS`feeYVac`TVdd`VdVdZX_Z;TReZ_hYVdVSj eVjvgZZ_T_eV_eZdRaac`acZReVUSjUZXWKV_eRfUZ $V_T V \tilde{Z} = V f e R \tilde{Z} a a c a c R s Z_Z d$ XFZNUSj yZekackeReZ_T^^f_ZeXeNa VMYZIY gZuh Vcd Wc^ RaRceŽ

 $E YV def UZ/d RgRZRS]V U Tf^V_e eYV dzVZ$ $T_d^{\uparrow} aeZ_{VA} YZVR_ac XR^{\uparrow} Vd gVc dVIV_e$ jVRcdŽ_"**%eYVZcRfUZ/TVctYRcVhRd&\$~ ŁhYZ/V eYRe`WW&VZX_ac`XcR^^VdhRd%(~Ž6gV_Sj "**' ŁY`h VzvLeYVZcdYRVYRUcZN_e` &*~ ŁR_UZ_ "**(ZehRd'#~ 14?EGL"**(L"**)/Ž2_RjdZX aV a]VdacWWcV_TVdLeYVF? 5 A d cgV dr h deYRe eYV XXRe ^ R[`cZej 1(#" / `WXda`_UV_edUVI]RCV RacWWW TVWc4YZWR łac`Uf TWJac`XR^ ^ Z XŽ EYVacWWCV_TVVkc4YZWR_ ac`XcR^ ^ VdZ_TcVRdvd faeYVRXVdR_XVR_UUh_eYVdTZłVT_`^ZT $dIRVZ@_i aVaVZ eYV faaVc deRef^ acWWc$ ac`XR^ ^ Vdac`UFTVURSc`RLŽ

3cZWVV_eZ_drfjUSV^RUVVeYVhRj_ReZ_ł R] TY/VScReZ_dRcVTYR__V]/UeYc f XY eYV^ VURZ Edruzz_R]jLeVV_Rz_dXcVReczfR]didTYRdeVV ") DVaeV SVcR_UeVV> ZZERG ARCRUV YRgVSW_ _`e[fdeRT^^V`dReZ_`WeYVyHV%SfeR]d $R_{a} = a^{C} R_{d} R_$ VITVAUVI edgRXR_TVIf_df]Z_ValleYReyTVJVSdReZ_d

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`WeYVHV%JR_]VRUe`Sja]RIZ_XT_ec`]d`_ aRceZIZaReZ_ŽE`URJŁeYVTV/VScReZ_`WeYVyHV‰ YRddyZANUehRud^VUZRWAGZAZOŻEYV_RaZ_ XReYVcdRc`f_UeYVeV/VgZZZ_dveZEYVV^S/V ReZT ac`XoR^ ^ VZdeYVEVJVe²_ 1EVJVeY _/ŁhYZIY XV_VcR]]j RIYZvgVdV_`c^`fdcRoZ_Xd1Z_#!!!Ł $dR \ Z \ X eV \ R \ V C \ R \ TYR \ V \ EV \ Z \ X$ dVTeZ_RTYZEVU&Ž aVCTV eRXVa`Z edŽDZ ZRC W_TeZ_dRcVaVcVvc^ VUSj da`cedVgV_eddfTYRd eYV}iefcVd`WeYV_ReZ_R]W eSR] eVR^ŽEYVdV ^ VLIRdaVTeRT]VdYZ_eReeYVTYR_XVZ_ec`Uf TVUSj eV/VgZZ_Ž=ZVeYVecRUZZ_R] WdeZgZZdLZe Vi Rjed R_ViedRdLZ_RcjViaV2Z_TV`W_ReZ_Rjf_ZejŽ3fe eV/VéZZ_ZIRS/Ve`^f]eZa]j dZX_ZTR_eVéV_edR_U dacVRUeYVV``eZ_R]ViaV2Z/TV`_R^RdddIR]VŽ

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4`f]UeVJVgZZ_SVR_VhafS]ZTRV_ROEYVeVZ1 VgZ.V_TVeYReZeYRdSVT ^ VeYZIWcT _eV a`dRg $dTZ_{ij}Z_5 VdZ_e_eac gZVR^WaZ_Xa]RIVeYReZi$ `aV_hZeY`fecVdecZfeZ_e`R]|TZeZkV_dD2_UZeRd dW de`SVYJaZXe`SfZURT^^`_`fe]``\Ž $:d\mathbb{Z}_{2} \otimes U^{T}\mathbb{Z}_{R} \otimes U^{T} \otimes$

hYZY Vývj`_VaRceZZaRevde`d^VUVXcWO:eZd _`h e` eYV dTcW_Ł Raa RcV_ejjŁeYRe R] TZeZkV_d efc_e`]VRc_RS`feZdfVd`VVT^^`_Z_eVeXdeŽ:e Tf]USVdZUeYReeVVgZZ_ZITeVReZXRWcf^ WE TZZKY_ UNSREVE ^ VUZREVU Sj eYVZ' RXVd` VEYV eVJVgZZ__VhdŽ3fehYReyT^^`_h`dU%aZXYe

ZeSVfdYVZ_XZ_O:_ 4 YZYŁRdZ_`eYVcTf_ezXdŁ ZeZdckR/ZkU eYRee/VgZZ_ZdYVjaZ_Xe`T_defTe eYZIT^^`_`fej``\SjdkeZ_XeYVafS]ZTRW_URL eYVXR^Vh`c\hZeYZ_hYZYaVa]VVC^f]ReVeYVZc a`]ZZIR] UVIZZ_dR_U[fUXV^V_ediyacZ_Z%&R_U eYVRee2SfeZ_`VKXda`_dSZZej VcZdfVd`VXV_ł VCR]Z_eVCVdaYyXR^Z_X%ZEYVCXff]eZ_XUj_R^ZdŁ Y hVgVLRcV_`ef_UVde``UŽ

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EV/V&ZZ_ZLeR_dNC^Z_XeYVafS]ZTdaRIVŽ:_ 4 YZ/VLeYZLZLR dEREV^V_e`VeYV`SgZfdLZ_d VAC RdZecWWdde` ^ RdIRITVddSj 4 YZ/VR_dŽ2]^`deR] fcSR_Y`^VdYRgVReV/V&ZZ_R_UReJVAdeVZXYe`fe `WgVcj "! 4 YZ/VR_ddhZEIYZe`_VRIYURJŽ

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^`f]Ud`aZZ_dRS`fe_ReZ_R]RWWOdZ_aRezTf]Rc Wrc^`dVeYR__VhdaRaVd`ceYVdUZ_UŽHYV aVa]Vda]RIV`WCVdUV_TVZdT_dZMCVULeYV dEfRZ_ZddZXYejjUZWWCV_eŽHYZV)#´`V&Y`dV dfcgVjVUZ_DR_eZRX_ffc_e`eYVeVJVgZdZ_L`_]j ''´´`V&Y`dV[ZeZXZ_eYVdXZ_dUŽ

EYZlafS|ZTdaRIVTf|UL`WTfcdLSV_`^`CV eYR R RCTYZAVIRX `WafS|ZTOŽ: WATELev/VezZZ ac`XdR^ ^ Z_X eV_Ud e` SV YZXY]j dXX^ V_eVUL $hZey ac XeR^ \wedge VdWIf dZ X \ daVIZ TRFUZ/TVd$ 1° c_Z_Xd elso a cedd elso ZZ9 h verter Zd dkX^V_eReZ_`WeYVyafS]ZI%daYVEVZ_e`aRceZIf]Rc yaf SZTC%ZTT f_eVCVU Sj_eYVTV ecRZej `W VhoŽ $EYZITV_{ecR}Z_{ij}ZIR_{ij}eVV^{\circ}VZ_{i}a^{\circ}eR_{e}Z_{i}eVR_{ij}$ TZERKY_d Z_UZXWKZY_TV e` a`]ZEZId YRd cVUF TVU eYV ReeV_eZ_aRZU e`eYZdSjeVVgZZZ_ac`XcR^^VdŽ Ac`XR^^ZXZdeV_UZ Xe`dYZ&RhR, W/^ a`]ZZTd $e^{hRt}dYf^{R}$ Z $e^{kt}de^{it} dZdtW^{I}$ Z e^{kt} ReZ R RWWRZde`U^VdeZT`_VdR_UWV^XV_VdR]ZdfVde` daVIZT`_VZZeeYVdR^VeZ_VLY`hVgVLeYVIV edR a RIV` WVhdZdSVZ XcVRWc^ VLŽ4`_dZVcZ XeYV VgV/`Var`ZZZR UZRWWTeZ ŁZe WUde`SVdecVddWU eYRe_VhdR_UUTf^V_eRgi ac`XR^^VURCVeYV Why fozevid West ~ WestV4YZWR_dZ_evlogZhWUSj F? 5 AŽ? Vhdac`XAR^ ^ VdeV_Ue` SVacWWccVU Sj ^ V_Ł` [U\c aV a [VŁeYV]` h \c VT_` ^ ZT ded \t $ef^{A} R_U eY dV ZZ XZ TZEZ d`f edz V DR_eZEX Ž$ $5 Tf^V_eRg$ ac XR^{^ V}L[^] VL[^] VR_hYZVLRV[^]CV e`eYVeRdeV`Wa`^V_ŁRUf]edZ_eYV^VUZf^}YZXY decRef^ŁR_UaVa]V]ZęZ_XZ_DR_eARXŽ

EYVacWWV_TVTJRZ VUZIS`c_V`feSj T_ł d^ aeZ_ŽZTT dZ_Xe eYV"*** 4? EG_ReZ_R d`cgVjL*) ~``VaVa]VdJ eYV hRETY_VhdSf]i]VEZ_d`WhY^'& TJRZ e hRETY eVV W'^ SVZ_Z_Xe`V_UŽ2TefR] T_d^ aeZ_ d^ hd R dZ ZRc eV_UV_TJLRd^ VRF dVUSj eYV ReVRXW Y`fdW^ JU dRZ_XŽ:_ eYV TRV`WDR_eZX LeYZI c`dVW'^ * a`Z_edZ_"**%e`"! a`Z_edZ_#!!!Ž :_`eYVc h`dtLUF cZ_X #!!! R_ReVRXV`W") eY`fdR_UY`fdY' JUd`c %(# eY`fdR_UaVa]VZ_ DR_eZX hRETYU eYV_VhdVgVj_ZX eŽYV]VgV] `WT_d^ aeZ_ZdZ'ZRCRTc`dtR] d`TZIVT_`^ZT Xc`fadŽ

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e`UZEIF dd_VhdR_UUTF^V_eRg`ac`XR^^V&ZZ TR_SVdZUeYReeAJV&ZZ_XV_VREVdRafS]ZTdaRIV e`hYZIYR] efc_e`Z_V&c^eVv^dAJgvdRS`fedfSl [VTed`VXV_VR]Z_e&&&ZEYVZ_V&c^ReZ_eYReZd ^ZtHZ_XLeY`fXYLZIhYRedfS[VTed RVUN]ehZeY R_UY`heYy`RVa&dV_eVLŽDefUZd`VW&WhTJfV&L RJeY`fXYd^VRVac&gZAUSjeYV]Zde`V&YV"! dfS[VTedeYRecXTVZgVUeYVX&ReV&e_VhdTgvdRXVZ_ #!!!ŽEVJV&ZZ_XgVR]ZeJV^`dVeZ`Ve`yXV_VR] Z_e&&d&GS[VTedh#'´´/eYR_e`da`cedR_U`eYVc daVTeRecXVgVedh##´´/Ž

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dkgvor] RohvTæŽDV_dreZ_RJZh ŁTV_ecrJZh Ła`]ZEZ TR] SZRdR_U dvJVvTV_d cchZa Rcv TZEvU RdevV^`de _VvRezevVvR1ved`Vv4 YZvR_evJvzeZZ_Ž

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> ¶g¶jzg¶²¶- ga^äääää</sup>L¶äø¶iä Ýzäæzä²a₂Úźzałź"i®UóÆä ää" Ý 🛙 Å äännen kuunnen JzÝännen kuunnen ¶äännen kuun kuun kuun 🦉 🔊 ääfií ännnnnnnnn annnn ''ännnnnnn â ännnnnnnn þännnnnnn þ ääfi è äinnin muunin 1/2 äinnin mute â äinnin muuni /ainnin muuni /ainnin muuni /⊅þ ääe¶æ**ënnunnunnunnunnun**™ää**nnunnu**ۏ ä**nnunnun**b ä**nnunnun**b

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Z_X^`cVR_U^`cVT_eRTedhZeY`eY\caVa]VLRe \g\cUZ`Z_ZHZ_XT deŽH Y\c\RdZ_]Re\"**&eY\c\ h\c\RS`fe#! ^Z]Z_:_e\c_\efd\cdeY\c\Rt_`h d ^ V&! ^ Z]Z_ Rc`f_UeYVh`d]UŽ4 YZVYRd_`e SW_]W&/SWZ_U+Z_ ;f_V"**&eYV&/hV&'"\$# dZevdhZeY eYVŽ7U ^ RZ_, Sj ;f_V#!!" eYV&/hV& ' (1#\$)ŽEYV42D6? #!!! d`cgyj V&Z ReVUeYRe $(\breve{Z}^{\sim} W_{4} Y_{Z} W_{E} Y f dY^{\circ}]UdYRUR_: _ekc_ VeT_{} _{}$ _VIZ_ $Z_{2}^{}URIT dZ_{Xe} eVVF? 5 A #! ! " df cgYL " <math>(\breve{Z}^{\sim} W_{4} Y_{Z} W_{E} df dV eVVH VS cWf Rc_{} JZ$

-BH9FB9H-B+++5H+J9G:CF7++₽9BG

H YfY 'gU Uf[YVi hbchYUg'mei UbhļÚVY bi a VYf cZ=bhYfbYhghYgUbX 'b]hJUhj Ygk \cgY U]a 'g'rc dfc! a chY K YV UVWW ggZcf U```UbX YbUV Y cd]b]cbgUbX' bZcfa Uhcb cZ]bhYfYghc WhhYbghc VY Yl WUb[YX'' H YgY 'b]hJUhj YgUfY \Uj |b[Ub i bYj Yb 'a dUWi'C bY' d]cbYYfb[YZcfhigh YA]b]gfmcZ9Xi WUhcb '9b UW'g' @b_gQdfc[fUa a Yžk \cgY Ua V]hci gd Ub \Ugg W WYYXYX 'b WcbbYWhb[i d'- \$i cZh Y GUHY!g Vg! X]hYX'gWcc 'dcdi Uhcbž]bWi X]b[gWcc g]b fYa chY' fi fU``UfYUg''8 Ygd]hY U``'h YgY YZcfhgž \ck Yj Yfzh Y' Î X][]HU`'[UdI']b '7 \]Y'ggh``j Yfmk [XY''

6miUbX `Uf[Yž Wj]W=bHYfbYh]b]hJUhj Yg UfY a cfY `LYmhc dfcj]XY U Vi `Yh]b Vc UfX `gYfj]WY h\Ub` cddcfhi b]hYg Zcf]bHYfUWhcb cf gYfj]WY dfcj]gcb'' BcbYh\YYggžh\YfY \Ug VYYb a Ucf dfc[fYgg]b ZU! W]HUh]b[`HUg_gg W UgHUI dUma Ybhžgc WJU``\ci gb[` Udd `JWUhcbg UbX Wcbg a Yf Wca d U]bhg'' H\Y`k Um h\Y =bHYfbYhWUb VY i gYX `]b dfUWhWY hc `[YbYfUHY` WJ] [W]b_gUbX YI WUb[Yga UmVY]`i ghUhYX Vmik c ` Yl Ua d Yg'

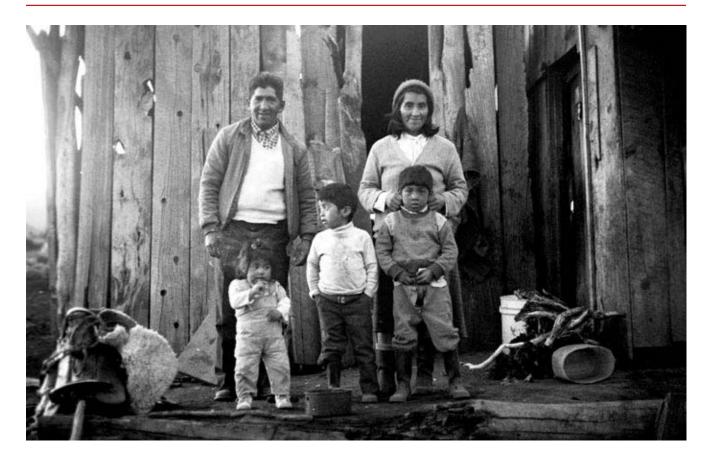
H Y Úgh WUgY 'g'h Uhc Z>i Ub Df fYnž h Y ÚWhci g' bUa Y i gYX 'Umh Y k f]hYf c ZUb 'Y!a U] 'gYbhci hhc fYei Ygh]bZc fa Uhc b Zc a 'X]ZYfYbh di V `]W UbX df]j UhY!gYWc f c f[Ub]nUhc bg' C Zh Y &+ 'W bhUWgź cbmÚ Y Ubgk YfYX fY Yj Ubhnž dfc a dhmUbX Z `m' GYj YbhYYb c Zh Ya 'Y]h Yf \UX bc hUbgk YfYX UZH'f U 'Zc ffb][\hž cf h Y UXXfYggYg di V `]g\YX 'Zc f h Ya ' cb `]bY 'k YfY'k fcb["'H Y fYa U]bXYf Ubgk YfYX 'UZH'f U 'cb['XY Unž cf X]X bch []j Y Wc a d YhY fYd `]Yg'' H YfY'k YfY bc 'g][b]ÚWUbh X]ZYfYbWg Ua cb['h Y' j Uf]ci g mdYg c Z cf[Ub]nUhc b Wc bg 'hYX 'ftli V `]W gYWc fzdf]j UhY!gYWc fzB; C E]b 'hYfa g c Zh Y ei U`]mi c Zh Y]f 'Ubgk Yfg'' =b 'UXX]hc bz >i Ub Df fYn k fch' hc ' h Y Y Y a U] UXXfYggYg c Z h Y Wc i bhmỹ %&S dUf]U! a YbhJfmXYdi hYg C b mb]bY fYd]YXžk]h gl fYd]Yg Uff]j [b[`k]h [b U Z/k XUngž lk c U a c bh "UhYf UbX" c bY UZhYf h fYY a c bh g 5 [U]bžh YfY k YfY bc X]ZYf! YbWYgUa c b[`dc]hWU dUfh]YgUgfY[UfXgh Y e i U]mi c ZfYgd c bgY"

H\]ghkc!dfcb[YXhYghg\ckgh\Uhh\Y`UW_cZ]bhYf! UWMpcbilg Xi Yibchhc Ubmik YU_bYgg bh YhYW bc! `c[]WU``VUgYžVi hhc 'h\Y`a YUb]b['UHUW\YX`hc ']h"5 ' gYWcbX`YlUad`Y`]g`\Y`dZ``\YfY"`H\Y`7cfdcfUWJCb` 9bW Yblfc 'XY DY< U`c`fb m@U FY]bUž]b h\Y YUghYfb ' giVifVgcZCUbhJU[cž]gUbcf[Ub]nUhJcbcZWcaaib]mi YUXYfgUbX UggcWUhYX dfcZyggcbU gh\UhgYY_ghc dfca chYWca a i b]miXYj Y`cda YbhUbXYbWci fU[Y` gYZ\Y`d`]b]hJUhjjYg''K]h\`h\Y`Ugg]gHUbWY`cZdf]jUhY! gYWrcf VigbYggYgž hk c Wcaaib]hm hY YWYbhfYg k YfY gYhi d`gc`h\Uha JWfcYbhYfdf]gYgžh\Y`YXi WU! hcbU`Wcaaib]mUbX`gcWJU``kcf_YfgWciX`UWWYgg]bZcfaUhcbcbhYKYV"HY]b]hJU`[fcidkUggccb ℃]bYXVmZJa]]YgUbXh\YbVmmcib[dYcdY"6YZcfY `cb[ža UbmcZh\cgY`k \c `cf][]bU``mk YbhU`cb[`Ug` gdYWUhcfgfYjYUYX]bhYfYgggUbX'g_]``gh\UhfYg' hYX`]bhYfVYWca]b[]bgfi WcfghcbYk i gYfgUbX [U]b! b[h\YgHUhigcZYUXYfgžgci[\hcihUbXfYgdYWYX Vmih\Y[™]Wcaaib]hm"

HY 9`9bW Yblfc HY YWbHY \UgZ ghYfYX bYk ``[b_g' bchcb mcb h\YK YV Vi hU`gc žUbX a cghdUfh]W Ufmž]b h\Y`c WU``i gYf Wca a i b]m"H [gg\ck gh\Uhh\Y'dc! hYbh]U``cZh\Y`=bHYfbYh[gU`gc 'h]YX`]b k]h 'h\Y mdY cZ gc W[U``fY`Uhcbg\]dg h\Uh[i [XY`][g i gY"`=b 'h\g WUgYž]h\Ug VYYb 'gYYb 'h\UhUWWYgg hc 'h\Y`K YV`]gbc hUb' Ui hca UhWdfc Wyggž Vi h]bj c j Yg'h\Y`Uddfcdf]Uhcb' cZU`fUb[Y`cZg_]``gUbX`Ub[i U[Yg' HY UWéi [g]hcb cZh YgY [gVYgYhVmYl dYWUhcbgź X]ZĹW 'hYg UbX']bgYW f]hYg': cf'h Y gUa Y fYUgcbž]h [g U' [ccX'WébhYl hZ f'h Y XYj Y cda Ybh cZgcW]U`` WUd]hU``]b Wéa a i b]hYg''=hWUb 'h i g VY WébWi XYX' h Uh =bhYfbYh UWWgg [g U'a UhhYf 'bch 'f gh cZX][]hU`` WébbYWhcbg Vi h cZgcW]U``WébbYWhcbg h cc'' H Y' X][]hU``]bZUgffi Wh fY [g bchYbci [\ 'hc WYUhY'gcW]U`` bYłk cf_g UbX W] [W]bhYfWéi fgY''8][]hU``cf 'bchžWéa ! a i b]WUhcb [gg]h``U'gcW]U` d\Ybca Ybcb'flbhYf![fcid'fY`Uhcbg:h\UhXYdYbXg' cb'hmdYg'cZ`Ub[iU[YžYldYWUhcbg'UbX'Weaai! b]WUhcb'ghmYgzZcfag'cZgY[aYbhUhcb'UbX'aih'U' fYWe[b]hcbz'UbX'h\Y'YlYfWgY'cZdckYf''7\]Y'\Ug U'[ccX'X][]HU``]bZUgffiWifYzU'h\ci[\`acfY']g'g]`` bYYXYX''6ihk\UhlgfYU`m'UW_]b['gh]``UfY'h\Y'gcWU`` UffUb[YaYbg'UbX'aYbHJ``achj'Uhcbg'bYYXYX'Zcf']bX]j [XiU``YldYf]YbWYghc'VY'U[[fY[UhYX'UbX'X]g gYa]bUhYX''

$7 < 5 \text{ DH9F}^{\cdot *}$

9H B=7 8=J9FG+M5B8 H 9B9K 7I@HF5@7<5@99B; ! 9G = 3.7 < = 69



H + 9 = A DC F + 5 B 7 9 C : 'H + 9 = B 8 = 9B C I G D 9 C D @ 9 G = B 'H + 9 . 7<=@95B⁻=A5; =B5FM

=b 'h Y Wc ``YWhj Y]a U[]bUfmic Z7 \]`YUbgži h\Y]bX][YbcigdYcd`YgUfYgYYbUgdUfhcZ h\Y`Wi`hifU``ibXYfd]bb]b[`cZbUh]cb\ccXž R_UeVy_RoV_`ecVARdUVURdR_Z`aVUZ`V_ee` eYVT f_eqj dU/gy]`a^ V_eŽ@_eYVT_ecRqiLeYVZc T]RZ dRCV gZhVU a` dEZgV]j R_U UZETCZ Z_ReZ_ RXRZ_deeVV Zl`aa`dVUŽ2 d`cgVj TRccZVU`feSj R acZAREV`cXR_ZAREZ_Z_8cVREVCDR_eZRX ac`gZVd ZWC^ ReZ_e T_}c^ eYZZŽ_eYYZZAh WS ~ W f T_ VIEWUHZEY eYV> Raf TYVaV a]VREVSWZ U DR_eARX_cVarLV_edLeYVVWW.e`VeYV> Raf TYVde` yhZ_SRI\eYVZc]R_UdR_URIYZgVd ^ VRfe`_`^j

eY dV ZZ XZ eYV IRazer eYZ \ eYReeYV> Raf TYVd RVUZEZ ZRVURAZ deSj 4 YZVR_dR_U(*~U _`eeYZ_\eYY_h`f]Uegie`UZdfRU/Rd_žLRfX/eVc $W^{\wedge} \sim Reg Z XRj T_X Raf TYVZWYV hZMVUe$ 1Af S|Z= Vec Ł#! ! " /Ž

:eZdZ_eVcVdeZ_Xe`_`eVeYVSVJZWVW(!‴``W cVda`_UV_edZ_eYZd`aZ_Z_dfcgVj_eYReyZ_eVcVded eVVgZ]V_TVZ = R2dRTR_RLeVV> Raf TVVVRcd]R_UNYŽJ VéReeYV dR VeZ VL' S″ dR e/ReZVEVV $W^{\circ} eYV4 Y_{Z}VR_D Rev ZU[f de Za VR_h Y_{Z}VL))^{"} W hVeV > Raf TYV eVy yh f]U SV Re eVV SR ZIRUA$

} XY6Z_XWCeYVZc2XYetYZo2XYetYZo2XYetYZo2XYetYZo2XYetYZo2XYetYZo2XYetYZo2XYetYZo2 eYZ_\eYV> RafTYVdd^f]UYRgVd^VVVXCW^W Rfe`_`^j hZeYZ_eYV4YZVR_DeRevLVieV_UZ_Xe VUFTReZ_L[fdeZTVR_U`eYVCRVRŽ

EYVF? 5 A #! ! "? ReZ_R] Df cgyj clýgkRjdgkij dZ_Z; TR_eeV_UV_TZkilh YZTY df aa`ceeYVZJNReYRe 4 YZJNR_d TZkij RaacVIZBeVdeYVZ a`ceR_TV`VZ_ł UZAV `f dTF jef ckiZERS]V#(Z]f decRevdeYZŽ

AV a]VRV dX_Z TR_ej ^ VVUth_ e eVVVd VZ_ Tf]ef d?] VVZERXVZ_ eYV> Vec a]ZR_ CVZ_ 1S' ~ Ver dVZ_eVcgZhW/R_UZ_ eYVCVZ_ ` W GR]aRCRol 1S# /ŽEYV} Xf ddWceYVCVZ_ ` W 2df TR_3RLZ_eCVdZ_XjL^ RETY eYV_RZ_R] Rgvd RXŽEYVCVZ_ ` W1 ` bf Z' S` ZleVV _ VerRe^ ` de ZV_eZ Vdh ZY eYVZ_UZX_ ` f dTf]ef dd1)) ~ /Ž

> VR_hYZNLAYZNR_dU _`eSV/Z&V?ReeYVUZN WEV_TVZ_U&Y`a^V_e]V&YSV&hW_eYVZ:Tf_egi R_UZed_VZXYS`fcdZlUfVe`ZedYRgZ_XWhVcZ_UZX @/.łäá

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táðæ
Đã äÝā² z ¢ c
d¶ĩÚÝā] z gOi Ýz äæz ÚzāOúzā‰ö z Úã
 ${}^{e}q$ ¢ z² ¶ĩ Ýā
Áz ¶Å@žØz² đơi z ÝÈ

ää "Úz äinnin muunin muu

>¶ï ÚgznäB1Ł; äl Oxo¶²O&≥ï Údzonai þþ½Ê

 $\begin{array}{l} V_{f} daV a] VZE YVXCVReSf] \ \ WaZZ_UZRXCVd \\ hZey deRev^V_e d] ZVeYV^_Va^dUZ_eS] V \#) \\ \end{array}$

H + 9 - B 8 = 9B C I G DC DI @5 H ⊂ B - B 7 < - @9

$$\begin{split} & EYV"**\# A`af]ReZ_ 4V_df dVdrS]ZhVU eYRe \\ & eYV&Vh V&VR]^ `deR^ Z]Z_ aV a]Vi**) ES) & RXUU `gVc"%Z_ 4YZV hY` UVI]ReVU eYV^ dv]gVde` SV \\ ^ V SVdo` Wc T]`dVe` R_ Z_UZXV_`fdXcf aZ_XL \\ & If]ef cV` caV a]VZ@V&VdvL*#) E' !ZVV_eZ_VUhZY \\ & eYV> Raf TYV aV a]V d eYReLT f_eZ_XTYZUV_L \\ & d^ V "E#) #L" " aV a]V cV]ReVU `c SV]`_XUU e` \\ & eYRe VeY_ZTXcf aZ`_ e` eR]L*Z`` `VeYVT f_eg`d \\ & a`af]ReZ_ deReVU eYRe eYY_SV]`_XUU e` d^ V \\ & Z_UZXV_`fdaV a]VZ$$

2 [Relcdef U dr'hWelthe eVkVhVV#S%48%]aV a]V] $Z_Z Z Z UZ_V^f d> RafTYVT^{f_Z}$ eZdZ eVd feY`W4YZ/ZEYZIZ_`eR]`h} Xf ckL T_dZ_WZ_XetReeYkVT^^f_ZZd\VaRZeVeVZC Tf]efckL]R_XFRALcVZZ_ R_UecRUZZ_R]hB d`W]ZWZEYVJ^R_Vfa & SL&!) d`cR] Y`f dY']Ud Z Y^`X_V f d> RafTYVT^^f_ZZdhYkVetV Z UZ_V^f dTf]efcVZdclac`UTVUUR Sj URZ

 $3VaUVdeYV > RafTYVdLhY Wc^{V} eYV]RcXVde$ $<math>Z_UZAV_{fd}XcfaZ_4YZAVLeYVCVRCVeYV2j^RcR$ $Z_eYVARc_`ceY`WeYVTf_ecjL^`de`VAY^]ZeV$ $Z_2cZIRR_U:bfZbfVSfehY RdZ_YRSZES`eYeVV$ $RjeZa]R_`R_U eYV dReZ_Vd eYV 2 dRIR`VD`dLhY`$ $]ZeVZ_eVV`RcMd`VeYV 2 dRIR`R dRe~RcdZ_eYV$ $CVZZ_`V2_e`WARCHER R_Ud`R]]Xcfad`VBfVI$ $TYFRR_U4`jRZ:_eYVARcdfeYLeYVCVRCVXcfad$ $`WcRhRcMARcR UJR`R RLUXIV UVUW'^ eYV$ `cZXZ_R] Z_YRSZER_ed`WeYVT_eZ_V_eddfeYvc_ ViecV^ZejŽ:_ eYVARIZ;TeYvcVZd6RebVc:dR_U hZeyRa`af]ReZ_`VNS`feeYcWeV`fcR_UaVa]V

F95 GC9FH€ B 5 B 8 F97 C; B + 1€ B C: 9H & B = 7; FC I DG 5 G DFC 8I 7 9FG C: 7I @H F9

EYV]RV"*)!ddh eYVSVZ_ZX`VRXV_VR ^`gV`V_e e` c\Rdb\ce eYV \eY_ZT a\cd_R]Zg``W 4YZ\Vd Z_UZ&V_`f d aV a]\vZEYc f XY R hY`]V gRzXg``W'cXR_ZREZ_dLR] \eY_ZT Xc`f ad SVXR_ e` R]\ceeYVT f_eq`e` eYV_WUe` cVT X_ZX\eY\Zc V/ZeV_TVLRTI\aeeYVZcTf]ef cR] TYRRIR\cZEZTdR_U h`c\ e` hRddR_RTT ^ `UREZ_SRdW`_ eYV T_ded TEZ_`VR^f]eZff]ef cR] d TZkġZEYV&VhRd RTYR_XVZ_eYV`cZ_dReZ_`VWeY_ZTT]RZ`dT_ł dZeV_ehZeY hYRe`YRdYRaaV_WUZ_ ^ R_j aRced`W eYVh`cJUR_UZ_=REZ_2^ VCZRŽ_UZ&V_`f daV a]V RV_`h U/`R_UZ_X_`e[f cbT_cc`]`gVceYVZcdi d f cTV4d TYRd]R_USf eR]d eYVcZXYee`T V/ZeZ_ d TZkġ`_eVXc`h_Tf]ef cR] eKc^dZYCZWEf dR _Vh TYR]V_XV=eYVTYR]V_XV`VUZe\cdEjZ

EYV_Vh RTT^^`UReZ_SVehW_4YZVR_ d`TZAġ R_UeYVZ_UZAV_`fdaVa]VdhRdafee`eYV eVdeZ_eYVVRdj "**!dLhYV_eYV6iVIfeZeVdV_e 4`_XXddRdve`WJVAR]cWXc^deYReh`f]UYReV YRURa`dEEgVWWMTe`_ZeVdVeY_ZfcVJReZ_dZ_ 4YZJVŽEYV`S[VTe`WeYVT_dEEfeZ_R]cWXc^hRd e`XQEVcVTX_ZEZ_LReeYVYZXVde]VAR]VgeVLe` ^f]eZVeY_ZTZġ R_UZ_UZAV_`fdaVa]Vd cZXYee` $\begin{aligned} & \operatorname{chc} U \operatorname{TVeV} X_{z} \operatorname{TI} e \operatorname{cVR} U^{A} \operatorname{R} \operatorname{RVeV} X_{z} \operatorname{cdd} f \operatorname{cTVd} \\ & \operatorname{R} U \left| Z W d \operatorname{deV} d \check{z} \operatorname{YZ} R^{A} \vee U^{A} \vee \operatorname{e} \operatorname{Rdc} \left| \operatorname{VIeV} U \right| \right. \\ & 4 \\ & - X \operatorname{VdI} \operatorname{R} U \operatorname{e} \operatorname{YZ} R^{A} \vee U^{A} \vee \operatorname{e} \operatorname{Rdc} \left| \operatorname{VIeV} U \right| \right. \\ & 4 \\ & - X \operatorname{VdI} \operatorname{R} U \operatorname{e} \operatorname{YZ} R^{A} \vee U^{A} \vee \operatorname{e} \operatorname{Rdc} \left[\operatorname{VIeV} U \right] \right. \\ & 4 \\ & - X \operatorname{VdI} \operatorname{R} U \operatorname{e} \operatorname{YZ} R^{A} \vee \operatorname{R} \mathcal{I} = \operatorname{Rdc} \operatorname{V} \operatorname{R} \operatorname{Rdc} \left[\operatorname{VIeV} U \right] \right. \\ & 4 \\ & - X \operatorname{VdI} \operatorname{R} U \operatorname{e} \operatorname{Y} \mathcal{I} \times \operatorname{R} \mathcal{I} = \operatorname{R} \operatorname{R} \operatorname{R} \mathcal{I} = \operatorname{R} \operatorname{R} \operatorname{R} \mathcal{I} \\ & 4 \\ & - 2 \\ & -$

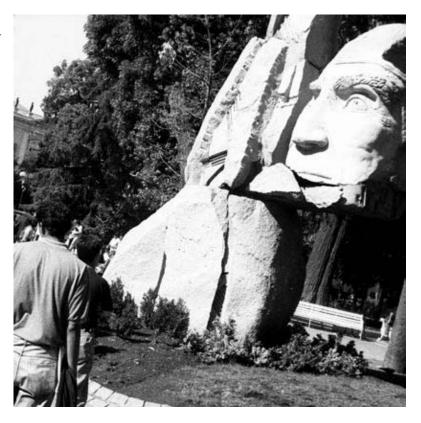
:_ "**SLY`h VgVL e^{V} :_UZV_`fd 2Te I=Y :_UXV_RNh RdaRdM ŽH YZV_`e V_ $e^{V}Z_XT_{d}Z$ $e^{Z}_R vT X_ZZ_{Le^{V}Z}U VdXR_e VR_{d}e^{T}de^{T}$ T ^ f_ZZVLac` $e^{V}Ee^{V}Z_R ULVEVESZY d de^{d}d^{T}$ Wc $e^{V}Z_V a_R dZ_{Lac}^{-} e^{V}Z_UZV_{T} d^{TF} e^{V}$ R_UTEVR $e^{V}R_Z de^{T}e^{Z_R}^{-} vTYR_Z^{+} VcUv_{d}^{T}a^{T}$ Z_Xaf S ZTa` Z_ $e^{V}Z dRVR^{T}Z_{e}^{-} fXY R_{E}^{-} e^{S}V$ R_ $UR_{R}^{-} Tv^{-} a de^{T}E^{T}V_{R}^{-} e^{S}V$ R_ $UR_{R}^{-} Tv^{-} a de^{T}E^{T}V_{R}^{-} d^{S}V$ R_ $UR_{R}^{-} TV^{-} a de^{T}E^{T}V_{R}^{-} d^{S}V$ R_ $UR_{R}^{-} eSW_V_{T}Xe^{-} d^{S}V_{R}^{-} d^{S}$

5 B9K 5; 9B85 : CFH 9 = B8 =; 9BCIGD9C D@9G

:_ eYVdaYV&V WUFTReZ_R_UTF] of cVLh YReeYV TYR]]V_XV `WUZgVdZj cVbfZVdLRTT dZ_X e` eYV T ^ ^ f_Zj]VRUVdT_df]eVU1F? 5 AL#!!!S/LZl Wc4YZVR_d TZZj e` UVgVj`a R_Vh RXV_URŽEYZl dY`f]U ac`gZUV Wc eh` ^ R[`c eeR_dWc^ ReZ_dL eYV } cde cV]ReZ_X e` XV_VCR] VUFTReZ_ R_U eYV dVT_U e` eYV VUFTReZ_ ac`gZUVU Z_ZUZV_`fd $T \wedge \uparrow f_ZZ UZ YVR X \uparrow V_eZ eYR X_V UT TR$ $eZ_Z 4 YZ VYR SW_Tf ef d? j Y ^ XV_ZZ ZZ$ $d&V ej a UVZ ej VUYV 4 YZ R_DER VYR SW_$ eR XYE h ZY ZE V VXR UV C YVZ ej V UZ ZZ f $R dL C VZ_d c d TZ X f a de YR YR V_ e a]B W$ $R YVX ^ ZT VR UK Z c |VZ_eYV_R Z_R DER Z$ $C VA VT R_U V_T f C X V Ve W UZ VC Z j h f]U$ c\bfZVR`V_U`V_e`WffccV_edefUjac`XA?`^\d R_U\UfTReZ_RJT_eV_eR_UR_f_U\cdeR_UZ_X`W ^f]eZff]efcRJZh`LS`eYZ_YZde`cjR_UZ_^R_j RobVTed`WeV\dTZV_T\dR_UYf^R_ZZXČŽ

 $2d c WR U de V V U TR Z_ ` V Z_U Z V_ ` f da V a] V L e Z I YR I YR U R e Y c f X I j Y ^ ` X / Z Z X TYR R I e A L e V R Z S V Z V R I T d Z X e e V T ^ f Z j] V U d d T _ d] e V R Z S V Z V R U D Z h R_Z Z X V e V d V a ` a f l] R Z _ d Z _ S ` e Y e Y _ ` a Y R_ U d f e Y ` W Y V T f _ e j L D R e V d Y `] Z X YR J S W_ f d U R I R_ Z d e f ^ V e V c T _ d e f T Z X T f] e d] j Y ^ ` X / V f d T Z Z X / d Z Z Z ` c V T / e j V R d L d ` R] a Z ` e d T Y ^ V d Y R y V S W_ T R c Z U ` f e h Z Y S Z Z X R] Z e d T Y ^ V d Y R y V S W_ T R c Z U ` f e h Z Y S Z Z X R] Z e d T Y ^ V d Y R y V S W_ T R c Z U ` f e h Z Y S Z Z X R] Z e d T Y ^ V d Y R y V S W_ T R c Z U ` f e h Z Y S Z Z X R] Z e d T Y ^ V d Y R y V X / U R] j R g Z P S] V R U e c Z X d Y `] d Z e Z e C I f] e d] Z d Z f e Z _ d h ` f] U S V R ` _ X e Y V e A d S V e T R J E e V T f _ e j ` d Y _ Z U Z k d j Z e Z e C I f] f d] Z d Z f e Z _ d h ` f] U S V R ` _ X e Y V e A d S V e T R J E e V T f _ e j ` d Y _ Z U Z k d j Z d Z f Z = 0 h ` f] U S V R ` _ X e Y V e A d S V e T R J E e V T f _ e j ` d Y _ Z U Z k d j Z e Z e C I f] f d] R U e d V T f _ e j ` d Y _ Z T U Z k d j Z d Z f Z = 0 h ` f] U S V R ` _ X e Y V e A d S V e T R J E e V E e V T f _ e j ` d Y _ Z T U Z k d j Z = 0 h ` f] U S V R ` _ X e Y V e A d S V e T R J E e C V T f _ e j ` d Y _ Z T U Z k d j Z = 0 h ` f] U S V R ` _ Z A C J Y ` J Z E Z E C I f] f d] Z e Z e C I f] f C] X e Y C = 0 K T f _ e j ` d Y _ Z T U Z k d j Z = 0 K Z Z M Z = 0 K Y _ T U E e Y T f _ e j ` d Y _ Z U Z k d j Z = 0 K Z Z M Z = 0 K Z Z M Z = 0 K Y _ Z T U Z k d Z Z = 0 K Z Z M Z = 0 K Y _ Z U Z K d Z Z M Z = 0 K Z Z M Z = 0 K Y _ Z T U Z K d Z Z M Z = 0 K$

2ddWRUUZ_UXV_`fda`JZZIRJ cZXYetLeYVZ_dZ efeZ_RJ djdeV^drfJUVdHSJZMT^aJVeVjj_Vh Wc^d`WaRceZIZARZ_R_UdAcXdV_dRZ_ŽEYVUZW WcV_eVeY_ZIXc`fadYRgVIZgZTR_Ua`JZZIRJ cZXYed Rd4YZWR_dLSfe_`eRdZ_UZXV_`fdaVaJVŽEYVCV ZIR dZJ f_cXd JgVUUVSReVZ_eYVTf_ecj RS`fe eYVUVdZRSZZcj`VXVTX_ZZ_XVEY_ZTUZgVcZcj Z eYV_`c^RzgVR_URU^Z_ZtecReZgVdecfTefcXd`V&YV Z dzEfeZ_RJa`JZZIRJ djdeV^ŽEYVZJMR`WICVRZ_X Ra`JZZIRJ V_eZcj eYReac`gZUXdZ_UZXV_`fdaVaJV hZeY cVacXdV_dRZ_YRd_`ejVeSW_cVT_TZWU hZeY eYVTf_ecj`dZ_eVXReVLLf_ZRcj_ecRUZZ_



 $\label{eq:constraint} \begin{array}{l} & \label{eq:constraint} &$

A C 89FB = N5 H€ BžDC J 9FHM5B8 B5HJ 97I @H F9G

> `cVa`dZZgVjLdc`_XReRIY^ V_e e` eRUZ eZ_R] TF]ef cVLe` eVZc ZV_eZZdLTf d`^ dR_U VgV_cZfR]dLZl_`eZ_T_dZeV_ehZYaRczTZaRZ_ Z^`UVc_LX]`SR]ZkUT^^f_ZRZ_tac`UFTZ_ $R_U eVIY_`]`Xj_deV^ dZ5 VgV]`a^ V_edZ_^R_j$ $Z_UZXV_`f dT^^f_ZZdLR]SVZeRdVJVTe^Z_`cZjL$ $YRgVUV^`_dcReVU eVZc RSZZj e` T^SZ_VS`eY$ $RdaVTed`Wd TZA]]ZW+Ra`h VcW]RdVceZ_`WEY_ZTI$ $Zj <math>R_UZeV_dZeVaRceZTZRZ_Z_YZXJj T^a]Vi$ ^`Ukc_ac`TVdHkZEYVTYR]]V_XV^W`Ukc_ZREZ_ ZleYkVLY`hVgVLWceYVdVT ^ ^ f_ZZdRdWceYV cVde`V&YVT f_eqŽ

A`gkġ ZIRTYRRTEkZEZT`WZ_UZ&_`fdT^ł ^f_ZZZELS`eYZ_TZZZER_UZ_eVVTf_egidZWZ 2]] eVVdTZR]R_UYVR]eYdEREZEZTddr`h eYReRcVRd hZEYRYZXYT_TV_eCEZ_`WZ_UZ&_`fdaVa]VRV h`cdVa]RTWUeYR_eYVTf_egiRtRhY`]\ZA`gkgi ZEUFVe`^R_jWRTe`cdŽ_eYV}cdea]RTVLRTTdZX

e`d^VLeVV]`dd`WJR_Ue`eVVDeReVZ_eVV]ReV _Z_VeW_eY_R_U_VRdj_ehV_eZeY_TV_efcZddTcVReVU eYVT_UZZ_dWca`gVcgi $Z_ZUZXV_{f}dT^{f} f_Z$ eXdtaReeZIf]Rcjj R^ `_X> Raf TYVdŽDVT _UjjłRaRee W/^ eVV]`dd`VJR_ULeYVdVT ^ ^ f_ZeZ/dYRgVdfW WAYU WY^ eYV UVXARLReZ_ `W_Ref dR] dVd f dTVdŽ EYZUJjŁZ_UZXV_`fdcfcR] a`gVcej ZdT__VTeVU hZey eyv Tozzel` Veer LZez_R RXozIf]ef cveezxx cvusj X SRZ $R_U^R R_V e^a V_Z X D^R R_V kcl.$ hYVéYVc> Raf TYV`c`eYVchZMLYRgVdW_cVJReZgV acZIVdUVIIZVWcR] eYVX`UdeYV ecRUZEZ_ł R]j ac`Uf TVLLdTYRdhYVRLa`eRe`VLgVXeRS]Vd $R_U \wedge W_{RZ}$ 7 f ceY]jL> Raf TYVT $\wedge \wedge f_ZZ$ dZ aRceZIf]RcYRgVSW_SV6ZXVUSjeYVZ_TcVRdVZ Welvelegi RTE 2526 Z eVVd feY`W4YZWLhZEYdv6Z fd T_d/bfV_T/d/V/ceY/ZcV_gZc_^ V_e`hZ_Xe` eYV UZERaa VRCR TV `Wh Revic d f cTV dLa Vc^ R V e d Z Uc`fXYeR_Ua``cWRC^Z_XT_UZEZ_dŽ

EYV^`deUZWIF]eTYR]V_XVWc4YZWR_dTZI VajŁeYV_ŁRe |VRde ZVZ_UZXV_`fd Zdf Vd ReVa|RIVU ReeYVWeWW_dLZde`f_UVcdeRUY`heYVeRd\`W `gVćT ^ Z_XUZERZ Z_RZ_ R_Ua`gVcgi cV/ReVde` eYRe `WICVReZ_X`aa`cef_ZeXdWccVacVdV_eReZ_ $R_UaRezZaRzZ_SjZ_UZXV_fdaVaVdR_UT^{1}$ ^ f_ZZZd`_RSRdZi`WZZ_Zj $R_UV_eZ_V^{-}V_eZ_E^{-}$ cWARdU eVVZ_UZ&V_`f dac`S]V^ Rd R_ ViTlf dgVjj a` ZZR`_VLZZRXYVLLZIe` ZVRZEZTR_URSI derRTeLXgV_eYVacVddZ_X_WUdVRIVUSj eY fdR_Ud `WaVa]VŽ2XRZŁe`dWeYVZ_UZAV_`fdbfVdbZ_ Rd ViT]f dZgVjj `_V`Wa`gVej cVUfTVd R T ^ a]Vi ZdfVe`[fde`_V`VZedgRzR_edLR_UeYfdU`Vd_`e ac`gZVRSRdZIVIc`gVcT^Z_XVZeYVca`gVcgiZedMW `ceYVd'S`dZ_ReZ_R_UUZTCZ`Z_ReZ_eYReRAWATe Z_UZ&V_`f daV a]VhZeYZ_4 YZ/VR_d TZkej ŽE YZdZd R f_} ZMVUUVSReVeYReeYVTf_ecj hZ]YReV è afœfVŽ



98I 75H€B 5B8 7 = J = 7 7I @H F9



7<=69 G<CI @8 F97C; B=10 =1G 57<=9J 9A 9B HG

2d} Xf cV"%dr hdz eVdaRV^Wf cUVIRUd eVV^UZR_f^SVc~VJVRddaV_eSj4YZJR_dZ eVVUFTRZ_d deV^^CVeYR_UfSJUŽEYZdZl `_V`WeYVWIE deVRe^R.V4YZJVRTf_egihZeY RYZXYJVJIE deVRe^R.V4YZJVRTf_egihZeY RYZXYJVJIE deVRe^R.V4YZJVRTf_egihZeY RYZXYJVJIE deVRe^R.V4YZJVRTf_egihZeY RYZXYJVJIE deVRe^R.V4YZJVRTf_egihZeY eVVe deJSfZeRVR`WIY`]acVZJZE deV afSJZIdVIE cVLFTRZ_SfUXJE`gVc dVIV_ejVRdz eVV 6_JRTVIJ=Z_dN_Vh`c\R_URU&Vc^Z_W VLFTRZ_cWC^LR^`_X^R_j`eVVc eYZ XŽ > VR_hYZJVLeYVCVZL`hXV_VRJRXCW^V_eZ_eVV S`eY eYVaf S]ZTR_UacZgReVdVTe`cddr`f]UUVg`eV eYVZ:SVdeVWWceZ

 $2 \ Via]ZZETF]ef cR] cVda`_dSZZEj YRdSW_UVgV]t$ $aZ_XdZ_TVeYV_Z VeW_eY TV_ef cj L^ R_ZWEWUZ$ $eYVacZ cZej XZgV_e VLF TREZ_ŽEYZIYRdSW_RhFj$ $VWZda]Fj Z_X_REZ_R] d [ZLRZEj LVda VIZR]]j hZEY eYV$ $-WUZdeZ3j Z_eVXREZ X4YZ/VRIR_REZ_LZE YRd$ Sc f XYeZ_TCVRZ_XdaZZEF R] R_U^ ReVZR] ac Xvdd e` ^ R_j Z6UF TREZ_ YRdSW_ R\Vj V/V V_eZ_ eYV T_ded TeZ_`VWREZ_R] ZV_eZej ZEYV`S[VIeZeV`W eYV DEREV Rd VLF TRE`c YRdSW_e` ac UF TVX`UL T_dTZ_eZ f dTZEXV_Z

7I @H F5@7<5B; 95B8 7<5@@9B; 9G:CF 98I 75HCB

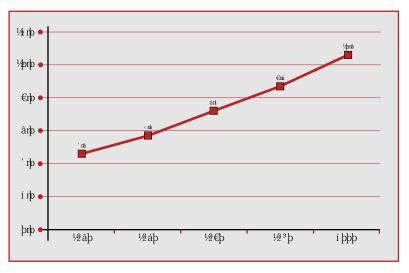
EYV4YZIVR_VLFTREZ_djdeV^YRdac`gZLVUeVV Tf_egihZeYRYf^R_SRCVeYReYRdac\aRcVUZeL `g\ceYV]RdeUVTRUVeLe`^VkeYV_VhTYR]V_X\d `WeYZITYR_XZ_XdTZkjZ

 $\label{eq:constraint} \begin{array}{l} 2eeYVdR^{V}VeZ^{V}VETZEXV_dYZa^{V}Xd^{V}R^{V} \\ T^{a}]Ve^{T_{e}}T_{def}TeLR_U_{h}TYR]V_Xd^{V}RgV\\ RZEV_{1}F?5AL\#!!!RZ$

2d} Xf cV" & dY h d de ZZ X_f ^ SVd` Vy`f_Xk aV a]VU _`ecVARUdIY`] Rda]R Z XR_Z a`d eR_ec`]VZ eYVeR_d`ZHZ_`WZZ J gAf VŽEYf d. RIT dZ X e` eYVF? 5 A #!!" d`cgYL]b`h Y` mci b[Yf'U[Y'[fci dg fl% ! &(`UbX`&) !' (HžU` `Uf[Ya U'cf]mdYfWY]j YgW.cc`UgUgci fWY` cZ_bck YX[Yi gYZ`Z fk cf_UbX bchUgU` gci fWY cZWJ]WJ U` Yg/Z `]UVcRVXc`fadh%&! &%R_U & R_U`gVc' eYVdEf RZ_ZleYVcVgVdZ

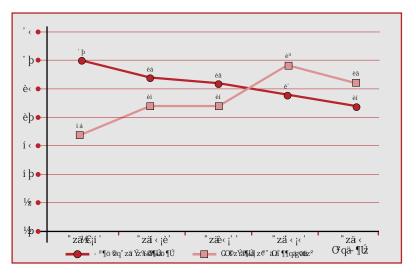
 $\begin{array}{l} 6Uf \end{tabular} Referred to the set of the set$

:_ 4 YZWLY h V&VLT TRZ_R] a` $[ZJ] R_UUVSRV$ YR&VSRUZIR] ji TV_eeVU`_ ac\aRZ_Xj`f_XaV a]V e` V_e\c eVh`dU`Wh`c\ R_U`aVReVZ_YZXJ ji T ^ a\&&ZVJ`SR] ^ Rc\\edZ2dhZ] SVdW_L_Vh a]R_ZXZISVXZ_ZXe`dr`h R_Rac\TZ&Z_`W eYV_WUVc\UTTRZ_e`eR_d`ZeRTF] ef d? Y\&Z eRXV`WeVVy_RZ_R] H V\@YReZISVZ_XV`aeZU`W ^ VR_ZXVc^ R_j 4 YZVR_dŽ S'%B=1 ä/₂ Ozq**C** äzzCŰÝä¶%aÁgco¶¶©¢" äO-¶²"ä¶õzÚ́i 'Ý



>¶ ï Úgznän, ÚźÅCUŹqä], øäB 1 Ł; mái þþ½É

S'%B=1 ä½ HoQæXæza-¶Ýæ-ŶÚæaæe®" æ¶ï ä¶æ¶ï æ¶%æ¶ï Úæe zææígo¶¶®æAzÚgz²æ7zÝÈ

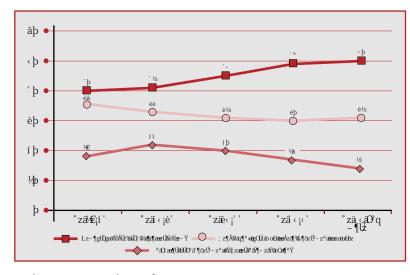


>¶ïÚgznäB1Ł; älOas¶²Oã≽ïÚozonaíþþ½Ê

H ≤ 9.7 = J = 7.5 H H ≤ 9G.5 B ≤ 69< 5 J = CIFC: MCIB; 7 < = @5BG

 $:eZIZ_eVCVdZ_Xe^{-}eVeYRLUVdaZeVeYVZ_a^{1}$ $[ZZIR] UZRWWEZ_Lj^{5}f_XaVa]VUZa]RJ R YZXY$ $UVCW^{-}WITZRJ aRceZIZRZ_ŽEYZUUVd_^{eR_V}VT_gV_eZ_RJa^{2}ZZIRJ^{cd}TZRJ WC^{d}X'hVgVeZ_^{eR_V}VT_gV_eZ_RJa^{2}ZZIRJ^{cd}TZRJ WC^{d}X'hVgVeZ_^{eR_V}VCh^{d}ZZZIRJ^{cd}TZRJ WC^{c}fXYa^{2}ZZIRJ$ $aRceZId^{c}cf_Z_d_VZXYS^{c}fCY^{-}UT^{-}ZeWdR_U$ $d^{-}ZZTT dZ_Xe^{eVC?}; d^{c}gV_{J}L&\#^{-}VVf_X$

S'%B=łä⁄a >ïÅŶĺÆMĮÆqz-¶gĺÓgæðÇÅzlégz²æð'zÝÈ



>¶ïÚgznáB1Ł; älOas¶²O@≥ïÚtzonái þþ½Ê

aV a]VaRceZIZAReVZ_ d $^ VWc^ ZEYV$]RXXdeac'ł a`ceZ_ 1") $^ / U$ d eYc'fXY da`cedT]fSdLhYZV [f de! Ž $^ /$ deReVeYReeYVjSV]^_Xe'Ra`]ZeZIR] aRcej R_U" Ž $^ /$ e Rf_Z_Ž

EYVEV $eV_UdTR_Rd SVdW_R^{^{}}_Xj^{^{}}_Xdc$ aV a]V1RXU "%`c VXYeY j VRc `WV/V V_eRcj dTY`]/ARTT dZ_Xe` eYVVZLV_TVac`gZUVUSj eVV cVTV_e def Uj `VVeYV:_eVc_RZ_RJ 2dd TZRZ_ VC eYV6gRif RZ_ `V6UFTRZ_RJ 2TYZkgV V_e1:62/L 4ZeKV_dZaR_UVUFTRZ_Z ehV_g1VZXeTf_e2ZeZ 4ZeZT_`h]VLXVR_UV_XXV V_eReRXVVfceWZ

E` ^ VRf dVeYVIZZT ^ ^ Ze^ V_e` WZXYeY j VRc $V_{e}R_{ij}$ dTY`] dtf UV_etRdAdt V_eth VdV RUV `WYVZZ_ekdvdeZ_a`]ZZTd_eYVZf dV WYV^ VUZe` [VRc_RS` f e VgV_etZ_eVVT f_etj R_UeYVZch Z]Z_Xi _vdde` Xké Zg`]gVUZ_UZWWCV_etj avd` Vd1 TZi]` c a`]ZZTR] RIZZ_ŽZTT d.Z_Xe` eYVdtf Uj L4 YZVR_\d } WY` f e` W#) T f_ecZdSj eYVUVXCW` VZ_ekdvde dY`h_Z_a`]ZZTdŽ5 V& ZVeYZLeYV]VgY]` WY_TVc_ Zd]` hLhZY [f de% ~` `W4 YZVR_df UV_edZ_eYV VZXYeY j VRc` VWJV^ V_eRcj dTY``] d3 Z_XeYY RV ZektvdzUZ_a`]ZZTdLhZY_` UZWWCV_TVSVeh W_ eYVXV_UVdŽ

 $\begin{array}{c} \mathsf{CVWrdLZ} X \, \mathrm{deVIZ} \, \mathsf{TZg} \, [gV \ VeZ \ a \ [\mathbb{ZZIR}] \ `c \ d \ \mathsf{TZR} \ \mathsf{RIFZZEXdL4} Y \, \mathsf{Z} \, \mathsf{Re} \ \mathrm{def} \, \mathsf{UV}_{ed} \, \mathsf{RV} \, \mathsf{RS} \ `gV \, \mathrm{eVV} \\ \mathbb{Z} \, \mathrm{ekc} \, \mathsf{ReZ} \, [R] \, \mathsf{RgVdX} \, \mathsf{LaReZIf} \, [Re] \ h \ \mathsf{VkV} \, \mathsf{TYRZg} \\ h \ `c \ ZIT \ TVc \ \mathsf{UZ} \, \mathsf{ZTT} \, \mathrm{dZ} \, \mathsf{Xe} \ \ \mathrm{eVV} \, \mathrm{def} \, \mathsf{U} \, \mathsf{LeVV} \\ \ `_] \ j \ ej \ \mathsf{aV} \ `WI \ gV \, \mathsf{eZ} \, \mathsf{RR} \ a \ \mathsf{ZEIR} \ a \ \mathsf{ReZIZRZ} \\ eYRe \ \mathsf{Rd} \, \mathsf{SdR} \ \mathsf{eZR} \ \mathsf{aXI} \ \mathsf{aXI} \, \mathsf{ReXV} \ \mathsf{Vdef} \, \mathsf{UV} \, \mathsf{ed} \, \mathsf{UV} \, \mathsf{ed} \, \mathsf{U} \, \mathsf{LeV} \\ \ `_] \ j \ ej \ \mathsf{aV} \ `WI \ gV \, \mathsf{eZ} \, \mathsf{RR} \ a \ \mathsf{CIV} \ \mathsf{edXV} \ \mathsf{Vdef} \, \mathsf{UV} \ \mathsf{edUW} \ Z \ \mathsf{H} \\ a \ \mathsf{cdR} \, \mathsf{eZdg} \ \mathsf{eZXZ} \ \mathsf{Vdef} \, \mathsf{cV} \ \mathsf{ReZ} \, [R] \, \mathsf{V} \, \mathsf{Vdef} \, \mathsf{UZ} \ \mathsf{cdUW} \ Z \ \mathsf{H} \\ a \ \mathsf{cdR} \, \mathsf{eZdg} \ \mathsf{eZXZ} \ \mathsf{Vdef} \, \mathsf{cV} \ \mathsf{ReZ} \, [R] \, \mathsf{V} \, \mathsf{Vdef} \, \mathsf{U} \, \mathsf{edUW} \ Z \ \mathsf{H} \\ a \ \mathsf{cdR} \, \mathsf{eZdg} \ \mathsf{eZXZ} \ \mathsf{Vdef} \, \mathsf{cV} \ \mathsf{ReZ} \, [R] \, \mathsf{V} \, \mathsf{Vdef} \, \mathsf{U} \, \mathsf{edUW} \ Z \ \mathsf{H} \\ a \ \mathsf{cdR} \, \mathsf{eZdg} \ \mathsf{eZXZ} \ \mathsf{Vdef} \, \mathsf{cV} \ \mathsf{ReZ} \, [R] \, \mathsf{V} \, \mathsf{Vdef} \, \mathsf{U} \, \mathsf{edUW} \ Z \ \mathsf{H} \\ a \ \mathsf{cdR} \, \mathsf{eZdg} \ \mathsf{eZZd} \ \mathsf{RZZ} \ \mathsf{Ndf} \, \mathsf{cV} \ \mathsf{ReZ} \, \mathsf{RS} \ \mathsf{J} \ \mathsf{L} \ \mathsf{CU} \ \mathsf{J} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{L} \ \mathsf{R} \ \mathsf{L} \ \mathsf{$

:eZIZ_ek&keZXe`_`&LeYRe`_R] Wfc `VeYVdTR\VdUVdZ_VUSj:62 e`RccZgVReR^`&V RTIfdreVRaacVTZreZ_`VeYVejaV`VTZgTV_XXXI ^V_edr`h_Sj_defUV_ed1T_gV_eZ_R] TZEXV_ł dYZaŁd`TZR] TZEXV_dYZaŁVIaVTeVUaRceZTZReZ_Z a`]ZEZTR] RT65ZZEXdLR_UT_}UV_TVZ_VLFTReZ_R] aRceZIZaReZ_/Łj`f_X4YZjVR_ddTcVRS`gVeYV Z_ekc_ReZ_R]RgVRXNŽ

4 YZNR_ df UV_edZ_ eYVVZXYeY j VRc`WJV V_dRg dTY``] U RTef R]j dVT X_ZAV eYRe SVZ_X R TZEXV_ Zg`]g\dd ^ VWc^ R] Rda VTed eYRe_WU e` SV`S} d\cg\UŽE Y\j R]d]RcXVj R\cdveYRe eYZIZ_g`]g\dR YZXY UVXCW`VW_XRXV^ V_ehZeY eYVT ^ ^ f_Zi R Ud TZkj 1dW> :? 65 F 41:62L#!!''/Ž

EYZIdef Uj Rjd dr`hdhYReRXWReZ aRTeeVV ^WZRYRgV`_j`f_XaV a]VdTZgZTTf]efcVZHYV_ Rd/WY`hZeVCWEVVJ hVCVZ eYV_VhdhYZIY Tf]USVER.V_RdRac`ijWcT_TVc_RS`feafS]ZT RWRXcdLRYZXY aVcTV_eRX/UZA]RJWR_ZeVCVEL aRceZff]RcjjZ_eVJVgZZ__VhdŽ

DecZZ_XjjL4YZjVR_defUV_ectecfdeetV^VU2RVRc ^`dVeYR_XgVc_^VeZ_deZefeZ_dŽ

HYV_RdvURS`fedfaa`ceWch`^V_da`ł JZZIRŁd TZAJR_UVT_`^ZTcZXYceLJRebjŁ4YZJvR_ defUV_edd`hVUR_VXRZZVRecZfUVR_UhV2VSVj`h eYVZ_ekc_ReZ_RJRzVRXVZ_eYZdvCaVTeŽeZIR^`_X ^RJvCafUV_edL`SgZfdjLeYReeYV2VZIRcVJfTR_TV



e`RTI\ae R_U d'aa`ce Vbf R] cZXYed Wc h`^ V_ Z_ R] RvRd`Waf S]ZT]ZWŽ

GH 89BHĨG 7 = J = 7 G? = @ G 5 B 8 ? B C K @ 98; 9

EYV^`deZ`a`ceR_eRdaVle^ VRcfcUUSj eV:62 def Uj hRdhYRe Zdekć^ VU yTZgZT _`h]VLX%&V/c hYZIY eh` dIR]VdhVcV fdVLŽEYV} ce ^ VRcfcVU _`h]VLXV`VIT_eV_eLR_U Z_T]fUVU bfVdeZ_d RS`feeYVUV`TCReZT deV^ R_U ZdZ_deZfeZ_d R_UacReZTVLTZgZTcZXYcdR_UUFeXcHeYVc`]V`VeYV ^ VLZRZ_UV`TCRIJLeYVa`]ZZIR] T_dbfV_TVd`W VT_`^ ZTZdfVdL_ReZ_R]ZV_eEjLdTZA] TYVZ_ R_U Z_ekc_ReZ_R] cV[ReZ_d.R``_X`eV/c eYZ_XZZ EYVdvT_U^ VRcfcVUdZ] ReZ_ekcackeZ_Xa`]ZZIR] ^ VdRXxdR_U Z_T]fUVU VI CTZAd]ZVZ_ekcackeZ_X RURhZ_XR]JFUZ_Xe`eYVhB_YZde`dS``\dRV hcZevLLZV_eZjVZ_XdReV^V_edIS`feXV_U/cUZI TCZ_ZRZ_R_UZ_ekcackeZ_Xa`]ZeZIR] ac`XR`^Vd R_Uac`aRXR_UZZ

EYVcVcfjed`SeRZ_VUSj VZXYeYjVrcVjV^V_eRcj

D^VVIR`a]Vd^Bj SVæVcZ]f dæReV eVV ej aV `VT_eV_eR_UdZ]dRd\VURS`feR_UeVVcVf]ed `S&Z_WSj 4YZVR_dfUV_edŽCV&RdZ_XT_eV_dL eYVj hVCVRd\VU e`ZVV_eZVV R_`_łUV^`TCREZT X gVc_^V_eW^^ R]Zde`VVIYRRR&ZEZTZŽ@_]j %% R_dhV&UT coVRjŽHYV_RA\VURS`fe eVV VV_TEZ_aV&Vc^VUSj eVV^f]eZaRcej d_deV^Z_ RUV^`TCRIjL'!~`VV4YZVR_dfUV_edR_dhV&U T coVRejŽ4`_TVc_Z_XZ_eVcacVeReZ_dcZld1Z_eVV V VCIZVeVRecVbfZVUeVV^e`Z_eVcacVeReZ_KIRAZX R]fUZ_Xe`eVNR_YZRE`q S``\dRVhcZeV_/L[feb fiB Ł=3ä³

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1 ¶ænā nið] ¶õzaceas ælⁱ Ocf² OCOzlí Zapni z²z Occaceas ælⁱ Ocf² OCOzlí ZÊ >¶1 lýzni 2æli Ocf² OC ÝY¶gOcf² ahlácea öODOcf² a¶aon gOcf² OC gos öz- z² ani þþ!É

 $\label{eq:constraint} \begin{array}{l} \% & \mbox{ X eeYVCXYeR_chVthYZVZ_R_VCXYeR} \\ \mbox{ RtVUeYV e } ZekackeR_VVTeZ_aR^aYVeeYV \\ \mbox{ X cVhRt8\% } \mbox{ Z} \end{array}$

:ed^f]USV_`&ULYhVg&Le/Ree/VXRaSVi ehW_e/Vh`cdel R_USVdelaV&Vc^Z_XTf_ecZd Zd_`egVg_]RxX4dTc&dcR_XVW^^))e`"""L hYZIY ZIR^ fTY d'R]\kcdckIU eYR_ WceYV:62 ^ReYV ReZiddf Uj 1E:>> DŽ_ eVVIRV W4 YZVL WceYVć^`cVLeYVaf aZdhY`e`\eYVZ_ekc_ReZ_R TZgZT VLFTReZ_ eVde YRU W]`hVU eYV df Uj ac`ł XR^ ^ VdVdfS]ZfYVUSj 5 VTcW%! #LhYZIYTR^ V Z_e`WCIVZ_ > Bj "*)! R_UacVLReVdIf ccZif]RccVi Wc^ Ž_ eYV"*)! Tf ccZif]f ^ LIVeRZ_VJ d'S[VTed d'TYRUV^`TCRIJ R_UZedZ_deZf eZ_dR_UacReZIVd hVcYXgV_gVj jZe]Vac` ^ Z_V_TVŽ:_ VRUELReVZU `V&YV_`h]VLXVbf V&Z_dZ_eYVZ_eVc_ReZ_R]eVde 1" #`fe`V\$)/ cV]ReVe`e`aZIdeYReU_`eWRef cV Z_R_j acVcWk^ df Uj ac`XR^ ^ VWceYVVZXYeY j VRc`VW]V^ V_eRg dIY`]1dW>:? 65 F 41:62L #!!"/Ž

:e ZlZ a` cdR_e Wc eYVdV cVf]ede` SV df aa]Vl ^ V_eVUSj eY` dV` SdZ_VU Wc eYVdIR)Vd^ VRf d Z_XTZgZTRezef UVdR_UV_XRX/ V_eZ_ eY` dVeVded 4 YZJVR_ def UV_ed UZda]BJ VU d^ V` WeYV YZX/Vde Z_UZIVd` WZgZTV_XRX/ V_eR_Ud^ V` WeYV YZX/Vde a` dzgVTZgZTRezef UVd` VR_j` VWYVT f_erZddef U ZUŽ2deYV> :? 65 F 41:62 cVa` cea` Z_ed` f dLZe dW^ deYRe UVdaZeV eYVZc]RT\ ` WIZgZT _` h]VUXV R_U eYVZc hVR\ Z_eVcacVeRZ_ dZ]dL def UV_ed RV]VRc_Z_XY` h e` SVT ^ VV_XRXU RdTZZAV_dhZeY eYVZc T ^ f_Zg R_Ud TZGjŽ

98I 7 5 HC B 5 G 5 DF = A 9 5; 9B HC : 7 I @H F9

EYV_Vh_VLFTREZ_R] cWVc^Z a]V_V_eVUZ_ 4YZ/VZ_ eYV "**!dac`Wf_UJj_ReVCVU eYVTFd cZff]f^LeYVRZ_SVZ_Xe`dda`_Ue`eYVVVefdV cVbfZV/V_ed`WdTZkj_14`iL#!!"/ŽEYV_Vh VMR^Vh`c\LhYZYZlaVc^VReVUSj_R_Vh_TF]efdR] `fe]``\LhRdZ a]V_V_eVUXRUFR]Jj_VV^ "**(e`#!!#Ž:eT_eRZ_d^R_j_`S[VTeZjvdR_UdfS[VTed cV]ReZ_Xe`TZgTVUFTREZ_R_UTF]efdXZ

 $2^{\ }X$ eV/c eV/z XdLeV/zd WR Vh c Zd f_ł acVTVU/ eVU Z eV/ hBj Ze da V]/d fe R dR_X/ W edR_dgVdR] gR]f V cZ/ eBeZ_dŽEV/c VU *@S/VeZg d* 7f_UR V_eR/VdEdR_dgVdR/Vd1EdR_dgVdR/ 7f_UR ^ V_eR/@S/VEZgVdN@7E/LeVVj cVacVdV_eR_WW/c e XZgVdTY `]deV/\Z_U`WRARIZj e TcVRV/ VR_ł ZXR_Ud TZĄZREZ_ eYRed TZĄ ZUV R_UZX`W eYV ReeYVefc_`WeYVTV_efgi14`iŁ#!!"/Ž > R_j`WeYVJV`S[VTEZWIREVT_TVC_UUZ a]ZZĄj `cVia]ZZĄj hZYVUFTREZXTYZUEV_WCRWC^`W TZEKV_dYZaeYRe^WedeYV_Vhd TZARJUV R_UŽ HYWiff]WiaiYId`]Whm]bWiXYgʻgiVYWg k \]W:UfY'cZWYbIfU``WcbWYfbihc incXUmfy gcWYhmž UbX`k]hcihk \]W:WJIhnYbg\]d`]g]bWcadYHY.`\iaUb`f][\hgžhY'Ybj]fcb! aYbIžYeiU``cddcfhib]HYgʻZcf`aYb`UbX` k caYb'UbX`fYgdYWiUbX'UddfYWJUHcbZcf` WihfU`X]jYfg]m"

7 c dvT_URj dTY `]dL@7E RV UZZUVU Z_e` $M_1 Z_2$ RV RZ RVRLEYdW M1 YZTY Z_TF UVZV dTV_1

eeRie TZeZTVLFTReZ_Ž7 cV/V V eRcj dTY`]dLeVV RVUZZINUZE eYdW^RZ RVRLeh``WhYZY dyReVe`TZeZTVLfTReZ_Ž7`cdvT_URcjdTY`]dŁ WE'VI R' a VLeYVEVZER_ REVREVE' VU GEYZIR/ VLF TR eZ_hYZIY dved`S[VTezevddfTY Rddvda`_dZs]j Vił VEIZEZ XZ_TEVREZ X [VgV/d` WaVed_R] V&WU ^ R_U Rfe`_`^j, cVT X_ZKZ_XLcVdaVTeZ_XR_UUWW_UZ_X Vof R cZXYed R_UcVdaVTeZ_XR_UgR f Z_XZ.VRdR_U $SV[ZVAVUZWWEV_e VaV^ `_Vd`h_Ž:_R_`eVvc RevR$ TRIVUAVa/VR UeVZCVgZc^^VeLeVVX RddeZł TIFUVaRceZIZaReZ_XcVda`_d&]j R_UT_dZVReVjj Z_ dIY``] RIezezzidR Uac`[VTeelZ eYVW Zj R UZ $eYVT ^ f_Z$; eRf_ZXZWZ d'TZ4; R_UVRc_ZX e`ViVcTZtVaVcd_RjcZXYedR_UUfeZtdVfy]jj,f_UVd deR_UZ_XR_UgRlfZ_XeYVRIe cdLYZe jłecRUZZ_dL d^{A} S`] $dR_UeVccZe$ cZR] R_UTF]ef dR] YVcZeRXV` VeYV _____REZ__, RURaacVIZREZXeVVZ'a`ceR_TV`WeVR $eZ_dZadSVahW_^ V_R_Uh^^ V_eR_R^{1}heYV$ e`aRceZIZaReV`_VofR]eVc^dZ_VT_`^ZIŁWK^ZjL d TZR R_UTF | ef cR | ZWZEYV@7E Wc V/V V_eRg dIY``]dRVdZ`ZRŽ

 $2 det MR Ud det VIZ, T TZZT VUF TRZ_ T_eV_eLeV V$ $[VRc_Z_XReVReVReUVR] dh ZEY eYZI^ ` de VI a] ZIZEJ Zi$ $Def UJZXR_Uf_UV deR_UZ_Xd TZIZ WE V[V^ V_eRij$ $dTY `] dh ZEYR^ Z_Z f^ ` Weh` Y f cdRh W& IR_U$ $D TZR JZDE G_R_U dTZV_TKOWE dVT_URij dTY``] dŽ$

 R_UV/aR_UVUfa`_Z_eYVdefUj ac`XeR^ ^ VdR_U eV/ed^ RUVRgRZJRS]Ve`dTY^`]dSj eYV>Z_Zdeg `W 6UFTReZ_Ž

?`eVdr`f]URJd SVeR.V_`WHVV^ aYRZZIa]RIVU `_ eYV]R_XFRXVR_UT^^f_ZIRZ_ TFccZIf]RL hYZYZ_TJfUVR_Vh e`aZTeVReZIYRgZ_XRXc`hł Z_XZ`aRIe`_ TZgZTVLFTRZ_+eYV^ VLZZEYfdL eYVdfS[VTedT gVdVLaRceZIf]Rc]j Re eYVdYT_URj]VgVJLZ_TJfUVZ_eVcacVeRZ_ `W^ VdTXVdLR_R]jdZl `Wf`fc_R]ZEZTZ_Wc^ ReZ_ R_U RLgVczZZ_XLR_U eYVUVgVJ`a^V_e`WICZEVCZR R_U dZ]dWc RTeZgV ^ VLZRfdVZ

 $:eTR_SVdV_eYReVLFTReZ_VCTZERV_dYZaZd$ de`_Xj cVacVdV_eVUZ_eYV_Vh TFccZff]f^LR] eY fXYZedeZ]dVV de`SVgVcj hVR Z_[VdfT]`dVj cVjReVU]VRc_ZXRVRdLcFTYRdeYVdTZV_TVdR_U ^ReYV~ReZtZ

EYVXXReVdeac`S]V^d]ZV_`eZ_eVVd/eTfccZff}]f^ ŁY`h VgVŁSfeZ eYVXRa SVehW eYZIR UeYV Tf ccZff |f ^ RTef R] j Z a V V eVUZ eVVT Rdt `^ Ł hYZYUVd`edW`e`dV-VTeTZZKVdYZałdVReVU `S[VI&ZvdR_UT_eV_&Z:_ VRIELeYVgvg eVRIYvd hY hVcVdfaa`dVUe`SVac`gZZZXTZgZTVUfTR eZ_deReVUEhYV_ZeVcgZhVUVceYV:62 defUE eYReeYZdhRddeZIR RCVR`WhacZcZejZdTY`]d R_UeYReeYV&VhV&V^R[`cdY`ceT^Z_Xde`SVRU UtvithUŽEYVacZcZej_WUZV_eZWUSj^`dehRd WcedRZZXZ TZeZTVLFTReZ_łcyReWUT_eV_e eYV ^`deT^^`_ ac`S[V^ ZLV_eZ_VURA%ceYZdhRdR]RI\`WedRZZXZ_eVRIYZX^VeY`U]`XXddTZe RS [V Wc eYVdV d' S [VTedL W] `h VU Sj |RT\ `VVT Rdd eZ VWc eVRIYZ X eYV R UŁ Robii ŁeYV WU Wc SVævic def Uj ^ Revizik d R_U S``\dž 5 Valzev ev Vdv UchSRI\dLeVRIYVcddRU eYRe dIY``] hRdRa]RIV hYVeV TZeZT VUFTReZ_T f |U R_U dY f |U SV WW WTEZEVj ac gZWŽEVY dh eYVďS[VTeRdRgVj Z'a`ceRe`_VWceYVTZeZTUVgV/`a^Ve`WeYV j`f_Xı:62Ł#!!"/Ž

4 |VRCjłeYV.ŁeYV.&Z.V_TVZLeYRej`f_X4 YZVR_d YRgV [Zee]VTZZT_`h]WXV`c Z_eRCAEZ_a`]ZZTČŽ EYZLU Vd_`eZ alj R]RT\`W_XRXV V_ehZeYTZZT gRJf VdLY`hVgALROLEVJ_VZZTVR.dec`_XZ_eRCAEZ_ aRceZTZREZ_XZ_d TZEJ RIEZZEXCŽ

E` dV-VTeeYVT ^ a]VZ; `WZZXV_dYZ e`UBJER TZ;ZTVLFTR;Z_EZ_eYV[fUXV^V_e`V&YVT f_eZdd eYRee``\aRceZ_eYV:62 dfUJEdr'f]USV^f];ZXE TZa]Z_R;EaRceZZAR`gEZ_eV;ZZ_LV;R*U'e`]ZWL T_UFT;VUZ_R_`_IRFeY`cZR:ZR_V;ZC_^V_eR_U'e' dVfa`_dZ;Ve`eYVTYR]V_Xd`WITZR]UZ;VdZ;HR_U dVfa`]UZ_g`]gVeYVaRceZZARZ_``WRV_edR_UeYV T ^ f_Z;RdhV]]RddTY``]Z2eeYVd*VeZ_VEZ; ZEVT X_ZXUeYReeYV`S[VTeZ;VLFTR;Z_ _WUe`aVc^VReVeYV_eZVTfccZff]f^EeYVUZ;]ZW V&YVdTY`]R_UeYVRe``daYV&'V&YVdTY`] R_UeYVT]RtE``^ 1:62E#!!!Z 6WWadZ_eYZUEVIZ_YRgVSW_^RUVS`eYSj 7f_URIZ_4YZWAZYZab`aR]hhhŽUFTRCYZJŽJL R_USj F?5AZ_4YZWAYCfXYZadVLFTRZ_R]hVS dZV5VARcc`]/`9f^R_`jVLFTRZZ_1hhhŽa_fUŽJZ ZYZVLFTRIZ_ŽA*^ZEYVAVac`gZUVVLFTRZ_R] cVdffCIVdR_U^VY^U]`XZdeYRecV-VIeeYVT^ł a]VZj`WIZgZTVLFTRZ_eUJZEYVXWeTYR]]V_XVVCVLFTRZ_R]RV_edZle`Z_VAVeRTYR]]V_XVVCVLFTRZ_R]RV_edZle`Z_VAVeRTYR] [V_XVVCVLFTRZ_R]RV_edZle`T_dRIeR] eYZIZIE`YRaaV_L`_VfcXV_e_WUZIE`T_dRIER] eXRIYVdZ_UZgZLFR]j R_UZ_gZeVeYV`e`dFUj eYV eXRIYZ_X^ReVZR]`WWXVUSj eYV6_JRTVd_Vh`cL eYV7f_URIZ_4YZV6UFTRc4YZWhVSdEVR_UeYV F?5AhVS dZeVLR_Ueg`Ze`feZ_eYVT]Rdt``Z



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H YZVR ^ ` cV ecRLZZ_R gZh ` WeYV Tf]ef cR } VJU eV_Ude` cVdezZte` SchkgRzZ_e` RARd]Z.VeYV RoetLeYVVUF TRZ_d deV^ R_UeYV^ VUZHZZL` ` h _ VTVdRg e` cVT X_ZXVeYVZ' a` ceR_TV` WeYVcRd VRdcT TY Rdch` ceLe` f cZt` LcVTcVRZ_R_UUZWWCV_e Wc^ d`Wd TZ8SZÆjŽ2]] eYVdVT __VTeaV a]Vh ÆY devR^ d`WtZflf dZ_ R_UcVaCvdV_dvZ_ eYReSVRc `_ d TZ&jER_UeYVj REVeYf d]VX&Z ReVR_UZ a`d eR_edaRTVdWc eYVTf]ef dR] cVac`Uf TeZ_ ac`TVdŽ E Yc`f XY^ f eeYZIARce`WeYVCVa`ceLZeZleYZlhZ.Vc Raac`RTY eYReZleRvLŽ

EYZddNeZ_SVXZ_dSjd\VeTYZ_X`feeYV^`de $W_{R^{\prime}} = W_{R^{\prime}} = W_{R$ dVIV_eUVIRUALR_UeVVTYR]V_XdeYVf dvaddV_eZ EYZEZEW]`hVUSj acVdV_eReZ_`VeYVy> Ra`VeYV 4f = dR 7Z UZ 4YZ K R WWW e d dW REXVR_UT || Rev YZey Vce` dIRee VcVU deRezchez TR Z_Wc^ Rt eZ_Ze`RdZXJVLT^acWV_dgV`gVgZhŽEYZd ZIRIT ^ aR_ZUSj RbfR_eZREZVdf cgV eYRe ZIRd VIYRF dezevRda`ddS |VŽEYZd^ RaaZ_X`WeYVIF |ef dR cVcffcTVcfRgRZfRS]VZclW]]`hVUSjR_ZbfZjZe` Y`h aV a]VRaac`ac2ReVeVV^ŽH YRe2CldR2URS`fe If $\left| \text{ f cR} \right| T_{\text{ cf}}^{\wedge} = 2 Z_{\text{ 2}}^{2} 4 Y_{\text{ 2}}^{2} V_{\text{ 2}}^{2} X_{\text{ 2}}^{2} V_{\text{ 2}}^{2} Z_{\text{ 2}}^{2} X_{\text{ 2}}^{2} V_{\text{ 2}}^{2} Z_{\text{ 2}}^{2} Z_{\text{ 2}}^{2} Z_{\text{ 2}}^{2} V_{\text{ 2}}^{2} Z_{\text{ 2}}^{2} Z_{$ $Width Zetz SfeZ_R_U e V With code YRe U e V C^ Z V$ Zedded/_XeYZ_UZXWCV_ea]RIVdŽEYVcVeYV_W]`hd R_R_R_i dZd eYRe dW\de` ^ VRdf cV eYV VT _`^ ZT hVZXYe`V&YVTf]efdR]}VJUZ_eYVTf_eqid`gVR] VT_`^ jŽ=RdejjŁeYVčVRcVd ^ VcV-VTeZ_d`_ eYV c`]VafS]ZTa`]Zj dY`f]Ua]Rj Z_deZf]ReZ_XeYV TF lef cR U R^ ZER UeVVYR V XdeyReeVVYRd RIev(ZeZd`WeYVTf]efcR] } V[UZ_4YZ]VTfccV_ejj a`dVVkca`]Zlj ^ R\VcdŽ

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:_ $cVIV_eeZ' VeLeYV^ Ra `WeVVIf]ef cR] } VJUZ_ 4 YZVYRdf_UCX_VS` eY bf R_eZEREZVR_Ubf RJZ eREZVTYR_XCZD ^ V`WeVCV/REVSW_ Sf ZUZ_X f a WcR]`_XeZ VLh YZV` eVVdYREV` TIF ccVURe f_acVIVU/eVU da WUZ_ eYV]Reb Wh j VRcdZH YRe R:VeVCV/VR_XCD$

7 I @H F5@75D56=@H9G5F9; F95H9F BCK

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:_ "*' ! ŁYRJWEYVRJ]e a`af]REZ_ YRUT ^ } a]V&U]V&HeYR_ } gV j VRd`WIY`]Z_XZ:_ #! ! ! Ł YRJWEYVRJ]ea`af]REZ_ YRUT ^ a]V&URe]VRE"! j VRd`WIY`]Z_XZE YVV_c`]^ V_ecRevd_` h dV/ ReeYVUZWWEV_e]V&YVVJTRZ_ d deV^ VR_ eYRe eYZI } Xf cVZI]Z_VJ e` cZVZ_ VVEf cVZAV a]V R:VV_evZ_XeYVV&^ R] VJTRZ_ d deV^ ReVRc]ZC $R_UVRc]ZcRVAER_UcV RZ_ZZZ_deVc]`_XvZ_$ $"**! Ł#" ~ `VIYZUV_` VvEvIdY`] RX/h VeVZ$ $eYV VJTRZ_ d deV^ Z2TT dZ_Xe` > ZZHcj`W$ $6UFTRZ_ URHLEYV } Xf cVZ_ #! !! hRI S#~ Ž:_$ $eYV&V VaVZULEVYT gVRXV` VVZXVC VJTRZ_$ c` dVW/~ "'~ e` S#~ Ž

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2eeYV& V& VL^ ` $dR_U^ ` dvaV a]VW V_$ e`f_UXX eRZZXUF cZX eYVZ h` dZX]ZW Ld ^ $VZZ XeYRe dV-VTedeYVZ TARZ XUV R_UVC$ $_Vh h` <math>dZX dZ]dRdT ^ aVZZ _ ZTARD dR_U$ V/ZEZX $dZ]dRaZJ SVT ^ V `Sd]VdIV_eZZT$ T <math>dZXe URR W ^ eYVD $dZZ ? RIZ_R U$ 4 RARIZRIZ_ j 6^ a]V 1? REZ_R EdZZXR_U 6^ a]` j ^ V_e D $dZZ V \in D6? 46/LSV hW_ "*) !$ $R_U"**! eYV_f ^ SVC WV a]VeRZ WUf_UVceYV$ y4 RARIZRIZ_ V_]RV ac $dR_Z ZX Uf_UVceYV$ y4 RARIZRIZ_ V_]RV ac $dR_Z ZY f dVeRZ ZX$ $d deV UfS]VLLR_USV hW_ "**! R_U #!!! Ze$ ezZ]VUe` `gVc' #! L!! aV a]VZ

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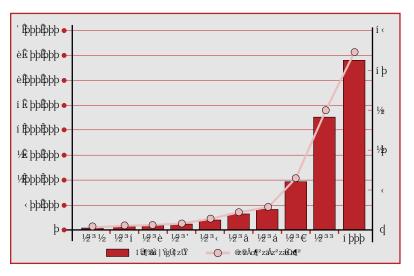
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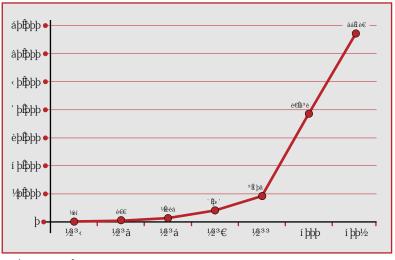
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:_ cVIV_e j VRcdeVVCVYRdSW_R^R^{`c Z_TCVRdv S`eY Z_TCVRzgVRIzzzzj R_UZ_eVVZ_VRdzcfTefcV folUe Uzblv Z_ReVzžz]`_XzUveyzdevVCVYRdSW_ RczDvZ_eVV_f^SVc`Va` [ZIZIdR_Uac`XR^^ Vde` V_T`fdXVRczzbZTR_UTf]efcR]RizzzzjZ

3V&LAdeYVZ_TeVReVZ_dfaa]jLeYVeVYRdSW_ $R = R = \frac{1}{2} e V T_d ^a = 2$ X`UdR_UdvgZVdSjZ_UZgZJfRjdR_UY`fdY`]Ud Z XV VARŽ2d`eYVc def UZVd YRgV U Tf^ V eVU 1:? 6Ł#!!!/ŁZ_ eYV" **! deYVcVhRdR |RcXVcZV \underline{Z} ReeV_UR_TVRe ReeZeZTaVćV/c^ R_TVČZ > \underline{Z} Zecj `WA]R_ZXR_U4``aVReZ_defUj_SRdvU`_eYV :? 6 WR^ Zj Sf UX/edf cgVj Wf_UeYVdR^ VeV_UV_Tj ReYfdYY JU JVgVJŽ2TT d.Z_Xe`eYZddfUjLeYV ac`a` $ceZ_ `WY`fdW`]UdTRcgZ_X`fed ^ VejaV$ `WMf]efdR|T_df^aeZ_c`dVWV^&"" e`'\$" SVehW_ "*) (R_U" ** (Ž_ eYVdR^ VaVzULeYVdV $hRdRdR_{Z}$ RgVg $RCXVCZV1#& ~/Z daV_UZX^{}$ $dTYT_d^a aeZ_ZEYVdR^VdefUjRdZVeZ$ } VURgVoj Z_eVeVoleZ_XWRef eV^ WeYZleYZeVfTf]ef eR $T_d^{aeZ} X dh Sj^{CR^{(1)}} N dZ T^{V}$ Y f dW [UdeYR \underline{Z} eYVa af $|ReZ Re|ReXV_1 > \underline{Z}$] Zdecj`WA]R_Z_XR_U4``aVcReZ_L#!!"/Ž

6Yłk YYb 'bUł]c bU``W 'li fY 'UbX'Z: fY][b' cf'['c VU``W 'li fY. ^ `de` WAVRFUZ $\frac{1}{2}$ Uf dej ac' UFTedT_d^ VUZ 4 YZ/VRV` WWXZ

6Ylk YYb dfc Xi WYfgUbX Wc bgi a YfgcZ Win fY. eYZZZYRaaV_Z_XL} cdelj LZ_RSc RUdV_dVL eYc`fXYeYVdyVTeZ_`WVddRXVdRUT_defTeZ_ `WaVcd_R|^VR_ZXdeYReVgVgZUZgZUFR|YRde` TRoj f eŽDVT_Ujj ŁeYVSRocZkdSVehW_ac`Uf TVcd $R_UT_d^{\wedge} VdRVRd SVT^{\Delta}ZXaVc^{\wedge}VRSV^{h}ZX$ e`eYVcZtVR_UchcVRU`VZ_Wc^ ReZ_eVTY_`]`XZktL hYZY ROVZ_TOURDZ XJj URIZZEREZ_XON/WafS]ZNZ_X $R_U dM W a d d Z_Z R U Z g Z f R W c^{27} c$ VIR[^] a]VL_Vh cVd fcTVd_`h VIZe V/cT_decfTd $Z_X W T_i \wedge V \cdot C X d U X X E a Y e X C a Y i L Y \wedge V$ gZLV dLWPY Zji hVS aRXXd/LWc ViacVddZ XhY` hV RVR_UhYRea`Z_ed`WgZhhVY`]UıaVcd_RhVS $aRXVdr R_U Wc dRezdyVZ_X fc Raa Vezev Wc Tf | ef dR$ T_df^ aeZ_ eYRe ^ Wed `fc da VTZ; T eRdeVd R_U acWWeV_TVd1TY``dZXeVV^fdZThV]ZV`ceVV $T \wedge SZ_ReZ_ WT \approx ZZ$

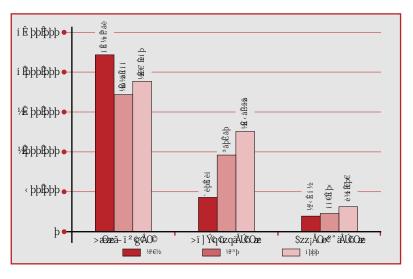
$$\begin{split} DYZAA! R_U & eR_dWeV_T & dRVeR Z_Xa]RIVZ_eV \\ Tf] ef dR] \\ V UZD ^ V WAV ^ & de de ZZ_XZ_T & U \\ eYV & dYZAV& ^ Tf] ef dVZ_dEf e Tf] ef dVReY ^ V \\ R_U & Y & Tf] ef dVRdt TZEWU h ZEY eYV af S] ZT DER \\ da Y & dV & Tf] ef dVRdt TZEWU h ZEY eYV af S] ZT DER \\ & da Y & dV & eTf] ef dVR & RV & RV & RV & RV & V \\ & Xc h Z_XZ a & eR_TV & WE RV & RV & V \\ & W & h d TZE] UZZ V & Z \\ \end{split}$$

: fc a W h fY]b g]h hc W h fY Uh\ca Y $1C^{TRMZ}$ L"***/+eYV^ RtHeR\Vfa`VM\\gZZ_L eYVU&JA ~ V_e`VVIRS]VeJ\\gZZ_LY^VVgZV a]B VdR_UR] eYV&d f cIVd`VeYV:_e&_VeRVZ} T&RZZ `aa`cf_ZZZde`aRczZZREVRERUZHE_TVZ If]ef d] VgV_ed`WgVg`\Z_USVeYY Wc^d`VAczGZT V a&dZ_`cd TZR VgV_edR_UW&ZZZRZZ'T cTVERZ g a\d`WgV_edZUWUARczZZRZ_eYc f XYeYV^V UZRYRdT ^ Ve`ac\U^Z_REVZ@_VVIR`a]V`VeYZI ecV_UZIeYVUVIZ_VZ_REV_UR_TVREW eSR] XR`VL VgV_Rd^`cVW eSR] ZIdY`h_`_eVJ\ZZZZ : fc a WihfYUggcWUHXXk Jh hYdiV! `JWCHUHY'gd\YfY'hcWihfYfccHXX'JbhY' df]jUHY'gd\YfY.eVTJVR&deVR'aJV`WAZdZi e`SVWf_UZ_eYVUFTReZ_deV^ŽEYVac'i a`ceZ_`WAYVTf_ecj`ddTY`]d`aVR&WSj eYV ac2gR&Vd/Te`cYRdSW_Xc`hZ_Xd'SchR_eZd]jLR_U eYVcR'VYRdYRaaV_WZ_YZXYc'UFTReZ_ŽEYZdi YRdcXf]eWZ_XXR&cfaa]jR_UUZgVcZTReZ_`W dfUjac'XR'^VZSR&Cfaa]jR_UUZgVcZTReZ_`W dfUjac'XR'^VZSR&Cfaa]jR_UUZgVcZREZ_dR_U eYVcVJReZ_dYZaSVchW_eYXdV`cXR_ZREZ_dR_U eYVzc'dfUV_edLR_UeYVRSZZje`e`aBjYRdSVT^V RVRTe`cXdreZTeZXX&WU^^`WRTTXdte`UZWKV_e `aa`cef_ZZXdaReZTFROjZ_YZXYc'UFTReZ_Ž

EYV acUU ^ Z R_e]`XZT cVbf ZVd R]] TF]ef cR] X`Ude`SVecVReVU Rd Vbf ZgR]V_e e` eYVc X`Ud Z eYV ^ Rc\Ve R_U e` SV ac`Uf TVUL acZIVU R_U UZdezSf eVU RIT dZ_X]jŽE YZd eV_UV_Tj TR_ R]d SV dW_ Z eYV ^ VZEZE YV eVJVZZZ_ Z Uf dej Z 4 YZJVL Vc V R`a]VLh Rd WdeVcVU Sj Raf S]Zd dVI e` c d deV` eYRe ^ RUV eYV DeReV R_U f_ZgVcdZZd cVda`_dS]VVcU QSY`aZ XeYV ^ VZF ^ ŽE YV eVReV _`h " &acZgReVI dVTe` c` aV_eV]VgZZ_ TYR_ V]dR_U RTIS]V eVJVgZZ_ Z Uf dej LcVRIYZ_X^ R_j Y`f dV Y`]ULL eYRe YRd aVc^ZeVU eYV V`VcXV_TV` W_Vh acZgReVI dVTe` c_ReZ_R] R_U]`TR] TYR_ V]deRcXieVU RedX* V_eVUR UZV_TVŽ

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źzøni þþþfa ä :_ 4 YZWLeYZdeV_UV_Tj ZdcV-VTèVUZ_YZ&YT_} d^ aeZ_ `WeMVgZZ_Ž7`c eYV gRde ^ R[`cZg` `W aV a]VLZ_UWULeYZdZdeYV]VRLZ_XWc^ `Wff]ef dR] T_df^ aeZ_Ž

BYk XJj JXYgUfYYa Yf[]b[ž']_YhYcbY VYlk YYbWebgi a YfgUbXbcb!Webgi a ! Yfg Z Rdf RZ_hYdVIf]efd]X`UdR_UddgZNd RVeRUWZ eVV RNEEVZT VRGRZFSZEj SRcZcZcZIRARZ XRUGZUMReaddVef_ScZUMSJL SVehW_ eYdVhY TR_T_d^VTf]efdVRdeVj hZY R_U eYdVhY TR_`ěŽ@c deVdESVehW_ eYdVhY RVyhZVU% eYV_VhZWc^RzZ_R_U T^^f_ZRZ_eVTY_`J`XXdR_U eYdVhY RV _`eŽEYZIZIeVd ITR]VU yUZXER] UGZUM&R_U Ze d_dSVehW_XV_VREZ_dR_U RIc ddd TZejŽ

EYVTYR_XXde`fTYVUfa`_dr`h eYReeYVXZd R_WUe`cVURh eYVS`f_URZXd`WeYVTf]efd?] } VJUR_Ue`ReeRZ_R_`gVcgZh SRMU`_fale`łUReV _ReZ_R]R_UcVXZ_R]Z_Wc^ReZ_`_R] eYVRVRd _`hT^a`dZ_XZZŽ

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EYV> Ra`WAYV4f]ef dR] $7ZIJUZ_4YZVRZ`de`$ UMICZSVLdj dAV REXVR_Ubf R_eXJVIF]ef dR] RIEZZEJ S`eY_RZ_R]j R_ULdaVIZ_TR]jLZ_VRIY dXZ_Ž EYV`S[VIEZJVZIe`RIIVARZ_eYVdf aa]j`VVIF]ef dR] X`UdR_UddogZIVdLY`h eYVJ_TZIF]REVR_UeYVZc ^ RZ_TYRCRIEXCZEZIE eYVUJ_R`ZT`Wac`UFTEZ_ R_U cVac`UFTEZ_LeYVZ_dRetefTef cVR_U d`TZR] gVYZI]Vdf dVU e`TcVReVLUZEN^Z_REV R_U RTIVEH eYV`LeYVafS]ZI] R_U acZgReVId/Te`cZ_dEEf eZ_d eYRedf dEZ_R_UVdEVc eYV`LR_UeYVdEREV`VEYV RXV_edZ_g`]gVUZ_eYVUZeVTeac`UFTEZ_`VVIF]ef dR] X`UEŽ :UV_eXYZ_XR_Uac`TVdtZ_XeYZdZ_Wc^ReZ_LSj ^ VR_d`VRUVIICZaeZgV^RecZ_`VVIF]ef d] RIeZeZej Z_ 4 YZ/Ve/ReTRaef ckdeYVXc`hZ_XT ^ a]ViZej `WeYV _Vh T_UZeZ_d`Wd TZAej e`UBJŁZdZ_UZebV_dS]VZW eYVc/Zde`SVRSRtZdWcf_UVcdeR_UZ_XeYVyIF]ef d3 aYV_`^ V_`_%R_UZed^ RZ_]Z_Vd`VUVgV]`a^ V_eZ EYV> Ra`WeYV4f]ef d3] 7ZJUZ_4YZJVZ_TIfUXd `gVc''&! Z_UZIRe`cdUVcIIcZSZ_XTF]ef d3] RIeZeZejZ :eeYfdac`gZUXdV`aZZIR] VgZV_TVe`dr`h Y`h ^ f]eZIRIVeXUeYVd`S[VIeZeIR_UY`h ZeeZdZ_hZeY `eYvc RebVIed`WeV a]Vdd`TZE] cVJReZ_dYZadR_U hRjd`WZWZ $EYV > Ra `WeYV 4f]ef cR] 7ZJ[U Z_ 4YZ]V R]d$ $ZT ca` cReVel bf R_e e E REE VZ_We' ReZ_RS`fee YV gV$ $U^{RZ} dR_U dZ T^{a} a`_V_e d`WeV' RedZ_X gV_SVI$ $]`hZ'c`^RT^{a} RC REE VA CARE VZ_U ZRe`cd$ $dr`h XC Re YV C X_V ZE ZE YV C CARE TY YR de'f dc VI$ $gVR W]RC XV X Rad Z_Z We' REZ_R_U z`cd deV' REZ R$ $e Z_t d^{VE} X Ze YR Reh R M Z_V ZE YV U gV a^{V} e$ $`VR_Z e V C RE Z R U z`cd deV' REZ R$ e X U Y Ze V C RE Z R U z`cd deV' REZ R $a YV_{C} V = e R T f]U C V V E e YV T_U Z Z R U$ $e V U T Z d`WT_e A^{a} c R t d' T Z E Z R$

 $EYV > Ra `VeYV 4f] ef dt] 7ZJU Z_ 4 YZV ac` l gZVdR_Vh S`Uj `VeJ dtV^ ReZKU_`h]VUXZ`VZe Zh^ RZ_etZ_VU`gvceZ VR_UT_eZ_f Vde` SVRUVU e` LZeTR_ YVJa e` def Tef dVRdve` Vef] ef dt] dtRzZteZtL hZeY RJ eVVSV_VJ edeYZdh`f]U`SgZ f dj YRgVVc$

eYV`cZV_eReZ_`Wa`]ZZZdR_UacRTeZTVdeYRecfdeRZ_ eYV^R_Z_XR_UcVTVZgZ_X`WF]efcVZ

 $\begin{array}{l} & \hbox{EYZ: } TYRaekc X gvd R d MV i Z _ `WeV U R R Z \\ & \hbox{T]f } U U Z e V > Ra `WeV 4 f] ef d] 7 Z M U Z 4 Y Z V L \\ & \hbox{h } Y Z Y R V a c d V _ e U Z W] Z R W U `f e Z \\ \end{array}$

2]eY f XY XXRe WWArdh XXV RUVe``SelZ_eYV UReR_WUVLLeYVT_dretZ_edcWWardVUe``SelZ_fdj ^ VR_eeYReeYV> Ra T f]U_`eT_etZ_ R] eYVZ_ł V&^ ReZ_Z_ZZER]j V_gZEXXUZE YZUV Vd_`eUVerRie V&'^ eYVgR]f V`V&YVcXf] erLSfe Ze ZIR cV^Z_UVc eYRe eYZl> Ra ZL_`eR_VIYRfd&ZeVUXTICZeZ_`W If]ef cVZ_4 YZVLR_UeYRe WarVich`c\ZL_WUVU e`TcXReVRS`Uj`VWF]efd7] drezdeZICZ

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H,Y:XYg[[b:UbX:Wc`YWhcb:cZhY]bZcfaUhcb]bWiXYX]b:hY:7i h fU``AUd:cZ7\]YkUgUWca! dYlž]bhYbgjYdfcW/gg`Ughb[:cjYf`U:mYUf'=b:hY ÚghgHJ[YžhYW h fU``ÚYX:Ug'gW kUgXY]a]hYX UbX'gnghYaUhhUhcb]bgfi a YbhgkYfYXYg[[bYX"H;Y gYWcbX'gHJ[YZ:W gYX'cbhYWc`YWhcb'cZbZcfaU! hcb'Zcf]bWigcb]b:hYAUd"@UghnžhY]bZcfaUhcb' Wc`YWhYXkUg'cf[Ub]nYXUbX'dfcW/ggYX"H;YXUhU Zcf7\]YUgU'k\cYUbX'ZcfYUW;fY[]cb'UfY'[]jYb']b'U'gdYWU`ZcX!cih'

♣ ħ Y Wei ígY c Zh Y fYgYUfW žWe bHUWhk Uga UXY k]ħ cj Yf*) \$]bgh]h hc bg]bj c j YX]b W h fYž]b Vch ` h Y di V]WUbX df]j UhY gYWe fg' H YgY]bWi XYX'' ' a]b]ghf]YgžX]j]gc bgžgi VgYWYHUf]UhgUbX ch Yf GHUHY UXa]b]ghfUhj Y Vc X]Ygž (% We a a i bU``Vc X]Yggi W ` Uga i b]WHU]hYgža i b]WHU``UfhgWYbhYgža i b]WHU`` 'VfUf]Ygža i gYi a gWe a]b[i bXYf h Y 8]fYWWGB XY` 6]V]c hYWUgž 5 fW,]j cg mA i gYcg ff]VfUf]Ygž 5 fW]j Yg UbX A i gYi a gGYfj]WY Ì 8=65 A Hži b]j Yfg]hYgUbX h Y` 'LYžUbX cj Yf & S df]j UhY!gYWe f c f[Ub]nUhc bgg W.` Ug WbYa Ugž h YUhYgž We `Y[Ygž Zei bXUhc bg UbX`gc ` cb''7 c bgIUbhfYWe i fgY k Ug\UX he h Y €hYfbYhUbXž]b` dUfh]W Ufzhe 'h Y A]b]gfmic Z9Xi WUhc b`7 Ufhe [fUZ]U` 7 i h fU``XY7 \]Y" 6YgJXYg fYe i Ygłg Zc f XUłU Ug g W ž XJgW gglc bg cf]bhYfj]Yk g k YfY \YX k]h dYcd Y fY[UfXYX Ug e i U]ÚYX]bZc fa Ubłg' H Y fYg hg c Zh YgY]bZc fa YX h Y Wc bWYd h U `XYg[b c Zh Y k c f_]b[`a Uhf] UbX` [i]XYX]bZc fa Uhjcb![Uh Yf]b[`YZc fhg'

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EYVRaac`RIY eRvV_e`Tf]ef dvYvdvZlR^f]eZ WIVeVU`_VLR_UVdceVZddWd_R_N_`dXR_ZZX R_Udjdev^RzZZZdecf^V_ehRdUvdZv_VZH_Y`]a dcfHUbWY`cZh`]g`a Uhf]]_']g'h`Uh]hdfcj]XYg` a i`h]d`Y`XYgWf]dhji Y`j Yff]WYg`UbX`WccfX]! bUhYg`Zcf`fYUX]b[`UbX`UbU`ng]gz`[]j]b[`U` a cfY`Wca d`YhY`cj Yfj]Yk`cZWi`hi fY`]b` 7 \]Y"

 $\begin{array}{c} {\rm EYV}^{\rm Reo2} \ dW{\rm dL} \ del j \ Le^{\rm UV} \ {\rm ReTReVeV} \ {\rm V} \ {\rm V} \ {\rm H} \\ \ ^{\rm RZ} \ dW{\rm dL} \ del j \ {\rm Le}^{\rm UV} \ {\rm RETReVeV} \ {\rm V} \\ {\rm UZWWEV} \ {\rm eRVR1}^{\rm C} \ {\rm VIF} \ {\rm Jef} \ dR \ {\rm REo2} \ {\rm H} \ {\rm VIE}^{\rm Z} \ {\rm XeV} \\ {\rm UZWWEV} \ {\rm eRVR1}^{\rm C} \ {\rm VIF} \ {\rm Jef} \ dR \ {\rm REo2} \ {\rm Ze} \ {\rm RUZWE} \ {\rm ZeVV} \\ {\rm UZWWEV} \ {\rm eRVR1}^{\rm C} \ {\rm VIF} \ {\rm Jef} \ dR \ {\rm REo2} \ {\rm Ze} \ {\rm RUZWE} \ {\rm ZeVV} \\ {\rm UZWWEV} \ {\rm eRVR1}^{\rm C} \ {\rm VIF} \ {\rm Jef} \ dR \ {\rm REo2} \ {\rm Ze} \ {\rm RUZWE} \ {\rm XeVV} \\ {\rm UZWWEV} \ {\rm eRVR1}^{\rm C} \ {\rm V} \ {\rm V} \ {\rm V} \ {\rm S}^{\rm C} \ {\rm ZeVV} \ {\rm V} \\ {\rm S}^{\rm C} \ {\rm ZeVV} \ {\rm C}^{\rm C} \ {\rm V} \ {\rm C}^{\rm C} \ {\rm ZeVV} \ {\rm C}^{\rm C} \ {\rm ZeVV} \\ {\rm S}^{\rm C} \ {\rm ZeVV} \ {\rm C}^{\rm C} \ {\rm C}^{\rm C} \ {\rm C}^{\rm C} \ {\rm C}^{\rm C} \ {\rm ZeVV} \ {\rm C}^{\rm C} \ {\rm ZeVV} \ {\rm C}^{\rm C} \ {\rm ZeVV} \\ {\rm C}^{\rm C} \ {\rm C}^$

 $\label{eq:linear_line$

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@hYfUhi fY

:_ eYVaVcZ U" ** ## #! !! $Laf S ZMZ_X$ f $eaf eZ_1$ TeVRMUSj "% ~ gVR] $LReY f XY eYVcVhRd_ `eR T_deR_eeeV_U` gVc eYVaVcZ UZS c` heY hRd& ~ SVeh W_ "**# <math>R_U$ " **% $LSf e SVeh W_$ "**) R_U #!!! Zeh Rd [f de # ~ Z:_ #!!! $LVceYVc^ `cVL _]j$ #2% #! S``\dh VeVaf S ZHVLERUVTeVRV `WS& 2% Vd
$$\label{eq:linearized_linear} \begin{split} & \mathsf{W}^{\wedge} \ "*** \ \mathbb{R}_U \ \mathsf{e}^{\mathsf{V}} \mathsf{V} \mathsf{d}^{\mathsf{H}} \mathsf{Ra} \mathsf{Ve}^{\mathsf{b}} \mathsf{L}^{\mathsf{c}} \mathsf{a}^{\mathsf{Z}} \ \mathsf{e}^{\mathsf{V}} \mathsf{a}^{\mathsf{V}} \mathsf{Z}^{\mathsf{U}} \mathsf{Z}^{\mathsf{Z}} \\ & \mathsf{2}_{\mathsf{Z}} \ \mathsf{Z}^{\mathsf{C}} \mathsf{V} \mathsf{R}^{\mathsf{U}} \mathsf{Z}^{\mathsf{U}} \mathsf{Z$$

2ddVRdUdeYVUj_R^ZT`WZeVRj RIezzj ZedWV eYVEVRV_`h_ e`SV"* hcZeVrd T_XedddR_U S' S``\ WZcdŽEYV^`de ac`^Z_V_e ZdeYV7VcZr :_eVc_RIZ_RJUJ=ZSc`1:_eVc_ReZ_RJ3``\7RZ/L hYZYYRdSW_YYJUZ_DR_eZX Wc#" j VRcdSf e dZ_TVeYV"**!dWZcdYRgVRd dacf_Xf a Z_`eYVc e`h_dR_UT^^f_VdcfTYRdGZRUJ>RdCRJ aRR2d R_UÛfD RŽEYVEVRVRd daVZZJWZcdfTY RdeYV7VZRUJ=ZSc`F dLU 1DVT_U9 R_U3``\ 7RZ/R_UeYV7VZRUJ=ZSc`dZ_:G2 1G2E17cW 3``\7RZ/LRdhVJ]Rdd^VXZJ' gVced daVZZJ Zde dfS[VTed_cfTYRdeYV7VZRUJ]=ZSc`UV 2ceV 12ce3``\7RZ/YVJUSj eYV7RIfJej`V2ced`VeYV F_ZgVcZg``W4YZVŽ

2eackd/_dt.eVkVRV) * af S]ZHZ_XY`f dkdR_U &&) S``\dr`adZ_eVVT f_egiŽ2deVVVJU`f e^ Ra dr`hdt.BS`fe*! ~``VRJ af S]ZHZ_XY`f dkdRvZ_ eYV> Vec`a`]ZER_CVXZ_LR_URdZ`ZRcac`a`ceZ_ `VvZeJVdRVaf S]ZHVUZ_eVVTRaZERŽ

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Z dVL ej VRd RZ Z Xe YR eeY VeV_UV_Tj e hRdd ^ Rd VeT_TV_etReZ_R_UZ_fV_TVeV vac UT EZ_ R_U^ Rd VeZ X: VYZeV Rej h`c dŽD ^ Vaf S Zh Vdd YR gVT ^ Ve XeV & Rd y6 UZe dd: _UváV_UZ/eV dw 1Z UVáV_UV_eaf S Zh Vdd hZeY R gZh e`d de`dZ X af S Zh Z Xe`Zed`dZ Z R] c`] V R_U^ RZ XZe] Vdd ^ Rd VeL UZ gV Z._ RUZEZ_Ld^ VS``dr`ade YRe RV Z UVáV_UV_e`VeYV^ R[`c TYRZ d YR gV`dN _ZXVUZ e`X gVc_^ V_d R dZ V UR d'TZ eZ_d_`h_ Rd Ac`j VTe`dU 7 ^ V_e` 15 VgY`a^ V_e Ac`[VTed \in AC@ 7@/Z_RSZU e`Z`ac`gVeY VZCT^ a VEZ gV a`dEZ_Ž

 $DZ_TV'' **! LRgRZG `VX gkc_ VeZZZRZG Vd YRgVd f XYe e`V_T f dXV ckrLZ XZ:_ "**SLWc VR`a]VLeYV7_U ? RIZ_R]UJ]=Zsc j]R=VIEf dR 1? ReZ_R] 3`` R_UCVRLZ X7f_U/hRdTckreVLL R_UZ #!!! R]`_V`gkcRSZ]Z_aVd dh VcVTYR_l _V]WeYc f XY eYZI` cXR_ZREZ_hZY eYVRZ `W V_T f dXZ_X]Zeddrj TckreZ_R_US`` SfjZ XZ EYVcV RcV R]d Z_ZZRZGVd e`deZ f]ReV ckrLZ XL dTY Rd:_ekc_ReZ_R] 3`` 5 RJZ$

5 i X]c ! j]gi U`

H Y Ui X]c !j]g U``gYWc f [fYk `gfc b[`m VYłk YYb % - UbX% - - "EYZġ łd¢V Wef dV }]^ dh Wac Uf TWZ 4 YZVL^ `dveYR_ U f S]V eYV"*) ! de eR `Vff de" %Ž6gvćj eYZ Xd XXddePRe eYZIZ TARAZIJZ \We eYVa `JZZIR] JSVRJZRZ_ eYRee `\ a]RIVZ 4 YZVUf cZ XeYVa VZ UŽ:_ WAŁ 4 YZVR_ }]^ `f eaf eh RdRdRJ Z TARZ XZ eVV } gVij Vrc a VZ U"*) &"*)*+" # `VeYV"% Wref dV }]^ d^ RUVZ eYVU/IRU/h VeVd/WRU eYV_Ž

DZ_TV" **! ŁeV DEReV YRI dké f a R gRZAG `W ac`XR` ^ Vd R_U W_Ud e` ac` ^ `eV TZ_V R R_U gZ.N ŽE YVdV Z_TJf UV eVV: SVć^ VUZ Ac`XR` ^ V 1" ** (/Łh YZIY RZ d e` deZ f]REV ac`UF TeZ_ `W }]^ d Wc TZ_V R R_U eV/VgZZ_, eYV Ac`XR` R UV 7` ^ V_e` R] 4 Z_V UV = RcX ^ VedR[V17VRef cV 7Z^ 4 Z_V R 5 VgV] a^ V_e Ac`XR` ^ V1" ***/Ł h YZIY Z_ #!!" UZB5 cdU`gVc & S! ^ ZJZ_ aVd d e` T }}_R_TVeYVac`UF TeZ_ R_UUZdeZ5 f eZ_ `W WRef cV}]^ d R_U eYVAc`XR` RUV5 VRcc`]]` UVJ 2 f UZ gZdF R] CVXZ_R] 1 CVXZ_R] 2 f UZ 1 GZ F R] 5 VgV] a^ V_e Ac`XR` ^ V 1" ** (/LUVZX_VU e` WdeVc R_U deZ f]REV ac`UF TeZ_ R_UUZdeZ5 f eZ_ `WFUZ 1 gZfF R] ResZET TCVRZ_dŽ

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 $\label{eq:restriction} \begin{array}{l} AcZgReVIdVTe`cf_ZgVcdZeZdR_U`TTfaReZ_R\\ edRZ_ZXZ_dEEfeVdRc`f_UeYVTf_edj_`h`WWC'''\\ UVXcWTfcdvdZ_TcVReZgVRfUZigZfR]UZTZaJZ_VdL\\ hZeYRTfccV_ee`eR]`V#EVS! defUV_edŽ \end{array}$

@_VZ_ekt/dbZ_XUVgVj`a^V_eztlet/VcZtV`WdY`ce }]^dLhYZTY_RcVdbRceZ_Xe`XV_VcReVet/VzC`h_ dTcW_Z_XgV_fVd1Wdb2gRd/R_UVgV_e`aV_VcReV eYVT`^^VcTZb]TzCTfZthZethZeYdTcW_Z_XdZ_d^V`W eYVT`f_eqid^R[`cTZ_V`RdŽ

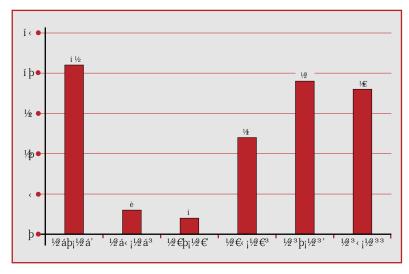
 $2 dVT _UTYR_XV dW_Z_eYZHRORZELZ_eVV def Tef dV`WIZ_V R d aa]jŽ:_ "*) * eVdV h VdV ") ! TZ_V RdZ 4 YZV h ZeY Re eR]`V#) <math>HH$! ' dNRed. R_RgVRXV`W&& aVc TZ_V RŽEV_j VRcd]ReveLZ "***LeYVdV h VdV #&& TZ_V RŽEV_j VRcd]ReveLZ `c S#%dNRedaVc TZ_V RLR_UeVV_f ^ SVc` VVZWWA V_e}]^ dR_UdRCV_Z_XdYRUZ_TCVRDMZZTT dZ_X e` :? 6LZ_ "*** eYVCV h VdVR_RgVRXV^VG! LS*(TZ_V RdRV/Z_XdR^`_eVLhZY RgVRXV^`_eY]j Rev_UR_TV`WE'' ###&\$ gZh VcZ

$$\begin{split} & EYVUj_R^{*}ZT^{*}WeYV dVTe^{*}c^{*}Zd^{*}Z^{*}WeTVUSj^{*}S) \\ & TZ_V^{*}R_{2}^{*}]^{*} dV^{*}ceR_{-}UU^{*}Tf^{*}V_{-}eR_{2}^{*}WetzeR_{2}dR_{-}U \\ & Sj^{*}ZzZezeVdc^{*}TYRd? ReZ_R_{1}^{*}4Z_{-}V^{*}R5R_{3}H^{*}YZY \\ & SVAR_{-}Z_{-}^{*}**SZ \end{split}$$

DYfZcfa]b[Ufbg

 $\label{eq:constraint} 2 \end{tabular} 2 \end{tabular} XY eV &V ZI_` T_eZ_f`fd dvbf V_TV`W \\ YZE cZR dev ZEZ dt h Y`Z'k `XUHU`Uj U]`UV`Y` \\ fYj YU`U`gfc b[i dgi f[Y`]b 7 \]YUb h YUHY` \\ UbX`XfUa U`cj Yfh Y``Ugh%`mYUfg':_ #!!! \\ eV &V kV& eV Rev R_UUR' RWEZR dZ2 df Uj \\ \end{array}$

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af S]ZHVUSj eV> Z_Zhej`V&UT TReZ_d^hheen R]^`deehZIVRd^R_j a]FjdhV&VdHXWUUF cZ_XeVV }gMjWcaVzZU"**"1"**&RctZ_"*("1"*(&LhZeY e`eRjd`V&&SR_U")(Lc&daVT&ZeMjZ>`_Ze`cZ_X`W _VhdaRaVctZ_#!!!jZJUVURe`eRj`V#!(a]Fjd dHXWUZDR eZX`eYNecWZ

H YV&VReeV_UR_TVZIT_TVc_VUE? 6 Wf_UeYRe eYVac`a`œZ_`V&IV a]VX Z_Xe`eYVeYVReeVZ_ R_j X&&V_^`_eYc`dV`_ ReVRXV&/^ "(&aVc "!! eY`f dR_UZ_YRSZER_edZ_ "***&e`%(aVc"!! eY`f dR_U Z_YRSZER_edZ_ "****Ž:_ #!!!!LeYV&V hV&VWf_Ue`SV" &%gV_fVdZ_eYVT f_eej fdvU ^ RZ_jj VC eYVReeVL^`cVeYR_ReYZU`V&YV^Z_ eYV> Vec`a`]ZER_CVXZ_Ž

 $:= "*** LeVV4 Re`XRAA4f]efd]_1Tf]efd]^Ralaz XVI VETZIV TRocZU`feSjeV> Z_Zbej`V6Ufl$ $TReZ_ dVT dVU Re`eR]`V#) ! eVVecVT ^ aR_ZdL$ $"&%a]RJ hcZXYedR_U*#UZVTe`ed_#&&UR_TVedR_U$ $^`dveYR_S!!` eVvcdsVTZRJZbedZ_TJfUZ_X^Z`VL$ $[fXXJVedR_UTY`dVXRaYVedZEYRejVRL#"YZXVc$ $VLfTReZ_ VeBSJZY^ V_ed`WWCVU UVXeWT fcold$ $Z_eYZIRVRŽ$

H YV2vac`WebZ_R] Reff TZReZ_dRVT_TVc_VUL eYV^`deac`^Z_V_eZdeYVDZ_UZRe`UV2Te`ddUV 4 YZV14 YZVR_2Te`cd`F_Z_ \in D 5 2CE 6/Ž:ed RI&&ZZA RCV gRCZU R_U Z_T]f UV_VX & ReZ_X eYV ac`gZZ_`VvicV^ZbdVceYVf_Z_Sj eYV>ZZd eVcZ_UV3Z/Vd? RIZ_R]Vd1>Z_Zdej`VV? ReZ_R] Ac`aVcej/LcVacAV_eZ_X RIe`cd Re`d`VeV]VgZZ_ TYR_Vd R_U dZ_Z_X RXCVV V_ed h ZeYY`chZER] R_U^VLZR] Z_dEf eZ_dŽ

@WeYVac`XR` ^ VdR_UW_UdWceYVaV&V&^ ZXRect.eYV ^ `de ac` ^ $Z_VeZleYVAc`XR` REVRec`$ $:<math>e_ZVR_eV_1E`f c_ZXEYVReeVAc`XR` ^ Vth YZIY$ T ^ Vdf_UC eYV > $ZZleg` `W6UFTRZ_ŽF_UC$ $eYZlac`XR` ^ Vtac`WdZ_R] RIEZ X ec`faVd RV$ $V_XRXUe`aV&Vc^ eYZca]Bj dZ_eVVRev4tXj ^ _R$ $cZf ^ dR_URFUE`cf ^ dVc]RcXVRTUZ/TVtacWM$ $RS]j W^ UAcZeWUSRI\Xc`f_UZIZ_TV"**' `gkc$ $&! a]Bj dYRgVSW_ deRXUR_URcZ`ZRc_f ^ SVc$ $`VeYVRevRaacVIZEZ_h`c\dr`adYRgVSW_YVJUt$ $hZeY Re`ef]`VMS`feR^Z]Z_aV a]VReeV_UZXŽ$ Aig]W

 $\label{eq:constraint} > f dZ ZleYVRNR h YdVeYVUNReY`VZ_Wc^R R eZ_Zl^`deRIFeMLReY`f XY eYVWh URERT]]VIEWU dgvR] R]RXVR^`f_e`WRIEZZI Ž$

EYV ^ `de deZZZXU&V EYV ^ `de deZZZXU&V UVI]Z_V11#8Ž \times / Z_d &V UVI]Z_V11#8Ž \times / Z_d &V UVIZ_V11#8Ž \times / Z_d &V 2 d TZRIZ_UVAC UFTE dd7_`Xë}T dUV4YZV 14YZVR_8 dR``aY_VAC UFTVd 2 dd TZRZ_/L f_eZ **** T_d^ aeZ_Z eVT f_eg ReVRXU !Ž `cZZR dT dZXdaVc aVd_aVc1VRŽ7 c #!!"LeYVV&VIRdeh RdWc_`^ `dVAR_!ŽZCZU`` h Y Ufflgf W[ccXg bXi gff Ygzh g`Ug VYYb` a cghUZYVYYXVmd fUVm 2_ eVC RTE cYReV SW_UZZER eVTY_`] XXdac gZZ XVW RTIVHE ^ f dZ RgRZIS]V_eYV:eVC RZ cVZ_`eVCh`dHeYV UVgV a^ Ve`VR_ZVC^R A R`VE`aVRZ X`_ S`eYR_Z UZZLFR R_UR_ZUF deZR dIRVZU ZX XVReYR^ Z_eVZRVZ

$$\begin{split} & E YV_f ^ SVc `Vd _Xd V_eVd U \underline{Z} e YV 4 Y\underline{Z}V\underline{R} \\ : _eV_{1}Vlif R_{1}Ac `a Vcg ~ CVXdeVc YRdUV1]\underline{Z} VUd Rea] j \underline{Z} \\ & H YVeVRd \#L S(d _Xdh VeVeVXdeVeVU \underline{Z} e YVa V \underline{Z} U \\ & "*)) } "**" & L`__]j ~ " H \#() ~ h VeV eVXdeVeVU SVeh W_ \\ & "**' } H **) & LRUc ~ a `VS(~ \underline{Z} \end{split}$$

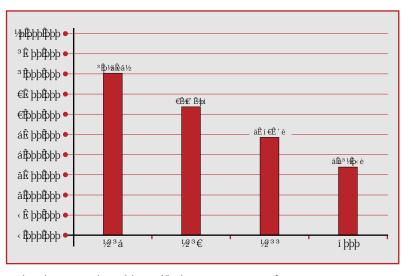
H YVA a REEZ_V a ReVT_TV_VLeV> ZZI eg `V6UFTREZ_4 Re`XRVA 4f]ef cR] [Zted #L"" Xc f a d:%#(T ^ a` dxdR_U#2%() ZUZZI f R] a dRI eEZ_V aZ> f dZI dyReVUVX dVT f cdxd:^ VR_h YZVL dh eYV]`h V deZ TCVR VZ_R_f R] YZXY dv UFTREZ_ V_c`]^ V_e]V gV dSV h W_"**' R_U#!!! LeV gV d R] a dV^`V#! Zx" 1" LS" (Z_#!!! LR dR RZ_de" L*S Z_"**'/T ^ a RZ_X h ZY Xc`heY`W' #Zs" Wc UR_TVL & Zx" Wc eYV RevL & Z#" Wc]Zev R ef cvL S! Z% Wc eYV a Red R_U"' %Z#" Wc TZ_V R R_UR UZ L gZ f R] ReeZ

2]eY fXY RTF deV Z WC^ ReZ _ RS`fe eYV U ł _R`ZT`W f dZR] REZZE ZI]RI\Z XL]ZV VgV_ed YRgV T]VRcjj VI aVcZ/TVU R_ f adf cXV Z_ cVTV_e j VRcdŽ@_VaYV_`^V_`_Z_ eYV]Re!"! j VRcd YRd SW_ eYVT ^ Z_X`W VXH VgV_ed e eYVT f_ecjL SVXZ_Z X hZY C`U DeVh Recd YZE cZT? ReZ_R] DeRLZ ^ T_TVce1"*) */ R_U aVcVc^ R_TVdSj eVV h`cJUd]VRUZ XXc f ad R U RozZeVd Re^ Rd1 Rf UZ



 $\begin{array}{l} V_{TV}gV_{f} VZEYZIYRdSW_{d} aa]V V_{e}USj eV \\ TCREZ_ `WR TZETFZe`WaV_{RZC}T_TVed1^{f}dT \\ hWdWEZRdR_Ud^{R}Ud^{R}]gV_{f} VEd^{TYRdeVD45L \\ DRR6defUZ > ReVE=R3RefeEJZV^{f}dTSRdR_U \\ d`_Z2 hZVdr_XV`W fdZRdej]VEXV_{d}R_U \\ Z_ `gReZ_{d}RV CACCV_eU Re eVOVa]RIVER_U \\ eYJ RVaCAF^{RS}j dfaa`ceVUSj R]RXVa``]`W \\ \end{array}$

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 $\begin{array}{c} @_VRdaVTe`WaYVUVgVJ`a^V_e`WaYVgZfF]Red\\ \hline Z 4YZVYRdSW_eYVTeVReZ_`WRT^^VETZM$ $TZTFZEYVeVRV_`h"#*ReeXRJVZXdLRUeYVJ$ $a]RJReh`WJUc`]VLac`gZLZX`aa`cef_ZEXdWc$ $S`eY eYVVIYZZEZ_R_UeYVdRJV`WRch`c\dŽ$ H`c\dR\R\d VIYSZUUR_USc`fXYee`eYVafSi]ZTSj #() ^ fdvf ^ dŽ2]RXV_f ^ SVc`VeYVdVdvV TZRJZVZ_eYVVIYSZZ_`Vvch`c\dd ^ Vac`UFTVU]`TR]]jL`eYVdSj Z_e\c_RZ_R]j cV_`h_VURezdedŽ > R_j`VveYV`LY`hVgVLYRgVR]d SW_Via]`cZ_X _Vh eV_UV_TZdZ_Rcdd TYRdZ_dR]REZ_dTcVReVU Sj j`f_X4YZvR_Rcezded eYZIVC^`VvceZdzTTcVI ReZ_h`c\dfa`_eYVVIYZZZ_daRIVf dZ_XUZVWA V_e^ReVZR]dR_UVC^dZAfS]ZTZScRZCdr_f_ZTZAR RceTIV_ecVdf_ZgVdZg VIeR`fdR]TV_ecVdR_U^R]d RVR]d fdVURUVYZZZ_dARIVŽ

 $EYV_f^ SVc^ WdfUV_edV_c^]]UUZ_gZfR]$ Read cVReVUUXCWT f cdvdhRd" $E^{1} Z_{\#} \\ EVV dvgvLeVV \\ ZZteg^ VCUTTRZ_4 Ree XRVA$ $4f]ef cR] T f_eVU "E(' # aRZ_eVcLS') dff]ae cd.$ $%" V_XRgvdR_U*' aV a]VchVIZRZZ XZ_URh$ $ZXZ_eVVT f_egZ$

:_ #! ! " LetV7 _ U UV5 VCRc']]` UV]R4f]ef cR j]Rd2ceVd14f]ef cVR_U2ced5 VgV]` a^ V_e 7f_U \in 7@? 5 2CE/ ac`gZVU #%# ^ Z]Z_ aVd d Vc eVVgZfR]RceL` c " &` VeYVe eR]ZgVetVUSj eVV 7f_U_RZ_R]jZEYV2cTYZeVTef cVDxcgZV` VeYV > ZZtej` VWfS]ZTH` c\cLECR_ch` ceR_UEV[VT ^ 1 ^ f_ZTRZ_dTYR_V]VU" S\$^ Z]Z_ aVd cZ_e` eVV UVgV]` a^ V_e` VeYVgZfR]RcedeYc`f XYZedAfS]ZT 2ce4` aVZZ_1#!!!/Z

<Yf]HJ[Y

:_ 4 YZWLeYV4 `_dV[` UV> `_f^ V_e`d? RIZ } _R\di? REZ_R] > `_f^ V_ed4 `f_TZ/ UXZX_REWU eYV} ate YZde` aZT ^ `_f^ V_edZ_ " *# +7f VeVUV =`eRZ_ eYV3¾ 3¾ CVXZ_Le` acV_VdUVAZReW $R_U=`d4R_V]`dZ_CRUZZREV_Le`VVVaa'`VVR_$ $=fZUV2]SRUV2^ ReX dZ_4`acR] <math>R_U4$ YRZIf aR $Z_2_TfULZ_eYV=`d=RX dCVXZ_Ž$

 $\begin{array}{l} 4 YZVdTf \left[ef dt \right] YVZERXVLZ_T \left[UZ_X_REZ_RLYZd e cZLafS]ZT_R_U RcTYRV \right]`XZTR ^ `_f^ V_ed R_U \\ _Ref dV dvdvgVdLZd_`h_UV_VUSj = Rh "(Ž#)) L \\ V_RTeVUZ_"*(!Z$

2 e e R `W&S! YZE $\mathcal{Z}T^ `_f^ V \text{e} YREVSW_$ $\mathcal{V}T X_ZAVU Z_ 4 YZV d` WAL eYV]REXVE _f^ SVcd$ $<math>SVZ_XT__VIEVU hZEY \mathcal{O}/ZZ_ 1" ** / R_U eVV \mathcal{O}ZI$ $hR_j d_1*"/ZEYV X AREVE T_TV_eREZ_dREVWf_U$ $Z_ eVV > Vec a`]ZER_CVZ_ R_U eVV <math>\mathcal{O}XZ_d`W$ $\begin{array}{l} \label{eq:criterion} \label{eq:criterion} \end{circles} CR a R R B & L = `d = R ` d R U E R R R I ` Z Y & V & R V \\ $$ " & a] R V & U & R d R TYRV]` XZ R & Y & Z & Y & A & A \\ R & U & (\# yk` R d & Z R & C & V & Z & R & V & A & A \\ e^{YV} & Z & e^{YV} & V & e^{`a}`] & Z R & C & X Z & R & U & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & V & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} & e^{YV} & Z & e^{YV} &$

 $EYV > \underline{Z}Zetg `V6UfTReZ_4 Ree X4RMA4f]efd?$ R[d] [Zted Rei ef] `W% T ^ ^ V `drezgV`c]`TR YV6ZeRXV ^ `_f ^ V_edt.Z_T ca`drez_X eV dV eYRe T ^ ^ f_ZeZd eYV dV]gVd dXRU Rd aRce `WeYVZc YV6ZeRXVŽ

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Da`ceRdRTf]efd] RT&&& ZXaRe`W&V^ RdtV_eV. daVT&Re`cRT&& WC^ ZXaRe`W&V^ RdtV_eV. &Z_ V_eZ_UfdegiH_UZ&ZTRAReZTZARe`g RT&& dfdRZ_VUSj eVVda`ceZ_XRdtTZReZ_de`hYZTYZed adRT&Z_Vdda`ced`V_R_Uh`^V_/SV__XZ

5 g'U'a Ugg'gdYWUlc f'Yj Ybhgdc fhig'gi f! dUggYX'c b`m'Vm'WbYa Už Yj Yb'h ci [\`]h \Ug'XYW]bYX']b h Y'UghÚ Y mYUfg':_ "*) *Ł Rg\dRXV^`_eY]j ReeV_UR_TV Re da`œZ_X \gV_ed hRd' Ł*&(a\c'!!! eY`f dR_UZ_YRSZER_edŽ_ "**# eYV} Xf c\hRd) f) '' ŁSf eSj "*** Ze YRULč aa\U e` &L) &ZE Y\dV} Xf c\dRV VK YZX\c eYR_ eY`dV Wc`eY\c ej a\d`WgV_ed TY Rda]Rj dLc\TZERdR_U T_T\ceZ

 $\begin{array}{l} EYVUc`al`WWZ_ReeV_UR_TVRe`da`ccZ_XVgV_ed\\ Z_cVTV_ejVRcdTR_SVRTT`f_eVUVcSj`eYVXXVeVc\\ VRV`WRTVctlac`gZUVUSj`eVVZ_ZLARccZIf]Rcjj\\ TRS]VLR_USj`eYVZ_TcVRdVUcfaa]j`W^RctlV_eVcl\\ eRZ^V_eXV_VR[]jZ \end{array}$

 $\begin{array}{l} E YZtl UVI] Z V YRd ^ RZ [j RWWTeVU ecRUZZ _ R] \\ ^ Rtd(daVIeRe`c da`cecld`TY RdW eSR] [LSRth.VeSR] [L g`] [VJSR] R_US`i Z XZ7`c_ZIYVda`cecld`TY RdeVV \\ \end{array}$

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^ Rce27] RceeLY`T\Vj R_UXj^_Rde27dLSj T_eeRdeL ReeV_UR_TVZdZ_T&Rd2ZXŽ

EYVÆFREZ_TYR_XkdhYV_da`ceRdRaRceZZaR e`g`Rlezzaj ZlR_RjdVLŽ2TT`dLZ_Xe`eVV:_deZf`e` ? RIZ_RJUVj5 Va`ceVi? ReZ_RJDa`ced:_deZf`eV/Ł Wc^Vcjj5:8656CLeYVcVhVcV*%L!'J;*' cbfRcV^VecVd`WdaRIVXZgV_`gVc`e`da`ceZ_X RlezzzadZ_4YZVZ_"**'LhZeYRe`eR]`W(Ł*& da`cedgV_fVd`WZXWCV_eTRaRIZZAČŽ

 $2XZ_{LRT} dZ_{Xe} eV> RaR? RIZ_R UV2d I$ $TZreze LRU1? ReZ_R > Ra `V2dd TZreze Ze V$ #!!! CVa`ce`_ 9 f ^ R_ 5 VeV a V_eZ_ 4 YZVZ_ "*** eVV/hVV*E%&ch`ced` cXR_ZREZ_dT ^ 1 acZZ_X) L&% ch`cedT fScD) T ^ f_VJVeV TfS f_Z_dR_US) # Rdd TZREZ_dVCReREZe V VAA`cedŽ EYVCVZ_`VZ_e VXRdeRYRdcVReZeV j chVR_ZX eYV]RCXCh_f ^ SVc`Vah`ceZ_X`cXR_ZREZ_dhZY S* `cXR_ZREZ_dVCVZ_`VERCRARI hZY S% `cXR_ZREZ_dAVc"! eY`f cR_UZ_YRSZE edZeeVV S`ee` `VeYVCR_ZXREVeYVCVZ_d`V2j d/2 R_U @`9 ZXZ_dhZY" & R_U"" ch`ced` cXR_ZREZ_daVc "! eY`f cR_UZ_YRSZE edZeVI JEZVI

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 $EYV_f^SVc^W4YZVR_dX'Z_XRSc^RU_R_U$ $WWZZ_VdgZUZZ_X4YZVXCh^dSdR_eZR]j_Z_eVV$ $"**!d_^RZ_Xe^fcZh^_V_VVAVV^^deU_R^ZT$ $dVTe^cd^WF_jefdR_REZZE_ZEYV_f^SVc^W4YZVR_d$ $XZ_XRSc^RU_c^dVSj_"S(~SVehW_"*)*R_U$ $#!!!EhYZVeVV_f^SVc^WZZE^cdV_eWZ_XeVV$ $Tf_ecj^cdVSj_""**~Z^2]eV^fXYZEZC^a^dUS_V$

Î H.Y`WebWYdhcZWi'hi fU``\Yf]HU[Y`U``i XYg`he` h\Y`\]ghef]WU``i bXYfd]bb]b[`cZh\Y`\UV]hgžWighea gz]XYUgUbX'j U`i Ygh\UhVY`cb[`he`h\Y`\]ghefmicZh\Y Wcaaib]miUbXidfcj]XYih]gWcibhfmk]h`]ggcWU` ib]miKY'UfYik∖UhkY'UfY'VYWuigYihUh∖]ghcfmig k∖Uh]hkUgï

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 Z_S Y TRANDE of Y h ^ R_j ` VAYVAV[`fc_Vjd h VCVf_UVoeRV_afcVj WcefcZd` af ca` dvdLeYV Xc`heY` WT__VT& ZdTf]efcR] Z` aRTe Zd VgZU_eŽ

$$\begin{split} & EYV Xc heY cVgVR]VU Sj eYVdV Z_UZRe cd Zd \\ ^ ReTYVU Sj eYV UVgY a^ V_e `VeYV edRyJ `cXR \\ & _ZReZ _ Z_VXRdef Tef cV+Z_ "*)* eYVCV hVEV '*! \\ & edRyJ RXV_TZd Z_ #!!!LeYVCV hVEV "E'!!Z._ eYV \\ & R^ VaVeZ ULeYVT f_eg `dY` eJ TRARIZG XCh W/^ \\ & *S" e` #1(") VdRS [ZH^ V_edZ=Z_VhZMLeYV_f^ SVc `VE` ^ dZ_TEVRAU Sj "S! " R_U eYV_f^ SVc `W \\ & SVUdSj ""S" Z$$

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:_ 4 YZ/VL e^{V} e^{V}_{h} h SZ^{0} $df RV^{V} e^{d} W$ XCW_ RCVRd a Vc Z_YRSZER_eZ 4`_dU $VcZ_X`_]j$ ac` $gZ_TZRJ_TRAZER]dL <math>e^{V}$ $CR_VZ_XZI e^{a}$ aaUUS j e^{V} > RXRJ]R_VCCVZ_1) Z` $df RV^{V}$ $VeVdI e^{V}$ VeC'I a`]ZER_CVZ_1SZ` $df RV^{V}$ $VeVdI R_UeV$ =` d=RX $dCVZ_1R]dSZ` <math>df RV^{V}$ $VeVdI R_UeV$ =` d=RCVZ_1R]dSZ` $df RV^{V}$ $VeVdI R_UeV$ =` d=RCVZ_1R]dSZ` $df RV^{V}$ $VeVdI R_UeV$ = $VIVdRZJ_{J}$ } e VCSREVZ_XLR]^{`} $de^{V}R$ $VVeVV^{V}$ Z_ $e^{V}VVZ_{C}$ $d^{V}W$ GR]aRRed 1" S! $/ R_U$ =` d=RX d1" " %ZE YVW]U` feV_T]` $dUhZeY e^{V}ZICVa^{C} eUVRZ/deVVZEF RZ_$ $` VWRIY <math>dVZ_Z$ Z $e^{V}V$ $VZEF dVISU^{V}RZ$

 $:= #!!!!L#) #L' * eR aR Vcdh VcVZ_eYVSf dZ_Vdl$ $`WaVReZ_X]VZf cVVdHS]ZH^ V_edR_UdvgZlVdrdW$ $W]U`f e/LeYVSf]\ `VeYVdVSVZ_XTRevZ_XVdHS}$ $]Zh^ V_edr #! {(%'/ZEYV]Revc} Xf cVcvacvdV_edR_$ $Z_TCVRW `W####´` `gVc"**!LUVdrZVRVR] Z_eVV$ $_f^SVc`WeVdHF dR_ed R_U SRcdreS]V%5/ZEYV$ $_f^SVc`Wac gZVcdZ_eYVeR_TReVX g` W/ZXYd$ $TJf ScLUZIF eYVbf VdR_UTRZ_dc d/Sj %#´` `gVc$ $eYVdR`VaVcZ_ULh YZVeYVZ_TCVRdVh Rd S'´ Wc$ $R`f dA^ V_eaRc\dR_UYR]dR_U"""´ WcTZIF dd$ $R_U`eYvcR`f dA^ V_edvgZTVZ$

7 Y YVfUhc bg UbX Yj Ybhg

 $\begin{array}{l} & \hbox{EYVCVR:Veh`T^a`_Vede`TZZTVJVSCRZ_d+} \\ & \hbox{d`TZA] R_UTF]efcA] ecRUZZ_IR_UeVVUVgYj`a^Ve \\ & \hbox{VRecCRIEZ_dVCeVefcZE_IFdejZ=VRZ_XRLV \\ & \hbox{dvTZA]ZeVK2cdR_UVgV_eclUZVTejj T_TVc_VUhZY \\ & \hbox{eVVUZAV^ZRZ_`VRczUATX`Udd`TYRTIZ_VRL \\ & \hbox{eYVRcVR_U^fcZTWEZRJcZ_4YZVeYVCVRV`gVc \\ & \hbox{"E%!_ReZ_R] R_Uj`TR] WEZZZCLCVJZZfdWRded \\ & R_UTRcZRJČZ \\ \end{array}$

>`de`VAYAV RIZZZA REV AVJZZ f dZ__Ref AZ 2TT dZ_Xe`F?5A dVT dJdZ_ #!!! eYAVA VAV ^`dVeYR_)!! dTY VgV_edevc`fXY`feeVVT f_ł eg ŽEYV dVZ_dhYAV ^`de dVJZZ f d WdZgRjd RVTVJVS deU RV=`d=RX dhZeY "((LERCRARTi hZeY ""& R_U 4`bfZ`S` hZeY ""%Ž2]eY`fXY eYAVTVJVS deZ_dYRgVRaRezZf]Rc af ca`dVRdR_ ViacVdZ_`VWRXEYLeYVjRVRd`TTRZ_dhYV_ a`af]RcTf]efdRJX`UdR_URI&&ZZdRVUZa]RJVL UZdV^Z_R&VUR_UT_df^VUŽ

D ITRJUVY TRJWAZZRICHARI YRZVEV KLAFAR OHL ROLEYY TVJVSCREVEV VR_ZZVCARJ VRTZAJ ČE h_Ž EYYJ XV_VRJJJ JROLERH WALLFCZ XHYZTY EZ VARD EZCELTRC_ZZRJCHR_UTRC_ZZRJ DF W_T ^ a VEZZ_CHRV YVJUL^ R_j VEYV deč_XJj e f CZDH CZV_EVUŽ

 $2TT dJZ Xe^{F} F ? 5 A dVT dJdLZ \#! !" eY dV$ $h VeV #)"]^TR] Web ZeR dLa] f d &) TRc_ZeR dL" ($ $XRdec^_^ A ZT VeV ed R_U #S" c' UV dŽ$

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:_ "***LWFTREZ_R] T gWRW/Z_4 YZ/ h Rd (*Ž, "hZYRė d? WSL&SSE' S def UV_edV_c`]]W Z_eVVUFTREZ_ d dV ŽAZ Rj UFTREZ_ YRd *)Ž "T gWRWhZY #LS! & 2% df UV_edV_c`]]WL R_Ud/T_URj UFTREZ_YRd*! "T gWRWhZY & 2%)! SD, S# V_c`]]WŽE YVT gWRW WZXV & UFTR eZ_ZLS"Ž& LhZYRė d? `W#%L (# def UV_ed 1Z_T]f UZ_X f_ZgWdEZdLT]]WXd R_U eVTY_ZTR] edZ_ZXTV_eWZŽ

4 YZVU Vd_`eYRgV^ R[`cZ]Z&XRJ ac`S]V dd ^ `de`V&YVUSRVZIRS`feeYVbf RZj `WUFTRZ_Ž :_ "**' eYV_Vh VUFTRZ_cWc^ SV&R_e`SVRal a]ZUŽ@_V`W&d^ RZ_ZZ&R&ZVdZleYVVieV_dZ_ `V&YVdIY``] UBLEYVRZ`SVZ_Xe`ZTCRdve`eB dIY``]Y`fcdSj #!!Y`fcdRjVRŽ2_`eYvCZHFV ZleYVdBJ1`_d&VVcj`f_XaV a]VZ_eYVdIY``] d dv^ Ž2 gRZAj `Wac`XR^ ^ VdYRgVSW_Z a]Vl ^ V_eVUe`RUUVdleYZLaR&ZIF [RC]j Z_a``cCRVRČ EYVCVf]ed`V&YZla`]ZJ RCVa]RZ_e`dVZ:_ "*)!Ł j`f_XaV a]VRXUSVehV_"&R_U #%Z_fcSR_ RVRddfUZUVCR_RgVRXV`WŽ jVRcŽ3j "**!Ł eYZlYRUZ_TCRAUSj !Ž#e` "!Ž jVRcŽ:_ #!!!L Y`hVgVLeYV}XfcVhRd" "Ž%jVRcLR_ZTCVRV`W

C f[Ub]nUl]c b UbX gffi Wi fY c Zh Y YXi WU! l]c b gmghYa

 $\begin{aligned} & 2TT \ d\underline{Z} X \ e^{-}:? \ 6L\underline{Z} \ "*! \# 4 Y\underline{Z} V YRU " \underline{H}(!) \\ & acZ \ Rj \ dTY \]d\underline{L} \ dVT \ _URj \ dTY \]d\underline{L}' \ dRT Vc \\ & edR\underline{Z} \underline{Z} XT \]] VXdR \ U \# f \ \underline{Z} VcdEZ \ d\underline{Z} \ Z' \ "*** \ eYVcV \\ & h VcV&L \ \& \ _f \ cdVj \ dTY \]d\underline{L}' \ \#*(\ acZ \ Rj \ dTY \)d\underline{L}' \ dTY \]d\underline{L}' \end{aligned}$



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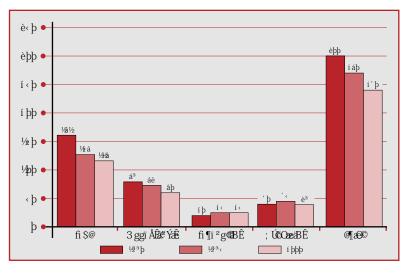
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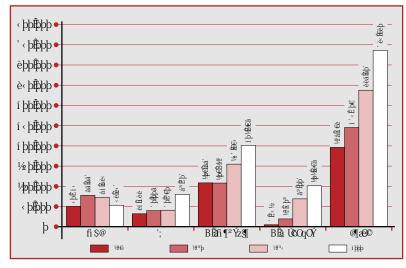
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:_ " *') Łeh `T ^ af eVcd h VcV T __VTeVU Vc eYV} cceeZ`VVgVZEYZthRdeYVSVXZ_ZX`VeYV _Véh`c_`h _`h_ RdeYV:_eVc_VéŽ:ehRd`_]j \underline{Z} "**" LY hVgVLeYRe eYV } cde Yj a VceVi e hVS aRXVhRdTeVReVUZ_eVVF_ZeVUDeReVeZEh`jVRcd $EYV:=\&c_veZeVVWe&detXchZxeVIY_`)`XZR$ $aYV_`^V__ZYf^R_YZeb`gLR_UZeYRdaV_t$ $VeReVUgZefR]j VgVg RVR`Vd`TZRLTf]efdR]R_U$ $VT_^^TZT]ZWZ:=4YZVL`_VYfdW`]UZ_dZ_Z$ $fcSR_RVRdYRdRT^afeVeLR_U(Z~YRgVR_$ $:=&c_veT__VEZ_142D6? DfcgV/Z$ @∕.łä€ =Oq¶äÝa⊖ae¶²ÝnäjøäozOŰå

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>¶ï (ģznā>ï] ÝzgĺźaÐĺ£biqza@z@g¶-ï²@Gg¶²z Ýnä>B/@ł. nai þþ½Ê

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 $\begin{array}{l} EYV^{S}[VI \overleftarrow{\partial} gV^{WeYZ}]TYRaeVcZIe^{UV}\\ Tf]efdR] ac^{3}]V^{WeYV}Tf_eejdCVZ_dL\\ hZeYRgZAhe^{UV}eZVZ_ZVeYVZ_UZWWCV_edecV_XeYd\\ R_UhVR_VddVdZ_eYVTf]efdR] \} V[UŽ \\ \end{array}$

E` $eYZIV_ULR4f$]ef dR] 5 j_R` ZI` :_UN 145:/ R_UR4f]ef dR] CVd f cTVd:_UN 14C:/ YRgVSW_ T_def TEVUŽEYVaf ca` dV` VeYVdVZIe` ac` gZUVR d_eYVeZT` gVgZh` VeYVTf]ef dR] } VJUZ_4YZVL SVRZ_XZ_^ ZUeYRe eYVCVRV^ R[` c T_dedRZed R_U dA` ceT ^ Z_XdZ_ZVC^ ReZ_LYZE` cZIR] W]]`hlfa R_UURRd deV REXRZ_Ž

$$\label{eq:constraint} \begin{split} & EYV45: \ensuremath{\mathcal{Z}} Rd_eV\ensuremath{\mathcal{Z}} V\ensuremath{\mathcal{Z}} \ensuremath{\mathcal{Z}} V\ensuremath{\mathcal{Z}} \ensuremath{\mathcal{Z}} \ensur$$

dZ_d+Tf]efd?[Z_d&EfeZ_d&VTY_`]`Xj R_UaYjdZR] Z_WRdefTefdZEYVdVac`gZVR_`gVgZh`VWRIY dXZ_Z_dV]ReZ_e`eYVRgVdRXVWceYVTf_egid "\$dVZ_dŽ

E`T_def Te eYV45: $\mathbb{R}_U 4C: \mathbb{L}\#\%\mathbb{Z}_U\mathbb{Z}\mathbb{R}^{\circ} dd$ h VEV dy VTEVU VEV eYV "& alf d $\mathbb{Z}_U \mathbb{T}_f UVU \mathbb{Z}_e eYV$ > Ra`VeYV4f] ef d? 724 JU \mathbb{Z}_4 Y24V h ZeY Reg2h e bf $\mathbb{R}_e e25/\mathbb{Z}_X eYV L25WeV_e L2^{\circ} V_e \mathbb{Z}_d^{\circ} VeYV \mathbb{Z}_U \mathbb{Z}VV\mathbb{Z}$ EY' dV TY' dV_REVL $\mathbb{Z}_e eYV [f UXV^{\circ} Ue^{\circ} VF? 5 A.$ $V_{T} X e^{\circ} dv^{\circ} h eYV dReV^{\circ} VeYV Tf] ef d? } YU \mathbb{Z}_e$ eYV L25WeV_e L2^{\circ} V_d \mathbb{Z}_d \mathbb{Z}

H YZVEYVZ_UZRE cdj ZJUR_ RSd]f eVgRff VVk: VRIY cVXZ_ŁZ_ d ^ V TRAKI TVERZ_ TCZEVCZR h VEV Raa [ZUUe` ^ R.VEYVCVCF]edac` a Vcjj T ^ a RCRS]VŽ 6RIY Z_UZIRÈ chRdR_RjdUTRAVSjTRAVR_UdZ TCZACZRhVCVCHS[ZAVUVCTR]IF]RZ_XeVVUZ_V_ł dZ_dR_UZ_UZIVAŁZ_RIT d.R_TVhZeYeVV_RefdVW eYVgRZES]VSVZ_XT ^ aR:NUŽEYVC/RC4

†EYVgR]fVdZ_RSd]feVeVc^d

 $\dagger 3j \text{ cVXZ}_R a`af] \text{ReZ}_$

 $\dagger 3j \text{ eVV}_f^ SVc^ Wr f dW^ JUdZ eVVdWZ_$

†42D6? Df cgy cvf]eLRdRaVcTV_eRXV

 \dagger DYReV ` WeYV'If] ef de] } V]U Z_ eYV e` de] Wc eYV d XZ_

† 5 ZWWAY_TVSVehW_eYVaVETV_eRXV`WeYVe`ł eR]Z_eYVAXZ_R_UeYVAXZ_`da`af]ReZ_RdR aVETV_eRXV`WeYVhY`]VTf_eg`d

DeRezteZIR| TR/TF|Rez_dh/&VeYV_TRocZU`fee` $dR_ \ eV dXZ_ dW cVRIY UZ V_ dZ_ ŽE YV gR fV d$ WcWRIYZUZIRe`chVeVefc_VUZe`KdTeVdueYV dVZ_ddT dV ^ ZfdeYV RgVdRXVLUZeZUU Sj eYV ej aZIR UVgZReZ_/ŽEYVgRJf VdeYf dT_gVceVUhVcV eYV_fdVUe``SeRZ_RgVcRXVdeYReT^a`dVUeYV }_RJZ_UVIŽEYVOVTRTIF]RoZ_d^RUVZea`dd2S]V e T^aRcVgRcZRS]Vd^VRcfcVUZ_UZXWKcV_ef_ZcdZ EYf d h Y W U f h g b h g W U d h f g c k h YdYfZcfa UbWY`cZUbm[]j Yb`fY[]cb`]b`fY`U! hcbhch\YfYgh'Bchcb`mg\ci`Xh\YfUb_[b[cZhYfY[]cbgVYWcbgXYfYXžhYfYZcfYžVih hY [Udg VYhk YYb h Ya Ug k Y " EYVcVf]ed h VEVEYV_R_Rj dVUR_UeYVdEFReZ_`V&YVEVXZ_d Z_VRIYUZ V_dZ_hRdT_dZV&VU eYVYZXV&RcVI XZ_ddT ckleYVXXReVcZedTf]ef cRJ UVgVJ`a^ V_eŽ

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EYV 45: ac gZ/Vd R $^VRf cV WeYV da VIZ T$ RI62526 XV_VREVU Sj TF] ef cVZ_VRIY cVXZ_Lf d Z_X"" Z_UZIRe cd VR_Z XVU Z_e eVVZ cVda VI625 UZ V_cZ_drdWeS]V& /Z

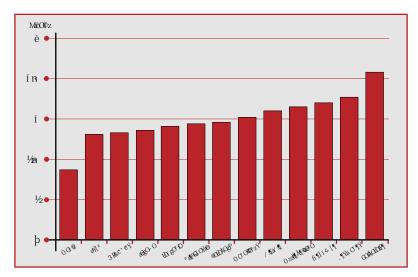
EYZEZ_UVI UZGZZNOLEYVT f_ecj`dCVXZ_dZ_e`Wfc Xc`fadudW}XfcV#%ZEYVGR]aRRR&LCVXZ_UZE a] R_{1} deVVYZXVde]VgVd`VUF] ff dR] U_R`ZI`ŽeZd W]]`hWJSj RXc`fa`VXXZ_deVRedT dVRS`gVeVV RgVRXV=`d=RX dL4`bfZ S`LeVV> Vec`a`]ZR_ CVXZ_L3¾ 3¾ R_U> RXR]R_VŽZ eYZU Xc`faL hZeY^VLZA'l]`h dT dVLT^ acZMERRARIIL2_l e`VXXRHL=R2dfTR_94L2eRIR`RL@`9 ZXZ_dR_U 2j d/2Ž=RdejLeVV> Rf]VCVXZ_dT dvd]`hVdž

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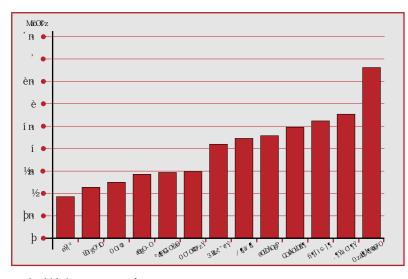
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9j YbhgʻX]a Ybg|cb EYZtl UZ`V_dZ_Z_T]f UVd eh`Z_UZTRe`cd+Wdt eZgZZtl R_UVgV_edLR_UTZ_V`RLeYVRetVR_U`eYVc dY`hdR_UaV&Vc^R_TVchdW}Xf cV#&Z

7 c eYZUZ V_dZ_ŁeYV dXZ_dVRJ TJVRcjj Z_e eYdXZ f adŽ:_ eYV} cdeZIeYV> Vec a`JZR_ CV XZ_ŽEYZIZIVU]`h UUSj =`d=RX dL4`bfZ S`L GRJaRCRA LERCRARTIL3¾ 3¾ R_U @`9 ZXZ_dŽ =RebjL> RXRJR_VL2_e VRACHL20RTR`RL> RfJVL =R2dRTR_MAR_U2j d½ dT cVSV]`h eYVR2VRXŽ

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 $EYV]VRU `VeYV > Vec`a`]ZR_CVZ_`gVc`eYV `eYVedZI]ReXVjj UFVe`eYV_f^SVc`VVIZ_V^RL eYVRevVR_U`eYVc`dr`hdR_UaVeVVc^R_TVEZYV ^`_eYj RgVeRXVZIS' dr`hdR_UaVeVVc^R_TVd aVc''! eY`fdR_UZ_YRSZR_eeLhYZVeVV}XfeVVc eYV_Ve_YZXVeHdT cZ_X cVXZ_ZI]Ved eYR_YR]W eYZh" (/Z$

= VRUZ_XeYVd/T_UXc fa ZI=`d=RX dLhYZY YRdeYV^`deWd5Z5Z3dR_UV&Y_ed+`g\c\$&& Rj VRŽ :ecR_\dYZXY\deZ_eYVT f_ecj Wcc\/ZZ fdWd5Z9RdL]`TR] TM\ScReZ_dR_UW}\Wd5Z9RdEYZTT_ecRdedL Wc VR `a]VLhZY eYV_VZXYS`fcZ XcVZ_L=R2d Rf TR_3RLhYZY cR_\d_VRc eVVS`ee`^ Wc S`eY Z_UZRe: cdŽEYZIT_}c^ dR dZX_Z TR_e WREf cV`W eYZIUZ V_dZ_+eYV^Rc\UR_U df cacdZZ XXRa d\aRReZ_XeYVeYZUXc fa Wf^ eYV`eYVccVXZ_dL Z_UZReZeV`WeYVcVReZeVj f_UVCVgVf aVUf aa]j `Wff]ef cVReYZFS]Ve`eY`cVXZ

5WhcfgX]aYbg]cb

$$\label{eq:linear} \begin{split} & E YZl UZ \ V_{c}Z \ _Z Tf UXd eYCW \ _Z UZRe \ cd+Tf \]! \\ & ef cMcMReAURCH TZRZZZG LacRIGZ \ _VcdR Ucdf UV_ed \\ & V_c \]] VUZ \ cMReAUR \ f cMchudW \ Xf \ cV\# \ /Z \end{split}$$

7 f c Xc f ad Rev UZ&Z Xf ZhVU+ eV CVZ_d`W 4`bf Z'S`R_U2j d/2 ReVZ} acea]RIVLW]`h USj 2 eRR^ RL> RAR]R_VL@`9 ZXZ_dCR[aRR84 R_U =`d=RX dR_UeYV_Sj = R2dRTR_9742_e`WARHEL ERCRARTI R_U 3%4 3%4 R_ULZ_ eV]`h Ve a]RIVL > Rf]VR_UeVV> Vec`a`]ZR_CVXZ_Ž

EYVcf cacZZ_X]VRUkchZa`VM`bfZ S`Z_eYZi UZ`V_dZ_ZIRIT f_eVUVkCSj eYV]RXV_f^SVc`W aV a]VaRceZIZaReZ_XZ_RceZteZTRiezzeZd1hcZeVcd. aRZ_eVcdL^fdZZR_dR_UaVeVkc^Z_XRced+"!Žs´´` `VeYVe`eR] WceYVhY`]VT f_ecjŽ

EYV TROV `WEYV > Vec`a`]ZER_ CVXZ_ŁhYZIY dR_\d]ROHZCIONEZZ_XZHYVCVRCIZ_RSd]feVeVc^ dZe YRd^ `cVacRI&ZZ_VCIR_U`cXR_ZREZ_deYR_R_ji hYVCVJOULhYV_eVCIV}XfcVCIRCVhVZXYeVUSj`eYVc gREZES]VoLcTTYRda`af]REZ_ŁeYVaZTefcVTYR_XXd XCVRejjZ2_UZWWCV_eTROVZIeYRe`W>Rf]VLhY`dV a``ca`d&Z_ZiVddV_e&Z]]jUFVe`]`hdefUV_e _f^SVddi# $%' / Z_Tf$]efcVicV,ReVUVX6WTfcdvZ

9Xi WUHcb`X]a Ybg|cb EYZtZ_T]fUkteh`Z_UZRe`cd+VUfTReZ_R]TgVd RXVR_U`TTfaReZ_R]edRZ_ZX1dW}XfcV#(/Ž

$$\begin{split} & EYV cVdf \] eddr h \ eYV cVdZ _ dUZgZLZ XZ e \ Wfc \\ & Xc \ f adZ 7Zde T ^ V2_e \ VMRdeR R_U > RXR]] R_VdL \\ & eYV_ GR] aRR8d R_U ERR8aRI \ Z E YV eYZU Xc \ f a \\ & Z_T] f UVd eYV > Vec \ a \] ZeR_ CVXZ_L2eRIR \ RL=R \\ & 2dR TR_8AL4 \ bf Z \ S \ L3\% 3\% R_U2j \ d/2Lh YZV \\ & > Rf [VL@ 9 ZXZ_dR_U= \ d=RX \ dcR_ \] RdeZ \end{split}$$

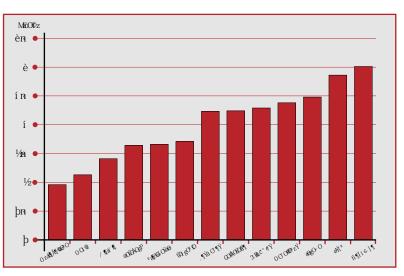
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$$\begin{split} & E YZd UZ \ V_dZ_ \ Z T]f U de YVW] \ h_Z X Z UZR \\ & e` cd _ Vh da Ra V d a V Z UZR d cR U \ dR Z_ d R_U \\ & TRS] Vel V Z Z_ TYR_ V d u dW \ Xf cV #) / Z \end{split}$$

EYVT f_eqi dd XZ_dW] Ze Wfc Xc fadZ2eeYVe a ReVGRJaR Red L3¾3¾LeYV> Vec a [ZR_ CVZ_ R_U=`d=RX dŽEYVdVRVW]`hUSj =R 2df TR_¾R_U> Rf [VLeYV_ Sj @ 9ZXZ_dLER R aRII L4`bf Z S` R_U2_e VWR REZ:_ eYVS`æ`^ Xc fa ReV2dRIR^ RL> RR] R_VdR_U2j d 2Z

EYZIZIEYV} cdeUZ V_dZ_WchYZIY eYVT f_ł eg čdeYcW^ `deYVRgZj a`af]REVUCVZ_dVRJ Z_e` eYVdR^ VXc`faŁZ UZIREZ XRT ccVREZ_SV6hW_ a`af]REZ_R_U^ VUZRUVGY`a^ V_eZ4`_gVcdVjŁZ ZdetzZZ_XEYREEYV6h` cVZ_d`VEYVVRCd feYT^ V]REH_hYV_T^^`__dV_dVh`f]Ud`XXdeeYReeYVj h`f]U_WUR^ `dvREgV^ VUZRJ dEV^ SVIRfd/`W eYVZcgVcj cV^` eV_VdZ6RIY`VEYV^ YRd[fdedh` cVZ_R] aVZ UZIRJcLY`hVgVdER_UeYY_YRgVeYV WhVdecRUZ dERZ_dŽ





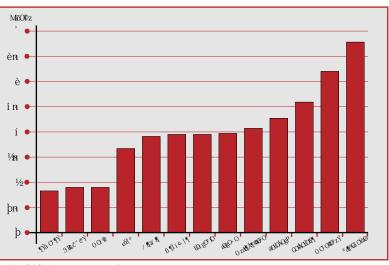
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2_`UUWWAE CVZdeYVVI TVácZ_R]jj]RXVd aa]j `VVIRS]V eVJVgZZ_ TYR_Vd Z_ GRJaRRRA ŽH ZEY ""# dZ_R]d RgRZRS]VLZE ZI ^ f TY SVeeVc d aa]ZU eYR_ eVV> Vec`a`]ZER_CVZ_LVCVI R`a]VLh YVV eYV2VRV) & TYR_VdZ2]d deZZ_XZdeVVNTeeYRe =`d=RX dYRd"') dRLZ dReZ_dLR_U eVf ddR_\d } cde Wic eYZdZ_UZRe` Z

; ccXgUbXgYfj JWYgX]a Ybg]cb

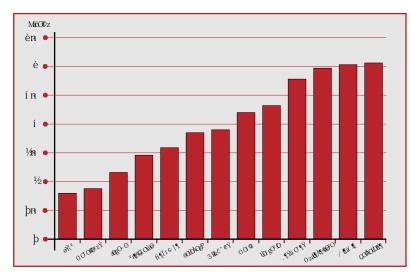
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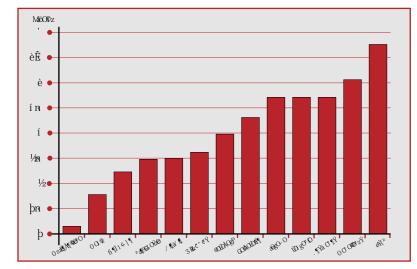
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 $EYV & VZ_d W[] Z_e` \} gVXc fadZ:_ \} cdea]RIV Zd2j d/2LW] `hVUSj > RXR]R_VdL=` d=RX cL=R 2 cdf TR_3R_R_U 2 cdR R RLeVV_Sj GR]aR R2d R_U ERCRART Z'__ eYVWf ceY Xc fa RCV@` 9 ZXZ_dL3¾ 3¾R_U2_e` VKM cdR W] `hVLLZ_eVV]R deXc falSj 4 `bf Z_S`L> Rf [VR_UeVV> Vcc a`]ZR_CVZ_Z$

$$\begin{split} & EYV > Vec`a`] \underline{Z}R_CVXZ_cR_\d] Reb SVIRf dV \\ & eRi aRj Vcd V_XRXVU \underline{Z} Tf] ef cVicV] ReVU RIZZZZd \\ & 1'' #! * #/ RcV`_] j Rd`R] ac`a`ceZ_`VerVe`eR] \\ & 1 # & (!('' * / Z)) \end{split}$$

$$\label{eq:error} \begin{split} ERS]V\& \ dr_{deV}dVZ_dWceVV \} gVUZ \ V_{deV} \\ dT_a \ a \ dr_{AeV} \\ 45: gRf \ VZ \end{split}$$

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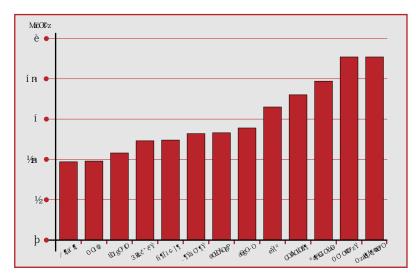
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EYZIZ UVI 14C:/UVRJdhZYeYV&VZ_dZ_dR]]VU TRARTZG WCT_UFT&ZXR_UUVgY`aZ_XTF]efd? RI&ZZZIŽEY&VUZ?V_dZ_dYRgVSW_UVZZ_VUe` TRaefcVeYZLhZY"\$Z_UZRe`cdudWerS]V&#/Ž EYV4C: UZZUVdeYVT f_egi ddVZ_dZ_e eYdW Xc f adŽEYV> Vec a`]ZER_CVXZ_R_U> RXR]R_Vd [VRU eYV dR_\Z_XLW]] h VU Sj 2_e VRAHHLGR] aRRAA R_U2j d/2LR_UeYV_Sj 2eRIR RERRARI L =`d=RX dL4`bfZ'S`L@`9ZXZ_dL=R2dfTR_ML > Rf [VR_U3¾3¾1dW} Xf dVS! /Ž

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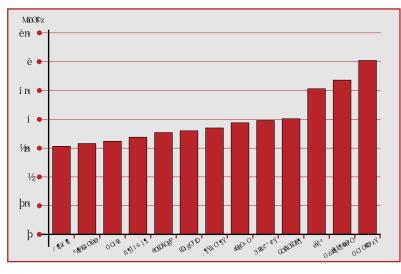
>¶ïlýznäÅlźÅOlźqäjøäB1Ł;naíþþíÊ

D\mg|WU``]bZUghi Wi fY'X]a Ybg|cb EYZIUZ`V_dZ_Z_T]fUXdeXVW]]`hZ_XZ_UZIR e`cd+TZ_V`RdNedLeYNecXELe`eR] dbfRV^ VecVd`W da`cedWNZZEZdR_UXcW_RcNetR_UeYV_f^SVc`W g`]f^ VdZ_afS]ZT]Z5dr2ZdidWetS]V&#/Ž

 $:= eYZUZ V_dZ_L`_]j eh`Xc`fadIR_SVUZeZ'$ $XfZhVUŽ:_ eYV} cdeXc`faLhZeY gRJfVdhV]] RS`gV$ $eYVRgVRXVVcR] eYVdXZ_dLRV> RXR]R_VLeV$ $> Vec`a`]ZeR_CVXZ_R_U2j d/2Ž2]]`eYVcdXZ_d$ $RVZ_eYVdXT_UXc`faŽ$

 $@VZ_eVEVdeYVeVZdeYVeCVdV_TVZ_eYV$





>¶ïlýznanÁlźÅOlźqä]øäB1L;naipþíÊ

JVRUZ_XXC fa`WAYVeh` dVZ_dZ_eYVWcd feY`W eYVT f_eejŽEYZIZIaRce20f JRcjj de2Z_XSVIRf dVZ eYV45: > RXRJJR_VdR_U2j d½ RdVU h_Z_dZ eY a]RIVR_U dvT_U W/^ JRde a]RIVLdVdaVI6ZeVjjŽ:_ `eYVch` dd1e4YdVdVZ_dRtVbf ZeVhVJ] ac`gZUU hZEY eYVZ_de3JVUTRaRIZej_WUNUVcTf Jef d3 RT6Zej Zej LSf e Zeh` f JUdW^ eYReeYVdVYRdSW_RVW2f cV e` ^ R.V`ae2 f^ f dV` WeYZŽ

 $EYV> Vec`a`]ZER_CVXZ_dR_\d] cobVceYcW`W$ eYV} gVZ_UZIRe`cdf dAU+TZ_V`RdARed_XcW_RcARd R_UeYVRec\daVcZ_YRSZER_eZ`_ eYZITRAVeYVZ_VR4 cdef Tef cVUZ`V_dZ_U`VdRTT dUhZEY eYV45:ERd eYVcVXZ_dR_\ddVT_UVCS`eYZ

 $EYV dVT _ UXc fa `WZ V dvXZ _ def c_d `fee SV^ `dvY^ `XV_V f d_d XXdz X eVRe]h]g bch bYW ggUf] mh Y WUgY h Uh W `h fU``XmbU! a]ga `]g X]fYW mXYhYfa]bYX `Vmc f`fY`UhYX` hc `U`fY[]c bly [bZUgfi Wh fY'' 3j R_U]RXLeVV 45: TYRedd `h X&Re&cgRZRZ _ dR_UUZWWZ TVd R` `_XdvZ _ dZ$

HYW.bc`c[miX]a Ybg]cb

$$\begin{split} & EYZIZ_{1}fUXI \ gVZ_{2}UZIRe^{C} cd_{+} \ i \ U eV_{1}VaY_{V} \\ &]Z_VL^{S}ZVeV_{1}VaY_{V}_{V} \\ & IZ_VL^{S}ZVeV_{1}VaY_{V}_{V} \\ & T dVXdaVcYfdVY_{1}ULT^{a} feVcdaVcYfdVY_{1}U \\ & R_U: eVc_VF_{VEZ_{d}VCYfdVY_{1}UUdV} \\ & XfdV \\ & S\#/Z \end{split}$$

 $:eZIYVEVeYRe]RXVZ_VbfRJZ3VdReVVf_UŽEYV eVZ_dVRJ]TJVRejjZ_e eYeWXcfaeZieYV}ce`_VL T^acZiZ_XeYV>Vec`a`JZR_CVZZ_L>RXRJ]R_VdR_U2_e VRXRdHZZIVV]`hVUSjRXcfaT^a`dvU `VGRJaRR324_R_UERCRARTIŽEYVS`ee` Xcfa T_eRZ_d33V433VL2jd2L=`d=RX dL@`9ZXZ_dL 4`bfZ S`L=R2dFTR_3RL2eRTR^RR_U>R_JVZ$

:_ eYV TRdV `WeYV > Vec`a`]ZER_ CVXZ_LZEd $d\mathbb{R} \setminus \mathbb{Z} \times \mathbb{Z}^{1} \mathbb{R}^{1}$ [J Uf Ve`YZXY eV]VaY_j aV_VedN $e\mathbb{Z}_{LS} eY$ } iVU]Z_V1"ZS]Z_VdaVc Y f dW^]U/ $\mathbb{R} \cup ^{SZ}V1S\# ^{SZ}VaY_VdaVc"!! aV a]VZ$ > RXR]]R_VdR_U 2_e`VXXRdER $d\mathbb{R} \setminus hYVCVeYY$ U ^ \mathbb{R}^{2}]j SVINF dV`VeYV_f ^ SVc`VY`f dVY`]UZZV cVT dVcdLT ^ af eVcdR_U:_eVc_VET __VTeZ_dZ eY`dVcVXZ_dZ = RXR]]R_Vd2% `VVcSR_Yf dVI Y]UdYRgVRgZUV L#& RT ^ af eVcR_U" # R_ :_eVc_VeT __VTeZ_Z
$$\begin{split} & EYVCVZ _ hZY eYV]`hVde i VU]Z_VeVVAY _j \\ & aV_VeReZ_ZI> Rf]VLhYZVeVV_VhZY eYV]`hVde \\ ^`SZVaV_VeReZ_ZI2j d2Z2dCVRUUY f dVY]U \\ & eVTY_`]`XjLZ_2j d2 [f de #! ~`VVY f dVY]U \\ & eVTY_`]`XjLZ_2j d2 Rever dVZ dVC; Z > Rf]VL*ZX \\ & YRgVRT ^ af eVC; R_UZ_4`bf Z S`LSZX RVT_1 \\ _VIEVUe eYV:_eVC_VZ \\ \end{split}$$

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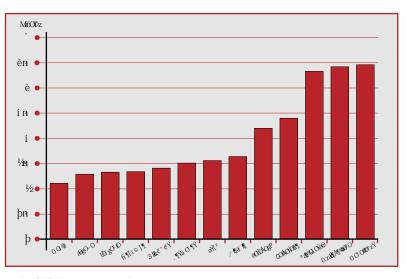
 $\begin{array}{c} {\rm EYZl} UZ^{*} V_{-}dZ_{-} Z_{-}^{*}T]f UVd eYcW Z_{-}UZRe^{*} cd \\ {}^{+} f dvf^{*} dLXR_{-}^{*}U JZSdRZdL^{*} f_{-}ZZaR_{-}^{*}Red \\ {\rm TV_ecVd^{*} c^{*}Tf} ef dR_{-}^{*}T ca^{*} dRZ_{-}dLR_{-}^{*}US^{*} \ dr^{*} ad \\ {\rm 1dW} Xf dVSS/Z \end{array}$

 $8 \vee \forall R || j dv R \cdot Z \cdot X \cdot Y Z \cdot Y \cdot R \cdot U || h g R f \cdot V R R \cdot V \cdot e$ $eY R e W c R R \cdot e Z \cdot 3 \cdot 4 \cdot 3 \cdot 4 \cdot Z \cdot R \cdot M \cdot R \cdot e Z \cdot Z \cdot Y h \cdot V \cdot V \cdot Z \cdot Z \cdot R \cdot M \cdot h \cdot f \cdot Z \cdot Z \cdot R \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot e Y \cdot Z \cdot Z \cdot R \cdot E Y \cdot E Y \cdot Z \cdot Z \cdot R \cdot E Y \cdot E Y \cdot E Y \cdot E Y \cdot E Y \cdot E Y \cdot E Y \cdot Z \cdot Z \cdot R \cdot E Y$

$$\begin{split} & EYV def ReZ_R d & AR d & f_ZZAR Red TV_e & d \\ `c Tf] ef dR T ca`dReZ_d & Zlgkj UXWWEV_e Z_eVV \\ & d & XZ_d`WCR a R & L2_e`WWAR R_U & d & R \\ & h & YV & * ~ L' (~ R_U' (~ WT^{h} f_V & d & VI \\ & h & YV & * ~ L' (~ R_U' (~ WT^{h} f_V & d & VI \\ & egy & J & L & R \\ & f_V & f_V & d & f_V & f_V & d & I \\ & egy & J & L & R \\ & f_V & f_V & d & f_V & f_V & f_V & d \\ & egy & J & R & f_V & f_V & f_V & d \\ & f_V & f_V & f_V & f_V & f_V & f_V & f_V & f_V & f_V & f_V \\ & egy & f_V$$

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 $EYV UZWWEV_TVd Z_eYV dR_\Z_Xd eYV dVZ_d$ RIYZGVZ_eYVeh`Z_UZIVdXGVR_ZJAR`W`h hV] RCVZ_dTf]ef cR_U_R^Zh^ RETVdeYVTf]ef cR] cVd f cTVdRgZJRS]VŽERS]V&&ch`hdeYReeYVCVZ_d hYVEV eYV eh`^RETY^`de T]`dV] REVERBARIEL @`9 ZXYZ_dR_U > Rf]V1VRTY RE RUZWWEV_e]VgV/Ž EYVCVZ_dhY`dVeh` dR_\Z_XdRVVKdeYvdeRaRee \$'%B=ł ä≥í @zgoe²¶¶" øäq≎ z²Ý¶²

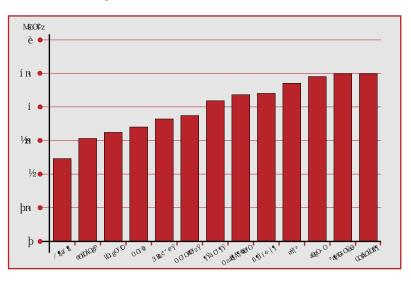


>¶ïlýznäÅlźÅOlźqä]øäB1Ł;näíþþíÊ

 $\begin{array}{l} RV33\%43\%4h \fbox{P} RUZWWEV_TV^{M}4A^{b}fZ^{S} R_U \\ = \ d=RX^{d}h \Huge{P} RUZWWEV_TV^{W}RU2j d_{2}h \Huge{P} F \\ RUZWWEV_TV^{W}(\H{Z}) \end{array}$

:_ eYVTRW`W2jd $_2$ LeV_WREZV $dX_ ^ VR_d$ eYReZe $_d$ _dYZXV&Z_ eYV4C: eYR_Z_ eVV45:Ž :_ `eYvch`ddLeYVdXZ_ ZUVKCjj hV]] V_U hVU hZeYTf]ef d?] ddf cTVdLSf eZdTf]ef d?] Uj_R`Z' ZIdV[REZVj]]`hŽEYVZ_T_dCeV_Tj Z_ eYZTRVZI eYRe2j d/2 YRdT_dUARS]VZ_dR]]VUTRARIZ; Vc df aa` ceZ_X `c VCeVZ_XTf]ef d?] REEZGjLSf eeYZd REEZGj ZL_`eVV]j UVEV[aVUZ

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>¶ï ÚgznäÁlźÅOÓzqä]øäB1Ł;naíþþí Éa

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 $\begin{aligned} & \operatorname{annumental matrix}_{2} \operatorname{got} \left\{ \begin{array}{c} \mathsf{g} \\ \mathsf{g} \\ \mathsf{g} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{g} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{e} \\ \mathsf{f} \\ \mathsf{e}$

>¶ïlýzmäÁlźÅOÚźqä]øäB1Ł;mäiþþíÊa

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>¶ilýznaklúz AOÚzqa]øa B1L;naiþþíÊ

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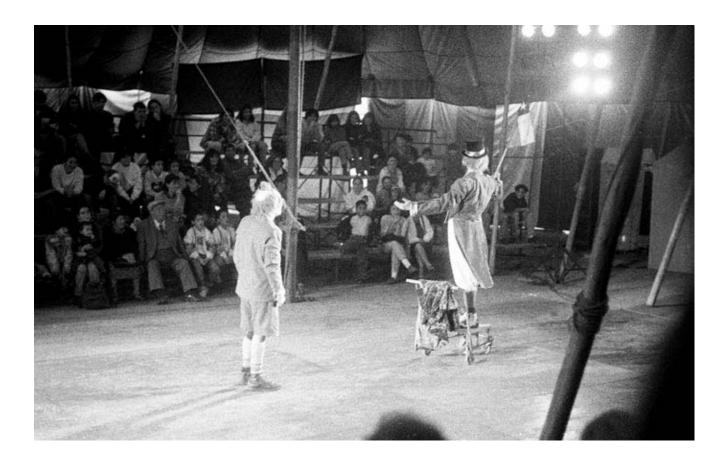
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$H_{c}9^{\circ}8=J_{c}9FG_{H}MC$: 7I @H F5@7CBGI A DHCB

5 ```h.Y.Yj]XYbW' UbU`ngYX g\ck g h\Uh a Uf_YX]bYei U`]mcZUVWYgg hc W `h fU`` Webg a dhcb]gU fYW ff]b[Z/Uh fY cZ7 \]`! YUb gc WJYm' 7 ceYVgRe^ R` cZj ŁaRczZZRZ_ Z If]ef cR] T_d ^ acZ_ZI]Z ZAUe eVJVZZRZ_ R_U cRLZ ŁZ T ^ VSVZ XeVV^ RZ_WATE ceYReUAcZyd aV a]V` WRITVdle` eYkc \Z UZŽ

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@WR] eY dVZ_ektgZh UU kć eYVF? 5 A #!!" Df cgYjŁS' ~ YRU S`f XYe_VhdaRaVcdZ_eYVaRde hWVŁS#~ YRU af cTYRdNU`c`eYvhZhV`SeRZ_VU ^ f dZT eYY_hVEVZ_ektVdeVU Z_UF cZ_X eYV aRde ^`_eYŁR_U#(~ YRU eRVV_deVade`af cTYRdV`c `SeRZ_eYVS``\deYY_hR_eVUZ_eYVd?`VaVzUŽ H YZV" & deteVU eYY_YRU SW_e`eYVeYVRevL ^ f ddf ^ d`c V YZSZZ_dZ_eYV]Rde eYVeYVRevL [f def ' d`c V YZSZZ_dZ_eYV]Rde eYVEZV RZ_ eYV]Rdeh WXŽ@_]j "#~ YRUSW_e`eYVIZ_V RZ_ eYV]Rde^`_eYLR_UR^VEV*~ dzU eYY_YRUSW_ e`T_TVccdZ_eVV]Rde eYW^`_eYZ2^`_XeY dV hY TRozZU`fed^VIFjefcR]T_d^aeZ_Ł%/ WeeYReeYW/RIezzeZdYVjaWeYV`e`UvgV`aRd ZUzzLFR]d#(″eYReeYVj XRgVeYV^``dve`eR]\ RS`feLR_U#*″eYReeYVj RIbfRZ_eWeYV`hzeY `eYvchR]d`WzeZ_XR_UeYZ_\Z_XŽ

 $EYVXV_VR_UZdezSfeZ_`WF_]efdR_T_d^aeZ_TR_SVR_R_jdUfdZ_XRd_eYVeZTZ_UM_T^SZ_I$ $Z_XdvgV_ZeV^d`_R_RUZEgVSRZH_VhchRaVcL$ $aVZUZR_dS``\d_fdZLTZ_V^R_VYZSZZ_dR_U$ $T_TVccZEYVR_R_jdZdhRdc/dczZeVUe`eYVd/dvgV_$ $ZEV^d`_eYVSRZE!eYRe eYVj_hVCVeYV`_Vd^`ce$ $T^^`_jj_Rd1ZZeVUhZeYTF_]efdR_T_d^aeZ_Ž$ $@SgZ_fdjLeY`fXYLeYVCVRV`eYVcRIeZgZZdeYRe$ $TR_SVT]Rd2_VUR1dTYLeYVgZZ_SVZ_XeYVacZ_V$ V KR`a]VŽ

7 cT ^ aRdRegVaf ca`dvdL]RdejjLevVZ_UVi hRd UZgZUVU Sj Tf]efd?]T_df^ aeZ_]VgV]Z_e`Wfc Xc`fadŽ

A]b]a U`Wi hi fU`Wobgi a dh]ob

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 $2eS) ~~ VeYVd? a]VLeYZIZIeYV]RXVeZ`fa ~~ VeYVWfcZ`_eYVZ:VeYVeZ`VLReeYVhWVV_UEYZd ~~ VSVd^ RZ_j hReYYeYVeZ`VLReeYVhWVV_UEYZd ~~ V^SVd^ RZ_j hReYYeYVeZ'L_R_UEdezZ_XjFL ~~)~~ VeYV^ cBj eYVj YRgVIRS]VeYVgZZ_Z eYVZ: Y ~~ VEZVIREgYj]RcXVac`a`ceZ_d`VeYV^ RcV RXU && R_U`gVEW RJVL^ V^SVd`VeYV]`hVc d`TZIVT_`^ZTXc`fa R_UcfcRJZ$

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EYZUXC faLUY_URDR] eY dVhY YRgVT_ł d^ W[fdc`_V`WYVdyZ ZeV d]ZHVLŁT^ acZud #& `WAVa`_UV_eZEYVZcTf]dfdR] T_d^ aeZ_ ZUX_VR]j T_}_UUe`_VhdaRaVdthYZY8#" `W eYV SfjLR_US" ~ `WYV dJ eYY YRgVIRS]VeNV gZZ_Z_eNVZ Y^ VZZ dV[REGV] YZX ac`a`ceZ_ SV]_Xe`eYVZ eVc* WZRVd TZ IVT_`^ ZTXc`faŽ

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$$\label{eq:constraint} \begin{split} & E YZ dX^{\circ} f a \ T \ ^ a c Z M d\# (\ \ \ \ \ W A da \ _ UV_e dR_U \\ & Z T f U dR_] e^{\gamma} dV h \ Y \ T _ d^{-\gamma} V eh^{-\gamma} c e^{\gamma} dW^{-\gamma} W V \end{split}$$

d&V_Z&V d]Z&VZ2]eY fXVeVY YR&VRd SdR_eZ]V&V] `VVIf]efd] T_d^aeZ_ŁZe W]dhV] dY`ce `V&YRe`V&VYZXYV&T_d^aeZ_XC faLhY`dV ^ V SVcdRVVRC^`cV]ZVj e`ReV_UT_TVcdZ aRczIf]RZEYZZZe&C^VZRVXC faZUZ&ZAYUU Sj ZedT_d^aeZ_`WfdZT1&` /LhYZYT^Vd dVT_U`_]j e`_VhclaRvC cVRUZ_XZ:ed^V SVcd ReV]ZVj e`SVj`f_XaV a]VRXU") e`#%L^RJVL R_U^V SVcd`V&YV^VZAAJVRXU") e`#%L^RJVL R_U^V SVcd`V&YV^VZAAJVRXU") e`#%L^RJVL

<][\ 'W' 'h fU' 'Wc bgi a dhc b

EYZdXc f aLh Y dV^ V SVdT _d ^ VSVahW_ WfcR_UdvgV_`WeVZeV^d]ZeVULZdeYVd^R]Vde $\operatorname{Re}\left[\operatorname{feb}^{"}\right]^{"} WeVdR^{a}VZ4^{-}dr^{a}Z_{Z}ZYZY$ Z_R] TReVX cZdLhZeY T_TVce ReeV_UR_TVdT cZ_X] h = 1Zed ^ V^ SVed Zd_`e Re eYV ViaV_dV`WeVjVgZdZ_ $T_d^{aeZ}_{Lh}YZYZdRd YZXYZEYZdXc faRd$ YRdeYVYZXYV& Wgy`WRTVdde`TRSJVeVJVgZZZ_ Z_ eYVY^VI'! / /Ž2deYVZcac`} [Vh`f]Ud'X XVdeL^V SVcd`WeYZclXc`faeVUe`daVUeVVZc hWV_UddVRUZ_XU]ZdeV_Z_Xe`^fdZlLX_Z_Xe`eYV TZ_V R`cT_TVadR_Uaf of Z_XakVTZ; TY`SSZAŽ > dedWeYdVRIeZeZdRdRhR `WVgY`aZXRd \underline{Z} Uz \underline{Z} Lf R \underline{Z} 5 V^{$^{\circ}$} XRaYZR \underline{J} LR RXVac a \underline{C} RCVRXVU") è \$%R_U^R]VLSV]`_X è eVVYZXY d TZ łVT_`^ ZTXc`fa R_U ZzVZ_fcSR_DR_eZX Ž >`de`WeYV^ RcVdefUjZ_X`ch`c\Z_XL`WeV_ Rd ac`WadZ_RoŽ

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@_V`V&YV^`de^Rc\UUd\REZ_dAZdZleYRe SVehW_dTZSSZZEj R_UTF]efd?]T_d^aeZ_Ž EY`dvhY`T]RZ`e`SV^`deZeVXReVUZe`dTZR] _Veh`c\d.ZZZZ.eY`dvhY`YRgV^`de VZZ_UdR_U V_[`j`eYV`dv]gdhZEY`eYV`LR_UhY`YRgVYZXYC]VgV]d`V&RezTZARZ_Z`cXR_ZREZ_d.T_d^V ^`dvTf]efdŽ2eeYVd?`VeZ`VLeYVdVaVa]VRV]VdlacZgRJjl`cZZ_eVUR_UYRgVRSc`RUCdTZR]Y`l cZc`_Ld^VEYZ_XEYReZI^ R_ZWEVUZ]`hVc]VgV]d `W`Zterf de`hRUd`eYVcZZjT_eRZMEVUZ]`hVc]VgV]d `W`Zterf de`hRUd`eYVcZZjT_eRZ_d`hdRT]VRc eV_UV_Tj e`SV^`cVVR`ZjlR_UacZgRJjl`cZ/eVU R_U]VdlacfdZ_XZ

9 ZXY & TF] ef d?] T_d^ az_L Re R_j ZT ^ V [VgY] R_U Z_ R_j VT_` ^ ZT def ReZ_L ZI R]d Rd d TZENU hZY R XXRN & RaadVIZEZ_ V& UZY dZj R_URXXR & CadVIZE a dEZ_ e hRdde [VCR_TVR_U _` _ HZRZ Z_RZ_ŽAV a] VZ_ e ZZIX c f a R]d dY h T_dZEV_ej YZXY & [VgV]d` VZ_UZZU RZRZ Z`:_ ` eY & h`dd e YJ RV` dZ_e Ue hRddd / WV & d ^ Z_RZ_L dy NA VIZ_ R_U dy NA RZRZ Ž =RteljiLeY`dVhY`dVTf]efdR]T_d*aeZ_Zl YZXYdeeV_Ue`UZta]Rj Rdec`_XdcTZgZTReeZfUZŽ EYZEIZh^R_ZWOEVUZ_XXRevCRaadVTZReZ_WcUvi ^`TdRIjLXXRevCT_TVc_WcT^^f_Zj RWKZd R_U]Vdtla`]ZZTRJUZRWWTeZ_Ž3j T_ecRteLeY`dV hZEY]`hVcTf]efdR]T_d*aeZ_eV_Ue`SV^`dV UVRTYYUWY^ eYVdVeYZ_XZŽEYVj RtVZ_UZWWEV_e e`UV^`TdRIj R_UeV_Ue`eYZ\eYReVgVj`_VyYRd e`XdeSj eYVSVdeeYVj TR_%Z

H YReZ a ZREZ_dU eYVÅVRH TZEZ_dYReVVć eYVTYR]V_XdSVZ_XRUUVÅHUZ_eYZIARe`V&YV CVa`œOH Y WebWi globggi [Yghih UhXYj Y'! cd]b[`[fYUHYf cddcfhi b]HYg Zcf UWW/gg hc` W 'hi fU``[ccXg UbX gYfj]W g Wei `X`\Y'd hc` Z fh\Yf U W 'hi fU``YbHYfdf]gY 'HUbgWYbX]b[` h\Y]bX]j]Xi U`gd\YfY UbX'dfcj [X]b['h\Y'VU! g]g Zcf U'a cfY VfcUX`mfYÛYW]j Y gcWJYm'

=``\UPEW^ eYZIdeR_Ua`Z_eLeYVZ'a`d eR_TV`WhYReeYVTF]efd?]Z_Ufdeg YRde``WWCZI V_YR_TVLŽ4R_RXXReXcacVLZa`dEZ_e`d TZA Z_eXXREZ_SVTEXREVUSjT_df^aeZ_`WFF]efd? X`UdR_UdvgZVdD4VceRZ_jjLdZ'a]ZEZT^VTYR _Zf`dYRgV_`a]RTVYVEVZ?`_VEYVVELEYVVgZ UV_TVdW^de`dfXXdeR_`aa`cef_ZjZleYVEVZ

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2deYVURRdvéWæYTJVRcji ckýkRjL2; fih Y j Ugi a U'c f]mic Z7 \]YUbgžW' h fU`We bgi a dhje b`]gWe bÚbYX he h Y We bgi a dhje b c ZhY Y j [gje b` Ug h Y ge Y c f'd f]a Ufmige i fWY c ZUVWY gg he ']bZ fa Uhje b UbX Y bhYfhU]ba Y bh': e ZheY keW keV gVej Z' a` ceR_ee`]`` \ T]` dVji ReeYV cV]ReZ_dYZa SVeh W_eV]VgZZ_R_U VgVej UBj Tf]ef eVZ_4 YZV e` URJŽ

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EV/VgZZ_gZh/VdRtV_`h_e`SVYZXY]jdA4 ^V_eVLLR_UZeh`f]USVa`Z_eVdde`ReeV^aeR UVCRZaeZ_`WeYRegRtZkjZ?`_VeYV/VdLetVF?5A #!!" DfcgyjacgZtVdR_Raac`iZ_ReZ_ŽEYcW ejaVd`W&ZhV&TR_SVU&&Z_XfZhVUŁZ_RTT d.R_TV hZeYeYVadWW&V_TVdRdTVæRZ_VUŽ4`_eeRgiehYRe ^ZXYeSVViaVT&UŁ_V&YVcdTZHVT`_`^ZTdeRef^ _`cVUfTReZ_R]JVgYJ_`ca]RTV`W&ZUV_TVRWWTe eYVZcT_}XfdReZ_Ž

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EYV]RX&deac`a`ceZ_`V&YV4YZJVR_dZ_e&d gZhWJ1%/~/SVj`_Xe`eYVejaV`WAFUZ/TVeYRe fd&deJVgZZ_ WcV_e&deRZ^V_eZEYVj efc_eYV eMVgZZ_`_hYV_eYVj X&eY^VR_UeYV_eYVj aVcd_RJZVeYVZcgZhZ_XSj TYR__V]Y`aaZ_XZ >RJVdR_Uj`f_XaVa]VRXU") e`#%ac&U^Z _ReVZ_eYZdXc`faLhYZIYh`f]URIT`f_eWc&YV ac&WEV_TVWcda`cedac`XR`^Z_XEYVj RJd eV_U e`aeWc}]^dR_Ud&Zdac`UfTWRSc`RLLRdR hRj`W&RZ_XŽ

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2 gkg UZWWCV_eXcfa ZleYV`_V^RUVfa`W ZUZgZLfRJdhY`fdVeVJ\gZZ_RdRdfcTV`VZ_Wd ^RzZ_ŽEYZRFUZV_TViS''´ / efc_deYVdke`_WcR daVTZ;Tafca`dve`hReTYeYV_Vhd`cd ^VdaVTZJ TfccV_eRWWCdac`XR`^ VŽ:ed^V SVdRV^`cV JZVJj e`SV`JUVcRUfJedR_Ue`SV^`cVZ_eVcVdeVU Z_yhYReZdX Z_X`_Z_eYVTf_eqj%Z

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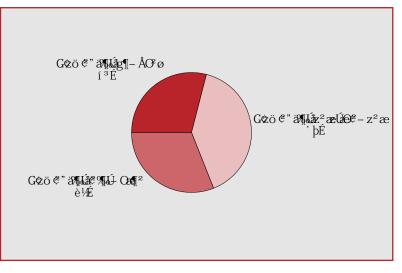
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DVT_UjiŁeYVeZ VdaV_ehReIYZ_XeVJVgZZ_YRd e`SVT_dZNOVLŽ5ZWWOV_edefUZdddvgvRjZedVieV_eŽ 2TT d.Z_Xe` eVV Revele df cgV/ RePARS VW/^ eVV ? ReZ_RJEVJV@ZZ_4`f_TZJ14`_dV[`? RIZ_R] UV EVV2ZZ_€4?EG/1#!!!RŁT_UFTeVUZ_"***Ł RgVdRXVeVJVgZZ_Via`d`dVeZVhRd#Y`fcd&& ^ZfeVdaVcaVcd aVcUR Z "**** LT oXLV/ZX S`eY`aV_eWygZZ_R_UaRjeWygZZ_Ž2dZ ZRc R^`f_e`W&Z VhRddaV_e |ZdeV_Z_Xe`eYVdRUZŽ 2_`eYVc^ VeY`Uf dvdeYVV/VTec`_ZTyaV a]VI^ VeVc‰ ^ VRfcV^ V_edTRczZU`feSj RaczeReVT ^ aR_jŁ EZ VI:S`aVŽ:_ #!!!LRgVdRXVgZhZ_XeZ VhRd\$ $Y f d' S^{Z} f d S d T U R L R Z T C R V W$ $R^{\uparrow} = dR_{T} + dL_{TV} + \delta Z = VVSZ + dL_{TV} + \delta Z = VVSZ + dL_{TV} + \delta Z = VVSZ + dL_{TV} + \delta Z = 0$ $ReVaVa[VW^{\prime} eYV]$ hVc d TZ $VT_^{\prime}$ ZT VeV[L]h`^V_R_UeY`dVRXVU`gVc&&Ž

$$\label{eq:constraint} \begin{split} & EYZUJj LZEdr^f JUSVeV^V SVEVUeYReeVVgZZ_\\ & T_dr^aeZ_Zl^W_T^SZ_VUhZEY^eVcRIegZ. \end{split}$$

eXeLJZVVRZ_X`ccVRUZ_XeYV_VhdrRaVČ_`eYVc h`dULeNVgZZ_fdVZIRTEGVR_UdNVTEGVŽ@V8V_L ZEZIRd TREFRIR_Uc`feZ_VR_UZ_g`lgVd`_jjaRce`W eYV^Z_UŽ2TT dZ_Xe`cVARCTYSj4Rd`d4ReRi 1#!!!/LgZhZ_XZIRdT`_URG_RTEGZEj VcRS`fe % ~``WeYV eZ_VdaV_ehReTYZ_X`aV_R_UaRj eNVgZZ_RZVŽEYVF?5A#!!"DfcgVja`Z_ede` eYVdR`VT_TIfdZ_LZUZREZ_XeYRe"S~``VaVaJV efc_eYVeNVgZZ_`_WcT^aR_jLYWUZ_XZe`_jj

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 $5 V/ZSVERAVJj `c`eVVchZMLaVa]VUEh`_eVV$ $dZ_dR_Ud_S`]deVReeVVZZ_ac`gZVde`TeVReV$ $R_Z RW`WhYReeVVJReV`chR_ee`SVLR_Ue`$ ZeVcackeeVV^VR_ZXd`WZWZ_dTZkjZ2d;Vd/d $> Ree/43RSVc`1"*))/a`Zed`feLeVVVV_TeZ_$ `VeVVZZZ_ac`gVdES`gVR]Le`SV`_V`W`VZR $eZ_, `c deVVdLZeac`gZVdRhVS`W`VZRZ_d$ SVchW_aVa]VdZgV_egVTRATZZdR_UeVVdTZR cVacVdZedZ_dR_U_`c^ deVRedTZkjSc`RJRded eYc`fXYeVVgZZ_^VERVZZTTdZXe`eVV $F?5A #!!"DfcgVjL4YZVR_dacWVc_VhdLTfd$ $cV_eRWWZdac`XR`^VdE}]^dcb`cedac`XR^^Vd$ $<math>R_UdVgZZ$

 4^{+} c^{-} Z XhYRe hRd df da VTeVL def UZd df h eYReaVa]VdUVI]RCVUXV_cVacVWcV_TVd`_j aRd eZR]]j ^ ReTY eYVZc RTef R] T _df ^ aeZ _ 1 Rd^ VRef cVU SjetVaV a]VI^ VeVcR UY fdV]UdeZ XZD Ra `aVARL_Vhdac`XAR^ ^ VeL}]^ dR_U^ ZTV]]R_V f d ac XR^{$^} ZXRCVR$] ^{$^} CV c$ [VdUbf R]] hV] dval</sup></sup> ckd/_eVLŽD Ra`akRd dW^ e` YRgV eVV YZXYke RTef R] dReZ_XdZ_ ^ `de dedReRLR_UTYR__Vjd.eV_U e Xzzverv acz czą RdRcvff jeży2 TYR_Vj zd_`e dW_ RdR df TTVdd SVIRf dV ` WZed_Vhd ` c TV/VScZej ac`XcR^ ^ Voz) h d TTVddf RTYR_V ZddW_e SV UVaV_Ud`_Y`h a`af |RcZedd Ra`aVcRZPZGZhVcd f_UVadeRUeYZŁRUdURLeVazZWaZWaZWaZWaZWa ZŁRIT d.Z.Xe Rdłczenczewie yXzyvaV a VeYV `aa`cef_Zeje`]ZeV`feeYVZcU&VR`dgZTRcZfdj%Zu D'Ra`aVaRd^`SZZKVR_URTefRZKVd'TZR|Z'RXZ _RcZkd+yj`fRcVRaaVR]Z_Xe`hYReZclZ_aVa]Vd $T \parallel VI \in V f_T_d I Z f d \sim 6 D S R \cup ^ R X R Z V L 6$ > VćIf cZŁ#?`gV SVc#!!"/Ž

2_`eYVchBj`WMR^ZZXRIFB]T_d^aeZ_ Sj XV_dVZle`dWhYZTY ac`XR^ VdRV^`de hRETYVUŽ2deRS]V&) dr`hd_eYV"!^`cehRETYVU ac`XR^ VdZ_eYV} cdeYR]WV#!!"Z]TJfUVeh` d Ra`aVRdR_UR^ VUZRVgV_dLSfeR]d_RTfccV_e RWWXdac`XR^ VR_UR_VhdSf]]VZZŽ

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2 def Uj T_UTEVUSj eVV> ZZdej `WA]R_ZX R_U4``aVCR2_1#!!"/`_ eVVSRDCI`WAV7R`ł Zj 3f UXAE Drogyj R_Rj dU Wfc RAVEL RLaRe `W Y f dY']U Tf]ef d2] T_df^ aeZ_+]ZeVCREf dV R_U acZ_e^VUZRL RF UZ ł gZef R] X`UL R_U dx gZTVŁ ^ f dZL R_U gZef R] ReeZ: e R]d Z_TIf UVU R_y eN Vcd% TREVX cj ZEYV`gVCR]] dxf]e dx`hd eVRe Z_ "**' ł"**(L'S´`VY`f dY`]UL af cTYRDU`_V`c `eYVc`V&YVTF]ef d2] X`UL R_Udx gZTVd^ V_eZ_VZ EYZLaVCTV_eRXVCA dxU/_edR]RXVZ_TCVRU^ gVceYV "*) (ł"*)) a VZ U1&" /Z

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 $4^{d} acZ_S j$ TREVX of UZ2ZVdfa UZ3Wd V_elj UVaV_UZ_X`_hYZIYd TZ IVT_`^ZTXc fa Zl eR.V_ŽEYVR UZ I gZfR] dvTe cZleYV^`def_VbfR]L hYZV eYV JZEVCREF dV R_U acZ_e^ UZR TREVX of Zl eYV`_VT_df^VU^`deVgV_]j RTc ddeVVZ_T^V bfZ_eZVVŽ

$$\begin{split} & EYVUV_{j}_ZZ_`VWF] ef cR_{j} T_d^{a} eZ_f dVU\\ & Sj eYV> Z_Zdeg`VVA]R_Z_XR_U4``aVcReZ_V_{j}\\ & T^{a} aRdtMUeYVTF] ef cR_{j} ac`UFTed^`deT^^`_] j\\ & cVARcUVURdSV_{j}`_XZ_Xe`eYZd_{j} VJUŽEYV7R^Zj\\ & 3f UXAEDF cgy_{j} V_RS_JVU ac`XVcHe`SV^RUVe`_{j}\\ & hRcURRVM_{j}VcR_R_{j} dZ_{i}T_gVcZ_X`eYVcX`UdR_{i}U\\ & dvcgZVdRdhV_{j}Z \end{split}$$

H YREREVEYV def Tef del Y f d.Y [UTYREREVEZ de ZT Roth TZREVU h ZEY YZXV (c TF] ef del T _ d ^ aeZ_0

=Ve Ze SV dZU`_TV RXZ_ eYRe W`h fU``We b! gi a dh]c bž Ug XYZ]bYX`]b`h Y`A]b]ghfm c Z D'Ubb]b[$UbX.7 ccdYfUl}cbghiXnž]gghfcb[mi$ WebX]h]cbYX.VmiX]gdcgUV.Y]bWea Y" EYV $def Uj Z_UZReVd eYRe Ze Zel eYZd gReZES]VL dReYVc$ $eYR_ R XeVReVc `c]Vdb/c acWWeV_TV Vc Tf]ef dR]$ $T_df^ aeZ_LeYRe RIT f_ed Wc eYV UZWWeV_TVZŽ$

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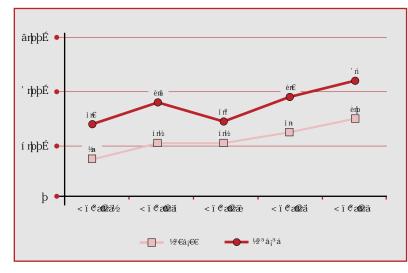
$$\begin{split} & \text{EYZ}(cMReZ_dYZ) Z(R)d \quad U^{\land} _decReWUZ_UZ(VR); L \\ & Z_eYVWc^{\land} WT ccMReZ_d SVehW_ eYVWFTR1 \\ & eZ_R] RecRZ_^ V_ed`WeYVYf dW^]UYWRUR_UeYV \\ & UVaV_UV_Tj dReVZ_eYVYf dW^]UZ(Z_R); dZ1`WeYV \end{split}$$

 $\label{eq:constraint} $$ VIf] d d T_d a Z_Z CVRZ_e e $$ Y f d Y JUZT V ZV A V ZV SVRd f e Zd XV VR a] ZRSZZGZ$

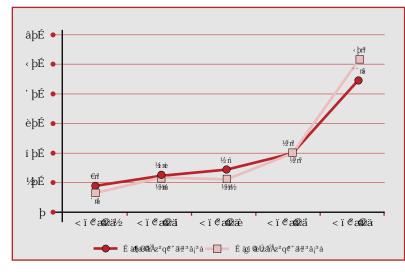
7I@HF5@7CBGIADHCB`5B8`=B7CA9.`@B?G`5B8` DCH9BH5@

 $\label{eq:linear} \begin{array}{l} H \ YVcV \ eYV \ cV] ReZ \ _dYZa \ SVeh \ W_ \ TYR_XVd\\ \underline{Z} \ \underline{Z} \ \underline{T} \ ^V \ R_U \ TYR_XVd \ \underline{Z} \ Y \ f \ dY' \]U \ Tf \]ef \ dR] \end{array}$





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EYZI UV``_dedReVU a`dEZgV VJReEZZgi R_U R_ Z_TEVREV PZXVEZ_T ^ VJVgVJeLJZVEY dVdW_Z eVVT_`^ZTT_UEZ_d`W*)) R_U"**(ŽEYf dL eVVZ_T ^ VVJReEZZgi `VeYVhY`]Va`af]ReZ_c`dV W^{1} ! Z^{6} %Z_"*)(e!Z#\$SZ_"**(LSVZ_XYZY Z_S`eYaVZUUR_UYZXVEZ_eVVjVRc1"**(/hYV_ Y f dV^]UdYRUYZXVERvEXVZ_T ^ VJVgVJdŽ?`e `_]j TR_eYVa`dEZgVZ_eVdaVZUZ_T ^ VJVgVJdŽ? evReeYVZXVEZ_T ^ VJVgVJdRVLeVXVReVE eVV aVETV_eRVY`We`ePJZ_T ^ VeYRe X Vd`_ TF]ef eV aVETV_eRVV`We`ePJZ_T ^ VeYRe X Vd`_ TF]ef eV aVETV_EXV`We`ePJZ_T ^ VeYRe X Vd`_ TF]ef eV

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7 cbg a dhcbcZWi hi fY \Ug[fck b]b fYWWbhnYUfgź UbX U gYWcf cZ]bXi gfm\UgUWWcfX]b[`mgYhci hhc dfcj]XY]hcb U a UgggWUY" b a UbmfYgdYWg]hWb VY gUX h\UhzVYgXYgh\Y dfcWygYgcZ[fck h`UbX XYj Y`cda Ybhz a Ugg a Uf_Yh W\UfUWhYfghWg \Uj Y` We a Yhc U ÚY X hUX]hcbU`mhYUhYX UgYl Wi gj Y`cf` Î ci hgXY h\Y`a Uf_YH`" b gbc `cb[Yf h\UhzVYWUi gY` Ug XYa UbX \Ug fgYbz h\g ÚY X`\Ug]b]hg ck b`k Umi VYWe a Y U gfUhY[]WcbY" b ca]Wa dcftUbWY` [g]`i gfUhYX]b HUYY*("

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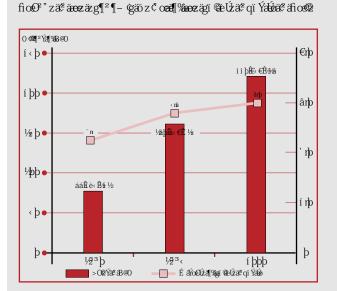
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i gYX'Vmh\Y'7 YbhfU`6Ub_cZ7 \]Yž`LYk gYžXcYgbch hfYUhh\YWih fU`gd\YfYUggcaYh\]b[kcfh\UbU`ng]b[]b]ngckbf][∖h"Ht fYa YXmh\g`UW_cZ]bZcfaUh;cbž i gY k Uga UXY c ZXUHU dfc j XYX Vmh Y GYfj [Wc XY] =a di Yehr g=bhYfbc gffbhYfbU`FYj Ybi Y GYfj WYÌ G=LZc f h\Y'h fbcjYfXYWUfYX`]b'h\Y'WcibhfmVmU``WcadU! b]YgdUm]b[jUiY!UXXYXHJIfJ5H"7cbg|XYf]b[h\Y WWUfUWAYflehWeUbXWcbehfUlbhecZh\leXUHUVUeYžUb UX`\cWXYÚb]hcb`cZh\Y`W`hifU``ÚY`X`hc`VY`eiUbh! ÚYX k UgXYg[[bYX" 5 WWc fX]b[`mžh\Y W h fU`ÚYX]g XYYa YX Zcfh\Ydi fdcgYgcZh\gYl YfWgYhc jbWi XY WcadUb|Ygk \cgY`bYcZVigbYggff€=7 WcXYŁgh\Y dfcXiWhcbUbXX]eff[VihcbcZW/hifU``[ccXgUbX` gYfj JWg H\Yh fbcj YfcZh\YgY Wca dUb]Yg[]j YgUb Uddfcl a Uhcb cZh Y YWcbca Wa dcfHUbWY cZh Y W h fY bXi gfm K h h gUddfc UW zh Y W h fU ÚY X]ggd`]h]bhc h∖YZc ``ck]b[gi VgYWhcfg 5fhUbX 7 ca! a i b]WUhcbgžGcWJUV]]ImiUbXDUghaYgž9XiWUhcbž UbX'GiddcfhfgYY'UddYbX]| '- Ł"

5 WWcfX]b['hc 'h]g Yl YfW[gYž] b &\$\$\$`h Y Î W h fY]bXi gfmi UWWci bhYX Zcf*ı 'cZU```gU`Ygžk]]h U'hchU`` h fbcj Yf cZcj Yf ++ 'a]``]cb I HA 'fÎ i b]XUX'hf]Vi hUf]U' a Ybg U'İ cf`a cbh`mhUl i b]]gžUb]bXYl !`]b_YX'i b]h

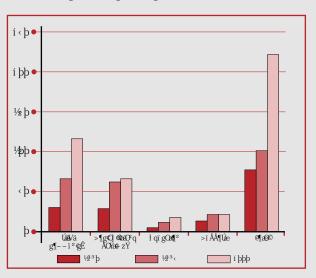


>¶ĩ (ắznă) tźÁOźqä] øB1L; a¶²äæzä] OřÓᶉzĺóg¶äqzä– Åï zÝá∯Ý䲿ٶÝáÇ ''ÌåqO@ä í þþ9£

i gYX 'Zcf'HJI 'UVWci bhb[žk cfh 'Uddfcl]a UhY m I G` '(&'Ug cZYUf'm&SS' L''5g'Z[i fY'' + 'g\ck gž]b'h\Y'% - Sg'h\Y'h fbcj Yf'cZh\Y'W'h fU`'ZY'X' ghYUX]'m[U]bYX'[fci bX']b'h\Y'bUhcbU``hcHJ''' H\Y'Yj]XYbWY'U'gc'g\ck g'h\Uh'h\Y'gYWcfhỹth fb! cj Yf'\Ug [fck b'Vma cfY'h\Ub'h\Y'Uj YfU[Y'Zcf' U```]bXi gffYg''8i f]b['h\Y'UghXYWUXYž fYWcfXYX' h fbcj Yf`[fYk 'Vm'%{(1 `]b'h\Y'YWcbca m[YbYf! U``mžk \]Y'h\UhcZhY'W' h fU`'ÚYX'[fYk 'Vm% *1 "

5bU`ngg cZh Y`XUHU fYj YU`g k \]W. g VgYWc fg d UnYX h Y`Uf[YghdUfh]b h g[fck h "H Y 5fhUbX 7 ca a i b]WUhc bg UbX`@Y]g fY`g VgYWc fg WYUfm Ya Yf[Y`Ug h Y`Uf[YghWc a dcbYbhg cZhcHU``h fb! cj Yf'`K \Yb`[fck h `]b`h Y`g\UfY`cZhcHU``h fbcj Yf` HU_Yb Vmh Y XJZYfYbhg VgYWc fgcj Yfh Y XYWUXY` lg UbU`ngYXž \ck Yj Yfž]h ffUbgd]fYg h Uh h Y`a cgh XmbUa]Wg VgYWc f`lg 5fh UbX`7 ca a i b]WUhc bgž k \cgY`g\UfY`fcgY`Vm, \$1 žZc`ck YX`Vm9Xi WUhcb` ff*1 ŁUbX`Gc WUV]`]mUbX`DUgha YgfH1 Łžk \]Y`h Y` g\UfY`cZG ddc fhZY``VmUVci h&)1`fgYY´Ú i fY'', Ł''

H\Y`fY[]cbg`k \YfY`h\Y`ÎW`hifY`]bXighfmä`UW WcibhYX`Zcf`h\Y`\][\Yghig\UfY`cZhcHJ``fY[]cbU``



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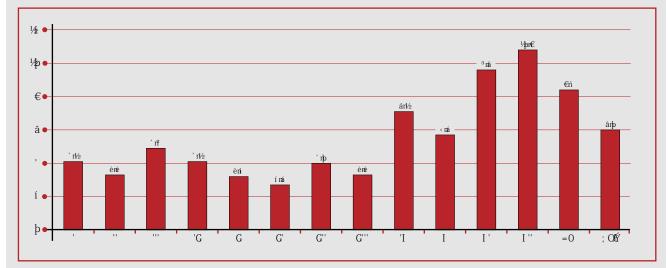
>¶î lýzna lźÅOŹqä] œB1L; a¶²äœzä] OYYa¶‰zlógg¶äqzä–Åï zYa¶Y䲿l?¶YäŞ''läqQ@ä í þþ½

h fbc j Yf b &\$\$\$k YfY A U[U`UbYgfL=Lk h %\$", 1 ž5m gfbfL∔k∥h - "*ı fpenfcb[mbû YbWXVmhYhcif]ga gYWrcfLUbX1AYAYhcdc]HJbFY[]cbfAFŁk]A; "(1 " +b C Ñ ∦ [|bgfJ +zJUdUfU‡c fJ +z5 bhc ZJ [UgfU f+LUbX 6t 6t fl = tžVmWcblfUgtž | gg/UfY | gfYUhi Ymck "

H\Y`ghY`cZh\Y`ÎWi`hi fY`bXi ghfmi`\Ug`bWYUgYX`b` U``fY[cbg"+bhYAYhcdc]HbFY[cbžZcf]bgHbWYž h\Y'h fbcj Yf'cZh\Y'W h fY'gYWcf'a cfY'h\Ub'Xci ! VYX°cjYf'h\Y`XYWUXY"'H\g`]g'g[b]ÚWUbh]b'fYgdYWi cZh\YfYgcifWYgbjcjYXžgbWYh\YbUhcbÑgWUdHU`` $\label{eq:linear} $$ Ug' ZJf'] [\ Yf' W' h fU`g' Yg' h Ub' Ubnk \ YfY' YgY']$ fgYY'HJV'Y'*) Ł"'FY[]cbU``XUHJ'UfY'Vfc_Yb'Xckb' bhc 'gi VgYWcfg'b UddYbXII '- "

@Ughnžhg a dcftUbhhc bchYhUhhYÚ i fYgZcf hfUX[b] 'UWhj [miUfY'fY'UhYX'hc'; 8D'] fckh\'b'h\Y' mYUfgUbU`meYX" Hi gž]hWUb VY gYYb hUhh YÎW ! hi fY`]bXi gffmli X]gd Ung U`XnbUa]ga `h\Uha U_Yg`]hi Ub UhfUWhj Y gYWc f Zc f bj Ygha Ybh





>¶ï Lýzna; LźÅO.Źgä] øäB1Ł; a¶² aæza a O.YYa¶%aszlógg¶agza – Åï z Ya∯Ya² ælź¶YaS ''ÉagO@nai þþ½£

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7I @H F9'DC @-7-9G 'C DH-C BG'5B8'7C BG+F5-BHG



7I @H F9 DC @7 =9G =B H + 9 % - \$g

H YRe ZleYVC]V VEYVDREVZ d/ReZ_ e Tf]i ef dO._ 4 YZW RdadźZ f dTYRaekdYRgVdr h_ŁeYV _Vh T_UZZ_d`WIF]ef dT TARZ_RVX gVć_VU Sj ^ Rc\Ved]VŽ7RTW hZY eYVa`hVMJ UJ_R` i Zd`WYVIF]ef dZ UF deg R_UeY dVhY T_d^ V Zdac`UF Ted.h YRe UZWWZV_TVU TF]ef dT] a`]ZZd ^ R.Ve` eYVVC^ dR_U dAdVG/eBeZ_d`WZWZ d TZ{g} O: VZe Zlecf VeYReLyT ^ aR-VUe` eYVc_R eZ_dZ_=RZ_2^ VZIRLA YZV]RT\dIF]ef dT] UAeY∞ 1Df SVCTRMF i L"***RL"*"/LZIeYVDREVV&EVZ_X SVENC]Z_RXSV6h W_TF]ef dT] a` [ZZX6%ac`a` dVUR_U
$$\label{eq:linear} \begin{split} Z^* a & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V U S \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ & \| V = V \\ &$$

EYVTF] ef eV a`] ZZdd V&RS] ZHVU S j $eYVUV^{1}$] TREZT8`gVc_^ V_eZ_"**! V^S`UZUS`eYTYR_XV R_UT_eZ f Zj Z_eVJRZ_e` hYReYRUX_VSWAVZ EYVUZER`e`eXz YRURa` hVAV] Sf eUZWAAZ aRTe` `_ 4 YZVR_TF] ef eVZEYVeVARETY`WZZ3ef__Vc YRddr` h_Y` h Rf eY`eZRZR_ZT`V_eVZdyRTF] ef eR] ^`UV] eYRecAjRIVdeYV`] UeeZRU`VDREVL]Rh R_U VUFTREZ_hZYR_Vh T`^SZ_RZ_`WYVAV^`_ZT UVEZTV&%"**) Ł*#ZEYZd_Vh`dVk WZdLY` hł Vývě Z d We RdZe U Vd_`eac`UFTVeVVT]]VTěžV ^ VR_Z Xd R_U Z RVZ RZXd eYRe d TZVáj _WUd e` Z eVXReV Užývdžij Ž5 V^ `TRIJ ScVR dh ZEY eYZi Rf eY`cžeRZR_ TF]ef dQ ^ `UVJL R_U eYV } cde eRd `VVFF]ef dQ TCVRZ _ Zle`UV^ `TREZKV eYV JZW `W 4 YZVR_ d TZVáj ŽH Y UJa c ZW' hi fU`dc `]Vvnighc` []j Y W ffYbWnhc \i a Ub f][\hg:Ugh Y VUglg c ZYj YfmXUmgc W[U``fY`Uh]c bg\]dg UbX`h Y` gc W[U``]a U[]bUfm':eZle`RVK^ UV^ `TRIJ Rd eYV_`c^ RežgVWK^ Vh`c\ hZYZ hYZYT]]VTěžV Vi a VčZ TVdR_UZV ežEXdRcVe`SV]VXěZ ZXUŽ

EYV dZef ReZ_d SWXeV R_U RAAWC eYV RUgV_e`W UV `TORIj Z "**! UZA R decZZXUVXCW `W $T = eZ f Z i Z TRaZ R Z e^R R (VeVT _ `^ i UZ R U)$ U VdacVeRZLaVć^ VReZ XVeVij RohVTe` Vol TZR ZVVŽ EYV^ Rc\VeeYfdT_eZfVde`SVRdvT_Uf_Rg`ZJ RS [VVAR^ V~ VAVWAEV TVŽ3VIRF dv~ VAYZET eZ fZjł RT_ecRUZTe`q`Uj_R^ZTYRdV^VcXVUŽEYV^Rc\Ve ZdeV_UZ_Xe`dacVRU Zedy]`XZI%&gVghYVcVLSfe hZey feSVZ_XRS/Ve aV&Vc ZedVV_TeZ_dZ^ `_X `eYVceYZ_X4ZeZd_`eac`Uf`TZ_X|ZW^\VR_Z_X4LXV_} VARZ XT ||VIOZVZIV OZZIC CTOURZ XeVV^ `OZRI eZ_dcVbf ZVUV/cd TZR Z_eVXReZ_Ž4`_dVbf V_ejj eYV&VZdRaV& R V eeV dZ SV&hW eYV^ Rc/V&L RdadRTeZTVR_UZ RXZ_RgLR_UDeReVTf |efcVa` |Z TZKŽEYVAVa`]ZTZKYRgVe`T ^ Ve`eVc^ dhZeYeYV dVRZEj TeVREVUSj eYV^ Re\VeLhYZVT ^ aV_dReZ_X WcZedWZZXZŽ

3jT_eRdehZeY eYVUZIeRe`cdYZeLhYZIY YRUR Xourelic Z' artie`_ Tf lef cV Z_ R Sc` RU dV_dVLZXZL `_ d`TZR] cV]ReZ_dYZadXV_VcR]]jŁa`]ZIZVdZ_ eYV UV `TCREZT dj deV RIe ^ `CV `_ da VIZ; TL]Z ZEVU } VIUŽH YReacVU ^ Z ReVUUF cz XeVV | Rob UVIRUV `WeYVehV_eZkeYTV_efg hVcVdvTe`dR]Tf]efcVa`]Z $TZdWIf dZ_XLWcViR^a]VL^ VcZeRXVR_U^ eYV$ $TeVReZ _ R_UUZetV^ Z_ReZ _ `VReeh `c\dR_UetaVIZ_T$ X`UddTYRdS``\d`cTZ_V`RŽE`fdVRUZdeZ_Tl $eZ_UdRh_Sj > R_f V_j 2_e Z 8 Rec Ve^_1 \#! ! "/L$ eYVIf | ef cVa` | ZZZd` W4`_TVeRIZ_ 8`gVc_^ V_ed 1eVV4`_TVeRIZE_ZeVTV_eeVIJVeVT RJZZ_Tfd cV_ejj Z_a`hVc/YRgVSW_TYRcRIeVc2kVUSj eYcW `S[VTezevd+"/ac`^`ez XeYVSRdzTv&WU^d`WW ^`TdRIj R_U^ RddRITVdde`Tf]efdRJX`Ud±#/dfał a` ceZ_XTf |ef cR| RTeZeZeXdR_UV_T f cRXZ_XRceZeEZT ac UFTEZ RUS/XV VCREZ XeYVZ dEZEFEZ RIRU

}_R_TZR] dvdif cTVd_WUVU Vvc eVvdVeh`eRdvdŽ

:_eYV} ade deRXV`W4`_TVaeRIZE_X gVc_^V_eL eYVRU^ Z_ZteReZ_ `WARecZIZ 2j]hZ_ hRdTYZk-j T_TVc_VUe`dY`cVfaeYVUV``TcRezTd_deV`Ž@_TV VXVU^^ `VVCVReZ_R_UViacVddZ_YRUSW_XfRd ReWULZehRd VIVaRje e XV VaRevRyUV `TareZT Tf]efcW%eYReTf]UT^Ve`eVc^dhZeYYf^R_ cZXYed gZ]ReZ_dh YZele V T f cRXZ X ReeZef UVd`W e`[\cR_TVR_Uc\caVTeŽEYVC\ce2XC\a`ce1"**"/ hRdf_bfVdeZ_RS]j_eYV`fedeRUZXViR`a]V`W UV `TCREAKZ_XTF]efcRIREZ_ŁVĘV_ZVZehRd]Zee[V RaacVIZReVUŽ5 hh Y gUa Y ha Yždfc [fYggk Ug a UXY b WYUhb f fYUhYf Yei U hmcZUW Wygežetha i `Uhbf 'a Ugg dUfhWdUhcb UbX` XYWYbhfU`]n]b['WY `hi fU`'dfc Xi Whjc b'UbX' a UbU[Ya Ybh':eZdV_`fXYe` cVIR]Yh^R_j TF) of cVW degeR dR UT ^ a VegeZ_dh VcV YV JUR U $Y^h \wedge R_j \wedge f dM \wedge dL Z dR Z dR UTF | ef dR TV_edd$ hVcV`aV_VUeYV_ŁR_UY`h ^ fTY dfaa`œhRd XZEV_e`Z_ZZEREZEVdZ_eYVcVXZ_dR_Ue`WWW.ded $e^{h} R V 4 YZWR_T f e dV \sum h_Rsc RU EZ Z.$ "**%Z6WW.cede`TcVReVc1f_UZ.deZefeZ_dR_UXV.} VEREVaf SZEIdVIE c}_R_TZ_XhVCVRd CVZZVUŽE YV =V/UV5 RIZ Vd4f | ef cR|Vd14f | ef cR|5 ReZ d 2TeL $c_y=V_1 GRU_{6} RdZeSVIR^V_ h_ hZX$ e`eYVVWW.dcd`VeYVeYV_DaVR\Vc`VeYVDV_ReVe` dVTfcVZedaRdRXVLeVVTcVReZ_`VeYV> Ra`TY` 4 f | of dR| 4 V ccVR U eYV 3 R|^ RIVLR 4 V ccVL eYV T^aVerrow VVUZX^RUVRepropriate 7@?51 $2CE R_UeYVY | UZX WeYV | ade 4 ^ ^ Z dZ Wc$ $4 f = cVRcVd \wedge VVIR^{1} = cRIZ_{2}$ eZ_UzzeV_SjeVV} ade4`_TVaRIZE_8`gVc_^V_eŽ 2 Tozezi R cvezich ` Vhi YReh RdRIYZkgvUZ eYVaVcz U a`Zede` yXXVRe RIYZkgV^ V_edZ_ VdeRS [ZEYZ_X R TF | ef cV ` WUV ` TCRIj R_U TF | ef cR UV ` TCREZKR eZ_ŁSfegVij WinhYkVTfjefcRjUV `TcRIjhRd T_TVc_VU%bDfSVcTRcMRfiL"**%L) #/ŽÎ7i`hifU`` XYa c W/UW/ii ža YUb]b['W' hi fU``W/YUhji]hmi b gc WYhmUh'Uf [Yžk Ugh Y i bÚb]g YX Vi g]! bYggcZh]g; cj Yfba Ybh

EYV8`gk_^V_e`V6URU 7dZT_eZfWe af ccfVIf]efd3a`]ZZdhZYeYVR`V`S[VI252vZ_ aRczIf]RŁZcdfXYee`TcVRVZdzfeZ_dTRaRS]V `WWd2vZ_XLU3hZ_Xe`XeYVcR_UT`dZ_RZ_X eYVUZWCV_eRfeY`cZzdR_Ua`]ZZdZEYV"**)

SZJŁd Schlof V_ej R^ V_UVU Sj etVackolV_e 8 `gł Vc_^ V_eLZdeZ]SVZ_XUVSReVUZ_4`_XVddŽEYVcV $hRdac XdVd1 = R_f^SVc WdV_edLZTfUZXZ1$ TeVRelvedZ_eYVeVJVgR_eSfUXvedR_Udec`_Xdfaa`ce Wceał]VgV] dIZV_eZ; T cVdWRcTYŽ@_TVUV``TdRIj hRdd/If cVLY hVgVLeYVTf |ef cR| c` |V` WeYVDeReV $dW^{V}Ue^{-1}$ $dVWF dZ 3V dLV dR |RI \ Wa^{-1} |ZZR|$ hZ]R^`_XeYVaRceZdLeYZdTR_SVafeUh_e` $eYVZ \sim fV_TV WRTWeRZ \gamma RCVEZV] X_1 % R_U$ eYVeV_UV_Tj_WcTf]efd?]`WWWZ_Xde`SVT_df^U aRdzęvijŽEYZdzzefReZ_^VR_eeYReeYVUZXWKV_e d TZR RTè cdh VćV [VddRS]VR U YRU Wh Vć`aa`d ef_ZeZde`aReeZZaReVRIezgVjjZ_Tf]efcVŽEYVycZtV `VeYV^ ReUVE/2`_Z!" ***/ cVef]eVUEZ_UVUEZ_ T_ecRUZTeZ_dSVehW_dTZR|acRTeZTVdR_UeYVZc T]]VTeZeV cVacVdV_eReZ _d eYRe 4 YZ/VR_ d TZA WAZVU e`eR\Vac`aVdjZe`RTTf_eŽ

DfYgXYbhF]WUfXc '@U[cg']bhYbXg hc 'Wcb! Zcbhh YgYWU `Yb[YgUbXa U_YW 'hi fYh Y'

_YnbchYcZ\jg; cjYfbaYbh'<jgjgjbZJWihY Úgh, cjYfba Ybhrcg\ckUgnghYa UhWWca! a Jha Ybhhc WY hi fU dc JWm EYV WIZR UNI RR $eZ_1 > R_j #!!! / WeYVIF] ef dZ_a [Z_j WeYV4 YZ_NR_$ DeReV felZ_Vdd ^ VSRdZTacZ_TZa_VdHeVVRfe _ ` ^ j `W d TZAG hZey RVRIZZERZ Xc VVC eV DEREVLTC RESEV ^ ReZ_R_Uac`[VTeZ_`WILV_eZejEVUETReZ_WcTE]} ef dR Rh Rev_VddR_UacVdkgReZ_R_UafS ZZKReZ_`W eVVT f_eej dTf]ef dVYV2ERXVLUVIV_eeRj2EReZ_ R_UL Z_XV_VR]LVbfR]Z;; `WRITVdde`ReeLTf]efdR]X`Ud R_UeVIY_`]`XjŽEYZIXV_VRJ Raac`RIYZISRI\VUfa Sj T_TONEV^ VREFONDŽEYV`aV_Z_X`V¥R>`_VUR 1eWaddeW_@ER aRRIVR_U`eWcYdER&VdEVdLTf] ef dVWdeZeRdR UXReYVdZ XeLa`Vegi VgV edR UeYV T__VTeZ_SVehW_afS[ZTh`c\dR_UReeh`c\dRdV VIR a Va VRTF of da Zi Zev UVUe SVR REEV ZXXVLZV_e`WgVqiUR; [ZZZXZ?`_VeVV/vdteVvc`[V`W eVVDeReVR_UZedTf]ef dVa`]ZIZdRdVUZa]R, W^`de TVRC ji Sj RWA WALOVRIYZ XZ ZZROZVÓŽ

H + 9 - B G + H + C B 5 @ 65 G - G C : 7 I @ H F 9 D C @ 7 - 9 G

CF; 5B-₽5H€BG

EYV`cXR_ZkReZ_R| decf Tef cV eYc`f XY h YZIY DeReVTf | ef cVa` | ZZd RcVZ' a | V V eVU Zd h VR $R_U f_WIf dVUŽE YVdV a^]ZIZVd ReV UZdecZSf eVU$ R^` X_f^Vc`fdS`UZvdhZeY_ ` TV eeR|T`d UZ_ReZ_X RfeY`cZejŽEYV^RZ_Z_deZefeZ_ZdeYV > Z_Zdeg` V6UfTReZ_ŁhYZIYY`fdvdeYV4f]efdV $5 Z_{Z}ZZ_{Z} Z E YV = Z_{S} C_{Z}C_{L} 2 C_{Y}Z_{S}Vd R_U > f dM$ $f^{d}D_{c} = 32 > /LhYZY dYRCVd eYV^RZ$ dvda`_dZSZZZEj WceYV_ReZ_dYvCZERXVhZEY eYV $? ReZ_R > _f^ V_ed4 f_TZER d T^ Vdf_Uc$ eYZda`ceWZŁRdU eYV4` dy` UV4RZTRIZ $4\mathbb{Z}$ V^A Re^A Xii \mathbb{R}_1 7Z/^A 4 Voe \mathbb{R}_2 \mathbb{R}_2 3 RU/ \mathbb{R}_2 U eYV 4 ` ^ Ze¹/2UV 5 ` _ RIZ _ Vd 4 f]ef cR]Vd 1 4 f]ef cR] $5 \ ReZ_d4 \ ^ 2eeWZ2 d Zg g eWZZ YKZERXV$ ^ ReeVed ZieVV5 ZVITZ_ UV2 cbf ZVIef cR12 cTYZ eVTef cVDVcgZTV `VveYV> Z_Zteg` `VVefS]ZTH` c\dŽ 2_`eYVcS`Uj hZey [Vdb/ca`hVcdZleYV5 VaRce^ V_e $W_{f} = V_{V_{1}} + f_{ZReZ_R_U4f} = V_{U4f} + V_{U4f} + V_{U4f} = V_{U4f} + V_{U4f}$ ckerzenD644/thYZYT ^ kdf_UkceYV> Z_Zek/Z $DVTCVERCER48 \vee VCR UV8 SZC_ 1 > ZZEcj WeVV$ 8 V_V&R] 8 `gVc_^ V_e DVRVATZEVŽCVAb`_dSZZG Wc^ R.Z_X4 YZVR_ Tf]ef dV_`h_ RSc RUVAJde eYV 5 ZVTTZ_ UV 2 d_e d 4 f]ef dR]Vd1@VVTV`W 4 f]ef dR] 2 WWXdd` V&YV > Z_Zdej` WT dZX_ 2 VW WXdZH ZeY fedWZ_Xe` JZEVGVj DReVS`Uj hZeY Tf]ef dR] dVdb`_dSZZEZdL^ V_eZ_ dr`fJUSV^ RUV `V&YV4`_dV[`? RIZ_R] UVEVJVZZE_ 1? REZ_R] EVJVZZZ_ 4`f_TZ/LeYV> Ra`TY`4 f]ef dR] 4 V_edV R_ULWc TZ_V Rac UT TZ_LeYV4`ca`dRIZ_ UV 7`^ V_e`UV]RAc`UT TZ_ 1Ac`UT TZ_ 5 VgV]`ał ^ V_e4`ca`dRZ_ € 4@C7@/Z

EYZIWRX^V_eReZ_ZIaRedj Uf Ve`eYVgRzZej `WWV_TeZ_dR_UUV^R_UEZ:eZIRJd R ckef Je`W Z_deZef eZ_RJ h VR_VeLY`h VgVZ:eYRd JVU e`eYV `gVdJRaaZ_X`Va`h VcdR_UYRd^ RUVZeUZWIF Jee` UVZX_R_UT`dLZ_REVT YVcV_ea`JZIVeLTRog`fe WWWIeZgVUVIV_eRZEREZ_R_UcVXZ_RZEREZ_R_U V_XRXVhZEY ReeZetaR_Ud TZRJ RIÈ ceŽ

6WW kede`V_U`h eYVTf_egi hZeYR_Vhdd eV``WFjefcRjZdeZefeZ_dSVAR_hZeYeYV2j]hZ_ 8`gVc_^VeŽDfSdVbfV_ejjLZ_5VIVSVc"**)Ł AcV3LV_e 7 CVZ dV_e 4`_XVXtl R SZ] $e dV CXR_XV$ eYVDeReVoted Tef cVdcVda`_dXS]VVXcTf]ef dC] a`]ZIj Ž AcV3LV_e=RX de`` f a eYVSZ] R_URaa`Z_eVUR AcV3LV_eXR] 4f]ef cV2UgZt ce`T`dZ_ReVa`]ZIj Z_eYZIRCVRŽ WAVSZ]ZIaRthULe UBj dZ_deZf eZ_R] WRX^ V_eRZ_ hZ] X2gVhR] e`R cV cXR_ZREZ_ SRcMU`_ R 4`_dN[`? RIZ_R] UV 4f]ef dR 1? R eZ_R] 4f]ef cV4`f_TZ/ R_UR7`_U`? RIZ_R] UV 5 VeRcc`]]` 4f]ef dR] 1? ReZ_R] 7f_UVXc 4f]ef dR] 5 VgV] a^ V_eZ

H + 9 @ ; 5 @ : F 5 A 9 K C F ?

EYVAV` cXR_ZAREZ_R] ac`SJV` dR:V JR:XVj UfV e` eYVZ_RUNDFRIj` VeYV JVAR] VAR` Vh`c\ hZeYZ hYZIY Z_deZef eZ_d`aVAReVŽ 2e eVV SVXZ_ZX`W eYV "**! deVV:V hV:V`gVc S!! UVICVAd`c JR:hd T gV:Z_XIF jef cR] ZdF VZ?` ac`X:VdHhRd^ RUVZ `cXR_ZZ_XR] eYVAVR_UVAZ_XeYV`Z_e`d_deV`ReZ JVXCJRZ_LA ZE:hR:dUVIZXU eYRe_Vh ac`gZZ_d h`f JUSVV_RIEVUSj Z_TJF UZ_XeYV`Z_`eYvc]R:hd `c RaaV_UZ_XeYV`e` eYV SF UXVeZ5 VA:ZV eYZi VARX`V_eReZ_LgV:j df SdeR_eXI ac`X:VdHYRdSW_ ^ RUVLZ_TJF UZ_XeYV;CR]UV&e4f]ef cR] 5`_ReZ_d 2Te 1"**!/LeYV:_UXXV_`fd AV a]Vd 2Te 1"**\$/



H ≤ 9: = B5B7=B; C: 7I @ H F9

? VÆYVčeYVT f_eqi der RUZ_d_`ceYV^ Rc\\é U^ Z_RZ_ R_UZ_dezef eZ_R] hVR_VdleYRe Tf d cV_ejj ackýz RVT_UTZgVe` af S]ZT }_R_TZ_X `VVIF]ef cR] RI&ZgZZd`f eZLVeYVVUFTReZ_R] R_U f_ZgVcZgj daYVcZZEYVTYc`_ZTWRc` VDEREVZ_ł eXCWCV_TV1aRceZIF]Rc]j Z_ R_RVR Rd dV_dEzgVRd Tf]ef cV_YRd_`e ackýV_eVU d^ V }_R_TZ_X]Z Vd W^ SVZ_XVERS]ZHVULY`hVgVZEh` ^ VIYR_Zh` d dh`f]USVUZEZ_XFZHVUŽ@_VT ^ SZ_Vdaf S]ZI R_U aczgReVIdVTe`cW_UZ_XR_UdW\de`ScZ_XZ_aczgReV da`_d cdYZa eYc`f XY eR ScVR\d eYV`eYVcac`gZVd UZVTedf aa`ceeYc`f XY T^ a VZEZgVW_UZŽ

 $\label{eq:hydrodynamics} \begin{array}{l} H_{\rm V} & @Ym XY & 8c b UW c b Yg & 7i & h fU Yg \\ 14f & ef cR & 5 & BeZ_d & 2Te' & h Rd V_REW & Uf cZ_X \\ eYV & cde & eVc^ & WeYV & TVceREZ_L & \#) & ;f_V \end{array}$

"**! Ł Rd a Roe `WeYV = Vj UV CWAC^ R EczSf eRcZR 1ERI CWWC^ 2Te/Ž<_`h_ Rde/VyGRJU/e%2TeL ZedfXYee`ac`gZUVR_Z_ded^V_eWcSoZ_XZ_X Z_TF]efcR]da`_d:cdYZaW/^acZ9ReVV_eVcacZ4NŽ AcZgReVda`_d`cdac`gZUV&! ~ `WWV_UZ_XWcRał ac`gWac`[VTedLhYZVeYVViTYVbfVcac`gZVdeYV `eYVcYRJVSgihR<u>egZ</u>XTVceRZ_eRJVdŽEYV]RhTR^V <u>Z</u>e`WEIV<u>Z</u> 2ac<u>Z</u>"**"LRU^ <u>Z</u>ZEVEVUSj R4`^ ZE1/2 4 RJZ TRU cUV5 `_RIZ_VdAcZeRLRd1 AcZeREV5 `_R eZ_d2ddddh V_e4`^ ^ ZeeWŽ2d`W#!!!Łac`[VTed h`œY'Ž#SZ[Z_aVddYRUSW_Raac`gVUZ_RVRd RdUZgVcd/RdZ_V8Rchef Tef cVLRU^ Z_ZheReZ_LVgV_ed RUeWTeWReZ_RUac`UFTeZ_`WRoch`c\dZR hZLVcR_XV/VRcVRcŽEYV]RhhRdcVIV_ejjR^V_UVU e`^R\VZed`aVcReZ_d^`cV~ViZS]VR_UVRIZZEReV R_Z_TOUROVZ_U_ReZ_dŽ

EYV7_U ? RIZ_R] UV7 ^ V_e UJ = ZSc j $|\mathbf{R} = V \text{Tef} d\mathbf{R}_1$? $\mathbf{R} \in \mathbf{Z}_{\mathbf{R}}$ $|\mathbf{X}^{+} \setminus \mathbf{R}_{\mathbf{U}} \cup \mathbf{C} \vee \mathbf{R} \cup \mathbf{Z}_{\mathbf{X}} \mathcal{T}_{\mathbf{L}} \cup \mathbf{C} \vee \mathbf{R} \cup \mathbf{Z}_{\mathbf{X}} \mathcal{T}_{\mathbf{L}} \cup \mathbf{C} \vee \mathbf{R} \cup \mathbf{Z}_{\mathbf{X}} \mathcal{T}_{\mathbf{L}} \cup \mathbf{C} \vee \mathbf{R} \cup \mathbf{C} \vee \mathbf$ hRdTeVReVU`_ "!;f]j "**\$Sj gZeefV`WeYV UVdTcZSVU RS`gVLZed VV_UZ_XT^ Vd`fe`WeYV _ReZ_R| Sf UXVéŽ 2]]`TReZ_Zd eYc`f XY af S[ZT $T ^ aV_{22} Z_d YV_J USj eVV4 ^ aV_1 RIZ_R UV_1$ =ZSc` j $|\mathbf{R}=VTef d\mathbf{R}_1$? ReZ_R 3``\ R_U CVRLZX $4 f_{Z} Z E V 7 f_{U} Z R U^{2} Z E V V 5 E^{1}$ Zetej `W6UfTReZ_eYc`fXYZed4f]efcV5ZeZZZŽ $: ed af ca`dVZde` \}_R_TVREZZZdR_Uac`[VTed]$ RZ^WUReac`^`eZ_XcWRLZ_XLecRZ_Z_XWcaVa]V $V_XRXUZ_afS]ZYZ_XR_U]ZGRg_h`c\LS``\ac`l$ $Tf cV V_e Wc af S ZT Z CREZCLS`` VRXcL4 YZVR_$ $S`` \setminus V_1 a` ced R_U Z_eV_c_ReZ_R T` aV ReZ_Z_eVV$ }VJU`V\$``\dR_UcVRUZ_XLeYfdTf_eVcRTeZ_XeYV `SdeRI]VdUVcZeZXW/^ eYVRaa]ZIReZ_ `VG2E e` S``\dŽ2d`W***ŁRe`eR``W SZ[Z_ aVd dYRJ SW_ UZtezSfeVU eYc`fXY 7f_UT ^ aVezZ_dWc S``\ac`TfcV_V_d_TYZUUV_d]ZeVcRefcVLXcR_edWc hozeved R U zever Tozzieł Tevrezevh`e Wehozeved R_UXR_edWceVRIYVcdR_U]Z5cRcZR_dŽ:_ eYV]Rde eh` j VRcdeYZIVV_UZ_XYRdXc`h_ Sj `gVc`\$! " ŁRd YRgVeYVW_UdX Z_Xe` 7@? 5 2CEŽ

H\Y:cbXc`XY8YgUffc``c`XY``U'7i`hfU' mUg5fhYg14f]efcVR_U2ced5VgVj~a^V_e7f_U €7@?52CE/ZdeYV]RcXvdeDeReVda`_d cdYZa`c acVUNTVatic WUTCVREVURUEVV UZT eZfVU SjeYV^ ZZERcj 8`gVc_^ V_eŽehRddvéfaZ_"**# ZeYVWc^`WRcZU/ce`eYVSfUX/eRTeLhZeYeYV $RZ^{*} Watc^{*} = eZ_XeYUVgY^{*}a^{*}V_e^{*}WT_e^{*}dVR_U$ ReedZ_eYVT_f_egieYc`fXYafS]ZTT^aVeZZ_dŽ :edW_UZ_XT^VdW^ eYV_ReZ_RJSfUX/eR_U $U_RZ_dZeZdf_SjeYV>Z_Zdej V6UfTeZ_Z$:_ eYVac`gZ_TV&LeYZIc`]VZIa]RJVUSj_DVTcVeRc9Rd $CVXZ_R/d > Z_ZEVZR/d > Z_ZEVZR/d > Z_ZEVZR/CVXZ_R$ DVTcVeRc2Red € D6C6> : D' Wc 6UFTReZ_Ž2S`fe '! ´` `WeYVe`eR|SfUXveXVde`eYVcVXZ_dŽ:_"! j VRccL7@? 5 2 CE YRdUZteZSf eVU" ' L**H#\$\$L) & aVade` & #** ac` [VTed Z_ eYVRCVRd` V & ZfR] Reed 1' \$#ac` [VTecht RF UZ 1gZF R] TeVReZ_1981/LeVVReeV R_UUR_TV18%(/L^fdZT1888/L]ZeVdRefdV1\$"%L ecRUZEZ_R]Tf]efcVdi'"%LYVCZERXV1"&"/LTf]efcR] $R_URceZeZTVgR[fReZ_1'\%/L]$ TR] TcRAedR_UTF] ef cVd1*" (/ŁZ_VMRdef Tef cV1#S) /ŁZ_eVXReVU Roed $\label{eq:linear} $$ 1\%/4: eV_ Redu*/4j feV cTVdeRdu*S/R_U Z_UZW_fdaVa]Vdu(!/Z $$$

 $:= RULEZ _ e^{i} eYVRS^{i}gYLhYZYRVR] R_R^R R^{i} XR^{i} ~ WW_UZ_X^{i}VYR_Zh^{i}dtZ_deZef eZ_dR_UdvTi e^{i}dt] e^{i}dt] e^{i}dt] a^{i}ZZAL^{i}V_eZ_^{i}f SV^{i}RUV^{i}W$

$$\begin{split} H_{N}Y &: c bXc `XY `5 d c mc `U `Dfc [fUa Ug' \\7 i `li fU `Yg 14 f]ef cR] Ac` XrR^ ^ Z_X Df aa` ce \\7 f_U cf_ Sj eVV? ReZ_R] EV/vgZZ_ 4` f_TZL \\hYZY YVJUWf cT ^ a VeZ_dZ_ #! !! 1VUF TREZ_R] \\ac` XrR^ ^ VLTR` aRZX_e` af SJZZKVTYZUV_`dac` l \\XrR^ ^ Z_XLcVXZ_R]_`_l} TeZ_ ac` XrR^ ^ VdR_U _ReZ_R] } TeZ_R U_`_l} TeZ_ ac` XrR^ ^ VdR_R \\R]` TREZ_Xd ^ V'''' (^ ZJZ_aVd dZ` \\ \end{split}$$

H, Y :: c bXc 'XY '5 d c mc 'U = b]W[Uh]j Ug 7 i 'h fU'Yg FY[]c bU'Yg 1CVXZ_R] 4f]ef d 3 :_ZZF2ZydDf aa` ce 7f_U \in 72:C/ d_ Sj eVV5 W aRce^ V_e`W4f]ef dV`V&YV4`^^ f_ZIReZ_R_U 4f]ef dVDVIdAR:ZRELhY`dVaf ca`dVZde`ac`^`eV If]ef d?[R_URe:ZRELhY`dVaf ca`dVZde`ac`^`eV If]ef d?[R_URe:ZRELhY`dVaf ca`dVZde`ac`^`eV If]ef d?[R_URe:ZRELhY`dVaf ca`dVZde`ac`^`eV If]ef d?[R_URe:ZRELhY`dVaf ca`dVZde`ac`^`eV X gld:_^VeLR_URd:W**(YRURac`gUURS`fe '!! ac`[VIedh`ceYRe`eF]`V&S!^Z[Z_aVd dŽ

$$\begin{split} H.Y.Di V`]W5fh7ca dYh]h]cbg cf_Sj eVV\\ 2cIYZeVTef cV DVcgZIV`VeYV > Z_Zdeg`VVAfS]ZT\\ H`c\de`dv]VTeh`c\d`VAdeVVcZ_deR]ReZ_Z afSh\\ [ZTSfZLZ_Xd`ch`c\d_RdcVbfZeVUSj]RhŽEYVcV\\ hVcV") T^aV&=Z_d`VeYZhZUZ_"****}H!!!Ž \end{split}$$

H.Y.7 C F: C 'Dfc [fUa U'XY':]bUbW[U! a]Ybhc 'XY''U'=bXi ghf]U'5i X]cj]gi U`12fł UZ łgZf R] :_Uf deg 7Z R_TZ_XAc`XR' ^ VŽEYZł $d_dT^ aV$ 52Z_dWc WRef dV}]^ ac`[VIed eVV hZ_VdRcVac`gZLVU hZeY (! ~ `WeVV d52 ReVU }_R_TZ_XT dedZ 7Z_R_TZ_XZ_ #!!! e`eR][VU")) ^ Z]Z_ aVd dWc#) ac`[VIedZ

> $f_ZZaRJZZdYRgVRJd ^ RUVWW (ad `VeYVZc `h_taRoeZffJRc)j eY dV W4 `_TVATZ_tCRJaRcRat R_UDR_eXEX LR_UacZgReVR_U^f_ZZaRJT ca`ł dReZ_dR_UWf_UReZ_dYRgVh`c\Ue`^R\V TfJefdRJRIEZGZZda`dXSJVZEYVCVRCV}_R_TZ_X ^ VTYR_Zh`d`eYVc eYR_ eYVT ^ aVEEZgVW_Utt dTYRt4@C7@`d}]^ t^ R.Z_X]`R_dR_UtZ_eYV af SJZMZ_XZ_Uf deg LeYVUZWWCV_e eR_ ^ VRdf cVd$

ac`gZNUWcSj eYV3``\dR_UCVRLZ_X2TeŽ

 $EYVUZWWEV_eZ_ZZRZGVChV]Z]fdcReVeYVZ a`d eR_TVeYReTf]ef eV}_R_TZ_XYRdeRvV_`_Z7i `h fY' gdYbX]b[`]b`% - - `]gYgha UhYX`Uh&S`V]``]cb` dYgc gzUVci hh fYY'ei UfhYfgcZh]gWca]b[`Zca `h Y'di V`]WgYWcf' 7f_UZ_XYRdZ_TeVRAU XeVRejj Z_cVTV_ej VRcd.Z_T]fUZ_XT_dUARS]V Z_gVde^V_e n RSZ]Z_ avd dRj VRc/Z_Tf]ef eR] Z_WRdefTef eVeYcfXY feeYVT f_ejZ$

 $:e Z UZWIF]e e UVJZVC R gVd Z R Z R_RVR Rd T ^ a] V Rd TF]ef dR a]Z j Z Eh ` T _ T] f dZ _ d U$ $V V XXLY h VgVZ@_ eV ` _ VYR_ULdVTe dR a `]Z$ $TZ dYRgVT] VRcjj a] R VURac` ^ Z V_ec`]Vf_UVceV$ $4 ` _ TV dRTZ_ 8 ` gVc_^ V ed E YVCVYR dSW_de` _ X$ DeReVdf aa`œWcTf]ef d?] T&ReZ_R_UT_d^ al eZ_ŁRdaRœ`WR_WWkœe`&T_TZJVeYVUV R_Ud `WYZXY'Tf]ef d%daZeY eY`dV`WeYVTf]ef d?] Z_Uf d eg Ž@_ eYV`eYVcYR_ULDEReVa`]ZTZdWcTf]ef dV Z_eYVSc`RUdV_dVdW`hVR.ŽH YReT_TVc_YRd eYV4YZJR_DEReVdY`h_WcZdf VdTdfTZS] e`dł TZ4j dTY RdeYVT f_eg `dTf]ef d?] UZ\$Vd&jLeYV cWkc^f]ReZ_`WREZ_R]ZU/e6jLeYVUZ\$VTf]eXd `WdTZ8] T^^f_ZReZ_`ceYVhVR_Vd1`WF`]!]VTeZeVZ`RVZ_RZXdD=Z]h]gUWWYdhYX'hUhW''! hi fY'd`Ung`U`WYbhfU`fc`Y`]b`h.Y`Wci bhfm%j XYj Y`cda Ybhžh.Yb`h.Y`W`hi fU`X]a Ybg]cb` cZdi V`]Wdc`]WJYgk]``\Uj Yhc`VY'[]j Yb'h.Y`

D5 FH)



D9FGC B 5 @@ 9 B 5 7 < 5B; B; GC 7 -9HM

:_ 4 YZM LVIV_ eIf] ef d? TYR_XdYRgV aV_Wf a dZ_Z, TR_e`aa` cef_ZZXdWcaV a]Ve`UVgV] a eVZc `h_hRj d`VZgZ_XZ3f eeYVLVRLV^R[`c`SdHI]Vde` cVR]ZZ_XeYZIa`eV_eZR]ZEYV_Vh dZf ReZ_ ^ VR_d eYRe Z_UZgZLF R]dYRgVe` ^ R_V f_acVTVUV_eVU WV Wcede`UV}_VeYVZCZUV_eZg_R_UXZgV^ VR_Z Xe` eYVZca]R_dWc]ZWZ

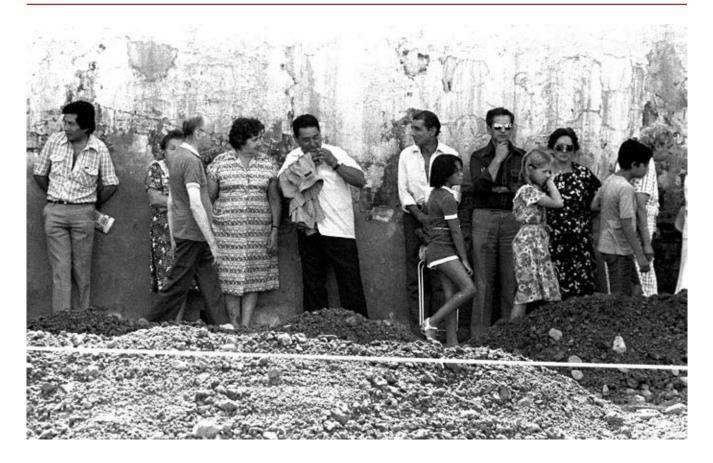
EYVTYR_XXdYRgVXgV_Rdc`_XS``dee`Z_UZ gZLF RZRZ_Z_4YZVŽ=bXj Xi U`nUhcba YUbg h\UhdYcd`Y`\UjY`hc`aU_Y`h\Y]f`ckb`dYf! gcbU`XYWgcbgUVcihh\YW\cWYgžjU`iYg UbXfYUhcbg\dghUhl chcaU_YidhYlf `]Z/d`Ubg"=h\Ug[fckb]bgfYb[h\UggcW}hm \UgʻgYhibWfYUgb[ghcfY VmdYfgcbU`Ui ! hcbca nžhfUX]hcbg\UjY`cghh\Y]fUih\cf]mž $UbX^{\cdot}Ub^{\cdot}]bWfYUg]b[^{\cdot}Wc]Wf^{\cdot}cZkUmg^{\cdot}cZ^{\cdot}]Zf^{\cdot}$ \Ug'VYWca Y'Uj U]'UV'Y"Ac`aVcjj f_UVcde`UL ZUZZIFRZRZ_ZIRXWRe`aa`cef_ZijWcWgWjł `_VŽ:eZdRecV`V_U f dZ_UfTV`V_ee`eYVXc`heY `WWWU^^Le`]VdR_TVR_UTZeZTcZXYeeŽ3VZ_XVM]jj \mathbb{Z} UZgZLf R ZIRh R `WWREZ_Xe` _WMVR_U`eYł VcdŽ2eeYVcR^VeZ^VLZeU_Vd_`eUVaV_U`_]j`_ VRIYaVcd_ŁSfeZdReRd、WceYVhY`|V`WaTZkjŽ :eZleVVT]]VToZV ZW WI TZG eYReac gZVdeVV VEYZIR] gR/f VeLeYV ~ CXR_ZREZ_ ~ WT ^ ^ ~ _ WWW.deL eYV]R XFRXdR UeYVdaRIVdeYRe^ R\VcVIZac`TR cZXYeeL`SZAReZ dR UcVReZ dYZada`dZSIVŽ

EYVZ_W& ReZ_T]]VIEWUW& eYZICVá` œd Xi XvátdeYRe ^ R_j 4YZJVR_dU _`e YRgVeYVd TZR] cvd f cTvdeYy _WUW&d TTvdtvj Z_UZgZLF RJZReZ_Ž :VR2]RT\`Wi TZR] df aa` œ^ VR_deYReaV a]VYRgVê $eR_VeYVV_eEVCvda`_dSZZej f a`_eYV dvjgvd eYZi$ $TR_SVRd f cTV`WR_XfZh4L]`_VJZ_vdtR_UWf dedR$ $<math>eZ_Z_deVRU`VR_`aa` cef_Zej VcdvjVvAvRjZeReZ_Ž$ $7f ceVc^`cvLaczgReVd WWZZ_XdTR_hVR_V_RhY`]V$ $d TZAjZH ZeY f edRezUNDE cj aVcd_R] ZJV_eEZId` c$ $cNRd_RS]j detS]VcdrReVU gRjf VdLd TZR] ZZVTR_SV$ $decZaaVU`Wef deR_UR_j dV_dV`WeYVVef cvZE YZi$ $TR_cVdf]eZ_aV a]VhZeYUdhZ_XZ_e`eYV`dvjgvd$ $R_U eYVZc T]`dvTZCT]VLUVa]VeZ_X j Ve VeYeVc eYV$ $T ^ ^`_ df aa` ce_WUVUVc eYVT_def TeZ_`W$ $aVcd_R] ZJV_eEZIČZ$

EYZI} WY ARce`WYVCVa`cedW\de`R_dh\ceYV bfVdEZ_`VWY`h aV a]VZ_4YZV_`h ViaVZV_TV eYVeRd\`WM/VVT_defTeZ_eYReTf]efd]TYR_XV ZIZ a`dZ_X`_eYV`ŽEh`RdaVTed`WYZIbfVdEZ_ RCVV`aYRZKVU+hYReZ`a]ZIREZ_dU`VdeYVhVR} V_Z_X`WT`]]VTeZVdT aa`ceR_UXfZLR_TVYRgVVkc eYVT_defTeZ_`WZUV_eZZdR_UaVcd_R]a]R_dD 2_UhYReT_dNbfV_TVdU`dTTVdHdR_UVWZfdd Z_eYZIZ_UZZJfR]eRd\YRgVVkcT]]VTeZV`dVcR_U d`TZE]cV]ReZ_dYZaD



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AV a]VRV_`h`S]ZXUe`TY``dveYVZ;]ZWa]R_d WceYV`dvgVLd`S[VTee`eYVdVR]T_deRZ_edfa`_ eYV`Ž>`cVZ`a`ceR_ejj deZ]LeY`fXY1R_UeYZIZI hYReCVR]jj TYRRTEVEZXVdeYV_Vh_dEfReZ_/LeYVj RCV`S]ZXUe`SRdveYVdVac`[VTed`_eYVdVZAE_X VJV`V_edeYRed TZ4j ^ R_VdRgRZFS]Ve`eYV`Ž:_ ^ R_j TRCHLZ_UWULeYV}VJU`Va`ddS]VViaVEZ_TV ZLXc`hZ_Xd`bfZT\]j eYRed TZ4j TR__`eVgV_Vd ^ f]ReVRUVbfReVXfZR_TVVkcUVRZ_XhZeYZE

 $EYV TYR]] V_Xd R_U UZ/VIF] eXd `WICAReZ_X R$ $[ZWa]R_Z_eYZd hRj ^ VR_eYRe eYV eRd, YRd e`$ $SVT_W_eAUZ_RU/ZSVAReVLCV-VIEZ/V hRjŽEYV$ $gZZdHEf UVd`VaVcd_R] [ZWRCVSVT ^ Z_XR_`S[VIe$ $`WSdkgReZ_R_URe'aZT`VIF_gVcReZ_`VeYV$ $} cdeZ'a`ceR_TVŽEYZdyR_Re'^j%`VaVcd_R] [ZW$ $RTTM/VReVdZ_UZ/ZLFRZReZ_LRdZe^R-VdaV a]V$ $^`cVRhRV`VeYV aVcd_R] daYVcVd`gVc hYZIY$ $eYVj YRgVe`VI VEIZ/VT_ec`]Z=b`hc XUniŷ gc V!$ $Ymž'Vc`YYWjj Y`]ggi Yg'UFY`VY]b[_X]ggc j YX`$ Ug'dYfgc bU`]XYbHmiVYVc'a Yg'h Y'df]a Y`ÚY`X:cZc VgYfj UHcb'UbX'UWfcb"

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eZdU VdZe^ WehZeYOE` R_dh Vc eVvdV bf VdZ_d V aZZIR]jiŁZeZL_VIVdRj e` YvRch YReaV a]VYRgV e` dbj RS`fe eYVZc`h_ ViaVcZ/TV` VZ_UZgZlfR] ZREZ_Ž2TT dJZ_XjiŁF? 5 A T`aVcRevUhZeY eYV 7RIf]ej` VvAd TY`]`Xj` VeYVF_ZeVcdZLRU4 Re² [ZR UV 4 YZVe` T_UFTeR bfR]ZEReZgV defUj SRcMU`_ Z iUvaeY Z_eVcgZh dudWRaaV_UZ \$/ŽE YvdVh VcV TRccZU`fehZeY R% idec`_XdR`a]V decf TefcVUSj TCZeVcZR`VW^a]`j^ V_eLdecRef^ŁXV_UV4LRXVR_U cVXZ_Ž

EYRe df Uj ac gZIXdeYVf_UkaZ_ZXWc eXZl ARce `WeYVCVa` œŽ: e YRdSW_RUUVU e`R_UVI aR_UVU W'^ `eYkc V` aZZIR] d f cTVdLUkgVj aVU S`eYSj F? 5 A Wc eYZdCVa` œR_USj `eYkcZ_dzZ ef eZ_dZ^`_XeYV^ `deZ a` œR_eRveYVF? 5 A #!!" Df cgyJ R_URdf Uj `V/ZWYZde cZdESRAU`_ VZdZ_XRIT f_edth YZIY XRgVVkeYkcZ_dZXfedZ_e` h YReVRIZZEREUR_UYZ_UKUU fTTVdbMJ T_def TI eZ_ `WaVkd_R] [ZWa]R_d1dWRaaV_UZ %ZEYV T_TJf dZ_d`VeYZd ARce ReVSRAU`_ R_Rj dZl `W VgVg eYZ_XeYReh RddZUZ_eYVZ ekcgZh d.R_U_` e `_R_j aRceZlf [Rc` aZ Z_ V ackdbW eYkvZB f`ekd YRgVSW_ZTJF UW e` VV` a]ZjVeYVT_TJf dZ_d R_Udr`h eYV\Z_U`VJR_XFRVaV a]Vf dVe` eR]\ RS`f eeYk4VZdf VdZ_VgVg USJ [ZWZ

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EYVT f_egi YRdTYR_XULR_U`_V`WYV^`de dezZ_XUVgY`a^ V_edZdeYReaV a]V_`h`cXR_ZV eYVZ:]Zgvd^`cVZ_UZgZLFR]j eYR_ hRdeYVTRdvZ eYVeZ V`WYVZ: aRv_edR_UXR_LaRv_edŽ

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k YfY U`cha cfY gYlhYX k]h k \Uhih Ym\UX VYYb Vfci [\hi d k]hžUbX bck 'h Ym\Uj Y` UbYk Å h Y]f ck b k UmcZgYY]b['h]b[g'' K \Uh=X]gWcj YfYX fYU`mk Uga Y/k \Uh= ZYY`bck]g'h Uh=Z i bX a mhndY UbX a m ck b k UmcZ]j [b] 'Ï

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H YReZI^ VR_eSj Z_UZZLFR]ZREZ_ZIE/ReceRUZ eZ_R] cWWCV_edR_UgR]FVdRVdW_Rd`aeZ_dR_U _`eRd`S]ZREZ_dth YZVReeYVdR^VeZ_VZ_UZZLFF R]dRVSV&eVcRS]Ve_UdZX_`cTY``d/WceYV^dRgVd

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eYV\ZU`WZWeYV[hR_eŽ7f]]ZUZeZUFRZAReZ_ Z'a]ZddyWWeVeVc^Z_ReZ_ŁdyWWehReV_VddR_UdyWV CVRZKRZ_Ž2deYVF? 5 A #!!" Df cgV CVgVRdLb 7\]YdYcdY\UjYUfY`UhjjY`m\][\XY[fYY` cZbXjj jXi U`jnUhcbžU`h.ci [\h.YfY'UfY'a U! cfX[ZZYfYbWYgh\UhX]j [XYUcb[gcWcXY! a c [fUd\]W]bYg" EYZdZdV-VTeVUSj eYVeFS]Vd Z_eYV[WaYYR_UT]f^_ŁhYZIY dY`h eYVcWaf]ed`W R_RUZZZZUNIT_defTeVU`_eVVSRdZI`WVfc Z_UZIRe`cd1dWRaaV_UZ (/Ž7ZdeljŁeWhZ]Z_Xł _Vdd`VZ_UZ&ZUFRIde`deZT\e`eYVZc`aZ_Z_dVgV_ hYV_eYVj df_T f_eVce` eY`dV`WeYVcaV a]V`c Z_deZefeZ_deYReRCVZ'a`ceR_ee`eYV^ŽDVT_UjiŁ eYVZ'RXV`WeYV'dygvdeYReeYVjhZty'e`ac`[VTe e` eYVažEYZUjjŁeYVUXXWe` hYZY eYVj ReecZL SfeVeYVT f cdV`VeYVZc]ZgVde`aVcd_R]UVIZZZ_d `c`fedXLVTZETF^deRTVdŽ7`fceY|jŁeYVVieVee` $hYZYUVIZZ_dRcVeR_V_R^{(1)}_XedRUZZ_R^{(1)}Z_Vd^{(1)}c$ `_]jRAWCT_dTZfdVgRfReZ_Ž2TTdJZ_Xe`eYZd \mathbb{Z} UVI LRS` f e YR WeYV a` af $\mathbb{R}\mathbb{Z}$ _ YR dR ^ UZ ^ \mathbb{Z} YZXY`CYZXY]VgV]`VZ_UZgZUFR]ZKReZ_Ž

?`_VeYVJVdH_ZeZlf_VgV_]j UZdeZSfeVUŽEYV hVZXYe`VeCRUZZ_YRd_`e]ZAWUWCR]]Z_eYVCR`V hRjL_`eVgVg`_VYRdeYVCR`V`aa`cef_ZZXdZ_ ac`daVTeLR_U_`eVgVg`_VZIVbfR]j hV]]VbfZaaVU e`TY``dVSVehW_eYV`R_UCKPZXVeYV`Ž

 $\begin{array}{l} 6^{a} aZZIR | URR d' XX de eYR e^{V_{V}} YR gVR d/ZXYej \\ YZXY dc | VgY | `VZ_UZ gZLF R]Z R eZ_ eYR_ h`^V_Z \\ :e h`f | U dW^ eYR e dYW VAE dC^{Z} R eZ_ ZI^{A}` dV \\ R dF`f dW c eYV | R eVc eYR_ Wc^{V_{V}} SVIR dV eYYZ \\ eR UZ Z_R | c`|VdUV_V eYVZ ZV_eZZ dSj | Z_VZ X eYV^ hZ eYVY^ VR_U^ R EYZ RZ Z X eYV^ e` R \\ UX eW W^{A} af S | Z' UVIZ Z_I^{A} R Z_X R_U UVS R eVL \\ R_USVIR dV eYY `TIF aj R d'S` d Z_R eVa` dEZ_Z \\ eYVh` d|U`Wi` cVZ \\ \end{array}$

EYVj`f_XkcaVa]VRVLeYVXVRvceYZZUZ gZLFRJZRZ_ŽEh`UZWWCV_eWX1e`cdRVReh`c\ Yk&ZEYVj`f_XkcXV_VRZ_dYRgVXc`h_faZ Rh`dUeYReZIXV_VR]j^`cVZUZgZLFRJZVUeYR_ eYVZ:acUVIVd1cdhRdLR_UeYVZ:RezEfUVdcV-VTe eYZTYR_XZ2eeYVCR`VcZ_VLj`f_XaVa]VYRgV WhVccka`_dSZZZdR_U`S]ZREZ_deYR_RUF]edL hYZYXZgVd^`cVcTaVe`eYVZ:RezEfUVdR_UUV dZvZFHYV_eYY_RVRUF]edLeYY_^ZXfeWy]JVd1 dMWUVeCc^Z_VUeYR_eYY_`hSVZgVeYV`dv]gvd e`SVLSfeeYVjhZjTVceRZ_jjSV^`cVZ_UZgZufRjZXU eYV_eYVZcaRcV_cdRcV_`hŽ

2Tf eVUZWWCV_TVd`VZ_UZZLf RJZRZ_TR_Rd SV dW_R``_XeYVUZWWCV_ed TZA] deRHŽH]gg\ck gʻ h\Uh h\Y`WUdUVJImiZcf gY`Z.XYhYfa]bUHjcb` XYdYbXgbchi1 ghicb dYfgcbU`W\c]WYgžVi hi U`gc icb UVWYgghc Vch W`hi fU`UbXia UHY! f]U`fYgci fWYg"EYZdf_VbfR] UZHZZf eZ_^ VR_d eYRe_`eVgVg`_VIR_Ugy] a eYZcZ_UZJLfR]ZRI eZ_e`eYVd? VVI eV_eZ

-A 5; 9GC: -B8=J=8I 5@N5H€B

 $\label{eq:linear} 2dh V] RdSVZ_Xf_VgV_j UZdeZSf eUZ_adRieZVL Z_UZgZLf R]ZReZ_R]d^VR_dUZ0000V_eeYZ_Xde^UZ0VV WeV_eaVa]V, UZ0000V_eTR dvdRevReezZSf eUUe^ZZ$ $AVa]VdaVR^VVVT]Z_ZXcVVgR_TV^Wd TZR]$ $TReVX cZdhX/UVEL]RdERXLXV XRaYZR] TREZ_/$ $RdRSR2EWcUXeXc^ZZ_XZ_UZgZLf R]ZV_eEjZEYY$ $R]d cWWce^eYVUZ000V_eZeZ_Xc^]V^WT_d^aeZ_$ $R_UeYVVV^a]ZjVZ_Xc^]V^WeVV^VUZ0Z$

ÎKY 'žh YfYğ U'chcZZ fY][b]bÛ YbWYž cb hY Yj]g]cb Z f]bg/UbWYžk \YfY h YmŘY U'k Ung g\ck]b[\ck h]b[gUfY XcbY]b ch Yf We'i bhf]YgžUbX dYcd Y HU_Y h Y]f 'YUX' Zca h Uhl fA UYžc XYf UXi hži fVUbž]bhYfa YX]UhY Q9; Ł

EYVZ_eVcgZhddi`h eYReZ_UZgZlFRZREZ_R_U eYVUVI]Z_Z_XRFeY`cZg``VecRUZEZ_YRgVSW_RI T^aR_ZUUSj R_fadfcXVZ_UZgVcdEg R_UXVReVc e`[VcR_TVŽ

Î =h]b_ k YMY a cfY cdYb bck 'Ï =b k \Uhk Un8

Î @_Y fYgdYWJb[ch Yf dYcd Yfg cd]b]cbgž UbX 'YHJb[ch Yf dYcd Y 'Jj Y h Y k Um h Ymk Ublžf][\B'+hk UgbÅi`]_Y h UhVYZ fYž dYcd Y i gYX hc]bHYfZYfY a cfYÅ '7 ci d Yg 1 ghi[c]b['UbX'`]j]b['hc[Yh Yf bck žh Uh k Ug'hchU`mi bh]b_UV Y VYZ fY'' = a YUbž gca Y dYcd Y '']_Y [YHJb['a Uff]YXžgc 'ÚbYž Yhh Ya žVi hch Yf dYcd Y 'XcbMžUbX h Uhŷ' ÚbY hcc'Ï

fl Ya U'Yžmci b[ži fVUbž]bhYfa YX]UhY'G9; Ł



2XZ_LeYZlac TVdh Wedh ZYS`eY Raac gR] R_U UZRaac gR]ŽE` d ^ VLaRoeZlf]Rdj eYVj`f_XddL Ze Zl R_`aa`cef_Zj e` af cef VeVVZc`h_ZVR]d e` eYVcd.Ze Zl R eYcNRe e` eYV ^ cR] Z_eXXZj `W d TZdj+hYV_ ^`cV`aeZ_dR:VRgZIS]VLaV a]V ^ ZXYe yeR:VR hc`_X ef c_%c eYVCV ^ ZXYe SVR y]`dl`WxdaVI&Zo R_j ZV_eZjVZ_UZJLF R]ZREZ_ hZeY V&WU ^ R_UR_RSdV_TV`WIV_df ckLR_URał ac`gV`WZe` eYVcdZV_eZjVZe hZeY Z_UZJLF R]Zr L dJ] ch_VddR_UR_f_hZ]Z_X_Vdle` ckJReVe` eYI VcdLR_U UZRaac`gVŽE YV XcNRe ^ R]`cZg LeY`f XYL SVJZgVeYRe eYVcVRcVS` eY X`U R_USRU Rak VIed e` eYZITYR_XIŽ

7 c ^ R_j aV a]VLZUZZLFRZARZ_ RJd YRdR daVIZ T ^ VR_ZXeYRe cVJRevde eYVT f_egiddvi TV_eYZE giŽed XXv&dZVRZ___`e[fdeW/^ eYV T_deRZed`WF]efd]ecRUZZ_LSfeRJd W/^ eYV cv&zZZ_dZ a`dvUSj eYV^ZZERj 8`gvc_^ V_ \tilde{z} 7c`^ eYV dR_La`Ze`VVZUZZLFRZRZ_LeYRe avZUZddV_RdT_ecRUZE giŽ@_ eYV`_VYR_UL T_d^ vZC R_U^ ZtefdeR'`_XZUZZLFRJdh vZv dec`_XUZZvd`VZUZZLFRZFŽ@_ eYV`eYv&Z} UZZLFRZREZ_hRTIVVI\VUSVIRfdv`aa`cef_ZZd e`a]R_V&Wj Wc]ZWh vEv]Z ZeVZ Î C b h Y c bY \ UbX h YfYğ h [g hYW bc c []! WU fYj c i hcb k \ JW \ Ug Ub]bû YbW Ug k Y ZVYWU gY h [b[g UfY Uj U] UVY bck h Uhk YfY Z fV XYb UbX h Uh \ Uj Y h Xc k [h h Y X]WUhcfg \]dÅ DfYj [ci g [YbYfU! hcbg] Y X UhU ha Y k \ Yb mci Wci Xbhi gdYU_ mci f a [bX ZYY mÅ / UbX = h]b_ h [g \ Ug X]fYWmUZYWWX h Y k UmdYcd Y h]b_ UbX h Uhğ k \mh YmiY]_Y h YmUfYzk \]Y i gZU h ci [\ k Y Yl dYf]YbWX U chcZh Uhz k Y WUb gYY UbX i bXYfgUbX bck h Uh]hğ bch]_Y h Uhi]b ch Yf d UWYgZUbX V[hVmV]h k YNY i g|b[1\\cgY ZYYXca g1\Uh Yhi gXc k \Uhk Y k Ubha cfY k]|\ci f ck b`]j Ygž k \]W\]gk \Uh]ga U_]b[1\\YgY W\Ub[Yg \UddYb'Ï

fl Ya U`Yžmci b[ži fVUbž]bhYfa YX]UhY G9; Ł

7 c^ R_j 4 YZVR_dtZ_UZ5ZLf RJZREZ_ YRdRa`dZ eZ5VRdt TZREZ_ hZEY eYVecR_dEZ_ e` UV^ `TcRIjŁ hYZYY ZdgZdhUU Rd R_ `aa`cef_Zj e` JZ5VZ_ R_ V_gZc`_^ V_eeYReac`gZUXdeYVdT`aVR_UV&WU^ e` cVRJZSVaVcd_R] JZWa]R_dŽ

D@5BB-B; 5 @ 95A - 8GH7CB: @ 7HB; 89A 5B8G

2]eY f XY eRLEZ_R]^ `U\JdYRgVh VR.V_UVR_U aV a]VRV_`h VXVce`UVAc^ Z_Vh YRe\Z_U`VJZW eYVj hR_ee`]VRULeYZIU Vd_`e^ VR_eYVj YRgV_` ^`UVJdRgRZIS]VŽ:_VRIELeYVj fd'R]jj Z.V_eZJVeYV TYR_Xd_`h X Z_X`_Z d TZkj hZY eVVRaaVRd R_TV`WVh gRJf VIR_USVRgZ f caReAc_dŽ_deVRLL eYVac`S]V^ dW^ de`SVeYReeYVd/RcVd7Z&Z_XR_U ^ f ef R]jj T_eeRLZIe`gLR_U eYRe VRIY`V&YV^ ZI acVdV_eVURdR_R]^`def_Rg`ZJS]VUV^ R_UŽH.Y` YZZ:fhic ZWc bgfi WIb[`U`gY'Z]a U[Y`UbX`U` gUHgZUWc fm`jZY`d`Ub`Jb`h.Y`a]Xghic Zh.YgY` dUfUXc1]WU`XYA UbXg'gYYa ghc VY'cbY'cZ h.Y`[fYUhYghgftU]bg`cb`dYcd`Y`hcXUm"

ÎHYa cfYWc [WYgmci \Uj Yžh Ya cfY WebZ gYXmci UfYžVYWUi gYmci XcblÅt _bck k \[W. cZU``hcgY h]b[g`]gth YcbY mci fYU`mk UblÅ 9j YfmVc XmgUmgžĐ Yhcb k]h mci f`]ZYNh Ydfc VYa]g =¥i bch[c]b[hc HU_Y]hVYWUi gY]hŶgZ][\hYb]b[fYU`mžVi h mci IĴIY] chgc a UbmWkc [WYgT] fl Ya UYZUXi ½zi fVUbž\][\G9, L

EYVU/ R_Ud`_aVcd_R]ZV_eZj VlacVdNUZ eYVZ_eVcgZhdTR_SVUZgZWUZ_e`eYCWXc`fad= eY`dvUvZgZXW/`aRceZTZREZ_Z_eYVd_deV`d `Wd TZdgLeY`dvUvZgZXW/``eYvcd_R_UeY`dv eYReaV a]V^ R_Vfa`_eYV`dv]gVdŽ H≰9/89A 5 B 8 G C : CC 7 = 5 @CMCH9A CžC F Î H≰9 A 5 7 < = B9Ï

:_eYVLZWWCV_eRIT f_ceLeYVZ RXV`Wd TZAG Rd Rd d&V`cWWcdVdaVIZA]ji e`ZedVT_`^ZT`cXR_ZAR eZ_ŁaRceZIf]Rcji h`c\R_Ud TZAdVIfcZej dj d&V`dŽ EYVaVcTVaeZ_ZleYReeYVdV^R.V`_VR_UeYVdR`V UV`R_U+Z_UZZLIFR]aVcWc^R_TVŽ

Î 9 YfmighYd mci HU_Yžmci ÑY Ug_YX hcc a i W cZ^A gc k \ Yb Yj Yfmh]b[Ng gc XY! a UbX[b] ž]b Yj Yfmk Unž]ha U_Ygmci Å a U_Ygmci Å ZYY`h UhYj Yfmh]b[NgU[fYUh YZC flžY j Yfm`lhY'h |b/ žUbX'nc i ÑY U'k Ung' ghti [[]b[k h h Uhž hXc Ygb h Yhmci UcbY VYWUigYmci h\]b_ h\YbYl hdYfgcb a][\h VY [YH]b[cb VYHYfžUbX]Zmci gUW Yb cZ mci a // \h/Yhh\fckbci hcZmci f*cVÅ cf 'i ghdUggYX cjYfÅ /h\Uhŷgh\Y ghfU]bÅ mci 1 ghXc bNiZYY`\UddmUVc i hh |b[g'Ubm a cfYžf]/ \lBÅ Zcf gca Yžch Yfg=Wci XbÑi gUnž=XcbŇi_bckÅž=Ňi HU`_lb[UVcih dYcd Y b a mgh UhcbÅ žVYWU gYh YfY UfY XJZZYfYbhg]hi Uhcbg \YfYžUbXmci WUb XYbhZna cfYk h cbYVYWUi gYh UhỹthY cbYinci ``]jY']bžUbXihUhỹgik \Uhi=Na hY``]b[` mci UVci HÏ

fAU`Yžmcib[žifVUbž`ck'Q9;Ł

EYVEV ZELR gVcj hZLVEREVRU a VETVaeZ_ eYRe h`c\YRdTYR_XUUZ_RhFj eYRe YRdeeR_dWc^ VU Ze Ze` eYVTV_ecRj ReaVTe`VaVcd_Rj]ZWZEYZd WWJZ_XZdT_dGeV_ehZeY VI a VCZ/TV+Z_RYZXY[j UVEVAF]RevUd TZRj dj deV^L^ R_j`aa`cef_ZZdUVc a Vcd_Rj UVgVj a^ V_e UVaV_U`_ Y`h ^ fTY Zd VRc_UV&/ h`c\Ž2eeYVdR^ VeZ VLeY`f XYLeVV UV R_LU^ RUV`_ aV a]VSj R dTTVdM/j h`c\} Z_X]ZWdW^ e` XCRee`T aVhZeYŽ2eeYV]VRdL e` ^ R_j` eYCRdaVTed`WaVcd_Rj]ZWYRgVe´SV dRICZ_TVUe` eYV`Le` eYVLeY_eeYReeYVgVcj ZJNR `VRaVcd_Rj]ZWa]R_SfZeRc`f_Uh`c\T ^ Vde` SVdW_RdRT_ecRUZEZ_Ž

E YZd T ecRUZteZ TRoted R a R] `W aacVddZR U ZIVXEZ RT `g\c eVZ RXV`Wh`c\ Rd Ze Zd MaWZZ/TWeURJŽJVeZeZdUZWZCF]ee Rg ZLŁ dZ_TVeYV]`dd`Wh`c\ZddW__`e[fdeRdRdfcTV `WWT_`^ZTYRUUHYZaŁSfeRjd`RdyaVcd_RjR_U d TZR UNREYZZ 3 VIR dv Ze Zdd R] I T_d^ Z XLEYV ViaV2Z/TV`VA`c\Z`acVX_ReVdeYVZ`RXVaVa]V YRgV WITZE CXR_ZEREZ_ŽH i gžigc WU i gmghYa gi UfY dYfWY]j YX Uggca Yh\]b[Yl hYfbU`ž]a ! dYbYhfUV`Y`UbX`Yl]ghYbhJU``mcddfYggjjY"' H\cgY`]bhYfj [Yk YX`X]X`bchYbj]gU[Y`Ubm ch\Yf`Zcfa cZcf[Ub]nUh|cb`h\Uhikci X` a U_Yh Ya Ygg WobhUX]Wo fm H]ggYYa g hc UVW/ci bhZcfh\Y]a U[YcZgcWYhmUgUb ÎYWebca]Wa UW]bYÏ k \]W [h]g i gY Ygg hc fYglgh

Î 6YVVI gY flyj YbLih cgY k \c [c U[U]bghih Y' a UWV]bY UfY VY]b[dUfhcZh Y a UWV]bY'Ï fA UYZUXi 1zi fVUbž\][\ 09, Ł

 $EYV_{y}^{R}RYZ_{w}ZIR_{d}^{d} aRRU_{i}ZR_{z}^{R}R_{v}ZR_{v}^{d}$ $hI_{g} + RYZY_{w}ZY_{w}ZV_{z}^{d}R_{v}Z_{z}^{d}R_{v}Z_{z}^{d}R_{v}UU$ $e^{i}C_{R}V_{e}^{d}Z_{e}^{d}TIV_{e}^{d}M_{i}^{d}]_{j}Z_{e}^{d}U_{v}^{R}R_{v}^{d}A_{v}^{d}R_{v}^{R}$ $aVCV_{e}^{d}Z_{e}^{d}TIV_{e}^{d}M_{i}^{d}]_{j}Z_{e}^{d}U_{v}^{d}R_{v}^{d}A_{v}^{d}R_{v}^{d}$ $uVRIY^{A}V_{e}V_{e}^{d}V_{v}^{A}T_{i}V_{e}^{d}Z_{v}^{d}Z_{v}^{d}Z_{v}^{d}Z_{v}^{d}Z_{v}^{d}V_{v}^{d}N_{v}^{d}$ $aVa_{i}VSV_{u}^{d}EZ_{e}^{d}d_{i}V_{e}^{d}hYZY_{v}^{d}V_{v}^{d}V_{v}^{d}N_{v}^{d}$ $e^{V_{i}}R_{v}f_{u}Z_{v}^{d}A_{v}^{d}Z_{v}^{d}R_{v}^{d}Z_{v}^{d}R_{v}^{d}$ $R_{u}UVA_{v}^{d}R_{v}^{d}R_{v}^{d}Z_{v}^{d}Z_{v}^{d}$

H≰989A5B8GC:CH≰9FGžCFÎ8=GHB7H€B H≰FCI;<CI779CCÏ

EYV dVT_U UV^ R_U Zd eVRe ^ RUV Sj ` eYVcdL



R_UZe`aVdevdZ_gRzfdhRjdŽH YReTc`aaVUfa ^`de Voolf V_elj Z_eVz_eVcgZhdhRdyWcMZ_% R_UyhYReaV a]Vd3 %ZEYVg`ZV`VeYVy`eVVc6 obf ZvdaV a]Ve`efc_eYVd4/WZ_e`RcVacVdy_eReZ_ VceYVzcSV_VjeŽDYcd`Y`UfY`YI dYWhYX`hc`VY` g`VWVggZ_žYI WY``]b`Yj YfmUfYU`cZ`]ZY`UbX` g\ck_ihUhihYmWUb`gYhihYa_gY`j Yg`UdUfhi Zca_ihY`fYgh`HYReZiUV`R_UVUZ_aRe2Tf]Rc RcVVT_`^ ZT`d`TTVdtLR_fahRdU`TRcWc aReYL T_daZff`fdT_d`^aeZ_LeYVcZXYeaVcd_RJ Rał aVRR_TVR_URy_`c^R%MCZj_]ZWZ

Î 6YWU gY =h]b_ gc WYImcf h Yk cf Xž= Xc blvi_bck k \Uhir WU``]lž\Ug VYWca Y Yl hYa YmWca dYhhj Y UbX'h Y cb mk UmcZ [Yhhb[Ubnk \YfY cf glUbX]b[ci lžX]ghb! [i]g\]b[mci fgY Zig hc gd YbX U`chc Zha Y UWX]Yj]b[h cgY [cUg h UhYbUV Y mci hc Y] WY 'f

fAU`Yžmci b[ži fVUbž]bhYfa YX]UhY`G9; Ł

:eV VEXIdW^ hYReaV a]VdJ eYReeYVdVU/ ^R_UdREVUZ/WIF]ee`XvéRc`f_UŽEYVJ`aV_eYV hJ; e`eYVd/TX_ZZ_R_URTVaeR_TVSj`eYvd eYReREVd dec`_XJ; UVZEVUŽ2_UaV a]Vd`h_dv/W Z`REVZIZ_G`]gVUŽEYVd/UV^R_UHREVR] eYV^`cV Z_VJFTERS]VZ_eYReaV a]VaVEVZEVEZIdVTX_ZZ_ RdSVZ_XVgVc^`cVVffdgVR_UUZWIfjee``SeRZ_Ž

EYVaV a]VZ_ekgZhWT]RZ We SVVcTWZ_e R_ReezerUV`WT^ af dzeVT ^ aVezezeV_VddSj eYV ViaVTeReZ_d`WeYVcoŽEYZdac`gZVdTlfVde`Tcfł TZR] Rola VTed`WefS[VTeZgVViaVcZV_TVe`URjŽ7Zcde]jŁ ZUZZIFRZARZ_SjUZZZTZ_^R\VdZUZAVIFJee` SV/_Xe daVIZ/TXc f adŽAV a VdW dReYVce cZV RS`gVVgVg``_VR_UVgVg`eYZ_XŽEYZdZUVecZ`V_eR e`deRS]VL^fefR]dVTX_ZZ_R_UZ_YZSZedaVa]V $W^{\wedge} dR_{Z} XeVZ WWZ XdRS^{1} feeYVTYR V Xd^{W}$ aVcd_R]]ZWZ2dRcVcf]eLaV a]VWW]Zd]ReVUR_U }_UZeYRUe`XZeVRdYRCVU^ VR_Z_Xe`eVVZc]ZVVi} aVZV_TVŽDVT_UjiŁR_ZV_6Z; SRMU`_ eYVZVR`W ViTV]]Z_XZl`_VeYReZlT_deR_ejj cV]Z_bf ZlYZ_XeYV a`d&Z_dZeYRdcVRIYVUe`afcdfVeYV`_VdRS`gVŽ $5 \text{ ZdeZ} \text{TeZ} _ \text{Zd} \text{R} _ \text{ZV} \text{e} \text{Zd} \text{e} \text{e} \text{VeVc} \text{T} ^ \text{Vd} \text{Z} \text{e}$ SVZ_XŽEYVeh` eYZ_XdłeYV]RI\`WT_TcVeVXc`fa ^ V^ SVcdYZa R_U R_ ZV_eZej eYRe Zd T_deR_ejj ^`gZX`_ł RcVdec`_Xjj Z_eVccV[ReVUŽ

 $\begin{array}{c} EYVEV RV \ eVVC Rdv Vied e \ eVVUV \ R_Ud^RVV\\ Sj \ eVVcd \ cZ \ a \ dVUSj \ cV[ReZ_dhZeY \ eVvcd_R]! \\ eY \ fXYeVJ \ U \ \ e] \ \ hReZ_dhZeY \ eVvcd_R]! \\ eY \ fXYeVJ \ U \ \ e] \ \ hReZ_dEYVCVRVLWcVI \ R^ \ a]VeVVZ \ l \\ yh YReaV \ a]VcJ \ \ zZEYVCVRVLWcVI \ R^ \ a]VeVVZ' \ l \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ gVUZ \ cV[ReZ_dVZadhZeYZeZ \ Revel \\ a \ \ dEZ_dZg \ \ dVZReZ_LRWWEZ_k \ cVVVeV \ cV \ RVVVeV \ cV \ R_Ud^RVVeV cV \ R_Ud^RV \ cV \ R_Ud^RVeV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RVeV \ cV \ R_Ud^RV$

H≰9'89A 5B8G'C: 'H≰9'C9@ žCF Î5I H≰9B! H¥7 +HЙ

H YfY]g U bYYX Z f Î Ui h YbHWJmi VY! WUi gY h Y Î a UW]bYÏ UbX h Y]a dYfUHj Yg c ZÎ h Y c h Yfg UfY YI dYfJYbWXX Ug gc a Y! h]b[U]Yb UbX YI hYfbU h Uhdi g dYcd Y VYmc bX h Y UWWYdHUV Y]a]ngzh YVeYVceYVdv [Z ZdRVUVeVc Z WSj gRJf V& ad TY] XZR dRevd `c eYV ej aV WI TZR cVJReZ_dYZad UVEXVZ/2f1 eYV_eZZg %ZdR^ SZAF `f d=Z^ RJ ^ VR_ RUVEXVVc V R_TZARZ_ `d.Vbf R]jLR]`_XZ Xe VIRAVŽ

ER\V_R] e`XVeYVeLaV a]VU`_`e dW^ e` dVI ReVe`eYVUZXWKVeeYZXdcVbfZVU`WeYV Sj d dev drevv evvalle Uevv dygvdRdev f XV evv h VcV dZ a]j RjeVc_Rezevul ev Re ev Vj T f]U TY`dV R^` XŽEYVI RCV_`eViaV2ZV TVU RdRlevc RozeVeL SfeRddZff]dR_VfdLf_Rg`ZLRS]VUV^R_UdŽEYVj ReVervZ' ^ `gRS]VSRI\Uc`a RXRZ_deh YZIYaV a]Vd ZWalR dYRve SVWc WZH g g c bY c Zh Y _YmbchYg cZh\Y W ffYbh |bX|j |Xi U`|nUh|cb' dfc Wyggž Ug dYc d Y Yl dYf YbWY h h Y ghfU]b`cZ\Uj]b['hc fYgdcbX'hc WcbhfUX]W hcfmXYa UbXg UbX h Y WYfHUbhmh Uhbc a UhYf]U``mj]UV`YžgcWJU``mUWWYdHUV`Y UbX'dgmWc`c[]WU``mgUhgZJWcfm`]Z/'d`Ub' WUb VY Z fa YX k h ci hfYZ fYbWY h h YgY 18 V&X/_L" **#, 6Yd/_SV&L" **) /ŽH ZeY fea V&Vd ^ R_TVLeYVEVZEL`]ZeZ_Xe`SVYRU, hZeY`fedfTTVdeL d TZR dVT X ZZ ZHYRUe T ^ VSj, R UhZeY fe UVERIY^ V_eW/^ R] eYZŁZEZUZZWIF jee T__VIe hZey hYRe`_VSVJZZgVde`SV`_VdecfVdJJŽZ

 $:UV_eE_{1}^{2} R_U^{2}Wa]R_dRVUVdEZSVLEAVWAL$ $|ZVaReYdeYc f XY R ^ Z_V VU ` WT _~ZEZ X UV$ $^ R_UZD ^ VaReYdRVd TTVdW/L eVvdRvf_d TI$ $TVdW] ` c e of ` f dZD ^ VEZ Vd]RXVT_TVdZ_d$ $RV^ RUVe` f edZVU/ R_UdR_U^ R_j aVd_R$ $Z af]dvdRvd aacvdWZD ^ VEZ VdUV/ZReVSf e$ $d dRZ RSJVSR/R_TVdRVRIYZ&VUeYc f XYT ^ ac ł$ $^ ZWZE YVVRVRJd deReVXZd` WT_W_eRZ_hZYY$ $R_U`aa`dZZ_e` f edZVU/ R_UHR_Ua`hVVM$ $R_VC^ REZ_` WYVU/ R_UVCR eV_eZZjZZXZL$ $eYVVRVT f cdvdZ_JZWeYRe_V&VCRIYZ&VR_j T ł$ $YCV_TVJVRZZ AV aJVUWW_TV/VdRXZ_deeYVT_ł$ $~ZICd` VeYVZc V_gZ`_^ V_eZZYZZZ XCRZWE j$ $Z_UZZLF RJZRZ_Z_G`]gVdR_f_V UZ_XSR/R_TZ_X$ $RIESV6hW_R] eVVdeVeZ_dZ_Z$

Î@57? C: H+A9ÏžCF H×9K95?B90C;C: CC7=5@A95B-B;

?`eR] eYVUV R_Ud WATZ_XaV aJVRdeYY eg e`T_ded TeRaVcd_R] ZJV_eZj hVZXY fa`_eYV VbfR]jŽEYVUV R_Ud`WyeYV^ RIYZ_WodW^ e` acVU^Z_REVŽ@S[VTeZgVjjLeYZd^ R_VdR_XCVPeUVR] `VdV_dALdZ_TVaV a]VdRSZZj e` ac`gZJVVCeYV ł dMgvd]RcXVjj UVaV_Ud`_eYV`aa`cef_ZZd`WWCVU Sj d TZQ dj deV^ dLaRceZff]Rcjj h`c\ZDfS[VTeZgVjjL Y`hVgVLyeYV^ RIYZ_V%j``^ d.d`]RcXV SVTRfdV ZeZ`a`ddRaRTV`WZZWeYRe]VRgvd]ZegVeZ`VVc `eYVceYZ_XDZ

Î H. Y dUWY cZ ZXÅ žVYVU i gY nci gYY h Y k cfX hcXUnž Jhğ U``ei JW žei JW žWa Y cbž \i ffmi dž\i ffmi džei JW žYj Yfnh Jb[Ŋğ U` fi g\Å žUa]bi hY \YfYžUa]bi hY h YfYžUbX h YfYğ bc Ha YZ f Ubnh Jb[YgYžVYVU i gY gca Y\ck Yj Yfnh]b[Ŋğ U'k Ung U fi g\'Ï fA UYžnci b[ži fVUbž\][\Q9, L

EYV]RI\`WeZ VZdd^VeYZ_XgVg cVR]ŽEYV UV^R_Ud`WeYVy^RIYZ_V%]ARgV]ZegVeZ VZ_eYV URJ e`afccfV`eYVcRdaVTed`VJZWLcfTYRdeYVVR^ł ZjŁWZY_Ud`ccVjR ReZ_Ž

3feeYVy]RT\`WzZ`WZzCl^`cVeYR_eYVRSdV_TV `WXXWeZ`VŽ:eUVzgVdW/^RgVg`UVA`Tf]efd?] R_UadjTY`]`XZIR] acUZIR`V_&Z_RJjdKd`WhYRe aVa]VdBjRS`feeYVd`S[VTed`XXVdadeYReeYV y&Z V%oWeYVy^RIYZ_V%oR\UdZYRUe`dAva SRT\W^ZadUV`R_UdR_UdWeYV`Z_aVdaVTi e&ZZEYV]RI\`V&Z VdW^de`SVdyReVUe`eYV Z_RSZAGje`dWeYZXdW^^RgZuha`Z_eeYReTR_ dr`heYVdZ_Z_TR_TV`WeYVdVUV`R_UdWc`_Vd `h_a]R_dZ_]ZWZ

Î: fca ci lg]XYžnci gYYUa UW, JbYk \JW Jgh Y WImcZk cf_ž']_YUdUWYcZ JZ h Uhjg Uk Ungh YfYUbX h Uhinci Ifinic _YYd WYUf cZ:VYWUi gY =_bYk h Uhih Y WcgYf =[chž h Ya cfY =k Ug [Yh]b[gi W_YX]bžVYWUi gY nci ÑYž=gYY]h']_YÅ U'_JbXcZZc [th Uhinci [Yh]bhc UbX h Yb nci ÑY]bg]XYZUbX Jhỹgc \UfX hc [Yhci hcZ]hž cc_ Xck b cb nci fgYZ UbX gYY h Uhinci ÑY]bg]XY h Uhih]b['Ï fA UYžmci b[ži fVUbž]bhYfa YX]UhY C9; Ł

EYVZ_RSZZEj e`dWeYZ_XdW/^ eYZlgZha`Ze ^ VR_deYRe`_]j eYVU/^R_Ud`WeYVy^ RIYZ_V‰ RVgZES]VLTRCZ_XR\Z_U`VydyWWXX&M__VdYZ H\Y`UW_cZha Yžk\]W`]ggi W_UfYWffYbh WcadU]bh]bthY`X]gW gglcbgcZ7\]YUbgž gYYaghcaYUbthY``UW_cZU'dYfgcbU`cf Wc`YWhj Y`aYUb]b[`WUdUVY`cZdiHhb[` h\Y`WcbhfUX]WcfmiXYaUbXg`cb'dYcd`Yhy` `]ZY'd`Ubg`]bhc'dYfgdYWhj Y"

ÎHY [fYUha Ugg cZdYcdY]b h]g Wei blfmž k \ c UfY XYdc]HWhYXžk \ c UfY Webgi a Yf!]głžk \ c \ Uj Y bc \]ghcfJWU`a Ya cfnžk \ c \ Uj Y bc j]g]cb cZgcWYhmÅ Ï fl Ya UYžUXi `lži fVUbža YX]i a !`ck @9; Ł

Cca Y]bhYfbUhJcbU`Wa dUfJgcbgfYj YU`h\YYbcf! a ci g`cUX`cZk cf_]b[`\ci fgVcfbYVmdYcdY`]j]b[`]b`7\]YUb`WJhYg fl 6Gž &\$\$\$\$L'`A cfY`dfYWJgY`XUhU` g\ck h\UhUVci h\UZh\Y'dcdi UhJcb`\Uggca YZYY` hJa Yž U'h\ci [\`h\]g`]g`j Yfmi bYei U``mX]gff]Vi hYX` Ua cb[`gcWJU``[fci dgf7 UhUzbž&\$\$\$L''Ch\Yf`XUhU` fYj YUž Z fh\Yfa cfYž h\UhdYcd Y k ci X'dfYZYf hc WUffmcb k cf_b['b h\Y]f ZfYY ha Y'fl B 8 Dž &\$\$\$UL'' 5 WWcfX[b[hc 7 UhU'z bÑgghi Xnžh\fYY'ei UfhYfgcZh\Y' dcdi Uhfcb k cf_b[Zca 'A cbXUmhc : f[XUmU'gc k cf_' h\YgUa Y'bi a VYfcZ\ci fgcb GUhi fXUngzk \]Y UVci h U ʿÚzh\Xc 'gc cb Gi bXUng Ug k Y`" :_ eYVRSd/_TV` VRaVcd _R R_UT]]VlēgVgZhł a`Z_d_eYVd/UV` R_UdRVdW_ Rdf_ReVdS]VŽE YZd RWWdeVZZ RXVaV a]VYRgV` VeYVZ` h_ TRaFSZZ eZdŽH Y]bhYfj]Yk g'fYj YU``U`gffcb[`ZYY`]b[` c Z d c k Yf`YggbYgg c f`]bWUdUW]hm`a Ubm]bX]j]Xi U`g`ZYY``i bUV`Y` hc `Vf]b[`UVci h h Y`W Ub[Yg]b h Y]f Ybj]fcba Ybhh UhUfY` bYYXYX]Zh Y]f d`UbgUfY hc Vea Y hc Zi]h]cbŽ 2]] d ced` VeiV a]VWV] eYZlhRjŁW/^ eY`dVhY h`f]U]ZVe` TYR_XVeYVZ h`c\Z XT_UZZ_de` daV_U^` dve? VhZY eYVZ VR^ ZZdLSfeVW] eYV TR_`eLe` eY`dVhY` SVJZgVZeh`f]USVZ a`d dS]Ve` TYR_XVeYVa`]ZZTR`cVT_`^ ZTd deV` Z eYVhRj d_UUVUe` ScZ_XRS`feeVV\Z U`VeTZkj eYV h`f]U]ZVe`dWŽ

Î l bZ fli bUhY nÅ VYWU gY =[chhc h Y glu[Y k \YfY =1 ghglUfhYX hc UWWYdhh Uhh]g]g h Y k Umh]b[g'UfYža]gYfUV YžUbX gc \ck Yj Yf k]``]b[=Ua UbX \ck Yj Yf a i W Ybh i g[Uga ` UbX YbYf[m=j]Y [chž=jši 1 ghgk YdhUcb[VmU``h]gÅ Ï fA UYžUXi hži fVUbža YX]i a !`ck @; Ł

2_Z`RW`WZ VZIZ_d\aRHSJV\&'^ Ra`d&gy Z`RW`W_Vd`h_RSZAj e`RIĕŽEYV\\\ef dV\i Zhd hYV_TYR_XVZda\cTV&g\URda`ddSJ\LR_UeYZdZ l a]ZdRSVJZW&YReaV a]VdRIeZ_dTR_ScZ_XRS`fe eYZHTYR_XIŽEYVJ\\dHV\&YaV a]VYRgVZ_eY\&C`h_ RSZZj e`RTH_eYV^`dVZ ^ VUZNeVR_UTf ceHZ\VUZd eYVZ:Z`RW`V&YV\\ef chLR_UgZIVg\cdrZH ZeY_` e`^`cc`hLJZWZdeJ\CT`aVUZ_e`eYVaC\dL'eR_URJ] U\^R_UddW^ Vbf RJj Z`a`ceR_eR_UaC\dLZXŽEYV Z_e\cgZhdckgVR] RhZV\dac\RUZ_RSZZj e`eYZ\ SY`_U eYVaC\dL'eLd ^ VeYZ_XeYRe ZiRdt TZNU hZeY]`h dyI\W&W^Ž

ÎBck žk \Yb =X]X a U_Y d Ubgžbch]b[WUa Y cZh Ya "GYWUi gY h YfY k Ug U ha Y k \Yb =Wci X h]b_ U\YUXžUbX bch]b[ž bch]b[WUa Y cZ]hi fA UYžUXi 1ži fVUbž]bhYfa YX]UhY G9, Ł

A =GHFI GHC : "H≰ 9"C H≰ 9F

3V&UVdeYZdd/_dV`WeYVVNefdvLdTZR][Z_\dRV R_`eYVc`WeYVdTZR]dvdfcTVd_WUVUe`T_decfTe ZV/c6&ZdR_U]ZWa]R_dZEYVjac`gZUVR_Z`RVZ_Rj `V&YVyH V&&YRe X&ydaV a]VR YZXVc dXRU Wc eYVZc`h_KSZZGj e`RT&ZEYVcfaa`ceR_UTRaRSZZ eZd`WeYVcLeYVcVT X_ZZ_R_URWWTeZ_eYVj X&yLT ^ Ve`Wc^ aRce`V&YVZ_UZgZLFR]ch_dyW Z`RXZ5ZTFdZ__Vh`c\dr UVaZ_WSj ef dL R]`h [ZWV1aV5Z/TVde`SVdTZR]ZKVUŽEYcf XY eYV^LZ_UZgZLFR]dUZT gVc eYRe eYVdVV1aV5Z/TVd ReV_`ed ^ VeYZXafcVj aVcd_R]LSf eeYReeYV6V RVYZde cZR]R_UdTZR]V&Te cdeYReZ_fV_TVeYV^Ž EYZLUZT gVcj ZLZ a`ceR_e Vc eYVT_defTeZ_ `VMRAVU^VR_Z_X6Z

HZEY feR_Rock `Wate`_Xd'TZR]S`_UdtaVa]V RV/VdVbfZavUe cvRZveyvZcavcd_Rja]R dŽfde RdZ'a`ceR_eljŁeYV/T^Ve`dWhYReZd`fecZUV `WeYVd/WeYVd TZR] V_gZc`_^ V_eLRdWeVZX_Lf_ł T_ec ||RS|VR_UeYf deYcVReV_Z_XZ2deYVf af ccf V eYVZc]ZWa]R_dL^fTY`WeYVZcV_VcXi_^fdeeYVcVi WEVX Z_e``cXR_ZKZ_XUWW_TVdRXRZ_dehYReeYVj aVcTVZgVRdeYVUR_XVcdRcf_UeYV+T^aVeZZ_ W/^ `eYVcdL]RI\ `W/S dVIf cZijLReeRI\deYRe X $f_af_ZMULRSZerg UV R_UdZ: WaVed_R]a]R_d$ U_`eZTIFUVR UUGRh d'deV R TVW/^ y`eYVark eYV SVT ^ VRacReVX ` WVW TVRXRZ dev eYValZ $EYVWRc`WeYVR_`_j^`fd@eYVeLUVelle2SVURe$ [V_XeYZ_eYV"**) CVa`ceLZdRd R^R_ZWeReZ_ `WYVUZINTF | eZdZ g` | gVUZ T_ ded TeZ XdRezUNNT e`q`aVcd`_R|ZV_eEZdŽ

ÎÅ h Y k UmdYcd Y Ufci bX \ YfY `cc_ Uh nci fYU`mVch Yfga Y U`chÏ

 $K \setminus UhXc mci gYY] b h cgY cc_g3$

Î: fi ghtUhch gca Yha YgžYhj nžU`chcZ Yhj mÅ /\mdcWfgnigca Yha Ygžgca Yha Yg =ĴYYHU_YXhc dYcd Yk \c [c Đ Ynž=Ši [UXh\]b[gUfY[c]b[k Y``Zcfmci ž=Ši [UX` h\YmJYYk cf_YXci hÅ NžVi h]bg]XY'=_bck h\Uhh\\Uhh\YmJYhY``]b[a Y]gh\YYI UWi cddcg]hY'Ï

ÎÅ =ih |b_]hỹ \UfX]b Uk Umin \Uj Y UdYf! gc bU]hmcZnci fck b \YfYžh Ym[YhUhnci ž dYcd Yk \cgY cd]b]cbg nci XcbÑiWUfY UVci hgłUfh[Yht]b[Uhnci ž]hỹ VYhYf i ghic _YYd ei]YhÏ fA UYZUXi izi fVUbž]bhYfa YXJUhY Q9, Ł

:_UzgZLfRJZReZ_ŁeYV_ŁZŁ_`eRafcVjjdfS[VTezgV

ac`TVdt_`cRafeVjj acZgReV`_VŽDFTTVdtUVáV_Ud `_aVa]VdRSZZej e`^`f]UeYVV_gZc`_^V_eeYVj]ZgVZ_łZ_UZgZuFR]jj`cT]]VI6ZgVjjŽ2_UeYZdRSZZej]RcXVjj UVáV_Ud`_cVdfcTVdeYReRVRT6FR]jjdTZRJŽ 3f eeYVWIeZleYRe]hlgh Yj Yfm]bUXYe i UWncZ h YgY fYgc i fWYg h Uha U_Yg]bX]j [Xi U`]nU! h]c b`\UfX`UbX`gfYggZ ``]b`7 \]`Y"

= B8=J=8I5@N5HCBCHF5H9; =9G

3 VZ_XR_Z_UZGZIFRIZ_4 YZVZIRYRUR_Ud ^ VI eZ_Vd]`_Vj_TYR]V_XZJVeaVa]VU_`e`_eYV hY`]Vegi e`Rg`ZJZZ;fdeRdT]]VT6ZgVZV_662Xd RcVhVR_V_Z_XtaVa]VRVSVT ^ Z_XRhRv`VZ_UZ gZIFRIZRZ_LR_UeYVdVac`TVdVdRvVRTVJVRZ_X R]]eYVeZ_VZeZIRVRIELe`LeYReaVcd_R]cKRIZRZ_ UVaV_Ud`_VRTY Yf ^ R_SVZ_XR_UeYReV&WU ^ e`UVIZVhYRej`fhR_eZIRgRJfVZ3V4hW_RaRe eYReZIX_VVcX`UR_UR_f_TVcRZ_V6fcVET_l defTeZ_XRaVcd_R]JZWa]R_ZIRTYR]V_XVeYReZi d ^ VeZ_Vd ^ Ve dTTVdWJ]jLd ^ VeZ_Vd_`eLSfe eYReZIR]^`ckRhBjdVYRfdZ_XZ

> R_j [ZWa]R_dR:VacZ R:Zj deR:VXZdWcT ał Z_X h ZEY Viek_R] eYcVRedŽ6]f UZ X eYCV eYcVRed dW^d e` SV eYV VZde deVa e`h RcUd dR:ZMXTe`cj Z_UZ;ZLFR]ZIREZ_Ž

Î=Xc bħiVY]Yj Y]b îh Uha cXYž=łá WUi [\h i d]b]hVi h=Xc bħiVY]Yj YÅ žgc k \Uh= k Ubh]gZcf łh Ya fl \Yf W]XfYbLic VY_Ydh ci hcZ]lźlc "Jj Y]b îh Y k cfX k]hci hVY]b[gc a i W cZh Y k cfX flÅ lž=a YUbžnci ħY]bg]XY U gnghYa îh Uhk cf_g]b U dUff]W Uf k Unžgc g]bW nci ħY h YfYžnci `\Uj Y hc [c ` U c b[k]h]lžVi h]hXc Ygbħia YUb nci ħY HU_Yb]bžf][\l8 6YWUi gY îh Uhỹ k \Yb îh Y flci VY glUffgžk \Yb nci ħY HU_Yb]bž=a YUb ` k \Yb nci fYU`nžfYU`mih]b_]hỹ gc]a dcf! HUbhhc "Jj Y i d hc îh Y Yl dYWUhcbg îh Uh Wa Y Zca U``h Uh?

585DH⊞; HC Hk989A5B8GC: Hk9ĨA5! 7<-∄9Ï

EYV&VR&VUZXWW&V_ehRjd`WT_WJ_&Z_XeVV eY&NRedŽEYV}cdeR_U^`de`SgZfdZtle`RURae d'TTVdbMJjj e`eYVUV R_Ud`VeYVy^RIYZ_V&R_U eYVy`eYVdVZ@_VdvLa`_UV_eTJRZ`VU e`YRgV dd]gVU eYVT_edRLZEZ_SVehW_YZLda`ceZ_X g`TReZ_R_U eYVVR^ZLj Z`RZ_Rcj YVWJed TZ4j hRdZ a`dZ_X`_YZ`Sj RURaeZ_Xe`eYVU^ R_Ud hYZIY eYReZ`RXVV_eRZJVUŽ

y.ehRdcVR]]j YRcUe XVeZ_e eYV_ReZ_R]ıc hł $\underline{Z} X \in \mathbb{R}^{\wedge} \subset$, : $\operatorname{ecR} \underline{Z} \setminus U \setminus g \setminus g \cup L$: $\operatorname{YRURC} h \underline{Z} X$ ^RIYZ_VYVEVZ_^jY`fdk ,d`^j]ZWIYR_XU hYV_:YRUe`eR\VeZ`VRhRjWo^^eYReŽ7ZdeZe hRdSVIRfdV`Wf_ZgVdZgLSVIRfdV: UZLjeYRgV eZ Vê Û S`eYeYZ Xa D'EhV]E: YRUê < EhYRe hRdYRaaV_Z_XeVV_hRdeYRed TZkji hRdaf dYZ_X ^Ve`afe^jdefUZVd}cde 3VTRfdVRda`ced ^ R_LRc hVL: U_e _ hLYVVZ 4YZVeV ^ Z&Ye VRc_ &! `c'!! eY`f dR_U aVd dR^ `_eY Re^`deLR_UeYRečd_`eV_`fXYe`\Wa'eYVNR^Zj :hRee`YRgV :ň a``cRU:hRdĕXZXe` $^{R}VU' hZey hYRec' hZ_XT f UXZeV^ VLd Z_$ eYRehRjeYVcVhRdacVdfcVe`T_TV_ecReV @W TfcdHZWeYYUe U^ VL[VeddWLhV]]aR j`fL: $U_e^{\tilde{e}_{tot}} He^{WR_URYRWZ_Z_LWfc^Z_Z_L}$ V_`fXYWc^Ve`\Wa^jWR^ZjjZ_dNRd_RS]V dej JVR_UUVUZIReV^ j dvJV& c`hZ_XLeYV_ : h`f JU YRgVUVUZIReVU^jdMV&c`hZ_Xމ

Î Cc WYYmYY dYWg mci îc \Uj Y U ei U]Ú WUHc b VYZcfY mci WUb [c c b îc glUfhU ZUa]mÅ žh Yb k \Yb mci ÑY U dfc Zygglc bUž mci ÑY YI dYWYX îc a U_Y U gi WWYgg c Z]hÏ fA UYžmci b[ži fVUbž]bhYfa YX]UHY C9; Ł

3fe_`eVgVgS`UjYRdeYVRæzSfeVde`RIYZgV eYV\Z_U`VaVVXC^R_TVUV^R_UVUSjeYVddeV R_UeYVdTTVdIViaVIðUSj`eYVdZEYVd/RæzSfeVd Z_TIfUVdVrd_FSJVVRc_Z_XdLRYZYJVgV]`VvarZ}



 \mathbb{Z} XLVUFTReZ_Led TZRJ deRef dR_UeVVcZXYeaYj dZRJ RaaVRCR_TVLR^`_X`eVVcdŽ

 \hat{I} Gc WYImilg"]_Y U V/c c[]WU Wc W_. mc i \Uj Y hc VY Xc]b[h]gžUbX h]gžUbX h]gÅ Ï

5bX`\ck Xc`mci _YYd`id`h\UhdUWY3<ck` XcYg`]ha U_Y`mci ZYY3

Î GhYggYX" =a YUbžgi ddcgY Zcf gca Y fYU! gcb cf ch Yf =k Ubhle gli Xnž Vi h=VUbliž UbX =\Uj Yblij chUbma cbYnž VYWU gY gc WyYm gYlgh Y df JWYgž =a YUb h Y a Uf_YlÅ 5bX h YfY ne i UfYžne i WUblitUZcfX [hgc ne i XcblitXc [hUbX h Uhỹ h Uhžme i HYUX k UhYfž h Yb ne i RY hec c X": cf k cf_žgc WyYmYI ! dYWg ne i he VY UWYfHU]b U[YÅ H Uhỹth Y ch Yf df Yggi fYž VYWU gY ne i \Uj Yhe [Yh a Uff]YX VYZcfY ne i RY 'S [Zne i RY U a Ubž [Zbchh Ymh]b_Å ž=Xcblit_bck žh Ymh]b_ ne i RY k Y[fX']

fAU Yžmci b[ži fVU bž`ck G9; Ł

 $EYV dV UZ W IF [eZd^ V.R_ eYRe RURacR2_ Zl_`e R]h R] dgZh VU W ^ eYV de Lla`Z_e` VR a Rd ZgV gZ eZ Z Z Z Z Z Z M W R_ RIYZ gV V_e eYRe cVbf Z V dc Z] dZ 7c` ^ eYZ de Lla`Z_eL^ R_j Z UZ Z J f R] dc VT _ de Te R_R c R Z gV` VM W V R] Z R Z_ R_U TRA RIZ W ca V cd _ R] R I Z_ h Z eYV de V Ž$

89.9B8=B; 5 DF=J5H9KCF@8

7 c R_`eYVć]RXVXc f a `WáV a]VLeYVT_eR UZTeZ_SVehW_eYVZc`h_acWWccVUhRj`WZgZ_X R_UeYVUV R_U1`WYVd deV^dW^de` XcWreVc T^ac`^ZMŽEYZdafedeYV^Z_RUZWTf]eaVcd_Rj a`dZZ_Ž7 c R dBrceLVgV_eYV^`de RTfeVRhRcM _Vdd`WeYZdT_ecRUZTeZ_U`Vd_`e]VRU aV a]Ve` yScVR.%hzEY VI eVc_R]UV^R_UŽ

H.Y ghfUhY [miz: ``ck YX`]gbchhc VfYU_k]h` h`YgY`gnghYa gžk \]W`]g`]a dcgg]V`YžVi hhc Vi]`XU'dUfU`Y`Î k cfXcZcbYNýck bÏ k \YfY` h`Y`GY`Zh\Uh ZYY`g`XYb]YX`Vmih Ya `WUb` fYWc[b]nY`UbX`fYU`]nY`]hgY`Z AV a]Vfd R]jj T_defTeeYZh`dUZ_acZgReVLZ_Zt]ReZ_W`^ `eYVd`cZ_dZV_edRicZTVWceVVZcTYZUSZ

9`h U j`f cVRTee`eYVdVcf]VdeYRedTZkg UZTRANCIe`j`fLhYReU j`f U RS`feeYVLU j`f dR.VeYVL]VRgVeYV < 0

Î=YUJ YIX Ya ŽUbXIX YII Y=cVYnilg lc UI f]j YUhk cf_UhUdUfljWi Uf lja Y"=Xc k \Uh]gfYei]fYX Zf k cf_bcfa U`nžk \JWi]gU k UnicZVY \Uj]b[IkUhXcYgblÅigi]ha YžVi h cbWY =Å ci hcZh YfY =h fck]hcZWea ! d YhY`nž=Zf[YhUVci hgcWyYmŶg Uk gž=`]ghYb` hc a i g]WžfYUX a mVcc_g""Ï fA UYžnci b[ži fVUbž ck C9, Ł

@_TVTcVReVULeYZIacZgReVh`cJUZId`VM]`W ^VR_Z_XER_UeYV`aa`cef_ZEXdWcdM/WARJZReZ_ Ze ac`gZUddW^ d`f_VVZZ_XLeYRe eYV dRIcZ_TVd _WUVU e`RURae e`d`TZR]djdeV^ dR_UeYVh`cJU `Wh`c\dW^ ^fTY^`dV^ R_RXXRSJVLR_UVgV_ eR\V`_ Ra`dEZgVX]`ddŽ2_ RJZV_ReZ_X[`S^ R] hVJ]SV[fdeZ_WUZWE^ R\VdZea`ddS]Ve`VLFTReV `_VdTYZUEV_`cSfjeYV^fdZT`_VhR_edR_UeYV VJVRec`_ZTVbfZa^V_ee`JZEV_e`Ze`_Ž

CH 9F D 5 7 9G

EYVyh`dJU`W_Vd`h_%dedReV3j d^VZ Vd ^R_ZWdedZedMJVZ_eYVT_dedTeZ_ŁdvR]`cZ RXZ _RgŁ`VyR_`eYVca]RIV%ZEYVCVLeYVRfeYV_eZTdJW TR_SVcARJZAVUhZeY`feR_j_WUe`JZgVZ_aRcR]JVJ h`dJUŽEYVy`eYVca]RIV%ZeleYVcAR]^`VWsfeYV_ł eZIZj_R_UZeTR_SVWsf_UZ_eYVVkefcVLeYVaRde `ceYVackdV eŽ HYV_ZEZZ_ eVVWef ckLevVy`eYvca]RIV%zd_`d ^R]j `fedZ.VeYVTZejLT]`dVe`_RefckL`cRSc`RLŽ :_ eYV WefcVy`eYvca]RIV%aVa]VU`_`eh`c\L `ch`c\ZIUZWWEV_eeYvEVW^ hYReZeZIZ_eYV y^RIYZ_V%JCRAAh`c\LWcZ_deR_TVL`cerRUZEZ_R] RXEZIF]efcXŽ

Î=ZYY =Ãi ZU`]b[Å =VY[]b hc k cbXYf \ck h]b[gk]``VY XcbYž \ck h Ymk cbŇiVY` XcbYž=ĨX``_ Yhc [YhUk UmZca h Ulžgc gca Yha Yg=h]b_ =ĨX``_ Yhc VY]b 7 \]cfž VYWUi gY =ZY`nci WUb `]j Ya cfY Ui h Ybh!! WU`mih YfYžnci _bck 38fYgg]b[UV]h`_YU` <]bXi žh Uhk ci X VY a m]XYU'Ï fl Ya UYZUXi 1ži fVUbž]bHYfa YX]UHYC9; Ł

7`cRWhŁeYVy`eYk`a]RI%ZdZ_eYVaRdŽ:_ eYVySjX_Va]RI%ZehRda`ddS]Ve`WW]eYRe`_V hRdRaVdd_ŽEYZdZi_`eeYVd?^VRd_`deR}Xd?Wc T]]VłezgVZLV_eZZd`c`eYVcWc^d`VWT_`^ZT `ca`]ZZIR]`cXR_ZREZ_Ž=b`h.YgY`bUffUhj Ygz h.YfY`]g'bc`X]gWYfb]V`Y``cb[]b['Zcf`Vm{cbY` gcWJU`Zcfag''CReYV&LZeZl_`deR}Xd?WcReZ V hYV_eYVcVhVcVTVcRZ_cVdfcTVdeYReZeh`f]U SVX``Ue`YRgVRgZJRS]Ve`UBJŽ:_e7ZhySjX_V a]RI%eYVcVhRdeZ_VL`_VTf]UXVeSj hZeY]VdŁ aVa]V_Vh`_VR_`eYVČZ:eZhacZ_RzJj Ruf]ed hY`Vg`\VeXZŽ

Î A i a g'bck 'i ghih jb_ UVci ha cbYmUbX h\Ym[]j Y h\Y_]XgU\ci gY_ Ynžgc h\]b[g \Uj Y W\Ub[YXžVYWU gY]hk UgbNiUVci h a cbYmVYZ fYž]hk UgUVci hUZZYWJcbž cj Yž VYWU gY W\]XfYb k YfY h\Y a cghgUWYX h\]b['Ï

fl Ya U`Yžc`XYf`UXi `lži fVUbž]blYfa YX]UhY`C9, Ł

hZeYeYV]ZW VeYVacVdV_eŽ

AKYRadWceYZłdWRt _Ł^ `de`WYVKAb`_UV_ed _RcRezgydda' h WeYReeYY acWWcyWe T _def Te y`eYyca]RIV46Z_eYVacydy_etygy_ZWYVdyh VYJVdt dRUZIR]R_U^ `cVac`S]V^RZIŽEYYCyth YReZh^ `de aVcd _RJLRfeYV_eZTR_UUZWWCy_eRS`feeYV^ ^ RJ SVJVdHIJWRcR_UYRUVce`dRevISfeeYVRUgR_eRXyZł eYReZETR_SVV1aVZZ_TWUZ_cVR]ZWZEYYCytaV a]V TR_SVh YReeYY RYhZeY feYRgZ_Xe`JVRgVZef_eJ e`^`cc`h`c^ZdJZeW/^ jVdeyURZ

Î=ZYY`U'bYYXZcfgdUWYždYUWY`UbX'ei]Ylž

UbYYX'hr Xc gla d'Y'h lb[g'k lh U``a m gYbgYgUhi bYX hc h Ya Å =Z=YUhVfYU_ZUgh =k Ubhhc Yb c ma mVfYU_ZJghž=Xc bhk Ubh hc VY Xf|b_|b| a mWcZYY |b U fi g\žVi fb|b| a mhcb/ i Y'VYWUi gY'=ĨjV' | chhc \i ffmci hž VYWUi gY = j Y [chhr VY gca Yk \ YfY Y gYÅ HY k Um=WUb / c UVci hh lb/g lb h Y Whnž bch[Yhhb[]bhc hfUZ(W/Ua gžVY]b[UVYhc $U_i c |X_i f_i| g \leq f_i g \leq$ k U_ UbX bc h[Yh]bhc h Y WUf/'i gh[fYUh" $G_{\mathcal{C}}$ $h Uh \not g k \setminus Uh \neq \mathcal{J} g Um b [<math>\check{z} = \mathcal{Z} Y \check{z} = \mathcal{W} U b a U_Y$ gca Yfcca Zfa mgYZUbXWfYUhYUgdUWY $k \setminus YfY = WUb$ j Y Ug = d YUgY k h cih Uj !]b[hc ^cghY UbmVc Xnž=Xc bNik U_ cj Yf UbmVcXmhcXc $hUbX = XcbMi \setminus UjYhcVY$ [c]b[Ufci bX a U_]b[[fYUhWUb[Yghc Ubmh\]b['Ï

fl Ya U`YžUXi `lži fVUbž\][\`G9; Ł

:_ eYV_RCREZENELEYVEVREVEYCWChYVEVCI`VWG Voj UB; ViaVEZ/TVEYRERVT_deof TEVURDY eYVc a]RIVE%eeYVW?ZjEVEWEZ_VER_UT]`d/VEZ/UŽ EYVEVDZ]SV]``\WJRE^`CVT]`d/j]REVC`_hYV_ eYVEVaVEZ/TV`VZ_UZEZEFRZERZ_Z_EYVUZWEV_e REVRCI`VVRZj; JZWT^VEC

H YVEYV čeYY SVJ`_Xe` eYVaReH LeYVacdd/e`c eYV Wef c/Ly` eYVca]RIV6/BEV dW_ Relaf c/Jj Z_UZ gZLFR]`aeZ_deYReTR_ SVRIYZ/g/UeYc`f XY Z_UZ gZLFR] WWW.ežE YV_RcHezgydU _`eeRvVfad TZR] `cZLV]`XZIR]a`dEZ_dZ?`cZleYVC/R_j UV/EVve V_[Zde`eYVcd`_ eYV[`fc_Yj e`yR_`eYVca]RIVZZ

 $\begin{array}{l} CV{IIf $\underline{Z} \times \mathbb{R}^{e} eV_eZIZ_{ij} \ W^{\wedge} h YRe eYcV_eV_dZ_iZ_i \\ R_ $\underline{Z} \cup Z_{i} I_{i} R_{i} R_{i} Z_{i} Z_{i} d TZ_{ij} eYRe $ZIeV_eYcV_eX_RX_i \\ EYV bf Vde $Wc \ \mathbb{R}^{e} eYV_eZIZ_{ij} \ ^{VR_{-}}d]^{\ \ } dV_{\underline{Z}} \times eZid^{2} \\ 3VIRf dVeYV_eX_{i} Z_{i} e_{V}V_{c} \ ^{\circ} af $S[ZTUZIIf dZ_{-} R_{i}^{\circ}] fe \\ \end{array}$



eYVYZek cZIR]R_Ud TZA]TYRRRIekc`VR]eYZekeYv&V Via VcZv_Tvd RcV Wyee e`SV aczgReV ^ ReeVccŽE Yfd. hYV_aV a]VWWJgRXfVjjf_VRdjRdRcVdf]e`V&4V^Ł eYVjac`[VTeeYZdf_VRdv`_e`eYvZc`h_dvJVVZ'RXVŽ EYVdyJVZdZv_eZ;VURdZeddfcTVŽ

Î Å a ma i a gUJXŽia mk cfXžmei JJY WUD[YXIXVYVU i gYVYZ fYž=a YUDž=hfmhe VYYUgn[c]b[ž=hfmhe]ghYb UDXVY\YdZ ž UDX UhYm=JYYVYW a YÅ =i gYXhe gYYa m a i a UDXXUXW a]b[\ca YZca kcf_]_Ynca VJYgžh UhYg\ck = A [c]b[he YbX i džUDXUWhi U`mh\UhYgʻi gh\ck = Ua YbX!]b[i dÅ I

Î Å not i f dYfgc bU']lmiW Ub[Ygž]hVYW a Yg Ygg ho YfUbhVUg/WU'nžh Y gUa Y k UmUg not i h]b_ a cfY UVci hino i fgY Zih Uhğ bch \YU'h nž=Xc bhth]b_]hğ \YU'h mZ f gc WYhnž h Uhğ \ck not YbX'i d XYgfc n]b[not i fgY Zi fA UYZUXi 'lzi fVUbz]bhYfa YXJUH 'Q9, Ł

Hk 9 9L 5 7 9F65 H98 G9@ . DFC H97 HB; C B 9G9@ : FC A 5 DFC 6@A 5 H7 B8 J 8 I ! 5 @N5 HC B

RIVESREZ_`VRUVEEVUZ RW`WhYRe`_VZ] eV RF eV_eZT DNJÆE YV VI RIVESREZ_ZI eV eYVZ RXV`VEYVeN RIVESREZ_ZI eV eVZ RXV`VEYVeN eXIRALe^VUZIJRIVZ_XZ_ dec`_XT]]VIEZEVEVWEV_edR_UZIJREEZ_`aa`dEZ_ e`eYVV_gZ:_^Ve`VVJ dEV`dR_U`aZZ_ddW_ RIXZZ_XEZN e`eYVZ_RF eYV_eZT DNJÆV

;`d/hR_eVUe`h`c\RdR_ReeZHLSfeeYVUV^R_Ud `WZd&FReZ_]VUYZ`e`eR\VR[`SZ_RSR_\+

Ccž]hVch\Yfgnci k \YbgcWYInigUngÎnci ci [\hhc VYk cf_]b[žVY]b[gi WWYggZ`UbX` a U_]b[a cbYnÏÅ 3

ÎE i]hYžh UhVch Yfga YžYl UWhm'l

5bXk \UhXc mci Xc hc WcdYk]h h]ggffU]b]hWUi gYg mci 3

 $\hat{I} = \tilde{M} \hat{I} ghifYg \| bYXbck \ddot{T}$

Mci ŊŶY'[]j Yb']b3

Î = ĴY Y []j Yb]bžVi h]b ł\Y \ c dY ł\ UhdYf! \UdgÅ /a UniVY VYWU gY c Zh UhÅ H Y h]b[]g t\ UhÅ]hğ U``WebbYWYXZVYWU gY =WUbliti [Yha Uff]YX UbX \ Uj Y W]XfYb]Z=ĴYY [c h bc h]b[ž=a YUbžmc i _ bc k 3 = WUblitiXc]lž gc]hğ gc fhc ZX JZWY lÅ ž=a YUb]hğ U```__ Y U WFWY h UhbY jYf YbXg'I

H YfYlŷbc k Umci hB

Î B c ž=h,]b_ h, YfY]g U k, Umic i hž]hĝigca Y! h,]b[]b h, Y a]bX'Ï

K ∖ Uhỹgʻmci fʻk Umici hB

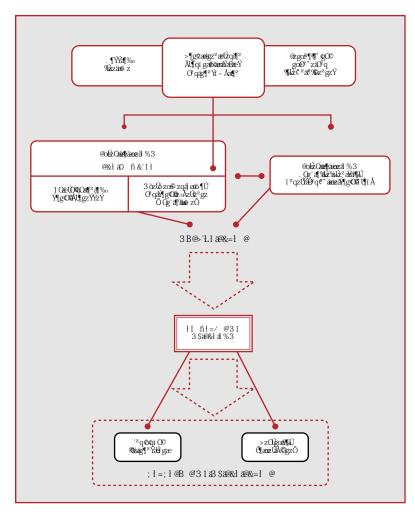
Î=h,]b_ h,Y k Unici hžfYU`nž]g'bchhc []jY'U` XUa b'UVci hYj YfmVcXmY`gYÅ Ï fA U'YžUXi hzi fVUbž]bhYfa YXJUhY Q9, Ł

9 UWY fVUHc b`c Zh Y`GY Z]g`bc hh Y`]bYj]! HUV`Y`Wc bgYe i YbWY`c ZUbm`]bX]j [Xi U`]hU! hc b`dfc WY ggž Vi hfUh Yf`c Z U`Zi ghfUhYX`]bX]j [Xi U`]hUhc b`dfc WY gg"`:e cVdF]ed W/^ T_~Ze SVeh W_aVcd_R] [ZW R_U eYV`cXR_ZAR eZ_`Wd TZ gj Z@_eYV`_VYR_ULeYVh VR.V_Z X`W eRUZZ_R_U`WAYVcZXZ ig` Wd TZA] g deV^daf dYVd aV a]Ve`hRUd dyWVA&c^Z_RZ_,`_eYV`eYV&L eYVhBj d`TZA] g deV^dRcV`cXR_Z&UUU Vd_`e]VgV eYVeZ`VLcbRIVL]R_XFRXd`c TRaKSZEZ/deYRe Rv _WUVUVccd/WVA&c^Z_RZ_ŽGYWUi gY`dYcd`Y` `UW_`Wc`YWjj Y`fYZ/fYbbg`UbX`ZYY`dck Yf! Ygghc g\UdYh Y Ybj]fcba Ybhgh Ym`]j Y]bž gc WU``ZY ZY `gcddfYggjj Y UbXh fYUhYb]b[" H YmfYUWiVmX]gUbW[b[h Ya gY j Yg Zca gc WYhm UbX fYhfYUh]b[`]bhc h Y GY Zi Ug U k UmcZfYWcj Yf]b[`h Y]f ck b]bX]j [Xi U`]hm

EYVVI RIVESREZ_`V&YVDVJVZdReV&b`_dve`eYZd T_~ZleeYRe^V&Vj h`cdv_dZeŽ2daVaJvhZeYURh &/^ dTZb] JZWLeYV&VRQVRUj dIRETVeVd fcTvdReV UVaJV&U j Ve VKceYVČZEYVTRARIZEj VC T]JVTEZEV]`_XteXc^ RIEZ_LhYZIYZdhYReZ_TEVREMdaVaJVd WWJZ_X`WAVcd_RJWWWEZEV_VHZZfjeZ_ReVj hVRAł V_VLŽ2_UeYZdWWJZ_X`WWWEZEV_VHZRIYRdSW_ dW_LZdVAU_EZEJWZZK RJZREZ_Zle`dTTWCŽ 7ZXfcV%d cf^ RZEVGEVUj_R^ZGEYREJVAUX6/ eYVdTZbJUZAVIFJEZd`VZ_UZZLFRJZREZ_e`eYV V RIVESREZ_`V&YVDVJVŽ

 $EYVRZ `VeYZIUVIRZaeZ_ZIe`dr`heYVVgi Vgi UJ_UZ_V_dZ_`VWF]efd]TYR_XLeYVadReZIR] ^ R_ZWHRZ_d`VZ_UZGZIFRJZRZ_UZWIF]eZdZEYV ZURZIe`dgVR]e`eYVZ`a`ceR_TVVk2Yf^ R_UVi gV] a^ V_eZ_dTZG RdRhY`]V`WRdvVIed_`c^ R]j dVRdUURdVT]fdgVj acZgReVLdTYRdeYVJZgVd`W T fa]Vd`cUZIIfdZ_dR^`_XVSV_UŽ$

\$'%B=łäþ @ozäq%õgi @ozÝä¶%ä6°q©¢qiOQiQe¶²



$7 < 5 \text{ DHPF}^{-}$ &

H + 9 7 < =@95B : 5A =@M 69H 99B 7I @H F5@7 < 5B; 9 5B8 H 98 ≓ : =7I @H9GC : "=B8=J =8I 5@N5H €B



EYV4 YZNR_ VR Zj ZfTYR_XZ_XŁZ Zd`CXR_ZKR eZ_ŁZ_ZdZ`RXVR_UZ_eYVCJReZ_dYZdR``_X Zd^ V`SVdŽAV a]VaVcTVZgVeYZfTJVRdj R_URd d TZReVZehZeY eYV^`UVc_ZREZ_`VVeYVT f_eqjŽ 5 ZfIf ddZ_dRS`f eeYVVR'Zj`V&V_Ckg`]gVRc`f_U eYVZ aRTe eYRe d TZRJ TYR_XkdLR_U aRceZff [Rdj Tf]ef cR] TYR_XkdLYRgVYRUfa`_Zž

Î5 chcZh |b| g \Uj Y WUb[YXÅ H |g \Ud! dYbYXk |h a mXUi [\hYfzf][\lB 6YWUi gY g \Y Uk Ungi gYXhc gUmhc a YZh i a ZXc mci k Ubha Y hc VY f gh]_ Y nci 3 H Ym X]Xbl\li Yhmci [c ci h]bhc h Y ghYYHzcf [c ci hk]h Vcng\la /bcZa m cj YZh cgY k YfY X]ZYfYbhHa YgÅ Cc =]_Yh YgY WUb[Yg hccZ]_Yh Y fYUhcbg \d dUfYbhg \Uj Y k]h h Y]f WU] XfYb bck žh UhWća a i b]WU hjcb h Ym \ Uj Y k \ JW = fYa Ya VYf = X]Xb Nii \ Uj Y k]h a mck b dU fYb hyž UbX k Y Vća a i b]! WU hY VY hYf bck Å Ï fl Ya U YžUXi hži fVU bž ck Q9; Ł

@aZ_Z_dRS`feeYVZ`aRle`Wff]efd]TYR_X/`_ eYVW^Zj;gRgŽD^VRdaVTedL]ZVeYV_Vhc`]V`W h`^V_ŁReVgZhUURda`d&gVLhYZV`eYVddfTY RdeYV]RT\`W&Z`VWcW^Zj;XReYVZ_XdRVdW_ Rd_WR&Zj`XeYVCZ_XdRVdW_ Rd_WR&Zj`GedaVTZTTYR_XdRV_`eeYV^RZ_ a`Z_e`WT_TVc_Z@gVcZLZ_XeYV^R]]ZdR_`eV `Wh`ccj_RS`feeYVWefcVZK\UHYjYf']a_U[Y` dYcd`Y`\UjY`cZhY`ZJa_]`mfUbX`griX]Yg` g\ck_ihUhihYfY`UfY`a_UbnłžfY`Uhjcbg\]dg` VYłk YYb`hY`ZJa_]`miUbX`gcWYhmUfY`ZY`h hc `\Uj Y`VYWca Y`dfcV`Ya UhJWU`" EYVEVZd R WWJZ_X eYRe eYV UV R_Uda]RIVU `_ WY ZZdd Sj d TZAg ^ R.V Ze YRdU Wc eYV e` aVEVVc^ eYVZc W_TEZ_ŁeYV gVcj c`]V eYRe ^ R.Vd WY ZZdd Z a`ceR_ee` 4 YZ/WR_Z

> R_j aV a]VR:VcVd2X_We`eYv0/UR_Xkdt.Sfe ^`deUv02X_dedReVX2/de`T aVh2EYeYV^ŽEYV^`de T ^ ^ `_`_V2de`egie`T]`dVeYVVRY*21jZ_fa`_ ZedM_WateYRe22:212'aVg2Zfde`eYVZ_~fV_TVd`W d TZÁjŽEYVÁV de REV XZALU SVR: d^V VAFZELSFE eYVj YRSV R OLLNI WWWTE+ eYVj hZLV_ eYV XRa SV ehW_ VR*Zj R_U d TZÁjŁ^RZ_XZE VSV_ YRUU: Wc TYR_XXA e SV^R_RXUZ_ eYVU ^ VAEZT TZTIVŽ EYZEL e R_dVA:^REZ_ `V EYV VR*Zj Z_e R c WAXV VA^ d TZÁj ZEF_U F SEVU j R c VREZ_ e eYVA TZR U _R*ZI d U c TSEVU j R c VREZ_ e eYVA TZR U _R*ZI d U c TSEVU j R c VREZ_ e eYVA TZR Z ^ V c V j R X c R e V U c V V V F R jZj `V ZVZ_ d TZÁj RE JR X Ž

:5A =@MHMD9G5B8:5A =@M89AC; F5D<=7G5F9[·] 7<5B; =B;

:_4YZ/NLRUZ_R]^`deVg/dj`eY/cTf_egjZ_e/V h`d/ULW/c^d`WR^Zjj`c2R_ZREZ_YRg/TYR_X/UŽ EY/d/RcVe/_U/_TZ/de/ReV^V/XXLY`hVg/dL`g/c bfZEV]`_Xa/vZUd`WE2^VŽ

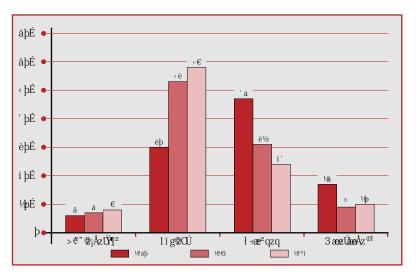
EYVUZWIF jej `VIT ^ aRZ_XeYVd f cIVd RgZJ RSJV ^ R.Vd Z YR RCU f de` da VR. `VIJVRc eV_UUŽ 5 RRW ^ :? 6 R_UeYV4 2D6? drogy dr` h eYR L `gVcR]`_XaVZ U1" * (!1#!!!/AV eV_UVUY ZXd YR VUNJZ VUR_U_f TJVRcR_UdZ_XVaVd_ VY Z JZdYR vZ_TCVRMUZDZ_XVaRV_e_f TJVRc VY ZXd h YZIYZ_TCVRMUZDZ_XVaRV_e_f TJVRc VY ZXd h YZIYZ_TCVRMUZBZUJJ Uf cZ_XeVV hV_eXeYTV_ł ef g L dW e` YR VSW_T ^ Z_Xfa RXZ_de eVV JZ Zde` eVVZ Xc` heY Z_ eVVJRe UVIRUŽ eTR_SV dZJ eYR LU da ZUJ Y CV VA` L a RXZ_de eVV JZ Zde` eVVZ Xc` heY Z_ eVVJRe UVIRUŽ eTR_SV dZJ eYR LU da ZVeYVaCU ^ Z_R_TV` Wh` ła RV_e _f TJVRc VY`ZZ dL eVVZIR XCV e UZV dZ ' VZ' WC^ Z2 T ^ a RC Z VC f UJ 164 = 24 L #!!!"/dr` hd eYR eVV UZ teZSf eZ_` W` f dW` JU g a VdZ_ 4 YZ VZI T]` dVe` eYV=RZ_2 ^ VC R_ RG VC XZ

 $\label{eq:linear} AkeYRadeYVXeVReVdeTYR_XVYRdSW_Z_eYVejaV `VS`_UdeYReUVJ_VVR^Zj cNJReZ_dYZadadTYRd ^ RczZXWLSZeYLVRcjj actX_R_Tj R_U R_f]^ V_e dReVdudW} XfcVd%# R_U%S/Ž$

EYVS`_UdeYRe eRUZZ_R]j YVJUY fdW`JUd e`XeYVcYRgVhVR\V_VUd ^ VhYReZ>`dV^ RczZXd RVSVZ_XR_f]JVLZ\d ^ VR_UT dej eY fXY eVV ac`TVLfcVZZEYVac`a`ceZ_`VSZeYd`fceZLV^ Rd cZXVYRdcZV_LR_U^ RczZXVZeM/WRdZ_TCRRZ_Xj SW_da]RIVUSj T YRSZRZ_Ž6Rdj ^ `eYVcY``U YRdR]d Z_TCVRMŽ

2]] eYZdd XXXddelYRe ^ R_j aV a]VaVCTVZgVedH UZZ_R] Wc^ dRdackgV_&Z XeV/ W/^ UkgY] aZ_X eYVej aV WMREZ_dYZadeYY hR_eL`cRdWZZ_Xe cV-VTe eYV daVTZ; TT_UZZ_df_Ukc hYZTY eYY RCVe`SV]ZgVU`feZ> R_j j`f_XaV a]VhR_ee eR.VeYVZc cV[ReZ_dYZa hZeY eYVZc aRce_Vc WkeYVc hZeY fe j Ve ScZ_XZ_XR deRS]V W^ Zj Z_e`SVZ_X RSR_U`_VU h`^V_`c dZ_XV^`eYVcd YRgV e`

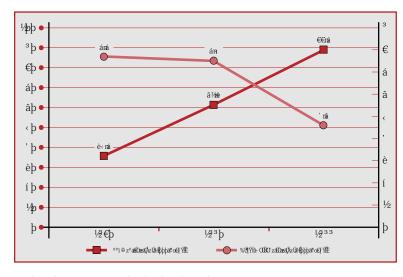




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>¶ĩ Lýzna, ¶Åï Qaqf² äCP qã&¶ĩ Ý¢" afi z² Ýi Ýz Ýnäl∕a á þnäl∕a €í äCP qäl⁄a ³í nä² Ýaãac∯ä Qg¶² Oãqzal ÝaQqhíagO/áÇ11 ÈÉ

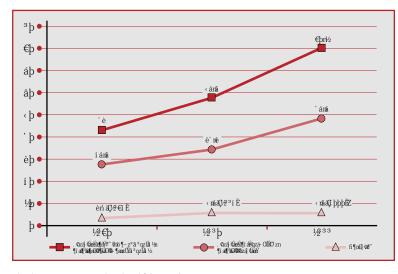
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. Tozä tázetáli zározali na CÚCC za qzlove tegali z tázt tega z té



QÎRβ Ýaŭeđaja Qe¶² Odqză Ýa⊙µŘagO(ŘákŰj\$zga¶²Ê >¶ĩ Úgznai Od¶² Odĩ² Ýaŭezeđ∥%a adulfagYaÇ11 lini þþ½Ê @ / . 1 äñ 3

 $G \dot{z} \ddot{o} \dot{Y} \ddot{a} \|^2 \ddot{a} \cos(\dot{q} \dot{z}^2 \ddot{a})^2 q \ddot{a} \cos(\dot{a} \dot{z}^2 \dot{a}) = G \dot{z} \dot{Y} \dot{z}^2 \dot{a} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2 \dot{z} \dot{z}^2$

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>¶ï Úgznabalt; äl One¶²O Ga≽ï Únzonaŭ þþ!∕É

`cXR_ZKVRY`fdY`]UTRARSJV`WFdHZ_ZXeVVZ: TYZJUZY_ŁhZeY`feeYVZ_g`]gV^V_e`WeVVWEYVC; ^R_j dváRReVU aV a]VhZY'e`deRceRoKoV hZeY R_`eVcaRce_VESfeTR__`eVC^RZKVE/VcV/ReZ_ł dYZa, `eYvcd_hY`YRgVSW_RSJVe`R_f]eYVZ: acVgZfd^RccZKX/LTCVReV_VhWA^ZXdT_eHZ_ZX TYZJUZY_Sj UZWWEV_eWRYVcdŽ

EYVIVUV `XRaYZTYR_XIdRVSVZ_XRT ^ 1 aR_ZUUSj R]eVCReZ_dZ_Z RXId`VeYV VR ZjŽ 5 ZgVoZg R_UZ_WC RZg Z_VR Zj RcR_XV V.ed RVZ_TCVRZ_Xj dW_Rd_`c^ R]ŽEYZd Xc hZ_X [VXEZ RIJ ZlaRcej UFVe eYVhR] eYVTF]ef dV`W Z_UZgZf R]ZREZ_R]`hdaVa]Ve UVIZUVVceYV 1 d/gVd`_Y`h eYVZd TZR]eZdd^f f]USV cXR_ZVL R_UXgVdeYV eYVcZXYee R]eVceYV Ž:e ZdR]d UFVe 'hY'k JXYgdfYUX'dYFVWdhc b'hUhih Y' Xca]bUbh]bgh]h h]c bU`UffUb[Ya Ybhg Zcf' ZJa]mcf[Ub]nUh]c b'UfY`]b W[g]g'UbX'bYYX' hc VY WUb[YX netS]V(!/Ž

> `dVeYR_YR]WWR] dda`_UV_ed dXRdU eVV Wr`Zj Rd aRce `WeYV_RefcR] Tj TJV `WJZWZJVe %% L^R_j `WeYV j`f_XaV a]VLSVJZØV eYRe eYV UZgVcZg `WWR`Zj eZdLeYV UZJVTF]eZd eYV dW ecRUZZ_R] Wr`ZZd X Z_X eYc f XYLeYV TCZCd `WeYV aRecZrCTYR] ^ `UVJLeYV aRceZC] dvaRreZ_ `WeYa RecZrCTYR] ^ `UVJLeYV aRceZC] dvaRreZ_ `WeYa C UFTeZ_LcMifrZj R_U Wr`Zj JZWLR_U eYV JVXEZ RIj `WeYV UZWWCV_e `aeZ_dLR]] ^ VR_ eYRe eYV Wr`Zj dr`f JUSVdW_RdRgRZZSJVd TZR] T_decTrZ_1eKSJV' */Z

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>¶ï ÚgznaB1Ł; äl Ove¶²O®sï Údzønai þþ½Ê

EYVWc^ `VeYVW? Zj dW^ de`SVSVT ^ ZX ^`dV`aeZ_R] R_U~ViZS]VSj eYVU3jŽJVe'h Y` j Ugha U'cf]micZ7 \]YUbg gYY'h Y]f`ZJa]mi hYg Ug'h Y'a cghi]a dcfhUbhZJWicf`]b'h Y]f` dYfgcbU``]XYbh]hYg`UbX`]b'h Y]f`dfcgdYWg cZfYU`]n]b[`h Y]f``]ZY'd`Ubg" EYVF? 5 A #! ! " Df gyJ Rd U+yAV a]V]``\e`UZWWCV_eeYZ Xdh YV_ eYJ ej e`UV}_VeYV dV]g'd`cd3 hY` eYJ RVZ H YZTY`VeYVW]`hZXh`f]Uj`f d3 YRdSW_ ^`deZ a`ceR_eZ_UV}_ZXhY`j`f RV0%d VeYV dVa`_ddReVU25ZNUZ_e` eY`dVeYRedWc'e` eYV WY Zj ij`fc VY`ZjLj`fcTYZU2V_/ R_UR]]`eYvc dVa`_ddEeYVeeV`V_U fdZ`a`ceR_TV`VeYVV8' H Zj`TR_SVdW_ieKS]V("/Ž

H YV_aV a]VdaVR\RS`feeYVWY ZjŁeYVZc`h_ `cR_jS`Uj`dhYReT_TVc_eYV`RV_`ed ^fTY eYVdYZedZ_Zd`cXR_ZREZ_`cUV``XRaYZdRd eYVTYR_XdZ_eYVhBjZd^V`SVddVJReVe``_V R_`eYVŽARceZIFJRcV`aYRZdZdaJRIVU`_TYR_Xdd Z_eYVcVJREZ_dYZaSVehW_aRV_edR_UTYZUCV_Ž @WT`fcdxLaV a]VdZ`RXVR_URdXdh`V_e`VeYVdV UZWW/dXVRejjUVáV_UZ_X`_hYVeYvcZeZleYVaRd V_ed`ceYVTYZUCV_hY`RVdaVRZ_XŽ

K < 5 HH = 9.05 F9B HGH = B?

EYV^ RZ_UXWWC/TVaVCTVZgVUSj aRV/edZleYRe TYZUEV_`h SVT ^ VRUF]eR_UZ_UVaV/UV_eVR2ZC eYR_SWXXZEYZCZReecZf eVUe`RgRCZG` WHR'dKZ 7ZcdejHR_U^ `deXV/VR]jHeVXVZleYVXVR2vCZ_UZ gZUFRZREZ_WdeXCWSj TF]ef cR]TYR_XZDVT_UjH VRZKCR_UVRC]ZCRITVCde` ^ `UVc_ _`h]VUXVR_U dZ]dLhYZY gVcj bfZl\j V_RS]VTYZUEV_e`UVR] UZVTej hZeY eYVh`c]UhZeY`f e eVVZ_g`]gV^ V_e `WeYVZ:aRV/edeYVdZ]d_WUWe`ZeVcRe e` eNRIY eVVZ:aRV/edeYVdZ]d_WUWe`ZeVcRe hZeYRd TZkj eYReZITYR_XZ_XhZeYUZkj Z_XchWUZ Î=łħ /b_ łħ Y bYk [YbYfUł]c bġźW]XfYb Ug gł W UfY]bfYX]V mg_]Z ZZ f]bgłUbWYż= Xc bħii bXYfgłUbX Ubnħ]b[UVci hWea di łł YfgUbX =Vci [\hc bY łħ UhgYha Y VUW ' SS łħ ci gUbX dYgc g c f gc źU b]WY d]YWY cZYei]da YbhUbX =VUbIħiYj Yb li fb]hc bź VYWU gY =Ăi głi W VUW]b łħ YÅ žVi h ħ Y_]XźĐXUXđÑ Y gUngžĐ YfYħUbX łħ Y _]X dfYggYgUVi łħ cb UbX dfYggYgUbc łħ Yf Vi łħ cb UbX]hk cf_g*=łħ]b_]hŷ łħ Y bYk [YbYfUł]c bža migcb \Ug łUi [\ha Y U`chcZ ħ]b[g'Ĭ fħ UYZUXi łži fVUbž ck 09, Ł

7`fœYjjŁeYVX RV eV TYR_XXX WY ZZX RV f_UXX Z_XSVIRFdV`V&YVUV R_UX`V% `& R_U eYVVT_`^jŽEYV_WU`cUXXVe`Z_TXRVeYV

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Hoggoza¶%aaaza%¶@¶ö ¢" aq¶aa⁄¶ï ag¶² Ýqz lå–¶Ýaa≎ Ŷ láÐ aa¢ aqz в ¢" aö oq¶aa⁄¶ï aOlźĐa ÇÅz lágz² aÐ' z YÈ

>¶ï ÚgznaB1Ł; äl Ove¶²O@a≽ï Údzonai þþ½Ê



ARCV_edWWjeYcWReV_VUSjeYcWVTYR_XxdtZ_hRjd eYRe UZWWC UVAV_UZ_X`_Y`h eYY dWeYVc`]V`W eYVWR Zji Z_ cV]ReZ_ e` d`TZKejŽEYVcVRcVeY`dV hY CVERZ R_ZUR VEYVIR Zj RdRa RIV Weef Th ef cVU dVIf cZej R_U Rf eY cZej ŽE YV ZVR Zl eYRe Zed ^ V^ SVaddY f JUSVaYj dZIR] ji R_Uad TY]` XZIR] ji Z_gf__VdRS|Ve`eYV^V_RTVd`WRdTZXaj TYRdRIA eVcZkVU SjaYjdZRJgZ]V_TVR_U^`dRJUZddVcZ E`UR,`d^``cVY`c7k`_eR] VR^ Zj; cVjReZ_dVZadLeYV Z'RXV'WYZUCV_RdY' |UVcd'WZXYedhZEYcVca`_dZ SZZEj WCeYV dygVdR_UeYVhVR\V_ZX`V&ReVC_R RfeY^2Zji h`f]UdW^e`^R_VZeUZWTf]eWcaRd V_ede` UvgV]` a $decReVXZvd` VaV_VVT__eR_U$ dywww_tvz_eyzetyzucy_žeyzetac`S/V towed $R_V_c^{-}$ fdT_~ZieWcaRcV_ed`WeYZdejaVLhY` eV_Ue`]Rj eYVS]R^ V`_eYVZcTYZUcV_R_Ud TZkjŽ

EYY WY a`hVdVdde`VIVCTZWeYVRfeY`zêj eYY WY ZigVeVUZ eYV'Ž

Î? |Xg hc XUmUfY i d h YfY k]h h Yf dUfYbhg" =a YUbžh Y c bY k \c g\c i hg c i XYghc f k \c gUng k \UhXc =WUfYž=h]b_ h UhŶg k \c lŷ]b W Uf[Y h YgY XUng Ï fl Ya UYZUXi hzi fVUbža YX]i a ! ck @, Ł

AREV_ed`VR UZWWEV_e ej a V REV eY dV hY`dW eYVWY`Zj RdRa]RIV`VWWWAZ_R_UT^^f_ZIR eZ_Łd^VhYKEVeYRe^R_Vdfa Wc eVVT JU_Vdd R_U VITVdJZVUV^R_Ud`Vdf TZAj fedLNŽEYVdV hVJT^VXXREVC Vof RZj R_U UZDIF dZ_R`_X WY`Zj^V SVcLRdeYVj dWcVJREZ_dYZd`VeYZd \Z_URdYVJaZ_XUASVj a a Vcd_RZZ/dR_UdZJdeYRe XZgVaV a]VXXREVC Z_UAV_UV_TVR_U Z_UZZLFR] RF eYV_eZZj Z_eYVVATV`VeYVUAVcd_RZZ_XUA ^R_Ud`W1TZAjŽEYZdj aV`VWY`Zj JZWcVbf ZXd XXReUVUZREZ_LY`hVSVZAREV_edWMJ eYRed TZAJ UV`R_ULLARceZIF]RCj h`c\LU_`e]VRgVeYV V_`fXY eZ_Ve`cKRZAVEVZCZ_RXV`VeYVWY Zj Ž EYYJ SJR`Vd TZej R_UeYV^d/SdVC eYZELhZeY eYVTYZUEV_TRERIGZIEZ dŽ

Î H. Uhğ "JZ" Cc mci Ñ Y [chhcží][\ hžh Y Vcgg gUng glUmi bl] b]bY. gc i bl] b]bY [h]gz]_ Y [h cf bch'5 chcZha Yg = \Uj YbŇk UbhYX lc " =h]b_žb]bY cÑVc WžUb \ci f Ygg k [h a m k JZ UbX XUi [\hYf "=Ñ cb m \Uj Y ha Y hc YUhža mXUi [\hYf k] ``VY]b VYXž=Ñ gYY \Yf h Y bYI hXUn 6YWUi gY hca cffck Ŋ Ubch Yf XUnž Yhỹ \cdY gc Ubnk Unfl fh UYZUXi hzi fVUbž ck (9, L

K < 5 HH = 9.7 < = 0.8 F9B H = B?

EY`dv'hY`dW WY`Zj cVJReZ_dVZad W/^ eYV TYZJUda`Z_e`WgZh eV_Ue`T ^ Vfa hZeYZ`RXd UZWWEV_eW/^ eY`dv`WaReV_edŽEYYj aVETVZgVeYV TYR_XdESfeeVj YRgVR^`čVa`dZegVZ`RXV`Wal TZGj R_UReVdReYVETZETf^daVTeRS`feeVVVR^Zj`d RSZZEj e`cVda`_Ue`TYR_XVŽEYZEZdeVVdR_Ua`Z_e `V&YVj`f_XdecVda`_UV_edŽ

7 ceYV ŁWY Zj cYREZ_dYZadRCVZ_UZWIF]eZd R_UeYY WWJ RUgVcdMj RWWNEVUSj eYZĎEYY U _`eSJR`Vd TZdjŁSfe]RcXNj dWeYVReeZefUd`W eYVZ: aR:V_edR:ITR dZ X:eYVac`S]V dZEYVj eV_U e`Vi`_VReVeYV LY`hVgVd:Sj R:Xf Z X:eYReeYVZ: eRUZZ_R] faS:dZ, Z X:ac\gV_ed eYV W^ RTel Z X UZWWEV_ejj Ž 2 f eY` dZR: dR_{C} Reodef UVd: ^ Zhef dd: _V4)VTe R_U R VRZf dV e`Vf ac\dt RWWF2_ R:V eVV T ^ a]RZ_ed ^ `de` V&V_ g`ZIVU hYV_ TYZUEV_ UVdTcZSV eYVZ: VR`Zj YZde`g R_U V_gZc`_^ V.eŽ EYVj dW eYVdVRdUVj TZV_e SVTRf dV d`TZ9 TYR_XV R_U eYVZ_T&RAUTRARSZZEX.dR_U cZXYed` Vj' f_X aV a]V^ RUVUZWWEV_ecVJReZ_dYZadS` eY a`ddS]V R_U_VTVdRjŽ

H ± 9 : 5 A = 20 M 5 G 5 * 89 9 B 7 9 5; 5 = B G H G C ! 7 = 9 H M

EYVUZWWEV_TVSVehW_ eYVeh``fej``\dZl`Sł gZfoŽEY`dVhY`daVR\RdaRV_edeR]\RS`feeYV UZWIFjeXd`V&VeVe^Z_XeYVEvV_TEZ_RdZeVe^V UZRZdSVehW_eYVEVWYZjR_UdTZKejŽEY`dVhY` daVR\RdTYZUEV_UVETESVeYVUZWIFjej``W&WZ_X

eYV^ dylgvd W/^ ecRLZeZ_RJ VR^ Zj cv/ReZ_drZadŽ EYZdUZXWKKV_TV^ZXYeSVT^^`_e`gZ/hd`_ eYV WRYZ ZUZWWCY_eTf_ecZkdLR_UUReVSRI\ TV_f cZkŽEYVaVIf JZcZj ZleYRea UbmdUfYblg bck VY`]Yj Yh Uhh Y]fHug_Ug']bhYfa YX]Uf!]Yg VYlk YYb h Y]f ZJa]mUbX gc WYlm]g hc XYZYbX h Y]f ZJa]mU[U]bghgcWYhnžk \]gh a UbmW\]XfYb Xc bchWfY Yb[U[Ya Ybh k]h, gcWYhnUgh Y]f fYUgc b Zcf k Ubhb[hc ZYY'h Ya gY'j Yg'Zca 'h Y'ZJa j'm' 6gV Wc j`f_XaVa]VLeYVLeYVLRY Zj ZIRSVeeVca]RIVeYR_ d TZkjŽ:e ZleYVa]RIVh YkVaV a]VRVac`eVIeVU W/^ d TZKA R UhYVEVEVY TR R SVEVV MgVEZ EYVZ RXV VEYV RY Zj RdyZ dZ V/Ley f cellen R_1 `eYvca]RIV%aR]ZidhZeYeYVVRc]ZicUvdTcZaeZ_`W d T2X4j Rdy`fed2L1%%R UyR|2Z/%Z2dh2Z|SVdW VKceYVć`_ŁeYVćVZIRcY/ReZ_dYZaSVchW_ eYVc`]V RddZX_VUe`eYVWR^Zj; R_UeYV[VeyV]`W^Zdecfde e`hRdddTZAjŽ

\Rightarrow 5; 9GC: H = 9: 5A = M

:^ RXXd`VXYVXY Zj; R_Ud`TZkj; R:VZ_eXcVJR4VLŽ 2 ^ f]eZgRZFeVR_R]; dZl`VXYVbfVdtZ_dRS`feeYV VXY Zj; Z_ eYVF?5A #!!" Df cgY hRdfdVU e` Xc`fa UZWWCV_e gZVhd`VVZeR_UZdCVJReZ_dYZa hZeYZ_RXXd`VXdTZkj;ŽEYVR_R]; dZlT_dZVXVU bfVdtZ_dRS`feeYVZ a`ceR_TVRecZsfeVU e` eYV VXY Zj; Z_ R cR_XV`VVR16ZgZEXdLRS`feeYVaJRIVd hYV2VaVaJVJZVU e` SVLR_URS`feeYV^VR_ZX eYV; RecRIYVU e` eYVZc`h_VXY ZjZdtdVRaaV_UZ (/ŽEYVR_R]; dZlcVgVR]d}gVUZWWCV_eejaVd`VWY`ł Zj; Z_ RXXŽ

8YHJWXYX⁻]a U[Y

7`caVa]VZ_eYZITRAX`gLeYVWA`Zj_Zl_`e hYReUVj_VdeYVZ:ZUV_eZjL_`cZIZ=hYVeVeYy V_[`jeYV`dMgVd^`deŽ3VZ_XhZeYeYVWA`ZjZL_`e eYV^`deZ`a`caR_eeYZ_XWceYV`ER_UeYVjeV_U _`ee`TRoj`feRIeZgZZdhZeYVFYZ; A`CV`WRdfcTV`W ec`fS]VŽEYZIZIeYVZ`RXVeYRe''%``WVda`_UV_ed YRgV`WAVZcWA`ZZXZEYVjeV_Ue`SV`]UVcRUF]eeL h YZY ZI_REFOR T_OLVZ_XeYRe WY Zj RI6Z922Xd RV`VWXdZ a`ceR_TVZ_eYVZ:URZj]ZgVdR_UeYVV RV_`TYZUV_Z_eYVY`^VZJ`f_XaV a]VZ_eYV]`h Vc dedef ^ YRgV eYZ:IZ`RXV Rd h V]]LeY`f XXL aRceZff [Rc]j ^ R]VZ

FY`UhcbU``]a U[Y

EYVÅV aV a]V]ZVSVZ XhZY eVVZ VK* Zj, R_UL VåVIZA][jLeR]\Z Xe`VRY ^ V SVŽEYY TRoj`fe RI&&&ZdR_UX`fehZY eVVZ VK*ZXČEYVK*Zj ZIRa]RIVhYVVZd^ V SVd]VRc_e`cVR*Zj ZIRa]RIVhYVVZd^ V SVd]VRc_e`cVR*Zj e`VdeVy UZIFdIa`]ZZTdR_UdTZ&jŽEYY] [ZV e`dWVK*Zj S`_UdZ_eVc^d`WZR]`XFVŽ2]eY`fXY eYV RV[RXV]j UV_USj eYVZ VK*ZZDEZZZ]eY`fXY eYV_]j a]RIVhYVVeYVZ ZJV_eZj ZIT_defTeVLŽ 2TeZZZdR_UcV]RZ_dZad`feZDVeYVVK*Zj RV Rd gVg Z a`ceR_eVcaV a]VhZY eYZIZ RXHhY` ^ R.Vfa "(~`VeYVZ_eVcZAh d?`a]VŽ:edTYZWV ac`a`_V_edRVaV a]VZ_eVYZXVcdeRef^]ZZZ X Z DR_eXX HR_UZZIWF_UZ_R]]RXVXc`fadŽEYV&V RVaV a]VhZY T_dZVdS]VVUFTRZ_R] TRAZRJL BcfaUhjjY[•]]aU[Y

EYVÁVAV a]VdZV_e&j ZlUV}_UUR^ `deVITfł dZgVj Sj eVZCVP ZZdŽEYY U _`eTRoj `fe^ R_j VP Zj RISZZdESfeeYVVP Zj ZITJVR j hYVOVY YRgVV_[`j UUAV dv]gvd^ `deZ_d/TV_eeZ VŽEYY eV_U_`ee`X `fe`VeYVY fdVe`XeVAER_UeVy RV_`eZ_eVCAEVUZ_a`]ZZTR] `cd`TZR] ac`S]V dŽ EYVZCVP Zj Zd ReYVcd ^ VeYZ_X dv]VW_T]`dVU hYVCVeYY TR_}_UCAER_Udfaa`ceŽEYZdZdeVV Z RXVdYRCVUSj eVV]REX(deac`a`ceZ_`VAA`_ł UV_ed1%5″ /ŽEYVaV a]VT_TVc_VURCV]ZVJj e`]ZeVZ_d d?]RCVREZj dAcXdV_eVUŽ

GYZXYbmb[]a U[Y

EYVZ_eVccV/ReZ_dYZaSVehW_WP Zji R_Ud TZkej

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n	PP	rp	PP	TP	FF

>¶ï ÚgznäÁlźÁOÓzqä¶²äæezä] OÝÓ/á¶%äæezäB1Ł; äl Oed¶²O&a>ï Útzonai þþ½É

Zdd^VeZ_VdT^a]V^V_eRg R_Ud^VeZ_Vd`_V `Waa`dÆZ_ŽEY`dVhY`Y`|URyUVeRIYVU%Z`RXV `WeYVWR^Zji RcVRdaV1ZRj1RdNŽEYV/U_`eUV}_V eYV dygydZ_dyReZ_e`eYVZcVR^ZZddSfeeYYjU _`eU`d`Z_cVjReZ_e`d`TZkej VZeYVZ`eZdoReYVceYV `aa`dzeveeYvzcuveriy^V_evov^ eYvzcur^ zzdzd`W RaZNVhZeyeYVZeUVeRIY^V_eW/^dTZkijŽEY`dV hY`YRgVeYZdZ'RXVRcV_`eXgV_e`WcXZ_XhZ.V d TZR cVReZ_dYZadLR_U eYZd Zd cV-VTeVU Z_eVVZc YZXY dReVd` Wa' TZR] R^ ` dR]ZA^ R_UZ_e`]VdR_TVŽ:_ XV_VCRULeYVjeV_Ue`eR\VR_VXRezeVgZuh`WeYV TYR_XXd eYRe YReV TIf ccVU Z eYV T f_eq R_U WWJT_WWWWSjetVŽAVaJVZ_etVyUVeRIYVU‰ TReVX of XV_VcR]j TfeeYV dygVd`WWdV^ VR^ Zj R_Ud'TZR] cWWcV_edLSfe_`e SVTRfdVeYV/ YRgV $R_VaVIZA]_j YZXY UVXW VZ_UZZLFRZARZ_, Z_$ WATE EYY REVEV VREZ UZZLI RZKUŻCREY VLEY V WW eYRe eYVZc VR^Zj `WWkd_` ReZeVe` eYV ac`S]V^dTcVReVUSj d`TZVejLSfeRTefR]j eV_Ude` dvác UfTV cR a]ZijVeYV Ž

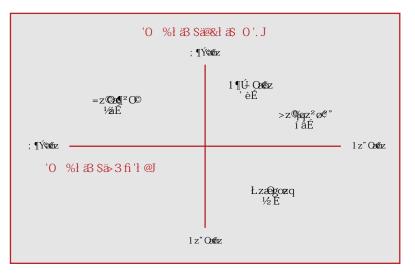
 $EY dV hY YRgVRycVReZ_R]\%Z RXVRcVZ R$ UZWWEV_edEFReZ_ŽEYVjRVjkc^Ra`dEZEVZ'RXV`W d TZK j R_UVdeRS |ZY dec`_X |Z_\dh ZeY ZeŽE YVj RcV eYV^ `dee`]VdR_eR_UUV^ `TdReZIR]]j `dZV_eVUR_U eV_Ue`eR\VR^ `cVMg`fdBS]VgZMh `WgYVTYR_XVd Z_eYVT_f_eqŽ4`_d\bfV_ejjŁeYVj_RcVac`fU`W 4YZ/VŽEYVZcWR^ZjjZ`RXVZd_`eeYRe`WRXc`fa T] $dVRXRZ_ded TZkj, devVeLzeZdeVVV acVdZ_ <math>W$ eYVZ RXVeYV YRgV WaV a VL WeYVZ WLdR U cZXYedŽEYY eYV dygvdUZa]B eYVYZXYVeUXXW `WZUZGZLFRZZREZZ ZeYVCR^a]VRUdWeYVNR^ł Zj RdRa|RIVhYVVZUZZIFRZj TR_SVCVRZVU R_UhYVCVaVa]V]VRc_e`cV[ReVe``_VR_`eVVcŽ EYVac`S[V' RdeYV dWZeZd_`eeYRed TZA YRd TYR_XULSfeeYReeYVhR, WR ZZdRcV_`h`cXR _ZKVUUVd_`eR]`heYVZc^V^SVcde`UVgV]`a eYVZcZ_UZeZUFR]R_UdTZR]gTReZ_ŽAVcYRadWc eYZd CVRd_LeYVj eV U e`Rddvce eYRe eYV VR Zj Zd R_Z dezef e Z_Z Tozotkóž

EY dvhY Y JUL ` c' REZY & UydyWUV_j Z_X Z RXd` WAYVWY Zj eR VR dRYVC_VAREZY gZh ` W d TZdj R_U eYVTYR_XdZe YRdf_UXX_VZE YVZ Z dEZ Te Zde` hZEYURH W/^ d TZdj R_U^R/V eYVWY Zj eYVZc`_]j dZ{Z TR_eh`dJUŽ:eZdhYV_ eYY RVhZEY eYVZ: WY ZZdLZ_WRELeYReeYY WWJ ^ `de a Roe `Wd TZA'g Ž:_ eYZd ckda VTe eYY UZWWC $dZ_{\pm}Z_{\pm}TR_{\pm}e_{J}$ W/ ^ eY dV hY Y]U `eYkc Z RXkd `WeYVWP Zj Ž

H YZIVS` eY eYVAVXc f ad YRgVR_VAE262VRe2Z ef UVe`hRdUdd TZAġLeYVAVReV^R`c UZWWAV_TVd SVehW_ eYV^ŽCVacVaV_eRe26vd` Wy_`c^Re26vm VY ZZAd dW^ e` hZeYUCH W/^ d TZAġ_`e SVI TRf dVeYVj ReVCKREZ_XRXRZ_deZeSf e SVIRf dVeYVj V^S`Uj TVæRZ_ ecRUZZ_R] TF]ef dP] ecR26d h YZIY ackgV_e eYV^ W/^ dWZ_X h ZMc d TZAj daRIVdRd a`ddvdZ_X R_j dZX_Z TR_TV` WeYVZc` h_ŽE YVj dW^ e` SV UVERIYVU W/^ d TZAġ SVIRf dVeYVj }_U^ VR_Z_XRJ^` de VI TJf d2gVjj Z_RY`^` XV_` f d U^ VdeZTR_U]`TR] ZWZE YZEZ_ eVV2c[f UXV^ V.et.Zi h YVCVeYVZc dZX_Z TR_ES`_UdRvUvgVj aVUŽ

 $\begin{array}{c} & {\rm EY} \ dV \ hY \ R_{\rm M} \ c^{\rm A} \ R_{\rm y} \ dM \ UV_j \ Z_{\rm x} \ & {\rm Z} \ R_{\rm x} \ & {\rm W} \ \\ & {\rm eYV} \ & {\rm W} \ & {\rm Z}_j \ {\rm LS}_j \ T_{\rm eR} \ & {\rm H} \ {\rm R}_{\rm y} \ \\ & {\rm eXV} \ & {\rm W} \ & {\rm Z}_j \ {\rm LS}_j \ T_{\rm eR} \ & {\rm H} \ \\ & {\rm eXV} \ & {\rm W} \ & {\rm Z}_j \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm A}^{\rm a} \ \\ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ & {\rm eXV} \ \\ & {\rm eXV} \ & {\rm$

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$$\label{eq:restriction} \begin{split} & \text{RV}_`e_\text{Ref}dR] \text{Sfe} \end{tabular} \text{TXdg} \end{tabular} R_U e^{T}\text{R}_{\text{A}} \text{TXdg} \end{tabular} \text{TXdg} \end{tabular} R_U e^{T}\text{R}_{\text{A}} \text{TXdg} \end{tabular} \text{TXdg} \end{tabular} R_U e^{T}\text{R}_{\text{A}} \text{TXdg} \end{tabular} \end{tabular}$$

H 9 D 5 F 5 8 C L = 7 5 @ = A D C F H 5 B 7 9 C : H + 9 : 5 A = € M

E`4YZVR_deYVVR^ZjZleYVa]RIVeYReUV}_Vd eYVZcZIV_eZejŽEYVjWWjdvTfcVeYVcVLR_UZeZehYVcV eYVj V_[`j eYV dVjgVd^ `deŽEYVj h`f]U]ZVe` XZeVVeV_^`dVeZ Ve`ZeŽEYVVR^ZjjZdZ a`ceR_eŽ 3feeYZUUVd_`e^VR_eR_jejaV`VWR^ZjZd acVU $^{Z}R_{d}$ [Vddd2] eYReeYZdZ a`ceR_TVZ a]Zd R]RI\`Wac`S]V^dŽH\Y'dfYXca]bUbh]a U[Yg' cZhYZJa]mghYaZica dfcVYaUhJWYIdYf]! YbWYgcZgcWYhm H.]gaU_Yg]h\UfXYfZcf ZJa]]Yghc VYWca YgUhgZJWhcfmd UWYgZcf h\Y`dYfgcbU``UbX`gcWU``XYj Y`cda YbhcZ h Y]f a Ya VYfg EYVaRcRU i ZR] }_UZX`WeYV F?5A#!!"DfogVjdYf]USVdec`_XjjV`aYR dXxU+hYZveYvW?ZjZthYReU}_vdeYvZv_eZj `WeYV gRole ^ R[`cZej` `W4 YZJVR_dLRS`fe'!″` `W eYV^ eYZ_\eYReZ_ZdadVdV_eWc^ZeZdRdfcTV `Wec`fS]VR_UT_~ZTeL`cZdZ_ToZKZŽ

EYVViaV2Z/TVeYRe^ R_j aV a]VYRgVYRUhZeY [ZWZ_dTZkjŁR_UaRceZIf]Rc]jhZeYdjdeVdR_U \mathbb{Z} de \mathbb{Z}_{d} _`eac`gZVeYVSRCKIWcRcReXNMe`cj_ViaV2Z/TV `WaVkd_R]UvgVj`a^V_eR_UT]]VTezgVSVj`_XZ_XŽ :_bfVde`WeYVWc^VELhZeY_`hYVcVVJdVe`efc_ WceYVViaVZZ_TV`WZZ]`XfVR_USV]`_XZ_XLeYVj hZeYLdRh Z_e`eYVNR*ZjjŽD ^ V}_UeYVeYVdR^ V UZKVIF]&ZdR_UT _~ZTedRdZ_d TZKgLR_USVT ^ V UVERIYVU W/^ S`eYŽE` `eYVceLeYZIhZeYUcRhR] ^ VR_dRcVRWc^ ReZ_ `WeYVecRLZZ_R] ZNReYRe `_]jU^VeET]ZWIR_ac`gZV^VR_ZXR_Udfał a`ceŽ@eYVcddeZ]RcVRW&_eVUSjhYReeYVjViaVcZ V_TVRdd TZR V/T]f $dZ_R U^{R}$ V/V/ZCVR* ZZ dZ_{e} RCWWWW/M/ d TZKjłR_UZ_ ^ R_j TRdvdRXRZ_deZEŽ =Rdelj1Ld^ VaVa]VLhYZV_`ehZthZ_Xe`ScVR\eYV]Z_\SVehW_d`TZVej R_UeYVNR^Zj `ce`hZeYUeRh

 \underline{Z} e` eYV]ReeVeLUZET gVc e` eYVZc VorderReZ_ eYRe d`TZKej YZ_UVcd eYVUVgV]`a^ V_e`VeYV\Z_U`W VR^ Zj cV]ReZ_dYZdeYReh`f]UV_RS]VeYZd]Z_\e` SV^ RZ_eRZ_UVŽ

Dec`_XVR^ZZIdRcVRSRdZTacVT_UZEZ_WcYfł ^ R_ UVgVJ` a^ V_eŽH ZEY` feeVV` ŁZEZUUZWIf]ee` $RIYZgVeYV \setminus ZU$ VaVcd RIVgV a^ VecVbf ZVU WERD TZG VIRIOZVIZ OVAROVULOM VIANZR OZ UZ gZLf RjdŽ3f eeYVdecV_XeY R_UTV_edRjZj__WUVURcV _`e`WeYV\Z_UeYReeYVUReRcVgVRJŽ:_4YZJVLeYV Z'a`ceR_TV`WeYVWP^Zj; WebfV_ej; UKoZeVdWV^ eYVhVR_Vdd`WdTZkejR_UeYVUZWTf]ejaVa]V YRgVZ_RIYZkgZ_XaVcd_RJUkgVj^a^V_eeYVcVZEYZd $\mathbb{T}\underline{R}_{c}$ of $\underline{c}_{z} \mathbb{Z}\underline{e}^{2} \mathbb{R}$ of $\mathbb{R}\underline{c}\mathbb{Z}\underline{Z}_{z} XXc$ f_UWcd/WWW_TV RXRZ_ded TZK jŽE YV deV_XeY `WeYV 4 YZVR_ WP^ } Zj ZIR[^] SZAF [^] f d.SVIRF dVZe ZIR deV_XeY eYRe TR_ SVefc_WRXRZ_de_eYVcVdeŽEY_dVhY_deReVeYRe WAY Zij X RIdR U cV[ReZ_dYZadRcVR] eYRe ^ ReeVad RtVf of Riji eYVgVoj aV a VhY RtV^ `de UZdecf del WeYVcdŽ

EYZtydetV_XeY%daVR\V_ddTZkijłR_UTR_SVT^V RecRaWceYVWYZj ZedyVXH\Y`acfY`h\Y`ZJa!]`micdYfUhYg`Ug`U`WcadYbgUhcfmigcifWY`cZ a YUb]b[g'UbX'`cmU`l}Yg'h\UhUfY'dfcdYfm gcWJU'z'h,Y'a cfY']h]g'kY][\YX'Xckb'Vm UXX]hcbU'`XYaUbXg''H,Y'kYU_bYggYg'cZ gcWJYmiUfY'h\ig'hifbYX']bhc'U'gffU]b'cb' h,Y'ZJa]m'EYZdYRaaV_d_`e`_]jReeYV]\&J`W ^ VR_ZXdR_UV`&Z_d.SfeR]dReeYVaCREZR]\&J'`WREZ_ŽAZgRZARZ_ R_UUXXF]REZ_`W SRDTV&^d`WITZ]d/If Czj 1YVR]eY'TR\LaV_dZ_d. h`c\L\UfTRZ_/YRgVerR_dWckUR]RXVSf d.V_ `WXda`_dSZZgi`_e`eYVW?ZjZEYVa\CT\aeZ_ `WRTCZEZZ eYVW?Zj eYRedfUZdc\g\R]Zl]RX\j Uf Ve`eYVdeRZ_eYZl`g\c]RUZda]RIZ_X`_ZHR_U e`eYVVa\CZ/TV`WY`hW?ZZddecfXXJVe`T aV hZeYeYV_Vh&Rc\dRZZ_VUe`eYV`Sj Tf]efcR] TYR_XZZ

:eZL_Ref d?] W&WY ZZde TYR_XVRd TZdj U VŽ 3feac S]V dR:ZU/hYV_eYZdTYR_XVScZ_Xd_Vh cVda`_dS:ZZZdeYReReV_`e^ RETYVUSj eYVUgy] `a^ V_e`WAZ]de T aVhZeY eYV ŽEYVdVdZ]d ReVf dfR]jj ac gZUUSj d TZdj R_U d TZAJ S`_UŽ :eZdeYf daRceZIf]Rejj UZJVIF]eWcd TZdj R_U eYV WY Zj hYV_eYV]ReeVcZdWcTVUe`UV}_VZedJVAdR UWW_TVRARZ_deeYVWc^ VŽ



69-B; [·]5 [·]K C A 5 Bž69-B; [·]5 [·]A 5 B ["]H s → D5 7 HC: [·] 7 < 5 B; 9



K \Yb h Ym`cc_ UhW Ub[Yg']b [YbXYf fY`Uhcbg Zca h Y dc]bhcZj]Yk cZh Y]bX]j [Xi U`]miUbX Yei U`]mih Ym XYg]fYž dYcd Y Uddfcj Y cZh Ya `][\`m'k \Yb']h Wa Yghc h Y cddcfh b]]}YgUbXdfcV Ya g]bj c`j YX`]b fYU`]n]b[h YgY XYgfYgXUmVm XUnž \ck Yj Yfžh YmgYY h YgY W Ub[Yg Ug U a U'cf gci fWY cZWcbĴ]Wh

H ± 97 < 5B; -B; FC @ C: K C A 9B

7`c^`de aV a]VLeYV hRj h`^V_dc`]V YRd eYVT f_egidTf]efd?] TYR_XdŽ@VR] eYVTYR_Xd Vg`]gVUZd`_V`VeYV^`de`SgZfdd_^ae`^d`W aVcTVZgVLLVkeYVc^`dvLzZdeVV`_VeYReZdgZhVU ^`dea`d&zgyljŽEYVF?5A#!!" Dfcgyl dr`hd eYReeYVUZWWCV_eXc`fadTgyl&UUSjeYVdR`a]VR&V Re`_VZ_eYZIRdbldd`V_eŽ

EYVZ_łUA eY Z_ekcgZhdck@kl] eYRe eYVTV_ecR WRef cl^ WYZL_Vh dEf ReZ_ YRcISW_ etVerR_dEZ_ W/^ Rc`]VTV_ecNU`_ ^ `eYk?Y` UR_UY`f dY']U RU^ Z_ZhEREZ_ e` `_VeYRe eR\kdZ_ eYVh`cJU`W h`c\ R_Uaf S]ZT RIEZEZCZ

K \ Uhi \ Ug W Ub[YX mci a cghB

ÎK cf_ž]hý XcbY a Y [ccXhc [Yhci hcZh Y \ci gYÅ UbXh Uhý h Y a U]b h]b[ž=h]b_ž [Yhh]b[ci hhc k cf_ WUb[Yg Yj Yfnh]b['Ï fl Ya UYžUXi hži fVUbža YXli a !ck 'Q9, Ł

 $\label{eq:restriction} \begin{array}{l} AReeZIZAReZ_Sj h`^ V_ Z_ Wc^ R] h`ch`fedZV\\ eYVY^ VYRda]R_ WURTV_eR_ c`]VZ_ eYZITYR_XXZ\\ EYVcNRd_ Wc Ze ZleYV_WU Wc YZXVc VRc_Z Xd\\ d eYRe U^ VedZT`S[VFeZgVd eYV^ cMgVd TR_SV\\ RIYZ&gVLZ9 ZXHbf R]Z_ i VUFTReZ_LYVR]eY TReVL ZV_ eYZ fTReZ_ eYc f XY T_d^ aeZ_LcVR04ReZ_L\\ R]] eYvdVeYZ_XdUV^ R_U^`cVR_U^ `cVZ_T^ XZ\\ 4`^ SZ_VUhZeY eYVZ_cdeSZZ_ eYReZIRWRef cV`W\\ eYV]RS`fc^ RcVeLeYZHYRdUZgV_h`^ V_Ze eYV\\ h`cVWCIVZ \end{array}$

4f Jef dR] R_UUV^ XRaYZTYR_XdYRgVRjd RII T^aR_ZUR_UV_T fdRXU eYZIac`TVdŽD^R]Vc VR^ZZdL^``dVW^RJVY`fdY^]UYVRUR_UeYVcZV `VZ_UZZJFRJZRZ_YRgVTcVReVU`aa`cef_ZZdUVc h`^V_e`Raac`RIY eYVZ:dVJVARJZREZ_W/^ R Sc`RUVcaVdeVTeZVeYR_eYRe`WeYVY`^ VŽ

2_`eVc Wate c ZleYVa`hVcW] Tf]ef cR] `f eaf e `VWV Z_Zt`hYZIYŁW/^ eYVaVcdaVtëzgV`Wobf R] cZXYed_YRdTYR]]V_XU eVVa`hVc^VTYR_Zt`dcVf dezTeZ_Xh`^ V_`dZV_ezgi e`eYVY`^ VŽE YZIYRd XgV_ cZtVe`af S]ZT`a`]ZIZd eYRe RcVTcVRZ_X R_ Z_eVcVdz_XVR^ Vh`c\ Vc eYVacRtëZTR] ac`TVd1`W cUVJ_ZXWV R]VZJV_ezzVdŽ_4 YZVLeVcVRcV[Rhd R_UZ_ZZRezgVdhY`dvVWWatd cR_XVV6/^ eYVac`ł ^`eZ_`VWcVReVcVbf Zgi Z_T_[f XR] cV[ReZ_dvZad e`eYVTcZ_Z R]ZReZ_`VWM f R] YRRdt' V_eZ_eYV h`c\a]RIVŽER.V_R]] e`XVeVveRUZZ_R] Vbf Zgi XRa SVeh W_ ^ V_R_Uh`^ VŽ

 $H YZ V dZ ZZ R_e Z e V T f e j d YZ e c ZR$

 $\begin{array}{l} UVgV_{a}^{A} V_{e}LeVdVTYR_XdRVdeZ] Z_TZaZ_eSj\\ Z_eA_RZ_R_deR_URUdŽ > VRf eVUSj W^R_VaRd\\ eZZREZ_Z_eVVh`c\WcIVR_USj XV_UAcVbfZj\\ R_UV^a`hVc^V_eL_Vdtac`XddYRdSW_^RUV\\ Z_4YZVeYR_Z_dZ`ZRcjj UVgV_`aVUTf_ezZd\\ VjdhYdXZ \end{array}$

K < 5 HK C A 9B 5 CD F9 HC . 5 K = 89F 5 B 8 A C F9 9E I 5 @K C F @8

7f]] a Rez ZZ RZ _ Z d TZ gi eYc f XY h 'c' R_U Vof R] cZXYed ZIR X R] eYRe h ' ^ V_ Rob ZV e Ž: e Zd _`e[f de VRc_Z Xa ' h Vc eYV f dW ŽE YV f R]d dW eYV a` eV_eZd e` R_NC^ eYVZc Z UZgZL f R]Zgi R_U af cdf V eYVZc a Vcd_R] UVg/\`a^ V_eL d ^ VeYZ X eYRe Zd UV `_dedReVUSj eYVUZWWZ X^ VR_Z X deYRe ^ V_ R_Uh` ^ V_ ReeRIY e` h `c' udW efS]V(SZ

2eeYVd? VeZ VLh`^ V_Z eYVY folhZydR_U cleZtVddX? V_eVlacVdRUv2EVe`U`d ^ VeYZX UZWWZV_ehZeY eYVZ:]ZzVZ

 $\label{eq:linear} \begin{array}{l} 2 \ X & R_j \ h^{\ } \ V_h & Z & S \ R & A \\ \hline & R_j \ h^{\ } \ V_h & A \\ \hline & R_j \ Le & V \\ \hline & R_j \ Le & V \\ \hline & R_j \ Le & V \\ \hline & R_j \ Le & A \\ \hline & R_j \ Le \ Le & R_j \ Le & R_j \ Le \ Le & R_j$

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>¶ïlýznablt; älOngl²Oasïlózonai þþ½Ê

@/.łä' G&ö Ýall²äxQ) GeOGQa&GGeYáçolli Ýzö GzÝaCP qa1źa41źzYáhi] ÝO-Å@ÈqAzUýz²æ7 zÝÈ

H oz ² äo¶ ï äæe ^e ä¶ ‰æz å gað œz Ýao¶ ï ä ấ ¶ Ú- O‰ag OÚád ï aðo ¶ ï @ ao¶ ï å vo, ammunum og ammis z- O2 ammis aos J¶ï äz ‰ Š @ qa? ao o£ao¶ ï aq¶ ammunum minne à ammune à ammune à ammune à J¶ï äö ¶ ï @ ao za∯aq¶á¶ – zæe " ż Ś zammunum minne à ammune à ammune à @ cz œz 2 Q æa¶ ï a∯ ź ©æa∯a¶ æz ĺÅz ¶ Å@ ammunum minne à ammune / p ammune / p L- ¡L ammunum minne minne ammune / p ammune í a @ a@ammunum minne minne / p ammune / p ammune / p

>¶ï ÚgznaB1Ł; äl Oan¶²Oã≽ï Údzonaĭ þþ½Ê



e`RSR_U_eYYY^ VŽCRYVELAYY hR_ee`SVRS]V e`a]R_eYVZ:]ZgVdW/^ RSc`RUX:aVxdaVTaZgVŽEYV ZeVcgZhddr`h eYRehYV_eYY TR_V_RXVeYVZ Y c%:_dLeYVZ:Z RXV`VAYV dygVeLeYVZ:VR`ZZd R_Ud TZA; TYR_XXddX_Z;TR_ejZ

4`_W_eWhZYRhZVch`dUh`^V_d&ARaV eYVZ: dMWZ`RXŽHZY eYZl_Vh ac`daVTe SW&V eYV`ŁeYY_UZT`gVcZ_eYV`dMgVdTRaRSZZZdWd ^Vcj_UV_ZUSj_eYVecRUZZ_R]c`]VZ`a`dWfa`_ eYV`ŽEYVd&f]eZHZXYVcdMW&W^Ž

Î=ĨYYXY Y'C dYXĨ=ZYY`a CfY]bXYdYbXYbH' :]fghcZU`Ĩ=ZYY`=Ĩi fYgdYWhYX`a cfYÅ`Am \igVUbX`]gU`a U`Y`WU`i j]b]gh'\Yi\ci [\h k ca Yb k YfY'h YfY'gc h YfY Wc'i X`VY gca YcbY Ufci bX hc k U]hcb \]a "Cc i\]g h]b[Ĩh]g`W\Ub[YĨ\Ug`a UXY`a Y`[fck UbX` fYgdYWia ngYZUbX`]h\Ug`a UXY`a Y``] a ngYZVYIHYf Ug`k Y``Ï fl Ya U`YĨUXi hĩ h\Ubĩ\][\@, Ł

 $\label{eq:rescaled} \begin{array}{l} & R & Z_j & C_R & Z_d & R & R_d & R & Z_X & R_v & A_v & A_v & R_v & A$

$$\label{eq:constraint} \begin{split} \dot{e} X &\dot{e} Y V \\ \dot{e} X &\dot{e} Y V \\ \dot{e} Y \\ \dot{$$

Î=[chZYXi d VYWI gY=ZYh]_YU[Y]g\UÅ =k Ug[Yh]b[\ca Yj YfmUhYžj YfmhfYX fZca k cf_LUbXh YfY \Y k Ug k U]hb[Zcf a Yhc UhYbXhc \]a /=a YUbžh UhWUbŇiVY f][\hÅ I bh]`=WUa Yhc a mgYbgYg=hci [\h Yj Yfmh]b[k Ug'h Y k Um]hg\ci X VYžh Yb k \Yb =glUfhYXhc gYY h Y fY Uhcbg\]d a m XUi [\hYf \UXk]h \Yf \i gVUbXž=gi XXYb m hci [\hZk \UhUb]X]ch=ŷY VYYb'Å Mci _bck žh Y XUX VUh]b[h Y VUVnžhc XUm]hŷ mci f hi fb hc Xc h]g UbX a mhi fb hc Xc h Uhž nci [Yhih YZc X fYUXm'A m\i gVUbXbYj Yf gc a i W Ug'gYhYmYgcb h YZc XÅ Ï fi Ya UYžUXi hzi fVUbZ\][\C9, Ł

K C A 9B HC 85 M H 8 9 GHF5 B G C : 9A 5 B ! 7 Đ5 HC B

EYVAV TYR_XX&LhYZV UVAZKVU R_U d f XYe Sj ^ R_j h`^ V_LYRgV_`e SW_ VRd ŽEYVJ YRgV ReVXU UVAA'c` eVUTF]ef dR RdF ^ aeZ_d d TY Rd eYVZLV_eZ TRZ_`VV V_ hZeY af S]ZTR_Uh`c\Z_X [ZWR_U`Wi`^ V_ hZeY eVY`^ VR_UTYZU d RcZ_XŽ 7f ceYVc^`cVLh`^ V_ YRgVWf_UeYReV_eVcZ_XZ_e eYVZc_Vh c`]VZIRVAR XYeLcheRZ_VU ac`TVdŽ

EYVXXR4VædæRZ_ZIZ_eYVCVJRZ_dZaSVehW_ h`c\R_UVR^ZjŽHYfY`]gUVcbÛJWhVYłkYYb` h`Y`lfUXJljcbU``XcaYgłJWXYaUbXgik\JW` Xc`bch[c`UkUnžUbX`hY`bYk`XYaUbXgi cZkcf_"ERSJV(&dr`hdY`heYVeh``gVcJRaZ_ h`^V_d]ZgVdLX&ZXCZVe`hYReYRdSW_TRJVU eYVZ:yU`fSJVh`c\Z_XUB9%ZEYVCZefReZ_ZlaRd eZf]RcjjUZWIfjeWch`^V_YVRUZXY`fdVrJUČZ

4`_~ZTeZd_`eT_}_VU`e`eVVT_eRUZTeZ_d SVehW_^`UVc_h`c\R_U eVV eeRUZEZ_R]VR^{1} Zj Ž?VhZ RXVd`VVEYVR^Zj ReVRJd RdfcTV `WdeeRZ_ŽEYVh`^R_Zd_`]`_XVc VfaVTeVU e` hRZe`_YVc Yf dSR_U`c]``\RANC eVVTYZUEV_ R]`_VŽCREYVELdVVZd VfaVTeVU e` SVR aZJRc`W eYVZc Z_UZEZUFRZAREZ_ a]R_dŽEYV_VhZ RXVd`W h`^V_dc`]VZ_eYVVR^Zj UV^R_U eYRe d/VTeVI ReVR_V_gZc`_^V_e hYZTY WdeVcd YVc TYZUEV_d dylWdeW^ ŁJWC_Z XTRAFSZEZdŁdylWeWJZC_TVR_U RSZZEJ E CYJREV E `EYVCH R_U CVCHVEWZC_TVR_U R_UHYZTY ac gZJMYVCYF CSR_UHZEY CVT X_ZZ_ R_UV^ `EZ_RJ CHEZHNIEZ_Ž._ `EYVCH` CULRCHHRd CW_ Z_VRCJZC TYRAEVCLEYVW? ZJ ZIVI AVTEVUE ERVRJ^ `CEVITJF CEVCHXLEYVW? ZJ ZIVI AVTEVUE ERVCHVERVLEYV REVIZE ERVCHVERVLZEVTF JEE AVCVC^ Z_ EVV CHJEVEL EVCHVERVLZEVTF JEE AVCVC^ Z_ EVV CHJEVEL

@_ e`a`WeYVdeRZ_dZ_eYVY^VLeYVXVRV eY`dV`WeYVh`c`a]RIVZ7`ch`^V_LeYVUZWIF]ej `WRLRaeZ_Xe`eYVaRIV`WyeYV^RIYZ_V&hAZYR]] ZedT_dbfV_TVdWceYVUVgY`a^V_e`WREZWI e`g`Z_UZgZLFRZREZ_LZTT^a`f_UVUSjac`S]V^d daVTZ_Te`eYVcXV_UVcZEYY_RVaRZU]VdHYR_ ^V_WcVbfZgR]V_eh`c`R_UYRgV]VdHTYR_TV`W ac`^`eZ_Ž7fceYVc^`cVLeYVZ.h`c`Z_XdEfReZ_ ZLUAV_UV_efa`_eYRe`VeYVZ.YfdSR_ULdZ_TV hYVcVeYY_JZgVR_UhYReY`fcdeYY_V&a YRgVe` SVRcR_XUWceYV]ReVcdT_gV_Z/TVZ

$$\begin{split} H & \land V_W [et ReeYy RVR] h R_d & ez Z [Reh`c`L RdZWeYVZ; RSZZej e`U et Z_XdRdh V] Rd & V_h V V Z_U f Se Z YZd [VRUdeYV`e`a] RIVVi et RUV R_U d'`_ et V dv[gvLaRez If [Rc] Z_et VRVR h Y V V et V] RV & `de [Z V] e`SVU f Se U R_U S V Ze [VL+et VZ; RSZZej e`T_ec`] et VZ; V`eZ_Z$$

Î=[chłłfYXcZVY]b[hYgłfcb[cbY]bhY cŹWYżcZ\Uj]b[hcVYhYgłfcb[cbY]b hYcZWYżcZ\Uj]b[hcVYhYgłfcb[k]h hY YlYW hjYgžk]h a mVcggžUh\caYk]h a mgYŻ=kUgʻighXYaUbX]b[hccaiWcZ a mgYŻ! flYaUYżUXi hzifVUbž\][\09, Ł

EYf d.e' h`^ V_dU fS]Vh`cZ_XUJ; ZHUUU eYVyU fS]VdedZ_%JRf dU Sj eYVac`TVdt`VUf] ef d?] TYR_XŽEYVT_~ZleTcAReUSj eYV_Vh UV ^ R_Ud`WeYVY`^ VZIT ^ a`f_UUSj eYVdedZ_ `WeYVZc h`c\Z_X V_gZc`_^ V_eZ 7 c bgffi Wf]b[`]bX]j [Xi U`]mihc XUm]g`Xci V`mX]ZÚW` hZc f` U`k ca Ub"

J`f_Xich`^V_eV_Ue`eV]]Rd ^ VhYReUZXWKCV_e

de g ŽEYY RV^ ` cVRaacVIZREZV` WAVVTYR_XdŁ R_UV_[`j eYV Ž3VIRF dVeYY YRgVWhVcWr Zj cda`_dSZZEZdŁeYY V a VCZ/TVeYV dcdZ d` VAV h` c\}Y ^ VcYREZ_dYZa JVddZ eV_dJj Ž2eeYVdr V eZ VLeY FXYLeYY dV_dVe/ReeYVZacZeZXVU/dEF} RZ_ZI`_]j eV a` drg R_UeYReZehZ] V_UhYV_ eYY Xké ^ RocZUR_UYRgVTYZLEV_ŽAVCYRadRdR cVdF JeL^ R_j j` f_XcVda`_UV_edacWVce` a` dra`_V ` c Rg`ZUeYZddVaŽ

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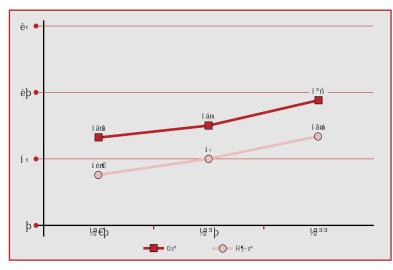
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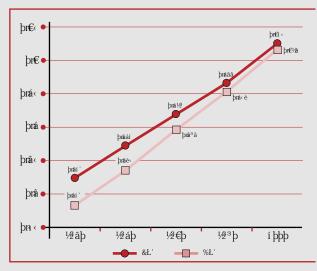
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H + 97 < 5 @ 9B; 9HC A 5G7 I @ B + M

$$\begin{split} & \text{EYVc} [Vd \end{tildelta} \en$$

 $\begin{array}{c} H YV_ `_V We Vc]Vd IYR_Xd d U Vde V e V d.\\ R e Y e V da WUR_U UZ VIZ_ `WYR_XVU _`e \\ R h B d^ REIYZE YVX We d Z de A e YRe V TIF a VU \\ Z h `^ V d Z R Z R g R_U a d R e Z V V V d g \\ Z h `^ V d Z R Z R g R_U a d R e Z V V V e \\ Z h `^ V d Z R Z R g R_U a d R e Z V V V e \\ Z h `^ V d Z R Z R g R_U a d R e Z V V V e \\ Z h ` V d Z R Z R g R_U a d R e Z V V V e \\ Z h ` V d Z R Z R g R_U a d R e Z V V V e \\ Z h ` V d Z R Z R g R_U a d R e Z V V V e \\ Z h ` V d Z R X P & R I F \\ Z h Z d Z d Z e \\ Z d Z d Z R Z R g R_U I F \\ e V V V V R & R I F \\ Z d Z d Z d Z & R & R \\ Z d Z d Z d Z & R & R \\ Z d Z d Z & R & R \\ Z d Z d Z & R & R \\ Z d Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R & R \\ Z d Z & R \\ Z d Z & R \\ Z d Z & R \\ Z d Z & R \\ Z d Z & R \\ Z d Z & R \\ Z & R \\ Z d Z & R \\ Z d Z & R \\$

5F95GC: D9FD@9L+HM

EYZITYR] V XVe` ^ Ruff Z VZV & di YRdRZM e`gRg Z XUVXWdZ eYVUZWWCV edaYVXd` VURZj Z VZZTVZZITYR_XXdZ h` ^ V eYReYRgVTR] VUZE Z e`bf VdZ_ŁZZIZ eYVRXRZZ g`gZ XeYVXXR2Vde Z eVGREZ_hZY eYV eYReeYV] VgY `VaVka]ViZj Zd YZXYVdŽ 4 YZVLeYZI^ RZ g' VR_ddV]RZ dYZd hZYZ eYVRY Zj R_UT fa]VdR_USV6h W_aRV ed R_U eYVZ TYZUZV ŽE YZIZI hYVXVUZ6hZ e RS`fe aRecZCTYR] Rf eY` cZg LeYV^ RJV^ `_`a`]j` VMI fR Z ZZRZZVLRF eY` cZg LeYV^ RJV^ `_`a`]j` VMI fR Z ZZRZZVLRF eY` cZg ZZ ^ `UV] ^ VREYVCY` UR_U eYVf_V6f R] UZecZ6f eZ _ `VVI^ VEZTVV_TZ_dZd V aVZV_TVU Z aCREZVZE YVXVUGV]`a^ V ed RV SVZ XCVZ WCTVUSj_Vh JRhde`ac`eVTeeYVRY Zj L TYZUZV_ R_Uh`^ VZ

EYV faYN Roll UVd_`edW^ e YN gVSW_d Xon Re Rdj Ve Z_ eYV } VJUd`Va`]ZEZT dR_U h`c\Ž EYZ LZ T_dZEV_e hZey eYV WATe eYRe ac Xoud Z_ TO NEZ_XV of RJ RITVOUW ch`^V_Z eYV UN ROURD YRd SW_T^ aRCREZ VJ aVTEVU W/^ eYV_Vh_J`XZ TR_aVCYR ad SV VI aVTEVU W/^ eYV_Vh_J`XZ TR_aVCYR ad SV VI aVTEVU W/^ eYV_Vh_J`XZ L`h`aVCREZ XZ_eVV`cXR_ZCREZ_`VVh`c\Ž? Vh `cXR_ZCREZ_R] dEREVXZ dSRCMU`_Y`cZk`_ERJ_VI X eZREZ_R_UT`aVCREZ_cV/ReZ_dVZadLR_U`_ ^`dV~VIZS]Vh`dZ_XRcR_XV^V_eeL^RJ_VIeV_U eYVaVca]VIZsj_RS`feZUV_ezej e`eYVh`dZ_Xh`dU Sj_Z`aVcZ]Z_X^ROHF]Z_VRfeY`dZej Z_eYV}VJU`W ^ReVcZR] ac`gzZZ_Ž

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3j T_eRRehZeYh`^ V_d]ZSVReZ_hYZYYRd T ^ VT ^ a]VeVhZeYZV]`XXdtd TZd]^`g^ V_edt USReVR_UeYVT&ReZ_`VR[ek_ReZy^`UJdeYV dEf ReZ_`W RdIf]Z_Zj TR_aVeYRadSVd^ ^ VU f a Rd`_V`WZV_eaVa]ViZjZb dfUWfJWYZa U`Y`]XYbH]mi]g`VY]b[`WU`YX`]blc `ei Ygf]c bz`Vi h h\YfY`]g`bc `gc WJU`miUddfcj YX`Ub[i U[Y` k]h`k \]W.`lc `Uff]W `UHY`h]gž [f de Rd eYVeV Zd_`Sc` RU USReVR_U_` d TZd] ^ `gv^ V_e Vec ^ V_d]ZSVReZ_L]Ve R]`_VZ_dEZf eZ_R] cWec^d `c RJeAc_ReZyV^`UJ/df a`_ hYZIY_Vh adRieZVd TR_SVSRMUŽ

 $:eZIRTET R]j h`^V hY YRgVX_VWeYVEZ REZT REZT REZT REZVERVER VY RUT]Z.Z eVVEYVEZ REZT REZ A V REV VW RUT]Z.Z eVZ VV REV V$ $WEYRE V YRGVX_VC ^ VhR e hRUCKVREV VD RZ Z eVZ VL A VhR e hRUCKVREV VD RZ Z eVZ VL A Z eVVEYC E Z eVZ E RZ Z R Z V EZ Z R Z V EZ Z R Z V EZ Z R Z V EZ Z R Z V E Z EZ R Z V E Z EZ R Z V E Z EZ R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V E Z EZ Z R Z V EZ Z R Z V EZ Z R Z V E Z EZ Z R Z V EZ Z R Z V EZ Z R Z V E Z EZ Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z V Z Z R Z Z R Z V Z Z R Z V Z Z R Z Z Z R Z Z R Z Z R Z Z R Z Z$

ÎH YgY UfY IA Y IA Jb[g'IA UIA\Uj Y fYU`m[ch a Y k cf_YX i džZYY]b[IA UIA=Xi U'gcflicZ g'Uj Y UbX IA UIA\Y \UgbNii[fck b Ug'U'dYf! gcb"H.]g']g'k \UIAfYU`ma U_Yg'a YZ f]ci gž ZYY]b[IA UIAA YfY]g'U'dUflicZ \]a IA UIAğ'g]``` [_YU`]IAY Vcnžgc`\]g'a i a a m\Ug'lc``cc_` UZAYf`\]a žcf`\]g'bUbbnžk \cYj YfÅ Ï fl Ya U'YZUXi 1ži fVUbž]bHYfa YXJUHY C9; Ł

7RIVU hZEY eVZtlf a YVRgRJLR_U hZEY _`eVZ_Xe eVJ] eVV^Y h eVVZta`dZEZ_dh`f]USVcV cXR_ZXUL ^ V_WVJ eYReeYVJ RcVcVda`_UZ_XdReYVc aRdZgVJj e`eYVTYR_XXdSVZ_XUZZV_Sj_h`^ V_Ž

Î=h,]b_ h,Uhfa YbE\Uj Y`\UX`hc`UXUdhhc` h,YgY`VXUb[YgÅ VmVY]b[`acfY`gi Va]g! g]j Y'Ï fA U'YžUXi`hži fVUbž`\][\`G9, Ł $6gV_ZVf_eYZ_ZXJjLeYZdaVca]VtZgScZ_XdWceYTVceRZ_gaZRJcVRTeZ_dVO'^ eYV^V_hY'$ $VtaVcZ_TVZEZ> R_j `VeYV^LVcaVTZRJJj j`f_XL$ $hVJ]VUFTREVU `_VcLYRgVUVgV] aVU Z RZZ RZZd$ $`WT` aVcReZ_ R_UT ^ ac` ^ ZHZ_VR^ Zj]ZNL$ $R_URhZJZ_X Vcde dWeYV^ eYc fXYZ$

Î 5 bX UgZ f a m`]IhY VcnžGYVUgIz bž\Yjğ [cha Yž\Yjğ[cha Y Vmh Y bcgYžVYVUi gY \YjğVf]`]UblžVV.]XfYb UfYVf]`]UblÅ =Xcbjki _bck ž=`cj Y WUb[]b[\]a ž=`cj Y VUh! [b[\]a ž=`cj Y di Ihjb[\]a Xck b hc gYYdž= `cj Y a U_]b[\]gZ cXž=`cj Y]Ižmci gYY3Ĭ fA UYZUXi jzi fVUbža YX|i a !`ck G9, Ł

3f e eV&VRV `eV&dhY` &RIE Sj UV` _ZZ_X eVVIYR_X&Z_eVVW RJVc`]VŽ2TT dZ_Xe eVV Ł eV&VYRgV&df]eUZ_RTZZA` W dV%LeYRe`dV& Z_hYZY eV&diVdYRU ac`aVcy&&VE&VE `eV&ZEYY YRgVRJd &Af]eUZ_eVV^` &RIU `eV&ZEYY YRgVRJd &Af]eUZ_eVV^` &RIU URZ_` `Wi`^ V_ŁhY` eVY TJRZ_YRgV]`de eV& dJV&&AVTZEYV_` &RIXXR Wc y`dV%eYRe eV& aV a]VUZbJRJ ZI`SgZfdj RjVRc_ZXe` &T g\c eVVZV_eZj eYReeYY eVV dJg\dYRgV]` &Z

 $K \setminus Uh\tilde{g} \setminus UddYb b[hckcaYb3]$

ÎH YMNY UVcj Y h YagY jYgžk ca YbgUd h Yf \igVUbXgXck bžh Uhŷth YZIg\]cb''

ÎK ca Yb k YUf ħ Y hci gYfg bck "Ï

Î ∔Îğîk ca YbÎğî 'JVYfUl_ilc bžih Ymik UbhYei U?]Imžih YmĨAY dUn]b['i gʻVUW_]b`ci f`ck b` We`]b'Ï

Î H. YmŴY hc hU`mg\Ua YYgg'bc k žf][\hi h fci [\h Y k \c Y c Zgc WyYmfl fA UYgzUXi hzi fVUbž`ck 'Q9, Ł

 $H YV_ ^ dt = TZZZZT ^ UTA ^ V_ ZletV^ VeY U f dUe dRddweeYVf_UVc^ ZWZW_ZEJLR_UaRd eZIf [Rc]j eYVaRecZeCTYR] VR^ Zj dj deV^ LeYZT^ Rj SV XZV_ addieZIR] WWWIeZ_ eYVWc^ ` VZZ [V_TVŽ$



H ≤ 9 A DC FH5 B 7 9 C : : 99@B; G ≥ 5 : : 97 H ⊂ B 5 B 8 · · · 7 C B J 9FG5 H ⊂ B



D'TZR] \mathbb{R}_U af S]ZT]ZW YRd $\mathbb{R}h$ \mathbb{R} d $\mathbb{C}h$ \mathbb{Z} VU \mathbb{R} d'S[VI& gV SRUEL eVRe ere dIV_Ud af $\mathbb{C}h$ $\mathbb{U} \land \mathbb{V}e$ \mathbb{Z} $\mathbb{C}h$ $\mathbb{R}e \mathbb{Z}_d \mathbb{R}_U \vee \mathbb{T}_{\uparrow} \land \mathbb{Z}$ ere $\mathbb{C}h$ $\mathbb{Z}_d \mathbb{R}_U e^{1}/\mathbb{Z}$ \mathbb{Z} a Ree \mathbb{Z} \mathbb{F} \mathbb{R} $\mathbb{U} \vee \mathbb{Z}_{\uparrow} \land \mathbb{U}e^{1}/\mathbb{Z}$ $\mathbb{Z}_d \mathbb{R}_U e^{1}/\mathbb{Z}$ $\mathbb{Z}_d \mathbb{R}_U$ $\mathbb{V} \land \mathbb{Z}_d \mathbb{R}_U \land \mathbb{Z}_d$ $\mathbb{Z}_d \mathbb{R}e^{1}/\mathbb{Z}_d \mathbb{Z}_d$ $\mathbb{Z}_d \mathbb{Z}_d \mathbb{Z}_d \mathbb{Z}_d$ $\mathbb{V} \vee \mathbb{Z}_d \mathbb{R}_d \cap \mathbb{Z}_d \mathbb{Z}_d \mathbb{Z}_d \mathbb{Z}_d$ $\mathbb{Z}_d \mathbb{Z}_d EYZISVZ_XeYVTRMLeYVUMáVdeRdaVTed`WaVd

d_R|cV|R&Z_dVZadTR_SVdV_e`SVcV|VgR_ee` Yf^R_UVgV]`a^V_ee``ŁdZ_TVeYVac`UFTeZ_`W Rd`S[VTegVdV_dV``WeYVyH V%ZtRTV_ecR] RdaVTe `V&EZEYZtTYRaeVchZ]UVdTcZSVd^VTYR_XdeYRe RcVRWWWEZ_XaVa]VdV^`eZ_R]]ZgVdLdMfR]ZejL WZV_UDYZadR_UaVcd_R]T_gVcdReZ_dLR_Ud^V TYR][V_XdUVczgZ_XW/^eYVdXZ $2d Z U \xi Z U F R Z R Z - R L R L Z \ d eV U e'$ $SVT ^ Va V cd _ R Z V L Z G R IY c R Z _ d Z Y R d e' SV$ $d R a V U Z U \xi Z U F R] j S j e V V U _ R Z d Z Y R d e' SV$ $d R a V U Z U \xi Z U F R] j S j e V V U _ R Z d Z T ^ ^ f _ Z$ $I R Z _ R U T ^ Z e' V e d a V I f Z c e' Z Z 6 ^ 2 Z 6 ^ 2 Z - d$ Y R s V R T V e R] c ' V V V Z Z d R c d f] e L R j a V a] V $e' U R J X \xi V f _ a c V T V V Z Z d R c d f] e L R j a V a] V$ $e' U R J X \xi V f _ a c V T V V Z Z d R c d f] e L R j a V a] V$ $e' U R J X \xi V f _ a c V T V V Z Z d R c d f] e L R j a V a] V$ $e' U R J X \xi V f _ a c V T V V Z Z d R c d f] e L R j a V a] V$ $e' U R J X \xi V f _ a c V T V V Z Z d R c d f] e L R j a V a] V$ $e' U R J X \xi V f _ a c V T V V Z Z d R c d R e V C S S V R] ` e V c d T Z h e Z d Z h Z Y e V Z c d ` f d ' c a R e V C S S V R] ` e V c d T Z h e Z d Z h Z Y e V Z c d ` f d ' c a R e V C S S V R] ` e V c d T Z h e Z d M e Z h R U d M f R] S ` U S V h W ^ R R L U h ` R R U h ` R R Z h V W Z d c v d V R E Z X Z Z d M V Z c V a V Z d C V C W Z d C C U T E Z N R V M Z j ` c V T _ ` Z T V V T E Z Z$

Î=Ăi WebgWYbhci g UVci hih |b| g Uh\ca Yž Vi hih YfY UfY YggYbhU h |b| g th Uh\Uj Yhc Xc k |h i gžk Y Wea Y Úfgh"±hǧ\UfX Zefa Y hc gUnžmci _bck žk Y Wea Y ÚfghUbX a m W\]XfYb Wea Y gYWebXžVYWJi gY h Uhǧ gca Yh |b| =gh]`ÚbX]h\UfX hc Wea Y hc HYfa g k |h ž\Uj |b| hc VY U k ca Ub ÚfghUbX U a ch Yf gYWebXžVi h=Ăi Wea d YhY mWYUf UVci h]hžh Uhǧh Y k Um]h]g'I fl Ya UYZUXi hzi fVUbža YX]i a !ck @, Ł

 $\label{eq:started} \begin{array}{l} AVeYRad SVIRT dV `VeYV bf Vde VC Rf eVV_eZZej Ł eYZd Z`RYZ_Rj`VeYV Tfa]VU Vd_`eT_eV^{1} \\ a]ReV eVV UZd1]feZ_`VVed^V `SVcd Z_UEZLf R]! \\ Zej Z5 VdaZVeYV de`_Xjj df S[VIeZeVR_UV^`eZ_R] \\ TYRKREAC RCIEZS W.e`eYZd cVReZ_dYZeVVZd_``eVR] UVdZVe`^VEXV FeYV`eVVZ'_eYZd acVIZW \\ dV_dVEYV_Vh Z`RW^WeYV Tfa]VZd_`ec`^R_eZTZ \\ CReYVc eYV T_eRcj, eYZdh Rj`VT_def TeZ_XeVV \\ Tfa]VZd[fdeZ VUSj eVVgVcj VReeYReZeR]`h deVV \\ Z_UZgZt fR]dT_TVc_W e`VeRZ_R_U cVRZEV eYVZe``h_aVcd_R] ZV_eZZKZ$

Î 7 Uf cg \Ug [ch \]g `]Z Z \Y WUb Xc k \Uh \Y k Ubhz = WUb Xc Ubmh]b[`=k Ubhž Vi h k YMY hc [Yh YfzfYU`m]hỹ `]_Y h Y hk c d]`Ufg \c X]b[`i d U \ci gY'' =Zcb mh YmWei X VY c]bYX hc [Yh Yfž Vi hk Y_bck h\Uhk Y WUbMi a Yf[Y]bhc cbY Ubch Yf VYWUi gY]Zk Y X]X` h\Y \ci gY k ci X ZU``Xck b'ï fl Ya UYZUXi hzi fVUbža YX]i a !ck C9, L

9ACHCB5B8C9LI5@HM

$$\begin{split} & EYV \ensuremath{\underline{Z}} Xh \ensuremath{\underline{Z}} Xh \ensuremath{\underline{Z}} YeY \ensuremath{d} S[VIe `W T fa]VdSc`f XYe`feeYVZ a`eR_TV`W^` \ensuremath{\underline{Z}} R] \\ & UT ^ f \ensuremath{\underline{Z}} V'` \ensuremath{\underline{Z}} V'` W'` \ensuremath{\underline{Z}} R] \\ & UT ^ f \ensuremath{\underline{Z}} ZCV[Rescy]j \ensuremath{\underline{Z}} eeVV \ensuremath{\underline{Z}} V' \ensu$$

DuffRJZ; ZdW_RdRgZFJU_RZW&Tfa]Vd JZWeX&Y&R_UV&aVcd_RJKRZ_Ž:eT^ł acZMdU_RZDARU^VR_ZMARWRYZUZ; ET YRde drRaVR_Ua]RIVReeYVdkgZVV&RVcd_RJV1 acXdZ_ŽAVa]VdWeYZRRARCZXRXCRETYR_XV W^ eYVdufRJZ; `VackgZfdX/VRZ_dLhYZY eYVJUKICZSVRdd^VeZXcWf]R&USjdTZkjR_U UZWIFJeWcZUZgZfRJde drRaVZ

Î C bY fYU`mc Vj]ci g WU Ub[Y]g]b Wei d YgÑ gYl i U][mžk \ [W]]g ZYYf bc k žmc i HU_Y][h a cfY ZYY mUbX a cfY h\Yk Ummc i k Ubh UbX bc hh\Yk Ummc i h\]b_][hci [\hhc VY Xc bY]]

fl Ya U`Yžmci b[ži fVUbž]bhYfa YX]UhY`C9; Ł

2TT $dZ_X_j Ldv fR_{Z_j} ZISVT^Z_X dvRez_v_j$ $Z_UAV_UV_e^WaCTCAREZ_R_UeVVZ_defeZ_^W$ $^RczZXZEYZIR_SVdW_LWCVR^a]VLZ_eVVVRIe$ $eYRedv fR_dVRZ_dReVf dR_j ZZZREVU^feZLV^W$ $^RczZXZAVa]Vj^f_XCeYR_eVVRgVRXVRXVVC$ $^RczZXV1#*Wc^V_L#Wch^V_YRgVdvIfR_$ $<math>cVRgVdvIfR_dLWC^V_ej eYR_^JUCaVa]VZEYZI$ $<math>df XXddeYReadVRZER_dvIfR_aRZEVCRVL^e$ $TRfR_SfecXvf[RZ]$

 $5 \text{ ReR ac' UF TWU Sj} eVV4^{2ZE} ? RIZ_R UM$ DZLR1? ReZ_R 2:5 D4`^^ZHZ_14@? 2D 5 2/ d'XXdHLWdeYVc^`ckLeYRedMfR] cyReZ_dReVSVI XZ_Z XReR_WCZCRXZH YVCWRR``_XAV a]V S`c_Z "*S! eVV^VLR_RX/VZZHZ_hRd"*Ž Wch`^V_R_U" (Ž, Wc^V_LR^`_XeY`dVS`c_Z $\begin{array}{c} \begin{array}{c} & & & & & \\ & & & & & & \\ & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & & & & & & & \\ & & & &$

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>¶î lếz năl ² gi z Ya6ail Qe ¶² O8aqzafi¶– Ŷ Gé0- ¢² đặa> z-i O8az² afi os@nafi¶– Ý¢ ² ail Qe ¶² O8aqz®o- ¢(O4Gi31 >'Ł Èna ½ 3 €Ea

> "*) ! eYVRXdRv") Ž.R_U"'ŽŁ vá Vlázyj ŽE YZI d`h Sfe deVRUj U ZANE h ROLDIVR]ZC Z ZEREZ _ ZIR gVcj X`UZ]f de REZ _ `VeYVTF] ef d?| TYR_Xde YRe YRgV`TTF ccVUŽ2^`_X`eYVc eYZ XE Ze vásk?] de YV Xc h Z_XXRa SVeh W_ dví f.R] ac RieZ V R_U VY Zj eZcE eYV VXWU^ j`f_XaV a]VYRgVRe.R_ VRC]ZC RXVe UVIZUVY`h e`SVYRgVLeYVXCVReVcZ a`ceR_TV Red RIYVUe`Z_eZ`ReVcV]ReZ_dvZad R_UeYVXc`h Z_X]VXEZ_RIj`Va(VRET cVR_URWMREZ_RIeYVCTSdeR_TV `VaVvd_RIS`_UEŽ

> $$\label{eq:linear} \begin{split} & 2TT \ dZ \ Xe \ eYZ \ dR \ Vd \ eYJ \ L() \ \ \ \ VeVaVa]V \\ & eYZ \ Z \ Z \ Z \ dL \ C \ XWc \ d \ V \ Ve \ YReVg \ J \ f \ eRg \ dJ \ Rd \ dZ \ AJVR \ dL \ Rd \ AJVR \ dZ \ AJVR \ dL \ AJVR \ AJVR \ dZ \ AJVR \ dZ \ AJVR \ dZ \ AJVR \ dZ \ AJVR \ dZ \ AJVR \ dZ \ AJVR \$$

 $\label{eq:linear} \begin{array}{l} \label{eq:linear} \end{tabular} XV^ We V bf R \end{tabular} \$

Î H. YgY XUngž Znci ÑY bchgUhgÚYX gYl i U`nž nci WUb hY``nci f dUfhbYfžnci WUb XlgWigg Jhk Jh nci f dUfhbYfÅ žnci WUb gUnž cc_ž dYf Udg k Yg ci Xhfnigca Yh Jb[YgYÅ Ï fA UYžc XYf UXi hzi fVUbž JbhYfa YXJUHY C9; Ł

A]VRofdVZd_`eeYV`_]jafca`dV`WdMfR]ZejŁ Y`h\gVZžecTT_ee2SfeZ_e`eYVTfa]VdV``eZ_R] cVJReZ_dYZaZcT]VRc]jR_`eYVZ

:e^R SVeYRek \Uhig W\Ub[b[b a Ubm dYcd YNg YmYg]g bch]b[Ygg h Ub h Y]a ! $U[Y^{c}Z^{c}jY'' = gVTR_{-}]^{Xc}SVZV_{e}ZVU$ $hZey R_ Z_dezef eZ_R_ZWU cV_ReZ_dVZeLRdZ_ ^ Rd$ cZRXVL`chZeYRVWCZ_`WZ_UZeZLFRZEZWELRdZ_c`ł ^ R_eZIZA^ Ł`chZeYS`eYRe`_TVŽE`URJŁ]`gVdW^ d e`SVZ_dvaRdrS]VV&/^ eYVVdR^Vh`c\TcVReVUVcZe Sj $Z_UZ = T_{Z} = gVZ = J_{T_{A}}$ ZXZeckof]edZ_Z_TckRchUZ_UZeZufR] Rfe`_`^ j R_U $X \in \mathbb{R} \cup \mathbb{R$ eV]]VIef R]]jŁV^`eZ_R]]j R_UaYj dZR]]jŽ=`gVe`URj Zg gvdRUVXcW V&V_dZ_SVehW_ZUZZIRZZKŽ EYZIZIHYj eYVvgvq URj]ZevcRef cV~_eYVcv]ReZ_ł dYZad`WTfa]VdYRdSWAf_e`daVR\`WT_~ZTeR_U T ^ ac` ^ ZLV ^ ` cVRd eYVVi acVddZ _ ` VIR ^ Ref eV]`gVeYR_RdRdX_eYReeYZd]`gVZdhR_Z_XŽ

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:edW^de`SVj`f_XaVa]VLV^S`UJZX_Vh Z`RXZ_RZdR_UZV_&ZXdHY`RV^`deRaadVIZA &ZV`V&YV_Vh_Wc^d`V&MfRZijŽEYVj_WWjeYRe eYVdVRVSV&&cd`Z&Ue`hYReeYVj_eYV^dMg&dRV `chR_ee`SVŽ7`ceYV^LdMfRZijZiZ a`ceR_eV& aVcd_RJU&jY`a^V_eR_U~ViZSZZijZ_T_defTd Z_XcVJRZ_dYZadhZY`eY&dŽ

 $\hat{I} = c bWY [c hlv [Yh Yf k]h U V cmUbX h Y$ Ufghilja Y k Y k Ybhci hk Y g Ydhlv [Yh Yf zh Yb UZh fk UfXg = gU[Xzbc z h]g]gbl h Y k Um $h Xc]|z = bYYX h _ bck \ a Ufgh UbX k]h$ $h Y bYl hcbY]hk Ugb h h Y gUa Yzf][\ B 5bX'$ ='h]b_ 'h Uhỹ [ccXž='h]b_ ']hỹ [ccXVY! WUi gY mci `YUfb 'UbX'mci]ỹ Y [chž`]_Yža cfY` hc 'lU`_ 'UVci hï fl Ya U'Yžmci b[ži fVUbž]bhYfa YX]UhY 'C9; Ł

 $\label{eq:starting} \begin{array}{l} 3fed ^ VaVa]VLR_U VdaVIZR] ji Ruf]ed dvRie \\ TcZEZIR] je eVdv TYR_XdZ_dvfR]Zej ŽE YVj dW \\ eYV Rddev^ Z_X W^ eYV_Vh Reszef Uvd`W \\ h`^ V_LR_U eVV dvfR] advT TZej R_U Rdvkæzgvi \\ _Vd1`WevVdvRdXzgZ XcZeVe eVVTYR_XdZ_eVV \\ hRj T fa]VdcV]RevZeYZdZ avZdh YRed ^ VRuf]ed \\ dWRdevVv Ref dR]`dUvc`WeYZ XdZ$

 $2Uf]eh^{\wedge} V_eV_Ue^{\vee} UhV]^{-} eV cZh eV y dW eV cWTYR_Xda^{2} Z_Xe^{2} eV VW^{2} Zj LhZe^{2} [fgV_ZV dM fR]Zj cV^{2} Z_Xe^{2} VR df cR_TVe/Re_VPe^{2} vdhZ] eR V cV ch^{2} dSZZj Wc eV Zc TYZU cV_ZE YV WRc^W Y RgZ_X eW_RXV^{2} eV cd_VR^{2} Ve^{2} Vc^{2} Vc^{2} c c dZ_XV^{2} eV cd_Z eV Zc VR^{2} Zj Z_Wc^{2} de^{2} Z z] Z_dRS^{2} fedM fR]Zj Z$

Î H.]g UXmgUJXžk \mXc blkimci []j Y mci f XUi [\hYf WebhfUVWdhj Yg3 A m\U]f Ua cgh Z[™]ci lÅ =gUk]hUg gca Yh]b[']_Yž'_Y' gYbX]b[\Yf cZhc dfcgt]h hY \YfgY ZVY! WUi gY [Z=[]j Y \Yf d] 'g gc g \YWUb gYYd k]h h]g cbYZUbX]hXc Ygblkik cf_ ci lžg \Yfy [c]b[hc [c cZk]h gca YcbY YgY UbX h Yb k]h gca YcbY YgY UbX k \cÅ Gc th Yb h]g]gth Y k Um=gYY \Yf \Uj]b[VcnZf]YbXgž gUm[b[žf][\lž]hŷtU[™]cj Yf k]h i g bck Å =ŷ Y VYYb k]h mci U k \]Y UbX h Yb]hÑ VY gca YcbY YgY UbX h Yb gca YcbY YgYÅ Ï fl Ya UYZUXi lži fVUbža YX]i a !ck C9; Ł

 $EYV^{a}Z_{d} a d d AUSj ^ V d ReV_{ee} e VV$ VR^Zj Sfee e VV^ d MgVd R_U e VZc ^ Rdff]Z_Zj Ž 7 ch`^ V_e e e V V d Mf R ZZFRZV V R J V_Xd $\label{eq:restriction} \begin{array}{l} R_U \mbox{Worker} & R_V \mbox{Worker} & R_Z \mbox{R} \mbox{H} \mbox{Worker} & R_Z \mbox{R} \mbox{H}$

Î H. Uhỹ f][\ lžth YmXYVVXYZVYVU gY h Ym Xc bhī_bck k \ Uhh YmhY Xc]b[žUbX Uh h Y YbX cZh Y XUm]Zgca Yh]b[\ Udd Ybgž h YmXc]lžU W]X Vea Yg U cb[UbX h Uhỹ h Uh K \ c gi ZY fg h Yb]Zh YfYhỹ U W]X3Å =]_Y h Ya hc VY XYhY fa]bYXžV i hbchgcÅ K ca Yb k \ c UfY a cfY XYhY fa]bYXžk]h a cfY]b]hJUhj YZ cc_z=UbX h Ya a cfYÅ

h\YMMY W\]X]g\žh\YMMY bcha UhifY Ybci [\Å H\YMMY bchZ ``ma UhifYžh\YMMY` \UZk Umh\YfYžVYWUigY h\YfYNg bc UXj Ub! HU[YZcfh\Ya `]b`\Uj]b[gYl k]h\Ua Ub'' 8cYg'Uk ca Ub`VYWca Y`a cfY`cZUk ca Ub` VYWUigY`cZh\UBÄ

fAU`Yžmcib[žifVUbž`ck`G9;Ł

:_ df^ RgŁetv Rykc ReZ_ `WZ_UZZI RJZj Xgwł cztwe RaRozif JRchRj `W cwR_ZzZ X etw cwJReZ_drZa `WR T fa]VŽ-łi jg` ja dcfłubh Ugʻ Uʻ fy`Ułjc bg\ jd`VYłk YYb` jbXjj JXi Uʻgʻ UbX`Z; f` h\Y`k Umi jh Ya dck Yfgʻ dYfgc bU``XYj Y`cd! a Ybh UbX``YUfb]b["EYVT fa]VSVT ^ VdR_ $V_UZ_zdM_WZ_UZddZ_Z TRZ_SVT ^ VdU etWVU$ W/^ ^ RczZw/R_U ac`T&RZ_ŽEYZI V_T fd&Xd aV a]Ve` YRgV^ `dv~ViZS]VR_U^ `dvT ^ a]M cvJReZ_drZad.h Y&VT_~ZIeR_UT ^ ac` ^ ZWRW RUXZKS]VaRe` WZWe X&VZDM fRZj SVT ^ Vd RTV_eCR_Ra VIEY&Z2Uf jedRvf_VRJ RS` feeYZŁ j`f_X^ V_RITVaeZŁR_Uj`f_Xh`^ V_RvgVg V_eYf dZdzTRS` feZZ

EYVT]]VIƏZVR_UafS]ZI yH V%Z a]ZdRS`_U `WIZZI VZZ UAZZE YZI dvG]edZ_eVVTdVRZ_ `W R dfS[VIƏZV dvR]Zij `W f df R] dvT X_ZZ_ R_U RTIVadR_TV eYRe VI eV_Ud SVJ `_U S]``U eZd R_U `S]ZNRZ_dR_UeYReadVIVUvdeYVRXdW V_edR_U RdR_XV V_ed dvbf ZVU Wc eYV adRieZIR] Sf dZ_Vdd `VIT ^ ^ `_]ZWZ 3f e VZV_UdYZa U Vd_`eT ^ V W/^ _`hYVdZ: e dvbf ZvdRa`dEZgvLRWMTeZ_ReV Z RXV`VeYV`eYVZ7 c eYZLd TZdj _WUde`SV dvadvd/evURdRa]RIV`VRWMTeZ_RdhV], eYRe ZL eYVCV_WUde`SV dY`ZZZ_ eYRe Vbf RZizJEcf dL h`dtLcVIZac`TZijEZ_dY`ceER] eYRe T_dEZf eVd eYVd S[VIEZ_WCYEZ_ WceYV`eYVZ

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> V_eV_Ue TRZ ^ ` VWZ_UdeYR_h ` V_L R_Uj ` $f_XaVa]V^ `<math>VeYR_$ `JUc ` VZ_T^T 1 $aRrezevetc^ dRF_ZevetZRU4Re^3/ZRdfU TZevU$ $Z_eYVaCtdWf_UeYRe4YZVR_dYRUR_RevErVV W$ $ZZeVVaCtdWf_UeYRe4YZVR_dYRUR_RevErVV W$ $ZZEVVE_ZEVUDERevE156DF4L$ $RW^WZ_HUVI]RCUZ_eVVF_ZEVUDERevE156DF4L$ #!!"/Z

 $EYVEV^{R} SVR_f^{SVc} WARd_dh Y_j aV a]V$ $YR_jVc_jR_{2}E_jV_j W_h W_{2}/UdZ_4 Y_2/Z_{2} V^{V}V^{2}$ $Z_j Y_2d_b c_2TR_R_U T_f e_{1} c_{2} c_{2}X_2 Z_{2} C_{2}U_{2}Z_{1} R_{1} U_{2} e_{1} c_{3}T_{2} c_{2}X_2 Z_{2} C_{3}U_{2} c_{3}T_{2} e_{2}X_1 V_{2} v_{2} e_{1} V_{2} e_{2}X_1 e_$

$$\begin{split} & EYZderRUZZ_R]SRI\Xcf_UZL_`eV_`fXXLYhł\\ & VgVdLe`Via]RZ_hYj aVa]VYRgVd`Wh VGV_Ud$$
 $_`hŽ:_4YZVLRdYRdSW_dW_LTf]efdf]TYR_XVZd$ $Z eV_dZgVZ_XZ_UZgZtfR]ZREZ_R_U]``dV_Z_XVR^Zj$ $S`_UdŽ@_eYVVRIV`VZdLeYZdd'f]USVR_Z_TV_ł$ $eZgVe`XcVReVCUVgV]`a^V_e`VVGVIEzgVV^`eZ_R]$ $eZdd`fedLVeYVY`^VŽJVeeYZdU`Vd_`edW^ e`$ $SVYRaaV_Z_XŽ$

?`eR] Wc^d`Wd TZR]^`UVc_ZREZ_cVdF]eZ_R ^`dV`aV_g`aV`Vd TZRSZZG`Z_d&RULRdYRdSW_ dW_LeYVWfdeReZ_`VV_UZGLFRZREZ_TR_JVdU aV a]Ve`dWA cWAXVZ_ecRUEZ_R]g`aVdŽ:_WddL eYVF?5A #!!"Df`cgY_cVgVd[de?Re`eY`dVhY` WWJ eYY_YRgV]`de`fe`Sj_eYVcVTV_e`TYR_XXdZ_ eYVT`f_cg`R]d_eV_Ue`SVeYVgVg`aV a]VhY`U _`eYRgVV&Z/LtdR_UhY`^`deUV}_VeYV`dA/gVd SjeYVWY`ZjŽ

4`_g\ddyjLeY dvhY dy eYy YRgVeYV^`de V&V_ULeV_Ue`SVaVa]VhY`gZh eYVTYR_Xd R_UeYV&`h_ VlaV&V_TV`W1TZkj ^`dva`dZ egyjZAVa]VhY`YRgVd&&XVXEj o`VZV_UAZad R_UdYR&URI&&&XV_VARJj hV] UZa`dVU e`hRUH`eYVdR_Ue`hRUHUZg\dzjZ2deYVZ_UVI `We`]VR_TVR_U_`_HUZIKZ ZR&Z_dr`hdidWRał aV_UZ (/ŁaVa]VhY`eV_Ue`V_[`j eYV`dv]g\d ^`dehZeY eYVZ_V&V_URRV^`dVe`]VR_eR_U]\dd UZIKZ ZRe`g`eYR_er`dVhY`V_[`j eYV`dv]g\d ^`deVJdvhY\&Ž

EYZEZ_efc_YRda`dzzgVVWWARd`_d`TZKjZedMJŽ/ EY`dVhY`YRgV^`deVZZ_UdR_UeV_Ue`V_[`j eYV`dMgVd^`deZ_eYZET^aR_jYRgVRXVRevC acWWEV_TVVVcUV^`TCRIjŁaRceZIZAREV^`cVZ_d`TZR] `cXR_ZRRZ_dR_UREV]Vdda`]ZZRIJj UZRWWARVŽ

: f]YbXg\]džUXYa cWUHWdfYX]gdcgHcbž Wj]W]bj c`j Ya YbhUbX`cdYbbYgg`hc`gcWJU`` fY`Uhcbg\]dgk]h\X]ZZYfYbhch\YfgUfY`U``]b! hYffY`UhYXŽEYf d.V_T f dXZ_XWZ/UhYa T f]U ac`gZVRSREKIWcR^`cVd]ZUTZgZTF]ef dŽ @∕.łä€ĭä

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 $2 d TZA V_gZC_^ V_eeYRe^R Vdaf S ZTR_UTZGT$ $ZWRX `UdveZ_XVcdreZMRTe`g`VfaVZV_TVdhZeY$ $UZdR_eR_Uf__`h_ `eVvdZdf_UfSeVU]j T_l$ $UFTZgVe`eYVUgY`a^ V_e`VWXZ/UdYZaZ3feR]l$ $eY`f XYZeZL_VTVdRjLZeZL_`ed`VVTZV_e`_Zed`h_Z'$ $7CZV_UdYZa R]d CvbfZVdV `eZ_dR_Uh`CUZZ$

Î: cf a YžZ]YbXg\]d]g \Uj]b[gi VYWg]b We a a cbÅ /VY]b[UVY hc HU_žmci WUb X]gWigg h\]b[gUbX gcfhcZj U]XUhY k \Uhmci ZYY": YY]b[h\Uhž=XcbNh_bck]Z]h[]j Yg nci Ubnh]b[fYU`nžVYWU gY =XcbMi_bck k \Uhh YfY]g hc []j YžVi hmci ZYY`h Uhh YfY`]g UZYWJcb h YfY VYlk YYb nci žgca Yh]b[ž Yj Yb k \Yb k YMY bchHU_]b[žVi hh YfYfg` gca Yh]b[[c]b[cb h YfYžUZYY]b[cZ k Ufa h žh UhgʻfYU`m]a dcfHUbhZ fa Y'Ï fl Ya UYžUXi hzi fVUbž\][\G9, Ł

:eZdgVg``VW_TJRZ`VUeYReeYVhRJ 4YZVR_d RVZdcV-VTeVUZ_eYVhRJ eYVj daVR\ŽEYVac`Xi _`dZdZd_`c^R]jj_VRezgV+4YZVR_dR:VdaZzEVddL R`SZAf`fd:f_hZJZ_Xe`T^^ZeeYV dMgVZEYZd Zddfaa`dkUljUV^`_dedReVUSjeYVZchRj`VvdaVRd Z_XLdUZWWCV_eVO^^eVV]`Voj/LT_}UV_ehRjeVV Z_YRSZEr_ed`VVVgVj`aVUTf_ecZddaVR,Ž

Î H.Ymỹ Y [cha cfYWXYY_ ih Ub i g" H.Uhỹ k \mih YmVYUhi g" H.Ymỹ Y [cha cfY dYf! gcbU] lmÅ =WUblŘigUbX 5f[Ybh]bYg" K \m WUblŘi=gUbX ih Ya 3 6YWU gY ih YmgUm h]b[g = k cblřigUnžUbX k YlY ih Y î W.]Yb]! hcgľ X [a] [bi h] Y cZî 7 \]YUbľ i gYXX[ga]g! g] YmQÅ = a YUbžk Y gYY ci fgY j Yg Ug ih Y Î W.]Yb][cgľ "

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y5`_`edg Zetj`f`]] da`Z_VgV; eYZ_X%ZiRaYdRV eYReZl`V&V_da`\V_`ceY`fXYeŽ:_4YZVLeYV&VZi RWRc eYRe dg Z_X eYZ_Xd`fe]`fU hZ] d\g\c eYV T^^`_`dUc`ceZdhZeY`eYVdŽ3VIRfdV`WeYV $d\g\cV_TVVc`dUceYReTYRRIE\cZx\d4YZN_deYZi$ $^VR_deYRedZV_TVZIeYVSVde`aeZ_Ž3feeYZIWRc$ $<math>d\gNCde`eYV^RV_IVZieYVSVde`aeZ_Ž3feeYZIWRc$ $cV[Rexd]Vdde`eYV^RV_IV_ea`hVc`Wh`ddeYR_$ $e`eYVdfdzZZ_eYReeYVT^^`_`dUcZIV#XZV$ $<math>R_UR]hRjd`_eYVa`Ze`WT]]Rad\Z$

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EYVEVZERhZWackRUaVETVaeZ_`WefaVe}TZR} ZġŽEYZdUVd_`e^VR_d^fTYeYReeYVdfS[VTed `WI'_gVcReZ_RCVWZg`]`fdLRdeYReeYVcVR|ZdfVd RVRg ZNUŽE VVCVRd _ VCeYZdZleYVWRceYReeYVCV Zd^`cVUZeZZXaVa]VeYR_f_ZZXeYV, eYRe ZeZdZ a`ddZs]Ve`RXcW`gVccVR|UZXWKV_TVdLR_U eYRe e`ViacVddR_UUZETFddeYVdV]VRUdZ_VeZERS]j e T_~ZTEŽEYZdUWA WARcf_UVdjZ_XdTZR dVIR eZ_dYZadYRdSW_a`Z_eVU`feeZ`VR_URXRZ_Sj $eYV9f^R_5VgV$ a^ VeCVa $edZ_4YZVZEYV$ cV[ReZ_dYZaSVehW_eYZdWRcR_UT_gVcdReZ_Z_ 4 YZVYRdSW YZXYZXYEVUSj R f^SVc`WddRdL hYZY cV/ReVZee`eYV`cZXZ_RJ Via VcZV_TV`VvgZł $V_e \underline{Z} eV_s \underline{K} \underline{X}_1 > f_\underline{X} \underline{R} \underline{X}_1 = \frac{1}{2} eV_s \underline{K} \underline{X}_1 = \frac{1}{2} eV_s \underline{K} \underline{K}_1 = \frac{1}{2} eV_s \underline{K}_1 = \frac{1}{$ dIRcd WAZ_ aV a Vd^ V `cZdSj cVIV_ea` ZZR ViaVčZV TVčŽ

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3feeYV}T&ZZfd`d\/cT_defT&UZ_eYZhRjZl U&cZ`V_dR]e`eYVT&UZSZZg``Vhi`d\/dR_U`V&Y`d\/ hY`da\/R\eYV`Ž3`eY'eYV"**)C\/á`ceR_U eYV #!!!C\/á`ceUV``_deR&VUV`aZZIR]jY`h]ZeeV @ / . } æ '² æ¶i Ú¶Å¢¶? 1¤Ð©¢" ǎO]¶i ææz äÅOÝæ ðÅz Úz22 æ7 z ÝÈ

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^ R.\Z.:e VdHS JZh Vd S` eY eY Zc Rfe`_`^ j R_U eY Zc JV X Z RIj RdaV a JVLR_USj eY Vd? Ve` \V_ Zc f aa` cedeY Zc dy WW &W^ ŽE YV dV dR V V ed UM }_VVRIY a Vcd _`ddy We VdaV TeŽH YV_ aV a JV YRgV ec`f SJV dJ Z_X yj Vd‰ c y_` %R_U Z_deVRU T ^ V `f eh ZeY R yj VdR_U_` ‰c R yd ce` V MaeYZd^ R. Vd Ze YR U/C e` V_XRXV Z_ cVJReZ_dYZad VdHS JZH VU eYc`f XY da WIYŽyDJZaa Vj %YR SZd` V da WIY d`X X de eYRe^ Zbef de e`h Rd d` eY Vcd ZH J` dV j cVJReVU e`]`h a Vcd_RJ dy WW &W^ Ž

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2_`eYVcWRefcV`WeYVTYR_XVZ_T_gVcReZ_Zd eYVUZET gvg eYReZeTR_SVRe``] Wcac`Uf TeZeZejŽ EYV |Revole `cXR_ZKReZ_R| eVV cZk1 decv6d eVRe eVV h`c\`WT`d.Z.ReZ.XXc`fade`TRcq``feeRd\dTR_ SVU_V^`dVWVIZZ_ejj ZVeYVWc^`WUZR`XfV R^` XXc`fa^V^SVcdZd^R RXVLŽ2ddVceZgV VdŁ TIRZEIŁEYVCNUFTEZ_`NR^SZAFZEIŁEYVNZZZEZ `WefS[VTeggVacVffUZTVdRUT_TVecRez_`_eYV WARdZ_T^^f_ZTReZ_RCVUW^VUe`SVZ_decf} ^ V_edWcdfTTVddŽHZeY`feUV_jZ_XeYVa`dZeZeV WWWTe eYRe eYVdV dedReVXZdTR_YReV`_`cXR_ZkR eZ_dR_UZ_UZeZIFRdLR_UZ_UWUeYVfcXV_e_WU WceYV Z_^R_j TRoWLZeZd_VTVdRoj e`a`Ze `fed` Vf_UXXRS]VRdaVTecŽ7f_TeZ_RZZZAYV UZEVTEZ_`WT_gVcdReZ_Z af ccfZe`WcXRZkR eZ_Rjac`UfTezezej^RjSVRjVe^`cVZ_eV_dzeVhRj WchY]]j dyWeWWeV_eZR] dj deV de` df S`d Z_ReV aVcd_R]R_UdTZR]dfS[VTezzzeje`e`eVVZcV_UdŽEYV WWWTed`WeYZIZ_Z_TOURDZ_XeYVUZIVIF]ej`WZ_UZ gZLF RJZREZ_YRgVSW__`eVLŽ=R_XF RXVZHF dvUe` ecR d'Zed ^ VéYZ XR eVIVUV ee` eYVacRTeZIRZZXd `WY``dZ_ReZ_ŁhYZYZłeYVV^``eZ_R|RW/k^ReZ_ `W_VdMWZ_cVIReZ_e``eYVcdŽ:X`cZ.XeYZdR_U gZhZX|R_XFRX/_|jZ_ZedZ_def^V_eR_TYRRIeVc Z:lRUfS]VIVLXVUch`dŽ

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EYVLØWTF JeZd`VIR_XFRXVdW^ e`UVcZeVVW^ eh` cVReVUeYZ Xd+RacVIRz f dZ' RXV` Wd.VdLR_U]`h aVcd_R|dM/WKdeW^Ž:eZtYRcUe`Z`RXZ_VR yXc fa]R_Xf RXVeYVRaj %LSVIRf dVeYVdVRvUWał c``eVUŁT^ a]Vi ac`TVdtVdhZeYRdec`_XYZe`cZIR f_UVETFccV_eŽEYZtUVd_`e^VR_ŁeY`fXYŁeYRe eY`fXYeTR_`eSVX&V_e`d^VTc&VcRteZ_Ž 7ZceljŁdYcd YbYYXhc HU`_ UVci hh Ylf Z/Ufg" 2deVV" **) 9 f ^ R_ 5 VeVj` a^ V_eCVa` cedY` h VUL WAZf cVe`U`d``_]j decV_XeYV_deYV^ŽEYV^`de Z'a`ceR eWWRce`SVUVRJehZeYdW^de`SVaVa]Vd WARC`W VR `eYVELR UeYVWARCeYReeYVZCT^^` `d.V.cZdWRXZIVŽEYVYZde`cZTR|^V``qiZd]RUV_ hZey of Ty WRodŽ@_]j Sj Via VZV_TZ_Xey VTevRezev a`ddszzezd`WASREVR UUZWWCV TVhz]aVa]VSV RS]Ve`TR|^ eYV^Ž

GYWE bX'nž h YfY'U'ge 'gYYa g'he 'VY'U' bYYX'he 'edYb'i d'WE bj YfgUhje bU''W Ub! bY'g'Zef'h Y'Yl dfYggje b'eZYa ehje bgë Veh ' dYfge bU'UbX'ge WU" EYZEZ TEVRAR aa 'ef_Z eZdWET 'aVREZ_R_UT 'dZ REZ_HERRH U Sj > ReeZ_Zh"**'/`_T_gVcREZ_dSVch W_aREZ/ed R_U^{VUZR} dEWWR 4 YZVR_Y deZENdYRdch'h_Ž > `de`VAJLEA' f XYLZEZ ac gVclaVcd_R]R_Ud TZN dMWCdEW LSVIRF dVaV a]V`SHZ_CT X_ZEZ_`_ eYVSRXEI WIYREZIA `de aVcd_R] e' eYV Ž

$7 < 5 \text{ DHPF}^{-}$) .

7<5B; 9G → F9@; -€IG → 89BH +9G 5B8 5::-@5H€BG



 $CV[ZZ_ZI'_V WAV^ `deZ a`ceR_eVIacVdZ_d `VWf] dd Z:e YRd R]h R da]R VUR TV_eCR c`]VZ aVd_R] cZ_e YRd R]h R da]R VUR TV_eCR c`]VZ aVd_R] cZ_ZZ dEZ_R_URDR df CTV`WT^ f_Zj ^ VR_ZXZ dX_VCR] SVRc`_eYVcVI]RZ_dYZ hZY cR_dTV_UV_eR cR_ZZ dX_VCR] SVRc`_eYVcVI]RZ_dYZ hZY cR_dTV_UV_eR cR_ZZ dX_VCR] cZ_RU^2Z dTZ dX_ZZ dX_VCR] cZ_RU^2Z f dVIacVdZ_ZE UR LEYVZZ_R R U `VEYVTYR_XdZ YRd f_UXX_V _ WUCHE SVR_R j dVUZ eYVT_eVIe YCV_EVIE Z R U `VEYVTYR_XdZ R CVVC eX$

EYVhVR V Z X `WeeRUZZ R] Z RXZ RZd`W $4YZVR U eYV RZ R] a `JZZR] T ^ f ZejLR U$ eYV WUVC Z UZZLF R] de`UVZX eYVZ Z V eZZdR U JZWa]R dVc eYV dygVLYR VRWA U a V a]Vd
$$\label{eq:linear} \begin{split} &|\underline{Z} \setminus dh \,\underline{Z}Y \, cV_{\underline{Z}}Z _ \underline{R} \ U \,\underline{Z} \, d\underline{Z} \, \underline{Z}
$$\begin{split} & EYVaVcd_R] \land R_ZWHRZ_d`WVJZZfdaYVd_`\land V_RRV \land R_j + Va]ZZEUV1]RREZ_dLafS]ZT\\ & R_UacZgReVacRieZVdLZeVcacVeReZ_dLWVJZXdL\\ & f_T_dIZfdac`TVdVcZCV4RcTYeYc`fXYd`cgVjd\\ & R_UZeVcgZhdTRdd`_]j RaRezR]ZXYe`_eYVdV\\ & aYV_`\land V_RZ7ceYZdcRd_dL}_UZXd`WeYZdejaV\\ _WUe`SVUVSReVUhZeYTRfeZ_ZD \land VYja`eVcdd\\ & RS`feeYV^VR_ZXR_UUZVTeZ_`WYR_XddZeYV\\ & cVJZZdej`W4YZVR_dRVUZIffd4UUSVj`hZ$$

$$\begin{split} & E YZ l cMZ Z dz j Lh YZ V Z dT _ eV_e YR l dYZ eW U L \\ & YR d_`eUVI J Z VU dZ Z TR_e j Z eVV]R de"!! j VR dZ \\ & 2TT d J Z X e` :? 6 UR H L SV J Z WZ 8`U W J W^^ \\ & ** ~ Z "*! (e` *% Z "** # Z E YV a d'U^ Z R_e j \\ & 4 Y cZ d Z R_e f d' W Z d d' J Z Z d Z j YR d_`eTY R_X U \\ & X Re j V Z V Z \\ \end{split}$$

 $4 YZ_VR_d c_VZZ_fd]_VR_Z_XdR_V c_VR_VC^VUSj$ $Z_eVc_ReZ_R] T^aR_cZd_ZEYV:=eVc_ReZ_R]$ D TZR] Df cg/y Ac XR^a V1:DDA/T^aR_VU eVV c_VZZ_fdSV_ZVWV VeVVZ_YRSZER_ed`V% T f_ecZd `_UZWWCV_eT_eZ_V_edR_UhZeYUZWWCV_e]Vg/yd`W UVg/Y`a^V_eZ@VR] eVcVT f_ecZdL4YZ_VCR_\U c_VgV_eY Vc eVVaVCIV_eRXV`VaV a]VSV/ZgZ_XZ 8`U146AI:DDAL#!!''Z

EYVZ_de£feZ_R|^ R_ZWHEReZ_d`WeYZHCVJZeZfd WWJZ_XYRgVR|d dr`h_ T_dELVHES]VT_eZfZejŽ HYZV eVVTYfcTYVdU _`e dW^ e`ac`gZJVR

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$$\begin{split} & Hogo \underline{a} \\ & Hogo \underline{a}$$

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$@[D^{2}] \stackrel{(a)}{\longrightarrow} 0 \\ (b) \\ (c) \\$

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$$\label{eq:transform} \begin{split} T & a \end{tabular} V \end{tabular} T & b \end{tabular} V \end{tabular} V \end{tabular} T & b \end{tabular} V \end{ta$$

H≰9⁻7<5B; -B; A5DC: 7<IF7<5::-@5HCBG

 $\begin{array}{c} @_VSR2TWc^ & WVZZfdWaVZ_{IVZieV} \\ WWZX^VSV_ZXZ & & _V^WAVZ_{d22}feZ_{d2}Re \\ VacVdZZ_eVVT^ f_Zj + eVVTYfdVVZ_{0}gVc \\ eVV__ZXeV^LeVVYRdSW_RdZXYeUVIZ_VZ \\ UVIRWUTYfdY^V SVCZZEYV^ & eCZZZTR_e \\ TYR_XLY hVgVLYRdSW_ eVVUZVCZ_TRZ_ & W \\ TYfdTVCR_UeVVCZAZ_eVZcVR2gVhVZXeZYV \\ CVIV_eUSREVRS^feeYV_Vh = Y_UV4f]edicVZ \\ Zfdh`cZZ RIeZZUZR2gV^WAZHTYR_XLR_U \\ WYVWc^R_CVTX_ZZ_ZYRCCVR2gVZ \\ \end{array}$

H YfY`\Ug`VYYb`U`g`ck `Vi hdYfg]ghYbh XYW]bY`]b`UZJ`]Uhcb`k]h`h\Y`7Uh`c`]W 7\ifW`"-b`fY`Uhj Y`hYfa gža Ya VYfg\]d`cZ Yj Ub[Y`]WU`W\ifW\YgždUfh]W`Ufmh\cgY`cZ DYbhYVcgU`cf][]bž\Ug] fck b`gdYWUW`Ufmi $gbWY h Y \% * $g' E YZIYRI^ RUV4 YZV^_V WYV T f_e Zidh ZeY e VYZXV de ac`a` ceZ_`WgR_XV/Z TRdZ_ DaR_ZM da VR/Z_X2^ VZIR1AR: VE!" **) / Z$

:_RULEZ_HRJeY f XY eYY YRgVRgVcj d'R] acVd V_TVLeYVCVRV_`_ł4YcZEEZ_Wc^d`WcXR_ZXU h`cdYZaUVcZgZ_XS`eYW^^ ^ZxCReZ_W/^ _`_ł 4YcZEEZ_T f_ccZddR_UeYVXc`hZ_Xa`af]RcZgi`W @cZV_eR]^jdEZZd`ŽEYVZcUVXcW`WZ_dEZFeZ_R]ł ZKREZ_R_UafS]ZTacVdV_TVgRcj XcVRejjŽ

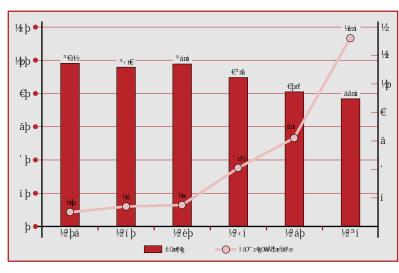
 $\begin{array}{l} @_Vh Fy `VY `\ Z XZ XCReVcUAEZ Re TYR Xdd Z cVJZXZ f dRWJZReZ _dZde`T ^ a ReVVRIY a Vdd _d`d Tf ccV_e a` d&Z _ Z eYZd cVXRU h ZeY eYRe `VeYV Y f dW` JU eYYJ XcVh f a Z ŽE YV dR` a]V f dVU Z eYV4 @? 2D 5 2 d` cgYJ ZdcVJVgR_ee` eYZdR_RJ dCd 1 eKSJV) */Z \\ \end{array}$

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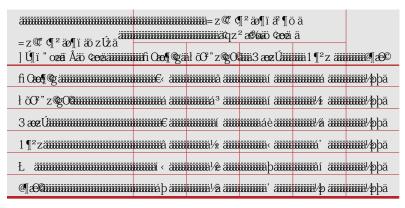
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$$\begin{split} H &\stackrel{}{} V R V \stackrel{}{} CV |Z V j e N R \stackrel{}{} V e dZ V e$$

2_Rj džlSj RXVX: faddr hdR]RXVcZVZ_ eVV _f ^ SVcdhZEIYZ_Xe R_`_lSVJZgZ_Xa`d&Z_Z_ eVVj`f_Xc RXVX: fadŽEYZd}_UZ_XZdR SZAFł `fdLdZ_TVZeT f]U^ VR_VZeYVceYRe_`_lSVJZWYRd cZM_ ^ `cVbfZT\j Z_cVTV_ej VR:deYR_acVgZ fdj `cdZ a]j eYRej`f_XaV a]VX_eYc fXY RdFXVZ_ JZWhYVcVeYY_Z_TJZ_V^ `cVe hR:UL_`_lSVJZWV R_UeYRed Schof V_e JZVVgV_edd TY Rd^ RczZXL TYZUCV_ `ch`c\]VRUeYV_SRI\ e`cVJZZ_ŽAV a]V Z_eYV]`hVcdeRef ^ TYR_XVeYVZ.a`d&Z_ ^ `cVXM bf V_ej eYR_eY`dVZ_eVZ_eCc^ VUZeVR_Uf aa\c deRefZ_eYV]`hVcdeRef ^ LaV a]VRV^ `cVJZVJj e` ^`gV`g\ce`VgR_XJZY_EVaVZZa]j h`^ V_Z $EYV^{Ra} `WCVJZZ fdRVVJZR2_de`UJ3 ZIR1 d TZRAUhZEY d TZ UV^ `XcRaYZTR_UXV XcRaYZTR] UXVWCV_TVČZEY VCVZIR d^ VhYRe YZXVC [VgV] `W TYf cTY^ V SVc0YZESVZe4 ReY^ [ZT`c VgR_XVJZTR]L R^ `_Xh`^ V_ eYR_ R^ `_X^ V_Z4 ReY^ [ZZA^ ZI ^ `cV YVRgZj c VacVdV_eVU R^ `_X`]UVc aV a]VL hYZV VgR_XVJZT YRd YVJU VVC0 j deVRU j gVc eVV j VRcdŽJ`f_XaV a]VRV^ `cV [ZV] e` SV_`_1 SVJZgVcdŽ$

2d eKS]V*! dr`hdLeYV 4 ReY`]ZT cVJZX _ YRd eYVXXReXde acXd/_TVZ_eYV^ VUZ ^ 1YZXY deReHL hYZVeYXVRvT_dXUARS]j ^ `cVVgR_XVJZR;dZ_ eYV]`hVcdeReRR_UgZaf R]jj _`_VZ_eYVYZXY`_VČ ? `_1SVJZWZXddYRa]j f a eVVd TZR]dIR]VŽ

EYV^ V SV.d`V&YVgRZfdTYfcTV.dR.V.R.d UZWWEV_&ZR&USj &V.Z. VLFTRZ_R]TRaZRJŽ?`_ł SVJZ&K.deV_U& YRgV&YYZXYV&]V&YJ`WLFTRZ_ R_U&YVSV&^R&V.j`WYV&`]d`W`UV.Z.Z.jdTY Rd&YV6_XJZYJR_XFRXLT^ af &Z.XLeYV:_&. C_U &YV^`SZV &V.Y&CgR_XJZRJdTJVRCJj YRgV &YV]`h V& VLFTRZ_R]TRaZR]`VRJ] &Y dV hZY CMZZfdRWJZRZ_dŽ4RY^JZdeV_U&SVZ_ R_ZeV.^VLZRVa`dEZ_Ž

 $CV[ZZ f dRW]ZReZ_dRVR]d UZWKV_eZReVUZV I$ $XdRaYZIR]j ŽH YZV4 ReY [ZZf'Zdec`_XcZ_eV$ $cVZ_d`VeVVRc_`ceY R_UeVVRcd f eYLVgR_XVI$ $]Zf'Zl^fTY SVeVc clackov_eVUZ_eYVcVZ_d`W$ $3%43%4R_U=R2cRfTR_97ZEYV4 ReY [ZT4Yf cTY$ $Zl^`cVfcSR_R_UeVVgR_XV[ZIR]TYf cTYVd^`cV$ $cf cRŽ?`_ISVJZVRCIR_f cSR_aYV_`^V_`Z$

 $CV[ZZ f d RW]ZeZ_d ReV R]d Red TZeWU hZeY dZ_Z TR_e UZWWEV_TVdZ_eVV d TZe] ` dZ_d ReZ_ ` W eY dV hY a` ddvdd eVV Ž6gR_XV[ZIR] d eV_U e` SV ^ ` dVZ_e`]VdR_ee` h Rdd UZWWEV_TVeYR_4 ReY`]ZdŽ ? `_lSV[Zgkdd YRgV eVV YZXV de]VgV] ` We`]VdR_TV R_U_`_lVZftZe Z_REZ_ŽEYVJ R]d UZWWE Z_ eYV dT aV` WeYVZE Zek& de Z_ eYV h` d]UZ6gR_XV[ZIR] d eV_U e` <math>\land RVeYV$] TR_VZXS` f cY` U eVVZE dZ_Z l TR_e h` d]UL4 ReY`]ZdRV^ ` cV` dZ_eVU e` h Rdd eYVT f_ej Re]RcXVIR_UVc_`_lSV[ZgkddZeZleYV h` d]U Rd R hY`]V eYRe Zl^` de Z` a` cR_eŽEYVJ

JZ.VhZVUZWWCdZZ_Z;TR_ejjZ_dTZła`]ZEZTR]`fel]``\Ž6gR_XV[ZTR]deV_Ue`SVZ_UZWWCV_ee`hRtUd UV^`TdRIjŁR_U`_]jR^`_X_`_łSV[ZZgVcdZtR ^R[`cZejT^^ZeeVUe`ZEŽ4ReY`]ZTdcV-VTeeYV Tf_ecjRe]RcXVZ_eYReR^Z_`cZejdTSdTcZSVe` UV^`TdRIjŽ

:_ d ^ V TROMA XV XRAYZIRJŁA TZ IVT _`^ ZIŁ TF]ef cR] R_Ua`]ZZIR] UZWWCY_TVALEY_Ue` T Z_TZJV hZeY UZWWCY_TVAZ_TYF cTY RM/ZREZ_ŁXZZZ XcZVe` _Vh Wc^ d`WAX^ V_eREZ_Ž: e Zda` ddS]Ve` }_U a``c RCNRdh YVCV VGR_XV/ZIRJR RCVR ^ R[`cZej R_U f aa Vdochef ^ f cSR_ RCNRdh YVCV cV/ZZZ_d` eYVc eYR_ 4 ReY [ZZci REV gZcef R]]j f_YVRU` VŽE YZd dX^ V_eREZ_ZICZ_WETVU Sj TVceRZ_WREF cVd` W eYVCV/ZZ_dTYRRIRVCZZ_XVRTY dTZ IXV XRaYZIR Xc` f aŽE YV^ f ej``\ R_UacRIEZTVd` WeYVVGR_XV/ZR TYF cTYVdac` gZUV eYVZc ^ V` SVcdh ZeY ac` eVTeZ_

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:_ekc_ReZ_R]T^aR:Zt_drhde:/ReeVVXRa SVehW_SV/ZWR_UacRieZIVZthZUcZ_4Y2/VerR_ VjdhYVcV146AI:DDAL#!!"/Z46AUReR1#!!"/ Rjd drh er/RecV/ZAZfd`SdvcgR_TVYRdUVI]Z_VU Z_4Y2/VZ_cVTV_ejVRcdŽ

H YRe RIT f_ed Wc eYZI dYRa UZIRVaR_Tj SVI eh W_SVJZWR_UadRieZTVO eZIXV_VR]j a`Z_eVU`fe eYRe`SdvogR_TVYRdecRUEZ_R]j SW_]`h Z_4 YZVL R_U eYZIZIRTICZSVU e` eYVaRceZIf]Rch Rj 4 YcZteZI R_Zej e``\Y`]UZ_eYVT f_eejŽCWWV_TVYRdR]d SW_ ^ RUV e` eYV VIZEV_TV`WU`fS]V deR_URUU eYRe^ ZXVe]VRU aV a]Ve`TJRZ' eYVj h VcVcVJZZ fd SVIRfol/eYZthRdeYVd1ZR]jTccVTeeYZ_Xe`U`Ł \g_ZWeYjhVcV_`eZhRUjT_gZ_TVUŽ

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 $5 VZ_dZf eZ_RZRZ_R_U d S[VIZZRZ_VRZ_VRZV] VRW TIF cWe UZWCV_e UXWU UAV_UZX`_$ $eVVIYf cIYe hYZYaV a]VRVRMZeVZ6gR_XMZ$ $IRdRV^` cVZVj eYR_4 ReY [Zde addezVeYZc$ $cMZZ_Z_dZf eZ_R]jLRdeS]V*S dr`hdZDf UZd$ $dZ TVeYV''*' ! ddgVR] eYReeYVdVZZ f dV a VZV_TV$ $Rdf TZRVU hZY AV_eVT dR] ej aVVgR_XMZr`ZdZ i$ $dARCS]VW^ eYVICVRZ_` WI a VZV_TVdeYReZgV$ $RdV_dV`VSV]`_XZ Xe`RT ^ f_ZjLRdR cWXXV$ $W^ eYVZ_dVIF dzj TR dUSj dRaZJTYR_XVR_Ud i$ $TZR VIJf dZ_Z3VIR dr`WrVd S[VIZZVVV_TZ_Z$ $aV&Vc^dVgR_XMZR] cVZZ_Z 4 YZVh`f]UdV$ $e`SV]Vddf dIVaeZ]Ve`UZ_dZF eZ_RZRZ_Z$

9 VEV RARZ_ eYV dÆF REZ_ gREZA dZ_ RIT d.R_TV hZeY SVJZAGVAT UV^ `XARA YZT R_U d`TZ TF]ef dR] TYRCRIEVEZÆZTÄZ: WAYV UZWWAZ/ egi a Vd` VAVJZAZ dÆj REV eR\V_RdR ac`ij Wa UVZ_dÆF eZ_RJZAREZ_ŁZe



ecR_daZVdeYRe^V_LeYVfaaVcdeRef^LeYVj`f_X R_UTZjHUNJ]VdRV^`cVacZgReVZ_eYVZcVJZZfd VfaVcZy_TVŽEYVdVRVeVVgVja`a`af]ReZ_Xcfad eYRedn`h eYVYZXYVde]VgVj`VVVdcRLEZ_RJZReZ_ R_UZ_UZgZfRJZReZ_Ž3jT_ecRdeTZcZh`^V_LeYV VJUVcjjLeYV]`hVcdecRef^ R_UeY`dV]ZgZ_XZ_dfcR] RvNcdhY`RV^`de]ZVjje`TYR_VjeYVZcVJZZfd VfaVcZy TVeYc`fXYZdeZfeZ_RJZxUacRieZIVZŽ

EYZIZ WC RZ_ d'XXvdedeYRe fY`][]ci g`YI ! dYf]YbWY`]gWUb[]b[i bXYf'h Y dfYggi fY cZ [YbYfU`W`h fU`WUb[Y]b h Y Wei blfmUbX` h UhžVmUbX`Uf[Yžh Y X]fYWfcb cZWUb[Y`]g'h Y gUa Y`\YfY`Ug`]b ch Yf`UfYUg cZ`]ZY.` hck UfXgh Y df]j UhY Webgfi Wfjcb cZa YUb!]b["EYZIYRIT_dVbf V_TVdR_U d7Zki TYR]V_Xd WcZ_UZZIFR]dtTyf cTYVdR_U d7Zki Z_XV_VRJŽ

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Uhih Ya WijijWU``m' 2_UeYZIRZZIA ZISRAU`_ eYVT_ecRe SV&h W_ eYV d'S[VIZZVTYRRIEAC` W cMZZZ_`_ eYV`_VYR_UR_UeYV`S[VIZZZ i R_U eYV_TVa`h Vz' V&YVZ_deZf eZ_`_ eYV`eYVŽ

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7c`^ eYVdeR_Ua`Z_e`WR_Z_U&SZLFRJZKUUWKeYL TYfcTYVdeV_Ue`SVdW_^V&YJjRdZ_deZfeZ_dL R_Ue`SVT^ aRcVUhZeY`eYVcZ_deZfeZ_dZ 4`^ aRcZd_dSVchW_TYfcTYVdR_Ua`JZEZRJaRd eZdV&WbfV_ejjT^VfaŽ

ÎFY][]cbg'UfY'hY'gUaY'Ug'dc']HWU^dUff]Ygž hYmbYYX'aYaVYfg'Î fAU'YzUXi`lži fVUbž'ck'@9, L

$$\begin{split} & \text{EYZt} \text{TZzZTZt} LXV_VR][j YVRUW^^j j^f_X \\ & \text{aV a}[VLZh W_ SRMU^_ eYVZ:gZh WeYVhB] eYV \\ & \text{4YZ}R_ 4Rey^ [ZT 4 Yf dY YRdSW_ X Z_XZ_ eYV \\ & \text{Reb UVIRUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_UV_TZd ReV ZV_eZ W R_U \\ & \text{RbddUZE YdW eV_U eV dZ W A BV ZZ W R_U \\ & \text{RbddUZE YdW eV T_UF ReVZH ReV ZZ W R_U \\ & \text{RYZM gRJf VZ2_f WRG f dS]VT ^ aRzt_Z Zh WV \\ & \text{URh_ YdWhZY eV GZZ Xd TZH T ^ Ze V e W \\ & \text{RVEW R W R_V W R_U \\ & \text{RVEW R W R_U & W W R_U \\ & \text{RVEW R W R_U & W W R_U \\ & \text{RVEW R W R_U & W W R_U \\ & \text{RVEW R W R_U & W W R_U \\ & \text{RVEW R_U & W W R_U \\ & \text{RVEW R_U &$$

eYV & Rey`]ZT4Yf cTYVEZ_`eYV cT^a]RZ_eZleYRe eYV4Rey`]ZT4Yf cTYYRdT_TV_ecReVU cVTV_ejj`_ Zdf Vd`WacZgReV^`cR]Zgi ŁaRceZff [Rc]j eY`dv cVReZ_X e`eYVNR^Zj; R_U dvf f; RZgj Ž e^R.VdaV a]Vf_VRdj e`YVRceYV4Yf cTYZ_eV_dZyVZ_XZd^`cR] deR_TVZ_ eYVdvRcVR4 eYVgVg`_VdhY`dvXc`hZ_XRTe`_`^j eYYj_`hTVjVScReVZEYVeYZUT`a]RZ_eZleYReeYZd _Vh`cZV_eReZ_ZdV acVdbVU_`eZ_afS]ZTU/SReV Sf eeYc'f XY eYVVV VCIZV/`WcRUZEZ_RJZ~fV_TVZ_ eYVTZETJVd`Wa`hVZ

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Î H.Y.7 Uh\c]W7 \ i fW\ \UgʻU'k UngʻVYYb` j Yfmdck YfZ ``]b`7 \]YždYcd Y [chUV]h HfYX cZU'k UngʻVY]b[hc X k \Uhhc Xc'Ï

Î=l\alpha]b_ k \UhdYcd Y UfY ei Ygljcb]b[]g k \UhXf]j Ygl\aY 7 Ul\c]W7 \i fW2]h\g bch h\UhdYcd Y \Uj Y `cgh\aY]f ZU]l\aT =a YUb mci WUb gYYZYj Yb l\ci [\dYcd Y [c hc Wi fW `YggZUbX [Yha Uff]YX]b Wi fW `YggZ Vi hmci `I ghbYYX hc gYY l\aYdfc Wygg[cb Zcf Gcf HyfygUXY `cg 5 bXYg]h\g l\fcb[YX'l

Î=h]b_ ih Y 7 \ i fW]gj Yfmci hcZhci W /]hỹ Ub UbUW fcb]ga ž]h\UgbŇi_Ydhi d k]h ih Y Ha Yg"H YmŴY a cfY UbX a cfY W hcZZÏ

ÎHY7\i fW \UgVYYbWUb[]b[UWi Umž]h\UgVYYb`ccgYb]b[i dUV]!žVi hU``hY gUa YžhY7\i fW kUblg'hcghcdhYfYV?!]b[U``hYgYUVcf]cbgžVi h]hkcbMi YhdYc! dYi gYWebXca gžk\YbdYcdYUfY\Uj]b[` gYI i U`fYUI]cbg\]dgVYZfYaUff]U[Ybck"' HUMỹk\YfYhY7\i fW]g[c]b[kfcb[ž= h]b_"HUMỹk\YfY]hỹ cg]b[dYcdY' fAUYUbXZYaUYžnci b[ži fVUbž\][\@, L

 $CV[ZZ_LeYRe ViaVeZ_TVhYZYL]ZV]`gVR_U VeX_LeYRe ViaVeZ_TVhYZYL]ZV]`gVR_U VeX_LeYRdYRd TZej`dR_UZ_UgzLfR]d^`e$ $eeR_dIV_UV_eR] bf VeZ_dR_UViaVeZ_TVLYRdYRU$ $R_UhZ] YRgVRgZER] c`]VZ_T_deef TeZ_XRT]]VTeZV$ $dV_dV`VeYVyH V%Z_4YZVZH ZeY`febf VeZ_LZe$ $hRd eYVTYf cIYVd eYRe Z_ eYV^ZLe`VeYV d`TZR]$ $T_~ZTed`VeYV]ReVehV_eZeY TV_ef g`d`TTWUVU$ $Z_^RZ_eRZ_ZXeYVZJNR`VLREZ_R]T^^f_Zj Rd$ $R_VeYZIR] S`_UR``_XaV a]VZEYVVWW.ced`V4Rd$ $UZ_R] CR4_DZgR9 V_c2ef V.e`VARZ_R_U_`h$ $Wc^aRe`VeYVT`f_eg`dYZe`cZR]^V``gZ$ $\begin{aligned} &3f e e^{i} V^{T}f \left| e^{i} d^{R} TYR_Xd_{h} XZ_X_{h} XZ_X_{h} R_V \\ e^{i} Re e^{i} d^{R} R_{g} d^{r} TYR_{h} V_XZ_X_VZ_5 ge^{i} U^{i} Z_{h} fa g^{r} \\ &c Z_{h} X_{h} U^{i} D^{h} U_{h} U_{h} e^{i} a U^{m} VY_{h} Y_{h} D^{r} Z_{h} fa g^{r} cZ_{h} Y_{h} U^{i} D^{r} \\ &U^{i} a c_{j} Y^{i} he k UfXg^{r} df_{j} U^{h} Z_{h} fa g^{r} cZ_{h} Y_{h} U^{i} \\ U^{i} a c_{j} Y^{i} he k UfXg^{r} df_{j} U^{h} Z_{h} fa g^{r} cZ_{h} Y_{h} U^{i} \\ U^{i} a c_{j} Y^{i} he k UfXg^{r} df_{j} U^{h} Z_{h} fa g^{r} cZ_{h} Y_{h} U^{i} \\ U^{i} A U_{h} Y_{h} g^{i} H_{h} U^{i} Y_{h} f^{i} & W^{i} W^{i} W^{i} \\ U^{i} A U_{h} Y_{h} g^{i} H_{h} U^{i} Y_{h} f^{i} & W^{i} W_{h} W^{i} \\ U^{i} Y_{h} y^{i} y^{i} a U_{h} U^{i} D^{i} H_{h} g^{i} Z_{h} Z_{h} d^{i} Z_{h} e^{i} \\ e^{i} T_{h} U^{i} U_{h} Z_{h} f_{h} Z_{h} e^{i} Z_{h} U^{i} Z_{h} e^{i} \\ a^{i} d^{i} S_{h} Z_{h}^{i} U_{h} Z_{h} f^{i} Z_{h} d^{i} A (Z_{h} Z_{h} d^{i} A (Z_{h} d^{i} A$

eZ_dLR_UeYVZcgZRJZj hZJ UVAV_U`_Y`h hVJ eYVj REVRS]Ve`dda`_UŽEYVWć^ R_UT_eV_e `VeYVdvdva`_dddZd_`ehZeY`feZ`a]ZREZ_dWc eYVdfdeRZ_RSZZj `VRUV^`TCREZTZ RZ_Rcj`VeYV yH VZc_eYVac`S]V^d`VZ_UZZJfRJZREZ_IRdeYZd CVa`ceYRdcVaCVEVUj deCddVLeYVaVcd_RJ R_U d`TZR]RdaVTedREVZ_ddaRES]VZ6WWcede`d]gVeYV^ ^fdeZ_g`]gVRa]fd3JZEZTUVSREVRS`feeYV^ VR_1 Z_Xd`_ hYZIY eVVS`_USVehW_eYVZ_UZZLFRJ R_UdTZ4j TR_SVSR4VZ



8 ≑ : 9F9BHK 5 MG[•]C : ^{*}@ ÷ 9[•] =B [•]7 < =@



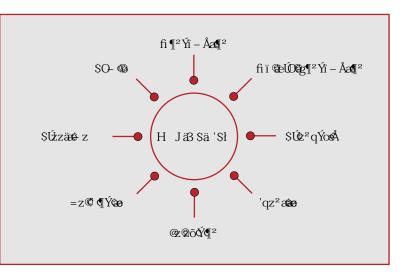
EYVZ aRIÈ WIF Jef dR TYR_XV`_ URJ; JZJZ XZI RJekéZ XeeRLÆZ_RJhRj d` VJZWR_UXV_kREZ X_Vh `_VÉŽ:^ RXkd`VeYVcM/WURJ; acRieZtVdR_UhRJ d `WM/REZ Xe` d`TZkj; RcVR]] TYR_XZ_XŽ2dRckff JeL R_Vh ^ Ra`WZ ZRZEXdR_UUZWKV_TVdR``_X d`TZN Xc` fadZiV`VeXZ_XŽE YZdvTeZ_`VeYVCV a`ceUkflčZSVdeVvhRj d`VJZWeYReacVU`^ Z_ReVZ_ 4 YZJŽE YVV` aZZIR] URERdkéVkeY Z_eYZdTYRekć d`XXkde eYRe eYvdV RV_`e acZgReVT_def Ted_`c VgV_Xc` fa`_VeLTEVRAURARZ_deRSRI\Xc` f_U`W cMREZVZ_UZWKV_TVe`hRtdd`TZkj; RdRhY`]VŽE YV ^ Ra`WhRj d`WJZWZ_4 YZJVZELReeYVdR`VeZ`VL R^ Ra`VkiV a]VdZ`RYZ_RZd`WtTZkjEkeVV\Z_U `WAYREZ_dYZadeYYj hZAYê WCXV/hZeYZeR_UeYV d'TTVdAdR_UWAZfcXdeYyj ^ WehZeYZ_eYVac`TVdAŽ HRjd`WZZWUVCTCZSV_`e`_]jdaVTZ;TZ_UZgZufRjdL SfeRjd eVVdTZAje`hYZTYeYVjcVjReVŽ

$$\begin{split} & \text{EYZIZI} ` \text{WeYV XXRev& Z' a` ceR_TV Wc Yf^R_UVgY}` a^ V_eXH YRe ZIRe deR VZ_eVV_Vh ac` TVdt ` VXLV_e&g` Wc^RZ_ZIeVVUVgY}` a^ V_e` VZ_UZ gZLF RJZREZ_R_UXXRevC` aa` cef_ZZXdWcaVcd_R] ch/WxRJZREZ_Ž2]cl Re deR VZIeVV <math>\setminus Z$$
 U` Vd TZG eYRe^ RJ cVd' eYVdVh RJ d` V/ZWŽ2_URdYRd SW_dVL_` e VgVg` d` TZG ac` gZLVd R d` ZeS]V a]RevVc^ Wc eYVUVgY` a^ V_e` VR d` S[VTeZgVj] cheXMRE g` Z_UZgZLF RJZREZ_Ž

H ± 9 A 9H ± C 8 C @C; M : C F F9G95 F7 < -B; K 5 M G C : @ = 9 \$'%B=łä³ HOze¶%äs%zäOÝÅzga¥

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 $\label{eq:linear} 2eRd Solbf V_edtXLdtAdh VCVRV_e ~ ZeM \\ XReVR] eVOUT RREVIEWSZHZICZ e RcZ XVR_R j dZZ \\ EYVOUT _U`CUVCX`fadh VCVRV_R deVOURCZX \\ a`Z_eVC eYZZ 3j ~ CVRZ_XR] eVOV d ~ ReZR] j \\ hZY`_VR_`eYVLZeh Rda`dZS]Ve ~ CVC`fa eVZc \\ TYRREVZHZICR`f_UT ^ a]V RcB d`VMVC1_R \\ TYRREVZHZICZ > f]eZgRZReV dEZHZIZI ^ VeY`Ud \\ 1Y` R dR_UT]f dtVcd h VCVfoUV c eYZŽEYV dZ \\ \eVC eYZZ 2 VC$



Xc f adc\df] d_{X}^{X} eYZIZ eXXRe\UR_Rj dZlh \CV e\c^ \Uy4 YZIVR_h Rj d` \VZIVZ

EYVX: fadtvf]&ZXW/^ eYZI^ f]&ZRZRWR_R] j dZlh VEVUVCT&SVUSj TC dVZ_XeVdVyeYZU` dV% Xc fadh ZEY eYV` cZXZ_R] gRZRS]VdW/^ h YZIY eYVj UVcZgVUŽH YV_ eYZI h Rd U _VLeYV TYRRI&cZ&ZCd eYReaRceZIF]Rcjj UV}_VUVRIY Xc fa T f]USVRał acVTZREVUŽE` dfaa]V^ V_eVRIY Xc fa ac }]VLeYV cV]ReZ_dYZa` VWRIY hZEY` eYVc df cgVj bf VdeZ_d h RdR_R] dVUŽ

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 $EYVWJ] hZ_XUKATCZacZ_ZIRyd_Radr^{0}W$ $eYVdZ_XcfadZ_{e}Vch^{d}LZcZISRAU_{a}cH$ $TZWTYRCRTeVCZbZTd_hYZVeYVRCMC^{WR'SZbZTd_j}$ $eYch_faSj eVVdReZbZTRJ_R_RjdZlYRgVSW_$ $VJZ Z_REVUZ$

Cffi [[`]b[ZJa]`ma Ub#k ca Ub`f&& Ł : def XAVUB Z UB `fee` YRGVR UMVe W^Zj [ZWLSVIRF dVeYRe ZleYV^ `deZ a`ceR_e eYZXeYVEV ZĽ6gNG eYZX: U`Zle` \Vá^j W^Zj XZX VGV eY fXY eYZHR_SVgNG YRUReeZ NŽ

 $Ddf XX Z XV P^{2} Z j^{V} V_{R} Uh^{^{}} V_{Y} Rev Red U I$ eZ_RIZ RXV VerVh`dU+eYVZc^ RZ T_Tvc_Zde` ^RZ_eRZ_`dUcR_UUVIV_TjZ_eYVAR^ZjŽEYVAc aVcd_R]ZV_eZj Zlc`eVUeYVcV,eYVj UVj_VeYV^ł dygvdSj eYVZcVR°ZjŽEYZd`fej``∖ZdcVZ_WćTVU SjeYVZccVZZZdZj,eYVjRcVSVZdgVcdhY`acRTeZV $eYVZccVJZZZ_RddZLf`fdjLR_U^R_j`WeYV^RcV$ VgR_XVJZIRJdŽEYV`fedZUVh`dJUYRd]ZegVRaaVR WceYV Ž:e^ ReeVade` eYV``_]j Z_d WACRdZeTR_ ac`gZVcVdfcTVdR_Udfaa`ceVVceYVReeRZ_^V_e`W eYVZcacZeReVX RŽEYVj daV_UeYVZcVXVeZ^V]``\ł ZXWchRid`WZ ac`gZXeYVZcWR ZidZefReZ_Ł $R_U h YV_e W_h h Rei Y eV_V g Z Z_e V Z c a c W K V_T V$ ZdWcfdWM ZWc^ReZ_eYRe^RvdeYVZc Zgvd VRZKZEYV X_VR]j YRZVWh WZ/UdR_UU _`e `eR^` XeYVZcZeVcVdedVZeYVcŽ

EYY RV_`eRhB dRS]Ve`d dRZ eYVZ W^Zj ZNRJŽEYY WY eVZ ZT ^ VZ ZRVbf ReVVceYZŽ EYVZ VI aVIBEZ_dVceYVWd cVRVf_TVdRZ HRd eYY YRgV]`de`feSj eYVTYR_XdZ eYVVT_`^jŽ 4`_d` acZ_ZL_`eR^ R[`cdfcTV`VZ eVZRZZ Ze`dTZcjLdZ TVeYY TR_`_]j RWXdUeYVSRZTŽ EYVdVUZNTF jeZdLT ^ SZ VUhZY eVZ eV_UV_Tj e`hZeYUBA Ze`eYVZ acZgReVh`dLL^ R.VeYV d ^ VhYRe^ZbcfdeW] R_UZ e`]VR_ee`hRdd`eA VcdŽ@_]j hZeYZ eYVW^Zj TR_eYy }_Ud ^ VRdV R Ucfaa`ceŽ

 $\begin{array}{l} \label{eq:linearized_linea$

fd R]jj dfaa`ce R]RXV_f^ SVc`V4V a]VLhYZY ZhhYj eVy TR_WWJ eYRe eYVZ: JZgvd RV R YVRg cvda`_dX5ZZijŽ

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: eYZ \ j`f R]h Bj dYRgVe` RahZVe` SVeekćj`f cod/YŽ/ EYRečch Yj : ^ R\VeYVVWWcee` XléeVVeYZXt: h R_e R_USVRITVAEVUSj` eYVcZŽ _`h eXReeYZIZUZIVIF]e R_UeYRej`f TR_cKR]jj`_jj cVjj`_j`f cod/YŽ/

 $: _dVIf cVRhzR_edRV_`edRez] WhzeYhYRe$ $eYY RVReackd/_ežEYY eYZ \ eYY YReVRUfg$ $e`SVevceYV dvgvžEYVRhzRez_d`WrzIXc`fa$ $eV_Ue`SVTYR_V]WeYc`fXYT_d`aeZ_ŽEYzd$ ZhhYvcVeYy dWRITVHZS]VaReYde`hRuUXc`heYLhZeY cVff]ed eYRe ReV aVcTVaeZS]V e``eYVchŽ3fe $T_d`aeZ_Zd_`eVgvg`eYZ_XŽ3VeeVzZxeVV ł$ $dvgvdRdd ^ VR_dSVZ_XcVT X_ZXU R_U RITVaeVU$ Sj`eYVchŽ

$$\begin{split} & \text{EYZELL} f c XV \equiver SVeekc e YV dMg kill The dvid e YV \\ & \text{R_i Zej LSVIRF dvie YV e Rdv Zl_` e R_ VRdj`_VR_U \\ & e YV RVRARZU` VWRAF c VZE YV e YZ_ e YVZ_X R Z \\ & d e YV c g R V Le YVZ_R] Z d Wh R_UVRESVEH W_Le YVZ \\ & RIYZej V V_e d d e YVE a c VIRCZ f d R_U e YVZ_a ReY R \\ & \text{I`_Vj`_VZE YVZC^ RZ_d f c IV` VZ_d VIF c Z j Z d Z \\ & e YV WVZ_X e Y e e YV U _` e T_ec`] e YV^` de Z l \\ & a`ceR_eg R Z S] V d Z g`]g VUZ_e YZ d b V v E YVZ_d e \\ & e YV ReR_j e Z V Z_e e YZ b f V e YZ_a`ceR e e YZ_X Z d \\ & e YV ReR_j e Z V Z_e e YZ b f V e E YZ a`ceR_ee YZ_X Z d_Vg k [f dee` ^ R_V U Z \\ & \text{E } YV U Z \\ & \text{E } YV Z f d e e Y V Z d YZ e YZ b f V e YZ_A e \\ & \text{E } YV R e YZ e R V Z_E e YZ e \\ & \text{E } YV R e YZ e R V Z e YZ e \\ & \text{E } YV R e YZ e R V Z e YZ e \\ & \text{E } YV R e R = 1 e X V Z e \\ & \text{E } YV R e R = 1 e X V Z e \\ & \text{E } YV Z e YZ e YZ e \\ & \text{E } YV R e R = 1 e X V Z e \\ & \text{E } YV Z = 1 e X V Z e \\ & \text{E } YV R = 1 e X V Z e \\ & \text{E$$

 $7 cZ_dViff cVRbhZR_edteVVR^2 Zj ZiRa]RIVh Y CV$ $VRIYZ_UZgZIFR] [VRc_de cV/ReVe `eYVcdZCV/ZsZfd$ $acRieZIVWRef cVdbf ZeV dec`_Xj Z_eYVc2]ZgVdLaVd$ $YRad Rd R_`eYVc a ReY e h RcUd d TZG Z_eVXReZ_Z$ $EYY_hReIY eV/VgZZ_ Wc T ^ aR_jZ2a Ree W ^$ $eYZLeYVc2 Tf]ef cR] T_d ^ aeZ_Z[]`hZ$

2 YZXY ac`a`œZ_`WZ_dVIf cVRdzZR_edd} eYY YRgV_`WZV_UdŁ`_jj RIbf RZ_eR_TVÖZ5 VdzZveYZŁ eYY ^ R.VWWXced e`VdeTS]ZY cVReZ_dVZadhZeY `eYVcd_VdaVIZA]jj Z_ eYVZ: daRV 62 VŽE YZddW^d e`SVRX`UhBj`WY_UZ_XcVT X_ZZ_LR_U`W]``\Z_XVVcd f cTVd`Waa`cef_Zj eYReTR_^RUV eYVZ: eRch`WdMVIZ ac`gV_V_e VRZKČZ $2Uf]eh^{\wedge} V_{R_{u}} UY f dh Z v dR V Y R g j dach dV_{eVUZ_{u}} f a L R dZ le V]^h d TZ l V T_^ ^ Z T X c f a Z$

7 cbhYbhYX ZUa]ma Ub#k ca Ub ft&& Ł : ġVXeR]`ġŊj WY ŻjŽ=f TŻj hVU_ehR_eVić R_jęYZXR_U: TR_ZUFJXV^jdJVWR SZĚZTEFRJJŁ eYZXIYRgVX_VhVJ] Vić f dLR_UeYRe^R\Vd^V bf ZV^aeZZHZŽ

4`_eV_eVU VR`Zj ^ V_ R_U h`^V_ WVJ X`U RS`fe]ZWLVZeY & SVIRT dveYy YRgVRIYZgVURX vRe UVRJ`C SVIRT dveYy YRgVSW_RSJVe d'dRZ RhBj `VJZW eYR ed ZdeYv^ŽEYY RVT_} UV_eeYR eeY VZ: ^ RZ_UVZEVI e`YRgV R dRSJVLYVRJeYj VR`Zj JZW Zdd^ VeYZ X eYY TR_SV d'cV` VRIYZgZ XŽEY VZ: d'TIV dZ JZW^ VR_deYy YRgVSW_RSJVe ac`gZV Rd JZJ SRZEI V & eY VZ: VR`ZZ dLV_RSJZ X eYV^ e` h VR eYC eYV f ad R_U U`h_d eYRe TZ:Tf^ dR_TVd RhBj dScZ XŽEYY VgV_YRgV cT TIVU VL h ZeY f e X vRe deRZ HZ_YR^`_ZZ XeYVZ cv4a`_dSZZ j e`h RLd eYV VR'Zj h ZeY dyVARJZREZ_ŽEYVZ: deSCINTEZ_ Z_JZWZ ISRUU`_ eYZ ISR_TVZ

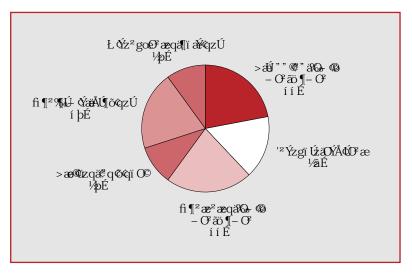
EYZLX: fa YRCR/RZZYJ dc`_X&/_UV_TJ e`ł hRUUZ UZZLFRZRZ_ŽEYZLZU/-VIAUŁR``_X `eYceYZ_XŁZ eYVT_gZIZ_ eYREZZUEYZC`h_ UVIZZ_dR_U ZWTY ZWEYREX e`SFZUEYZC` WE CZEYZU/WZ RWZIRT ^ aR_ZUSJ C/RZZ/ aWEIV`W Z_URS`feeYZC}_R_WLRUYZ ZJ Zł T ^ VZUC WIZ/ee` ^ WEEYZC; WUZZWIFC/`W eYZŁAV a]VZ_ eYZLX: fa RV_`ee` T_TC_VU RS`feT_d^ acZ_ŽEYY eR_VEYVcc`fS]VE RI bfZVeYVeYZXUEYJ [ZVR_URVZ_Ra`dZZ_ e` U dŁSfeeYY dWZERU[fde`_V^ `CVdfcTV`W XRZZ TRZ_ R``_XdgXEJ`aV_e`eYVŽ

:_eYVZ:daR:VeZ:VeYVjeV_Ue`TR:cj`feRTe&gZ eZdeYReac`gZ.VeYV`hZeYZ_U&gZ.fR]XReZ:TRZ_+ da`ceLcVRLZ_XL^fdZT`cY`SSZdŽ3jR_U]R:XXLeYVj YRgVRX`U]VgY`VWF]efcR]T_df^aeZ_Ž

> V^SVcd`VeYZIXc`faUZa]B, RaRezTf]RcT_ł TVc_RS`feeYVbfRZej`VeYVZcYf^R_cVJRz_dYZaČ EYZIZICV-VIEVUZ_eYVgVcjZa`ceR_ea]RIVeYRe eYVViaVcZ/TV`VWCZ/UcYZaR_UdTZSZZejYRdZ_ eYVZ:JZzVČZ

2d dVARUd eYV UV `XRaYZT TYRRIeVZeZid`W

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ckda`_UV_edZ_eYZdXc`faŁh`c\Z_XaVa]VR_U ^V^Skd`WeYV^VLZf^łYZ&YdTZłVT_`^ZT Xc`faReVaReeZff[Re]jhV]]ckáckôk_ekUŽ

Ghmì]nYX`]bX]j]Xi U``f1%\$i Ł

: $h\underline{R}_{ee}$ [ZgV^j `h_]ZWZ `gVXe^j `h_ ZJRd \underline{R}_{U} : $R^{T}_{U'e}$: \underline{R}_{c} (\underline{R}]ZEVeVV Ž: $\underline{eYZ} \setminus \underline{G}$ $\underline{VGS} `\underline{U}$ ZEV_ \underline{eZ} (\underline{Ve} U eVV R^{T} VZ. U hYRe: a](\underline{RdV} \underline{R}_{U} : \underline{V}_{1}) dRcZ XhZeY eVVaVa](V: [Z) VZ

 $\begin{array}{c} \label{eq:product} Dig [ZkVUZ_UZgZLf R]ddWeYVh`dURdT^a`ddU`VWVa]VdRYVceYR_`VWc`fad`cZ_ddZfeZ_dZ_eYZh`dUVdRYVceYR_`VWc`fad`cZ_ddZfeZ_dZ_eYZh`dUVdRYZd`cYVc`h_UCVR`dZEYYj dWVe`VdWeYV`dMgddW^ eYVeZd`WeRUZZ_`cZ_ddZ ef eZ_dZ_:_XV_VR]LeYVeWCVLeYY_RVUARIYVU W^ eYVdVR_URVVbfZVYRaaj e`bfVdz_eYV`ZWeYJ_U_`eRTT dUhZeY eYVZc`h_`aZ_Z_dZ2]RXVac`a`eZ_`VWYV`RV_`_ISVJZgVcdZEYYj U_`edWeYVVW^Zj RdeYV^RZ_`S[VTeZgZ_eZZ_eYZIXc`fa eYReeYVYZXVde]VgVd`VZ_UZgZLfR]ZRR eZ_RVVWf_UZ$

7 c dj JZVU Z UZZIFRLEYVZ `h_ a]R_d R_U gRf VdRVeYV^ `deZ a` ceR_eeYZ XŽEYVZ ZV_ł eZj ZUVJ_VUSj eYVR eVV_eZZ j hZY hYZY eYV T_def TeR_UUWV_UEVOVŽEYVT ZEVZ_XFZZX eYVZ RIEZZEVO bf VdeVvcd/WARZIRZ_Z R] eYV U ŽEYVJ f dVeYVZ VOV eZ Ve` Xc`h RdRavd d_LR_UeYVJ }_UZ_T_d^ aeZ_R_`aa` cef_Z j e` T_def TeeYVUVZZVUZ RXVR_UZ_d U Z XLe` XREZIVEYV dJgvŽAf jef d?] T_d^ aeZ_a]R dR_ Z'a`caR_eaRceZ_eV&cd/WeWRJ&ReZ_RE&&&& ^ Bj SVCRU`WeWCAVaVa]VeYReeYy UV&X_eW&c]ZgVcIRcleYVZ_UV&CVCUZEREVR_UUZA]Bj eWZcZW_ł &&j e``eWcdZEYY ydj]Z&%eWZc]ZgVZ

Dġ JZWUZ UZZIFRJdRV_`eZ UZZIFRZŒZĬĔYY YRġVa JV_ġ `WXX/UdR_UeYZ \ ZeZłcZXYee`eR \V R_ZektkieZ eYVT f_eq `dWafckŽEYY eYZ \ Ze Zih`cq Z XeYRed TZAġ YRdSVT ^ Vd Z aVcd_RŽ BfRZġ `WZWR_Ud S[VTEZYV N] SVZ X`fXYee` SVeYVYR] ^ Rc\d`WR X`Ud TZAġ ŽEYY ReVgVg e` JV&R_ee`hRUd`eYVcdeYVZ `aZ Z_dR_UeYVhB eYY JZ§VŽEYY eYZ \ eYRe VgVq`_VZIV_eZeWUe` SVeYVhBj eYY hR_eŽ3feeYY RV_`eZektkieWU Z a` JZZIdR_URV_`ecVXdeVXU'e`g eVŽ

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4`_V&^Zeac`gZ.VdRV_`eUZgV_Sj XvReZ.Vi RJŽEYY RVTJVRCe/ReeYVZc^RZ_cVa`_dSZZej Zl e`hRtUdeYVZ:TYZUU/_R_Ue/Re^V&Z_Xe/VZ_WUd ZleVV__jj eYZ_Xe/RecVRJj^ReeVoZ4`_d\bfV_ejjŁ eYY_UYg`eVRJ eVZcV_VXj e`VNJ}]]Z_Xe/ZlUFejŽ EYY_WJ e/ReeYY_YRgVU_Vd hYV_eYY_YRgV RIYZgVU e/VSRdZTeRA、`Vac`gZLZ_XhYReVgC Zl _VIVdRj e`eYVZcVK*Zj`dhV]]SVZ_XŽ:VeYY_dT1 TWUZ_eYZLeYY_VaVZ/TVRW/ZX`VY^ZdZ_ RIT^a]ZhVU%R_URA_``eYVcChRUe/R_eYV `aa`cef_Zj e`cVeVUSj R_jS`UjŽ

]VgV] `WRdaZReZ_ŽAVćYRad Wc eYV d? V cVRd_Ł T_Wć^Zdeac`gZV kdU`_`eaRezTf]Rdj WW] eYV ł dMgVde`SVVZeYVchZ_Vd`c]`dkdZ_T^aRcZti_ hZeY`eYVcaVa]VŽ

EYVZccVJZSZckZig eV_Ude`SV_`^Z_Rj, eVyTJRZ e`SVJZkgVLSfeU`_`eacRIeZCNZEYVZcTf]efcRjT_ł df^aeZ_Z[]`h R_UeVJVgZZ_ZiTYZV-j RdfcTV `WW_eVceRZ_^V_e Wc eVv^ZEYZIXc`fa Z_TJfUVd aV a]V`WVgVcj dTZłVT_`^ZTXc`faŁRXV R_U V^a]`j^V_edeRzfdŽ

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 $5 ZN_TYR_eVU ` f ed LNd RVUVERIYVU W ^ eVV$ h`dUeYy]ZyZZEYZZL` eSVIR dVeYy RVZł UZWWCV_dSf eSVIR dVeYy WY eRV ` f eZ YVZ dRIZ_ZI`_V WAU e^ V_eZ YY eYV ` f eZ YVZ dRIZ_ZI`_V WAU e^ V_eZ YY YRVTVRUU e` SVZZ VY RVUZZ Jf dZ_VU hZY dV ZI^ RUVWC` eYV ZZ VY RVUZZ Jf dZ_VU hZY dV [ZZ_R_UU _` eSVZZ VY RVUZZ Jf dIVVZE YY WY] eVV dR' VRS` f ed TZR]` cXR_ZREZ_dR_Ua`]ZZ ZE YY U _` eVgV_V aVIe^ f TY W^ eYVZ VR' ZZ dZ

EYV/YRgV_`ZJfdZ_dRS`feeYV^dMgVdŽEYV/ UZU_`eTcVReVeYVZc`h_ZUV_eZeXd eYVj RcVhYRe eYVjUZ_JZWR_UeYVZca`d&Z_ZdeYV`_VTYR_TV a]RIVUeVV ZŽCVARUZX eVvdR_Ud TZkjŁeVy ecje`Rg`ZUSVZ_X`gVchYV]^WSjeYV^ŽEYVj gZzh eYV^ hZeY ^ Zeef de R_URdVdReYVcZ e` [VdR e e`hRddeY`dVeYY_dWRdUZXWCV_eŽEYY_YRgV_` WZY_UdŽDZ_TVVgVgS`UjYRde`]``\`feWceYV^ł dMgVdLeYV/ V/aVTee`SV/WAR`_VR_U_`eZ`a`dVU fa`_Ž?`cU`eYVj Rd\^fTY`WeYV^dy]gVd ZeZd YRUV_`fXYe`X\ec`f_UeYVUZWTf]eZd`WZRZj]ZWŽ:_eYVZ:WWWeZ:VeYVj_YRgV_`RZ:d`WeYVZ: `h_R_UdeRy_ReY`^VŽEYVy_RtV_`eZ_eVtVdeVUZ_ Tf | of cV ceYV^ VUZZŽE YVZcdeR_TVZTT_dZdeV_ehZeY eYVZcSV/ZWeyReeYV/YReV_`a`hVce`TYR XVeyV hRjeYZ_XdRvŽEYVZcd/WWdeW^ZddReYVc]`hŽ

 $\label{eq:stability} \begin{array}{l} 5 \ ZN_TYR_eVU^{*} \ fed{L} \ dd RVe^{*} \ SVVM_UZ_VgVg\\ d^{*}TZ^{1}VT_{^{*}} \ ZT \ ded Ref \ LSf e \ RVT_TV_edReVUZ\\ eVV[^{*}hVc^{*}_VgXVg \ RVZVgVg \ e^{*}SV \ R_fR_{1}RS^{*}fd \end{array}$

 $\label{eq:linear} $$ VclaReZf[Rc] f_V a]^j VU^_VdLY f dh ZevdR_U $$ VclaLY f dh ZevdR_U $$

deRS]VaRce_VZŽEYVJWWJeVVJYRgV]`de`feSjeVV VT_`^ZTR_Ud1ZZJTYR_XXdZ_eVVTf_ecjŽ

$H_{c} 9.7 < 5.000$ B; 9 DC C98 6MK 5 MGC: 000 9

 $\label{eq:constraint} \begin{array}{l} \label{eq:constraint} & \label{eq:constraint} & \label{eq:constraint} \\ \end{tabular} The theorem \end{tabular} \\ The theorem \end{tabular} The theorem \end{tabular} \\ \end{tabular} The theorem \end{tabular} \\ The theorem \en$

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3V2LVdeVZeLeYVUZWWEV_ehRjd`WJZWRVRjd Rold TZReVUhZeYUZWWEV_ea`dEZ_d`_ \Vj d`TZRj ZdfVeLd`TYRdd`TZRjeefdeR_Udfaa`ceWcUVi ^`TdRIjŽ

4 YZWP_hBJ d` VJZWREVR^ R_ZWHERZ_` Wit TZAJ UZGVodZj ŁSfe RJd` VVEVV gRCZGj` VVEVJReZ_drZad SVeh W_ d TZAj R_U VRIY Z_UZGZLF RJŽ:_ ^ R_j TRACLEYY REVEYV cVcf Je` WR_VXREZGV cVJReZ_ł drZa SVeh W_ eYV eh`ŽE YZd SVZ_X eVV TRALE h Y` X]j Yfg]mih Uhibck 'YI Jg/g WebgJg/g Jb`k Ung' c Z]ZY VYIk YYb k \JW. "JHY We a a i bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a a i bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a a i bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a a i bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a di bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a di bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a di bJWUHcb' Jg dc gg/V'Y UbX`k \JW. "JHY We a di bJWUHcb' ZC be hWe blf]Vi HY Ic [fYUHY fgc WU']bHY[fU! Hcb'' 7RX^ V_eVUUZGVCZj ZIRT_dbf V_TVR_U ^ R_ZWHRZ_` VVEVVRSdV_TV` VR yH V& R_U eYZd ZIRac`SJV eYRETR_` eSVVJf UVŽ

EYVd TZAJ eYReZIV VXZ_XW^ eYVTF Jef cR TYR_XXdhZJ TVerZ_Jj SV`_VhY`dVhBjd`WZW RVgVj UZgVcdŽ3f eZehZJ`_Jj SVUV``TCreZTR_U We fdS]Ve Yf ^ R_ U&Y a^ V_e e e VV e e eYRe U&Y a^ V_e `WeY dy WR_U d/T X_ZZ_ `W eYV@eYVcRdvf_U&aZ_WSj Rde`_XyH WZE YZI hZ] YRe SVRyH %% WR_Vh deR`aL`WT fockL UY_W^ `d/Sj T ^ f_ZReZ_ R_UZ_e&REZ_ R` `_Xa]fd] Z/V_e&Zd R_U]/dI Sj R_ RSdedRe _`eZ_ `W d/Ac R_U f_ZejZE YV eRA `WSfZUZ_X e]/dR_TVLeefde R_U `aV_VdIe`h RdderV@eYVc ZleYfd R_ fcXV_e`_VZ_eYVaddV_eZWeYV WefcV Zle`SVd/If d/UŽ

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EYVUZ9VAZE `WhR d`WZWZIR WATE R_UZ+Zd d ^ VEYZ_XeYRe hZ] Z_eV_dZ9VZ_WAT AŽEYZI hZ] ^ R_VE`]VAR_TVR_Z_UZ4V_dS]VT_UZ5Z_WCeVV _Vh WA^ d`W1 TZ9 cV]REZ_dZ2ŽEYV]ZW W1 TZ4j ZIRERTE dtE RUHE`]VAR_TVR_UEVVARCTYVEV67R] Z9 REVTCT TZ9 ZVEVVTYR]V_Xd`WEV_Vh VARRV E`SVT_W2_EVUL[fdeReReZ`VhYV_Ze`]VAR_TV R_UUZTCZ Z_REZ_]``\]ZVVRd R_dh Vde`eYdV R^ VTYR]V_XdŽ

E`]V&R_TVCV/Revde`UZWWCV_TVŽ?`ee`[fdeR_j UZHZ_TEZ_LY`hVgv&LSfee`eY`dVeYRecv&f]eV&'^ eYVVIVCTZHVSj`eYvd`VeYVZ:V&WU^ R_UV&'^ cV&HVTeVceYVT^^`_V&WU^ `VW]13ZJSV_jL "****/Ž4`_dvbfV_ejjLZeZUZHZ_XFZHVUV&'^ eYRe RTTV&eR_TV`WUZgv&Zej hYZTYZISRMU`_ ^VcV \underline{Z} \underline{U} \underline{X} \underline{W} \underline{V} eYVjU_`eRWWTe`_Vd`h_Z_eVcVdedLcVXRdUVdd `WhYVeYVceYVjZ_eVcWeVhZeY`eYVcdŽHc`Yf! UbWY XcYg bcha YUb U dUggj Y Uhh XY hckUfXg'hY'chYfžVihUWhjY'WcbWYfb'Zcf' h Y ZYXca cZgc WYhniUg U k c Y 2dWc_`_łUZETCZ`Z_REZ_ŁZecVjRevde` eYVcRUZIRI, Vof Rit Zej `WR]]Yf^R_SVZ_XXŽ:e^VR_d_`ed`^fTY $R_f h Z_j Z_X \text{ Vdl} e^{-1} ac^{-1} e^{-1} Z_V \text{ Vdl} R R$ a`dEEgVUVdEVe``gVcT^VeYV^ŽEYfde`]VcR_TV acVLZa`dEZ_dza`[ZEZIR]jj T ccVTe%taRj d`VSVVRgt Z_Xe`hRdd`eYVcdŽ3`eYRcVR]d`S[VTezgVhRjd`W `cXR_2KZ_Xd`TZkjLR_UaRceZff]RcjjeYVT]]VTeZeV Z'RXZ_Rg'eYReUV}_VdVRIYaVcd_`_eYVSRdZd`W VbfR]ZejR_UVXWU^Ž

EYVRezef UV`W4 YZJVR_de`hRtUde`JVdR_TVR_U _`_łUZdłóż Z_ReZ_ YRdd ^ VT _ecRUZle`cj R_U ac`S]V ReZIR] WRef ckdŽH YZJV Sc`RU]j da VR Z_X eYVčV ZIR Xc`h Z_X RaacVIZReZ_ `WUZgkdzej R_U Vof RZcj ŁT _dzUkdS]VZ_e`JVdR_TVR_UUZdłóż Z_R eZ_ `SgZfdj aVdzde hYV_ZeT ^ Vde`aV a]Vd `aZ_Z_dRS`fe da VIZJT dzef ReZ_dR_U a RoczIf JRc Xc`fad`WaV a]VŽE YfdL dRIZch Ł TV_d cdYza R_U cMZXZfd`c da fR] UZdłóż Z_ReZ_ ReV ck[VIekU Sj `g\c)! ~ `WcVda`_UV_ed hYV_ eYVdV d'S[VIed ReV Rh VU RS`fe Z_XV_VdR] `c R5dedRie ekc^ dž: W bf VRh VU RS`fe Z_VZ_g`]g\UZ_LY`h VgVdLeYV dzef ReZ_ TYR_XkŽ

$$\begin{split} & EYV g Reh^{R} c Ej c V V I e e YV Z V R e Y Reh^{V} V \\ & R_U^{V} Y R V Z W E V e c Z Y e Z D^{V} V) ! ~ `VeY^{V} d V \\ & Z e V c g Z h V U S j : 5 6 2 D F _ Z j V c Z j ~ V 4 Y Z V # !!! \\ & U_{e} e e Y Z \cdot e Y Ree e Y V V d^{T} f] U S V h R X V Z V b f R Z j \\ & S V e h W_{V}^{V} V_{R} U h^{V} V_{Z}^{T} s h e e Y V V d^{T} f] U S V h R X V Z V b f R Z j \\ & S V e h W_{V}^{V} V_{R} U h^{V} V_{Z}^{T} s h e e Y V d^{T} f] U S V h R X V Z V b f R Z j \\ & R h W h Y e Y V c^{V} V_{L} h h^{V} V_{Z}^{T} s h e e Y V d^{T} f] U S V T_{d} Z V e V \\ & R h W h Y e Y V c^{V} V_{L} h^{V} h^{V} h^{V} h^{T} V_{d} h^{T} j h^{V} e Z H Z X H e Y Z \\ & A h W h Y e Y V c^{T} L h^{V} h^{T} J h^{T} V_{e} Z H Z X H e^{V Z V H e} V Z \\ & X h U Z e V c e^{T} d h R_{V} T_{d} Z V e^{T} J h^{T} J h^{T} J h^{T} J h^{T} J h^{T} h^$$

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:_cVJRZ_e`cVJZZ_LeVVCVZlhZUVďaa`ceVvC VXVU^ `VVh`cdYZdŽAVa]Vd3jeYReR]cVJZZ_d `fXYee`SVCVdaVT&UR_UgRJfVURZVVVceYVZ: T_ecZsfeZ_e`dTZV6jŽ>R_jaVa]VT_dZVVL Y`hVgVLeYRehYV&Vcd^V_VZlcVJZZfd`c _`eZlRCVRd_VcUZTCZ_ZRZ_Ž2TTdZXe` eYVd?VdfcTVL&" ~ RXCVhZYeYVdXXvdZ_ eYReyd^V_VhY`acRTeZtVdRvUZYZ_Zl^`cV efdh`ceYjeYR_R_REVZD#Z

 $\begin{array}{l} & \hbox{EYV dve `Wbf VdeZ_dZ_T]f UVU Z_ eVV:5 62Di \\ F_ZeVcdZej `W4 YZV d`ceVj cVeVZ]d_`_lUZTCZ`Z \\ & _Re`cj ReeZef UVde`h RdUdeYV > Raf TYVdŽ:_ WATeL \\ & aV a]Vd_^ a ReYZeVhZeY eVVZc UV`R_UdR_URXeW \\ \end{array}$

eYReeYYjReVV_eÆJVUe`]ZgVZ_RTTduR_TVhZeY eYVZcTf]efdŽ

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2 ^ R[`cZej R]d cV[VTe TV_d cdYZa R_U d aa`ce eYVV3WU ^ e` af S]Z1]j Vi acVdtlR]] R_U R_j ZJNRL SV eYVj cV[ZsZ f d`ca`]ZsZ1R]Ž?`_VeYV[VdLh YV_ T_V3/_eVUh ZeY eVVd XXVdsZ_ eYReyeYVCVdr`f]U SVaV a]VhY`TV_d ch YReZddr`h_`_eV[VzZsZ_L SVIRf dVhc`_XgR]f Vd`f XYe_`ee`SVdacVRU%Ls&" RXcWŽ

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 $\begin{array}{l} \mathsf{SV} \times \mathsf{AVReVc} \ \mathbb{R}^{\mathsf{SZgR}} \mathbb{V}^{\mathsf{TV}} \mathbb{Z}^{\mathsf{aV}} a \mathbb{V} a \mathbb{V} d^{\mathsf{Z}} \mathbb{U} \mathbb{R}^{\mathsf{U}} \mathbb{U} \\ \mathsf{RaaReV}_{\mathsf{e}} e \mathbb{V}^{\mathsf{Z}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{Z}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U}^{\mathsf{T}}_{\mathsf{d}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{V}^{\mathsf{SZgV}} \mathbb{U} \\ \mathsf{e} \mathbb{U} \\ \mathsf{E} \mathbb{U} \\ \mathsf{e}$

T d.Z_Xe`eYVV&^ V&MeeY&^ `ck!'! ~ SVJZgV& ZISV&&`e`RTV&eRS`@Z_RdRckJZj R_UJVXJRV e`V_d`dV&ZfIR@ZU`fef_U&SV&&CT_U&Z_d` 2eeYV&`V&`V&Y`fXY!'! ~ SVJZgVe?Ree`dV Z_g`JgVUZ_R_RS`@Z_d^f]USVaf_ZYVUŽ

E`]V&_TVR_U_`_łU&TCZ`Z_RZ_ RCVa`d&gyjj

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 $^ U_c_{zj} R_UYZXVcTf = dR T_d^ aeZ_ŽEVy$

RCVR]d Rdd TZREVU hZEY YZXYVc]VgV]d`VZ_UZgZLf ł

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=RdejjŁRXcVReVcacVLZda`dZZ_e`hRcUde`]VcR_TV

 $\label{eq:rescaled} \begin{array}{c} R_U_`_IUZHZZ_ZRZ_ZIa`dZZYJj RHTZREWU\\ hZY XNRAC ecf de Z_`eYVcd R_U RaacVIZRZ_WC\\ UV^`TRUJŽEY`dVhY`ReVJVdle`JVcR_ej UZb`dW\\ RVJZVj e`YRgVJVdlViaVzZ_TV^WXZZ_UHYZLe`\\ SV^`CVacZzRZde R_U e`SVUZRWWNRW hZY UM$

^ `TaRIjŽ

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J`f_XaVa]VŁeY dVW^ $eYVZ_eVc^VUZeV$ $R_UYZY dTZIVT_^ ZTXcfadR_UeY dVAZY$ $RYZYVc]VgN]`VWUTTREZ_eV_Ue`SV^`cVe`]Vd$ $R_eR_U]VdUZECZ ZRe`gŽEYVcVZd_`UZWWCV_TV$ SVeh W_ eYVdM VdZ_eYZdcVeV_VVZd_`UZWWCV_E dfUZdT_dZdVeV_UZ_eYZddVEZ_Z

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 $2 cV 4 YZ W_{e} d^{\ C} cV c]V dI Ze [V dR_{e} R_{e} U U dI$ $TZ Z Re g eYR_ eYy f dU e SV03 eY eYV: 5 62D$ $F_Z v ddg `V 4 YZ V #!!! Df cgy R_U eYV H`dU$ GR f V Df cgy L da VR U c gv eYv j VR d. Y RgV dg V U $RUVI]Z V Z_Ze [V dR_TV R_U U dI CZ Z RZ_ŽE Y d$ $X_V V R] eV_U V_J ZI R^ SZ RV eZ d^ V c v da V R d+$ $Ze]V R_TV Y R U J ZI R^ SZ RV eZ d^ V c v da V R d+$ $Ze]V R_TV Y R U J ZI R^ SZ RV eZ d^ V c v da V R d+$ $Ze]V R_TV Y R U J ZI R^ SZ RV eZ d^ V c v da V R d+$ $Ze]V R_TV Y R U J ZI R^ SZ RV eZ d^ V c v da V R d+$ $Ze]V R_TV Y R U Z L R^ Z Z R Z_L R S cZ _$ $R_U R e Z U V e h R U d^ Z `C Z Z Z V_V R Z H Y V V$ d TZ łVT _`^ ZTUZTCZ Z REZ _ ZTT _ TVc_VUŁY hł VgV& Ze YRdcZtV _Z d ^ VcVdaVTeeŽ

EYVR[^] SZGRV_TVd ZV. 6Z VU Z eYV [`] aZ Z d UVIICZSVUYVCVd XXVdeeYRed [^] VRVRd_WUe SV][`] \UURe[^] CVI][`] dyjŽ7 \]YUbg'UfY'a cfY'tc [!] YfUbh]b[†]h Y]f[[] YbYfU[`]dYfWYdHcb'c Zc[†]h Yfg^z Vi hih YmUfY'gf]^{``}\][\`m]bhc YfUbhik \Yb']h Wc'a Yg'tc 'gdYWJÚWg]h Uh]cbg'h UhWc'i 'X'UZ ZYWih Ya 'dYfgcbU`m'@_VhRj `VR_Rj dZ XeYZi $\begin{array}{l} \mathbb{R}^{\circ} SZAFZej Zle T_dZUc aV a]Vd^{\circ} aZ_Z_dRS^{\circ} fe \\ \mathbb{Y}^{\circ} MIFRdZH YV_acddV_eVUhZeYeYVd^{\circ} XXddZ_L \\ \mathbb{Z} eV:562DF_ZeVdZej `VAYZV#!!! Df cgVjL \\ eYReyY^{\circ} dAIFRddY^{f}]U_{eSVR}]^{hUe} eRIY \\ \mathbb{Z} dTY^{o}]dMa^{\circ} de^{VZY} dVZeVZZHVC^{\circ} VVZTC2 ZRZ_Z \\ dTY^{o}]dMa^{\circ} de^{VZY} dVZeVZZHVC^{\circ} VVZTC2 ZRZ_Z \\ 8ZgV_eYVdReV^{V_ey.h^{f}}]U_{e}^{o} ZUZW j d_{d} \\ eVRIYVchVCVRY^{\circ} dAIFR%Z eVF?5A #!!" \\ Df cgVjLY^{hVgVL'} '' UZRXCVUZ:_ `eVch^{dH} \\ yY^{\circ} dMIFRdTR_SV dTY^{i}]eRTYVcLSfeeYVj \\ TR_^{o}eRTY^{j} d_Z \\ \end{array}$

4 YZVR_ddW^ e` SVe` [VdR_eRS`f eeYVcV[ReZ_1 dYZad`WeYVcdRUZe`]VcReRS`feeYVZc`h_Ž EYV&V^Rj SVUfS[VdBR_URddReh`c\YV&VLRd ď XXVdeVUSj eYVTYRaeVć`_T_gVcReZ_14 YRaeVć %Ž:e^ZXYeSVR^ReeVc`Wya`]ZZZR|T ccVTe_Vd946 hZey aV a]VSVZ X YRaaj e`dvaVReeVV`aZZ_d Tf ccV_elj VRg f cVUSj TZgZTVeZbf VeeVLaRceZIf |Rclj ZW eYV/U`_`eZ`aZ_XVfa`_eYVZc`h_Z_eVcVdedR_U WRcdŽ3feeYZlcVgVRld^ `cVac`S[V^ ReZIR] RchVTedŽ : W4 YZVR_d RCV \underline{Z} e \overline{V} (VR_e \underline{Z} T _ TCVeV dZf ReZ _ d eYRe RWW eYV dygvelze zd SVIRf dv eyv SVIZev eYRe W_UR^ V_eR Rob VTed `WeYVZc]ZeVd R_U eYV ycZXYe%bhRj WcaVa]Ve cV]ReVe`_VR_`eYVc RVRedeR\VŽHYj RVeYVj hZjZXe SVe VR_e hYVeV`eYVcaVa]Vd]ZeVdReVT_TVc_VUDAVeYRad `fe`WZ_UZXWKKV_TVLSVTRfdVyRd]`_XRdZeU'Vd_`e RWWTe^j TYZU: U_e TRCV ZVZe RWWTed`eYVcCVZ 5 gYYa b 'h YfUbW' WUb a Ug 'U' || \' XY[fYY c Zgc WU``bX|ZZYfYbWY" EYVec`f S|VZd eYRe ZVR ZUZZLI RdRcVe YRgVeYV aa cef Zi e`afccfVeYVZc`h_ |ZEVdRdeYV/dW}eLR_WWW.ce

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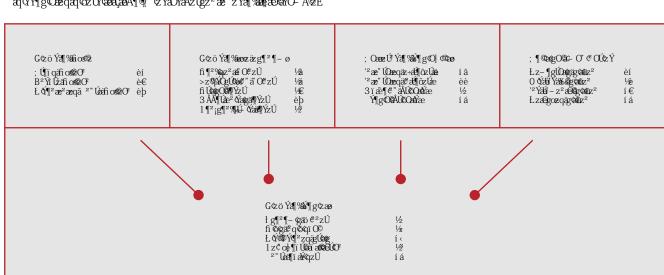
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; f de Rd dW^ Z_X e']V&P_TV TR_T_TVR] d TZR] UZZ_eVEVELZ_e']V&P_TV R_U UZTEZ Z_RZ_^ RJ UVEZVEVE' RUVEZVE' UWV_U RARCEZT]RC Z REV `V&TZE Z_REXV dVTEZ_d` V&TZE Z_4 YZV WRC eYREEVVI ZEZ_X d TZE]` dVEZTACVTRZ f d R_UEYZ TR_ cVET]e Z_R WRC `VUZZWEV_TV deYRe ^ ZEVE TR]] Ze Z_e' bf V&Z_1 dV/ dS]V''!''/Z:e ^ RJ SVLEYV_Ł eYRE Z_e']V&P_TVT_TVR]dT_dZ/ARS]V WRC `VEV `eYV&LSF e R_V&V_XVREVC WRC `VETZE]` dV/ CSVZ_X eYCREV_VUSj T_~ZTEZ

$$\begin{split} & E \left[Ver_TVR_UZe \right] Ver_TVRV_ `e[f deZ_UZZIFR] \\ & acVUZb `dZZ_d_VgV_ZVZ_eYV \right]_R_R_R_J dEleYY \\ & RVR ^ Revc `VaVcd_R ^ `dZjZjZEYY_RVXZgV_ \\ ^ Ve_ZXR_Udfaa`ceSj daVUZ_Td_TZR_Z_Rd \\ & ZdZ3j eYVdr `Ve` \V_LUVgV]`aZ_Xe`]Ver_TVR_U \\ _ `_lUZUZZ_ReZ_RdREGVTZgZTgZef VdcVbfZVd \\ & RTf]ef dR_Z RXZ_R_j eYReccVectVXWU ^ R_UVbfR] \\ & Zj WcR] RdRacVT_UZZ_ Wc eYVVXWU ^ R_U \\ & VR_Z_ZIFRZ_R_ZUZZIFRZ \\ & VR_j Z_UZZIFRZ


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H YRe ZJARU 4 YZJAR_dYRgV`VAPAZeT f_eqi O 6gkig S`Uj We'dR_Z RXV`VAPAVh`dURe`f_U eYV ŁS`eY`VAPAZeZ ^ VUZReV_VZXYS`feY`U R_U eY`dV hY` JZgV eYVEALR_U`Wit TZAj Rd R hY`JVŽEYY XZ_VRJJj RU ae hYZIYVgke V ZAZ_X T]]VT&ZgVZ RZ_Rj SV&Z_eXacAdeYAZe d'S[VTI &ZgV Vi aVEZ_TKZ_Rj SV&Z_eXacAdeYAZe d'S[VTI &ZgV Vi aVEZ_TKZ_Rj SV&Z_eXacAdeYAZe d'S[VTI &ZgV Vi aVEZ_TKZ_DYc d'Y'hYbX`he`VY`[i]XYX` Vmk \]WY Yj Yf`Ja U[Y`cZh Y`k cfX`a U_Yg` a cghigYbgY`he`hXa`Jb`h YJf`XU]`m`Jj Yg/Vm Ub`Ja U[]bUfm]b k \]WX h YmVUb fYWe[b]nY` h YJf`ck b`ZYUfg`UbX``ccb[]b[g"]b dYcd Yfyr]bX]j]Xi U```]j Yg HYbX hc 'VY' Uggc W]UHYX k]h 'W Ub[Yg]b Wc `YWfj Y]a U[]bUf]Yg' 3VRZ_XZ_ ^ Z_UeYVhBj d S[VF826V V aV62/_TVdR_U eYV]ZW`W1 TZ6j YR6VTYR_XUL eYVW]`hZ_X TYRaeVcdhZ]]``\ Re eYV UZWCV_e Z RXd`W1 TZ6j eYRe 4 YZ/R_ddYRVŽ

EYV ^ ` cV Rda VTed R a ZTef cV ` WEYV T f _ ecj Z_T]f UVL eYV ^ ` cVZ_Wc^ REZVZeh Z] SVŽ2TT cL Z_X]j LT _ cZUREZ _ h Z] } ccb SV XZeV_ e` Z` RXd cMReZ_Xe` eYcWclaVTZ; TRclaVTecheYVVT _ ` ^ j Ld ł TZESZZEj R_UUV ` TRRIJŽE YVCVaRceZEJ a VcTVaeZ _ d h Z] eYV_SVZ_eVXCR4VUZ_e` RXV_VCR] ` gVcgZhŽ

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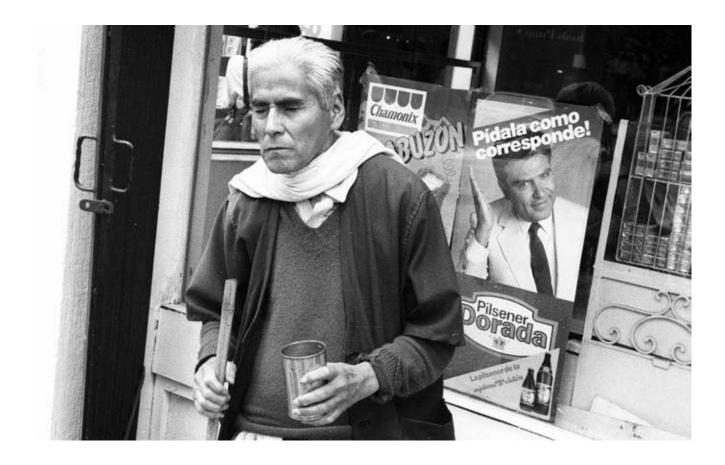
hZ] eYV_SVZ_eWXReWUZ_e`RXV_VR]`gVcgZhŹ EYV ^ VeY`U`]`XZIR] ac`TVUfcV_WUde`S

\$'%B=ł ä ½ äq�Y¶gOæqäqozUYœaQæÅ¶¶" & YaOYåÅzUźz² æ" z Ya¶%a∰æ@AO-Å&È $gyjZ_$ VRIY `V&YVeYCWRCNRdT_dUC&U1eYVVT } _`^ZTd deV & d TZSSZZEj R_Ua`]ZZCHEVVR_Rj dZl ac`gZLMdReja`]`Xj` `VXc`f adZ_RIT d.R_TVhZeY eYVZ:UZWWEV_e`fej``\dŽ6RIYXc`f a`VZ_UZGZ.FR]d Zly]RSV]]VU%bZEY d ^ VTYRREACZEZT WREF cVZE YV SL'!! cda`_UV_ecIVR]]Z_e`UZWWEV_eT_}Xf deZ_d UVaV_UZ_X`_ eYVUZ`V_dZ_UNRJehZEYZ:_` `eYVc h`ddLeYV dR`VaV a]V^ZXYe VR]]Z_e`UZWWEV_e Xc`f adZ_VRIYRVREADEYVT ^ ^`_Xc`f_UR``_X eYV`UXeC^Z_VZEYVC/REVTVeRZ_RW_ZZG1ePRe RCVT_dR_eLY`hVgVZ2dhZ]]SVdV/_Z_eYV]Rte TYRaeAdZ_eVXdReVUR_Rj dZ`VR] eYvgRZSS[VdT_ł dLACU jZ/UdRXV_VRJ ej a`]`Xj_eYReTRaeFcVdeYV UZgVcdZj`VWRIYRVREDFZVhV]]ZEYZI}_Rj aZIEf cV d^ df a eYVRcR]`WF f_eq Z_RXdUCZZ_XW/^ $eYV UZWWEV_e dvTe`cR]`f el``\dž:e dv`f]U SV dZU$ $eYReeYV UZWWEV_e ej a VdC vacVdV_e cVR] Xc`f aZ_Xd`W$ $Z_UZZUFR]dR_U_`e [f de deRezEZER] cVdF] edŽ$

EYVUZ9VAZEj `WREEZETUVAR_UT]]VIEZ9VZ RXZ _RZACK-VIECTEVCZY_VAT`WTTZ6jŽEYVXAVREVA eYVUZ9VAZEj `WTaVZ2/TVAR_U`fej``\drevV^`cV Uj_R`ZTeVVJZW`WTTZ6j hZj]SVŽ3fe_`eR]]UZ gVAZEj ZTX`UŽHYV_ZeZt]_`eT`dZ_REVUR_U ZeVXREVUZe`d^VyT^^`_h`d]U%LJZ9VAZEj TR_JVRUe`UZZ_eVXREZ_`cWRX`V_eREZ_`VeVV dTZRJVR5cZIŽHYV_eVVUZ9VAZEj`WTYZJR_dTZ6j ZHT_dZVAVLEVXWALEVAVZIR_WUe`T_dZVA hYRe`aa`cef_ZEXAR_UEYAVRedZe^ZVECVACACU/_e Wc_REZ_ISFZUZ_XVWACEŽ



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2_j VT_`^ ZT U\&\]`a^ V_e deRev\] Te\Rev\d yXRZ_Vcd%R_U y]`d\cdr\"aE YZd Zd_`eYZ_X_VhŽ 4 YR_XVZdSV_V} TZd e` d ^ VZ_eYVdr`ce R_U`z`c ^ VLZ ^ e\c^ Hh YZV eYVcdRvUZRUgR_dRXUSj ZŽ H YReZddeZZ_XZ_eYVIRV`W4 YZVZIY`h ^ R_j aV a]VWWJeYReeYVJ YRV]`de^`cVeYR_eYVJ YRV XRZ_VLZ5 VdaZeVeYVaRIV`WT_`^ ZTU\&\]`a^ V_e `g\ceYV]RdeUVIRU\L\UZcZh c gY]bhYfj]Yk YX` VmI B 8 D`gUk 'h Ya gY`j Yg`Ug`Î`cgYfg`" 6mi Vc'bhfUghž'i gh', 1 `gU]X'h Ymk YfYÎ[U]bYfg`" 4f ccV_eT_UZZ_d^ RJ YRgVYRUd ^ VeYZ_Xe`U` hZYZZYZ_eVcgZhdch VcYVJUZ_> RJ R_U;f_V #!!"LhYV_eYVf_V a]`j ^ V_ecReVde`URe"!" `WeYVRIeZeVa`af]ReZ_R_UeYV&VhRddeZ]_` $dX_$ `WeYVViaVIeVUfaefc_Ž

AV a]VdaVcNáeZ_d`WeYV dv[gvdRcVUEVTejj Rdt TZRENU hZeY eYVZ: d TZ IVT_`^ ZT a`dEZ_Ž EYVYZXYCf a Z_eYVd TZ IVT_`^ ZT dTR]VaV a]V RVLeYV^`cV[ZV]j eYVj RVe`WVj eYRe eYVj RdV XZ_VdLhYZVeYV]`hVcU h_ eYVj RVLeYV^`dv eYVj WVj eYRe eYVj RdV]`dvdŽ:ed f_UdecZeVLVi h dYcd `YNğ YWc bca]Wdcg]Ijcb]gbchUb ÎcV! 'YWjj YÏ `ZUWih UhYI]ggg]bXYd YbXYbhmicZ h Y]fgj V'YVVjj Y YI dYf]YbWY Ug]bXjj [Xi U`g" :e Zl RTef R]jj R d TZR] T_dec Te eYRe UkaV_Ud`_ VRIY a Vcd _`d a VcTVáeZ_ R_U RctVdd^ V_e `WYZd `c YVc`h_ dEf ReZ_ŽE YV^ VR_Z_X ReezSf eVU e` h`c\LeYVVI a VcZV_TV VJRS`f ccV/ReZ_dR_UV&f dV V^ a]`j^ V_eac`da VTedR:Vd^ V`WeYVVMTe`cdeYRe Z_~f V_TV eYVZ' RXV aV a]V YRgV`WeYV dMgVdŽ 4`^ aRcZt_dh ZeY_VZXYS`f ccLVI a VTeteZ_dRS`f e eYVZc TYZU U`d Vkef cV`c eYV UR^ R`WYRgZ X R Ucf XRUUZTeZ_eYVM*Zj R:V`eYVcVI R`a]Vd`WeYV dR`VeYZ_X=aV a]Vdcf S[VTeZgV\gR]f ReZ_U`Vd_`e _VTVctRzZj ^ REIY eYVCK RTef R] a` dEZ_Z_eYVd TZR def Tef cVZ4`_cdvf V_ejj LR_Raac`RIY eYRecVUF TVd VgVg eYZ_Xe`VT_`^Ztdh Z] f cf R]j VMZŽ

AV a]VdaVćTvácZ_`VeYV dvJgvdRdXZ_vdc`c]`dvddW^ de`SV[Z_\Ue`TvæRZ_aVcd_R]TYRd RTev5ZteZtőZ 7ZcdejjLcvda`_UV_ed`[fUX^ V_edeV_U e`SVXfZJUUSj Y`h eYVj aVcTvZgVeYvZcVT_`^ZT a`dZZ_R_Uac`XvddReeYRea`Z eZ_6Z_VZAV a]V hY`SVJZgVeYVj RVUZ_XhV]]Sj T ^ aRZd_hZY eYVZcaRv_edR_URV`acZ_ZteZTRS`feeYVVvfcdv eV_Ue`WWJeYVj RVXRZ_vdžDVT_UjLcvda`_UV_ed Z_RXV`VeYV`dvJgvdRtXRZ_vdc`c]`dvdeV_Ute`SV T ccV[ReVUhZeY eYVZcWJZXte`hRtUteYV4 YZJR_ VT_`^ZT dj deV~Ž8 RZ_vdeV_U e`Vfacvdtl^`dv T_}UV_TvLV_eeYf dZdt``c acZUZ=`dvdt`_ eYV `eYvc YR_ULRV^`dvJZV1j e`YRS`fc WVJZXd `VZ_d7lfcZejL]`dd`c R_XvčZ:_^`deTRtvdn'!" /Ł @/.łäł/pí

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aVa]VddMWZ:RXVeV_Ude`SVT_dZdeV_ehZeY eYVZ:WWZ_XŽ

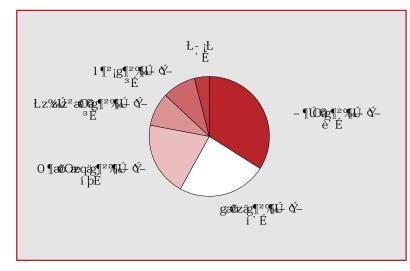
 $:eZldeZZ_XY`h ^ R_j dxda`_UV_edh8% / WMJ$ $VT_`^ZIR]j Z_dVIf dxZ7f ceYvc^`dvL`_VZ "! dy$ $eYReeYvJ YRgVWMZ_Xd`VR_Xbc`c]`dZ`_ dv`cd.$ $hfYY'dYcd'Y'ci hcZYj YfmZci f\Uj Y'fUh Yf`$ bY[Uhj Y'ZYY']b[g'UVci hih Y'W ffYbhYVc! $bca]WgnghYa "EYZl dX_Z TR_e }_UZ X SVRd$ $`fe eYV eV_UV_Tj ZJV_eZ WUZ eYV" **) CVa`cd.$ $T ^ aZAUSWAVeYVT f_eq`dVT_`^ZTU h_fc_Z$ $2dhRda`Z_eVU `fe eYV_LeYV} Xf ddWc ^ RIc`l$ $VT_`^ ZTaVAVc^ R_TVTR_ ^ R_VZe YRUe`XRda$ $aV a]Vdd'S[VI&gV VI aVZ/TVZH YVCRdZ_"**)$ $YZXY Xc`heY deXdhVcV_`e cV-VI&UZ_aV a]Vd$ $d'S[VI&gV deZURVEZ_L`_ eYV acVdV_e`TTRZ_$ $4 YZVR_dXV_VR]j WWJZ_dVTf cVLVgV_e`SdZ$

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9 `h U 4 YZVR_dRURaee` eYVUj_R`ZTd`WeYV VT_`^ZTd deV^02]] Z UZZJFRJdUQVJ`a deReV XZde` TRaZEVZXVRJSVde eYY TR_LZ_RTT d.R_TV h ZeY eYVZ: TRARSZZZZdR_U eYVCVd f cTVdRgPZJRS]V e` eYV^L`_ h YReVgVc`aa`cef_ZZJdRZDVZEYVdV RURaeReZ_ deReVXZd ReV eVc^ UJ yT_Vc^Zf^%Z 2aa]j Z_XR ej a`]`Xj_UQVJ`aVU Sj_C`SVce > Vd e`_L} gVVVc^ dTR_SVUZEZ_XFZHVULR_UeYVdVRV dr`h_Z_}Xf cV8#Z

EYV acU ^ Z.R_e derevý ZleYV _ VeVc^ W R^ `d] T_Wc^ Zl^ Ž2 eYZU `WeVda`_UV_ed RV Z UZZLFRJdh Y RLRaee eYVVT_`^ ZTd deV h ZeY eYVd JVRZ `WI eRTEZ_XeYVXCVReVdeR.LgR_dRXVVc eYV dygVdR_U eYVZ W? ZZdŽH Y Jf Wc bXi Wilg XYÚ bYX UgÎ Ua c fUÏ VYWU gY U``h YmWUfY` UVci h]ga YYHb[h Y Jf bYYXgzk]h c i hVc b! gXYfUhcb Zcf ch Yfg" 2_eYc a`] XZR df UZd $13R_{VUL} *$ WcdTZR SWRgZfchYZY ScVR\dRhR, W/^ eYV $^{\circ}$ dR] df]VdX gVc_ZXZ_eVcaVcd_R] cV]ReZ_dR_U hY`dV`_]j^`@ZERZ_R_UXRJZdeYVdReZURAEZ_ `WZ_UZ&ZLFR|R_UWR^Z; _WUdŽ:eZ1`WW_eYVdv6F]e `Wef cgzeR] decReVXZkd^ `ezeReVUSj dEf ReZ_dh YVčV VT_`^ZTa`gVcgiŁV^`eZ_RJUZERSZZEjŁR]RI\`W of Valk UR RSdV TV Walf ZDY V eViceo R dXdd dZ_dYRgVac`UfTURTf]efcV`WR_jeYZXXV6‰ R_U ylglog`_V Vlc eYV^ dl/glodZi e clackdl_ed eYV $]_R$ deRXV `WhZeYUdRhR| Z_e` R acZeReV h `c|UŽ $2^{\circ} R T_Wc^2 R R R R J Z Tek R U h_eYV$ d TZ IVT ` ^ ZT dIR VR UeV Ude` SV da ZReVUZ $\mathbb{R} \setminus \mathbb{Z} \cup \mathbb{W}$ [ZEZIR] $\mathbb{R}^{\wedge} \cap \mathbb{R}$ [ZEA $\mathbb{Z}^{\wedge} \to \mathbb{C}$ deal $\mathbb{V} \mathbb{Z}$ eVZd Xc`fadR, eYRea`]ZeZIdZda`Z_e|VdŽ

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2_`eYVch`XcfadhYd/T_Wc^Zf` JZdZ eYVhB, eYVfc/ReVe` `eYVcdRTTf_eLSVchW_ eYV^LWcRdZ ZRcac`a`ceZ_` `WcVch`_UV_edŽ EYVcVZleYVRE&VT_Wc^Zf` `WeY`d/hY`ReV hZJZ_Xe`U` hYRe&gVcZed&Vcle`RIYZ&VhYReeYVf hR_eZ_JZWn#% ´ZF_JZ.VeY`d/hY`d/T_Wc^1 Zf`ZIR``cRLaVaJVhZeYeYZIRLRacReZ_deReVyf RTIVae eYVVT_`^ZfdeV^ R_UdW\ e`RIYZ&V eYVZc`S[VTe&gVcReR_j T_dLSfehZeYZ_eYVVZdeZX d]VdZEYVf REV^`chYRe&Jf cVacCdV_eVUR`_X eYVj`f_XZEYV`eYVcXcfa1*″ / ZfTYRCREVCXU Sj_UWXeV_e&JT_Wc^ZfLR_UZeZ_TJfUVd^`cV ZdVffcVaVaJVhY`h`fJUU`R_jeYZ_XV1aVReU `WeYV^ Rd]`_XRdeYVj RIYZkgVUeYVZcXRjdŽ

EYV^ `deRIZZV dedRevy Zl^ `Zl^ `Zl^ ` Zî[^]ŽEY[^]dVhY[^]RU[^]aeZeeV_Ue[^]SVaVa]VhY[^] T } UV eji R U V eYf dZRdeZIR] ji RITVae eYV TYR] [V_Xkd`WT_`^ ZTUkgV[`a^ V_eR_Uegi e` ViecRTe eYVXXReVdea`ddZS]VSV_VjeWV^ eYV`aa`cef_ZZXd RgRZRS] $VZ_{e}VZ_{g}VCVda^{-}UV_{e}L^{RZ_{j}}W^{-}$ eYV^VLZE^ łYZXY decRef ^ ŁYRgVeYZI^ `eZeReZ_Ž EYY_^R\VfaeYVXc`fa`VyV_ecVacV_Vfcc%byY RcVeYVyV_XZ_V‰VWT_`^ZTUVgVj`a^V_eŽEYVdV XRZ_VathY`RVT_}UV_etUV``TareZR\jj}^Z_UVU aVa]VTRaRS]V`WTRaZRJZZZX`_R_UdYRaZ_XeYV `aa`cef_ZeZddeYVTf_eqi`WWkdeYV^ŁT^a`dV #! ~ `WeYV dR` a]VŽEYVEV eYf d dW` d e` SV [Vdd `WR_ yV_ecVacV_Vf cZR] TF]ef cV%eYR_ ^ ZXYe SV ViaVTeVUZ_RojdeV^SRoNU`_acZeReVV_eVcacZeNŽ :WeYZIZIT_} c^ VULeYVVT_` ^ ZTTF |ef cV V4 YZV T f]Uac gVe SVR_ `SdeRI]Ve eVVT f_eg dUM gVj`a^ V_eŽ

EYV} WY Xc fa `WWa`_UV_ed Zd d` R] $1^{*''}$ /L Sf eYRdRd/Ra jj UV__VUac`}]V+eVd/ReVeYV_`_ł T_Wc^ZteŻEYVZc gRJf Vd T_~ZTe h Zey eY dV`W eYVac\gRZZ_XVT_`^ZTd deV ŽEYVJ UZZUVZ_e eh`eV_UV_TZdŽ@_ eVV_VYR_ULeVd/ReVaV a]V h Zey dec`_XWWZ_Xd`VR_Xc R_U]`dde h Rd deYV VT_`^ZTd deV ŽEh`eYZUd`WeYV dJ eYReeYVJ YRgV]`de`f e R_UUZa JB, RYZXY UXCW`Wa`h Vd]Vdt_VdŽ2_JRXV_f^SVc`VeYV^LY`h VgVLRVZ_ eYV^VLZ^ YZXY d TZ VT_`^^ZTSdRI_VeŽ

CC 7 =5@B5H F5@4\5H€ B 5B8 H 9 M95FB=B; ∴ C F 97 C ! BC A =7 7 < 5B; 9

 $: _ UZ = Z L f R] d U _` e R U ae eY d V de ReVXZ d Re$ $d R_U^, eY j`ae Wc Ra Roe Z f] R ch R ` V R L Ra e Z X$ $e` eY V U ^ R_U d` V e Y V T _` ^ Z T d d V S V R f d L$ $R` _ X` e V c e Y Z X L e Y y Y R v V c ^ U Ra Roe Z f] R c$ $Z V R` V e V Z c RS Z Z j e` Z ~ f V_T V e V a c T V d Z : e Z l$ $e Y f d h` c e Y y ^ V e f c Z X & e Y v j a V ` W R e Z _ e Y R e$ $a V a] V S V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ $a V a] V S V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ $a V a] V S V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ $a V a] V S V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ $A V a] V E Y A C R Z _ R e$ $a V a] V S V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ $A V a] V C V Z e Z l a` d Z S] V e` e R V Z _ c Y R e$ A V a] V S V Z e Z l a` C Z S e Y eA V a] V S V Z e Z l a` C Z S = V eA V a] V S V Z e Z l a` C Z S = V eA V a] V S V Z e Z l a` C Z S = V e $A V a] V S V Z e Z l a` R a S] V ` W Y R _ Z Z X e$ $` a e Z _ d T]] V I E Z V R I E _ T R a R S] V ` W Y R _ X Z X e$

eYVddeV LRT_TVaeZ_`WeYVddeV RdRdTZR TeVReZ_LR_URgZM `WeYVddeV RdaRce`WeYV _RefdR]`dU/c`WeYZ_XZŽ

H YVEV eYV VT _`^ ZT ac`TVEH ZHT _TVc_VLL && `V&Y`dvZ_eVcgZh VUeY`f XYeeYReyRTeZ_XR] e`XVeYVLh VTR_TYR_XVeYVVT _`^ ZT d_deV^%Z2 eYZU eY`f XYeeYRe eYZHd_deV^ YRUSW_Z`a`dvU `_ eYVT f_egi Sj Rd`R] ^ Z_`CZgLR_U[fde(" eY`f XYeeYVVT_`^ ZT d_deV^ hRdZ`^ fetS]VZ:_ `eYVch`ddeLR^R[`cZej`WaV a]Vh`f]U]ZVe`dW eYVVT_`^ZT^`U]TYR_XUL:aReeZff]Rcjj aV a]V ReR]`hVcdTZIVT_`^ZT]VgYR_UeY`dvZ_d`cR RVROŽ2^`_XeYVa``cVdELeYVcVdW^de`SVR\Z_U `WVT_`^ZTyjVRc_Z_X%eYReSVRd_`CJReZ_e` eYVzCRTeFR[RSZZej e`RWWTe eYVcVZL_`CVR]hZ] e`^RVeYZ_XdUZWWCV_eL`_]jR\Z_U`VhZhVN] eYZ_\Z_XZAV a]VRV_`eT_dZVcZ_XhYReRTeZ_ eYY_TR_RTeFR]jeR\VLSfeRV^VCVJjVacVdZ_XR UVdZVVCTYR_XXŽ

EY dVZUZZUTRJdhY SVJZZVeYRe VgVcjeYZX YRdX_V_eYVdR^ VLUVdaZeVeYVTYR XvdLeV Ue` SV^`deV_eYfd2Rde2TRS`feR_VhdeRce2EYVhR eYVj af e Ze Zdc`f XYjj +yDWZ_XeYRe eYVVT _`^ ZT djdeV^YRd_eZ`ac`gVU^ja`dÆZ_ŁZe`fXYee` SVTYR XVLŽ%3feeYVjVRcZXVkcTYRXVRdZł ToURONAT_ac`a`ceZ_e`eYVWMRcaVa]VYRgV`WY_ł ~ZTeŽEY dVcVda`_UV_edhY`^`deUVdZCVe`Rg`ZU T_~ZTeRCVR(d ^ `de)ZV(j e` ViacVddRUVdZVVVc TYR_XIŽEYVT ccV[ReZ_df_UdaRcRUiZR]+eY dV hY`WACT_~ZTehReTYRXXŽE`afeZeR`eYVc hRjŁhYV_aVa[VU_`ehR_eTYR_XłZeUVd_`e dW^ e` SVSVIRfdVeYVj WRcT_~ZIeŽH YReeY dV hY`U`hR_eTYR_XVdW` e`SVdVa`_UZ_Xe`Zd eYV} code a Roe `WeYV` a eZ_+y2 TeZ X R] e`XVeYVeL hVTR_< %;VVTYR_XVZtUZgV_ Sj R]]LeYVeVZt_` WUe`WMRcT_~ZTeŽ

3j T_eRRehZey eVVj VRc_Z X%dW_Z $dReZ_$ e TYR_XVZ eVVVT_`^ Zid deV E UZc ZU``h Y`7 \]YUbg]bhYfj]Yk YX glUhYX h UhÎ gc VJU`]b! Yei U`]hJYg`Uj Y`U`k Ung`Yl]ghYXž UbX`h Ymi U`k Ung'k]``I`'= VdleYR_ReYZU1S'' / SVJZgVeYJ TR_TYR_XVeYV R_U'' (″ $eYZ \eYJ$ RVRac`UTE `V&YVVT_`^ ZI'd $deV ZE YZI^{A}$ R[` dzj daa` ceVceYVac`a` $dEZ_ eYReZ Vbf RZj ZIZ ^ f <math>dS$]VTR_ SVZ_eVacVeVU Rd $eYVy_Ref dZReZ_%$ VR d`TZR] $dEf ReZ_ZEYVAVAV a]VeV_U e`gZh d`TZej RdR$ $_Ref dR] aYV_`^V__ eYRe ZISVJ`_U eVVT_ec`]$ $`V&YVYf^ R_hZJZ$



2^`d?JZA`R_UR_REFORJZAVU dEREV`WEYZ_XdTR_ SVdW_Rdeh`dZUXd`WEYVOR`VTZ_ŽE`R]VdAvc VFeV_eL^V`SVcd`WEYZEJXc`Fa`aeWc^`eZGREVU T_Wc^ZA`Ž_eYZETRALEYV_REFORJZAVUd`TZR]`d UVcZddW_W7^RgVcjUZWWCV_eaVcdaVT6ZgVŽEYVdV REVZ_UZGZLFRJdhY`WVJeYY_RCVVT_`^ZTXRZ_Vcd R_UhY`RV^`eZGREVUe`dZ&VVgVcj`aa`cef_ZjŽ 7`c eYV`Ld`TZR]YZVCRCYZVdCVERZ_eYVRFOR`WR y_REFORJ`dUVC%Z

ER.Z_XeYVXc`faRdRhY`]VLR]RXVac`a`œZ_ Zl^RUVfa`VWLf]eZ_UZgZtfR]dReR_ZeVc^VZ ReVdTZIVT_`^ZT]VgY]hY`]ZgVZ_fcSR_RVRŽ ?Refd?JZRZ_LeYV_th`f]U_`edW^e`SVd_`_ji ^`fdhZeYeVVZ_U`VycVZX_RZ_%cvJNRZC^% `VW_RecZSfeVUe`]`hIZ_T^Vd/Te`cdŽ:eTf]U deYVccV-VIeRT_d/cgRzgVT_TVacZ_`VdTZd cVJRZ_d+yZcdR]hBjdSW_eYZthBjLR_UeVvcVd _`eYZ_Xe`SVU_VRS`feZ%ZEYVY`]UeYReeYZti y_Refd?JZRZ_%0VeYVdTZd`dVcYRd`_aVa]V dfXXdddeYReeYV^RZ_`SdRT]Vde`UvgV]`a^Ve Z_4YZvTf]USV`WRTf]efd?]_RefdZ9`hTR_ RdTTVdtM]_RZ_ISfZUZ_XVWVceSV^RUVhYV_ 4YZJR_dTcVRzgVV_V3jZlaRRJjdUUSjR_Refd?] ZXUgZh`VeYVh`d[U0

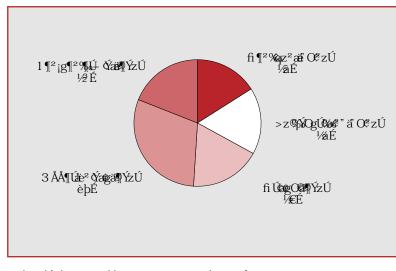
=A 5; 9GC: Ht 9 97 C B C A = 7 GMGH9A

EYVLÆZLVSVENW_VT_`^ZTXRZ_VcdR_U]`dvcd ZleYV\Y }_UZ_X`VeYZITYRaeVcŽEYZlUZIY`e`^j _WLde`SV^`UZ_VLY`hV&vESj ScZ_XZ_Z_eV `eYvcUZ`V_dZ_dcWvccVUe`ŽH YV_eVVUZWvcV_e gRZFSJVdRcVT ^ SZ_VLL}gVT]]VT&ZVZ_Rd ZdV^VcXvŽEh``VeYV^RcVYVJUSj XRZ_VcdR_U eYcWSj]`dvcŽ

H 9 7 C B: = 8 9 B H; 5 = B 9 F

 $EYV \} cde Xc fa `VXXZ VcdZleYV d` R]Vde `VeYV \\ gVET ^ acZZ X''' `VXVda `_UV_edZ ed^ V SVcd \\ ReV Z UZgZL f R]dh Y T _dZVc eYV dAgVd XXZ Vcd \\ R_U UZda]R dec `_X VXYZ Xd `VXT _} UV_TVL acZV \\ R_U UZeh RG dEc ` RS `feeYVVT _ `^ ZT d deV ŽE YVJ \\ R_V h Z _ VcdeYc f XY R_U eYc f XYLdy VXVdf dVUR_U \\ \end{tabular}$

$$\begin{split} & \text{S'\%B=} i \ \ddot{a} \ \dot{e} \\ & = z \ \dot{A} (\dot{z} \ \dot{Y} z^2 \ \textbf{e}) \\ & \text{General} \|^2 \ \dot{Y} \\ & \text{General} \|^2 \ \textbf{General} \|^2 \\ & \text{General} \|^2 \ \textbf{General} \|^2 \\ & \text{General} $



> ¶ĩ lắz nă lźÅ Oźqä ¶² äcezä Oź
Ý Čá ¶%äcezä B1 L; äl Oct ¶² Oão ĩ lắz orai þ
þ½ É

hZeY_`UfSedRS`feeYVZc^VZedŽEYVjRcV^`eZ gReVUSj TYR]]V_XVdR_UdW\e`RLRaeZ_RTcVReZeV R_UV_ecVacV_Vfc2R]hRje`VT_`^ZTUV^R_UdŽ EYVZc^`dedRJZ/eWRafcVZdeYVZcgZh`WdTZkj+ eYVj cVXRcUS`eY eYVVT_`^ ZTd deV^ R_Ud TZR \mathbb{Z} Vof RjæZdRd_Ref dRj a YV_` ^ V_RŽE YVZca` dÆZ_ Tf]USVd^^ WfaRd+yDWZXeYReeYZdTZR `dVcdfZed^VLZe^fdeSVRX`U`_VZ%?`eVeYReL Z_ eYZITRALeYVT_TVae`VeYVyRTe`c%ZIWf_U Z_Rdd172ReZ_hZeYRT_dedRZ_e`_eYVya`dd2S]W2G $? VZEYVceYVVT_^ ^ ZTddeV^ _ ceYVZ_VbfRZEZd$ Z_d TZA (TR] WC TOZZZA ŽE YZI dy WROOT CR_TVZI Rď SROU`_`eYVć TYRCRIEVÉZEZIČŽ> V^ SVcd`W eYZIXcfaeYZ\eYReTfccVedTZRTYRXXdYRgV RTJVRcUZEVTEZ_R_UWWJdfcVeYRe^`cVYRdSW_ XRZ_VU eYR_]`de Sj eYV^ Ž:_ XV_VCRJL eYVj RcV YZXY | $dMVT_{U} e aV a V VX^{A} eYV YZXY R_U$ ^ VLZ ^ łYZXY decReft RXVU`gVc \$&R_Uh ZeY RXVRe UVR] ` WUF TREZ_R] TRAZERŽE YV/ h ` c\ Z_ DR_eZEX $R_UZ d d R R R \tilde{Z}$

H = G = G = F = F = F = F; ; 5 = B = F

EYVol/T_UXc`fa`VWARZ_VcdZd[fdeRWARTeZ_]RcXlc1" (~ /Ž:ed ^ V SVcd.]ZVeY dV `WeYV} cde `VLdWeYV`dMgVdRdXRZVcdRUWWTT}UVe R_UV_eYf dBrdeZTRS`f eeYVVT_`^ ZT d deV^ ŽEYV chef je Zieł Reevy Rcv Rieżęnji T_Wc^ ZieR_UdW e TcVReVRa | RIVV/ceYV d/gvdReR | T dedŽF_|ZV eYV^ V^ SVcd` VeYVacVeZfdXc`faLY`hVeVLeYV RevTYRoRTeVOZKUUSj Robe`_XjVRc_ZXVVcTYR_XV Z_S`eYeYVVT_`^jRUd`TZVejŽEYVjdRjeYVj RCVXRZ_Vcd_j VeeYVj h`f]UdeZ]]ZVe`dWeYVVT ł _`^ZTdjdeV^R_Ud_TZRjZ_VbfRjZeXdecR_dWc^VU Sj RT^^`_WWW.ceŽEYZelSc`RUUV.dZVVV.cTYR XV dW^ de` SVS`c_`fe`WeYVdfS[VTezeVViaVeZ/_TV `WaVa]VhY`YRgVSW_RS]Ve`RjeVceYVZc`h_ dzfReZ_eYc`fXYUczgVR_UhZ[a`hVcžEYVT_ł T]fdZ_Tf]USV+y=Védh`c\e`XVéYVce`TYR_XV $eYVdTZR_{}^{T}dVdSVIRfdV^{j}VR^{a}VdYhdZeTR_{}$ SVU Vމ

EYVekt^ ydyfWARICZ;TZ_XXRZ_V%26tfdvUVkceYZd Xc`fae`V`aYRUKKVeYVWRTeeYRe26d^V`SVcdYRgV ^R_RXVUe`Xke`_R_USVT ^VXRZ_VcdSj ^VR_d

`VIRYRU decf XXIVŽE YVj REVXRZ_VcdSVIRF dv' VeYVZc `h_WWW.cedR_UdRIcZ;TVdŽ>R_j`WeYV^ deRceVU feReR] h d TZ lVT _ ^ 2T Vgy R_URV of dR Z `c2XZ_ŽEYYJ_Z_T]fUVRY2XY_ac`a`ceZ_ `W`h_ł RTT f_eh`c\ValY f dhZ VdR_U4 ReY]ZdZ2 $dZ_$ eYV} cce Xc`faŁeYVj eV_Ue`SVj`_Xa`]ZeZTR]j e` eYVTV_eeVR_UTV_eeVI]W&Ž:_ eYZ:17ReMLY`hVgV&L eYVdVa`]ZEZIR] a`dZEZ_dU`_`eeeR_dReVZ_e`RT]VRc Rdt V_e Va TZR $TYR_XZ > R_j Z UZZLFR dZ$ eYZEXC`f a SVJZgVeYReTYR_XVYREJSW_SV_Vj TZRJŁ Sfe^R_j `eYVcdSVZZgVeYReeYZ_XdYRgVX_V `_ eYVdR^ VŽEYV\Vj a`Z_eLeY`f XYLZleYRe eYV ^ V^ SVcd` V&YZCIXc`fa XV_VcR]jj UZca]Rj R]`h [VgV] `VR^``dRJZh` R_Ua`hVdJVdd_VddŽ4`_gVddJjŁeYVj RcV Wef cVI ` cZV_eVUŽE YZd d^{*} XXVded R a ` [ZeZIR] ji $Z^{*} a^{*} ceR_e T_T f dZ_{+} bX_{j} X_{i} U^{*} g^{*} Z_{c} a^{*} h Y^{*}$ `ck Yf ghfUh a `k \c 'UfY'Z h fY!cf[YbhYX'Xc' bchX]gd`UmU`\][\`YjY`cZdckYfYggbYgg` UbX Ua cfU]ga ": WeYZ Z d LZ Z T T TZ Wc af S|ZTa`|ZZZde`YVJa XV_VCReVRVKefcVI`cZV_eVU `fe]``\Ž

Ht 977F+H75@@CG9F

 $EYVTCEZTR[]`dvdXc`faT^acZtvd")" ``VR[]$ eY dVZ eVcgZh VLŽ2aRce VV ^ UV _ Z XeYV dvgvd Rd]`dvcd.Zed^ V^ SVcdU.Zeb.]R, WWZ_Xd` WZ_dVTf cZej $R_U R_X c e^{h} R c d e^{V} V T_{-}^{A} Z f d e^{V} R_U W$ $UZZ f dZ_^ VeR_UR_X ce hRddeyVTYR_X dZ$ XV VRŽEYV eV Ue`S]R^ VeYVvd deV %WceVVZc acVUZIR^ V_eŽEYVeVc^ yTcZeZIR]%Zelf dVU SVIRF dV $eYVdV aV a]V dW eYV VT _`^ j R_U Z_V bf R_ZZd$ Rdd TZR ac Uf Ted Z a dW Sj R d'R] ^ Z `cZejŁ $R_U Ze dW d[ZV] eYRe eYV ^ R_V eYVW] hZX$ $]Z \rightarrow yHVRcV$ dd SVIRf dV WeYV d deV eVV YRgVZ'a`dVU`_fdŽ%2d^ZXYeSVViaVTeVUW/^ eYVZcTcZeZTR] deR_TVLaVa]VZ_eYZtXcfaeV_Ue` devide/ReeYVTYR_XiddW_Z_4YZVYRgV_`T]VRc $RZ^{*} \subset U de Z_R e Z_Z Z 4 \subseteq d b f V_e j L d^{V} We V$ UZA]RJ R_`_łT_Wc^ ZeReezer UVe hRddeyVVT ł _`^ZTd_deV^Ž2]RcXVcac`a`ceZ_`VVeVV^ acWWc RoteRevXi `WeVIReZ_RIT_We^Zh hYVeVSj eVVi egi e`RIYZkgVeYVZcXR]dSj VM}]]Z_XeYVViaVTeR eZ_d`WeY`dVhZeYa`hVeZ:eZelZ_eVeVdeZ_Xe`_`eV eYRe yTCZEZIR]]`dxcd%eV_U e` YRgV R YZXYVc [VgV] `WZ_T^VR_UVLfTReZ_1T^a]VeVdVT_URg`c eVTY_ZTR|VUFTReZ_/eYR_eVV`eYVceh`ejaVd`W



]`dkdŽeZla`ddS]VeYReeYY_^ZXYeYRgVYRS`fcVU ViaVT&&Z_d`WYR_XV^_]je`dWeYVdVWfdeReWLL eYVcVdF]eSVZ_XTcZeZIZI^eYReedR_dReVda`]ZeZIR]jj Z_e`]W&hZ_Xa`dEZ_d`cUV&RIY^ V_eZ

H± 9°C DDC FH B=GH=7 °C C9F

EYV]RCX&& Xc faLT ^ acZZ X S! \vee WeY dV Z ekogZh VLL dYRCVd R_Z RZ RZ RG TYRCRIEVSZKU Sj h YRe ZleVc' VU yR' CRZA %Z . `eYVch ` dLLR d cgZgR] deReVZ hY YZ J čh V/WEV Sj R_j ^ VR_d eYVz ` h_ ` c eYVZ VR' Zj čh V/WEV Sj R_j ^ VR_d eYVj dW} eŽ:_T_UZZ_dh YVCVd TZR] ^ Zdef de Zd YZXY R_URITVdle [f dzTVf_TVcHZ_LEYZIR_SVRcR eZ_R] deReVZ VVceYVa`` cVdEXc f adŽ2_UZ_UXUL yR' CR% dXdeV_U e`SVV0' ^ eYV]`h VcdeRef ^ L f d R]j RXUSVch W_S&R_U%dh ZeYT ^ a]VeVacZ ^ Rj VLFTRZ_R_U]ZZZ XZ_Rac`gZ_TZR] e`h_` c TZg Ž2dh V] Rd ^ R_f R] JRS`f cVcd R_UY`f dh ZgV&L R]RcXVac`a`ceZ_`VeYV`RcVaV a]V]Z_VUh ZeY d` R] R_U^ VLZ ^ h dXvUZ_LF dej R_U eRUVŽ

 $2aRe W/ eVZcR^{d}T_Wc^Zt^Z_dNRZ_$ e' eVVT_^^ZT_deVL'aa`ef_ZteZ_]`dvdRV TYRCRIEVZtVUSj eVZcR]^`de'eR]jj _RefcR]ZtVU gZh `WdTZtejZ?Z_V`fe`WkgVcj "! ^ V`SVcd @∕.łäł/pè

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> `WeVVXcfaeYZ\eYRedTZAJZWofRJZZAdRhRJd VIZEŽ4`_gVcMjL^`de`WeYV^RJdeYZ\eYRe eYVVT_`^ZTd_deV^YRdSW_Za`dvUSjRd*RJ ^Z_`dZjŽEYVdVaVaJV^RJSVdfaa`dvUe`dvRd_ RdW]`hd+y8ZgV_eYRehVTR_eTYR_XVeYVVdESS JZEYVU`dvRLZedVgVcj`_VVceYV^dMgVdŽ&EYV WWJZX`VZ_dVTfcZcjR_Ua`hVdVdLVdUZaJRJVU SjeYVXcfaa`ZedZ_eYZdUZVTeZ_Ž

=Rdelj ŁeVVekć^ Raa JZU e`eVV} V&Y Xc`f ałh YZIY T^acZMd"*~``Wotda`_UV_edŁd`^ RzXtdeh` g&R T^a`_V_edŽ@_ eV`_VYR_ULV&Xe`fe`W VgVg "! ^ V`SVd`WeYZLXc`fa dWeYV`dJgVd Rd]`dVdZ_eVVVT_`^ZTac`TVdtR_UeYZ\^`cV YRdSW_]`deeYR_XZ_VUSj eVVTYR_XdeYReYRgV eR.V_a]RIVŽ@_ eVV`eYV&LeYY_RVUZEZ_XfZhVU W^^`eYVc`]`dVdSj eYVZcYZXVcUXcW`W`_1 T_Wc^Zh`ŽEYVZcgR]fVdRvV`aa`dVUe` eYV VT_`^ZTd_deV^LhYZY eYY_gZh hZeY WJZ_Xd `WY ddR UR XXZ

 $> R f R h^c V d R U j^f X R U f e d W ^ e V j^h h$ VcdedRef ^ RcVd ^ Vh YRe `gVdcVacVdV_eVUR^ `_X $_{1}^{T} Wc^{2} = \frac{1}{2} \frac{$ Xij R_UUVêVc^ Z VUe` TYR XVeYVVi ZeZ X`dVc` W eYZ_XOŽEYV(U_`eckoZX_eYV^dMgVd`cecje`}_U R_Z_UZ;ZUFR]d]feZ_e`eVVZcacVUZIR^V_eŽ@ał a`dÆZ_e`eYVyd_deV^%a`eZeReVdeYV^e`TYR_XV ZŽ=Z.VeYVdMWRICZ TZ XXRZ Vc Xc f aŁeYZlej aV `W/dxcdjdeYReZWgVg`_Vh`c\We`XkeYV&S`eY $eYVVT_^ ^ T deV R_U dTZR Z_V bf R ZZ dT f U$ SVTYR_XVLŽF_1ZVXRZ_VcdLY`hVgVdLhY`ViacVdd $V_eYf dZ d^R R_UT_{UV_TVZ_eYVhR_eYVT f_eq}$ ZIX Z XL ` IT _ WA^ Ze]` dkadWW dey var _ WAVŽ EYY/U_`e_`h hYRee`U`ŁSfeeYY/h`f]USV hZjZ_Xe`eR\VRTeZ_ZVeYvj hVcV`VWcVURX`U Revé_Rezevil dvardu [Vdd ` Va`] ZEZIR | R_UZIV | ` XZIR `cZVeReZŽ



D5 H9FB G C : CC 7 - 5 6--@HM



EYZ1TYRaeVc]``\dReaReeVc_d`WdTZRSZZEj $\mathbb{R}^{2} \times \mathbb{Z}^{2} \underline{Z} \underline{U} \underline{U} aRdNdS`eYeYVadRIeZIRJZZNd`WWJReZ_dYZadR_U $eYVZcd^{T}ZR_{c}d^{T}ZR_{c}d^{T}ZR_{c}d^{T}ZCR_{c}R_{c}$ Z_UZ&Z_FRZRRZ_dY hVUe/Red TZRSZZEj RaaVRde SVdecf Tef cVUR)^_XR_ R ZIT __VTeZ_XeYVVR^ Zj `_ eYV`_VYR_UhZeYd`TZkej`_ eYV`eYVeZEYZd ac`gZUVdeYVZ`RXZ_Rg`V&R`Vh`c\hZeYZ_hYZIY

VRIY Z_UZZLIF R] gZ/hd`eYvcdŽEYVhRj d`TZRSZZZ; `aVdReVdZ_adRTeZTVTR_SVT_dZVdVUSj_^VR_d `VIRd`TZR] eef dež^Zdeef de RiZdZ UZTReZ XY`h`aV `cT_decRZ_W_cV_ReZ_dhZeYeYV`eYVcRcVZHYV_ Df cgy/LeVVT ^ SZ_RZ_ `WeVdVeh` R Vdj Z/Ud WfcT_}XfcReZ_dŽ6RIYXc`fa`WeVda`_UV_ed V^S`UZ/dRdzVIZ/TT^SZ_RZ_`WarRTeZIVdR_U cláckál eReZ dŽ

5 GC 7 = 5 @DF = J 5 HGH

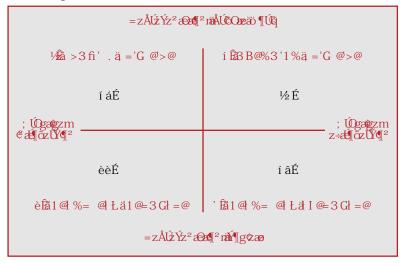
 $EYV \} cde Xc f a T ^ aczMdyRd TZA aczgRezded%R$ $eVc^ eYRed ^ RezKVdeYVT ^ SZ_ReZ_ `VWR^ Zj ł$ $TV_ecVUZ RZ_Rcj R_UhZeYUCRh_ YRSZedTYRRI$ $eVczdeZT`W ZdecfdeWJ aV a]VhZeY f e VZV_UdR_U$ $hZeY f ed TZA aRceZTZREZ_ŽAczgRezde4 YZVR_d]ZgV$ $Z_R_UVceYVZc VR^ ZZCH-y2d]`_XRdeYZ_XdRVX ł$ $Z_XhV]] ReY ^ VL: U_`eTRCVhYReYRaaV_dZ_eVV$ $T f_ecjZ6EYVJ RCVcGeZZXSVIRfdVeYVZc VaVcZ$ $V_TVZdT_}_Ue` eYVcCdeZZeVUY`cK`_`VeYVZc$ $_VZXS`f cY`UR_UeYVacCd/_eZ3VIRfdVeYVZc JZgVdL$ $hYReYRaaV_dZ_d TZAj ZLRZV_e` eYV^Ž$

y2d TZR acZeRezted%acVdV ed ^ VolaVIZ TecReetŽ E` SVXZ_ hZeYL'! `WaV a]VZ_ eYZdXc fa RcV $h^{V} = W^{A} e^{V} h c de Ref^{Z} + Z d LZ M R U$ eYVcVJRezevjj YZXY RevCRXVRXV`VXXc`fa^V^SVcdL $T f USV Z VU e R^ HR R HR T_1$ We^ Zh \underline{Z} eVVVT _ ^ A Zh daYVeVŽD ^ V \underline{Z} W eYZd.Xc`fadW.ViT]fdZgVjje`XRZ_eYV.XcWReVde RUBR BRAVVIC BYV MIGVER U BYVZC VR ZZEČZ_U eYZdeV_UV_Tj_VieV_Ude`a`]ZeZTdLhYVeVVdR^V ac`a`œZ_dr`h eYV`dv]gvde`SVZ_UZXWKV_ee` $UV^{\uparrow}TRIJZ3VHUV VT_{\uparrow}R^{\uparrow}RJHVHVT_{\downarrow}R^{\uparrow}RJHVHVV$ a`]ZZIR] UZRWWIEZ_ŁEYV^ `deac`^ Z_V_eTYRCRI} eVezdezt Zeley VWWZX`W'ddžeh` eyztud`WRd TZR acZeReZtedT_TfUVeYReeYVjYRgV]`de^`CVeYR_ eYY YRgVXRZ_VUSj 4YZVdcVTV_eUVgV`a^V_eL R_U gvc YR]VaVcTVZgVeYV^ dv]gvdRdVT _ ` ^ ZT]` d Važer V R] e XveyveLeyvelv Tyrerievezezidavevr eYVvgvg UBJ ViaVcZV_TVeYRef_UVc]ZkdeYZdg aV`W d TZRSZZEj + d TZR] VIT]f dZ _ Ž: _ ZELeYVVBRZ_Vdd`W eYVd TZR S`_UZd^ R_ZWEWUŽE YZWRXZZEj TR__`e SVReecZSfeVU`_]je`VT_`^ZTTRfdvdŽ7Rc^`dvL Ze ZdUFVe eVZ RXZ ReZdeYRe 4 YZVR d TZKej TeVRevel RS`fe Zed MV Red RT || VT&ZeV`d WŽ

-BH9; F5H98'9LHFCJ9FH

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>¶ï Úgzn**a**, ÚzÅOÚzqa¶²äaeezä) OÝÓ?a¶%äaeezäB1Ł; äl Oze¶²O6a>ï Úczonai þþ½Ê

CIH, C=B; DF=J5H+GH

H YV_ZET ^ Vde`d TZR] $cV_REZ_dA YZ_{VR}$ TF] ef $cVIR_$ `eSVUAZTEVURdS]RI\ R_Uh YZALZ_R_U `f $eZdYRdSW_dW_{LeYVVZ}IR dYRaLT_dZEV_e$ T_eRde SVeh W_ eYV yRd TZR] acZgReZEV&R_U eVV yZ_eVXREVU Vice`gVceZa A`_gVcdNjLXc`f ad # R_U SZ_eYVS`iL^ R_ZXf a R]^ `deYR]WVEVVdR`a]VL cV_REVe`d TZG Z_R]VddT]VRd TF eh BjZD^ VcVi da`_UV_edLh YZ_Va]RIZ_XeYVVR`Zj_ReeYVTV_eV `V&VVZc]ZgVdLRd TF]eZgReVd^ Vd`TZG eZdZ@eYVcd YRgVR_Z^ RYZ_Rj_`Vdi TZG ERVF_VRJ_RS`f e d TZG cV_REZ_dYZaZ



8 c fa # ZleVVď R]Vde `VeYVWfc1"% / R_U Zd ^ V SVd RV ý feX Z X acZgREZhťŽE YV ekć V aYRŽ&deVT ^ SZ REZ_`Wh`hBjd`WMREZ X e d TZ/g eYReRVX/VR]j cVRdUVURUZWKV eŽ > V SVd`VeYZLXc`fa T ^ SZ VV/V V_ed`VeYV yacZgREZł% g aV hZeY V/V V_ed`VeYV y4 ce`gkte‰ g aVŽ=ZVRd`TZRj acZgREZheLeYV/VZ UZZLfRdRV XV_VR]j T_TV_U`_]j RS`fe eYVZ VA`Zj R_U Y ^ VŽEYVJ RJd d/RVRd TZRJ ac`}]V4`]U/cRUf JeL]`hVcdeRef ^ L^ R_fR]JSS`fc/dR_U`h_HRTT f_e h`c/VdŽ2e eYV d?`VeZ`VLeYJ c/dV S]V yZ_eNJ XREVU V ec`gkte%ZZ eYVZ.`feX Z_XUZa`dEZ_Ž EYYJ YRgVa]V_g``VWZV_ULR_UeYY aReZIFJRCjj]ZV^ ZZ_XhZEY eYVZ_VZXS`fcdR_UaReZIZAREZ X Z_d TZE]`cXR_ZREZ_dŽ

EYVaRce2ff]R:Zej `WeYZIXc`faTf]USVeYVcVdf]e $`Weh` Welle`cdej aZIR] `WeYVy`feX`Z_XacZeReZEPZ`a$ $7ZcdejjLcV]ZZ_+ZeZddecZZ_XY`h^R_j`WeYV^RcV$ $adRI&ZZ_XSVJZ&gVcd:S`eYV&gR_XVJZIR]R_U4ReY`JZŽ$ $AV a]VhY`adRI&ZV/RcVJZZ_XV_VR]j YRgVR_$ $RW_Zej hZeY VR^Zj gRifVdR_URd`TZR] JZWSRcMU$ $Rc`f_U eYVTYfcTYZDVT_UjLeYVcVZIeYVcfcR]$ $`cZZ_`W^R_j`WeYVXc`fa`d^V`SVcdŽ:_eYV$ $Tf_eej dZJVLeYVecRUZZ_`VVI]`dvLVR^ZZRc`d/R$ $eZ_dYZadhZeY_VZXS`fccle/Ude`YRgVcfcgZgVU$ SVévé éYR_Z_TZZKŐZE YZIS VZ_XéVV IRMAL AVZZ f d adRIEZTV R_U éYV f cR] dkézZ X dW^ é` WWC R_ Via]R_ReZ_ Wc éYV R^ RJXR^ ` WyWR^ ZZI^ % R_ U]`IRJZI' éYRe IR_SV df ^ VU f a Z_ éYV a YdRdA yE YR_\ 8`U: `gVX e éYV_VZXYS` f cd é` YVJa ^ j WR^ Zj af]] eYc f XYŽ% a` _ dZ M Z_ X eYRe éY dW Z UZZZIF RJd.`]U/c RUF]ed W/ eYV]` h Vc derRef ^ Ł U _` ef df R]j ded j` f edZ VéV VZC Z ^ VUZ éVV_gZI c` _^ V_eL éVV]` TR] T ^ f _Zj TR_SV dW_Rd R_ V éV_dZ_ R_U dZ WCIV^ V.e` WWR^ Zj]ZWŽE Y dV Zd_` XARE XRa SVéh W_ éVVY ^ VR_U éVV ded WéL SVéh W_WR^ Zj d TZSZZEj R_U cV]ReZ_dYZ dW CXU Z_]` TR] TYf cIY` c_VZXYS` f cY``U` cXR_ZREZ_dŽ EYXdV a]V^ RJ SV dZU é` SV éVVY VR é% WéVV]` TR] T ^ f _Zj Ž

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8 c`fa \$ ZdeYV]RcXkdeLT_dRZ_ZXReYZU`W cVda`_UV_edŽEYV eVc^ yZ_eVXdReVU Z_ec`gVce‰ YZXY [ZXYed eYVT ^ SZ_ReZ_ `Wel TZR] Z_eVXReZ_ $R_U Z_{ec}$ gVcd $Z_Z E YV Rdt TZRe Z_Z R_ UU _VL$ SVIRFOVZE]Z_\dRT]]VI6ZEVZ_RZ_Rcj `WoTZkij hZey Rolyf TeR_TVe`YRgVUNRZ_XdhZey`eYvcdŽ@_ eYV _ VYR_UZd^ V SVdRVyZ_eVXReVU%SVIRf dV eYVj dY h R_Z eVcVdeZ eYVhRj eYVT f_eqj ZdX ł Z_XthZeYfeSVZ_XTYRfgZ_Z6Z7ŽEYVVR*ZjY]UdR]VddTV_eeR] a]RIVZ_eYVZc]ZgVdZ@_eYV^eYVcYR_UL $aVaVZ eYZW fa Wa eVZ UZ R_TWA eY dV$ $Rcf_UeVV + y, fdeSVIRfdV: \land ZeVeVeVUZ Yh$ eYVT f_eqi ZlU Z_XLU Vd_e^ VR_: YRgVe d_ hZEY eYVTc`hUŽ62_VgV_]RcXkcac`a`ceZ_`WeYVdV aV a]VeYR_ `VyRd TZR] acZgReZded%65 _ `edWeYVZc _VZXYS`focLU`_`eaRceZIZaReVZ_`cXR_ZkReZ_cL $R_UWW f_T \wedge We S VRc f_Ua caV a VZ$

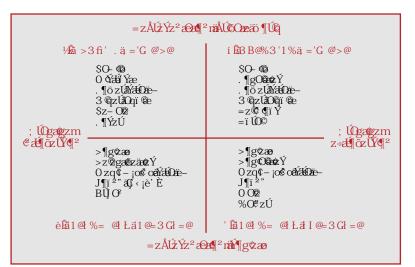
EYV R^SZAF f d a Reek UZta]R UU Sj yZ eki XREU Z ec gked% δ bf Zkd ^ cV U kRZ UU kra] i REZ _ŽH ZeY f e h ZhZ Xe]NR_ e ` YNR Zj ` _ eYV f cgy } _UZ XER TRWM δ KLZ X` VEV δ /TR_ dYU d ^ V ZX'e ` _ eV ^ Reek Z4 ` ^ a RZt _ h ZeY yRt TZR aczgRzZtet% ot ^ h d eYRe h YfY UfY 'hk c ` hmd Yg c Z gc WU`]bhfc j Yfg|cb'': _ eYV TRV ` W Z ek REW Z ec gkeet Ze Zlg]f _ eRg R_UZI ^ R_Z WEE UZ d NTEGV d TZSZZE eYRE Wc^ d a Ree ` VR Sc RU ckack / eRZ _ ` Wt TZk Z2 d TZR aczgReztet ` _ eYV eYK YR_ULU _` ef d R]j WcX/R_j d TZR S`_LUSVIRFdVeYY eV_Ue`SVaVa]VhY`RcV \{`T]fUVU€\{aV]]\U€ W}^ d`TZA]]ZWŽEY\Zc`_]j RTeFR]\{a\Z2_TV`WoTZA;jZleY\VR^ZjŽ

H YRe Z_~fV_TV ^ ZXYe yZ_eVX0ReVU Z_ec gVcet‰ YRgV _ eVV JZW W4 YZyR_ d TZ4j OE YY dvacvdv_eR eYZU`VM] eY dvZ_evcgZh VUR_UR RcXvac`a`ceZ_ `V&YV ReVj`f_XRUf]edi#&1\$%/SV]`_XZ_Xe`eYV ^ VUZ ^ HYZXY dcRef ^ R_U JZ5Z_XZ_fcSR_ReVRŽ EYY RCVeYf dZ_Ra`dEZ_e`Z_~fV_TVaRevc_d `Vd TZ5SZZ6jŽ> fTY hZJ UváV_U`_ eYV dyReZ_ł dvZa eYReZkdef T\ fa SVeh W_Z_eVx0ReVUZ_ec`gvced R_UZ_eVxReVUV ec`gvceLcZ_TVSVeh W_eYV eYY ^ R.Vfa'! '`` V&YVcR`a]VŽ

:_ T _TJf dZ _Leh` RdvVIed _WU e` SVV^ aYR dXwZ7Zddji LeYvVZlR } _UZ XeYRe Zd dX Z TR_e ZweYv UZWWCV_e T]]VIezgvZ RXZ RcZd RcV e` SV f _Uvde` U+ VT _`^ ZT ^ Reevid RcV` W _Jj cVJR ezgvZ a` dR_TVŽE YVZ RXVeYRe aV a]V Vc^ `W eYv dvJgvd Rd yXRZ Vd% c y]` dvd% Sj VT _`^ ZT UvgvJ` a^ V_eLR_U eYV XV_VCR] dv_dv` WYRgZ X XRZ vU`c]` deSj eYvd TZAJ TYR_Xddw_ Z 4 YZvL ZIR^ Rc\VUTYRCRIevizeETRe VZeYvc V_U` WeYVdaVII eff^ +Z_eVXRevU V ec` gvded R_U Rd TZAJ acZgNezdeŽ 3f eeYZddyWaVCTváeZ _ZL` eRUVevc^ Z Z XWR c Wc eYV` eYvc da` Xc`f adŽH i gz`Jh WUbbc h VY` 'UJX Xck b UgUfi`Y h UhdYcd 'YĨŷYWc bca]W gY'ZdYfWYdhcb d'UngU XYhYfa]b]b[fc`Y]b` h YJf`gc WJUV]`]mn'

 $EYV dVT _ U`Sdv&gReZ _ T _TVc_deVV UZWWeV_e$ $]Z \ dSVeh W_ T _TeVeV R_U Z'RVZ_RG V_a VeZV$ $V_TVZ: _ `_VTRMLeVV a ReeZUZReZ _ `Wy f eX Z_X$

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>¶ï Úgznä). ÚzÁCUźqä¶°äcezä] OYÓä¶%äcezäB1Ł; äl Cus¶°O&sï Úzzonai þþ½Ê

acZeReZtec%Z_eYV]`TR|T^^f_Z; SRR_TVdeVVZc yNR^ZZEZT%Z^RXZ_RcjŽ:_eYV`eYVELeYVd`TZRj Z'RXZ Rcj `WXZ eVXcReVU Z ec`gVced%a]RIVd eYV dyVTezev_VddevVj fdFR]jj UZda]Rj Z_ eVVZcUVRJZ_Xd hZeY`eYVcaVa]VZR_Vh |ZeYeŽy2dTZR| acZeR eZtel% ReVh`ceYT_dLVcZ_X dvaRcReVjjŽ>RcXRcVe $E Y Ref V (cdh V) | \ (h UZ) (cdh V) | \ (f T Y)$ eYZ_XRdd TZkjŁ`_jj Z_UZcZlf RdLZlRaa ZIRS [Ve` eYV Ž3fehZeY fectWkV TVe RyH VZeZUZWIfe e`TeVReVeZd`Wa`[ZLReZejŽEYVd`TZR]S`_UZde`` WARZIE TaVhZEY^REWCZRJZ_dVTfcZejŽF_TVceRZ_ej RS`feeYV^VR_ZX`WZWZ_d'TZkej ac`gVde`SV ^ $CVZ' a = def[Zy@_e] XIR Z_dVIf cZe <math>\infty$ 18 ZUV d." **" / Ł|Z \Ue`eYVYf^R_T_UZZ_Ł Zd ZV ji e` RWWTe Z UZeZLF Rd^ ` cVdec` _ Xji e` eYV VieVeeYReeYVihZeYURhZe`RacZeReVh`dUŽ



DC @= 175 @= A5; = B5F = 9G



EYVd. VéIY `W4 YZVdTF]ef dR] ^ RezZ. ackdV_éVU Re eYV `f edvé Z TJf UVU R dr `œ UV:TkZaéZ_``VeYV T f_egi da `JZZIR]Z RYZ_RZXÁŽCUWEV_TVh Rd^ RUV e` eYV VJV V_ed `WT_éZ fZgi R_U UZT _éZ fZgi TYRRIEV:ZKZ_X R \Z U `WyZ RYZ_Rgi `W d.Vc%Z 4 YZJVR_ YZE ġ ŽE YV ackgZ f d C Va`œ e` RU UCV:dNU eYV d'S[VIe `W d.Vc Z_ af S]ZT `aZZ_ 1F ? 5 AL#!!!! RZ@_ eYRe`TIRZ_ŁRaRCRU i ZIR] dEf REZ_h RdZLV_éZ VUZH YZVeh `eYZU:U VeY`dV Z ekcgZh VUZ_eYV'' *** Df œYV Vbf ReVU`d.VchZeY RXXNe Y f d/Sf Ze Sj eYVT ^ ^ `_ WW:ced`VR]JL ^`cVeYR_YR]VVVeYV dRh UZWWEV_TVd`VZ_eV:vide R_U`aZZ_dRdU/ez? V_eR]e` eYVT f_egi df_ZjZ EYVT_TJf dZ_h RdeYRev:da`_UV_edV_gZRXV`d UVcRdRT]]VTeZeVT _dedTeLSfeeYVjRddW^e WRcalfdZgRdd^VeYZ_XUZZZZZZŽZ_`eYVch`dUL eYVf_Zg``WdTZR]`dUvcYRdSVT^VRac`S]V^%Z EYZdac`S]V^RaaVReVUR]]eYV^`dVfcXV_eZ_eYRe eh` eYZUd`WAda`_UV_edSVZZgVU eYReZ_4YZV eYVcVhRd^`dVUZZZ_XaV a]VeYR_eYVcVhRdf_Zd Z_XeYV^ŽEYZJSRIVXc`f_UZIRfdWN]dV^Z_UVc`W Y`hZ'a`ceR_edTZR]Z`RXZ_RZZdTR_SVŽ

 $4 YZVR_dYRgVR_Rc^{*}d|V_XeYcVReZ_dYZahZeY$ UV $TCRIJZ4 \ C Z XacVeZ f dF ? 5 A UZ XeL$ % `WeY` dVZ_eVcgZhVUVi acVddVUf_deZ_eZ_Xdf al a`ceWcUV``TcRTjŁhYZV")″ eY`fXYeeYReLZ TVentZ_TZETF ^ deR_TVeLR_ Rf eY cZERZR_ X gVc_ ^ V_e Tf]USVSVævčŽ?`]VdddŽLŽ;TR_eZdeYVZ_UZWVd V_TVe`eYVTfccV_ea`]ZZTR]d_deV^UZa]R,UUSj R eYZU`W4YZWR_ďŽ2]^`deReYZU`W9Y`dVdf cgYjW $RVyZUZWKCV_CR_UeYZ \setminus Ze^RVd_ UZWKCV_TV$ hYVeYVceYVXgVc_^V_eZUV^ `TcReZT`cRfeY`cZ eRc2R_ŽEYVeV}_UZ_XelSVRc`feeYV}XfeVelVeV^ `eYVcd`cgVjdud`TYRdeYV=ReZ_`SRc²^Vec`/eYRe ZUV eZ4V4 YZVRd` V`WeYVT f ecZkdZ eYVkWZ hYVeVofaa`ceWcUV^`TeRIjZel]`hVdeŽ

2dRX/_VR of JVLZeZelect Ve`dR eYReh Y a cfY.]gc `UhYX`UbX`k]h XfUk b`dYcd`Y`UfYž h Y` a cfY⁻h Yma |gfi ghch Yfg UbX⁻h Y⁻a cfY⁻ `_Y`mih\YmUfY`hc `VY`Ya chcbU``mi bWca ! a IntX hc XYa c WUWM 2e eVV eV/c Vi eV/ VL eYVXXReVdedfaa`ceWcUV^`TdRTjZdWf_UR^`_X $aVaV_{Z}RX`U\}_R_TZRa`dEZ_R_UhZeYRYZXY$ UVXCW WITZRZ Z EVXCREZ ŽEYVT ^ a VI CVIREZ 1 dYZaSVehW_aVa]VdReeZefUVde`UV``TcRTjRU $eVZcVT_^ ^ TUUUTZR a UUTZR A$ SjeYVXc`fa`WeY`dVhY`SVJZkgVeYReR_Rfł eY czercze: X g/c ^ V e TR SV SVee/c Z TVceRZ dÆfReZ_dŽ> V^SV:d`WeYZdXc`faeV_Ue`SVj`_X e`eYV^VUZ_^łYZXY decRef ^ SfeWWJeYV^d/gVde` SVVT_`^ZT]`dvcdŽEYVcVZdR^Zch ReTYSVchW_ eYVZcdTZłVT_`^ZTa`d&Z_R_UeYVaVcTVaeZ_ eYV YReV VXEZ@_ eYV _ VYR_ULeYV RCVZ_ eYV YZXYVćZ_T ^ VSdRI\VedR_URcVhV||V_U hVUhZeY eYVd.Z]dcVbf ZVUV/c^ `UVc_ZREZ_ ac`TVd1/dŽ@_ eYV`eYVLeYZlfahRUJj^`SZJVXc`faZleYV^`de dV dezeve evvr ^ avezev vdi va Tza cvrez d e`URjŽ:ed^V^SVcdhR_ee`SVSVeeVceYR_`eYVcdL `cRe[VRde_`ee`VR]SVYZUŽAVćYRadVvćeYZdcVRd eYVj f d R]j VeZ TVeYVYZXYVe dReVd`VZ dVTf cZej Z_cV[ReZ_e`eYVVT_`^ ZTd_deV^LR_UeYVj_eV_U e`eR\VR_VXRezeVgZth`WerVhRjeYVZcaVcd_Rj $R_TZR | a \in Z_T YRdUvgv| a VUZ$

2d UZEIF dbWZ VRC Zć TYRaek dLaV a VdaVd $T_{aeZ} \ WeWZc \ h_ \ R_TZR \ a \ dEZ_ ZlUWa \ j$

Z~fV_TVUSjeYVhRjeYVjgZvheYVdTZRjS`_UŽ EYVa`eV_e2R]jjyRfeY`c2ERc2R_%Xc`faU`Vd_`eWWJ a`hVc]Vcd`cUZETCZ`Z REVURXRZ de |Z.VeYVyZUZW WKV_e%Xc`faŽ:ed^V^SVcdWWJeYVJRcVVMJjaRce `WalTZAGELR UeYVJ REVRS[Ve`]``\e`eYVVAAG eVŽ 4`_UZEZ_deVfddW^ e`SVWrgfdRS[Ve`dTZR] S`_UZXŽ?`_VeYVVdtLeYVYUZAJRJ VeVVd`VdTZR ^Zelef de R_U R^ `dR/Zh^ dZ'ZRc e` eY`d/Wf_UZ_ eYVyZUZWWCV e%xc`faŽeYVVXRZ,Vdd`VeYZdd`TZR S`_UZdaVcYRad`_V`WeYVdec`_XVdecVRd`_dWc acWWkcZXR RfeY cZERCZR cWZ VŽEYV aa deV

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cVJReZ_dYZaTR__`eSVcf]VU`feLY`hVgVvŽEYV T) dv Rdd TZReZ_SVehW_RfeY cZeRcZR_[VR_Z_Xd] RUZIV ož TRoZ hZey ev v ožsve RUTV ec V ožsve

df XXXdedeyRea` ZZZR RYMZRZ_dT f JUSVeYVacZh eYc f XY h YZIY aV a VaVcIVZeVRh cdV_Z X VeVZc `h_}_R_TZR]a`dZEZ_R_Ud`TZR]`d.VcZ_XV_VCR]Ž

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 $5 V^{T} T dR_{J} Z_{1}^{e} [f de R dZ_{J} V T_{V} e Sf e R$ ^ f) e XRIV e VUVI a V ZV_TVŽ_UZe XLF R dVI a V ZV_TV e YV UN `TOREZT` dU/cZ gVg UZXWKCV eh R dR UReeRIY gvg UZWWEV_e^ VR_Z_Xde ZEŽ9 Ze cZR] Via v 22/Tvd R_UWRcdZ_ eYVacVdV_eLeYVejaV` WrVefcVUVdZVU \mathbb{R} U vývá UR hR d` WZZZXR Z~fV TVeYVZVRd eYRe4YZWR_dWc^RS`feUV^`TdRIjŽ7`fcZ'RXXd `WW^`TCRIjŁWć^f]ReVU`_ eYVSROZI`WeYVDf ceVj }_UZ_X&RCVacV&V_eVUSVj`hŽ

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EYV acWWACVUZ RXVZd`WRXR^V`WIYR_TV hYV&V^R_j a]Rj SfeWhhZ_ŽEYVyUV `TcReZT XR^ V%ZddW_ Rdd ^ VeYZ_XV&/ ^ hYZY`_]; Rd^ R] VZEVSV_V}eeLhYZVeYVSf \`WZEZKV_deR\VaRce hZeY`fe^R\Z_XR_j c\R]Z`aRTeŽEYZclVjZeZegZh eV_Ude $acVU^ Z_ReVR^ _Xj f_XcaVa]VR_U$ eY`dVW/^ eYV]`hVcVT_`^ZTdecRef^Ž:eZdVM/ bf V_ejj Wf_U_`e`_]j R^ `_XRd TZRJ Z_UZezLf Rjd R_U]`d\ddLY`h\g\dLSfeR]d R^`_XaVa]VhY` WW eYV RVZ eVX ReVUZ e 4 YZVR_d TZK R_U hY`UZAB]RJ RYZXY]VgVJ`WAMWWAAA^Z_ReZ_Ž $EYZd d' XX/ded R a`h VX/M T_Tf dZ_+ [fYUhYf']$ |bX|j |Xi U`|nUhcb XcYg bch YUX Vm |lgYZ

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@_VZ_WfccVda`_UV_edV_gZRXVUV^`TdRIj RdRWeSR]^ReTYhY&VaVa[Vecje`hZLSfe hYVeVeVVcf [VdReVeYVcR^ VVvc VgVcj S` UŽE YZd gZh YZXYZXYedeYVTV_ecRjZg``V&c`TVLfcVdZ_eYV]ZSVAR]łcvacvalv_eRezgVeeRLZEZ_`WW^`TARIjŽEYZd Xc`faZd_`eY`^`XV_VfdVZeYVoŽEY`dVhY`dYRcV eYZdgZhZ_T]fUVS`eYaVa]VhY`RcVYZXY]jZ_eVl XCREVUZ é d'TZR JZWR UZ UZeztf Ridh Y UZA R Rd SdeR_e2R UVXcW Vac22Re2Ch ŽEYV^ `deZ`a`d eR_e $UZ_XT_Tc_deYV$ f_XZeZd f_XaVa eY dVRXU") e` #%thY`^`deZV_eZ(VUV``TcRIj hZey RXR^ V`WIYR_TVŽ:eZdRd eVV hY`SV/ZdeV eYReZedeR_UdRS`gVR]] Wcycf [Vd%eYReR:VeYVdR^ V WcVgVgS`UjŽeZdh`œYcV^V SVcZXRXRZ_eYRe yeYVj`f_X%RcV_`eRf_ZVkc^ dve`VvaV a]VŽ

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EYV eYZU acWWCV_TV Zd eYRe `WeYV Xc`fa `W aVa]VhY`ZV_eZWVV``TORIj hZeYRolYZa`_ hYZY Vývý`_VŁW/^ eYV TRaeRZ_ e` eYV dRZ^dŁ af]]de`XkëYkŽEYZdTf]USVekc^WRyT_dV_ł ďR%Z RXV `WUV` `TaRIjŽEYVyUV` `TaRIj` `W T_dV_dfd%aV_Ude`acVU`^Z_ReV^`cVeYVYZXYVc faZ_eYVdTZłVT_`^ZTdTRVeYVcVda`_UV_ed RVŽF_ZVeYVacVeZfdXc`fadLeYZd`_VZUVRZdj Y^^`X/_V f dŽEYVT _d/_df Rj gZ/h `W/V^`TdRIj eV_Ude`SVd/RcVUSj eY`dVhY`RcV^Rc\Ulj Wi ef cN^ cZ/_eVLLWWJ eYVj RcVVT _ ^ ^ ZT XRZ_VcdR_U RCVVM]jj Z_eVXReVUZ_e` eVV]ZVV Vol TZkejŽ3j R_U]RCX/LeVV/RCVRUF]eR_U]ZeVZ_DR_eZRXLhYZV a`]ZEZIR]]j eYVj dfaa`ce eYV 4`_TVceRIZ_ 1eYV TV ecVI WAAT RZEZ_ TF ccV eji Z a`h Vc/Ž

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AVCYRadeYV | VRce RecRIGZVZ RXV VVV `TcRIj ZdeYRe`VRdfaVc^Rc\VehYVcVVgVg`_VeR\VdhYRe eVy_WLŽehRdRhRjddVRd_RS]Ve`eYZ\eYReeYV $V_aV_Z/TV W RdT_d^a a Z_h f U d d e Z_h$ eYVROOEF UV VXLV | XZIR RUYVEV TVSVZ XCVA | RIVU Sj RWIFd`_ eYVa`]ZEZIR] y`WWCZ_X2%RegRZIRS]VŽ :_UWULeYVZUNR`WeYVTZEXKV_RdT_df^VcYRd $SVT ^ VRfdR ^ VZ eYV4YZVR a ZZR UV$ SREVLSfeZedW^de`YRgV^RUVWhVcZ_c`RLdZ_e` af SZT azz Ž7f œV c^{-} cVLeVVIYRRIeVZEZd W eYVXc`fadW^ e`SVT_ecRLZTe`qjŽ@_eYV`_V YR_ULeYVEVZIRacZeReze Reczer UVLRIT ^ aR_ZUSj $R_Rch^{+} R_UWTfd^{-} eYVacVdVeLRU$ Sj Rolec`_XWWZX`V&`hVdVdd_Vdd_`_eYV`eYV& ^V^SVcd`WeYZELXcfaeV_Ue`WWJeYReeYYjRcV XRZ_VdR_UdW\ e`TRaZRJZKV`_eYV`aa`cef_ZZXd `WeYVd_deV^ŽedW^dLeYV_LeYReeYVdfaVc^Rc\Ve ^ VeRaY c cVd _ ReVd^ ` de Wc eY dVhY` T ^ SZ_V eV_UV_TZXde`hRdUdd TZR] yacZgReZd`%hZeY Ra`dZ

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ezgVaVcTVaeZ_`VVeYVzc`h_VT_`^ZTa`deZ_Ž EYVReeZfUV`WeYVa`]ZeZTRJT_df^VcTf]USV UVcTc2SVURdeYRe`VRyac2gRezdeXRZ_V%Z

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AV a]VeV_Ue`YRgVR^`_`]ZYZLdReZTZNR`W a`]ZEZTELRdeY`fXYZehVeV`_VoZ_XJVLf_TYR_XZ_X eYZ_XŽ:eZd`_ eYVSROZd`WeYZdT_TVaeZ_L`WeV_ R_ZNRZW _VLeyRe TZZT a RozZZARZ _ Zdf d R]j y^ VRfcVU%Z3feUV `TcRIjZL_`ecVacVdV_eVUSj $RdZ_XVZ RXL_cR_a^JZZdSVT_UV_dVUZ_e^J$ R dZ X VZ RXZ R d Z4 Z Z K d V a V Z V a Z Z R d Z Z Z R d Z Z R d Z Z Z R d Z Z R d Z Z Z R d Z Z R d Z Z R d Z Z Rac`TVddVdUZWWEV_ejjŁUVáV_UZ_X`_ eYVdTZRJZRł eZ_eYV{YRgVYRUZ_eYVR^Z; R_URedIY^`], `_ hYVeYVceYVj YRgVYRU^`cV`c]VdtT_eRTehZeY a`]ZZTdLR_UhYVeYVceYZtYRdSW_XReZtVZ_X`c edRf^ReZT, R_U`_eYVgVq UZXWKV_e^VR_Z_XdeYRe T^Ve`ReeRIYe`V&WU^ŁVofRize;RU[fdeZIVZ eYV]ZW`WKRIYZ_UZeZLIFRJŽ@_ eYVSRdZI`WeYVdV R_U eYVc Vi a VZV_TV2La ReeZIF]Rc Z' RXVd ` Wh YRe a` ZZZdZdR_U`fXYee` SVRcVd/RaVULaZtefcVd eYRe ReVfd/URdToZeVoZRe`XfZ/VeYVhRjaVa]V V_XRXVZ_a`]ZEZIR] RWWRCdZ4`_dVbfV_ejjŁdReYVc eYR_ RefTVeeRZ_Z_X h YVeYVc eYVcV Zd ^ `cV `c]Vdd aRceZIZaReZ_ŁZeddW^ dh ZtVe` UZebZ_Xf ZtY R^ `_X UZWWEV_ehRjd`WaRceZIZaReZ_XŽ

EYV|RcXxdeXc`fa1#(/ `WeYVdZ ZleYVyUZRW WTeVUaRceZTZaReZ_%Xc`faŽ:_]Z_VhZeYeYVeV_ł UV_TZd Solveg UR^{-}_XeY $dVUZh[R] Z_XyR^{-} dR$ T_We^ Zh $\& \mathbb{R} \cup \mathbb{R}$ aczerie ($\mathbb{R} \cup \mathbb{R}$) aczerie ($\mathbb{R} \cup \mathbb{R} \cup \mathbb{R} \cup \mathbb{R}$) aczerie ($\mathbb{R} \cup \mathbb{R} \cup \mathbb{R} \cup \mathbb{R}$) aczerie ($\mathbb{R} \cup \mathbb{R} \cup \mathbb{R} \cup \mathbb{R} \cup \mathbb{R} \cup \mathbb{R}$) aczerie ($\mathbb{R} \cup \mathbb{R}) aczerie ($\mathbb{R} \cup \mathbb{R} \cup$ cVda`_UV_edSVjZlgVeYReyVgVq``_VYRde` XVeSj eYV SVæeYY TR_ŁSVTRfdVa`]ZZTdZda`Z_ejVdVZEYVdV Revervy]`dka%z_4YZVdUvgV]`a^V_eac`TVdL_`e d ^ f TY Z_ ^ Rev(2R] eVc^ d€cVda`_UV_edV0/^ eYV]`hVcdecRef^ RcVRIefR]]j_`^`CVYVRgZjj cVacVi dVeVUeYR eY`dVWV^ eYVceh`Xc`fad€Sfe d'S VIEZV jŽE V j dWeVV dygvdRdUZRUR eRXU SjeYVVT_`^ZTdjdeV^R_URCVR_XcjRS`feZeL $R_U eYV_1 dW eYV_2 dMgVdRdYReZX_1^be^feW_2^$ d TZR] TYR_XVLR_UR:VgVq UZZ]f dZ_VUhZeY eYZŽ EYY WW VITH UW R_URSR_U_WZ2S`fe VZXYe Z_"!`WeYZdXc`fa`d^V^SVcd^Zeefde`eYVcdLRU RolZ'Z[Rcac`a`ceZ_RcVT_TVc_VU`_]je`^We eVVZc`h__WUdRdSVdeeYVj TR_Z_RdTZVej eVRe YRCROWN ŽE YV ZUR eYRe a` ZZZ d Z da` Z e Vdd $dW^{\circ} de dacZ XW^{\circ} eYZ W aVZ/TV^{\circ} W dR_U$ YVJa]Vdd VddŽ



eZZaReZ_%ZdT_}_Ue`eYVT^^f_ZejŽ@gVc YRW Ked^ V^ SVcdSW __Xe` eYV]`hVcdecRef^ R U RCVW/RJVŽEYVdeReV/V_eeyReUV}_VdeyZtXcfaZt yj`fYRgVe`XVeZg`]gVUZT^^f_ZjRWWKZdLSfe hZeY feXkeZX^ZWUfaZa`]ZZZCZZ5VeAZeVeYVZc]`hd`TZ`lVT_`^ZT]VgV[LeYVdVaV`a]VeV_Ue`WW] eYReeYVj RCVXRZ_VcdŽEYVj UZba]Rj XcVReWRc`WY_ł ~ZTELY hVgVELR_UeVV ac`SRS]j ZLV_eZtVa`]ZEZTd hZeYdedRZ_dR_UUZezZZ_dŽEYVdVWRedYReVe`U hZeyeYVZ'a`ceR_TVeYVj RdZX_e`eYVVR^ZjŽEYZd ZłdW_ RdRcWWXVW/ ^ RJZY_R_eWćTVdud TZkj/Ł $R_U YRde SVUWW_UVURXRZ_de dX_d WUZZZZ_$ 1a`]ZZIdŽ5VdaZeVeYVTV_ecRJZj`VeYVVR^ZjŁeYVZc ViaVZZ_TVU Vd_`e]VRUeVV^ e`vR^ `dR] VR^ ZZA^ ‰ Sfee T_Tk_ WceYVT ^ ^ f_ZjŽEYZdacWWcV_TV Ztl[fdzZVUSjeVVZcaVcTVaeZ_eVReeYVjYRgVd^V $\langle \underline{Z} U W _{ec} \rangle$ globel VZCZ ^ VLZReV gZc _ ^ V_eL R_UeYZd] TR T_ec] gvc eVZc h_ RWRZdZdeYV `aa`dEV`Wa`]ZEZIC1ZieZieYidZ_eYV_R^V`WR_ Ra` ZZZIR ReeZef UVeyReeYZdXc`f a VRg`f cda` ZZZIR aRceZIZaReZ_ReeYV]`TR]VgVJŽ

? Vie T ^ Veh` Xc`f ad`Wybf R] dZv1"' $/ TYRRIAZXU Sj R_ Z_eVXde Z_ a`]ZZDZ'SVeh W_ eVV eVVj Wc^ ReVZU`WeVVd?^a]VR_UeVVT dV$

`Wa`]ZEZIR] a RoeZIZaReZ ŽE YV UZWWCV TV SVeh W eVV [ZdZ_eVZ a`ceR_TVeVV ReeRIYe`aRceZdŽ > V^SVcd`W_VXc`faWWjcVca`_dZSjVVVceYVhR eYVT f_egi ZdX Z_XLSfe^ Zdef dea`]ZeZTR] a RoeZdŽ @_V^ZXYeolaVR\`Wy_`_łaRcej aRceZIZaReZ_%Z EYV`eYVcXc`faŁSjT_ecRdeLU`Vd_`ed/RcV eYZdf_VRdNŽ:ed^V^SVcd^RZ_eRZ_f_cVdVcgVUjj eYReyj`f YRgVe`eR\VR_ZeV&&eZ_a`]ZEZTde` SVRS [Ve`TYR_XVeVVhR] eVVT f_eej Z1X Z_XZ 3jgZefV`WeYZIRTeZyVUZa`dEZ_ŁeYZI^ZXYeSV TRIVU eYV yTZgZT a RceZTZa ReZ _%Xc f aŽ> V_ R_U aVa]VW/^ eYVZeVc^VLZeVR U^VLZc^łYZXY decReRacVU ^ Z_ReVZ_ eVVeh` Xc`fadLR_Uj`f_X aVa]VRXU") e`\$%RcVYVRgZjj cVacVdV_eVUŽ HZEYZ_ eYZCIT ^ ^ `_ WR Wh `c\ eYVCVRCV gRCZR eZ_dŽEYV} odeXc fa 1RXRZ_de a RoeZd/ RaaVRode` SV^ `cVdIVaeZIRŁZ UWUT __VAdVURS`feTYR XXd eYRe Raa VRc e` SV UZ VTeZ_[VddŽ: ed^ V^ SVcdeV_U e`SV^`dVhZeYUcRh_ŽEYVd/T_UXc`faL`_eYV `eYVcYR_UŁWRg`fcdR^ `cVViec`gVceV_XRXV^V_e hZeY d'TZkajŽ:ed ^ V^ SVcd Vi acVcd XcVRe d'TZR T_}UV_TVR_UT]RZ' e`YRgVdec`_XV&V_UdYZadŽ EYVZcgZh`WeYVTYR_XdZ_ac`XXddZdaVc^ VReVU SjeYVZc`aeZ`Zd`Ž

EYV} WY Xc fa YRdR $^ dVT _dvgRegVZ RW$ `Wa`]ZZZZ 7 c " S" `WVda`_UV_eeLyX Z_X fe R_U g eZ_XZ leVh J e aReZZARVZ a]ZZZZ EYZI RJ SVeVc WeYVyVJVTe cR] aReZZARZ _% Xc fa Z_eYReZd V SVcdeV_Ue cVRUVVTZ_d RdeYVVdV_TV WZgZ aReZTZ REZ_ŽEYZ lgZh `W a`]ZZZ dZ Wf_U aReZT [Rc] R^ `_X cVda`_UV_ed W^ eYV VLZ ^ YZXY d TZ IVT _` ^ ZT]VgVL]UC RUF]edR_U acReZZ X4 ReY [ZCZE YY cVe7Z_RIZGZT ecRUZZ_Z_h YZYY JVTE cR] aReZIZARZ_ZIR_Z cVe7V CUZ ^ YZXY d TZ IVT _` ^ ZT]VgVL]UC

TZj`VANVAAIfcTVAR97ZFSJVe`AV^ JVALAAVV e`TRdeRc`f_UVAcR_jZ_def^V_eA/Re^ZAYeSV RSJVe`Z`ac`gVAYVNVJVAV`VANZCVA^ZZAZZ7f]]j RhRVA/ReeYZc`h_UVIZZ_dU`_`eT^VZ_e`AV ^ReeXLeYVAVaVa]VRVZ_AAAAU_`eZ_a`]ZZTR] aRceZTZARZ_ŁSfeZ_eYVWWWOEgV_Vdł`Va`]ZEZdŁ ZedRSZZEje`ac`gZLVd]feZ_de`eYVZ.VgVcjUBjUVi ^R_UZŽEYVZ_decf^V_eR]Z`RXV`Va`]ZEZdZd^`de V&VbfV_eljWf_UR``_XVgR_XVJZRJd-Z_YRSZER_ed `VVZR_6ZEX`Łh`^V_R_Uj`f_XaVa]VŽ

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H YRe ZNRUU 4 YZNR_d YRgV`Vá`]ZZRDEYV bf VáZ_ZIR aRceZIF]Rcjj Z`a`ceR_e`_VZ_eYRe UV``TCRIj ZleYVacZ Rcj RtV_Rh YVAVUZWWAV_eZ_ł eV&VdedR_U`aZ_Z_dRVRZAUaf S]ZI]j \pm T_~ZTedRtV dvéqVUR_UT^^`_Ztif VdRvCvd]gVUŽ^RZZRd Zd`Vá`]ZZIdeYf dYRgVT_dZVARS]VZ_f V_TV`_ eYVT_decf TeZ_`WAVyH V&R_UZedTYRRTeVZdZZZŽ 4 ZZXV_deV_U e`Z_g`]gV eYV`dv]gvd e`R X&VReVc `c]Vdhć UVXWZ_af S]ZTRWRZdRdeVZc UZWAV_e gZNhd`Vá`]ZZIdUZIREVŽ9`h hZ]Z_XRVTZZXV_d e`UZEIF ddeYVZc UZgVcdZj R_UUV}_VRh`dJUeYRe ZdT^^`_e R]JO

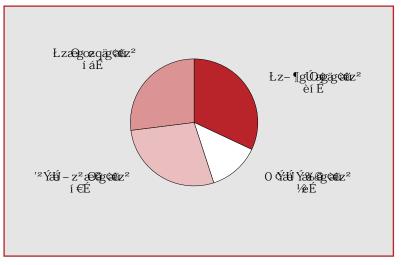
EYVRaac`RIY eR.V_Sj eYVF?5A #!!"Dfd gyj hRde`Xc`fa eYVeYcWeja`]`XZdRS`gVZ_e` Rd_`aeZTTYReŽ2deYVTcZeVcZr`VRdt`TZReZ_RV UZWWEV_eLd`e`RCVeYVXc`fadeYReV^VcXVReeYZd]\gy]`VRXXCVReZ_Ž

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2 eYZU`WeYV4YZVR_dZ_eVcgZhWUdYRcVhYRe ^ RJ SVEVE^ VUEYVZ RXZ_Rj `VRUV^ `TEREZTZEZ kV_+f_T_UZZ_R|dfaa`ceWcUV`TCRIjŁRgZh `Wa`]ZZIdTYRCRIeWZKVUSj TZeZTaRceZIZaReZ_R_U $RT_dV_dR_Z RW WV T dR_JZAfeZ_e \} Xf dvd$ Z RTT d.R TVhZey eVVd cgV dvd led eVZdXc fa T^acZtkd`g\c)! ~``WeY^dvSVj`_XZ_Xe`eYVTZeZT aRceZIZaReZ_Xc`faŁ(! ~``WeY`dVcVda`_UV_edhY` `aeVUWceYVZ'RXV`WRdYZaR_U'!″``WeY`dV dfaa`ceZXUV``TcRIjŽ2 gVg TJVRcac`} [VeYfd $V^{V} = V_{T}^{T} aRdR RW$ ac`a` $ceZ_$ `WaV a]VZ_ eYV^ VLZ ^ }YZXY decRef ^ hY RVhV] V_U hVU hZeY VLFTReZ_R] TRaZER]Ł ^ V_ RXVU`gVc%&LR_UeYVfcSR_ a`af]ReZ_Ž 3VollAdeYzdUV^ `XoRaYZTac` } [VL`eYVc gRcZRS]Vd _WUe`SVT_dLNAVŽ

7Zcdejj ŁeYV yUV `TCREZT TZERKY_%Z`RXZ_Rcj Zd dec`_Xj c``eVU Z_ aV a]Vd d TZR] acRIEZTVZTH Y` a cfY']bhY[fUhYX']bhc 'h Y'`[ZY'c Zgc WYhmUb']bX]j]Xi U``]gz h Y'a cfY'`]_Y'm\Y'cf'g\Y']g' hc `\c`X'U'XYa cWUh]W]a U[]bUfm" 2d eRS]V "! (dY h dL^ V SVd`WYZIXc`fa RVyZ_eVXREVU





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eZ VY c& Ž_U&ZI R|dhY RVZ ekkkeV'_j Z eV& VXS`fcY`UR_U]Zy'_]j Z eVackeV hZ]}_UZeYRUe aZkfcVeYVa`[ZZR]TYR]V_Xd eYReRZW`fe`WeYVUZekcZj Zf_Zj`WeYV_RZ_Ž EYV dfUj dY hd.Z_WRLeYRe eYZlUV `TCHZT Z RXZ_Rj ackfaa`ddbfZeVUZWWCV_ehBjd`WrVd TVZZ_XdaRIVR_UeZ`VZYjYb ci hc ZYjYfmihYb` XYa c WUHWWIDnYbg gYhh Ya gY'j Yg [cU'g Zcf'h Y'Z h fYž UbX`]h]g h Y'Wei blfm UbX` h Y'k cfX'Ug U'k \c Y'h Uhih Ym WebgIXYf`]a dcffUbhhc h Ya "'H Ym h i g dc ggYgg ZJf' VfcUXYfWe[b]hj Ya Udgh Ub'a Ya VYfgcZ h Y'ch Yf'[fci dg"

EYVeYZUTYRRIekZEZT`WW``TREZTZZKU dZl eYVZ:\][\Yf`XY[fYY`cZ]bX]j]XiU`]nUhcb":_ `eYVch`dtLeYVj eV_Ue`SVaVa]VhY`VZTV ^`dvd,/WhRV_VdLd,/WUAC^ZRZ_R_Ud,/WA RZRZ_RLZZZLFR,da`df]RevereRt1TZRedUV`TRTj hZYZUZZLFR a`df]RevereRt1TZRedUV`TRTj hZYZUZZLFR R`e`_`jZlS`c_V`feŽEY`dvhY`SVZgVeYRe eYVZ:JZgvdRvX gVc_VUSj eYVZ`h_UVZZ_d R_UeYReeYJ TR_TYR_XV`cRe]VRdzZ~fV_TVeYV dTZR`dVcRvSVevca]RIVUe`T^Ve`eVc`dhZY eYVf_TVerZ_eZdZ_YCV_eZ_UV`TREZTa`JZZTZ 3j T_eRRHZEdW`de`SVYRUVcVcaVa]VhY` WJ^REXZ_RZXUR_UYf^ZZRVUe`ARVd_d/`W eYV^ŽEYV_f^SVc`VaVa]VhY`WWJa`hVc]Vd $18#'' / ^fdeeYfdSVRTRfdVVcT_TVcZ$

=RobjLeYVT ccV[ReZ_SVehW_aVa]VdUV``} $TCREZTZ' RXZ_RG' R_UeVVZc \}_R_TZR' a` dZZ_ dY` f |U$ SVV aYROKKUŽ5V `TCROZITZOKV_deV_Ue`SVZ_UZ gZLfRjdhY`WWJeYVJRVXRZ_VcdVT_`^ZR]jłhY` UZalR, dec`_XT_}UV_TVZ_eVVT f_eq`dVT_`^ZT UvgV a^ V_eR_UhY RVYZX/j ^ `@2RevUSj eYV `aa`cef_ZZXdeYReVR(]e`eYV^ŽEYZdU`Vd_`e^VR_ [f de eYV^`dVV_eYf d2Rde2T`c yT_}UV_e%ej aV`W XRZ_V; ^ `de`WeY`dvSV]`_XZ_Xe`eYVydy]WrRt62;Ti Z_XXRZ_Vcd%JReVX g R]d]VR_ e`hRddeYZdd TZR] dáddy_ePez_`Wá`]ZZTČŽEYVZ adddZ_XZVL eV_ŁZłeYReVT_`^ZThVj]łSVZ_X^R, SVRacVcVbł fZEWWeW``TertjŽ?`_VeWyVeHerSJV"!) d'XXVed eYReeYVdfaa`d/UT ccV[ReZ_SVehW_a`]ZeZIR|R_U VT_`^ZTZ`RXZ_RZXdZd_`eS`c_V`feSjR_jdec`_X eV_UV_TjŁViTVaeZ_eVVViecV_VTRdvd`VeVVUV_`} TOREZTIZEZKV R UCYVUNERIYVUTZEZKV Ž

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@eYkVJV V_edRdt TZeVUhZYRdc`_Xa` JZZR ZV_eZjERVT ^ ^ `_ e` eYVeh` Xc`fadZ 7ZdeljE S`eYZ RZZRZdRVWf_U^`deVWbfVej R``_X aVa]VW^ eYVZeVc^ VUZeVR_U^ VUZ ^ HYZY deReR hZY d'SdeR_eZg VUFTREZ_R TRaZERZDVI `_UljEaVa]Vd'Sdt2SZ_Xe` VZeYvc` VeYVeh` Z RZZRZdUZeb]Rj R YZY UVCW` Ve`]VR_TVE T ^ SZ_VU hZeY]`h]VgVd` VWJVTe`dE] UZRVW1 eZ_EYR``dR]Zh`%R_U a`hVc]Vd1_Vd1ZE YZUJjE S`eYZ RZZdRZdRCVacWVcCU Sj yZ_eVXeVV‰ Z UZgZLFR]dTYRRTEVZXVUSj eYV`aV_Vd1`VeYVZ Rezef UV e`hRddd TZGjZ2e eYZIa`Z_eLeY`fXYE

> Złef dłuj TZZKY_dRVI]`dkće eYVyZ_eKARAU Z_eć głódźi._ `eYkć h`duł.eYY aRceZIZARAY Z_ d TZA]_kh`chd.Sfe dłyVłóżgłyjŽi._ eYzł Xć fa Zł Wf_U`_TVRXRZ_ eYVZ_T_Xf`fdT ^ SZ_RZ_ `WY V^ SłódYZa`WR^ VLZ ^ łYZXY deRef ^ R_UeW dłyWZ RXV`WR]`dkŹH Y ja U[_jbUfmicZh Y a]g! hi głź `WłhYb łłyb Xghc VY a c głik [XYgdfYUX` @/.}}äጶ³ ;¶@@@@~O`¢Oĺ#O`qäŶ@@@O&qz²æŠgOx¶²äÅzĺýz²æ)′zĺŶÈ

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 $\label{eq:constraint} \begin{array}{l} Ua \ cb[\ \ 7\ \]YUbg`k \ cgY`gc W[c \ YWc \ bca \]W \\ \ Yj \ Y`g \][\ Vi \ hk \ c \ Uhl \ Y`gUa \ Y`la \ YZY`` \\ h \ YmUfY``cgYfg' \ EYY \ WW] \ eYY \ YReV]`de`feZ \\ eh \ h \ hg \ dsj \ d\ TZR \ TYR \ XWLh \ YZYT \ WddeYV` \\ R_USj \ eYVVT \ `^ \ ZTd \ deV` \ Lh \ YZY \ R \ VdeYV` \\ WW] \ Z \ dVff \ dZ \end{array}$

EYVR'SZAFZA WAYZIX: fa ZIRICI CV-VTAUZ `eYVE WRAF CVŽ7ZcaLJENY VEVZIEVV_VRAZOVRHADI ^ V_eZcd^ V'SVcd^ R.V'WAYVTYR_XVCZ ac XXADŽ EYVJ eV_Ue' eYZ_\eYRALSJ R_U]RCXVLTYR_XVYRCI SW_UZEVTEZ_JVADŽDVT_UJEA `de^ Zahef davl) TZZZ RV_dREVyf_df CVTS` fe 4 YZJV&R_UU'f Seh YVEYVE eYVJ REVARCE` VR_j _RZ_RJZV_EZ JŽEYVCJ^ S`]CI R_UCZX_deYReT f]USZ_UEYV^ e' eYVT f_ecj YRgV SW_TRJVUZ_e' bf VAZZ_LCI eYVVR' V'WWWEV_TV WEUV^ `TRAZTA` JZZTCIYRCISV_ f_UKC^Z_VLŽ

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EYVadvýZ f ddvTeZ_dYRgVdr`h_ eYReaVa]V d'SdTcZSZ_Xe`Z`RXZ_RZXdRdUZWWcV_eRdeY`dV`W eYVyUV^`TcReZTTZEXKV%R_UeYVyV Zdecf deW]TZEZ kV_%deZ] d/ReVTVceRZ_WRef ckdŽ2]`_XELV eYvdvL Y`hVgVdLeYvEVReVR_`eYvc`dh`Z`RXZ_RCZdeYRe eV_Ue`SVWf_UR^`_XeY`dvhY`ReVZ_UZWWcV_e e`a`]ZEZTR]a`dEZ_dLR_UVgV_e`UV^`TcRtj ZedNVŽ/ @gvcYR]WVRJ]cvch`_UV_edReV`WeYvyZ_decf^V_ł eR%cvUvRIYVU%ej aVŽ

VUFTREZ_R_UR^V_eR]Y CZk`_eYReUVd_`e VI eV_USY`_U eYVZ ^ VUZEVZEYYJ [fUXVeYRe eYZ_XdRvV_`eTYR_XZ_XR_UeYJ WW]YV^ VUZ R_Ua`hVc]VdbZAVcYRadVc eYZdCRd_ eYY eV_U e`hZeYURh Z_e`eYVC acZgReVh`c]UR_Ue`dr`h _`Z_eVcVdeZ_afS]ZT RWKKCZZ]RcXVac`a`ceZ_ `VeYV^RcVh`^V_R_UVgR_XV[ZR]CZ5 VdaZeVeYV dZ ZRZZZdR``_XeYV`LeYVCVIZZKV_dRcVxc`faVU Rc`f_Ueh`T]]VI6ZgVZ RXZ_RZCZHYJ RCVeYVcV eh`cVacVdV_eReZ_dLhYV_S`eYXc`fadRcVZ_UZV WEV_ee`a`]ZZ7D0

:_ eYVZ`RXZ_Rg``WeYVZ_ded^V_eR] TZEZKV_ 1#) ″/Łeh` V/V V ed RcV `SdvcgVUŁ RaRce W/^ \underline{Z} \underline{U} \underline{Z} \underline{U} \underline{W} \underline{V} a`]ZEZIR] daYVEVe`]`TR] R_UZ_decf^V_eR] aRceZIZI aReZ_ŁR_UeYVZIV_eZ/TReZ_`WUV``TcRTj hZeY ac TVUF cVdR ULe R]VdN cVf eV eLh Zey Rof a Vc^ Rd \VěŽHZEY dVARdU e`eYV} cde`VeYVdVLZe YRdSW_ dW_eYReWc^`de^V^SVcd`WeYZtXc`faŁaVa]V $W^{\wedge} eYV$ hVc decRef ^ LeYV TR T ^ ^ f_Z; Zd eYVMR V WWW.TVŽ2_UVgV_eY dVhY acWW. e`aRceZIZaReVyRa`]ZeZIR]]j%Z_eYVZc]`TR]T^} f Zej R hV] gRf Va` ZZdW/ eVa` Ze` W gZkh `VZedW_TeZ_R]f eZZejŽ3j T_ecRetLeYVeYZU T^a`_V_e`WeYVZ'RXZ_Rcj ZddecZZ_X+eYVZ'RXV `WUV^`TORTIŽEYVZ decf^VeRITZEZKV eV Ude` ZUV_eZyVUV^ `TCRIj hZeYyRW eSR]] ^ ReTY hYVCV eYVcf VdRveYvcR^ VVcvgvcj S`U %Z

Eh` eYZ_XdT f]USVReh`c\ YV&Z7ZcdejjŁĨ]b! ghi a YbhU`WhnYbglžYj Ybh\ci [\h\YmUfY] [YbYfU``m'Zca 'U'`ck Yf'ghfUhia 'h\Ub'h\Y' ch Yf [fci dgžgYY h Ya gY j Yg Ug [U]bYfg" $F_{ZVY} Z e f dev f TZZKV_d h Y d X U _R_TZR$ a`dEZ_ZdRe`UUdhZeYeYVZcZ`RXV`VeYV^dygvd Rd]`dvaLeYV^V^SVad`WeYZdXc`faLVgV_eY`fXY a``dLeV_Ue`WW]^`cV]ZVydy]WRIcZ;TZ_XXRZ_ł Vcd/ZEYY RcVaVa]VW/ a``c_VZXYS`fcY``Ud hY YRgVSW_RSJVe XVe _ R_U^ R\VRa]RIVVc eYV d/gvdŽ2]`_XhZey eYZld/WavcTvaeZ_ŁeVy WW] T_} UV_TVZ_ eYVVT_`^ ZT dj d $eV^ R_UYReV$ RI6ZeV de ReVXI dWc`aV REZ_XZ_ZZT`ceYV`ŁeYV VIZEV_TV Wef VerReReverver VVerVer VVevevej S`U % U`Vd_`e^VR_eYVZ_deZefeZ_RZAReZ_`WY`_~ZTeeŽ CReYV&LZecVacVdV_edRXfRcR_eWeYRea``caVa]V hZj SVRSjVe`\Wa eYVXRZ_deYVj YRgV^ RUVŽ

EYVOUT _UeYZ_XZOUYVEV_UV_Tj e hRoudyRd ł TZR] acZgREZC % CYRE TYRCRIEWZAWO Z_obcf ^ V_eR] TZZW_CZ 4 `_OZOV ej hZEY eYVZ: acWWCV_TV Wc hZEYUCHAZ_XZ_e RacZgREVh `cJULEYVJ eV_Ue SV T_okgREZgVR_UZ_e]VcR_e `Wt TZR] UZgVoZej Z:eZd RobVTZCH `WacZgREZC eYREODT _ a VEZZ_ R_U T_~ZTehZEY `eYVCZE YZISVZ_XeYVIROMEYVacWWO V_TVWc yUV `TCRIJ Rolac TVUT cW6T f]U VI acVcH RUVCZEVe `y_Vf ecR]ZzW6a `]ZZTCZ:ea `Z_ecle` Rej aV `WUV `TCRIJ Z_ hYZIY eYVCVZd_`_WU e` SR_U e`XVEYVcR_UER_VCZUVZ

$H_{2}^{+}9.89H_{2}^{-}7 < 98.7 = H_{2}^{-}9B$

EYVZ RZ_Rj `WYVyUNRIYU TZZKY%T ^ ł SZ_VARUZRWWANUGZA `WY` ZZTALZY OVZUROTRE UV` TARIJ ZIVZZZER_UŁRARONU _` OUŁZ_UZWA V_TVO UV` TARIJ RAROJ OV Ž2]OY f XY OVOVRV OZ ZRZZZALAZY OVZ RZ_RJ `WYV^ ZDEF ODAJ TZZKYŁRUZWWEV_TVIR_RJA SVAVETVZGVIZH YZAE _VZYVE XC fa ZIZ_d ^ AROY hZY OVZUNRA `W UV` TARIJ ` c aRoj RM/ZGZ_ŁUNORIYU TZZKY_d XV_VRJJ YRZVOV^ ` CV_VRZZVZ RX40YY VI AVIE _` OYZ XW'^ VZYVE UV` TARIJ ` c a` JZZTOŽE YY U _` OVOV RYRZ_XR_Z ODF^ V_OR foZZJZ

EYV^ V^ SVcd` VeYZClXc`fa1#(″/fd`R]]j YRgV \mathbb{R}^{1} VLZ[1] h d TZ $\frac{1}{T}$ ZT $\frac{1}{2}$ ZY $\frac{1}{2}$ RV eYfdd^ VhYReSVeeVc`WWeYR_aVa]VZ_eYV`eYVc XcfaŁR_URJdeV_UeiSVjif_XkZ3VIRfdvR]RcXV ac`a`ceZ_`WeYV^ ReVRXVUSVehW_") R_U\$%L eYYj ReV^`eVe`]VeR_e`_ eYVhY`]VR_USVeeVc VofZaaVUe`aRceZZZReVZ eVVac`TVdd`WIYR XŽ 2eeWdR VeZ VLeY f XYLeYZdX fa YRdYRUR $V^{SZeVZ}XV_aVZ_TV^W_1]fdZ_Z6T_^{2}ZR]jL$ Zed ^ V^ SVcdReV_`eyeMVVRTcZ;TZ_XXRZ_Vcd%Sfe TIVRC) dvcdŽD TZRIJI Lei Leyvi WM VITIFUVUŽE YV ^ `de ac` ^ Z_V_e WRef d'd` WeYV Xc`f a YZXY/ZXYe eYVZcdeReV WVAd [ReZ_ŽEh` eYZLd` VZed^ V SVad SV[ZkgVeYReeYV] YRgV_`eSV_V} eVUReR] W/^ eYV TYR_XXd` V&VTV_ej VRcd:R_UeYVj RcVdZf ReVUReeYV faaVcV_U`WeYVa`hVcjVdd_VdddTRjVŽ7fceYVc^`cVL VZXYeZ_"! yUVRIYUTZZKV_d%JZa]Rj RYZXYUVXW `VR^^`dR]Z1^_R_U^Zhecf dee`hRdUd`eYVcdŽ

:_ eYVdV aV a]Vd h`c]U eYVdV Zd_` a]RIV Wc

a`]ZZIL`c Wc 4YZIZ>`de`WeYV ReVaVa]VhY`ReVyR_Xg RS`fe 4YZIV‰c yf_d dVRS`fe 4YZIV‰aadWkcZ_XLZ_ eYV]Reek: TRALe`d daV_U eYVZ:V`eZ_R]RJNJZEZ_Ž2_USVIRFdVeYV_REZ_ ZL_`eRa`Z_e`WeWKV_TVWceYV LeYVdVTZEXV_d R]d]RI\eYVWR^Vh`c\eYRefd'R]j XZGVd^VR_ZX e`UV`TRIJŽ

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CVgZhZ_XeVVUZWWCV_egZhdYVJURS`feeVV VT_`^ZTdjdeV ŁdTZKSZZEj R_Ua`]ZEZTdLd^V dX_Z;TR_eeV_UV_TZdTR_SVZLV_e2;VUŽ

7ZddjLeYVUZWWCV_e`cZ_dRZ_dZV_eZ_VUZ_ VRIY RVR eV_Ue`Xc`fa eVV dvjgVdRc`f_UR_ RZŽ:_cVjRZ_e`eYVVT_`^ZTd_deV LeYVVZi RdeZZ_Xjj TjVRcUZdZ_TZ_SVchW_eY`dVhY` WWjeYy RVXZ_VdR_UeY`dvhY`dWeVV dvjgVd Rdj`dvdZEYV]ReVcEYRJWVRJ]cVch`_UV_edEeV_U e``aVcReVSj R_VT_`^ZTTfjefcVeYReacVgV_ed eYV`WV dVZ_XeVV dvjgVdRdRTe`cdTRaRSJV`W TcVRZ_XR_UV_[`jZ_XRhZV cR_XV`Va`dZSJV `aa`cef_ZZVZJ6ed ^VUZdZ_TZ_dRVTR]VU WZDW_WV^TJ`dVe`LS`eY XRZ_VdR_U]`dvcd T ^acZEVdzVZTXc`fadŽ

? VI eL VI R^ Z ReZ_ `VVI TZKSZZEj a ReeVc_d cM gVR]dR_ RIZUZEZZ X cVah _UV_edSVeh W_ eY dV `cZV_eVU Sj R_ Z RXZ_Rcj `VVI TZAG R_U eY dV `cZV_eVU Sj R_ Z RXZ_Rcj `VVI TZAG R_U eY dV `cZV_eVU Sj R_ Z RXZ_Rcj TV_ecZ_X`_ eYVacZeReV h`c]U R_U eYV VR^ ZjZD ^ VUZEZ TEZ_d_WU e` SVUCRh_ YVEVE` ŽH YV_ T_cZLVCRZ_ ZLXGV_ e` Y`h`aV_ aV a]VRVZ_eYVZccV[ReZ_dZadhZeY `eYVcLeYVXc`f adeYRe V VCXVT ^ SZ_VR gRcZkgj `WYRRTEXCZEZCZA`]ZZIR]Z RZZ RZCL[RebjLdW e` SV cdcf Tef cVU Sj eYVUXcW`VVF aa`ce Wc`c Z_UZWKCV_TVe`UV^`TCRIjŽ

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`dUć Wć XAR_eVUŽ@_VXć fa U Vdd SVIRfd/Zed ^ V`SVcdeV_U e`dW eYZd`dUć RdeYV]VXEZ ReV `_VLR_U e` ^ R.VZeeVZc`h_, eYV eYVćSVIRfd/Zed ^ V`SVcdWWJS`eYV TJfUVUR_Ua`hVcJVcde`RjeVć ZEYVVVć^VcRdb/ceeYV dvJgvdRdRTe`cdcVRUj e` TRaZEJZAV__eYV`aeZ_dRZZZ_X`fe`WeYVT f_eg`d UVgY`a^V_eL.hYZV eYV]ReeVcWJ eYY_YRgV_` d`TZEJ cvd fcTVdh YReVgVc R_UREVeYfd`SJZXU e` XVeSj`_eVV2c`h_Z_JZWŽ

3VehW_eYVdV/eCV_VT_}XfcReZ_deYVC/RV `eYVc^`CVR^SZGRV_eZ_RXdET^SZ_XUZWWC V_eVJV_V_eCŽ

DVT_UJjŁRd_`aeZT Raac`RIY ckývRjd R XcWe UZgvczEj`WgZhcZSfeZde/ZdUZgvczEj_`eRVARM ^V_eAU`_VR^f]eZaJZZEj`WaTZRJZ RXcdR_U`cZ V_eReZ_de/RedW`e`YRgV_`T__VIEZ_R``_X eYV`dv/gvcDEYVIF]efcRJXRa SVehW_XZZ vcdR_U]`dvcd_SVehW_eY`dVhY`RcVcTZRJJjZ_eXAReAU R_UeY`dvhY`hZeYURh Z_e`eYVh`dU`V&YVR^† ZJHR_USVehW_UV`TREZTZZEZV_dR_UUZHXMMEAU TZZEZV_dTTfJURIEFRJJjSVe``XcVReVceYvCVe`SV R_jT^^f_ZREZ_SVehW_eYVT_decTEZ_`W

Î 5 'fYbYk YX 'UddfYWUhcb'cZdc'hWgzU'fYbYk YX 'Y[]ha UWnż g bXgdYbgUV'Y 'Zh\Y'Wci bhfmig'nc 'VY' a cfY'h\Ub'U'[`cf]ÚYX'U[[`ca YfUhcb'cZ]bX]j [Xi U'g' UbX'YbhYbW\YX']bhYfYgh [fci dg'k]Y'X]b[`dck Yfz k]h bc dUghh Uhh YmWUb fYWc [b]nY h Ya gY j Yg]b UbX h i gk]h bc Z h fY UgU Wc a a i b]mjb U [cVU !]nYX k c fX'Ï

A Ubi Y``5 bhc b]c ; UffYhfbž&\$\$&"

eYVyH WŽa eZleYVZ' RW' WHVyH WaYReeAjjdeYV Z UZgZLFRJ 4 YZJNR_h YReZd4 YZJNR_R_Uh YReZd_`dL h YReZa' VR_de`SV4 YZJNR_R_Uh YReZda'f JUSV JZ VŽE YZJU Vd_`e^ VR_ŁY h VgVdR_REZ_RJ ZJV_ł eZj eYReZddeZ_de`_VŽ?`cU VdZeZ alj RcVefc_ e`eYVZ RZ_Rj`WdVceYRehRd]`_XeYVXF RR_ł e`c`Wy_RZ_RJ f_Zj %ZE YV UZgVdZj`W4 YZJNR_ d TZdj e`UJ ZIRXZZ eYRe_WUde`SVUWLUVŽ H YfY WUb dYfZ/Wimk Y``VY U'a i`hd`JWJmi cZÎ K YŘJ z cZh'b We bhfUfmihc`cbY Ubch Yfz' dfcj JXYX h YfY UfY W UbbY`gc ZWca a i b]! WUhcb UbX'hUbg'Uhcb Ua cb[h\Y X]ZZffYbh [fci d]b[g' EYVac`S]V^ JZd_`eZ_gRZZj Sfe Z eYVRSZZj e`T&ReVUZj`Xf VR_URdaZze`VXgV R_UdRVR``_XeVUZWKV_eyH VCZ EYZUJj Łetv UZ kodzj `Wfej``\d_WU le'SV T_dZ V ku Va'^ eYVa`Z e`VgZh`VetvZt T^ł aRezS Zzj hZ eY ff^R_U kyj`a^V eZ_4 YZ v Z Eh` eV_UV_TZ dIR_SV UZ EZ XfZ hVU Ž 7Z delj ESV hW_R eYZUR_UYR WWYVCR`a]VeV_U de'Xc'fa Rc'f_U d TZ kack dy_eR Z_deYR Eh Z eY TV et Z_ck kygR eZ_d R kv Wg'f dS]Ve`Yf^R_U kyj`a^V e Z E YV d TZ ky R Z dIR RS JV W`eZ R Z KI E Z kU kyj Z R Z R Z dIR RS JV W`eZ R Z KI E Z kU kyj Z R Z R Z dIR R S JV W`eZ R Z KI E Z kU kyj `_U j Eh Y YI d Y f]Y bW c Z U'a c g hh fYY] b H b' fYgd c b XY b g' VZ L'A c g hh fYY] b H b' fYgd c b XY b g' VZ h Ya '' E Y kV a JV e'_U e' a k I VZ ky e YV T_`^Z E d TZ R L a`Z Z d dev^ W/^R_R R TZ de La`Z e Z

$7 < 5 \text{ DHPF}^{\cdot}$

=A 5; 9G[·]C: [−]H^{*}9[·]7 C I BHFM[·]5[·]: F5; A 9BH98[·]8=J 9FG+M



EYVW]]`hZXTYRaeVchZ] ac`TWUe`ZeVXReV eYVZ`RXZRZdZV_eZWZ eYVeYcWRARR_R]j dVŽEYZdVVCIZVhZ] YVJa cVgVI] hYReZ RXV 4 YZVR_dYRgV`VeYVZcTf_ejŽ

5` 4 YZJVR_d dYRCV R ^` cV` c]VdH T ^ ^`_ Z RXV` V&YZc T f_egi O@dLe` af e Ze ^` cVTRf ł eZ f dj +h YReZ RXdRcVeYVV` V& YZJVE YVVRcjj TYRaekdda` h WLeYRe ^ R_j 4 YZJVR_dh V&Vf_RSJV e` Vc^ ^` cVeYR_ R VKZcjj gRVf VZJVR` Vh YRe Ze ^ VR_ee` SV4 YZJVR_Ž9 V&Le` X&JVR_` gVgZh ` W eYVUZWWC/ eZ` RXdLeYVgi a`]` XXdac` Uf TWhZJ SV Xc` f a W Z_cMReZ_ e` Wf c Rta VRed+7 \]`YUb` [XYbHmžgc WUV]`]mžh Y YVc'bc a [WgngHYa ` UbX`dc`]hJVg" EYVdVej a`]` XXdWc^ VURdvT_U]V&JZ_cMReZ_e` eYVf_UVdj Z_XgRzBSJVŽ@_eYV SRZEL`WAYVAJARGEZIJ (ej a`]`XZAERET^^ Rij TYRCe`W eYVEYZUJV(gy]hZj]_`h SVacVAV_eVUŽEYZL(g a`]`Xj Z_T]fUVA`_]j eY`dvRchVTedZ_T]fUVUZ_eYVATcgYJL `WT fcdVZ:eSj _` ^ VR_dXZgVdRT ^ a]vEvaZTefcV `VEYVZ`RXXA`VAYZVEYREVIZEZ_eYVT f_ecjŽ ?`_VEYVJVdLZeZIR_ReeV`aee`eRvVR_V`aZZTR]``\ RecVacVAV_eREZ_d`VEYZI\ZUŽ

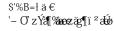
EYV^ RZ } _UZ X`WAYVV VCZAVZIY`h UgVdV Z`RZ RZdRVŽEYVTYRedY`hdeYReeYVUZWWAV_e Xc`fadZ e`hYZIY Z_UZGZIFRJdUZGZWUZ_dV[RZ_ e`aRceZIF]RcaRceZIRAVRed.dTYRd4YZVR_ZV_ł e&jŁd TZAjŁeYVVT_`^j R_Ua`]ZEZIŁCVAc`fa Z_ R T_dZeV_e hRJŽEYV d_`aeZTTYRceVeRS]ZMVd eYReeYV&VRV}gVXc`fad`VZ_UZGZIFRJdLVRIY hZeY RUZCEZ_TEG2Vac`}]VR_URaRceZIF[RcZ`RXZ_Rj`W eYVT f_egiŽE YZdCVF jecV-VTed_`e[fdeRdeRezdeZTR] `aVReZ_ SfeeYV WRIeeYRecVda`_UV_edcVR]jj U dYRCVaRceZTf jRc`fej``\dŽ6RTYXc`fahRdRdzX_VU RjRSVjYZXY/ZXYeZ_Xd^ VTYRCRTeV/ZdeZTeYReUZdeZ_ł XFZHVUZEWI^ eYVOOREZ_ VRIYTRALe`LeYVOVZI R_Z_UZREZ_`WAYZIYyoVTE`OR%ZFRZZOLEYY YRgV^`oERAV_ZAJ hZEYZ

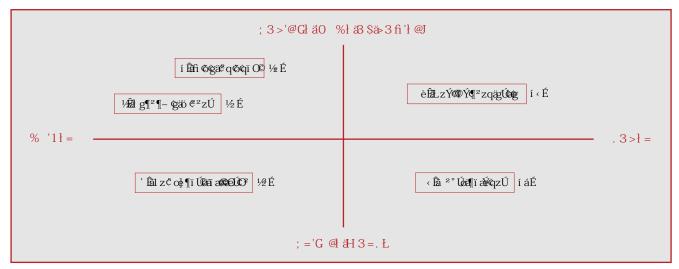
-A 5; 9GC: H≰97CIBHFM

HYV_ cWWkV_TVZl^ RUV e` R_ Z' RXV` WeYV Tf_eqiLeYZdZd_`ee`Z`a]j eYReeYVCVZd[fde`_V dZ_XIVZ RXZ_RqjŽ4YZIVR_d`SgZfdj YRgVUZWWCV_e Z'RXVd`WeYVZcTf_eqŽ2VeVcR]LaVa]VdURZj ViaV2Z/TVdRcVUZXXXCV_eLeYV2c_`h|VUXV`V4Y2V R_UZedYZe j gRcZkłeYV YRgVR] d ced WWZZkł RS`feeYVdZfReZ_`WeYVTf_eqiLR_UeYVZcgRfVd $R_U V_i a V = \frac{1}{2} d U Z W Z H Z Y e Y Z A Z e C V V V V V$ ^ V_eeLeYV T_decf Te R] d ced`WVacVdV_eReZ_d `WeYVolTZKejeYyj]ZeVZ_ŽEYZolUZeVodZej^RjSV T VTeVUfaZdTYRhR, eYReT^^f ZTReZ $\mathbb{R}^{2} = XeYVUZWWCV_ed^{2}ZR_{2}Xc^{2}fadZd^{2}c^{2}c^{2}Wdd$ ~fZLŽW`ethYReViZedZlRdvX^VevUUZevcdZiZ hYZYYRIYX° fadW^de`SVdveRaRceSjeYVhR ZegZhdeYVh`clUŽEYVUZbZTeZ_ZdZ'a`ceReZWZe ZIRITVaeVUeYRed ^ VZ RXV VeYVyH V%ZicVbf ZVU WceYVeVe`SVcVJReZ_d`WebfdeR_UT`aVeReZ_ $\mathbb{R}^{\times} X4 YZWR_d \check{Z}E YVeYVd \check{Z} WeYVCVa cet Z_WATEL$ ZdeYReeYVTYR]]V_XV`V&YV3ZIV_eV_Rcj Zde`f_UVd eR\VR ReZ ISf ZUZ Xac` [VTeLR UeYZIhZ] Zg`]gV

JZ_\ZXfaR_UT__VI&ZXeVVUZWWCV_eyHVC/ eYReT VIZeZ_4YZ/Ž?`hŁeYVO/RCTYV/ca`ddZSJV SoZLX/dR``_XXc`fad</gVRJdeh`W_UR`V_eR]UZ gZ/VELR_UZeYRde`SVRA\VUhYV&Y/ceY/dV^ZX/e _`eSVRdZ4_`VWXX^V_eVUUZg/dZgZ

H, Y g fj YmfYj YU'g Ub' [b]HU' X]gHbWhcb' VYłk YYb' [bX]j [Xi U`g k \c '\Uj Y'U' gc W]U'' fYdfYgYbHJhcb'c Zh Y' Wci bHm UbX'h cgY' k \c 'Xc 'bch' EYVWc' Vc ^ R.Vfa &% ` VCM da`_UV_edR_UeYV]ReeVc'% ~ ŽEYf daV a]VhY' YRgVd ^ V_RZ_R] ZMRdZXYejj `fe_f ^ SVceY dV hY' U _`eŽ2]``\ Re} McV& Z_UZReVdh YZY ej aVdW[] Z e' eYVdVch` TR' adŽ8 c' fad" L# R_U\$ R] YRgVZ RXd' WI TZGHRSVZe' aa`dZ X`_VŽ3j T_eRRH2Xc' fad%R_U&U`_`eYRgVRcVácVdV_eR eZ_` WI TZGŽEYVZc h` dU ZIeYV cVdæZRVU`_V 'VeYVW? ZjŽH YReU VdZe^ VR_WceYVZ' RXV`W eYVT f_egi hYV_d ^ R_j aV a]VRaaVRce' YRgV





2df^ZXeYRee`T_defTeeYZdZeZd_VTVdRg e` <u>|Z</u>\faeYVL**ZWW**EV_eT ||**VTe**ZEVZ` **R**×Z_**R**=ZELeYV ac`S[V^h`f]URaaVRce`]ZVZeYVXRaSVehW eYVXc`fadeYReYRgVd^VZ`RXZ_Rg``WdTZXg`R_U eY`dV€eYVy_VZXYS`fc]j feZZERCZR_%R_UeYVyR_ł Xq`fedZVC%GeYReYRgVhZeYURh_Ze`RacZeReV $h^dUZ@_VhR_VXVh_eYZ_1Z_1]ReZ_$ h`f]USVZWeYVeV`Xc`fadhVeVRS]Ve`TeVReV WceYV dygvdRcvacvdV_eReZ_ `WeYVSc`RU/cd ł TZKejeYY JZEVZ_ŽE`U eYZLeYY h`f JUYReVe` RTef Riji ViaVZV_TVhYRed TZKg ^ VR_dŽEYVZca``c d TZ IVT_`^ ZT def ReZ_ZIR_`SdeRI]VLY`h VeVeL e Xourelo Zelvarez Ze evo d TZR WAScZIŽ3j R_U RCX/LeY/CVZIR_Z gVcdVcV/ReZ_dYZa SVeh W_ $VT_^ AZT_UZZ_dR_UeYVa dVdZ_ WaTZR$ TRaZRJŽE YVa``dvcaV a]VRvLeYVWh vceZdeYV eV Ue`YRgVhZeYd TZkjŽEYZdhZeYUcRhR dW^d e`SVcVgVcdZjVLY`hVgVLRejVRdeZ_eYVTRdV`VeYV y_VZXYS`fdjfeZZERCZR_%Z2deYVZ_Wc^ReZ_XEV_ Z_VRC/Z/CTYRaeVcddY hdzy_VZXYS`fdjfeZZRCZR_d% eV_U e`SVZ_g`]gVUZ_eYVZc]`TR]T^^f_ZejŽ 6gV_ZWYZIaRozZZRZ_ZIfeZZRZ_ŁeVVVZI d^VdTZRJS`_UZ_g`]gVLŽ:eZdeYfdR^ReeVc`W deV XeV Z XeYZI TR Z eVXReZ R USV XZXd eYReeYV(XRUFR)); XRZ_RSc`RUVcV(aVcZV_TV`W d TZKġŽEYZlobeReVX, TfUSVeZUZ hZeY^VRcfcVd cMReZ_Xe`eYVdvT_URiZEŽ

H\YgYWcbXUl]ga Uf_gci hh\YXJj]XYVY! lk YYbh\cgYk \cjUi Yh\Y]fYl dYf]YbWcZ

gc WYmiUbX gYY h Ya gY j Yg Ug Î [U]bYfg UbX h c gY k \c hYbX h XYÚbY h Ya gY j Yg Ug î c gYfg "8 c f ad" Ł#R_U%IJf devcRc f_UeVV yMZ_Vcd%/U`WeYVR ZLh YZVXc f ad S R_U&W] R]`_XeYVy]`dcd%/UŽEYVdC a]VU&ZUVdf a Z ^ f TY eYVdC Vh B Rdh ZY eYV} cde R ZLSf eh ZY eYV`aa`d&VV aYRXEZH YZV%) ~ `WeVa`_UV_ed RVI]`dce`RyXZ_Vcd& RZ_Rj L&# YRgV^`cV Z_T^^`_ hZY eYVZ RXV`WeYVy]`dc%Z

 $2dYRdSW_a$ ZeW felevel dVdVdWZ RXdRdV Tf]efcR|T_decfTedRU_`e[fdecV~VTeZ_d`VTR y`S[VTezgv%dzfReZ_Ž:_`eYVch`ddLaVa]VTR_ WY] eYV[ReVXRZ_Vcd`c]`dvcdZcVcaVTeZeV`VeYVZc d TZ łVT_`^ ZT decRef ^ ŽERS |V"" # dY`hd hYRe T_d\bfV_T\deYZITR_YRgV\\cR\yV_ZZIdR_UUZ gZVdSVehW_eYVUZWWCV_eqiaVdŽEYV}cdeS]`T\Ł YVRUVUY._UZeZLFR dMWZ RXV%LdY`hdeYVa`dEZ_ `WeYVyUZEZ]fdZ_WUTcZeZT%SjT^aRcZt_hZeY eYV y_VZXYS`f cjj f eZZERCZR_%ZEYV } cde TReVX cj T_eRZ_dR]Rexic ac`a`eeZ_`VVZ_UZeZLFR d W/^ $eV^{V} UZ ^{1} WZ ^{2} deRef^{1} ^{3} / R_U aV a V Z ^{2}$ $Ra`dezeVaVcTVaeZ_`VeYVZcVg`]eZ_XVT_`^ZT$ dZefReZ_1&(″∕eYR_eYVy_VZXYS`fcjjfeZZERd ZR_%XcfaŽ3feaVa]VZ_eYZldVT_UTReVX qiRtV ^ fTY ^ `dV]ZVjj 1%(~ / e` T_dZVc eVV dVjgVd XRZ_VcdeYR_ eY`dVZ_ eYVWc^ Vc1#' ~ /Ž2e [VRde \underline{Z} eYZI dvah VTeLeYVdWdvLeYV yTcZeZT% Zd T] dv e eYVyRd TZR% oj a VŽ3j T_ecRdeLeYVy_VZXYS`fdj fezzerze %zer ev vyzez z uzez f R% R U

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>¶ï LýzräÅlźÅOLźqä¶²äcezä] OYÓ?á¶%äcezäB1Ł; äl Ozo¶²Oã>ï Lózorai þþ½Ê

eYVyVT_`^ZThZ_V&ZEYV&VU VddW^ e`SVR SRUZLeYV&W&VLWcUVgY`aZ_XT`^^f_ZReZ_ R``_XeVV&VeYVXCfadŽ

EYVONT_US]`T\Z eYVePS[VolY holeYVLZbez8f] eZ_`WeYV}gVZ`RXZRZZdZ_cV[ReZ_e`aRceZff]Rc WWJZ_XdŽAV a]VdZ RXV^ WAV^ dygvdRdXRZ_Vd c]`dvcddW^ de` SVRd1 TZReVUhZeY eYVWWZ_XdeYRe $4 Y_{Z}V_{R}U_{Z}d_{V}T_{^{T}} T_{d}d_{V} Z_{d}Z_{V}Z_{e}V_{Z}$:eZlderZZ_XeYRe eYVXc`fadRc`f_UeYVy]`dvt‰ V_U`WeYVR Zl€eYVyUZZ]f dZ_VUTcZeZI%R_UeYV yR Xcj `fectUNC%G RCV WRC ^ `cV |Z.V/j e` UZda|Rj _VXRezeVV``eZ_dŽEY`dVhY`eV_U`e`WW]eYRe eYVj RcVXRZ_VcdLSj T_ecRddLdV h R YZXYVc [VgV] `WT_}UV_TVŽ@_TV RXRZŁeYV Xc`fa |RSV||VU yUZEZ] foz_VUTczezto%deRUd`fež2]eY`fXYeYVdV Z_UZezZ_f_R]deV_Uei_SVj`_Xei_eYV^VUZe^}YZXY $deRef^{t}$ LeYV YRVeYVYZXYVde VYZXYVde VZZZ f dZ_{t} ^V_eLT_WWZ_R_UZ_dWTfcZejŽEYZdcV^Z_Udfd RXRZ_eYRe aV a Vd d TZ IVT_`^ ZT decRef ^ YRd `_]j]Z ZAVUZ a]ZIRZ_dWceYVZcZ RXZ_RZAd`W eYVT f eq ŽE YVVU ZZZI f dZ VUTCZZZI% R U eVVVR ł $R_UeYVVT_^ ^ T deV EReY f XYeYV coeZh CV$ ZVj e SV _ Xe eYV^ VZ ^ YZY decRef ^ R U eYVdVT Ue`eYVl`hVcdedRef^Ž

7c`^ eYVhRj eYVLZWWZ/eZ RXdUZGZVfaZ_ cMRzZ_e` eYVWfcRdaVRdT_dZXdVI4YZ/R_ ZV_eGjŁdTZGjŁeVVT_`^j R_Ua`]ZZdŁeh`

\$'%B=łä³ \$¢õzä⊱O"¢OÚ¢Ý T_TfdZ_dV V&XZ7ZdeljŁeYV 4 YZWŁdZ_eVd gZh UU UZgZUU Z_e`c`f XY1j VbfR] ac`a`œZ_d R`_Xeh`R VdeYVyZ RXV WI TZGj zacZgReVh`dU‰ R ZIR_UeYVyXRZ_Vz]`dV%R ZĎE YVUZIY`e`^`fd TYRRI&C`VeYZIT_}XfdRz_dW`de`Z_UZIREVR V&X^ V_eVU UZgVdZjŽH Y`[Udg VYIk YYb`h Y` XJZYfYbhj Yfglcbgig [[Yghih Uh]h]gbchYUgm Ic WcbbYWii dih Y XJZYfYbh[fci dg]bigi W.` U k UmUgIc WYUHY Uigflcb[']a U[YicZÎK Yž h Y7 \]YUbgj"

?`_VeYVVdLeYZdZ_bfZj dY`hdhYRe`aa`cefł _ZEXIAL eYV&V^R, SVe`SfZUScXLXVAR^`_X eYV Xc`fadŽ2_RjdZd`WeYVejaV`WUZgVcdZejdY`hd eYRe cVReZ_dYZad`WeYZd\Z_Uh`f]UYReVSV VARS ZYVU `_ R TRANS j ITRAV SRAZL h ZY UZWWA V_eV/V V_edZ_g` |gVU VRIY eZ VŽ7c` ^ hYRe YRd SW_dW ŁXc f adT f]U}_UT ^ ^ `_ Xc f_UZ $dZ' ZRc a VcTVaeZ_d` WeYVZc`h_VT_`^ZT dZef Rt$ eZ_ŁdYRCVU WWJZ_Xd`c`eYVc RdaVTedeYVj ^ ZXYe YRgVZ_T^^`_Ž:_`eYVch`d.dLeYVUZgVcdZg``W eYVyHV%TR__`eSVf_ZeVURc`f_URdZ_XJVRiZl`c RdZXVVXVVRZeVCVeVZ5b'aUVVCZ7VY'h\Uhig'WUdUV`Y`cZfYWcbW`ib[h\Y`X]j Yfgihm c ZWc ``YWhj Y]a U[]bUf]Yg]b h Y Wc i blfmk]``` \Uj Yhc VY Vi]`hi d c b a Ubm`Yj Y`gUbX`]b` a UbmUgdYWg c Z Z EYV UZ X dackt eVU $YVCV^{R}$ $YVa e hRUdR_f UZX Wa^V$ `WeWT_~ZTedRURWZZZdeYRehZ]_WUe`SV eR∖VZèRTTf_eŽ

¹ /Âd g¶²¶− göö ℰ²zÚ ½É ; Újï qa¶%ã cœ '²æ" Юæqæ:±∰özlåe fi¶²‰z²ãðz%Aglŵge″ ä O∉zÚ Łz−¶glûæjaçœiz²	í Îsh ©ga² q ©qi O© ½ É ; Úĩ qảĩ%h con '²æ" ứơ qặĩ%h con '²æ" ứơ chiế đế đế cá tác fì ¶²%g2° đế 2Ú Łz− ¶gữ độ các²			
è ਸਿ£ z Ý ﷺ Ý ¶ ² z qäg Úæg í < E B ² Ýi لَغَدَى ¶ ï æfi ∞ " 2æ" آلکھو مَعٌ طُح آمد fi لَا مُعَوْنَ مَعْظُ أَمَدَ لَغَا O V Kati Yasa ھو معتد ؟				
'Êl z ¢ of ¶ï Ú®ä æ@e0úO° ½É 2" ÚĕO¶î æfi o@ 3ï æ¶¢" älúconéæ >zØnúgú@e" ä O¢zÚ '2'YéJ – z2æ@gc@iz2	< ਸ਼ੈ 2 " ได้สู่] ï ဆို qz Ú í áE 2" ได้ช0, ¶ĩ ăH og Ýlg OBA (600) 3 ÅŶ (ඕ2 Ýæg 2 ¶2 ¦g¶2 %¶ É Váæŋ Ýz Ú Ezægoz qægate2			

>¶ï Úgzn**ä**, ÚzÅOÚzqä¶°äæezä), OÝÝä¶%äæezäB1L; äl Oæ¶°O®a>ï Údzonaĭ þþ½Ê



7 C B 7 @ G€C B G

HYj ZdeYV3ZIV eV Rj RaReeZIF [Rc]j d ZePS [V eZ Ve`UVSReVeYVT]]VIeZeV ZW`W4 YZVR dD:eZd `WI`fcdVRd_^S`]ZTUReVeYReT^^V`dReVdeYV Eh`Yf_UXUjVRcdRXLeYVTf_eqjYRU_`eSVI Xf_eYVeRd\`Wa']RIZ_XR_Z_UZeZLfRjLZ_UVaV_UV_e deR^a`_Zed]ZWRdRdTZkġŽEYZd`fel`WeYVIhRj TcVc`WeYVT_eZVehRdaRce`WR_V`aZVŽ $EYVWc^{h}d^{WT}^{h} f_{Zj}]ZWR_U eYV_{c}^{h}d^{W}$ d TZR Z_eVET f cdV eYVEV h VEV]ReXVjj SVj`_U eYV T_ec`]`WzedZYRSZER edŽEYVT]`_ZEJaVcZU]WeV Zed^ Rc\LSf e Zeh RdRe: _ UVaV_UV_TVeYRe4 YZVR_d dvé`fee`UVTZUVLVVceYV^d/gVdR_UReeYVZc`h_ $Z\lambda hYRe ZU WT f_eq eYV hRe V2 V XZ2e$ eYReeZ VLhZYUZXWZZXUVXCWd`VRhRcV_VdLeYVj UVIZINU e T_ded Te eYVZc ZIV_eZej R_UUV_J _VR yHWZ67c`^ eYV_`_ eYV4YZWR_ _ReZ_ hRde` $SVRh`c\ Z$ ac`XVdLVgVdTYR_XZ_XLTYR]]V_XVU Sj Viekć_RJ R_UZ_ekć_RJ WćTVŁSj ZNReŁgRJf Vd R_UZ' RXVd T_def TeVU $\underline{Z}_T^{\ \wedge\ \uparrow}_\ \uparrow c$ RU aeVU W/^ `fedZUVŽEYV_ReZ_TR^Ve`SVeYV[ZW/de`qi eYReR]] 4 YZWR_d^ RUVeYVZc`h_ŽedRIYZgV^ V_ed R_UdveSRT\dhVeVeYV^feT ^ V^WeYVZe`h_WWW.ced R_UT_{Zed} Zed VJRee Adde AZe WR_TVLLZWWCV_TVd`cR_ZRSZZEje RXCWŽEYV We^ Veh VeverV` WateZ X` WievRezezej LevrevU WV Wee<u>R</u>UdRidZTVŽ

5 8≓J 9FC9ž5A 6≓J 5 @9BH5B8 : F5; A 9BH98 [·] B5H€ B

 $\begin{array}{l} H YV_eYJ]`` SRI\`_eVeh` Yf_UVUj VRd\\ dZ_TV:_UVAV_UV_TVLeYV_Lh YRe 4 YZVR_d ReV\\ T_WO_eVU hZY ZI eYV^ dMgVZEYVZ VKef cV hZJ\\ UVAV_U`_Y h eYJ aVCIVZgVeYVZ RXVeYV^ Zc`c\\ cV-VIedSRI\ ReeYV^ LR_U`_Y h eYJ cV_Vh eYV\\ TYR]V_XV` VSVZ_XeVV^ dMgVZ3f e h YReU eYJ\\ aVCIVZgVO> R[`c RIYZGV' V_edLSf e R]d R`SZGR\\ [V_TVLUZgVdZj R_UVKXX' V_edeZ_Ž\\ \end{array}$

4 YZVYRITYR_XUŽE YVJVRIZA V V ALARHEL d^V `VRYV`gZRJE`eVdd_`]`_Xić d ERV_`h SVZ_X dfaa]V`V_eVU Sj R e`ccV_e`W_Vh WRFf cVd R_U Rezzf UVČE YV cVd]e Zl R UZSVcZEj eVRe Zl UZSVI f]e e`cVLFTVe`RT'^^`_UV_`^Z Re`čZYV^Zc`c

dv-VTedR R^ SZERV eZ RXV, Zed Z VR^ V edTYR XV UVaV_UZ_X`_ eYVR_XJVW/^ hYZYZeZdgZhVUŽ DW_W/^ `_VoltNtRotec`_Xtd' [ZJ_ReZ_R] ZV_eZej $Raa V Rcd Z 3 f e d W_W ^ R_ e V U W ^ e V a V c a V 1$ Tf_eqi eYRe WWJdYf^ ZZReVUSj Zed`h_ gZ]V_e T_~ZTed R_U ZccVT_TZRS | V YRecVLdŽD ^ VeZ Vd vHVLeYV4YZVRd%RcVacfUjjUVdTcZSVURd hVjT^Z_XR_UWX2/UjjŁ4Y2/VRdRTf_egie/Re Zd W/VTZV_e R_U ac`XXVdtZ_XŽ2e`eYVc eZ`VdLZ_ ^ ` ^ V ed`WWWTeZ_Ł4YZWR dRXVTYRCRIeWZKWU Rd]Ry R_Ud`gV_JjL]RI\ZXZ_ddaVTeVc`eVtdL ^ VR_łdaZZEVU R_U V_gZ f dŽD ^ VeZ Vd eYV/ RcV TR|WRSdRgvLeifXYaVaVaV, Re`eVvceZvdZwW WITE R R_UTYRERIEVEJVEDŽCVIR]Z_X_REZ_R VAZTEL aVa]VRWc^ eYVViZeV_TV`VRf_ZeVZzeVXReVU ReZ_Ž:__`eYVcTZETF^deR_TVeLeY`fXYLeYVf_dW 4 YZV Rd R T f_egi eYRe UVIVZgVd ZedyVSVIRf dv Ze X)`ddvd`gvceYVURc\vcdZV`VXedYZde`qŽ

E` d ^ VVI eV_eLR' SZERV_TVZIR_`c^ RJ aRee `VUIYR_XVEYV ef cSf JV_TV YRd dYZAVU eVV dR_U4L R_U eVVT ^ Z_XdrRaV` VeYZ_XdZd_`e VRdJ e` UZd TVc_Ž3f e eVV2Zd^ f TY ^ `dVe`Ze eVR_ eYReLR_U eYZ_XdhZJ_`e SVd_VRdZj cVd` JgVUZ2d YRdSVV_ dr` h_LeYVT]]VI6ZgVZ_RZ_Rj `VeYVyH V6Zddx6Z `f dj h VR_V_VLLR_U eYVVRX^ V_eVLLR' SZERJV_e Z_RYZ R2ZdeYRe YRgVV VCXUUV/^ eVVUZWKCV_e V a V6ZV_TVd` VUYR_XV R2VUZWIF]e e` cVRdM^ SJV Ze` RT ^ ^ `_ Z RXZZ

7<=@B998G57C@97HJ9=A5;=B5FM

4 YZVh RdRSJVE V V KXVRdR_Z U kav_UV_e_R eZ_SVIRF dvZeZ RXZ_W ZedyVRdeYVRF er c V Zed U ktz_j Z 4 ZEF ^ dtR_T kd YRgv TYR_XV Z E YVR te ct. eYVUV R_U te eYV kt f cT kd RcvR to UZ W Zed YVR e Z f e eYV TYR JV_XvZ te YVR V KZ Ze c ^ R V e V aa ` cf_Z eZ kd ` Ve YV kt f c V Zed ` h_t 4 YZ V_W kd R_Z ` R XV ` W Zed W R U kd K W R_U a ` dd S |VT ^ ^ f_Zej Z

 $\begin{array}{l} eYV") DVaeV^{N} & SVER^{R} RefY a]R^{N} USj eYV_ReZ_R^{R} \\ eVR^{L}R^{R} Rc^{T} f dV dYR^{N} UV^{S} eZ_{Z} ZEYV CVa^{C} ce \\ cVgVR^{L}C^{T} h VgVE eYRe R VGR^{N} V_{eVU} UZgVadEj ^{N} \\ ReZ_R^{R} Z^{R} RZ_R^{R} Zd Zd eYV dEf ReZ_ acVgRZ/Z X \\ e^{T} UJ^{2} ^{S} _ VeYVVELZeh^{T} USVhc^{T} e dWeYZd \\ RdZ_VgZFS_{VL} Uf_R^{R} def SVZ eZd^{T} e RXR^{N} V^{N} VM] \\ c_^{e} eYZ_X^{Z} f de RdeYVEVZd^{S} ZV_{e} eJ T_{de}Zf eVU \\ Sj d^{V} VeZ^{V} VVELY^{^{S}} XV_{E} td R_{U} aVc^{N} R_{V} e \\ 4 YZVR_VEVTVL_c Zd eYV dVC R aVc^{N} R_{V} e R_{U} \\ f_{}]]RS_{V}gRIFf^{Z} e eVdV_{C} d^{^{S}} VeYVYH VZdA YZV \\ ZIRh^{C} Z ac XXdtZ \\ \end{array}$

EYZL RZ_ISTZUZ Xh`c\TR_`e_`h SVRSR I U_VUhZY`fe[VaRUZZ XeV`aa`cf_ZZXdeYRe |Z/R/VRUŽZ T]]VIEZVZ RZ_Rj ZL_WUVLR``_X `eYVceYZ XLe`dkeeYVdR_URUdeYRehZ] XfZ/V Yf^R_U&yY`a^V_eZ WEZle`RE`_Zd`aa`cf_Z eZdLeYVT f_eg _WURGZZ_`V&YVVKfcVeYRe UMZ_VRevdeYVT ^^`_ hVJVKVZE UVZVZE:eRd cvbfZvdR_Z RV/VZeMVVVKfcVeYRe UMZ_VRevdeYVT ^^`_ hVJVKVZE UVZVZE:eRd cvbfZvdR_Z RV/VZeMVVVKfcVeYRe ZdL]Z ZREZ_dR_Ua`eV_eZZZdeYV#!!! CVa`ce a`Z_eVU`feLYf^R_U&yY`a^V_eV_eRZdT]]VIEZV RbZREZ_dR_URa`dEZVZ RV/VK1TZ6j~dRSZZj e`cKRZVeYV^Ž

3feRT]]VTeZeVZ RVZ_RcjZtRjd_WUVUe TaV hZey eYVTYR]]V_Xkd` WeyVacVdV_eŽE YZdCVa` ce YRd d/`h_eYReeYV]RI\`VIRT ^ ^ `_Z' RXZ_Rg' d\ff]ed Z_eV_UV_TZXde/RehVR\V_dTZXejŽHZeY`fe`_VL \mathbb{Z} Uzez If RJZReZ _ ac' TVdtVd YReV _ 'eYZ_X e' $|\mathbb{Z} \setminus$ eYV e XeYVŽ: UZeZUFR ZEVdSVT ^ V d ZEROj R_UT]]VTezeV]ZWSVT ^ VdRdfcTV`VZ_dVTfcZej dReYVc eYR `WT ^ a]V V dReZ ŽEYV] dvcd RcV ZUZęZUFRIdR_UdTZKajRdRhY]VŽHZeYfeR_ Z'RXV`WeYVT f_eejŁhZeY`feeYVacRieZIR]SfeRjd $d^{S} Z V a Z TV V V Z X a Re V RyH V Z Z d$ gváj UZI/VIF lee TčvRevRdec Xd TZR VRScZIŽD TZR TRaZERJLhY`dVZ`a`ceR_TVWcYf^R_UvgVj`a^V_e hRdRTV_eeR] eYV^ V`WeYV#!!! CVa`ceLUVaV_Ud _`e`_]j`_ eYV decV_XeY`Wd TZRJ`cXR_Z&ReZ_d SfeRjd LR_UaRce21f]Rdj L`_ Ra]Rf dSjVZ' RXZ_Rg `WeYVyH 1926

=RelijL`_jj Rolec`_Xd`TZkij R_UZ_UZgZLFRJdhZeY RdV_dV`WT`]]VI&gVSVJ`_XZ_X'TR_UVgVJ`ad`TZki ^ VR_Z_XdR_UgRJFVZŽ9`holec`_XgRJFVdRoVUVI aV_Ud`_eVVVieV_ee`hYZIYRd`TZkij ZdhZJZ_Xe` dVT X ZEVEYV RdaRce` VZEd MVLR Ue` UVW UeYV Ž ;fdeRdeYVEVZd_`aVcd_R|VeYZThZeY`feRdec`_X d/d/ WZ UZCZLF RZEIŁA CYVCVIR_SV_` A TZR VCYZT hZey^feRUXdZeVUZ_RXV_VeYVT]]VIezeVdAJVŽAfS]ZT gRfVdR $VR_VacVdZ_VAVVRWWAZ_Z$ hYZYRd TZK Y ULIZAN WEYZIYR Rd WUZ a ZR eZ_WceYVTYR]V_Xd`WeYVacVdV_eŽ7ZdejjŁZe R]`hdeYVWWWed`WaczgRezch``_T^^`_]ZWe` SVT_cc`]|VLŽEYZ_Xd|ZVT ccfaeZ_R_UTcZ V TR__`eSVT_ee`]]VUhYV_T]]VTeZeVcWWeV_edReV hVR\ŽDVT_UjiŁafS]ZTgRJfVdRvRcWWeV_TVa`Ze WcWWkade`ckataRZ_eYVeV_UV_Tj`WajdeV^dR_U Z_deZfeZ_de`dWeYV^dMgVdRdeYVViTlfdZeV`S[VTe eYVeV_UV_Tj`W^`UVc_`cXR_ZkReZ_de`cV/VTe R_j ToZeviZ_ Vievic_Rje eYV dvjgvidh YV_eYVj dvé eYVZcacZcZeZdZd`_V`WeYV^RZ_WRTe`cdSWZU eYVhVR\V_Z_X`WT ||VTegVd`S|VTeggejŽ

4`_def TéZ_XR_ReZ_RJ Z'RZ_Rj Zł} $de R_U$ WéV``de R Tf]ef d?] eRd ŽE YRe Zlh YRe Tf]ef dVZł WR`Z_Z_XR_Uf_U&dR_UZ_XeV/ZW'U/ fc`h_ d TZkj łj`f cd/R&U/i a VZ/T/dR_UeV/UZWWEV/T/d eYReUZjZU/j`f R_UL^`de Vda VTZ?]j łf dZ_Xe/Va]f ł d?Zj``V/ZWYZĖ cZ/dR_Uh Bj d`V/ZWe`d/Ra Ve?V d TZł] YRc^`_j Rda ZWU e`ŽE YZł Tf]ef d?] eRd YRd _`h SVT ^ Vac`S]V REZRŽH YV_ZE Zd/CVT X_Z&U eYRe UZj/dzEj TR_d/f]eZ_WRX^ V_eReZ_Le?Vf d X/_Tj`W?VIf]ef d?] TYR]V_X/eYRe4 YZ/VYR/R/VRU TR_SVRaac/IZZE/UŽ9 f ^ R_U/g/J`a^ V_eZ_4 YZ/V eRE/UZ_ac/dZ_X_WU`WF]ef cZH YReZIRedR/V R/Ve?Vh Bj dZ_h YZIY aV a]VIR_SVT ^ Vd/Wc/JZ R_eRX/_ed`cyd S[VIed‰/Wg/J`a^ V_edd TZSZZGj R_URd f_UU/`TRIJŽ

8C 9G HA 5?9 C9B C9 HC CD95? C: 7I @H F9 =B 5B 5; 9C:; @C 65 @N5 HC B3

EYV #! "! $3ZIV_eV_Rcj ZlT Z_TZIZ_X hZeY R$ TYR_XV`WVa`TY eYc`f XY`f e eYV h`c]UŽ 8]`l SRZREZ_Zlac`Wf_Uj eR_dVc^Z_XUB le`lUB [ZWVgVcj hYVcVZ:e ZlRd RTf]ef cR] ac`TVdLR_U Z_eYZlRCVR ZeZlTcVReZ_X hY`]]j_Vh Uj_R`ZdŽ 7RIVU hZeY eYZlZcVg`TIS]VcVRZej LZeZlcVRd_RS]V e`Rh hYVeYvcZe^R_VddV_dVe`daVR_`VR_REZ_R] Z_RXZ_Rcj Z_R_RXV`VNj`SRZREZ_Ž

7° cd ^ VLeYVd S[VTe` WTf]ef cVZd_` ^ `cVeYR_



RaZ/TV`W_`deRX2Rac`aRXReVUSjdTZ]`X2ded`c R_eYc`a`]`XXdedLR_Ud`^VeZ`VdYXde`cZR_dŽEYVj dWTf]efcVRdYReZX]ZejVcVjVeR_TVe`eVV_Vh TYR V_XdeYRe^ ReeVc+eYVVT _`^ jŁZ_eVc_ReZ_R cV]ReZ_dLeVVRIezezzd`WI`^ aR_ZdLeVIY_`]`Xj R_Ud WeeYŽ_RS`dJvdJvddh`dJUhYveVac`UfTeeL eRelvel ZURCHR UgRIF VolTZEIF IREVF Z a VUVULEVV dW_ReZ_R | ZWR_U Zed Tf | ef dR | SRdZ Rd dZ_X deVRUZji Z_e`ZcV/VgR_TVŽ:eZlecfVeYReXj`SRJZR eZ_TeVReVd_Vh_X1`SR] ac`S1V^d_eYVd`]feZ_dL Y`hVgVLhZ]T_eZfVe`UVaV_U`_hYRecVR T^^f_ZZXdRcVRS]Ve`U`hZeYeYVZc`h_daVIZ;T TRaRSZZZZCZE YVW]`hZ_XR_VIU eVhZ|Z|f decReV eYZŽ2]R_8cW_daR_`_TVViacVdbUXVRe`aeZ $^{\text{Zh}}$ RS`feeYV VdeRS |ZH $^{\text{V}}$ U e`WIRaZER Zh Z $Cf dt RZ 5 V ds ZeV Vg V g eY Z_XLYV eY f XY eL^ R_ Zd$ _Ref cR] j TRaZERZEŽ2 Wh j VRcd Revelev V UZREVC eYRehRdeYVCfdbR_VT_`^j]VUYZ`e`T_T]fUV eYReeYZty_Ref ct%6xZU_`eViZteR_Ue`RI_`h]VUXV eYRehYRe^ReeVolUZ_eYReTf_egihRde`}_UR hRj`VXXeZ_XViacVddZ_e`eYVV_`c^`fdhVRjeY R_UgRcZkij `WzedTf]efcRJSRdvZvZedVT_`^ j hVcV e``aVcReVReR]]dfTTVctMfy]j 19RccZtl_R_U9f_ł eZ_Xe`_Ł#!!!∕Ž

? `S`Uj U f SedeYReXj`SRJZReZ_ZiUZi`R_eJZX

eYVZNR`VeYV_ReZ_lDeReVeYRe`aVcReVURdRTV l ecR acZ TZa V WZ ebc ReZ R dVcW $eVV_Z V$ eW_eYTV_efg`_hRdŽ3feeY`dVhY`U`fSeeYV dZX_Z;TR_TV_WIF]efcVZ_eYZL_VhT_eVieRjd_dW^ e`YRgVWcX eeV_cVTV_eYZe`qiŽeZdZ_cVTV_eeZ`Vd eYReeYVh`dUYRgVdW_eYVV`VcXV_TV`VR_V_`d ^`fdac`]ZWGReZ_R_UgRcZkij`W_ReZ_R]DeReVd Ze ZdV_`f XY e`_`eVeYRe eYVF_ZeVU? ReZ_dYRd `gvć")!^V^SvćDeRevĆŽDIRcTVjjVgvćSWVćVYRd eYVEVSW of TY REVERCENTY VILV EEXCER ` X UZXWKV_eVeY_ZTXc`fadR_UZ_UZXV_`fdaVa]VdŽ EYVEVZER_Vh RaaeVIZReZ_`WY`hZ`a`ceR_eZeZel e`dfdeRZ_eYZdUZgVdZgjŽHYRejVdeVdLRjdW^Ue` SVgR_ZYZ_XSWWV`fcVjVdZd_`hgRjfWURdeYV hVRJeY`WXf^R_ZejŽ7fceYVc^`cVLTf_ecZvdeYRe WcUVIRUNddfXYee`efc_eYV`dMgVdZ_e`XNRe f ZRcj DeRevelyRevyRUe jZ/USWkevevvuZevkoZej `WeYVZcZ_eVc_R|TF |ef cVdŽD`^ VŁdTYRdDaRZ_ŁYRgV dval]gvUeYvdzf Rez_df TTVadury]j Ž@eYvaL]Z.VeYv WC^ VCD gZleF_Z_LYRgVSW_ [VdtWcef_ReVZ

EYVT VIZEV_TV`VSfcXV_ZXUZEVAZE hZY eV_UV_TZde`hRddY^ `XV_ZREZ_ZIRdfcTV `WUZEWIF]ejŁ`_VeYRea`dddXj`SRJZREZ_ hZY Zd`h_Tf]efd?]TYR]V_XVZEYVZ`a`ceR_eeYZ_X e`dVT X_ZXVZleYReeYVd]feZ_e`eYZETYR]V_XV ZdZ_ddaRHS]VW^ eYVd]feZ_dWf_USj_VRIY Tf_eej`cVEY_ZTXcfae`Zd`h_Ž8]`SRJZREZ_ U Vd_`e^R_V_REZ_lSfZLZ_XR_j_]VdlfcXV_eR eRth_Wc4YZVZCREYVEZe^R_VdZeM_VR_UWcZed _VTVdRej_aRceZIZREZ_Z_eVVXj`SR]T^^f_ZjZ

71 @H F9`5:H9F`H{9`9J 9BHG`C: %%C9DH9A ! 69F`&\$\$%

 $\label{eq:crew} CReV[j YRdeYVh`c]USW_d RhReV`VeYV \\ Tf]ef dd] dedZ_d`VXJ`SRJZReZ_RdZehRdReWCeYV \\ VgV_ed`W" DVaeV^SVcZ_HRbYZXe_R_U? Vh \\ J`c\Z`7WJZXd`VVcZWR_Ua`hVcJVd1_Vd1Z_eYV \\ VRIV`VeYZdf_aRcR]VJVUT_eV^aeVvcYf^R_JZW \\ hVeVT^a`f_UVUSj T_TVc_RS`feeYVaVgVcdV \\ T_dVbfV_TVdeYReTf]URZEV/hYV_XJ`SRJZReZ_ \\ hRd_`eRIT^aR_ZUSj RhReV_Vd1`VeYVIf]ef dd] \\ TYR]V_XdZg`]gVVZ \\ \end{tabular}$

$$\label{eq:constraint} \begin{split} & EdRUV \ R_U \ \} _ \ R_TZR \ cv \ Rez \ _dv \ Zad \ YRgv \ X \ SR \ \\ & ZAU \ Re \ R_de \ f _ U \ Z \ X \ dev \ SZ \ U \ Z \ XT \ f _ de \ Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ R_U \ \\ & Zdd \ \\ & Zd$$

 $\begin{aligned} & \mathsf{d}\mathsf{WZ}_de \mathsf{X}\mathsf{d}\mathsf{W}\mathsf{V}\check{\mathsf{Z}}> \mathbb{R}_{j} \ \mathsf{d}\mathsf{R} \ \mathsf{e}\mathsf{Y}\mathsf{Z} \ \mathsf{l} ac \ \mathsf{T}\mathsf{V}\mathsf{d} \ \mathsf{R} \ \mathsf{d} \ \mathsf{e}\mathsf{Y}\mathsf{V} \\ &]`_\mathsf{X}\mathsf{R}\mathsf{h} \ \mathsf{R}\check{\mathsf{E}}\mathsf{V}\mathsf{U} \ \mathsf{a} \ \mathsf{R}\check{\mathsf{P}} \ e \ f_\mathsf{U}\mathsf{V} \ \mathsf{d}\mathsf{R} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{X} \ \mathbb{R}_{-} \ \mathsf{U} \ \mathsf{a} \mathsf{V} \mathsf{R} \\ & \mathsf{E}\mathsf{Y}\mathsf{V}\mathsf{d}^{\wedge} \ \mathsf{g}\mathsf{R} \ \mathsf{T} \ \mathsf{d}\mathsf{V} \ \mathsf{d} \ \mathsf{M} \ \mathsf{e} \ \mathsf{f} \ [\mathsf{U}_{\mathsf{Z}} \ \mathsf{X} \ \mathbb{R}_{-} \ \mathsf{U} \ \mathsf{a} \mathsf{V} \mathsf{R} \\ & \mathsf{E}\mathsf{Y}\mathsf{V} \ \mathsf{d}^{\wedge} \ \mathsf{g}\mathsf{R} \ \mathsf{g}^{\mathsf{G}} \ \mathsf{d} \ \mathsf{V} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{d} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{U} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{L} \ \mathsf{d} \ \mathsf{R} \\ & \mathsf{E}\mathsf{Y}\mathsf{V} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{g}^{\mathsf{G}} \ \mathsf{g}^{\mathsf{G}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{U} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf{L}^{\mathsf{Z}} \ \mathsf{d}^{\mathsf{G}} \ \mathsf$

AV LYRad eVZI [f deZ VU`aeZ Zh``Sdff cVU eVV T_d\bf V_T\d`\Weh` RaaRcV_ejj dZ`a]V WXTedŽ @_VZI eVRe eVV]`dd`\VZ_YVZEVUZV_62ZATCAReAd Z_d\Tf cZg ZE YV"**%H`d]U9 f^R_5 \gV]`a^ V_e CVa`cea`Z_edeYZI`f e+y>`deaV a]VUVZgVd\Tf1 cZg W^^ eVVZ Zg`]gV^ V_eZ_RXc`f aLR W^ ZjL RT^^ f_ZgLR_`CXR_ZARZ_LR dRZE]`c \eY_ZT Xc`f a TRaRS]V`Vac`gZLZ_XRTf] ef dQ ZV_62G R_U R d\e`V\gRf Vd eYRe TR_^ R.VeYVZ_UZgZLFR] \WV] d\Tf cVm4F? 5 AL "**%Z8]`SR]ZREZ_ TC\ReAd f aYVRgR]dZ_TF] ef dQ ZV_62ZVZ`X_`cZ_XeYZITR_ EYV `eYVc WATE ZI eYRe eYZI Z_VgZePS |V TF |ef cR \underline{Z} dVTf \underline{Z} $\underline{$ T_TOVEV`aa`cef_ZEXd`WWWOVUSjX]`SR[ZEREZ_ R_UZedcháchák/_eReZ_RdR_Z'RXZ_Rcj `WeYVWM ef cVŽ3f eZe^ f deSVcVT X_ZkVUeYReeYVcVackdV_ł eReZ_`VXI`SRIZEREZ_RdRac`^ZeVV/ceYVV/vefcV YRd YZEYVœ`SW_WWS]VŽ8]`SRJZKREZ_YRd SW_ $Uczev_Sj \ W_ \} VcTV_j T^aVez_X^f ez_Rez_R$ T ca`dReZ_dhZeYgVq UZXWKV_e`S[VTeZgVq ZeZq_`e j Ve SVZ_XT_decf TeVU Rd R T ^ ^ `_ ac` [VTe eYRe TR T^^RUXVVRdfaa`œŽ:eZd^fTY^`dV hZMj aVčTVZeVURdRac`TVddeYReZdXV_VcReZ_X_Vh $R_UUWaVcZ_VbfR_ZZdZ8$] SRZRZ_ZRTf]efdR ac`TVdde/ReZITYR_XZ_XTf]ef cV, aRce`V&dURf_eZX TF Jef cR TYR V XVZde` UVR hZY eV dv TYR XdZ RhRjeYReeR\VdRTTf_e`WeYV_WUd`WeVvd_Rj R_UT]]VIezeVcfS[VIezezezkcŽ

GC A 9'? 9M=GGI 9G

EYVeZ VYRT ^ Ve`UZIIF ddeYVTYR]V_Xd`W _ReZ_ISF ZLZ_Xe`UBJŽEYZUVSReVhZ] SV ^ `cV WFZeMJLY`hVgVLZWE dR.VdRTT f_e`Wi ^ VTZi IF ^ dR_TVdZ_ eYV acVdV_e R_U d ^ VeV_UV_TZd eYReTR_SVVI aVTeVUZ_VVeF cVZEYVeC^ dZ_hYZY eYVh`c\`WIRZ_ISF ZLZ_XhRdf_UVce``UReeYV eZ V`WHV4V_eV_Rj hZ]_`]`_XcU ŽEYVgRf Vd Z_daZZ_XZehZ] SV eYV dR`V-dVJWUVEC^ Z_RZ_L V&WU ^ LVbF RZj Ld]ZRZEj Lac`XxVdŽ 3f e eYV hBj deYVdV RVf_UVce``U R_U cVZXVU_WU e SVRURaeVU e` eYV_Vh_REZ_RJ R_UZ_eC_REZ_RJ T_eV eŽ VEZL`ee`SVZ_XV_f`f deYVUSReVhZ] YRgVe`T_dX/ceYVdeYZ dXV_VReVUSj TF]ef cB TYR_XZZ3j hBj`VWI R`a]VLd ^ Vbf VdZ_dhZ] VJa ZV_eZJVeYVTc`dt`RURT`_XeYVhBJZ

7ZddLeYVJZW WRZ_dYRdX) SRJZWZ3VdLAd R] eVV eYVc Z aJZReZ_d WeYZLX) SRJZReZ_ ZdcUUY_ZX SRJZ RdsVIed WRZ_Y UŽH YZV eYVDeReVZIYRgZ X e dYRV_ReZ_R] d gvCvZx_ejL `eYvc RIe`cdR_UZ_deZf eZ_dReVXRZ_Z XZ_d TZR]
$$\label{eq:linear} \begin{split} Z &= ceR_TVZ > R_j `WeYV` daR_RZ_RZ_RS` dMdZ \\ H Y` dn` f]USVRS]Ve` aRceZZAReVLeYV_{Z_RZ_{}} \\ Sf Z[LZ_Xe` UR O@_ h YRe ZLAR` Wei gVdZZ_g` RdV \\ eYVZ: cZXYedR_U dVda`_dZZZEVde` SVSReVLO \end{split}$$

DVT_UŁAV a]VeV_Ue`SV^`ċVZ_UZZIFRJXVU eYR_SWAAZZ_`eYVch`dUŁeYVZ:ZIV_6ZZAGRAV_`e UVJ_WZ_RUBR_TVSj_gRfFVdR_UYRSZadVaHSJZHVU Sj_ecRUZZ_RJRFeY`cZZAGHeYVDHRAVLTYFcTYVŁa`ł JZZIRJ aRceZad`c d TZRJTJRdVAŽ:__VV6fcVeYZIdMJW UVAC^Z_RZ_ŁhYVASj_Z_UZZIFRJdT ^ SZ_VeYV ^`degRZUVJV^V_ede`T_defTeeYVZ:`h_dMj8VL hZJSVVRIZZERAUSj_eYVUZSVCZFWdR_XV`W VR_ł Z_XdR_U_d^S`]ddfaaJZUSj_T_d^ VcTFJefcVZ HZY eVVCZX_d`VXU/eZj_d_gRZUR_U~WeZ_XL hYReWWJZ_Xd`VXV]_XZ_XIR_SVZ_g`\UZ_aV a]V e`V_XRXVeVV^Z_RT]JVIEZVac`[VIE0

7f œYVc^ `cVLZeYRdSW_ dW_ eYRe^ R_j aV a]V]RI\ eYV^ ReVEZER_Ud'S[VI6ZeVcVd f cTVdeYY _WU e` eR\Vfa eYV`aa`cef_Zej `VVJSVZ_XeYV^ dv]gvd%Z EYVV&Vbf V_Tj h ZeYh YZY aV a]VZ_ eYZddEf ReZ_ efc_e`acZgReZt`R_U`aa`cef_ZdeZTT_Wc^Zt` dr`hdeYv&VZd_`XfRR_eWeYReeYVXR]`VZd UZgZtfR]Rfe`_`^j hZ]SVRIYZ&SVŽ:_RUZZ_Ł d`TZR]Uj_R`Zd]ZVUX&Xf]ReZ_V_TfdRXVy_VXR eZgVZ_UZgZtfR]Zt`%ZiVeYVhBj4YZyR_d`TZkjZd `cXR_ZXUEV_Ude`V_TfdRXVaVa]Ve`hZeYURh Ze`RacZgReVh`d]ULY`hTR_eYVdTZR]UZ`V_dZ_ `VZ_UZgZtfR]ZReZ_SVdeV_XeYV_UD

EYZUL EYV^ RC\VEHZ] T_eZ_f Ve`a]kj RTV_eCk c`]VZ_R]`TREZ_Xd TZEJ dxd f cTV&LR_UEYf dZ_UAAd ^ Z_Z_XeYVacZ cZEXdR_UcR_\Z_Xd`Wd TZAj Z3f e Ze YRdSW_ dw_ eYReeYV^ Rc\VEEV_Ude`eR\VZed `h__Z_eVc_Rjy]`XZ%RdR_V_UZ_ZedyJXH YV_ eYV ^ Rc\VE^ VTYR_Zf`T^ Vde`SVdW_RdaRce`V&V _Ref ck]`dVc`V&YZ_XdLZ_UZEZLF k] R_UT]]VTEZV `aa`cef_ZEZde`cV dVc d TZAj RcVhVR\V_VLŽ:e h`f]USVUZWIF]eVc 4 YZyR_d TZAj e`RVkc^ R decZlej d TZA] acZ_TZa]VZ_eYVRZ`dR_UacZ cZEZd `V&YVT f_ecjŽEYZdZdR_`eYVcTYR]]V_XVVc_R eZ_lSfZJUZ_XVWWced+Y`h TR_eYVdkeZ_X`Wd TZAJ X RJd SV cVT_TZJVU hZeY eYV cM_VkcVaf]ReZ_`W

7 f œYLe`UJ, dh`dUZIR_Veh`d``WiJR_Vetg Z_Wc^ ReZ_R_UT ^ f _ZReZ_eYReZIT_deR_ejj ReVcZ_XeYVhB, daV a]VcV/ReVe``_VR_`eYVčE YV a`hVc`W_Vh eVIY_`]`XZdR_U eYVRFUZ igZfR] Z_Uf deg YRdTcVReVUR_VI aR_UZ_XZ_RAVTF]ef cVZ 3`eY ZJV_eZZdR_U h`dJU gZhd ReVSVZ_XT_ł def TeVU`_eYVSRZd`VZ_RAVZH YReZISVZ_XdW_Ł eYVeWcWZZIR_VI eR dZ_Rg RTTV/VREZ_`VWZ V R_UR Xc`hZ_XVRX^V_eReZ_`WRcReZVZZ eV TYRRReVCZEZIC`VR_Z_RAVTF]ef cV1~`h R_UVRXI ^ V_eReZ_ł ReVRWWIEZ_XeYVT`f_eg`dZ`RXZ_Rg`Z 9`h TR_R_REZ_R] ac`[VTehZY]ReEZ_XVWWIedSV 72484 Let V d' S[VIEZe V I a VZ/_TVd et Re a V a]V YRg VZ_ et VZ VG VG UJ [ZGVdR V eR Z X`_ RTV_ed] Z' a` ceR_TVZ 5 ZVIE V a VZ/_TVLy]ZG % a VCIVAEZ_d R_UWWZ_XLRVT ^ Z Xe` SVet V^ RZ_RXf ^ V_e Wc [f dzJ vZ xa Vcd_R] UVIZZ_dŽE Y VCVZ U f SeL Sj T_ercht RS`fe XV_VR] TZEVZR`V WRZ_RJZ R_U]VXZZ RIJŽD TZR cVR ZG dW de` SV ScVR d Z X WW` Wf_ZG VcR]_c c' dR_UWRX^ V_EZ XZ e` T f_e[VcH Z_UZGZ FR] VI a VCZ/TVČZ 4 R_T]]VIEZEV ^ VR_Z XdR_U af S]ZT cRZ_R]VSVR VC VLVGV RdZ_UZGZ FR] d' S[VIEZEV VI a VCZ/TVČICUT X_ZKUD

DZLEYŁEYVWC^ d`WY WZREZ_R^`_XZ_WZZIFRICŁ R_USVehW_Z_UZeZLFRjdR_UdTZkejRdRhY]VL $YRgVSVT^V \sim V^{T} V \sim TZZEVVZZ_ZHR_VR^{T}$ `WY`hZdfSdeReZRRUeVeReZeVeYVWc^d`W ^WZREZ_SVehW_eYVZ_UZeZUFR]R_UdTZkejŁ SVehW_eYV]`TRJŁeYV_ReZ_RJR_UeYVXJ`SRJŁ SVehW_eYVaRdeR_UeYVVVefcVLR_USVehW_eYV] XZT Woldev dR_Uaved_R d'S[VTezzzej TR_SVŽ EYZdeV_UV_Tj^ R.VdZeUZWTf]ee`gZuheVVTf_eej Z_TV_eeR[ZEELY`^`XV_V f deVc^dR_Ue`TRdeeYV ac`[VTeRdd`^VeYZX^`_`]ZeYZTR_UZ_UZeZES]VŽ 3feZeUVd_`eURhR, hZeYeYV_WUe`T`dZ Revervuzandev e Ngyložz TTvácz Xervuzavcozej `W 4YZV^ VR_df_UXddR_UZ_Xd TZKg RdRac TVddZ hYZY UZXWEV_TV:1REV T_WY_eVUL^ VUZREVU R_U cVT_TZIVUŽHZEY XchZXUZXWKV_eZReZ_ŁhYRe TRARSZZZACI RCV RORZIRS]Ve ecr_dRev UZWWCV_TVdL R Uh YRe^ VTYR Zh dR VeYVEVe ef c_eYV^ Ze Ralf dRZbZT` dVdO

5 7 C B HF = 6I H C B H C H S 9 H 5 G? C : B 5 H C B ! 6I = 48 - B;

Î H, Y h,]b_]b['gdi ffYX Vmh Y 7 YbhYbUfmi bXci Vh YX'm 'U]X'h, Y'[fci bXk cf_'Z; f`h, Y'di V`]Wdc`]WJYg k \]W\`z`]b`h, Y`XYWUXYg h, Uh Z; `ck YXz` \Y`dYX'h; Z; f[Y'U'a cfY'a cXYfbžZU]fYf'UbX'a cfY'XYa cWUhW 7 \]Y"'fÅ L

F]WUfXc @U[cgžCWkcVYf&\$\$\$"

EYVACVALV_e`VAYVCVafS]ZTYRdTR]|VUVAcR _ReZ_lSfZUZ_XZ_ZZRZZVe`SVf_UvceR\V_Z_eYV]ZXYe`WeYV#!"! 3ZIV_eV_RgŽEYZdCVaCVdV_edR eh WURaaVR e RJ 4 YZVR dŽ: eT TVć dVgVj ł S`U SVIRFd/LRd YRd SW_ a`Z_e/U`fe Y/c/Le/V Tf_egidUZgVaZgiTR_`_]jSVTaVReZgVhYV_eYV yHV%ZTlfUVdeYV@eYVcdŽ3feZeZdRdR R_RaaVR e`R]]TZEZKV_dZ_eYVdV_dVeYRe_ReZ_lSfZUZ_XYRd _`eYZ_Xe`U`hZeYRdZ_XJVLViT]fdZeVy^`UV]%Zo CREVVEZETR_`_]j SVRT]]VT6ZEVF_UV6R\Z_XEYRe Zg`]gVdeYVDeReVR_UTZeZdTZejŁacZeReVV_eVd $acZWR_UdTZR$ $cXR_ZRRZ_dLecRUVRdtTZRRZ_d$ $R_U e YV RIRUV ZT h` d LZ? ReZ_l Sf Z LZ X e UR$ YRde`SVdW_RdR_Veh`c\ŁZ_UWURdR_Veh`c\ `W_Veh`c\dLR_UeYfdRdRa]fdRJZeZIL^f]eZIRIVeVU V elvacZNŽ

EYVRZ `V&YZICVà`œZde`T_ecZsfeVe`eYZi ac`TVdl`WbfVdeZ_Z,XLcWWTeZ_ R_UUVSRAZ H`c\Z,XVV^ eYVdeR_Ua`Ze`WYf^R_UVgY`ał ^V_eLR_U`_ eYVSRAZI`WR gRcZdg` `WV^ aZZTR] defUZdEZe`WWdRUZEX_`dZI`WI^VIF]efd]RdaVTed `V&YVd`TZS] ac`TVdIZ_4YZIVZEYZIdVTeZ_UHAd ReeV_eZ_e`d^VRcVRdeYRe_WUe`SVT_dZVdVU Z_eYVT_decfTeZ_`VWR_ReZ_ISfZUZ_Xac`[VTeL R_Ud^VXV_VR]TcZeV2Re`XfZV/RTeZ_Z eYVdV RVRLhZeYVR`a]Vd`WY`h eYyTR_SVRaa]ZUŽ

CHF9B; H≰9B=B; 5B = A 5; 9C: H≰9ÎK9Ï

 $2 \text{ acZ} \text{ Rg} = \text{ReZ} = \text{ISf } Z UZ_X \ S[VI & Z Rd eYZd CVa` ce YRd RCXf VLL YRd e` SV eVV d/RaZ_X `VR_Z RZ_Rj `VVH VLeVV 4 YZVR_d%eYRe V_RS]Vd Vgd Vg S`Uj e` WVJ a Ree`VRT]]VI & Z VCV dY S[VI & Z RXV + YRe eYV} = UZ_Xd de W eY YVCV dY h Z leYRe eYZd Z RXV `VWYV yH W & Z l d` Z a` ceR_e SVI Rf d/Ze ac` gZV d$

RdfcTV`WMRWU^W_Z_XLViaVZ/TVdR_UgR] fVEZ.eZIZ_eVEVEVEVUdTZAJEZ_ZTREZ_deVRe aVa]V}_UEVRd_dWEVEFSZEMZ_XS`_Ud`Wefde R_UT`aVEREZ_ER_UEVVEFaa`ceeVVj_WUe`U eYZEZ.eYZIhBJ_eVy_TR_^ZEXREVEVVEERZ_d`W Z_UZEZIFRZEREZ_Z:eRJd_^R_VEZEVEVEEVC e`RXEW`_eVVETZAJEZ_ERJE_CHEYE`FXYee`XFZUNR_U TYR_VJeVVZ_decf^VENT

5; @C65@5B8@C75@ÎK9Ï

CVT ^ a `dZ_XR_ReZ_R] ZU/_ééj TR__`eZ`a]j UVeRIY^ V_eVo'^ eYVX]`SRJZReZ_ ac TVdtŽ4`^ł a]VeVdV/WeTW/IZ/Tj ZL`ea`ddS]VLR_UeYVC/VgVc hRdRyaf cWaoyf_T_eR`Z_ReVU%eYZVR_ZU/_ééjŽ E`URJLZ_R_X]`SRJZ&U h`cJULh YRe ZI aVIF JZcjj y`f cd%zdeYVRcd3]`V&ZdJZ_VZ_Xe`XVeYvceYV]`TRJL eYV_ReZ_R] R_UeYVCXZ_R]`cX]`SRJŽEYVYH V‰ ZIS`c__`e`fe`Waa`d&Z_e`W&ZX_@eYVcdSfe Vo'^ eYVZ_eVc^Z_XJZ_X`VWcTVd`VgVcj UZWWEV_e `cZZ_d RYJ ScZLZReZ_`VY_XtdR_UZ_XecRUZZ_d hZeY VJV`V_edeR\V_W/^X]`SR] TF]ef cVŽE`URJL `fcy`h_%aF]ef cVZlh YRehVy^R_V`fc`h_%Sj Z_eVcZ_dZ_XyVVcVZ_%X`UdL]ZWdtj JVdR_UZ`RXZ _RZdLh YZIY eR\V`_R_Vh^VR_ZXRdeYY_RV RURaeVUe` eYVUj_R`Zd`V4 YZVR_d TZkjŽ

:eZłaRceZlf [Rc]j gZER] e` c\^ V`SVceYReeYVyH V‰ cVcf]edW'^ eYVT ^ Z_Xe`XXeYVc`VRgRcZcj`VWR eZ_cLcV[ZZ_dR_UVEY_ZTXc`fadh YV_ŁRAWc eYV eVcc`cZeRTed`W" DVaeV^SVc#!!"L^ R_j aV a]V RVeV^ aeVUe` cf_Z_fa`_ Ry_ReZ_R] Tf]cf cV‰ cW_ RdR SRcEZ_ f_Ucc dZXXZ 7f_UR^ V_eR]ZT 1`WWgVcj`\Z_U'ZIR WRc`WUZgVcZcj`eYRe TRFcVd aV a]Ve`W6J] SRT\fa`_RScd]f eVecf eYcR_UT]`cVU ZV eEZcZ

:WeYV3ZIV eV Roj ZdR_`aa`cef_Zej e`Rol hY` hVR:NLeYVT f_egi _WLde`eR]\RS`feeYVUZXWKd Vec`feVdeYReSc`fXYefde`hYVeVhVReV_`hŁ R_Ue`UZENFddUZXWKV_eZUARdRS`fehYVcVhVRcV XZ_XŽEYVZ`RXZ_Rgi `WeYVyHV%BrazAnd ReeYV \underline{Z} eVcd/TeZ_`WeYVaRdeR_UVfVefcVŽ:eZlS`c_`fe `VIRYZEE` q` R_UCVRJZKUZ_ RUKEEZ_REZ_ŽEYVYH V‰ VíZdedhYV_ZeZd]RdeZ_XŽ9`hTR_hVy^R\VeZ V‰ Z_R_RXVeYReZITYRCRIeVOZKVUSj eYVRITVJVCReZ_`W eZ VR URdec`_XWIFd`_eYVZ ^ VLZReVacVdV eO Eh` daYVCVd`VKZT6Z_RCVdaVIZ;TR]jj cVjReVUe`eYZd eV a`cR UZ V dZ Ž7ZdeljŁeV dV ZdeVa` ZZZd `WWZERXWŁSj hYZTYZd^ VR_eWgWgieYZ_XŁeR_XZS]V R_UZ_eR_XXS]VLeYRe 4 YZVR_d TZK j T_dZ.VkdZed `h_R_UeyRedvedZeRaRceW/^ `eyVcd TZ/eZ/dŽEYV a` ZZZd` WYVZZRXVT_dZded_`e`_]j Z_T_dVcgt $\mathbb{Z} \times \mathbb{R} \cup \mathbb{C} \times$ SfeRjd \underline{Z} Sc \underline{Z} \underline{X} \underline{X}^{\wedge} \underline{V}° \underline{Z} \underline{Z} \underline{e}° eV act \underline{U} 2 d RTeZeV ^ V ` cj Ł Y VCZERXV cVacVdV ed R d TZR eZ VeYRe VieV_UdSVj`_U`fcT_eV^a`dReZde` Z TIF UVeY dVhY TR^ VSW&VF dR UeY dVhY hZ[]T ^ VRAWZ

DVT_UjŁRa`ZZTd`WZ V_WUde`XV_VREVR gZZ_`WeYVWefcVZEYVa`]ZeZTR]Z`a`ceR_TV`W eYZdSVT ^ VdT]VRchYV_hVT_dZVceYVUZRWW1 eZ_UZba]RjVUSjd^R_j dVba`_UV_edWV^ eYV]`hVcdecRef^Ž3jT_ecRdeLaVa]VhY`UYRgV $R_Z X R^ Welv Wel CVU _ ef d R i Wel a h C Wel$ `cRTe`aa`cef_ZbZTR]]jŽ4cVRoZ_XRgZZZ_`WeYV Wef cVYRdSW_RTV_eeR] eRd\`Wa`]ZeZTdLR_Ud ZedY`f]USV_`hŁhYV_ VgVqieYZ_XdW^de`SV Uvý fotUSjetVZ ^ VLÆeVadváv_eŽ? `hła` ZeZIR ac`UfTeZ_`WeYVWefcVUVd_`e[fde^VR_dAd $eZ_XXR_dR_UeZ_VZ_ZdcVeRa^{1}ReZ_XTfcVe$ eV_UV_TZKČZ:e^VR_dT_decfTeZ_X`fe]``\deYRe a]RIVd TZR] aYV_`^ V_R Z_ R YZde`cZIR] T_eVieŽ @_VViR^a]VLVkc6fc`aVR_Tf_ecZkdLhRdeYV ZNR`V6fc`aVŽEYZdhRdRa`hVcM/ZNRhYZVZe V^S`UZU eYVZ'RXV`WR yH V%Z_ eYVac`TVdd`W TEVREZ_ŽCVUFTVU e`R_VT_`^ZTaRTELZeTVRCMU e`Z_daZVRdV_dV`V\$VJ`_XZ_XŽ

5 DC @447 GC: GD579

Roh Rezer UZ V dZ ŽEYVZ RXV VIn YReyH VLeYV 4 YZVR_d%RcVZdd/RaVU`gVc eZ VeYc f XY d TZR CMREZ dYZadLR UEYVWC^ d`WEYVOVCMREZ dYZad REVEZUE da VIZ Ta RIVEZH YV_ eYV ZW VO TZE ZddaReZR]jj WRX^V_eVUL`_ eYV`eYVćYR_ULT]ł [VTezeVZLV_ezej dW^de`hVR∖V_Ž@_VViR^a]V ^ZXYeSVDR_@ZRX hYV&VLRTTdLZ_Xe`F?5A def UZVELEYV |RI\`WRT ||VTEZEVZ'RXZ_Rg``WEYV TZEj ^ RJ YReV` cZXZ_REVUZ_RYZXY jj VARX^ V_eVU f cSR_ViaV2V_TVŽEYZIVIR^a[VhV]]Z]f decRevdeYV TF | ef cR UZ V_dZ_ `Waf S | ZTa` | ZZ dŽE YVa | R_ e` dWith af SIZTedR da eZ DR eZRX YRdReRZiej W RZ d+dReZ_RZKZ_XafSZTecR_da`cec`feVdLVRdZ_X eYV~`h`\vg\YZ]\dLUZTfdRXZ_XacZgReVg\YZ]\ fdVR_UcVUFTZ_Xa`]]feZ_Z_eVVTZ;ŽEYVdVXRdL hYZIYR:VdZ`a`ceR_eWcbfR]Zej`V]ZWZ_eYVIZejŁ TR`__]; SVRIYZ&WhZeYeYVT`aVReZ_`VRIŽ 2_UaVa[VhZ]SVhZ]ZXe`T`aVReVR_UXgV fadM}dYWc^d`WSWRgZfcZWeYYjaVcTWZgVeYV `S[VTezzydR_U^ VRdfcvd`VeyVa]R_Rdd^ VeyZ_X dYRVLd^VeYZ_XeYReZdy`f cdYZi_`eYVch`ddL eYVd TTVdd` VeYZlaf S]ZTa`]Z1j hZ] aRcejj UVaV_U `_eYVgZXfcZeTR_Z_WKdVZ_e`eYVZ`RXV`WeYV DR_OFFX yHVZEYVVIR^a]V`WeVVfcSR_Z'RXZ _Rcj dfXXVdedY`hZ`a`ceR_eZeTR_SVe`T_dXVc eYVIf]ef dR] a`Z_e`WgZh hYV_ af S]ZTa`]ZZZdRcV SVZ XRHAMŽ

D9C D29'B 998 'HC '9L D9F=9B 7 9'GC 7 =9HM 5 G' 5 '7 C @297 HJ 9'5 7 HC F

? ReZ_lSf ZUZ_XcVbf ZVd_`e[f de R_Z RVZ_Rq `WeYV yH V% S f e R dVT _U UZ' V_dZ _ Rd h V]]+ aVa[V_WUe`YRgVd^VViaV2Z/TV`WdTZZejRd RT]]VIezeVRIe ČE YVeh `RelvIedReVZ_eVevVK 4`]]VI6ZeVZ RXZ RCZKUT_}XfcVeYV`fe]``\`ceYV Zevlackezev T UV h Yvevsj 4 YZVR_d yevru%R_U ^ R\VdV_dV`WeYVhRjdeYVj]ZeVe`XWeYVZZeeYV dR^ VeZ VLeYVVI a VeZ/_TVdeYReRTIF ^ f |ReVZ_ eVVZc UR; łe`łUR;]Zgvde`XkéYvc Z_~fV_TVeYvZc gZyh`W d TZKġŽEYVEVZL_`^ VTYR_ZTR|T ceVTReZ_SVehW_ ViaV2V_TVdR_UZ RXZ_R2X4L`WT fockLSfeZeU Vd ^ R\VdV_dVe` daVR\`WWTZac`TR|T_UZEZ_Z_XŽ7`c $aVa]VhY^dVURZ_jVaVzZ_TVZd^_VM1T]fdZ_$ R Ua`hVdVdd VddL`chY`YRgVSVT ^ VT_gZTVU eYReVgVg`_VYRde`W_UVVceYV^dMgVdLRj`_VR_U $f_RZ_VU_ZehZ_JSVUZ_VIf_ee WV_R_jd_dV VSV_I$

]`_XZ_Xe`RyHWZc3jT_ecReHZ_UZgZLfRjdWWjeYRe eYY_RVZ_T_ec`]`WeYVZcRIeZ_dR_UeYReeYVZc [ZgVdR:VS`f_UfahZeY`eYVcdhYV_eYVjYRgVYRU cfTTVdHMJViaVZ2_TVd`WT]]VIeZgVRIeZ_Ž

H:9 9LD9F=9B79C:5 CC7=9HMH:5HC9HC 6CIB8CHCH:9ÎCMCH9AÏ

2deYVZ_eVcgZ/hddY`hVULaVa]V`VeW_WW `g\xhYV]^ W R_U U\yg`f c\U Sj hYRe eYVj TR]] yeYV ^ RIYZ_VZEYZd dV_dReZ _ `WYV]a]Vdd_Vdd dW de UZ ZZMŁY hvgvŁhYV_ eYV WW eYV RcVaRce`WR]RcXlcV_oZjeYReTR_dleS`f_Udle` eYVyd deV %ZyDkeZ_XS`f_Ud%ZdTdfTZR|hYV_R W_TeZ_R]d;deV^Łd*TYRd;eYV^Rc\VeLUVd_`e YRgVR_Z_SfZeyTfel`WW%68 VTYR_Zf^e`T_ec`]Zed $V_1 a R_d Z_{Z_1} dTY T R dV d Z dh c Z X dT R_V U f a$ Sj dh WaZ XRh R aV a Vdd S (VTegzej ŽF Jez Revij Ł eYZ:1Z:1UVecZ'V_eR]e`eYVWWIZV_eh`c\Z_X`VeeYV d deV deYV dygVdŽEYV" **) CVa` ceR_Rj dvUeYZd Uj_ R^T ZTR_UT_T]f UVUeYReeYVT f_eq dYf ^ R_ UVgVj^a^V_edvbfZVURT^a]V^V_eRcj_dV]ReZ_ł dYZaSVehW_eYV`aVcReZ_`WWV_TeZ_R|d_deV^d R_Ud TZR] df S[VTezzzej ŽE YZdUj_R^ ZT_WUde`SV d√ V SV&USVIRfdVZeZdd Z a`œR_ee` aV a]V e`WY]eYReeYYj TR_dZZ_eYVy^ RIYZ_VZZ

CWVc^ a`]ZZZdddrf]USVR_RjjdVUZ_eYZdT_ł eVieŽEYVZcdTTVdd`V&V_UVaV_Ud_`ed`^fTY`_ eYV R^ `f_e`WcVd fcTVd Raa]ZVU e` R a RoeZIf]Rc `S[VTezeVRd`_ eYVZ: RSZZej e` ^ `ezeReVaVa]Ve` XkeZ_g` |gVUR_U^ R\VeYVac` [VTeeYVZc` h_Ž@g\c $R_U RS^{\circ}gV eVV da VIZ T X R ^{\circ}VeVV af S Z a^{\circ}Z$ T_TVc_VULIRdeZ_XdfTTVdd1ZVdZ_^`@@ReZ_XaVa1V e`SVT ^ VRTe`cdZ eYVac`TVdtŽEYVViaVcZV_TV`W $SVZ_XaRe^WRdTZkjeYReZdTRaRS]V^WTZZX$ dTZR ac TVdtVdZIR] $eVV^ CVZ$ a eR_eZ_eYRe d^R_j aVa]VWWJ YVJa]VddZ_ eYV WATV`WhYRe eYV a VETVZEVRdy_Ref dR]ZREZ_%WEYVd TZR]`dUVŽ HYV_ddeV^dRcVgZhWURdaRce`WeYV_RefdR] `dU/c`WeYZ_XdlR_UV/aV/2Z/TVURdR_`gV/a`hVd Z_Xy^ RIYZ_V%oeYV_ Z_UZeZUFR]d RcV UVacZeVU `W TeVROZVZ ZZROZVŽ

GC 7 =5 @ D5 FH≠7 =D5 H+C B · 5 G · 5 · H+5 =B =B; ; FC I B8 : CF · 7 C @@97 H=J 9 · 5 7 H+C B

:_ #!! ! " LRacVOLV_02R TZ:TF]Rc decVdtW eYVZ' ł



a`ceR_TV`Wo1TZR]aRceZTZaReZ_R_UZedgZeR]c`]VZ_ af S]ZTa`]ZIjŽEYZIX R] ZIRJd YZXYZVeVUSj eYV }_UZXd`WeYVacVdV eCVa`œŽ@_VZ}gV`WeY`dV Zelvég Zuh VU WN Ze eVV v VZXYS`fdj fez Zercz R_‰ TReVX q ŽE YVOV RCV aV a]VhY YRgV h ZeYUCRh_ Z_e`eYVZcZ`^VUZReVd`cc`f_UZ_XdR_UhY`WW R_XqiRS`feeYVTf_eqiLVgV_eYfXYeYVjSVjZkgV eYV/RCVyXRZ_VcdfZ5VdaZeVeYVZcUVeRIY^V_eW/^ a`]ZEZTeLaVa]V`WEYZdejaVeR\VR_ZeVEVdeZ_eVVZc) TR T ^ ^ f Z; R UT f USVRIEZ ZŽEYV a`ddddtcVRezeVa`eV_eZRJLR_UeYZIT f]USVXRjeRi ZKUSj ZURdeyRedeZ f [ReVU]`TRj aRceZIZaReZ_Ž :Wy_VZXYS`fdj_feZZZRCZR_d%bhVcVV_TfdRXVUe` aRceZZZREVZ_T]]VIeZeVRIeZ_ŁeVY h`f]USV^`dV ZVje č RSR_U_eYVZcyacZeReZ(* %R_UWW) aRce`W 4 YZV dd TZV éj R_U Wef c VŽ

GC 7 -5 @@ ÷ 9 A 95 B G GC 7 -5 @DFC H97 H€ B

:_UZGZLFR]dU _`e [fde RdaZV e` yXXVU ^ `W TY ZIW deYy R]d UXEV et VTRARSZZEj e` Z a]V ^ V_e et VTY ZIV deYy YRgV ^ RUŽ2_U et Zd Z UZ gZLFR] TRARSZZEj ZTI]`dVj [Z_\Ue` et VTRARSZZEJ Zd `W TZZ et RhY`]VZH YV_aV a]VU _`e YRgVet V d TZZ et df cTV deYy _WUe` et R]ZV`aa` cef _ ZEX d R_UT f_etc et V cZh det Re UKgY`a ^ V_e Z_4 YZV $\begin{array}{c} \mathbb{V}_{efz} dz_{z} Uz_{z} dz_{f} R_{f} R_{e}^{-1} j efc_d Z_{e} W ded R Z_{R} Ua^{h} V_{e}^{h} V_{e}^{h} Z_{e}^{2} R_{z}^{h} z_{s}^{h} z_{s}^{h} Z_{z}^{h} z_{s}^{h} TZR ac' eVTeZ_ cV[ReVdRS' gVR] e' eYV^ ReVoZR T UZEZ d`WZWZEYVZ'a|ZTReZ_`WeYVRS`gVL Y`hVgV&LZde/Re^Re/VZR]d/TfcZej`fXYee`SVRI} EYc`fXY`feeYZlU`Tf^V_ehVYRgVdW_eVVZl ~fV_TVeYRe_VXReZeVWWZ_XdRS`fe4YZVR_UeYV VT_`^ZTd_deV^TR_YRgV`_d^TZR_cVReZ_dYZadŽ HYV_YRWVR] cvda`_UV_edUVI]RcVeYReLUvdaZeV eYVTYR_Xk&VgVg eYZ_XYRdX_V^ _ eYVd?^ VLeYVZc UZZ f $dZ_^ UedW de SVeYV de UE R$ R URWWIGZEVgf] VCRSZZEj Rd^ fTYRd`WT_`^ZT T_UZEZ_dŽ_WANTELZEYRdSW_dYh_eYReaVa]Vd VT_`^ZTdEFReZ_Zd_`eUZeVTejj T ceVjReVUhZeY eYVZcd TZRSZZEjŁ`cVgV_hZeY eYVZcZ RXV`VeYV^ł dMgVdRdXRZ_Vcd`c]`dVcdŽ4`_TVc_RS`fe4YZVR_d d TZR d/Tf cZejŁeYVćWVćVŁYRde`VieV_U_`e[fdee` eYVZc^ ReVoZRI ac`SIV^ dLSfeRId` e` eYVZcdfSIVII eZeVVíaVcZV_TVďŽ

7F95H⊞; 0C 7 -9HM6MCHF9B; H< 9B-B; H< 9 CC 7 -5@6C B8

:_UZ&UFRJdR_Ud TZAG RVA ` &UAd`WAYVA? V TZŽ_ cVJRZ_e`eYVUZWWCV_eyhBjd`VJZWALAYV CVa`ceYRdUV `_dacRevUeYV cVTZac`TRjZ a]ZR eZ_d`VZ_UZ&UFRJZREZ_ R_UeYV `cXR_ZREZ_ `W d TZAGŽ:_UZ&UFRJZREZ_ `VR_RdTZR] \Z_UeV_Ud e` cVdF]eZ_RdTZRJ VRScZTaVc^ VREVUSj ^ ZdefdeL hYZ/VRVRX^ V_eVUdTZAG eV_Ude`cVdF]eZ_R``cR] `c`aa`cef_ZdeZT SWR&Z fcŽEYV V&VbfV_Tj hZeY hYZTY eYZd YRaaV_d ^ VR_d eYVcVZd R_WUe` :_ eYVTRV`VWUFTReZ_R]cW&c^Ł^`cVdeVdd YRdSW_ JRZU`_ T X_ZEGVJVRc_Z_XR_UZedRaaJZ TRSZZEj e` eYV_Vh h`dJU`Wh`c\eYR_`_ `eYVc eYZ_XELd TY RdRTF]ef cV`WT`aVdReZ_ R_UTZGZT dV_dVLeYReRCVTdfTZRJe`eYVdTZRJS`_UŽ_e`URJ`d TZCTF^ dR_TVEL`aa`cef_ZEXde`^R\VR_UV_YR_TV VZV_UDYZad`ce`V_XRXVZ_TCECTRJUZETFdZ_`V&AV Z`RXXd`We1TZXg``WWXCVUSj_eVJVGZZ_dr`f]USV dW_RdaRce`VWF]ef cR]a`jZjŽ

H + 9 CC 7 - 5 @ 6C B 8 69; - B G - B DF - J 5 H 9 @ 9

5 ValZeV eYV VgZIV_TV`WY`h ^ f TY Z' aRTe aVa]VdacZeReV]ZeVdYReV`_eYV]ZW`WdTZkejŁ RS]R_\\e`\W2[V_TV`\W_U\dTV_Ud`_Zdf\deYRe VgVg`_VViaV2Z/_TVdLSfeeYReRcV_`eda`\V_ $RS^{f}eZ^{i}=dW^{d}eZ^{i}eV^{i}a^{i}dW^{k}eZ^{i}X$ eYVdV yacZeReV%Zdf Vd RITVaeVU Rd ac`S V d eYRe T_TV_cd TZK j RdRhY [VŽ7 cd TZR S`_Ude`SV decV_XeYV_VLLeYVcV_WU e`SV`aa`cef_ZeXdWc aVcd_R ZWe SVT ^ VaRce VeVd ZR USREVŽ $E YZd V_e RZd R_f^SVc We YZ_Xd ZE YVc Wud$ e`SVR acVUZda`dÆZ_e`hRcUde`]VcR_TVR_U _`_łUZETCZYZ_REZ_Łd_^aReYjR_UT^aRddZ_Ž D'TZK j Rjd_WUde UVgVj`ad ZERSJV]R_X FRXd We UVR Z Xh Zey eYVdV ^ ReeVed Z af S Z Z ^ `eV ~fZUcVRez_dYZaSVehW_acZeReV]ZWRUafS]ZT T_gvcdReZ_h`f]UXgVaVa[VXvRevccvdfcTvd WcURZ_XhZey eVVTYR]]V_XkdeyReRzEVeVkVZ2e eYVdR^ VeZ VLZeh`f UV_RS[VaV a]Ve`dWeYVZc `h_]Zevidev-VTevUZ_evVafS]ZTdaYvevŽ@_]jZ_ eYZthR, TR_ Ra]Rf dS]VyH V%SVTeVReVUŽ

5 71 @H F9C: HFI GH; 9B 9F5 H9G G971 F+HM

HZEY fed TZRJ S`_UHZEZIYRU e`WWJ dVTf d\Z EYZEZIEYV]\vdt_`\WEYVZ_dVTf dZg eYReaV a]\V1 a\V d\ZTVZ_eV\ZEY ^ \dR_UZ_eV\de\WEZZIEYV''**) C\va`ce af eZELeYVTcZ_Z_RJ ZHR ^ \eRaY`c \vc eYV ^ Zhef de Rc`f d\USj \g\vgi deR_X\vZA`_d\vbf \/_ejL eYv&VIR_SV_`WWJZ_X`WWTfcZej hZeYfeXcNeVc ef deZ_eVVR_`_j^`fd@eYvZeYZlackfaa`dvdR_ VfaVcZyTV`WT^^f_Zej eYRe^R_kdZea`dvZsJVe dWdeR_Xvcd_`eRdReYcNeLSfeRd`eYvc^V^SVcd `WeYVyHWZAFSJZTdvTfcZej V_eRZdRTfjefcV`W dvTfcZejER_UeYZdUvCZevdWi^eh`Tj`dvjcvJReVU eYZ_Xd+}cdejELWi^ eYvefdeR_UdvJVWd&W^ eYRe cvdfjeWi^^VVSVcdYZa`VRdec`_XyHW%oR_U dvT_UjEWi^ RhZJZ_X_vdle`eYZ\eYRehYRe UZdZ_XfZhVdj`fWi^ eYV@eYvcUVd_`e_VAReV eYVviZeV_TV`VRT^^`_SRdZISVchW_j`fŽ2VW }c^ReZ_`VeYZISRdZIUvchZevUZWWCVTVddW^ d e`SVR_VTvdRcjT_UZeZ_`VeYVyHWZaeZleYV ^ZdZ_`VR_ReZ_ISfZUZ_Xac`[VTee`V_cZTYeVZI SRdZIR_UX&vZedSdR_TVŽ

5B °C DDC FH B + M: C F 89A C 7 F5 H 7 ° DC @+ F G

EYVTF] of cR TYR] V_XV^ZXYe SV d^ ^ W f a Rd W] `hd+eYV acRieZIR] Wc^ d`WZWZ_ d TZkj _WUe`SV`cXR_ZXUZ_ dTYRhR; eYReeYV X&V aV a] VR WYZ_X`W1 TZR SV]`_XZ_X_ReeYV d^ V eZ`VLeYVCZIR_WUe`TCXREVeYV\Z_U`W4/_dVR_U c\ac\c4/_eRzZ_`VeYVyH V%eYRe V_RS]\c4aV a] Ve` RIE T]]VIeZyVj Z_dYRaZ_XeYV acRieZIR; Wc^ d`W eYZIT ^ ^`_]ZWŽ

aV a]VRVUV R_UZ_XVI a]R_ReZ_dVvcgVcj daVUZ T eYZ_XŽZ]VR Z_Xc` VWRhc`_Xjj TRJTf]ReVUSZJER_ VTVdZgVjj]`_XhR&Z RdfcXvcjER&Z ` WW UeYRe ZlaRde Zddd/]ISj UReVLR_f_[fd&Z VU eRV/T}_VŽ @_eYVWIV VZE eYVCH R-UdeYReU _`eRUUf a e` eYV Z_U` VXV_VCR] ac`S]V^ dh YZY RVeYVdf WWVa`]ZZZŽ3f e`_jj`_ eYVWIV` VZE SVIRfdVeYVZ_UZZJFR] h`dUZL` eUZg`cTVUVA^ eYVa`]ZZTR]`_VŽ_ eYVCd'S[VI&ZVTALR]] Z_UZZJTR]dgRJZ.ReV`cZgRJZ.ReV`_ Rd`R] dIRV eYVZ RXV` VUZgZTUZZ_ZjLac` eVI&Z_LafS]ZT`]ZW R_UUV^`TCRIj eYRea`]ZZZdV a`f_UdR_U cVacV dV_eXZ : VZe ZX` cVd eYVUVaeY IRe`_TVd'S[VI&ZV R_UUV^`TCRIJ eYRea`]ZZZdV a`f_UAR_U cVacV R_UUV^`TCRIJ eYRea`]ZZZdV a`f_UAR_U cVacV R_Ud TZR]` VV R]]dIRVV aVZ/TVLa`]ZZTd^ R] WWWEZ RV RIZZZ RIJ Z_aV a]VdV VŽ

CVT X ZKZ X eYV d'S [VTezeV R U d TZR] y cVRZej ‰ `WeYVdV VgVg UR, Via V2Z/TVd Rd ScZ_Xd R XcVRe `aa`cef_ZejŽA`]ZeZTdhZ|SVT`^VdZX_Z;TR_ehYV_ $Zeac^{2}gZVdTZeZkV_dhZeYeYV \setminus V_d^ VZ_eVcacVeReZ_$ R_UdX_Z;TReZ_eYReeYVj_WUe`^R\VdV_dV`W eYVZcURZji jZzvdŽ:_ aRceZlf jReLZe_WUde` TcVReV $R_U c d d e e V V R_Z d e Re d Z Re TZZKV_d$ cVbfZVe`]Z \ eYVZcaVcd_R| ViaVcZ/TVdhZeYWV Wade To $Reverv \setminus Z \cup WRe Z = eYRe Z UV d Z V UR U$ hZey eVVafS]ZTZ_ZZRezeVdf_UVceR\V_Z_afccfZe `WeYZŽEYZI^ VUZRe`q`W_TeZ_ZI_`eUZIIYRcXW eYc`fXYeVTY_`TCReZTZ_ZZRezgVd`ccYVe`cZTRS`fe T ^ aRddZ_ e`hRtLdeYVf_Vtoef_RevLSVIRfdvS`eY $Wey VolvScVR e V CV Rez_drza e Re]Z dz Uzezt R$ Via VZV TVR Ud TZR) č XR ZKReZ Že ZdZ a čer e e` d\aVReLeYV_LeYRe Ze ZeleYR_\de` R_ Z' RXZ_Rg `WeYVyHW%eYReaVa]VUZETgVcR_UcVR]ZkVeYV `aa`cef_ZEXIde`eR\VT_ec`]`WeYVZcRTeZ_dŽEYfdL eYV^`cVZeV`ScRIVdeYVTf]ef cR| UZ`V_cZ_ŁeYV ^ `dVa`]ZEZIdhZ] SVy`f cdZZ

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 $EYVYf^R_UgV^a^V_eZ_UV_195:/dW_de$ $^{\text{NR}}$ (Very Reverse) with $^{\text{R}}$ Transzer dz. R d TZAjŽedak_URUKVUTYRCRIEVĆ^ VR_deYReeYVdV ReeRZ_^V_edTR_SVT ^ aRcWhZeYRX RJ e`UVeVd ^ Z_VY`h ^ fTY ac`XXddYRdSW_ ^ RUVe`hRdd eYZdR_UY`h ^ fTY deZ] cV^ RZ_de` SVU_VŽ@W $T f collever 0.5 : Zf _] R_ReeV ace `aVReZ_R]$ ZKVeYVXV_VCR Raac`RIY`WXf^R_UVgV/`a^V_eL hYZYZIRhR, `VJ``\Z_XRed TZR]Zdf VdeYReTV_eeVd `_aVa]VRdeYVdfS[VTedR_UacZ:VSV_V;TZRcZd`W eYVUvgy a^ V_eac TVdžEYV95: aVReZ_RZAVd eYV^ `de`VddV_eZR] VJV^ V_ed` VeYZlRaac` RTYLSf e ZeTVæRZ_jjUVd_`eViYRfæZZdYRdSW_dZLŁ yeYVZ_UM_Zd_`eeYVT_Tvae%ZEYV95:ZdeYfd Z_eV_UVUe`T_ec25feVe`afS]ZTUVSReVcReVvCeYR_ e`dwlee]VZeŽEYVZ_Wc^ReZ_Zedfaa]ZddYff]USV $Rdafce UZIIf dt Z_R_UW de Y dz bf Z j Z e Z j Z V$ eYVU`ce`RY`fd4_`S`Uj hY`_`hd`_]j eYV $U c TR_dR[i] \ h eVY f dVZ_i S U dR[i]$ hR_eZ_Xe`_`h eYVY`fdVLY`hVgVLh`f]USV hVj] RUgZKU e`V_eVc Sj eYVU``dŽi2 UVeRZVU Via]R_ReZ_`WY`heYV95:ZHTRJTF]ReVUhZJSV Wf UZ RaaV UZ "!Ž

2]d LeVV 9 5: Zd UVdZ_W a ReeZff]Rcjj h ZeY R gZh e' ^ _ Ze cZ_X]`_XleVc^ ac TVdVdŽ:e Zd ^ VR_e e` cWWTe ded Tef dR] TYRCRTeVcZdeZTd` WR d TZKg `d UVgV]` a^ V_e dReYVc eYR_ da VTZ; T dY` cel ekt^ dzfReZ_dŽezdevfdSvaee`TRTIF[Rev]`_XeZ V dktZkd]Z.VeYV`_VackdV_eVUYktVŽEYZdRaac`RIY ac`gZNdR_`gVgZh`WYf^ R_U gVj`a^ V_eR_U ZedRIYZgV^V_edR_UdvéSRI\d`gvceYV]ReeUVIRUŽ > VéY U]`XZR]ji ŁeyVRIYZgV V_ed`WeyVUVIRUV TR_SVVgRffReVUW/^ eh`a`Z_ed`VgZhŽ7ZceljiŁ eYVEV ZdeYV Xc heY \underline{Z} eYV RSd]f eV gR]f V `WeYV 95: ŁhYZY dł-VTedeYVUj_R^ZT`WeYVac`TVdŽ DVT_UjjŁeYZdUj_R^ZTTR_SVRdAddUZ_eVc^d`W ZedT_eeZSfeZ_e`eYVf]eZ`ReV`S[VTeZeVLhYZIY Zde`T^VRdT]`dVRda`ddZS]Ve`eVVZJVRJXRJ`W Yf^R_UvgV]`a^V_e1cVacVdV_eVU deRezdeZIR]]j Sj eYVgRJfV"/ŽEYZddVT_URaac`RIYeR\VdRITf_e`W eYVWReeYReeYV^ `dVac`XdvddZl^ RUNLeYVXdVRevc $R_U^{\circ} CVZ_ecRIeRS_V eYV TYR_V Xd SVT^VZ:_$ eYZIR__VIVLeYVeh` Raac`RIYVdRcVW]`hVUZ_R T^a]V^V_eRcjWRMZ_e`[fUXVeYVdTR]V^WhYRe YRdSW_ RIYZIGVUR_UVGRJf ReVY`h ^ f TY dv RZ_d è SVU VŽ

7 c eV ackál_egkáZ_ `VeV da VIZA] 9 5 : Wć 4 YZV f dv YRdSW_ ^ RUV WRERW/ $^{\circ}$ eV 4 2D6? "**! R_U#!!! d cgV dT _UT TAUS j eV > ZZ dej `WA]R_ZXR_U 4 ``a VARZ_ R_U `WURER W/ eV 6aZU^ Z]`Y 5 VaRe^ V_e`VeY > ZZ dej `W 9 VR eZ YV da VIZA] 9 5 : Wć 4 YZV ZIR ^ `UZ W g VaZ_ `WeYV h `dU ^ VeY U]`YJ ZGRZZS] Vd YRgV SW_ RUUU `c cká] RIVU $^{\circ}$ ^ R.VZe^ `cV dv_dZgV e` eYV cki] Zdf Vd`WVgV]`a^ V_eZ_4 YZVZIT dJ Z Xj LeYV} Xf ckúj ZJUVU Sj ZERV_`eZ ekc_RZ_ł R]j T ^ aRdS] VŽ

=Z.VhZMLeYVURR af S]ZHVUYVVRV_`eT^1aRHS]VhZY VVZ_R] 95: } Xf VvZ_R] 4.22 av J_{2} `fdafS]ZIReZ_d1F?5AL"**', F?5AL"***, $> Z_Z Reg$ `WA]R_ZXR_U4``aVReZ_IF?5AL#!!!/ŽEYZIZISVIRFdVeYVVYRgVSW_TYR_Xd \underline{Z} eYVhR, $d^{\wedge} V \underline{Z} U \underline{Z} Re^{\circ} cd R V f d U 1 da V \underline{Z} T R] j L$ a`eV_eZR|jVRcd`WZZW]`de/R_UZ_eYVacZIVcReZd $f dVUe^{-1} R_VZ_T^{-1} V$ $M cVdZ_eVc_ReZ_R i T^{-1}$ aRdS/VSj T_gVceZXeYV^ Z_e` af cTYRdZXa`hVc aRcZej 1AAA/eVc^ dŽEYVOVTYR_XVdZ_` hRj RWWTe eYVf_UVdjZ_XT_TVaefR]`XZT`c^VeY`U``XZIR def Tef dv Werv95:Ž_Wef dvZedr f [USVa`ddZs]V e`WeeYvcR^V_UeYVgRzRS[Vdfd/UVvcTRTf]RzZX eYV95:Łe`eR\VZe`RTTf_eeYV`aZZ_dR_U dfXXXdeZ_d`WadVdV_eR_Ua`eV_e2R fdvd`WeYZd Zdecf^VeŽ

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EYV da VIZR 95: Wc 4 YZ/Vc dV W/ 1 Ž*! Z "**! e` ! Ž % Z #! ! ! Ž ` eWch`dddeYVT f eq dUFTVUeYVXRa d/aRRZ_XZeW/^ eYVZMRJUJJ_VU RdW[]Yf^R_UvgVj`a^V_eSj "* Ž@gvceYVav2Z `ULR] dVZ_d`VeYVT_f_eqiZ_TdVRdVUeYVZcYf^R_ UVgV/`a^V_e/VgV/dT_dZVdRS/jj 1dW}XfcV"/Ž

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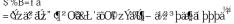
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:_eVc^d`VRSd]feV95:gRfVeLeYVcVXZ_eYRe ^`deZTcVRdNUZed]VgY]`VReeRZ^Ve`gVceYVUV TRUVhRd> Rf [VLhYZIY T]` dVU eVVXRa dvaRcReZ_X $\mathbb{Z} \otimes \mathbb{W}^{\wedge} = \mathbb{W} \mathbb{Z} \mathbb{W}$ Sj #\$" $\mathbb{Z}_2 \mathbb{V} \mathbb{Z}_2 \mathbb{U}$ @ 9 ZXXZ_dRtVRd R^ `_XeYVcVXZ_d^ R_Z_XeYV XVRevelac`XevelidW}XfeV#R_UeRS]V"/Ž_"**!Ł R] eYVAV AXZ_d YRU AVREZEW j]`h 95: gRlf VAŽ $ARce_{ij} RdRcVdf_{e_{i}}e_{v}cVVZ_{e_{v}}cVVZ_{e_{v}}cVVZ_{e_{v}}cVVf_{e_{v$ R_U $(2 \times 2^2 + 2 \times 2^2)$ $(2 \times 2^2 \times 2^2)$ $1Sj \# Z "! j VRadLdW} Xf cV SZ$

:_ eYZd`gVcgZhLERcRaRIi R_U2eRIR^ RdeR_U `feRdeYVcVXZ_dhY`dV95:Z`ac`gVU[VRde`gVc eYVUVIRUŽH YZVď SdeR_eZR ac`XXVdh Rd^ RUVL eYVVieV_ee`hYZIYeYVj Tj`dvUeYVXRaWVjhVj] dY ce `WeYV_ReZ_R] Reversivi) Ž ″ R U " ŠŽŠ″Ł cVdaVTeZeVjj/Ž

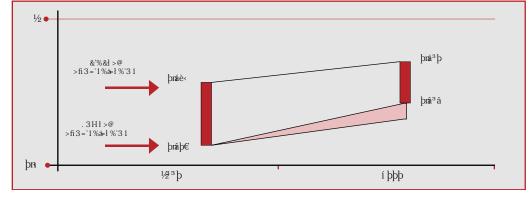
EYVON TYR_XXdZ_ eVV95: cVgVR] `_TV RXRZ_ eYReeYVCVZd `Rfe`^ReZTZ\SVchW_VT_`^ZT Xc hey R_UYf ^ R_ U/gV/ a^ V eZ72xf eV/dr hd eYReeYV&VRVCVXZ_dhYZYYReVaV&V&^VUdZ Z |Rc|j Z_VT_`^ZTeVc^dSfeac`XeVdbVUe`UXXWZ_X UVXCWdhZeYYf^R UVgYia^V eŽEYVcVXZ d`W $2 \in RIR^{n} R R U > RXR | R Vd RCV V e CV^{n} V V R^{n} a | Vd$ `WeYZEZEYVWc^VcdRheYVWRdeVdeR_fR|85A Xc heY gVceYVaVcZU"*) l **) l Sf eZedYf R Uvgy a^ V_eaVeVe^ R_TVhRd_ ed Uj_R^ ZZZ@_

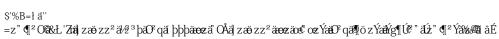
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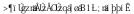
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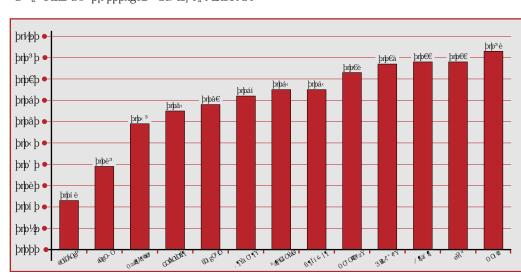
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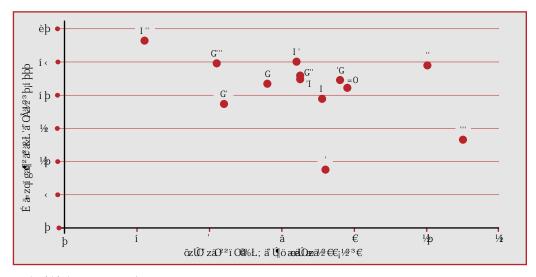






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 $eYV^{e}VC YR_{L} > RAR]R_Vd YRU eVV^{h} We dRV^{V}S 5 A X^{c} heYLSf ea VCWC^{h} VUSVeVC eYR_ ^eVC^{h} AX_{d}^{T} YF^{R} UQY^{h} a^{V}C eVC^{h} dX_{d}^{T}$

7c' ^ eYZIX_VR] eV_UV_TJŁeYVWJ hZ_XT_ł TJf dZ_V VXXd+VT_` ^ ZTXc heY ZIR_VIVdRcj Sfe_`edf WIZ/ eT_UZZ_WcZ ac gZ_XYfł ^ R_UVgY a^ V eZ9 f ^ R_UVgY a^ V eZIS` f_U fahZey eYVY ZIVIRd TZG ^ R_VIRERXZQV eZ VL R_UhZey eYVV aYRVdR_UacZ cZ5ZdeYRe X ZIVZŽ :_ `eYVch`dd ZXRd TZG ZIe Rg ZJaVaVaVf Reł Z_XX/XRaYZIR Z_Vbf RZZZd Ze ZI Z_UZAV_dSJV WcZe e` ^ R_V RIZGVLT_dTZ fd WW.ced e` W.devc a` eV_eZ3 d_ V.eŽ

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3Veh W_ "**! R_U "**#LR_ Reverse V W "" j VRcd aVc "L!!! Z_YRSZER_ed h VEV SVZ_X]`de Z_ 4 YZVSVTRf dV`VacV^ Ref cVUNeYdŽ:_ eYVaVcZ U "**' l"**) ŁeYZI]`dd h Rd U h_ e` *! j VRcd aVc "L!!! Z_YRSZER_edŽDZX_Z TR_eZ ac gV V_edh VEV $\frac{dW}{Z} [R] \frac{dWZ}{dt} = R 2 \frac{dF}{R} \frac{FR}{34} \frac{33}{4} \frac{33}{4} = \frac{1}{2} \frac{d^2}{2} \frac{R}{U} > \frac{F}{R} \frac{1}{2} \frac{1}{2} \frac{d^2}{2} \frac{R}{2} U > \frac{F}{R} \frac{1}{2} \frac{1}{2} \frac{d^2}{2} \frac{R}{2} \frac{1}{2} \frac{$

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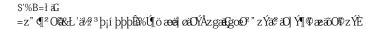
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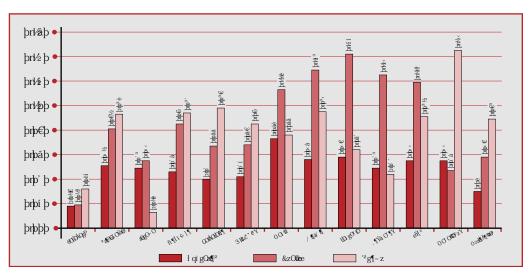
$$\begin{split} & EYV \}_{LZ} XdWc eYZdRa VTeUZU_`egRij ^ fTY \\ & W^ dWZ_ e dWZ_Z: = #!!!L]ZeVRIj R^`_X \\ & gVd #%de`UReYZY]VgVdZ R] dWZ_dLhZY \\ `_]j > Rf]V]RXZ_XSWZ_UdZYej Re*! ~ Z_eYRe \\ & R^ V j VRc`gVd #%d_RZ_R]j YRU R_RVdXV`W \\ & Zig VRcd`WUFTReZ_LhYZYZdRd RX`UcVf]eL \\ & ReY^fXY`VUF fcdVZeZdeZJ R]`_XhBj W^ eYV \\ & "& j VRcd YVJU fa Rd eYVZVRJZEYV dWZ_deYRe \\ & YRgV WeeYVe e X Z_T]fUV@`9ZXZ_dL> Rf]VL \\ & =`d=RX dR_U2j d/2LRgVdRZ_XRS`fe VZXYej VRcd \\ `WUFTReZ_Z$$

EYVÁV Z UZIRe`cd cV/ReV e`eYV ReeRZ_ ^ V_ed`W aV a]VhY`YRgVR]cVRUj]WAEYVVUFTREZ_djdeV^Ž 4`_dNof V_ejjLeYZIRdaVTe`VEYVZ_UM_Zdf aa]VI ^ V_eNUSj T_dZVREZ_ `VEY`dVhY`REVdeZ]Z_ ZELR_U YVCVd SdeR_eZR] ac`XcVdt YRd SW_ ^ RUŽ AcVidTY``]VUFTREZ_ T gNRXVZ_4 YZVYRd cZN_ =bWca Yg UgdYWh

 $\label{eq:starting} \begin{aligned} & 3 \forall h W_{-} "**! R_U \#!!! La & Trazer Y f d Y] U \\ & Z T ^ & Vic d V _ d U & Vis Y & Vis d V _ d U & Z & Vis V & Vis Y & Vis V & Vis Y & Vis V & Vis Y & Vi$

:_VbfR]Zej Z_ZT^VUZdecZ5feZ_cVRZ_W XV_VcR][j YZXYR_UdeRS]V`gVceYVUVIRUV18Z_Z T WWXZZ/e`WZX)/LhZeYZ_VbfR]Zej VRdZ_X`c h`cdV_Z_X`_]j e`RgVcj^Z_cUVXcWZ_eYVUZAV @_VgVg Z`a`ceR_eT_T]fcZ_eYReTR_SV $UdRh_W^{\prime} UdRZWR_Rj dZ1^{0} VeYV95: UZ^{\prime}V_{1}$ $dZ_dR_UgRzRS[VdZdeYReeYVYf^R_UvgV]^a^V_e$ ac`} |Vd`WeYVUZWWCV_ecVXZ_dRcV_`eR|Z\VŽ EYV}_R]95: gR]fVac`gZU/d`_]j Ra`Z_eVce` R XZZV_ cVXZ_`dXV_VcR] [VgV] `WReeRZ_^ V_eLR_UZe _WUde`SVofaa]V^V_eVUSj_dVaReVT_dZNd ReZ `WeYVUZXWWEV e dZefReZ dViZebZXeYVEVŽ: `eYVch`ddŁeh` dVXZ_dhZeYeYVdR^V]VgV]`W $Yf^R U(gV)^a^V e^gV(R)^R YRgV UZWWCV e$ ac`} [VdR UUZXWWCV eTYR] [V XVde`T_WV eŽ7ZX f cV%SRI\df a eYZIT _T]f dZ _ Sj dY hZ_XLcVXZ _ Sj cVXZ_ŁY`h VRIY`V&YV95: RohVTedUV&V(`aVU SVehW "**! R U#!!!ŽH YReZedY hdZdeyReYf} ^ R_ Uvgy]`a^ V_eYRd_`eW]]`hWeYVdR^ VaReY ZRICVXZ OŽEYVUVOZX RURaa ZIRoZ `WafSZT a` ZZZAR UCVXZ_R decRevXZAWCYf^R_UVgY`ał ^ V_edY`f]USVXfZUUSj R_ RhRcV_Vdd`WeYVdV aVIF |ZRZEZKÓŻ9 Ręz_XdeRezteZIR Z_UZIRe odeyReyVja $e^{2}XV_{e$





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91 d`cfUhcfmghi XmcZWcbj YfgUhcb UVci h7 \]`YUb]XYbh]mži g]b[`X]gW gg|cb [fci dg

EYVZJAR`WAYReZHy4YZJAR_%ZGRdTZA]T_defTe eYReYRdXGUFR]jjTgdR]JZAU`gAceZVZ_WWJ Z_X4Ld^S`]dR_Uh`dLdLR_UZedRIeFRZj`c]RT `VVEUVAV_Ud`_Y`haVa]VZ_eVcackeR_UcVJReV e`eYVdZEYVacVJZ_ZRgYja`eYVdZl`VAYVeAR` eYReT^aZJAUeYVCVA`cehRdeYReaVa]VhVcV_`]`_X4cTJVAcRde`hYReT_deZfeVUeYV4YZJAR_ ZJV_eZjR_UhVcVRaac`RIYZ_XeYZIZJV_eZjR_UZed ^R_ZWAREZ_dhZeYTcZcZRJUARIY^V_eZ

2TT $dZ_X_{j}HR_Va^{}_{a}$ $de g de U hRtT_UTEVU$ e UMZ ZeeV d S $der_TV WeZd$ TOZZTRJEUVERTYVU cV_{REZ_dYZa} hZY $eVVZVR WeYZVR_Ue VeHSSJZY$ $d ^ VSR dT UZWWEV_TVd Weaac RIY R^ __XUZWWd$ $V_{ea} af JRZ_Xc$ f ad ZH YRehRdR_Rj dVL da VIZJ $TR_{j}HVVT_gVcReZ_dR^ _XaV a JVhY YRU$ $_VgVc <math>ad VgZ f dj ^ VeRS f e hYRe hRd y4 YZVR_{m}$ $R_U hYRe Ze ^ VR_e e SV 4 YZVR_ZEYZUVRSJVU$ $eYV eVR^ e ^ Sd vgV hYRe Z RXd W4 YZV hVV$ $<math>Tf ccV_ej a cVU^ Z R_eLR_UY h aV a JV cVJReVU$ e eVV Z

 $EYV yLZIIF dZ _ Xc f a & eVIY_Zof V h Rd f dU$ I: Si DWL"*) & Z7 c eYV dv VIZ T af ca`dvd`VeYV $V(a)`de`g`Yja`eYvZeYZd^VeY`UYRCH_{ER_dXd}`gVc`eYVcdwTY_Zof VeY`UYRCH_{ER_dXd}`gVc`eYVcdwTYTV_eeVUeVTY_Zof VeY`_RUZIIF d
dZ_ Xc f aLeYVRZ'Zde`dvT_det TeeYVUj_R` h
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d'S[VTedR_Uefc_d`VaYRdV/RCVa`ddS]VZ_RaRd
eZIF]Rc xc`f aLR_Ue`dwh YZTYRV^RZ_deVR^ R_U
h YZTY RCV^REYZRZ'_RdRYCARZ_RDZ'_RdR'EVV dY_dVT_VRZ acVdZ_dR^$

 $\begin{array}{l} SVR1VceRZ_VLZ5ZIIf dtZ_XcfadTR_SVfdvUe \\ cvT_defTeeYV^VR_ZXRdfS[VTeTRczZdZ_afS]ZT \\ T_gvtcReZ_Z \end{array}$

EYVdARCTYWcf_Zj`VUZCT fcdVZthYReXfZVd eYVT ^ a`d&Z_`V&YVdR`a]VŽEYZtYRde`SVRd Sc`RUR_UUZgVdVRdZt_WUVUe`dRefdReVRUZt T fcdVR_UZed^R[`cUZWWCV_eZReZ_dŽEYV^ VeY`U Ztle`deRcehZeYRSRdZfdR`a]VR_UeYV_fdVeYV cVcf]ed`V&YVh`c\U_VhZeYZee`UV&C^Z_VY`h ^ R_j Xc`fadRcV_WUVUe`T ^ a]V&VeYVdVRcTYL R_UhYReeYVZcT ^ a`d&Z_dY`f]USVŽ

7 c eYVT _gVcReZ_dRS`fe 4 YZVR_ ZV_eZejŁ eYVZ_ZZEJ dR`a]VZ_T]fUVUWfc Xc fad+

$$\label{eq:linear} \begin{split} & \dagger > Z W X \hat{\ } fa \ \ W \hat{\ } f_X a \hat{\ } c R f] ed W \wedge e W \\ &] \hat{\ } h \ d \ T Z \hat{\ } V T \hat{\ } \hat{\ } \hat{\ } Z X \hat{\ } fa \tilde{\ } \\ \end{split}$$

$$\label{eq:constraint} \begin{split} & \dagger > Z W X \hat{c} fa `W f_X R U f] ed W \wedge eY V \underline{Z} eV d \\ & \wedge V U \overline{A} e V d T Z V T_ ` \wedge Z T X \hat{c} fa \tilde{Z} \end{split}$$

† > ZIVUX°.fa`Vÿ`f_XRUf]edW'^ eYVYZXY d`TZIVT_`^ZTX°.faŽ

 $\label{eq:constraint} EYV eV def dWe \ dMV le eVV a Rez ZZaR_edT_dL \\ VeV eVVW] \ h _XTYR REV ZeZd+$

 \dagger D TZ \dagger VT _ ` ^ ZT]VgV]+ a Vcd _R] Z_T ^ VŁ h VR]eVŁ YVR]eY d deV^ Ł VUFTReZ _Ł ` TTF a ReZ _ ` W eYVY' f dV']UYVRUŁej a V' WUFTReZ _R] VdeVS]ZM ^ V_e ReeV_UVUŽ

$$\label{eq:constraint} \begin{split} &\dagger = ZWdig ~ [V4a]RIV ` WdvdLV_TVL`h_`cTYZUUV_d' \\ &a]RIV ` Wdef Uj Laf cTYRUZ_X UVIZZ_dLa]RIV ` W \\ &h`c\Z \end{split}$$

 \uparrow A`]ZEZIR] eV_UV_Tj +`cZV_eReZ_ŽARcej RM/ZL ReZ_Ž

 $\begin{array}{l} 4 \ \underline{R} \ \underline{UZ} \ \underline{Revch} Y \ \underline{W}_{1} \ \underline{Z} \ \underline{e} \ \underline{e} Y V W_{1} \ \underline{N} \ \underline{Z} \ \underline{X} \ \underline{Revc} \ \underline{A} \ \underline$

 $\begin{array}{l} EYVT `dZ_Re`cZ_eVCWCVURd]Zee]VRda`ddS]VZ_\\ eYVXc`fa~Uj_R^ ZTR_UT_gVcReZ_ hRd~deZ~fd\\]ReVUSj~eYVW]]`hZ_XbfVdeZ_d+=VedeR]\RS`fe\\ 4YZVLhYRe~ReVeYV4YZVR_d]ZVO2_UhYRe~U \end{array}$

j`f eYZ_\RS`fe4YZVdXVXRaYjR_U]R_UHRaVO HYReU VdeYZddye jf 1dr hZ_XeYV R4YZVR_ ~RXOH YReZd4YZVdYZEgjZVO9`hU 4YZ VR_deR]\OH YReRVhV4YZVR_d]ZVT ^ aRAVUe _VZXS`fcZ_XTf_c6ZdO

$$\label{eq:linear} \begin{split} & 2]] eVXc\ fad^ VeZ\ acV^ ZMdaVIZA] j\ Vbf ZaaVU\\ & Wc\ eYZlej aV^ Wh^chŽ6RIY\ dvdtZ_ hRd Uf] j\ cVI\\ & T\ dVU\ R_U\ ecR_dTcSVLŽ3VdLVd\ eVV^ `UvRe`d.\\ & ch^ `ceYcW^ SdvgVcdhReIYVUVRIY\ dvdtZ_ W^^ \\ & SVYZ_UR^ Zc^ čZ YVecR_dTcSVU^ ReVcZI hRd cde\\ & R_Rj\ dVUdaRcReVj\ Sj\ eYcW^ V^ SVcd^ VeYVeR^ \\ & T\ ^aZZ_XeYVCVa\ ceR_UR_ `fedZVVI aVcd.R_U\\ & eY_ [`Zejj\ f_UvceYV]RevcdfaVcgZZ_Ž \end{split}$$

:_ R] eVXcfadLT_gVaReZ_RS`fe4YZVR_ ZV_e&j daZJj e`\dravLgRJZReZ_XeVVZ,Z&R Yja`eVVdvŽEYZIdr`hdeYReRT&ZZR]j UV&RIYVU Raac`RIY'e`eVVd'S[VTeZI_`h R_VdHS]ZhVUWR efd'`W&gVgUJJ T_gVaReZ_Ž7fceVVc^`cVLeVV T_gVaReZ_daZJj dRefdeVULhYZIY'dr`hdeh` eYZ_XdZ7ZadajLeYVCVZIRV&CUXcW`VT_dV_dfd `_ eVVd'S[VTeR``_XUZWWCV_eXcfadZDVT_UjL eYV SRdZT dR`a]VhRd d'WIZV_eVcVa]`dRe`g afca`dvdŽ

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Gh Xmcb dYfWrdhcbgcZ7\]Y]b X]ZZrfYbhUgdYWgcZ`]Zrži g]b[ZcWig[fci dgUbX d\chc[fUd\]WWc``U[Y

EYV UZII ġVġ eYRe eYV 4 YZYR_ZV eĞ hRd XV_VR]j clackd/eUR1YRgZX]`de TcVUSZZġ LRd UV:TcSSVUZ_RaaV_UZ "Ł^ RUZe_VTVdR; e`]``\ ^`cVI]`d/j ReeYVTYRRIEVCZEZIdR_UgRZFeZ_d`W eYZlclackd/_dEZ_RIZec/JReVUe`UZWKV_eRtaVTed `VVZVVŽEYVRZ`hRde`cVT_decfTeaVa]VdgZhd `VVZVVŽEYVRZ`hRde`cVT_decfTeaVa]VdgZhd `VVZVVZ ZjEh`cVET_d^az_LVXVv2`VEa`[ZZTd R_UcVZXZ_R_UEReeYVCR`VeZ`VEc`cVT_decfTe eYVUXWKV_eXcTz_`eYVcR2`LJRtejjEhRde`R1VcHZ_ hYRe \ZUd`VXLV_eZZdeYVaRozZZAR_edSVJZgVU hV2VV VXZ_XZ_4YZNŽ

 ^ `cVeYZ1eZ`V`_ ^ $RZ_decVR^$ ` $aZ_Z_dZ_VRIY$ $RVReYR_{} = eVVXV_VR_U_R^{T}U_R^{T}W_gVaR_Z_Z$ EYZIZIEYVWWIFdXcfa%eWIYZbfVi>Vce_Ł7ZthV $R_U < V_UR$]L" *& /Ž2dhVhVcVRS]Ve JVRc_Z eVV bf RZRozevolf Uj Uváliczsvuz Raav uz "Łevyzzh `W4YZWR_ZW_eZej Rdd^VeYZ_XZ'a|RfdZsjVZdgVej hZNdacVRUR_UeYV|R_XFRXV_WUVUe`RceZIf |ReV ^`cVdaVIZ TVRIed`cVWZ XdZdfdTR]ji |RI\Z XŽ:e Zd_`c^ R] Wc_Vh `c V^ VcXZ_XaYV_`^ V_Re` SV $UZIF dW Z_{2} Z ZW c^{A} W df_{2}$ d TY 62' VRdR_ Raac' ac2ReVL]VXE2' ReVU]R_XFRXV $YRdSW_Ugy^{a}WWceR_ZRS^{f}eeVV_Z afSt$]ZIŽ:ehRdeYfde`SVViaVTeVUeYReT_gVcReZ_d RS`fe4YZVR_ZVL@252K1Ree2fUKdR_USVRgZfcZ_ daVTZ/TR:VRdh`f]USVT_dedRZ_WSj eYVaRfTZej `WR_XFRXŽE` UVR] hZEY eYZtlac`S]V^ Łac` [VTezev eVTY_ZofVdhVeVfdVUe`deZ`f]ReVT_gVdReZ_Ž HZeYeVdVeVTY_ZofVdLWWJZ_XdR_U`aZ_Z_dReV } cdeZU/eZ;VUeVc`fXYaVa]VdTY`ZIV`WS[VTed`c Z`RXddVacVdV_eZ_XeVV`ŁRANchYZIYUZETfdZ_ `VAYVZc^VR_ZXSVXZ_dŽ

:_ eYZITRALEAVVaRozZZAR_edhV&VUZZAUUZ_e` eh`Xc`fad`VNS`fe}gVŽ6RIY`WAVV hRdXZgV_ RWJUVc`VVT]`fcaY`e`XRaYdeR.V_WV^ 4YZJ VR_ ^RXRzZ_VdR_U_VhdaRaVcdŽEYVj hV&VeVV_ Rd.VUe`fdVeYVdVaY`e`XRaYde` ^R.VRT]]RXV cVacVdV_eZ_X hYRe e`URj`d 4 YZJV R_U Zed aV a]V ^VR ee`eYV^Ž

@_TV KRY d'SXc fa YRU UVAICZSVU ZedT]]RXL T_gVaReZ_SVAR_ŽE YZIh RIXF ZJUUSj RT`dZ_R e`chY`W]`h VURdIYVLf]V`VSc`RUbf V&Z_dL`W eYVej a V+y=VédeR]\RS`fea`]ZEZdŽH YReZda`]ZEZd $[ZVZ_4YZ]V0\%cy=VédeR]$ \RS`feT_d^ a eZ_L Y`h U_4YZ]VR_dT_d^ V0‰ EYZdeVIY_Zbf VhRdRaa]ZUZ_" ! Xc f ad h Y dv UZteZsf eZ_Zdd' h_Z_ eVVeRS]VŽ

EYVX: fah`c\hRtIRczU`feZ acV ZkłdaW TZR]j VbfZaaVUV: eYVafca`dŽEYVX: fadhV V XfZNUSj RdaVIZRZeR_U`SdkgVUV/^ SVZ_UR ^ Zc`cSj eh``ceYdW`eYVcdaVIZRZedŽEYVX: fa RizzzzdhVVT_UFTeVUZ_5VTV^SV: #!!! R_U ;R_fRj #!!"HR_UeYVT_gkcRz_dhVdvT dAU R_UecR_dIcZSVUŽ

EYVXĉfah`c\ckf]&UZ_RVKCjj VXVViTYR_XV `V&ZhdZ_eYVRVRdSVZ_XT_dLXCVUŽEYVCVhRd RYZXY]V&J `VKXCW^V_eR^`__XeVVXĉfadŽHV hVCVf_RSJVLY`hV&VLeR`__XeVVXĉfadŽHV hVCVf_RSJVLY`hV&VLeR`__XeVVXĉfad cV&Y_XZ_V_&ZZdZ_4YZVZ2_RjdCl`V&VVXĉfad cV&VZ_XZV_&ZZdZ_4YZVZ2_RjdCl`V&VVXĉfad cV&VALXER___eVVYTJVeVCVhRd_``cXR_ZXU aVCTVáeZ_`V&YVHJJ4YZVR_ReEfUVdR_USVI YRZfcYRUUV&J`aVUŽ

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$$\label{eq:started_fig} \begin{split} & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Åg \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \end{tabular} 2 & \end{tabular} \\ & fi \P^2 \, gz \, Ag \end{tabular} 2 & \e$$

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EYVZ_ekkgZuhddfXYee`UZT gkchYReTYR_Xkd aV a]VYRU_`eZIVUZ_eYVZc`h_]ZgkdLW/^`__V XV_kReZ_e`eYV_VieR_UZ_dTZkgj XV_kR]jj Z_ eYVW]`hZ_XRxNRd=T fa]VdLeYVNR^ZjLh`c\LWW eZ_VLh`c\Z_X`cdefUjZ_XeZ_VZEYVj R]d dfXYe e`RdIVceRZ_hYReaV a]VWjedTZkgj ViaVReVU`W eYV^R_UYRUe``WWCeYV^Z_eYkd/RcVRdR_U hYRegjaVd`WMJWZ^RXVeYVj YRULZ_cVJReZ_ S`eY'e`eYVZcRSZZej e`RIER_Ue`eYV deReVXZd V`a]`jVUŽ

Gfi Wi fYUbXWcbhYbhcZJXYbh]miUbX``]ZY` d`Ubb]b[

EYV cVdNRcTY WIF dVU $\ R$ Decf Tef cV+ WWZ X $WT YWZ TVZ ZV eq R_U ZWa]R_ZXL c W$ ^ f]eZa]ZZZj R_UT ^ a]ViZjŽAcVdV_TV cRSdV_TV W d^{TZR} UV R_U d^{TZ} af edR_U_`c^ $dZ \sim fV_{TZ}$ XeYV def Tef cV $^ UUV_{eZ}$ R_U]ZWa]R_Z_XŽAVcTVaeZ_ `WANNARCAZ_REZ_gVcfdVieVc_RIUVARCAZ_REZ_ \underline{Z} cV[ReZ_e e eV/decf Tef cV VXLV_e2e R_U]ZVVa]R_1 $\underline{Z}XZS/4$ \underline{eV} N VR_Z_XZ_T]f UVUZ_UV}_ZZ_d` VXUV_eZ; R_U]ZW a R Z XŽD TZR TRAX cZkdeYRe aV a VTf ccV eji fd/e`ZV_eZyVeYV_d/gvd1XV_UVeLdTZR]T]RdeL ac`WKHZ_Ła`]ZEZTR]`CZV_eReZ_ŁCV]ZXZ_ŁVEIŽŽ D'TZR UV' $R_Ut__c' dR_U Z_a f ed eYRe aV a V$ $V_aV_{Z_T} = V_eV_e = V_{Z_T} = V_eV_e$ h_ZV_{eee} $UZIdZ_dSVdhW_aVdd_R]ViaVdZ/TVR_UVieVc_R]$ UV R_UdRdeYV (RWW TeeYVT_eV_e`W LV_eZe; R_U ZWWa R ZXŽ

DYfWYdh]cb⁻cZWUb[Yg

 $\begin{array}{c} AkčIkácZ_{} `VIYR_XkdZ_ZkV_czj R_U]ZWa]R_{} \\ _Z_X `gkc eYVZ_UZgZLFR]d`h_]ZWcZ_VR_UZ_\\ T ^ aRcZd_ hZeY VRc]Zc XV_kReZ_cZ6]V^ V_cd \\ d`S[VIczgVj ZkV_cz] kURdTRfdkdR_UT_dkbfV_Tkd \\ `VeYVTYR_XkdZAkcTkácZ_ `VeVkd_R]TRaRSZZC2d \\ R_U dr`ceT ^ Z_XdZ_eVVdRcTY Wc decReWZde \\ T aVhZeY eYVTYR_XkdZ \\ \end{array}$

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EYV d^ Zdef Tef cVU Z eVegZh eVTY_Zof V hRd fdVU e`T]]VTe URHŽ9`h VgVLhYV_eVVWTfd`W Z gvdžXReZ_hRd`_eVVTYR_XddV a VeZ/TVU Sj Z eVegZh VdRe UZWWEV_edHXxdZ_eVZE`h_]ZgvdL `c`_Y`h eYVj dh eVZE]ZgvdSj T ^ aReZt_hZeV eY`dv`WRc]Zic XV_VReZ_dd ^ VRTegvZ eVegZh eVTY_Zof Vdh VeV fdvUZ:_eVzTTRMLZ eVegZh Vd h VeV acvdV_eVU Sj hRj `WeZ f]fd' hZeV deReM ^ V_edRS`fe XV_VER TYR_XdT_dZVEVU e`YRgV `TTfccVUZ_UZWWEV_e ReVRd`VURZj [ZWR_U eYV_ RthVUY`h eYVj YRU VI a VeZV_TVU eYVdV 1ZVEYVj YRU/Z eVVZC`h_]ZgvdZA`_W2V d'S[VTe`_YR_UL Z eVegZh WdT f]U RU a eLUZUTfdd`c TYR]V_XVR a`dEZ_Ž

EYV <u>Z</u>ekgZh h`c\ hRd TRczUU`feSVehW_ ?`gV SVc#!!! <u>R</u>U> RcTY #!!"Ž

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 $H ` c \ Z X Y a ` e V d d d XX d U e Y e e V d S [V] e$ $e g V R d V l e (` Y L V e g T _ d e d T e Z _ R_U] Z W a] R_ l$ $_ Z X h V V Z ~ f V_T U S j ` S [V l e g V W l e d f T Y R d e Y V d X V Z e e V] Z W I j T] V e Y e Z U g Z L F R d Y R U c V R I Y U$ $R_U e Y V g a V W R a R S Z e X d a c g Z N U S j e V Z d T Z l$ $V T _ ` ^ Z T X c f a L X / U C R_U V a] ` j ^ V e a ` d E Z _ Ž$ E Y V d V T Z E X G R h V V f d U e ` d e f T e c V e Y V R ` a] V $h Y Z Y h R e ` T _ e Z % Z e X g Z h V d U Z t e Z f e U Z$ $R T d R_T V h Z Y e V W] ` h Z X T Y R R E X Z t A$

GHU[Y]b`]ZYWMWY

1eYVZC^ RZ_ TYRERIEWSZECT ZIEYREEYY YRGV_`ej VE ^`gVUe`h RdUdZ_UVAV_UV_TVZ_ R_j RVR/

 $\label{eq:linear} \begin{array}{c} \uparrow AV a]VhY RVSWZ_ZXe^{SVT} VZUVI \\ aV_UV_e^{V} \uparrow e^{V}ZVP^{*}ZZdZ^{-}V^c^{*}dVRVRd \\ 1dReZXRVP^{*}ZjLaRdV_e^{*}ULSWZ_ZXh^cd^{*} \end{array}$

† AV a]VhY`RtVReeYVT_d`]ZRtZ_dtRtVZ eYV dkejVU RtaVTed`VeYVZ:]Zgvd1h`c\LaRce_VtL ac`SRS]j hZtY RU`]VtTV_eTYZUV_/

† AV a]VReeYVa`dHT_d`]Z.RZ_dHXVhY`YRgV T^a]V&UeYVy^R[`c]ZWARd\chaaRcV_cZ_XLh`c\L VEIŽLXV_VAR]j``WA&ZV^V_eRXV

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† Def UV_edıZ_T]f UZ_Xj`f_XaV a]VhY`YRgV Uc`aaUU`fe`WdIY``}∕

†9`fdMhZgVd

 $\label{eq:constraint} $$ Ac`WddZ_R]dR_U daVIZR]ZkW h`c\Vd1dV]W V`a]`jW`c`eVdhZb/$

 F_dZWh^cVd

2d dXRUd eVV`eVvc TYRRTeVZteZd1DR_eAX gVcfd dVXZ_dLD68 R_U dM/LeVV dR^a]VhRd UZteZsfeVURdW]]`hd+

 $\label{eq:product} $$ FY[]cbg "! 1#^ WZ^ IYZY R_UYZY d TZ I $$ VT_`^ ZT]VgVL%ZeVC^ WZEVR_U^ WZ ^ I]`h d TZ IVT_`^ ZT]VgVL%]`h R_U WacZgVU d TZ I $$ VT_`^ ZT]VgV/Z:_eVcZgXhdh VCVYUUZ_eVVTZZd `Wbf Zbf VL4`bf Z`S`LGZRUV] > RLIR_eR4cf kL 4`_TVaTZ_L4`c`_V] R_UGZ]RccZR$

; 'A Yb.'"*

; Kca Yb. #"

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EYV} adeatevá Z_R_Rj dZ_XUReRh Rde` dVT_deaf Te eYV]`XZTf_UVdjZXeYVZeVcgZhWd_RccRoZcVRd RhY`]VŽEYZlac`gZUURcWWCV_TVa`Z_ee`V_dfcV eYRe df Sdybf V_e R_Rjj dyd R_U eYV XV_VdR] ^ `UVjd UVCZęVU W/^ eYV^ UZU_`e UZde`ce eYV`cZXZ_R ^ WR_Z_X`WWRIY_RccRezgVŽEYVZ_eVcgZ/hdhVćV eYV_TUVUŽEYZdhRdU_VSjWRXXVeZXeYV _RcRezevelt_TvafRzzXeYV_R_UeYV_cVRez_X eYVT_TVacfR] ^ ReVZR] `SeRZ_VLŽEYV cV[ReZ_d R^ `_XT_TVaedR_UR^ `_XTReVX cZdXV_VReVU eYc`f XY eYVT UZ_Xac`TVdddvgyURdh`c\Z_XYj } a`eYVdVdZEYVdVhVcVfdVURdTcZeVcZRVVcTRcgZX `feac`XcVddgVdR`a]VdvJVTeZ_ŁZ`ac`gZ_XeYV ZelogZh XfZMZVdRUWkeYVćVRS`deZXeYV \mathbb{Z} ZZZR] dIYV^ ReR `WR_Rj dZZE YZClac` TVUf dV hRd Va] jUf_eZeYVcVeZRdefdReZ `VeYVT_ł TVaf RI TREVX cZid XV_VCREVU Sj eYV R_RIj dZI YRU SW_RIYZgVUŁŻŻEſ_eŹełVa`ZehYVċVowoł/UReR $VZEYVCRUVU_Vh Z_WC^ ReZ__` cZ_gRJZ_REVUeYV$ h`c\ZXYja`eYVdVdŽ

 $\begin{array}{l} & {\rm EYZ}(R,R) \in {\rm ZR} \ {\rm ac} \ {\rm TVUF} \, {\rm eV} \, {\rm YU} \ {\rm eh} \ {\rm de} {\rm XV} \ {\rm de} \ {\rm UV} \ {\rm d} {\rm ICZ} \ {\rm deg} \ {\rm VR},R) \ {\rm d} {\rm d} {\rm ICZ} \ {\rm deg} \ {\rm VR},R) \ {\rm d} {\rm d} {\rm d} {\rm R} \ {\rm Z}_R \ {\rm R},R) \ {\rm d} {\rm d} {\rm Z} \ {\rm Z} \ {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d} {\rm d} {\rm d} {\rm d} {\rm Z} \ {\rm d} {\rm d$

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E` SVZ_ hZAL: h`f]U]ZVJ`f e` eVJ] ^ VhYReR _`c^R] hVXUB ZJZVVCj`fLVC/ eVvZ Vj`f Xie fa e` eVVZ Vj`f X e` SVŽ

> R.Vdf dVeYReh YReW][`hdZl/Vaedr` œŽ:_ł bf ZtVZ_e` eYVeYdWR:VRd+T fa]VR_UVR^ Zj 1d/aR dR/j/Lh`c\R_UV&Vv2 VŽ4]RZjVSRdTRd=VRd`W eYVd/R:VRdRdeYVj T ^ Vfa Z_ eYV_RcdRzgvŽi6ŽXŽ hY ^ U j`f]ZgVhZeYR_UdZ_TVhYV_LhYReU Vd j`fch`c\V_dRZLY`h]`_XU Vdj`fcURj]RdHhYRe U j`f adWkce`U Z_j`fcV&Vv2 VLVETŽ

:WAYY U`_`eT^Vfa_RefoR]jjZ_eYV_RocReZgVL Rol, WcUXIICZeZ_d`WKRIY RAKUZAVIEjŽ2d,Y`h eYY_CVT_TZVh`c\R_UWR^ZjŁX/UVcCVREZ_CŽ

 $HYRe Zdj`fch`c\]ZV07ZU`feY`h^R_j$ Y`fcdReVh`c\UUR_UhYReeZ`VeVVh`c\ZXURj SVZ_dR_UV_UČZ

HYReUj f U Z j f c VAVVeZ VO

9 `h h`f]Uj`fUdEZV`cTREREXEXVeVVeVVeV &_dZaj`fYRgVhZeYj`fcaRce_Ve02_UhZeYj`fc We^ZjL`ceVVaVa]Vj`f]ZgVhZeVO

5`j`f WWJT)`dVe``cZU_eZ; WUhZeYd^VdTZe? X`fa`ceV_UV_Tj05`j`f aRceZTZaReVZ_R_jX`fa `c`cXR_ZAReZ_0 &" 7 \Ub[Yg]b Yj YfmXUm`]Z/ A]R_ 2+@aV_ Z_gV6ZREZ_

2dTvoetZ_hYveYvCaVa]VYRgV_`e2TvUTYR_XveL R_UZ_hYReRXRdŽ4`_}_Vj`focM/We'eYVTYR_Xvel eYVjSoZ_Xfaob`_eR_VfdjEVgV_ZWeYvOvOv/ReVe` [foeRodZ_X]VRAVRLR_URoN_RS`fe+

† 9`h eVVj gZvh eVV TYR_XVdLZ_aReeZff]Rc hYVeYVceVVj dWeVV^RdeYVdVdf]e`VeYVZc`h_ Z_ZZFRegVL`WVieVc_RJUV^R_Ud`cZ'a`dEZ_dL`c `WT_eZ_XV_TZXd

†EYVZcdfS[VTægVVIaVZZ_TV`WYYR_XVR_UhYRe YRde`SVU_Ve`RURaee`ZeidedZ_dLT_ecRUZ1 eZ_dLVIa]R_REZ_deYVJYRgVe`XgV`eYVcdLT aZ_X deReVXZdLVEIŽ

†9`heYy VgRfReveYdVTYR_Xv&ZŽZLa`d&zgVj `c_VXRzZgVj

=BjeYVdeVdd_`ed ^fTY`_eYVUVdTcZaeZ_`W eYVTYR_Xd1Rd`_WWJZ_Xd+ya]VRcfcVd%R_UyZcZER eZ_d%Sc`fXYeSjeYVTYR_XdŽ

Egie``SeRZ_RTJVRcUVETCZaeZ_``WeYVTYR_XV SVehW_eYVacVeLe^`^V_eR_UeYVeZ`VhZeY hYZIY eYVT ^ aReZt]_ZtJSVZ_X^RUVZ2ch Z_eVet gZhWete daVTZfVeYVaVcZU`gVchYZIY eYVJ ReV ^ R.Z_XeYVT ^ aReZt]_ 1S`eY Z_eYVZc`h_]ZgVet R_UZ_cVJReZ_e`VRcJZcXV_VReZ_dŽ

? `h : _ `h RSZe^ `cVRS`fej`fL: hR_ee Rd, j`f e`eVJ] ^ VZV/f eVZ \ j`fc]ZVVRdIVR_XUT^1 aRcVUe` hYReZehRdSWCVieVZIbf VdZ_ZI^ `cVRaac`acZeVVkc^ ZUJVIRXU`c`]UvcaV a]VŽ

: $h`f]UR_{d} [ZVe` \ 'h Zy'f eY_ AZXHYgV TYR_XUh YV_j`f T^aReVj`fc]ZWhZYeV/Zyd`W VR_ZCXV VRZ_dtj`fcaReV_ed_VCZ_dR_TVZ$

9 `h YRGVJ` f VaVZV_TVU1UZUJ` f VaVZV_TVRV j` f VaVZV_TZ_X eYVTYR_XdRdeYY YRGVR\V_1Rd eYY e``\`ZR\V a]RTVO9 `h YRGVJ` f TaVUhZY eYV O 5 `j` f WWJ eYY YRGVRWWWEVUJ` f aRceZff [Rc]j` cRcV eYY TYR_XdeYRe YRGVRWWWEVU` eYvcaVa]VRchV][O

 $HYReUj f eYZ \setminus eYAVTYR_XdRcVUFVeO$

Z_eWeYZ_XIeYReReVZ_a`ceR_ee`j`fOHYReReV eV/SV&R_Uh`cobeYZ_XIRS`feeYZITYR_XIO(ScZ_X Z_WWJZ_XX

H YReX`UR_USRUT_dbfV_TXANgveYAVTYR_XAd YRUVk:j`fc]ZWZ_aRceZff]RcO

HYV_aVa]VU_`eefTY`_R] eYoWRANd `WWgNgUBj [ZWITfa]VINR^ZjLh`c\LWWWeZVV `WeNVZc`h_RTTdLeYVZ_eNgZhNocdr'f]USoZ_X faeYV`_V`c`_Vd`^ZeNUR_URd\eYV`e`ac`l gZUNRUMEZaeZ_R_UeYV_R_RHANdh`V_e`WeYV TYR_XAZ

A]R_3+8fZJUZ_gVdzXReZ_

 $: W^{T}_{X} TR_X dRV^ V_{eZ}_W da^{eR}_V f dj W I$ If dZ_ekgZh Wd^_ `_V^ WeYVeYCW da VIZ, TRARd R_ULZ_ eYVyRIZZVZ_ekgZh % dej]VLURh eYVZ; Rel eV_eZ_ e^TYR_X dR_U eYV_ }_U`f eh YVEYVceYVj Raa]j Z_eVZ;]ZzVLSWKVX Z_X`_e`e^VZ; TRf dR] V_a]R_REZ_dR_U RdVdf' V_eRdZ_A]R_ 2Ž

:_ `eYkćZekógZhoLd^ VaVa/VYRgVe`/UfdeYRe eYkVYRgVSW_SZXTYR_XkdiZ_eYVhB, WY Zj /ZW Zl`cXR_Z&VL`ceYVhB, Tfa]VdcVJReVL`ceYVhB aVa]Vh`c\R_UeYVZ:VaVZZ_TV`Vh`c\L`ceYV hBj aVa]VViaVZZ_TVeYVZ:V&WeZ_VZ9RdR_jł eYZ_X/Z/VeYZHRaaV_VUe`j`fO

:WeYY U dTTWUZ ZN_eZYZ_XTYR_X/LeYV ZevlgZhVcdrf]UT_eZfVRdhZeYAJR_2Ž

' "`=XYbh]hm

7Z_U`feYh eYY ZV_eZyVhZY eYVc]VdeYY YRgVZ_eYZheYVdV RcNRd/R_UYh eYY }eZe XcfadZ_bfZVhR/e hYReVieV_eeYy cVRUeVdV c]VdRIVddV_eZR]Z_UV}_ZX eYV\ZU`VaVd_ eYY RcViS/YhZ a`ceR_eeYVZcc]VZde`eYV, iT/Yh UVa]j_V_XXXU eYy WWJ hZeY eYVXcfa `cXcfadT_TVc_VUeYZIU`Vd_`eYRgVe`^VR_ UJZSVCReV^V`SVcdYZa`VXcfadLZbfZVRdhVJ] Ze`dTZAJTReVX cZdR_U]ZWdaj]VdhZeYhYZY eYV cVda`_UV_eZU/eZVdZ

7Z_U`fehYRetZ_eYVZcgZhteYVZcUZWWCV_ec`]Vd Z_eYVUZWWCV_eRCVRdRUUfae`1WWJZ_Xd`WTYVd V_TVLT_ecRUZEZ_/Ž

A]R_ 2

@VR] eYVeY_XahVgVer]\VURS`feLhYReZZeeARe ^`deUV_Vdj`fRdRaVcd_0 : $UV_ZXeVhRjj$ f RXLYRgVj f SW_Z ddZVU Sj d^V_V`cd^VeYZXO

A]R_ 3

 $J`f YRgVUZWWEV_ec`]V&=RdR d_ERdR h`cVZX$ $aVcd_ERdR WEVVEVEZ`d`aa]j RdRaac`acZeVV&V^$ $hYReZd_`h _`h_ RS`feeYVaVcd_/ZHYZTYU$ $j`f^`deZV_eZyVhZeVO@dhYZTYU j`f WWJZH``de$ $j`fOTY``dV`_]j`_V`WEVVdVeh` bfVdeZ_de`$ $afee`eYV^Z$

HYZYU j`f]Z\VSV&OHYZY`W&V^ h`f]Uj`f]Z\Ve`de`aUZ_XO

: _ UVJ_ZXeYVhRj j`f RXLYRgVj`f SW_ZddZVU Sj d^V_V`cd^VeYZXO

:_ cV]ReZ_ e` eYZddy]WUVJ_ZEZ_ŁW.a]`cVhYRe aV a]VWWJ yd TZAġ %W aVTed`WeYV`ŁR_UZWAYCV ReVdecRZ_d`cT_ecRUZTeZ_dSVehW_hYReePYJ WWJ ZdVI aVTeVU`WeYV`R_UY`h eYY_V aVcZV_TVeYZĔ 7Z_U`feRS`feT_~ZTedhZeY eYVdVUV`R_UdR_U T aZ_XdecReWXZdŽ

5`j`f WWJ eVRed TZAġ VraVRedj`f e`SVR aRd eZf JRch Rj0

5 'j 'f WWJelRed TZlej]RjdUh_d']VdWcelVhRj j 'f dr'f]UelZ \ R_URTeZ j 'f c c']VRdh^V_eZ_ eW^` 'deZ' a' cdR_e/O

9 `h U j`f cka`_Ue` eXkVUV R_UD9 `h U j`f ^R_RXVe` TaVhZeY eYZIT_ecRUZEZ_O1HYRe U j`f U hYV_j`f WWJ eAReeY`d/Rc`f_Uj`f VaVe j`f e` SVR aRceZIF]Rc hRJOHYRe U j`f WWJ JZ/V eVJZ_XeYV Ø

5`j`f aRceZZaReVZ <u>R</u> j X`fa`c`cXR_ZAReZ_O 5`j`f WWJ TJ`dVe``c ZAV_eZ VU hZeY <u>R</u> j d'ZRJ X`fa`ceV_UV_TJO. WeYVR_dh VcZL_`+YRgVj`f VgVc SVJ_XU e` RX`faO@d:UZUj`f ZAV_eZJVhZeY <u>R</u> j eV_UV_TJ Z_eVVaRdeO6i a]`dVScZV-jŽ

9 'h Z' a' $ceR_eZdeYZdX$ 'f a e' j'f O@dhYReUVdeVVX'f a cháck dV_e 'c ^ VR_e' j'f OHY_0

HYReX`fah`f]Uj`f]ZVe`SV[_Xe`0

5` j`f WWJ eYRej`f RCVR d^ VhYRe UZWWEV_e aVcd_Z j`fc UZWWEV_e RIBGZEZCO`c Z UZWWEV_e RCVRd`Vy?fc]ZWO

:WeYVR_dh\cZdj\d+*HYReZdZeJZ\VVkcj`fLeYZd*

 $SVZ_XUZWWEV_eZ_UZWWEV_eRcVRdDV(a)^cVWWJZXd$ Rdd TZReVU hZEY ^ f]GZa]ZZZj/

:_bfZVRS`feW_UR`V_eRJZV_eEjTYR_Xd`gVc eYVT fcdV`WZWnRg`ZJScZ_XZ_XfaTYR_XdeYRe ^ZXYeSVViaVReU`gVceYV[ZWIjT]VŽ

 $HY\underline{V} = AVa[VRcVRcVRcVVRS`feeVVLC]Z_{V}dR\underline{V} = UeYy T^{aRcVLZ_{W}RV}eaVZ_{L}dZ_eVVLC`h_]Z_{V}VLd^{V} W eVV dV dV dV_{L}:^{n} _`eeVVdR^VVaVd_ R_j^{-n}`cVZ_{L} H`f]Uj`f dV eVReRS`fej`fcdVVV$

("'@]2Y'd`Ubg

2d. aV aJVY h eYY dWeYV dMgvd Z_Wef dV 1eg e` }_U`fe ZWeYY YRgVR JZWaJR_R_UZWeYY dW eYZ H RI d ^ VeYZ_X eYY YRgVT _def TeVU V/c eYV dMgvd`c Rd d ^ VeYZ_XZ' a`dvU fa`_ eYV Sj eYVZ V_gZ`_^ V_eZH YRe U eYY eYZ \ hZJ UVeVc^ Z_V hYVeYvc eYVZ: Wef dVX Vd`_V hJJ `c eVV`eYvc0

: h`f]U]ZVj`f e`eV]] ^ VZWhYV_j`f hVeV j`f_XVeJ`f VgVca]R_VU`feY`hj`f hR_eVUj`fc]ZWe`SVV0'^eVV_`_1TgVceYVUZWVeVeRVRdŽ

7Z_U`feRS`feeYV_RefcV`WeYVZcZ:RXV`W eYVWAefdV1ZZZLeYVVieV_ee`hYZIYZcZlecVReVU RdRfe`aZEL`chYVeYVcRTeZ_ZlSVZ_XeR\V_e` eVRTZAVZeZ

 $5 \text{VdeVhR} j fc ZWZdXZX_h 1Z eVVRVR$

 $c \operatorname{ReVRd} V_eZ_WV eR_j j hZeY hYRe j f TV a_R_VU0$

HYReTRE dUZee`X eYVhRjZeYRd

HYReh`f]Uj`f]ZVj`fc]ZWiReh`c\ŁZ_eW WYZjŁZ_j`fc\WWEVV`e`SV]ZVZ_VHECO

2cVj`f UZXR_jeVZXe`^R\VeVZXlh`c\`fe eVRehRj0

 $HYReZdzZVUj f e a]R_VceYReO$

5`j`f WWJ eVRehYVeYVc`c_`ej`f cVRJZkVj`fc a]R_UVaV_U'_j`f`c`_`eVVceYZ_XODhYReO

5`j`f WWJj`f RcVViaVIeWUd TZIġ ViaVIedj`f/e` a]<u>R_j</u>`fc]ZWZ_RTVceRZ_hRJO

:Wd+9`h U j`f WWJ RS`feeYZO15` j`f WWJ a]VRCULO5` j`f WWJ eYKCVRCVdeRZ_d`cT_eRUZH eZ_dV

5`j`f WWJdTZAġZłYVjaZXj`f SVhYRej`f hR_ee`SVO:_hYRehRjdZdZeUZXeYZO:_hYRe hRjdZd_eZO

5 `Vde`UB'dd'ZdjZ 4 YZVXgyj `f c``^ e` VacVdd R_UU gy[`aj`fc`h_hBj` VXXZXFS`feeVZXdR_U j`fc`h_ JZWa]R_O

E`V_UeYZtaRceL: h`f]U]Z.Ve`Rcl,j`f hYRej`f]Z.VSVdeRS`feetVhRj eYZ_XRcVVk:j`f_`hŽ

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 $H Y W c b g f i W j c b c Z Z V \g f c f Y g$

 $EYV^{S}[VFezeV^{VeYz(def U} hRde^{RIVeRZ} Y^{h}]ZWYZZe^{ZdhVeVT}_def^{TeVUZ} 4 YZVLY^{h}e^{Yzd}ac^{TVdh^{Z}Ye}YRgVTYR_XULR_UhYRe_VhdedRZ_d^{h}e^{Yz}d^{h}VeVZg^{h}gVUZ_UV_ZX^{Ve}VRgVTYR_XULR_UhYRe_XIZZ_X]ZWa]R_dZe^{YVeVWeV_TVa^{Z}edR_UbfVdeZ_dXe^{Z}Z_X^{e}VVR_RJdZ_HVeVA$

H,Y`ghfU]b`VYlk YYb`]XYbh]lmiZ;f`cbYgY`Z#]XYbh]lmiZ;f`h,Y`ch,Yf

R/H YReR:VeYV cZXZ_d`WeYVeh` ej aVd`WLV_ł eZZAD9`h U` eYVateRZ_d`WeYZtlac`TVdtUVgVJ`a `gVceZ`VO S/9 RgVeYVEVSW_TYR_Xd&\Y_VgV_ed`gVceYV T f cdV`VeYVaVcd_d]ZWYZde`g`eYReYRgVSc`\V_ eYZdUV/ZIReVSRIR_TVSVchW_ZUV_eegi Wc`_VeN/W R_UZUV_eegi Wc`eYV`eYVc09`h YRdeYZdRWWTeVU WWkcede`T_decfTeR]ZWa]R_0

=XYbh]hmid`Ubb]b[#fYU`]nUh]cb

 $S = \frac{1}{2} h R_U Z_h YRe Reverver a R_d c R_Z WU`c$

X&V_d SdR_TVe UB 02 cVeYy T _def TeVU`_ eV SRZEI` VA YReaV a]VdWRdUVZERS]VVCeYV` dAgvd `c`_]j` VA YRe Zda` dZS]VR_UaVc^ ZdZS]VZ_ eV daRIV]VASj eVd TZEJ Z RXZ_Rcj R_Uded Tef cV` W `aa` cef _ZZXdD

 $\label{eq:constraint} T'H YReZ a WAR_U WRIZERe Ade YVC RZREZ_`W$ $\label{eq:constraint} ZMa]R_d DAVCT A acZ_d ZRE AC CZd`WR_R i dE d TZRL$ $TF]ef cRL VR'Zj Lad TY`]`XZRL V``eZ_RL YZE CZ$ $TRL Z_dEE f eZ_RL VETŽZ$

H\Y`Webghfi Whjeb`eZ`jZY`\jghef]Ygžef``jZY`]ngY`Z

 $\begin{array}{l} R &= Rel j \mbox{ LU } \underline{Z} \mbox{ LZ } I \mbox{ R} d \mbox{ W} \mbox{ eV } L \mbox{ Z} \mbox{ R} d \mbox{ W} \mbox{ eV } L \mbox{ Z} \mbox{ Z} \underline{Z} \mbox{ X} \\ \mbox{ h } Y \mbox{ eV } O \mbox{ H } \mbox{ Re } R \mbox{ eV } V \mbox{ W} \mbox{ ed } \mbox{ d} \mbox{ A} \mbox{ d} \mbox{ eV } \mbox{ R} \mbox{ eV } \mbox{ d} \mbox{ eV } \mbox{ d} \mbox{ d} \mbox{ eV } \mbox{ d} \$

 $\begin{array}{l} $S': deYV&R_j \in \mathbb{N}^{\infty} \ Wc \land R_{k} \ Wc & R_{k} \ Wc & R_{k} \ SVZ \ eYVZ \ PVZ$

T' H YRe_Vh `aa`cef_ZZARVV` VXZ_XWc eYVT_decfTeZ_`V/ZWYZE`cZATh YReREVEYV_Vh decRZ_dR_UWfdecReZ_dD(@aa`cef_Zej+VgXejeYZ_X eYReV_RS]VdaVa]Ve`WWjeYVjREVac`dEX_ZdedR_U XggVdTSdeR_TVe`eYVZca]R_dZTH YReZtaRceZTf]Rctj T_eV`a`dRcjRS`feeYV&VdecRZ_dD

EYVR_RJjÓZdevådeYV^ RezZ dr`hZ_XeYVderRZ d Z_ZV_eZej T_decfTeZ_ac`TvdtvdZ_JZWYZde`cZd R_U JZW a]R_d1VkefcvácvRJZkReZ_/ŽE`XfZV eYV cvRuZ_X`WeYV ^ RecZLLJZW YZde`cZdh VcV`cXR _ZkVUZ_e`eh`c`fXY ej aVd+R/JZvdcVRJZkU, S/ JZvda`dea`_VLŽ

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Eh V]gV]ZW YZte`cZtcfi h VcV R_R]j dVLŽE YVdV h VcVcV]RevUSj a``caV a]VVdV^ S`eYfcSR_ R_U cf dc] RcVRdR_USj aV a]VVdV^ eYVfcSR_ ^ZUJV T]RdER_Uh VcVT ^ aZVUSVehW_ "**(R_U#!!!Ž 2_RjjdZl`V&YVdčdZdV_RSJWeYVW]`hZXdSJV e`SVT_decT&UZ_RTCdR_TVhZeYeYVdh` ejaVd ZV_eZ_VUŽ

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HYW\b]WU`bchYgcbh\YIB8D&\$\$%diV`]Wcd]b]cbgifjYm

$$\begin{split} & EYVF_Z\!AU? R\!e\!Z_d5 VgM^a^V eAc^X\!R^^V \\ & 1F? 5 A'T^^Z\!t\!LZ_VUE:> 6 C6D62C49 \\ & 4YZVLR^RC^VeCVARCTYT^aR_jLe^VVdZ_R \\ & dR^a]VR_UTRcj^feeVV}VJLh^cVKR_R\!e\!Z_hZV \\ & afS]ZT^aZ_Z_dcgVJZEYVZ_def^V_eRaa]ZUhRd \\ & UVgM^aVUSjF? 5 AhZeYdfaa^ceVd^eVVdR^V \\ & T^aR_jZ \\ \end{split}$$

$$\begin{split} & EYV \} VJLh`c\ hRdT_UFTeVU W'^{-1} 2acd e`\\ & S! > RJ \#!!"ZE`T^a] VeV eV bf VdeZ_RZVL\\ & VRIVe \} VRIVZ_eVcgZhdh VeV YVJUZ_cVch`UV_ed'\\ & Y^VZZ_`eVcT^aR_jLDE2E4@>LTRccZU\\ & feVeVcT_d aVcgZZ_`VeVV \} VJLh`c\ S`eY`_eVVXc`f_UR_UZ_eVV`VVTZ \end{split}$$

7 \UfUWhYf]gh]WgcZh\YgUadYXYg][b.

F_Zevlad/`WevVdefUj+Z_YRSZeR_ed`WevYZvRXvU ") R_U`gvlŽ
$$\label{eq:response} \begin{split} & R^a]Z_XWR^{h^*}(h^* c^+ V_R_Uh^* V_R_Uh^* V_R_UU^*)\\ & R_U^*gVLSV_{Z_Xe^*}(e^*Vd^*T_2^*) \\ & R_U^*gVLSV_{Z_Xe^*}(e^*Vd^*T_2^*) \\ & R_U^*(h^*) \\ &$$

$$\label{eq:response} \begin{split} & \mathsf{DR}^a a] \mathsf{Vd} \mathsf{K} \mathsf{Ve}^c \ \mathsf{V}_c \mathsf{f}^c \mathsf{VRX}^{UUV\!\mathcal{K}} \mathsf{W} \mathsf{Vd} \mathsf{XZ}_R \\ & \mathsf{C} \mathsf{d} \mathsf{c} \mathsf{Vd}_c \mathsf{d} \mathsf{e} \mathsf{z} \mathsf{g} \mathsf{V}_c \mathsf{Vd} \mathsf{L} \mathsf{e} \mathsf{V} \mathsf{V} \mathsf{R}^a a] \mathsf{Vd} \mathsf{K} \mathsf{d} \mathsf{W} \mathsf{c}^c \mathsf{RIY} \mathsf{c} \mathsf{VZ}_R \\ & \mathsf{h} \mathsf{Ve} \mathsf{V} \mathsf{R}]^* \mathsf{TRe} \mathsf{W}^a - \mathsf{R}_c \mathsf{a}^c \mathsf{a}^c \mathsf{e} \mathsf{Z}_R \mathsf{I} \mathsf{S} \mathsf{R} \mathsf{d} \mathsf{Z} \mathsf{L} \mathsf{R}_c \mathsf{U} \\ & \mathsf{h} \mathsf{Z} \mathsf{e} \mathsf{Y} \mathsf{Z}_c \mathsf{VRIY} \mathsf{c} \mathsf{VZ}_c \mathsf{e} \mathsf{e} \mathsf{V} \mathsf{R}]^* \mathsf{TRe} \mathsf{Z}_c \mathsf{a}^c \mathsf{a}^c \mathsf{a}^c \mathsf{Z}_c \mathsf{e}^c \mathsf{e} \mathsf{R} \mathsf{U} \\ & \mathsf{Z} \mathsf{e}^c \mathsf{f}^c \mathsf{c} \mathsf{S} \mathsf{R}_c \mathsf{R}_c \mathsf{U} \mathsf{c} \mathsf{c} \mathsf{R} \mathsf{d} \mathsf{R}^c \mathsf{a} \mathsf{I} \mathsf{V} \mathsf{d} \mathsf{Z}_c \mathsf{a}^c \mathsf{a}^c \mathsf{a}^c \mathsf{Z}_c \mathsf{e}^c \mathsf{e} \mathsf{R} \mathsf{R} \\ & \mathsf{c} \mathsf{VZ}_c \mathsf{d} \mathsf{a}^c \mathsf{a}^c \mathsf{I} \mathsf{Re} \mathsf{Z}_c \mathsf{g} \mathsf{R} \mathsf{f} \mathsf{V} \mathsf{U} \mathsf{d} \mathsf{W} \mathsf{e} \mathsf{S} \mathsf{S} \mathsf{V} \mathsf{Z} \end{split}$$

 $\label{eq:linear} DR^{a}]\underline{Z}XgiaV_{+}^{f}]\underline{\partial \mathcal{L}}RXVLdcRzMUUSjeVV\\ cVXZ_R_UfcSR_{zcf}cR]RVRgRzMS]VEZ:_eVV}cde\\ dRXVLR_f^SVc^VAAcVdV_dRzWT^{f}_UdhRd$

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2UNE = ZR U > M ZNE Zi **)/3RXdeVUL> ŽR U7RcPRdL:Ž1#!!!/ <u>=RTf]efcRa`]3eZIRTYZV Rj]`daRceZU`dUVTV ec`Ž</u> $F_RVia]ZIRIZ_Rec`a`]^2XZIR$ $DR_{e}RX \pm 4YZVL7 U W4f = dR6T_{2^{A}}ZR$ 2]VIR UV£:Ži#!!!/ D^{TZ} XR Tf | ef dR $> VIZT 4Zit2_eYc a d7=24D@$ 2]^ RdkRL> ŽR U8 RccZUL> Ž1"**(/ yARceZIZaRIZE_a`]3eZIR V_[2gV_Vda`S]RU`cVdŽ 6gR/fRIZE_TFR/ZEREZERUV/Q`Veb`j_ZRY3%46V_ 8 fk^ ï_Ł=Ži VUZê c/Ł<u>6i a]` dRIZ_VdV_adZî |`X</u>RA a`|36277R: DR_678X Ł4 YZWLF_Z5Vcd/LRU5 ZWX A`ceRVd 2^ V U RL8Ži#!!!/ =RTZ URUa`de^ `U\c_R > RUZULA VIVAEV6UZE CZR2`f_ŁDŽi#!!"/ <u>2 ac`TfcRU aRcRidi `f_ZqVcd`U efcZd^`</u> 4 R^ aZ RdL3dRkZLARaZf d6UZé dR $2aaRUf dR L2ZR_UDeV_{L<ZI} #!!!/$ yDf dfrZ_FS [Va]f drZth R_UeYWWaf dv VSV _XZ_XM ZF?6D4@ŁH`clUTflefcVcVa`ce 2d 7743Ž <u>AfS]ZT daRIV R_U VXR]ZERCZR_T]RZ_dLf_UREVU</u> ^ R f dTcZaeŁ 5 VaRce^ V e `W8 `gVc ^ V eŁ F_Zevazej`V6dM PPP1"**'/ 2 RCTYZAVIRX `WafS|ZT da RTVdL^R f dTcZaeL 5 VaRce^ V_e`V&`gVc_^ V_eLF_ZeVcdZej `V6cdM PPP1#!!!/ 6] clyled UV RUZNEV TZR 4 RARIRAL 6 LEE OZR]? f Vor D TZURU 2gcZkWL=Ži"***/ y5 ZI X j cWW ZZLRUŽ 2 TVĆIR UV |R cV|RIZ_ V_eeVVdWRa1/\$JZRj ^ VLZdUVT ^ f_ZRIZ_% $\underline{Z} > \underline{VaRa}]362IRL? \pm *$ > VíZľ 4 ZejŁ4 V_ec`UV 6 def UZ dUV A`] 3 ezTR 4° aRRR 4YZV 3R}VUL6Ži"*&)/ EYV^`dR] SROZEL`VSRI\hReUd TZA ? Vh J`c\ŁEYV7cWAcVdd

4 _ VXXf cRIZ_Vd d TZRVd UV VdaRIZ d UV f d $\underline{a^{1}}$ \underline{S} \underline{Z} + \underline{R} \underline{d} \underline{U} = $\underline{R7}$ \underline{C} \underline{R} \underline{L}^{A} \underline{R} \underline{f} \underline{d} \underline{C} \underline{z} \underline{R} DR_07RX Ł4 YZV 3Rc > VVLAŽi"**)/y4`hS`jdR_UT_defTeZ_d?ReZ_RZecvacval_ePeZ_ `WaRde`dR]]ZWZ_a`dela`deR[ZR_4YZ[V%LZ_;`fc_R]`W $= \operatorname{ReZ} 2^{\circ} \operatorname{VeZIR} \operatorname{Def} \operatorname{UZVeL}? \pm \$!$? Vh J`c\Ł4 R^ ScZLX/F_Zękczej Acked 3Rf^R_ŁKŽi"**) R⁄ 8] SRZARZ_ŽEYVYF ^ R_T_dNofV_TVAL ? Vh J`c\Ł4` |f^ SZRF_Zevkozej Acktd PPP1"**) S/ <u> $H^c_{T} df^VZ_{R} = UeV_{ha^c}$ </u> > RZV_YVRUL@aV_F_ZgVcdZj AcVdd PPP1"***R∕ 4f lef cVRdacRiZd =`_UCVALDRXV PPP1"***S/ : dMRcTY`Wa`]ZeZTd 4 R^ SozzXIA Z AcVdd 3VT\ŁF Ži#!!!/ $y=Z_{e}Z_{i}X_{j}fc_{h}]ZWZ_{R}cf_{h}R_{j}h_{c}]U_{+}$:_UZeZUFRJZKREZ_ŁXJ`SRJZKREZ_ R_U a`]ZEZICH6 V 8ZUV dL2ŽR U9fee LHŽ1VUdŽL8) SR TRaZRIZA ? Vh J`c\ŁEYV? Vh AcVdd 3VT\ŁFŽR U3VT\ł8 \cdr\Z Ł6Ži#!!"/ : UZEZLFRIZKREZ +: dezefez RIZKUZUZEZLFRIZM R UZedd TZR R Ua` ZZZIR T dybf V Tyd =`_U_ŁDRXV 3V X ℝL:Ži"*) &⁄ <u>9 Zeè cZRUVj af VSj` ^ Raf TYV+DZXj` dI : I j I I</u> DR ØRX Ł4 YZVŁ6UZZ VODF C PPP1"**'/ =RT ^ f ZRU aVd ZRŽ6 da ` dd ScVZV eZRU j Tf]ef cR+]`d UVdRV14d UV]R ^ `UVc ZkRIZE V DR_ORX Ł4 YZVŁ6UZZ_VODF C

PPP1"***/ y5 V S`URdLgZR[Vdj e`ceRd162 <u>CVgZteR UV]R</u> 27RV ZRL? ±% DR_eZRX Ł 4 YZWŁ F_ZęVcdZURU 2 TRUV^ZR UV $9f^{R}Zf^{ } 4cZdzR^{ }$ 3V_YRSZ5ŁDŽ1"**"/ y> `UM|VUVd´WWVelZTYV_CRf^d%LoZ_D`kZRV H MeŁ%#ž# > f_ZIYŁ:_deZefe W.c D`kZ]`XZkŁF_ZevCodZece > í _TYV 3V [R^ ZŁHŽi"**)/ y8 VcR^ ^ VjeVDIYcZAAV_ 3R_UCZ#Z465_RdaRdrRXV ł hVċ∖ 7dR_\\KkdeLDf Yc\R^ a 3Vc^ R Ł> Ži"**)/ 2]] eYRe Zdd ZU^ VjedZe` RZ+EYVVi aVcZ/TV`W ^`U\cZij ? Vh J`c\ŁAV XfZ F D2 3ZSV_jŁ? Ži"***/ 5 V `TARIZRARAR RUZZVALRU 3RcTV[`_RL2cZV] 3`fd**Z**{f}{AŽi"*)% $5 \text{ ZbeZ TeZ} + 2 \text{ d TZR} \text{ TeZeZbf V ` WeYV [f UXV^ V e}$ `WaRdeV 4 R^ ScZLXVL > RdRIYf dveed 9 RogRdU F_Zevedzi AcVdd 3d__V&;ŽŽi"*)(/ : Uf decZR j ^ VcTRU Tf]ef cR]Vd V 4 YZ]V+ <u>UVdTcZaTZZ j TFR eZ TRIZ VdLh cZ X aRaVc</u> ?±\$&* DR_ORX Ł4YZVŁ7=24D@ PPP1"*))/ F_VdaV(`ecZkRU` DR or 24 March 12 DR of 24 De PPP1#!!!/ <u>6UFTRIZE_Ž6dIV_RcZdUV_Wefc`Ž?fVgRd</u> <u>eVT`]`X3Rdj d`TZURUUV]RZWć^RTZ_</u>Łh`c\ZX aRaVc DR_ORX Ł4 YZVLAC62= $3fT_{i} > cdtDZ_{i} ** /$ EYVUZRIVIEZICI` WAWZ X 4 R^ SozLXVL> RdRTYf dveed.> : E Advdd 3f c**\ŁAŽ**ı"**(∕ GRoZWZAA`WIF]efcR]YZE`cj ? Vh J`c\Ł4`c_V||F_**Z**z\ka**Z**ej Ac\kad DR eZRX Ł4YZWŁ4V ec`UV 6def UZ da RcR Vj

4 RUV2_L7ŽL9`aV_YRJ_L> ŽR_U@ee`_VL6Ž 1"**% v9 RIZR f Rava ViezeR TeizeZIRUV R^ `Uvc Z.RU+ |Rd UZ' V_dZ_Vd Tf |ef dR|Vd UV |R edR_dVc^ RIZ_ ac`UfTegerT_VofZRU%LZ_4`^ZUZ_^f_UZR UVTFjefcRj UVdRcc`]]`L^ R_fdTcZae DR_ORX Ł4YZV PPP1"**'/ 6 dR Vabf ZgR^ `UVc ZLRUŽ5 VaRcc`]]` LTZE URUR 374 j Tf]efcRV_2^1/cZIR=ReZRjV]4RcZSV 4 RORIROL? I VORD TZURU 4 RUV2_L7ŽLR_UDR_Z 1/2L;Ž1"***/ 6 XRe bf V RUR =RARAL3` ZZZLA f dR 6UZE dvd 4 RdeVIŁCŽi#!!\$/ 7c`^ ^ R f R] h`c\Vcd e` h RXV |RS`cVcd+ EdR dWc^ ReZ _ `WeYVd TZR] bf VdeZ AZTIRER RIL? Vh; Vady LEar artez Af S ZYVad $4 \operatorname{Rel}[d > \tilde{Z}_1 **) /$ y8 |`SR[ZkRIZE_ŁeVT_`]`X3RLecRSR[`ŁV`a]V j V acVARAZ CVZER 7RTé CAR 3RcTV R 4 Rde` cZRLZ2L4Ž1"*) (/ <u>EYVZ'RXZ Rozz dezef ez `Wat Tzkięł g`]Ž:</u> 4 R° Sozitvila Zi Advid PPP1"**'/ $=R^{*} eV/2U$]"Z dZX Z R TV+=Vd TRacWWf cd Uf $R_i cZ eW:G$ ARZŁDYZ 4 ReRii ŁĄŽR UDf_\VŁ8Ži"**!/ $4 \quad df^{*} \quad Tf = dR V \quad 4 YZVZ = RVZEVL^{*} \quad RdZg^{*}$ $\hat{c}ZXaRaVc? \pm$ DR ORX Ł4 YZVŁ7=24 D@ 4 ReRii Ł4Ži#!!!/ 6] f d U M e Z A a j V T d A U A V Z d L7@? 564JE ac j VTe? ±"*)!) &(DR_ORX Ł4YZV PPP1#!!"/ y > R]dLT ^ f_ZIRIZ_ j TZf URUR_3R466Z 6] > VcTf cZ L ##; f]iDR_@RX Ł4 YZV 465 1"**)/ $= d^{VZ} dVT^{f} ZRZ V 4YZV$ $DR_eZRX \pm 4 YZ/V \pm 4 V_ec$ UV 6 def UZ d a R d V 5 VcRcc` ||` PPP1#!!!/ <u>'9 RjaRezRbfVUWVUKO=RZVezLRU_RIZ_R</u> WW eVR RX SRZKRIZ

5 VcRcc` ||`

46A1#!!"/ 4 YRceZdLCŽi"*)*/ > RaRUV | RcMZXZ dLRUV 4 YZVDR eRX Ł4YZVŁ4V ec`UV6def UZ dA1/S/ZT d 46Ał:DDA1#!!"/ PPP1"**&∕ > RaRUV | RcV ZXZ dLRUV \$# aRead DR eZRX Ł4 YZVŁ4 V ec`UV6def UZ dA1/S ZT dR U : eVc RIZ_RID TZRIDf cgV/Ac XCR^ ^ V dZX[`") 3RTY RL8 VIZR 4? EG 1"**(/ : WC^ V VarUBARZT UV |R eV/VeZZZZ UV |ZScV <u>cVIVa</u>TZ_____***' 4f lef cVZ eYValf cR $DR_e aRX 14 YZV14 ~dV1 ~ RIZ_R UVEVVaRZ_$ PPP1"**)/ DR øZRX UV4YZV :_Wc^ V VaeRUBaleZT_UV]R eV/VgZtZ_UV]ZScV cVIVaTZ "**($DR_{e}RX L4 YZVL4 \ dV \ RIZ_R UVE VVeZZ_$ 56DF41#!!"/ PPP 1#!!! ℝ⁄ EVétVerl" (@Tè SVé Acz TzaRIVdever Jeru duvirv Tr ver RIZ_RIUV eWv272 "*** $DR_{ex} + 4Y_{A} + 2M_{a}^{2} = M_{a}^{2} PPP1#!!!S/ : Wc^ V VdeRU3deZT UV eV/VgZdZ UV]ZScV cVTVaTZ #!!! $DR_{\theta}ZX \pm 4YZV \pm 4^{-}dV^{-} RIZ_R UVEV \pm 2ZE_{-}$ EYVh`dU`VXX`Ud PPP1#!!"/ ? Vh J`c\ŁC`fe|VLXV =R`WoeRac`XcR^ïeZIRUV|ReVIVeZCZ a`cTRS|V V 4YZV#!!! 64=24 1"**% $DR_{eff} \times \frac{1}{2} M^{2} = M^{2} \times \frac{1}{2} M^{2} = M^{2} \times \frac{1}{2} M^{2} = M^{2} \times \frac{1}{2} M^{2} \times \frac{1}{2} M^{2} = M^{2} \times \frac{1}{2} M^{2} \times \frac$ 4`]`^ **RŁ7Ž**R UC` [**RŁAŽ**1#!!!/ =ReZRj Vj4RcZSV y6g` |f TZ__UN| ^ VETRU |RS` cR1%4Z =RccR3/4L7ŽR U GVEXROLCŽIVUDŽL<u>=RecR_dVC^_RIZ__VT_2^ZR</u> UV4YZV PPP1#!!"/ DR_e277X Ł4 Y27VL4 V_ec`UV6def UZ dA!/\$]27 d DR_62RX Ł4 YZV 4@? 2D521#!!!/ <u>6defUZ_RIZ_RIUVT^a`ceR^ZVe`dMfR_V</u> 6LhRdH:Ži"***/ 4YZV DR eZRX Ł4 YZWŁ4 `^ ZWZ_? RIZ_R UN D.52 4` cc\RLDŽL;`TVjj_{9`]eL2ŽL7Z& Vc`RL4ŽLC` ||\L 4Ž.R. UGZIf ĐRL> Ži#!!"/ 6YeV SVeXL2Ži"**)/ 9 Zee c RUM d ZAI I I TYZV ` =RVREZXTVU yeeVdZ DR ØRX Ł4 YZVŁDF UR^ VOZIR R 4`fd2D`Ł4ŽR_UGRV_kfVRL6Ži#!!!/ 6] **Z**cl? Ži^{"**})/ yD TZRSZZURU j Rd TZROZGZURU% Z 6def UZ d EYV8Vc^Rd $A^{1/s}Z d? \pm (($ DR Ø RX Ł4 YZV PPP₁"**)∕ 4`iŁ4Žı#!!"/ v6] Tf cc37f |f ^ Ven |RcUM VNef c 36Z AVena VTEZEREL > VIZT 4ZejŁ8 cfa` 6UZe cZR]? `c^ R g`]f^V%L?"# PPP1#!!"/ DR ø 2RX Ł4 YZV EYVA TZAG VZ UZEZLFRA

ĭ=V^`_UVT^^VcVack@V_eReZ_ĭŁZ_<u>2_RVd</u>Ž 6T <u>`^ZKŽD TZKKZ KZ</u> ?`gV SVd5 VTV SVd? ±' ŁaaŽ'' & & #! 6 da RIZ a 1/5 ZT Ł TC36ZIR j UVCRICRZKRIZ V V 5 V4 VeWRf L> Ži"**(/ > Z_VRa`]ZELF_ZgVdzEj`W&Z_Vd1eRAdVdd 5 VCR^ 2_Ł2Ži#!!!/ DR ØRX ŁA YZVŁDFUR^ VOZIR R 6dfUZ d'ScVIRR' ZHRULd' cgV af SIZHVUZ =R DR_eZRX Ł4YZVŽ:_deZefeV`WD`TZ]`X1ŁA`_eZ;TZR F_ZevcolLRU4Re² ZIRUV4YZV $5 \times 10^{-1} \text{ W4f} \, \text{lef} \, \text{R}^{+}$ 4 Ree XCRVIII TF Jef CR UV 4 YZV 2 eRd DR eZRX Ł4YZWL> ZZEWZ UV6UFTRIZE 5 f XRd > ŽR U: dV ch U 3ŽI" **'/ = RZ Uf decZRTf |ef dR| V |RUZ i ^ ZRUM UVdRcc` |]` j]R^ `U\c Z.RU+? f VeRd |VTef dRd aRdR 2^ 1/6ZIR DR eZRX Ł4 YZVŁD TZR UVgV a^ V e5 ZeZZ D'TZR aR ` CR^ R ` V&ReZ 2^ VeZIR y4YZVLA`]`_ZRL_ZXf_RaRceV%LZ_@cV/[R_RL4Ž 1VLZE C/Ł<u>AYZVV |R^ZR</u> DR_ORX Ł4 YZVŁA R_VR ARC31L6UZZ_d@UZV;RTS ? Vh J`c\Ł4`]f^ SZRF_ZgVcdZgi AcVdd =RTZZZZKRIZ _ UV]`daRUEVdj`ec`dV dRj`d

?VhJ`c\Ł4`_eZff^

6hVŁDŽi"*))/ 2]] T $d^{T}ZXZ' RX(d+EYVa) ZZ' d' V(de |VZ)$ <u>T_eV`a`dRqi Tf]ef dV</u> ? Vh J`c\Ł3R2T3``\d 7RT² ŁCŽi#!!!/ vCZefR[VeL} Volkedj a`UVe%Le6defUZdD`TZR[VeL? ± ") $DR_{R} = R7VL2cX_{e_{1}} = RF_{2}VcdR_{e_{1}} = RT_{e_{1}} ReYVcde __VL> Ži" **!/ 4` df^ VcTf]ef cVR Ua`de^`Uvc Zf =`UŁDRXV 7\c i U\kLAŽi"***/ =RRWIEZRUT |VIEZR > VíZT 4Zeji ERFofd 7\kcj1; ŽH`]e`_15 ŽR_U`eY\kclı"*)*/ E EYV_Vh af S]ZTRCV_R Z <u>9 Vc^ ød</u>? ±% ARZL4? CD6UZZ_d 7 eRZ VŁCŽi#!!"/ 4 YZ]V #! " ! Ł _f Vg`d VdIV_RcZ d UV]R T^f_ZIRIZ^e_^{*}LUTf^V_eWceYVDWXf_U 4`_XXXI UVAFS|ZIZIRU DR_eZRX Ł4YZWŁ2d TZRIZE_UV2XV_TZRdUV Af S|ZZRU12492A/ 7cR kŁ4Ži#!!"/ $= R^{f} dR R R V eV dR R$ DR OZRX ŁA YZWŁAJR VOR 7f V kRZRŁCŽi#!!!/ =Revivezze a1/S ZRV 2^ 1/2ZR=Rez RZCWC^ R acZeReZkRIZ $DR_{e}RX \pm 4YZVL7 U W4f = cR6T_{2}^{2} ZR$ 7f Xf V£2Ži#!!!/ AcZ VcRaRceV DR ØRX Ł4 YZVŁ2 XF ZRC 8 RcT3RL;Ži"***/ $y6daRIZ a^{1}sZTLdVeZUT^{1}_{4} j T_WZTe^{1}$ a`]362T V_4Y2W160 CV22HR UV]R2TRUV 2RL? ± % DR_eZRX Ł 4 YZ VŁ F_ZgVcdZURU 2 TRUV ZR UV $9 f^{R} R Z h^{3} 4 c Z h R^{3}$ 8 RcT3R4 R TZZ?Ži"*) (/ A`]36ZIRdTf]efcR]VdV_2^16ZIR=ReZR > VíZT 4ZejŁ8 cZRS PPP1"**&∕ 9 j ScZUTF Jef cVd $> Z_VRa^{3}$ ZLF_ZgVcdZg $^{VV}Z_Vd$ eRAcVdd PPP1"**'/ =RTZFURUUV]`dgZR[Vc`dŽEdRgVdBRdVZ'RXZRcZd $f cSR \ d \rightarrow \frac{1}{2} ZT \ Z'' \ast H + !!!$ > VíZT 4ZejŁ8 cZRS

PPP1"**(/ v6]aReeZ`ZTF]efcRUV> ½ZTj]RT_defTTZ Z`RXZ_RCZRUV]`_RIZ_R]%LZ_7]`cVdIR_`Ł6Ž $1 \text{VLR} \text{ (}216 \text{)} \text{ a Rec } \text{Z} \text{ Z} \text{ RIZ } \text{ R} \text{ UV} > \frac{1}{2} \text{ Z}$ > \IZ 4ZjL7_U UV4f]efcR6T_2^ ZR PPP1"**)/ =RdZ Uf decZRdTIf)ef dR[Vdj V] UVdRcc`]]` VT_2^ ZT_ i d'TZR DR_eZRX Ł4YZVŁ^ R_f dTcZae acVdV_eVU Re eYV $4 f [ef cR j 5 V dR cc^{2}]$ DV Z ReL: $eV d2^{4} V dZ R_{2}$ $5 V_{gV}^{a^{V}e3R}$ PPP1"***/ =RX|`SR|ZkRIZE_Z`RXZ RUR 3fV`d2ZV&LARZPd PPP1#!!"/ 4` df^ VodR UTZEZKV d > Z_VRa`]ZELF_ZĘVcoZej `W& Z_VeleRAcVel 8 RCT3R4 R TIZ ZL? ŽR U> `VERL4 ŽLVUČI"***/ = Rd Z Uf decZRd Tf]ef cR]Vd V]R Z eVXcRTZ <u>Rez R Vézir r</u> > $V_1Z_1 4Z_1 L 8 cZRS$ 8 RcT3RUV R9 f VceRL> Ži" ***/ CV-VIZ_VdR^VzZR RdZ6 dR dUVZ edri Yzze dzR DR eRX Ł4 YZVŁ=@> 8 Rocke² Ł> Ž2h#!!#/ > RcTY DR_677X Ł4YZV $8 \operatorname{Rec}^{2}_{L} \geq \mathbb{Z}\mathbb{Z}\mathbb{R} \cup 4 \mathrm{f}^{\circ} \mathrm{d}\mathbb{Z} \cup \mathbb{L} \otimes \mathbb{Z}_{1} \# ! ! "/$ AVETVATZ_VATF | of aRVAUV | RUXAZAF RURU $DR_{e}ZRX \pm 4 YZVE > Z_ZEVCZ UVA]R_Z TRIZ_j$ 4``aVARIZE 8 Rf TYVeL> Ži"**)/ $= \underline{RcM}\underline{Z}\underline{X}\underline{L}\underline{R}\underline{d}\underline{R}\underline{U}\underline{h}\underline{2} \quad \underline{TcR}\underline{d}\underline{Z}\underline{V}$ ARZL8RZ RU 8 Rk^ f c2L4 Ži#!!"/ 6] 4 YZVUJ 4 V eV RZŁ OV dr ZerdUV RTCZZ DR_eZRXŁA`_eZZZZRF_ZgVcdZURU4Re²]ZIRUV 4 YZV8\&XV_L<Ži#!!!/ EYV dref drew dryw ? Vh J`c\Ł3RdZT3``\d 8ZUV d.2Ži"**"/ <u>>`UVCZEjRUdMWZUVeZEj</u> 4 R° SczlXVLA Zi AcVdd PPP1"**#∕ EYVecR dWc^ ReZ `VZ eZ' RIj 4 R^ SczlXVLA Zi AcVdd

8 ZdV Ł3Ži"***/ <`]]V.eZeVZ.V eZece 7dR \WideLDf Yc\R' a 8 d kZ d ZDŽi"*) ' / =RT] ZReZ UV] "Z RXZ RZV ARZL8RIZ RU PPP1"***/ $= \operatorname{RaV} d M \wedge \frac{1}{2} d M$ ARZŁ7R RU 8f VcdRL7H Ži"**#/ y=VdRgReRcdUV|RcVaclorv_eReZ_RfI:IVdZUV%kZ 8Ž4`fVWX_RL<u>C1ZZgVeVc]RU1/2`TcReZ</u>/ ARCZŁACYCHYURY_UREZ_?REZ_RJUYCHOTZY_TYC A`]ZeZbfVd 8fk^ï_Ł=Ži"**(/ V> VZ dUVT ^ f ZRIZ Ł^ VUZREKRIZ UV R a`]362TRj_fVgRdeVT_`]`X38c966Z_8fk^ï_Ł=ŽL 6ia \dot{RIZ} VdV adZT $\dot{XR}a$ 36ZIR: DR_678X Ł4 YZWLF_ZEWCHIRU 5 ZWA A` ceRWd 9 Rc TYVŁ4Ž1#!!"/ y5 Vd Wc^ Vd Ve UVd ^ R_ZacVd V_ U1/2 ` TareZ%66 $CRZ1 _ A`]ZZDf VL? \pm #$ ARZEL7 _ UREZ _ UVODIZY_TVOLA ` ZEZOF VO $9 \operatorname{RocZi}_{\underline{l}} = \operatorname{ZR}_{\underline{l}} U9 f \operatorname{eZ}_{\underline{\lambda}} = \operatorname{LDZi}_{\underline{l}} # ! ! ! /$ $4 f ef cV^{ReeVcd+9} h gR f Vd dYRaV Yf^R$ <u>ac`Xdd</u> ? Vh J`c\Ł3RdZT3``\d 9 Z \VR ^ Vet 7Ži" ** &/ 4 f] ef cR UV] R V da V cR kR j d TZ/URU dZ <u>MTIF dZE Ł</u> DR; d425VZ9`aV_YR_L>Ži#!!"/ CVaV_dRcVj edRSR(` $2cW \in \mathbb{R}^{2} \cap \mathbb{R}$ 9`aV_YRj_Ł> R_U@e`__VŁ6Ži#!!!/ 6 XR VdR² $3fV_d2ZVdL7_UUV4f]efcR6T_2^ZR$:Sï ÐV&L;Žı"*) &⁄ <u>> ïdR]]ïUV]RdTZ]`XRLV]Xfa`UVUZ11fdZ`,</u> el/E ZIRj TceZIR 3RcTV/`_RLDZX/`II: :URCHF Zever RUUV4YZV1#!!!/ 6 TF ValeRa' SolvZ e` [Var TZRj UZCTToZ' Z RTZE DR 6277X Ł4 YZVŁ7f URIZE : UVRd

:621#!!!/ 4 Zezt WITRez RTc dd T f eezdd+ Eh V ei ł Wf c REZ_RTRAVATUZIAW/^ eYV:62 TZZTVUT TRZ_ ac` Me 2^ deVol.R^ HE YV:_eVc_ReZ_R] 2 dd TZReZ_ WceYV 6gRjfReZ_`V6UfTReZ_Rj2TYZgV^V_e PPP1#!!"/ <u>4 ZeZkV dYZa R U VUFTReZ Z eh V ej ł VZXY</u>e <u>Tf</u> $ecZdZZT \ h]VLXVR UV XRXV V e Re$ RXVWfceW 1Yeea-ŧžħhhŽhR^Žt^UŽUfžoZRž⁄ EYV:_eVc_ReZ_R|2dd1ZReZ_WceYV6gRlfReZ_ `W6UfTReZ_R]2TYZkgV^V_e : ||R_VE>Žı"*) '/ y6iecRl^fc`dŽF_RViacVdZ_UVTf]efdRRfe`cZRCZRV $4 YZVa der = ZRM_{64} ecZsfTZ VdL? \pm S^*$ $DR_{e}RX L4 YZVL7=24 D@$:=@ 1"***/ 7]VIZSZZKRIZZ V V ^ RCXV +]R CWVC^ R UV T edRe`UVedRSR[` $DR_eZRX \downarrow 4YZ[VL : eVc_ReZ_R] = RS`fc$ @cXR ZkReZ :? 61#!!!/ yF_RU WRRURUVRR TVTF of R Max Z <u>6 Wbf Vd</u> $6 de RUB de ZT d? \pm ($ DR_eZRX Ł4 YZNŁ:_deZfe`? RIZ_R UV6deRURdeZRd :?:1#!!!/ 6_TfVdR[2gVVd DR_@27X124Y2/VL:_d626fe`?R1Z_R]UV]R;fgV_efU :EG 6UZe cVd1#!!"/ <u>5 ZVTe cZ_RIZ_R UVV acVaRdj V[VIf ezg d</u> DR OZRX Ł4 YZVŁ: EG 6UZO CVA :R^ Vd Ł7Ži"**)/ 4flefdRlefc =`_U_ŁGVcd ;ReRYi AVdReV e`ŁDŽi#!!!/ y2 T cURR]^ RŽ2^ SZERJÝ_TZROVR^ SZA ZLRUNOUR $ZV \in ZRV RIZ R \ll 6 \det UZ dD TZR V \pm ")$ $DR_{R} = R7VL2cXV_{eZ}RF_ZVcdRUUV_{eZ}RF$; `TMj_ł9`]eŁ2Ži"**) R⁄ 6] a.Vd UV]R_`TYV+_f ValeaR War XZ WareR VkR YZe²cZR DR_677X Ł4 YZVŁA]R_VAR PPP1"**) S/ 6] 4 YZV a Vca V Ž5 V RgR kRc dZ ecR dRc R ecR_dRcdZ_aRdRc DR_ORX Ł4 YZWŁAJR_VOR 2021 <]VZŁ?Žı#!!#/ ? = X + ? daRIVL TY ZIVL Sd=`_U_ŁAZIRU c

<`dM]\VI\{LCŽi"**(/ > R k2L;Ži"**(/ y6] ^ f_U a`]362T UV_2D`dj [2gV VdV_4Y2V4 = Via 1/6ZV TVUV] YZE cZV 7R° ZZRZLRUŁRWIE dj RIEZE UVOVOW EVRCVINEV EVO ARZL8 RIZ RU a`]362T d%12 8 f k^ ï Ł=ŽuVU2ê c/Ł6ia]`dRIZ Vd < cRf dML> Ž1"**% V adZT]`X3Ra`]36ZTR: y=RZ_gVdeXRIZ_TFRZRezeRef_TR^a`UVa`dSZZLRUVd DR_678X Ł4 YZWLF_ZEWCOZURU 5 ZAX A` ceRWd jUXRAMANGCVZZEREV ROUVOUTRIZ ? ±# =RDVCV_RLF_ZgVcckLRUUV=RDVCV_R > Rce3/413RcSVc L;Ži"**\$/ <u>4`^^f_ZTReZ_LTf]efcVRUYVXV``jŽ7c`^</u> =RS`dNL>Ži#!!"/ eYV^VURe`^VUReZ_d vDZeV[VTIZ VdUV] 4V eV RZ%LZ 6] > VcIf cZL=`_U_ŁDRXV * Dvael SVc DR ØRX Ł4 YZV PPP1"**)/ y6iaV2V_T2RRfUZg2fRjjUVddV_TfjefdRj% =Ra \mathcal{R} KŽ₁#!!!/ $\underline{Z} > \operatorname{Res}_{4}^{2}(3\operatorname{RcSVc} L; \underline{Z}R_{U} = {}^{2}aVkUV]RC`TYVL7\underline{Z}$ =VdRIcVUf acl/dV_e 1 V dŽL<u>4f]ef cRL^ V Z dj d TZURU</u> AR:7212.7]R^ ^ R:7__ 3`X`eïŁ4V_ec`dUV6defUZdD`TZR]VdUV]R $F_Z (M, RU? RIZ_R UV4)^{^{1}} SR$ y=R dRUZIR]ZkRIZ _ UV `Ta`eZIR W Z_ZHR46Z_ PPP1#!!!/ 2 d ZEZZ J V ZE (24.6) dvg v d UV R UZW CV TZR y6] Whet c`bf V YRSZER |R ^ V `cZEV&Z_D`_TYVkL 4 RORIROL? I VORD TOURU $8 ZR UHZ VL > Z VUZL > f dV L^ V CZR j$ RIZ PPP1#!!"/ 3 X $\ddot{e} L > Z Z$ V 4 f e RA`]362TRj cVac`UFTT22 > $V_1Z_1 + Z_1 + A_1 = R_1 + A_1 + A_2 +$ PPP1#!!"/ CVT_}XfcRIZ_VdT^f_ZREZeRdUV]`a1/S]ZTŁ =R UZL@Ži"**#/ ^ R_fdTcZae 5 Vg² dR[^] V[^] edRgVk 3fV`d2ZV&LA|RV&R $> \operatorname{Ref} Z Z T D Z_1 " **' /$ $y=RaR[RSdRV_f_UZ]^X RdZ^1/ecZT + ^RcTd$ $= RccR^{2}/4t$; Z_{1}^{**} (/ Zdezer TZ_RVdj_VX TZRIZ_UVjdV_ezU %LCVezzer y=RecR VIe c2R Rez R^ V2IR_RR R^ UVC_ZRUM <u>GVcdZ_Ž6defUZdUVT^f_ZIRIZ_ja`]3ezIR</u> 6df UZ dA1/\$Z d2? ±'' 4ZejŁ F_ZeyVcdZURU 2fe²_`^R $> MZ\Gamma$ DR_&77X L4 YZVL4 V_ec`UV6def UZ dA1/\$jZr d > Vec`a` ZER R PPP1#!!"/ > Ref dR RŁ9 Ži#!!#/ : UV eZLRUTYZV R y=RTZEURUR \$PaVdSZ]`X\$PaafdP&LZeVcgZAhhZY DR_ORX Ł4 YZVŁ=@> $GZXZ_RCZ dVT LARecZ \ge Z 4 f ef dR ? ± #%$ =RdIYŁ4Ži"***/ DR eRX Ł4 YZVŁ5:32> 4f]efcV`WRcTZdZch > \Vf TTZL2Ži"***/ ? Vh J`c\LHZHZ? `ce`_ 4 ` ^ aR_j $y_{6}dW_{CR} a^{1}s$]ZIR j UV `TCRIZR V_ |R VCR UV |R =RdMLDŽ1"**\$/ Z W6^ RIZ_% > VeRa`]3621RL? ±* 6T_`^Zd`WZZ_dR_UdaRIV > $V_1ZT_4Ze_1L4V_ec_V6defUZdUVA^3$ 4`^ aRRR =`UŁDRXV PPP1"**%/ > Vce LCZL7ZAVL> ZR U < VUR]LAZI" * & /<u>EYV WIF dW Z every $h+2 \wedge R f R$ Wac SIV d</u> CV-VIZZZE R_UZEdUfS]Vd+DecfTefcVLRVdeYVeZIL $T \wedge f_Z_j \sim Z_3V_I + F Z_8 Z_U_d_2 R_U = R_M DZ_1$ R Uac TUf dd $\underline{CV-VIZeV^{^{\prime}}}$ $\underline{VecZeReZ_{+A^{\prime}}}$ $\underline{ZeZeCeRUZeZ_{R}U}$? Vh J`c\ŁEYV7cWAcVdd RVARY AZIGZ eVV^ `UVC_d TZR] `d.VC >:56A=2? 1#!!"/ 4 R° SCILINILA ZI ACVOU <u>4`_df^` Tf]efaR| UV]`dY`XRavdUV| 8 aR</u> $=^{2}aV_{kL}=\tilde{Z}_{1}^{***}/$ 4 V ec dT ^ Vélik Vál DR OFFX Ł4YZWŁF ZLRUW6def UZ dAc da VTOZE d > VIZT 4Z412; f Vdec` EZV^ a` > :56A=2?łA?F51#!!!/ 5 VdRcc = 1 of R V = RdT f RdUV4YZVLEV RdUV5 VARce]] Df deV_eRS [VdVZVdL? ±% DR ø RX Ł4 YZV

> :? 65 F 4 1> ZZecj `W6Uf TReZ_/1:62 ARc\V&4Ži"**)/ 1#!!"/ vCV/ZXZ j TF) of dP262Z E`]` kRL4ŽL=RYVCRL6Ž 4ZURUR RAJ VETRIZ V 4YZVŽCVEJERU dUM 1VUŽŁ<u>4YZVV]`d_`gVe</u>R 6 def UZ : eVc RIZ R UV 6 UF TRIZE 4 3 gZR V DR OZRX Ł 4 YZVŁ ACYZIU TZR UV |R CVa¹/S |ZIR j Valt UZR eVal UV " % RD al V_ #) a Redukt Ž 1 Yeen + žž 5`]^V hhhŽhR^Žt^UŽUTzoZRž?R=Z_Rjz4YZVRŽYe^/ A` |R j ZL<Ži" *&(∕ > ZZEWZ UV 6UFTRIZE_ŽEYV:_eVc ReZ_R EYVXCVReedR dV/c^ ReZ 2 dd TZReZ_WceYV6gR f ReZ_`W6Uf TReZ_R 3° de`_L> RdRIYf dvædL3VRT _ Acval 2TYZkgV^V_e Af SIZ 6EC@ 1#! ! "/ >` dL2Ž"**(/ `6 TFVdR> Raf TYVdłZ AfSZZ Vec'Ľ' 2fXfde =R ^ 1/eRaY`cV d`TZR]V+:^ RXVL eVccZe`ZcVL DR_oZRX Ł4YZWLG`i A`af]Z $T^{\uparrow} f_ZReZ_$ ARCZŁACYCHYCH ZEWCZERZYCUW 7cR TV Af XR: Ži ** (/ =RReV f RIZE UM TROEMIR UV4 YZV4f V Wbf V > `cRU1/2AŽi"**!/ adRX^ RZ Xi 3062T = R cVIf a VcRIZ UV | R ZIV eZIRU TF | ef cR $3RcTV_{a}^{T}REZR_e^{3} 3R_TY=Zc^{2}d$ REZ R VEIR R Z 7VC I UNAL 4 Z 2 df Zevier dR j ^ `U\c Z.RU.Rac` aZRLR Af e^ R ŁCŽi"**% DR_ORX Ł4 YZWŁER |VC 2^ 1/02TR > R\Z XUV^ `TaRIj h`c\ Acz_TVé_ŁAcz_TVé_F_zęvcozej Acvod $> d\bar{z}_{1} d\bar$ 227VdUVWR 22RŽ4fjefcRjdT2VURUV_2^1/62TR BfVgVUŁ7Ži#!!!/ $= \operatorname{Re} Z R$ <u>=Reczelykruj tyzv</u>łg`lf^VZ' 3ReTV RL2 RXR R $DR_{eZRX} L > df Ze 4^{f} JRIZ_Vd$ > 1 _TY^ Vj V£8Ž1#! ! #/ CZ f i Ł; ŽĄŽR UDZCZ V]]ZŁ; ł 7Ži "**' / :_eVcgZth hZeyERzZAV__RLZ_DZteVfl(?±\$ A`fcf VYZte`ZtVTflefcMIV DR_ORX Ł4 YZV ARZŁDY Z > f **Z**kRXRL; Ž4Ž1#!!"/ CZIYRUŁ? Ži"**)/ $y=RV_e^{-}RIZ_ZTZKeRV_V$ VI YRS]R $dR_{OZX}TZRK_{OZ}$ CVALF`dj ^ Va Ward16 dr `dUVTc & TRTF | ef dr $\underline{ARecZ \geq Z 4f} = \frac{f}{cR}? \pm \#$ d ScVV 4 YZVUV RecR dZZ / DR ORX Ł4 YZVŁ5:32> DR_@27XL4Y27VL4fRce Ac aZ @ ReRcc #L; Ži #! ! "/ C TRMZ] LCZ' ***/'9 ` ^ ScVdR | RUVZZROA` UVZLeeRSR ` j dM ` y=Rd Z Uf decZRd Tf]ef cR]Vd V_]R gZJV dWcR DR ORX Ł4 YZVŁ7=24 D@]ReZ ` R^ VCZIR_R46Z_ 8 RCT3R 4 R_T]Z_ZL? ŽR_U @cZ]]4`deRLAŽLA½Vk;Ž>ŽR_UEc`aVRL7Ž ZeVXCRIZE |ReZ`R^ VCZIR R 1"**'/ $> VIZT 4Zi \pm 8 cZRS$ EcZsfdfcSR Rd 3RCTV_RLARZPd:S16ZTR $C^{R}_{R}^{1} = tAZ_{1}^{**}/$ y=Vdfe`aZkdc1/2kCVd2gVdUV]RU1/2`TdReZ1/16Z @co2kLCŽi"***/ 5Ž4`YV_ R_U`eYVcdL<u>7cR TV+ |Vd c½`|f eZ_d</u> $\sqrt{5}$ Zevol RUTF lef cR j T d' `a` ZZd' `% Z > Rce³/4 <u>Z g**ZfS**]V</u>d 3RSVc $\pm; \tilde{Z} = 2aVk UV | RC^TYV \pm 7ZR U; RR^2 Z| \pm$ $ARcZL4R^{n}R_{l}=1/g$;Ž<u>Af]efcRjX</u>`SRZRIZE_ 3`X`eïŁ4V_ec`UV 6def UZ d D`TZR]Vd UV]R PPP1#!!!/ $F_Z V (R R U? R Z_R UV4^)^{\ } S R$ =RU1/2 `TcReZ/Z RIYVg1/2/ ARZŁSR]Z RU @dd15Ži"***/ y=`d^Ze`dUV]4YZ/VT_S`eRC%4Z_@cV]]R_RL4Ž DIVALDŽR U2]gR RLCŽI#!!!/ 1VLZE C/Ł4YZVV |R^ZR = R^ R|RWC^ RUV|RUV `TCRIZR $DR_{\Theta}RX L4 YZ VLA R_VR$ DR eRX Ł4 YZVŁ=@> @ddt4Ži"***/ =RaR eR]RUMZR eVZ=`d_f Vg`dVdIV RcZ dUV]R $T \wedge f$ ZIRIZE V 4 YZV DR_OFFX L4 YZVL=@> 1F_ZVCORRU2C4:D

DYZ RURUŽI#!!!/ 5 Z/V&UF X[RaR d 7 cR_\Wodt.4 R^ af d

 $\mathbf{DR}_{\mathbf{A}} = \mathbf{A} \mathbf{X} \mathbf{L} \mathbf{A} \mathbf{Y} \mathbf{Z} \mathbf{V} \mathbf{L} \mathbf{5} : \mathbf{32} \mathbf{S}$

DVa¼gVUR.7Ži#!!"/ y5Z]`XdV_]R4fVgRUV]:^Sf_TVV%LZ_eVcgZh hZEY > RETV]` > V_U kRL<u>ARecZ` Z4f]efcR</u>? ± ##

DV_VetCŽI"**)/ <u>EYVT cc`dZ_`WYRRRIeVc</u> ?Vh J`c\ŁHŽIŽ?`ce`__4`^ aR_j

DV_Ł2Ž"**)/ `2dZ_ gR]fVdR_UVT_`^ZTXc`heY~%_Z F?6D4@Ł<u>H`dUTf]efcVd&`œ</u> AR:ZLF?6D4@AfS]ZHZ_X

DIY^ fT]V&9ŽR_U> ReR>Ž4Ž1"**#/ <u>A`]&ZRj T`^f_ZRIZ</u> 3fV_`2ZV&L4Rij`X d

PPP1"***/

y=ReV/_`gV/RTYZ/_RŽ5Z11fcc1dTZA]jWATZZ_ UR^ïeZ117444<u>CVgZbRUV:gV/bZXRIZZ_j4c36211R</u> ?±# DR_627XL4YZ/VLF_Z2Vc2U.RU2C4:D

DR_eR4d1kL6Ž"**'/ @cZXV_j_Wefc_UVf_RaRd22_Ž7½eS`]LTf]efdR j_^_UVc_ZRU DR_eATX`L4YZWL=@>12C4:D

 $\begin{array}{l} & \label{eq:rescaled_re$

 $\begin{array}{l} DR_{R}R_{R}L > \tilde{Z}R_{U}GR_{U}CR_{C}^{A}R_{L} > \tilde{Z}_{1}\#!!!/\\ \underline{5Z}R_{U}Ve_{C}^{A}dV_{C}R_{C}dZ_{L}^{A}\\ DR_{C}R_{C}X_{L}L_{4}YZN_{L}=@> \end{array}$

 $\begin{array}{l} DR_{R}R_{T} \& ZR_{U} & DAZ_{e} \& L; Z & T & T \\ \underline{O} Z \& ZR_{T} & \underline{O} & \underline{O} & U \\ DR_{e}ZX_{t} & A & YZ \\ \underline{O} & \underline{C} & X & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} & \underline{O} & \underline{O} \\ \underline{O} \\ \underline{O} & \underline{O} \\ \underline{$

DRZ_eAf]XV_dt>ŽUV1"***/ =VXfgVc_V_VeUV]RTf]dfcV AR22L8R][Z]RU}=V5½Re

> PPP1#!!"/ y? f Vg ValV_Rz Tf] of dR M_{LC} V_{C} dR V dR V? \pm %*(DR eZRX Ł4 YZW EVZEMS`Z'ŁGŽi"*(\$/ <u>6]`}TZ TZFURUR`</u> DR_eZRX Ł? RdIZ V_e EZ: Z6Ž1"**% y=R_f VgRRJZR_kRŽ=RTf]ef cRTYZJV_RV_edR_dZIZE_Ł "**! }" **%&<u>C\\$ZHR4f]efo</u>RLokVIZR] VL76Z_ $DR_{e}ZK \pm 4 YZV \pm DVTCV = 0 + f_ZRTZ_j$ 4f lef dR PPP 1"***/ <u>=RZcfaTZ*_UV]Rd^RcRdjVj^RlVdeRcUV]Rd</u> <u>MZeVd</u> DR_ORX Ł4 YZVŁ8 CZRS` PPP1#!!"/ y6]T_d^` R]RTYZ[V_R%LZ_eVcgZ/hhZeY4]RfUZR $\hat{O}|R^{\wedge} \geq \underline{C} = \underline$ DR e277X Ł4 Y2/V E`^<u>|Z</u>d_Ł2Ži"**!/ v4` d^ VcTf lef cVR UeVVRf dR` VeYVT ^ ^ ` UZi %60 <u>dej [V</u> =`_U_ŁC`feWW

7cR_\VKceLDf Yc\R' a Df SVETRARf i L3Ži" **% yA`]3eZTRd Tf]ef cR]V& 3R]R_TV UV]R ecR_dZIZ_% Ac`a`dZIZ_V&? ±#&

yA`]36ZTRdTf]efcR]VdUV]R4`_TVceRIZ_+=`Xc`dj

UVERWALLZ_D_d_`hd\ZLDŽR_U_AREED`ŁCŽL<u>F_R</u> TF]ef_dRaRR]RUV_`TERIZRV_2^½ZTR=REZ_R

> VíZT 4ZqŁ7_U UV4f]efdR6T_2^ ZIR

DR ØRX Ł4 YZVŁDF C 6UZIZ VO

4 YZWL'f aRed $^ Uc ^0$

4 YZV f R TRYZE dR

 $DR_{\Theta}RX L4 YZVL=@>$

DR ORX 14 YZVL6UZZ Vd3

PPP1"**'/

PPP1"***R∕

PPP1"***S/

DecRf SL; \check{Z} " **)/ yAVcd_R]Vf_U\`]]V.egV:UV_e&e%LZ_2dd R_ R_U7cZdV1VU \check{Z} L:<u>UV_e&e%L</u>? ±\$ 7R_\M64 Df Vc\R' a

 $\begin{array}{l} Def{Z}_{A} E_{A}^{*} E_{A}^{*} & = 0 \\ E_{A}^{*} RcUd R & V_{A} aRcRUZX^{*} & V_{C} U/gM/a^{*} V_{C} \\ \hline DecReVXZ/dLa^{*} & ZZ/d R & U ac^{*} TV/dM/dLacV/M_eU \\ \hline Re F_ZeVU ? ReZ_d 4^{*} & WCV_TV^{*} & EcRUV R & U \\ \hline 5 VgM/a^{*} V_{C} 1F? 4E25/^{*} & @Te^{*} SVc^{*} *L \\ \hline 8 V_VgV \end{array}$

F 32 1#!!!/ <u>D TZURU</u>Ł? ±"' 3fV d2ZV R R e RF 3D1#!!!/ "=`_UEVET__`^ ZEL#" 5 VTV^ SVC F?5A1"**!/ <u>9f^R_Ukgy`a^VecVa`ce</u> @iWeURU? Vh J`c\L@iWeUF_ZeverZej Acver PPP 1"**"/ 9f^R_Ugy`a^VecVa`ce @iWdUR_U? Vh J`c\L@iWdUF_ZqVdZj Advdd PPP1"**#/ <u>9f^R_Ukgy`a^Vecka`œ</u> @iWeURU? Vh J`c\L@iWeUF_ZeverZej Acver PPP 1" ** \$/ <u>9f^R_Ugy`a^VecVa`ce</u> @iWdUR_U? Vh J`c\L@iWdUF_ZqVdZj AcVdd PPP1"**% 9f^R_Ugy`a^VecVa`ce @iWdURU?VhJ`c\L@iWdUF_ZqVdZqiAcVdd PPP1"**&∕ <u>9f^R_Ugy`a^VecVa`ce</u> @iWdUR_U? Vh J`c\L@iWdUF_ZzvkdZi AcVdd PPP1"**'/ <u>9f^R_Ugy`a^VecVa`ce</u> @iWdUR_U? Vh J`c\L@iWdUF_ZqVdZj AcVdd PPP1"**(/ 9f^R Ukgy`a^V ecka`œ @iWeURU? Vh J`c\L@iWeUF_ZeverZej Acver PPP 1"**) ℝ⁄ <u>9f^R_UkgVia^VecVaice</u> @iWdUR_U? Vh J`c\L@iWdUF_ZzVdZj Advdd PPP 1" **) S/ : _ Wc^ Vcl ScV5 VcRcc`]]` 9 f ^ R `Ž=RdaRcRU [Rd UV]R^`UVc ZkRIZE DR eZRXŁ4YZW PPP1"***R∕ <u>9f^R_UkgVia^VecVaice</u> @iWURU? Vh J`c\L@iWUF Zevade Acvad $PPP_1 "***S/$ $\underline{o} \underline{V} \underline{V} \underline{V} \underline{V} \underline{V} \underline{R} \underline{c}]]^{\circ} 9 f^{\wedge} \underline{R} \cdot \underline{V} 4 \underline{Y} \underline{Z} \underline{V} "**!$ ***) ŁEV^ Rd UV UVCRcc`]]` Df deV eRS [V dVcZVcŁ ?±\$ DR ØRX Ł4 YZV

PPP 1#!!! ℝ⁄ : Wc^ V d ScV 5 VdRcc`]]` 9 f ^ R ` #! ! Ž> Rd d TZURUaRCRX SVC Rc DR ø 2RX Ł4 YZV PPP1#!!!S/ ERIVed Sever RIZE j UV R URdUV) daf VSI d ZU3XAV RoHSRIR TVj aVcobVT6Z6RoL^ZV DR_OFAX Ł4 YZV PPP1#!!"/ 9f^R UVgVi`a^V ecVa`œ @iWdURU? Vh J`c\L@iWdUF Zevade Acvad F?5Ał46A1"**(/ 6 TFV&R RIZ RId ScVdVAfcZLRUYf^R R DR ø 2RX Ł4 YZV F? 6D4@1"**& @fcTcVReZeVUZeVccZejŽCVa`ce`WeYVh`c]U $4^{\circ} \wedge ZtZ$ 4f eARCZŁF? 6D4@ AfS]ZYZX PPP1"**)/ H`clUTf lef cVcVa`ce ARCZŁF? 6D4@AfSZYZX PPP1#!!!/ H`dUTf]ef dVdva`œ ARZELF? 6D4@ AFSZEYZX GZIYV&ReL5Ži#!!!/ <u>EYVdaReZR</u> <u>cV~VTeZ</u> <u>`WeYVafS</u>]ZL^ R_f dTcZae 4`gV_eqiLF_ZgVcdZgi`WHRchZT\ $GZIf DR > Ž_1 #!! "/$ =RSV||V1/a`bfVTYZVR DR_6777X Ł4 YZVŁDFUR^ VOZIR_R HRX V&AŽı"**)/ y7ValDeVIIf_XV_%LZ_2 adr R_ R_U 702XaV1VUdZL : <u>UV eZeoeV Ł?</u> ±\$ 7dR_\\KkdLDfYc\R^a H GD1#!!"/ H`clUGRIf VdDf cgVi DR OZRX Ł4 YZWŁ> @C: 4 YZW





United Nations Development Programme

OTHER HUMAN DEVELOPMENT PUBLICATIONS FROM THE UNDP OFFICE IN CHILE

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- INFORME SOBRE DESARROLLO HUMANO EN CHILE 2000, MÁS SOCIEDAD PARA GOBERNAR EL FUTURO

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As Chileans prepare to mark two hundred years of Independence, they are having to come to terms with themselves. Who are we, the Chileans? And what kind of country do we want? The Human Development Report in Chile 2002 is an invitation to debate these questions in society, from the perspective of a human development approach that seeks to make people both the agents and the actual beneficiaries of development in Chile.

The country is currently faced with a cultural challenge, since what needs to be debated are the ways people live together in practice and the collective imaginaries that surround this common life.

The Report presents the findings of a number of empirical studies, including a map of cultural activities in Chile. The research reveals that people's idea of what is "Chilean" has become indistinct. The image of "We, the Chileans" is weak and confused. This is connected to the apparent difficulty that Chileans have in experiencing society as a collective actor, able to mould its future. The studies point to a dissociated diversity. Reconciling the different experiences and representations of national life, then, is the cultural challenge that has to be taken up if nationbuilding is to succeed.