

GdU'i bX'9bhgdUbbi b[.'8]Y'VYghYb K Y``bYgg!CUgYb'k Y`hk Y]h

9bhXYW_Yb'G]Y'X]Y'VYghYb'K Y``bYgg!CUgYb'k Y`hk Y]h'j cb fi\][Yb'F \emptyset W_ni [gcfhYb'V]g'ni '[Ybi ggj c``Yb'GdU! 9f`YVb]qqYb'Z \emptyset f'X]Y'G]bbY"



GhY``X]f'j cfžXi '`Ài Zgh'VUfZi » 'ØVYf'k Y]W\Y'?]YgY`ghY]bYž'k À\fYbX XUgʻgUbZhY'D`ÀhgW\Yfb'Y]bYgʻK UggYfZU``gʻX]W\']b'Y]bY'K Y`h'XYf Fi\Y'YbhZØ\fh" \dangle X]YgYa '5fh]_Y``bY\a Yb`k]f'X]W\'a]h'Ui Z'Y]bY Ui ZfY[YbXY'FY]gY'ni 'XYb'VYghYb'K Y``bYgg!CUgYb'k Y`hk Y]h"'Jcb j YfghYW_hYb'\dangle k Y`Yb']b'XYb'6Yf[Yb'V]g'\]b'ni 'UhYa VYfUi VYbXYb ?ØghYbcfhYb' 'k]f'nY][Yb'X]f'X]Y'[Y\Y]a Yb'K Y``bYgg!GW\AhnYžX]Y X]f'b]W\h'bi f'di fYb'; Ybi gg'V]YhYbž'gcbXYfb'Ui W\'Y]bY'5i gnY]h j ca '5``hU["'

8 c W X Va]h b] W h [Y b i ["@Ugg i b g [Y a Y]b g Ua ']b '_i `]b Uf]g W Y 9 b h g d Ub b i b ['Y]b h U i W Y b " <]Y f 'Y f k Uf h Y b 'X] W 'G d U! 9 f `Y V b] g g Y ž 'X]Y X Y] b Y b '; U i a Y b 'j Y f k Ò \ b Y b 'i b X 'a]h 'Y I c h] g W Y b '? Òg h `] W _ Y] h Y b U i Z k Uf h Y b " I b X '[`U i V i b g ž 'Y g '[] V h K Y ``b Y g g! C U g Y b ž 'X] Y 'k] f _ `] W a Y \ f 'U `g 'b i f 'Y b h g d U b b Y b X Y 'A U g g U [Y b 'n i 'V] Y h Y b `\ U V Y b " `

A UWX 'X]WX 'VYfY]hž'XY]bY'G]bbY'Ui Z'Y]bY'5VYbhYi YffY]gY'ni gWX]W_Yb°'9[U`ž'cV'Xi 'XYb'dYfZY_hYb'Cfh'ZØf'Y]bY'5i gnY]h'gi WXgh cXYf'Y]bZUWX'bi f'@ gh'Ui Z'bYi Y'9f`YVb]ggY'\Ugh' 'gWXbU``'X]WX'Ubž XYbb'X]Y'K Y`h'XYf'9bhgdUbbi b['i bX'XYg'; Ybi ggYg'ghY\h'X]f cZYb°

9bhXYW_Y'X]Y'Fi\Y.'8]Y'[Y\Y]a Yb'K Y``bYgg! GW\AhnYb'Ui g'U``Yf'K Y`h

 $\pm 0.17 \] b \ Y f' K Y'h \ Z' X'] Y' c Zh' j c b' < Y_h]_' i b X' Ghf Y gg' [Ydf Å [h'] gh \ Z' []Vh' Y g j Y f V c f [Yb Y' C UgYb' X Y f' F i \Y \ Z' X] Y' X U f U i Z' k U f h Y b \ Z' Y b h X Y \ W_h' n i k Y f X Y b'' 8] Y g Y' [Y\Y] a Y b' K Y'` b Y gg! G W Å h n Y' V] Y h Y b' b] W h' b i f Y b h g d U b b Y b X Y' 6 Y \ U b X' i b [Yb \ Z' g c b X Y f b' U i W X' X] Y' A \ O [`] W \ _Y] h \ Z'] b X] Y' G Y Y' Y' X Y f' F Y [] c b Y b' Y] b n i h U i W Y b \ Z' X] Y' g] Y' V Y \ Y f V Y f [Y b'' ' J c b X Y b' gh] ``Y b' < U a U a g'] b' \ \ \ \ g h U b V i ``V] g' n i 'X Y b' U V [Y g W X] Y X Y b Y b F Y h f Y U h g'] b' X Y b' G W k Y] n Y f' 5 `d Y b'' \ \ \ \ \ Y] g h'' \ d Y f Z Y b'' 6 U` U b W 'n k] g W Y b'? Of d Y f' i b X'; Y] g h''$

GhY``X]f'j cfž'Xi 'VYhf]hhgh'Y]b'hfUX]h]cbY``Yg'< Ua Ua ']b'XYf

5`hghUXh'j cb'=ghUbVi `"'8Yf'8i Zh'j cb'9i _U`mdhi g'i bX'XYf'?`Ub[
j cb'gUbZhYa 'K UggYfž'XUg'Ui Z'ghY]bYfbYb': 'ÀWXYb'd`ÀhgWXYfhž
i a \Ø``Yb'X]WX"'BUWX'Y]bYa 'Ui g[]YV][Yb'DYY`]b['i bX'Y]bYf'gY]X][!
[`UhhYb'GY]ZYba UggU[Y'hf]hhgh'Xi ']b'Y]bYb'FUi a 'j c``Yf

XUa dZYbXYf'K Àfa Yž']b'XYa 'Xi 'X]WX'Y]bZUWX'ZU``Yb'`UggYb
_Ubbgh"'9g']gh'Y]bY'dYfZY_hY'JYfV]bXi b['j cb'?i `hi f'i bX

GY`VghZØfgcf[Yž'X]Y'X]f'\]`Zhž'XYb'5``hU[gghfYgg'\]bhYf'X]f'ni
`UggYb"

5 VYf'b]Wk h'bi f']b'XYf'HØf_Y]'[]Vh'Yg'ni 'YbhXYW_Yb.' \dir XYb'gh]``Yb K À`XYfb'j cb'GWk k YXYb'j YfghYW_Yb'g]Wk'K Y``bYgg!FYgcfhgž'X]Y XYb': c_i g'Ui Z'X]Y'?fUZh'XYf'BUhi f'`Y[Yb''<]Yf'_Ubbgh'Xi 'i bhYf ZfY]Ya '<]a a Y``]b'Y]bYa 'K U`X!GdU'YbhgdUbbYb'cXYf']b'Y]bYa <c`nZUgg'Y]bY'GUi bU'a]h'6`]W_'Ui Z'Y]bYb'[`]hnYfbXYb'GYY [Yb]Y» Yb''8]Y'6Y\UbX`i b[ga Yh\cXYb'bi hnYb'`c_U`Y'<Y]`_fÀi hYf i bX'Ufca Uh]gWkY'2 `Yž'X]Y'b]Wkh'bi f'YbhgdUbbYbž'gcbXYfb'Ui Wk X]Y'G]bbY'VY`YVYb''8]Y'?ca V]bUh]cb'Ui g'gWk KYX]gWkYf ; UghZfYi bXgWk UZhii bX'i bVYfØ\fhYf'BUhi f'gWk UZZh'Y]bY 5ha cgd\ÀfYž'X]Y'UbXYfY'FYgcfhg']b'XYb'GWk UhhYb'ghY``h''

8]YgY'K Y``bYgg!GW\AhnY'g]bX'a Y\f'U`g'bi f'CfhY'XYf'9f\c`i b[/'g]Yg]bX'9]b`UXi b[Ybž'h]YZ']b'X]Y'Yk Y]`][Yb'HfUX]h]cbYb'Y]bni hUi W\Yb i bX'XUg'Y][YbY'K c\`VYZ]bXYb'bYi 'ni 'YbhXYW_Yb''Gc'Yf]bbYfh YXYf'6Ygi W\'Ub'X]Y'Y][YbY'JYfk i fnY`i b[']b'X]YgYf'K Y`h'i bX'X]Y 5fh'i bX'K Y]gYž'k]Y'GY`VghdZY[Y'Y]b'HY]`'XYf'FY]gY'gY]b'_Ubb' Y]bY'XYf'k Yfhj c``ghYb'@Y_h]cbYbž'X]Y'k]f'j cb'i bgYfYb'5VYbhYi Yfb a]hbY\a Yb'_ObbYb"

?i`]bUf]gW\Y'9bhgdUbbib[.'GdU!9f`YVb]ggY a]h'; YgW\a UW_'i bX'; Ybi gg

GhY``Yb'G]Y'g]WX'j cfž'G]Y'g]b_Yb']b'Y]b'XUa dZYbXYg

K UggYfVYW_Ybži a [YVYb'j cb'Xi ZhYbXYb'?fÀi hYfb'i bX'XYa
gUbZhYb'D`ÀhgWXYfb'j cb'K UggYfž'k À\fYbX'Y]b'YfZU\fYbYf'GdU!

H\YfUdYi h'\(\alpha\) bYb'X]Y'; Y\Y]a b]ggY'XYf'`c_U`Yb'?ØWXY'cZZYbVUfh''\(\alpha\) K Y``bYgg!FYgcfhg'k Y`hk Y]h'\UVYb'g]WX'_i `]bUf]gWXY'9f`YVb]ggY

bU\h`cg'a]h'hfUX]h]cbY``Yb'GdU!5bk YbXi b[Yb'j YfVi bXYbži a
?ÒfdYf'i bX'; Y]gh']b'9]b_`Ub['ni 'Vf]b[Yb'''9]b'\Yfj cffU[YbXYg
6Y]gd]Y``\]YfZØf']gh'XUg'`i I i f]ÒgY'7\]j U!Gca ']b'<i U'<]bž

H\U]`UbX'''

<]Yf'k YfXYb'X]Y'5bk YbXi b[Yb'j cb'fY[]cbU'Yb'Ni hUhYb'VY[`Y]hYh''
; Yb]Y» Yb'G]Y'Y]b'YbhgdUbbYbXYg'?fÀi hYfVUX'a]h'Yf`YgYbYbž
\UbXj Yf`YgYbYb'H\U]!?fÀi hYfb'cXYf'`UggYb'G]Y'g]W\'VY]'Y]bYf
H]YZYba UggU[Y'a]h'?c_cgbi ggÒ`'j Yfk Ò\bYbž'k À\fYbX'G]Y'XYb
_Ògh`]W\Yb'8i Zh'XYf'h\U]`ÀbX]gW\Yb'?ØW\Y'i a 'g]W\'\Yfi a
k U\fbY\a Yb"BUW\'XYf'6Y\UbX`i b['Yfk UfhYh'G]Y'Y]b'YI ei]g]h</pre>

 $UV[Ygh]a \ a \ hYg`A Yb\varnothing \check{z} XUg`b]Wh`bi f`X]Y`G]bbY`j Yfk \grave{O}\ bh\check{z} gcbXYfb Ui W\ [Ygi bX\Y]hgZ\^OfXYfbXY`5gdY_hY`]b`XYb`JcfXYf[fi bX`ghY``h" 8]Y`?ca V]bUh]cb`Ui g`K Y``bYgg`i bX`_i`]bUf]gW\Ya`<cW\[Ybi gg j Yf`Y]\h`<math>\Rightarrow$ fYa `5i ZYbh\U`h`X]Y`VYgcbXYfY`BchY"

±0 '*JdUb ']gh'XUg'5a Ub 'GdU']b'? mc hc 'Y]b'k Y]hYfYg'? 'Y]bcXž'XUg Y]bY'Gmbh\YgY'Ui g'; Ybi gg'i bX'9bhgdUbbi b['V]YhYh'' <]Yf'_ÒbbYbG]Y'hfUX]h]cbY``Y'CbgYb!6ÀXYf'VYgi W\Ybž'[YZc`[h'j cb'Y]bYa8Y[i ghUh]cbga YbØ'Ui g'gU]gcbU`Yb'; Yf]W\hYbž'ni VYfY]hYh'a]hNi hUhYbž'X]Y']a 'NYb!; UfhYb'XYg'FYgcfhg'Ub[YVUi h'k YfXYb"'8Ug <][\`][\h']gh'X]Y'A UhW\U!A UggU[Yž'VY]'XYf'XUg'U`hY\fk ØfX][YF]hi Y``XYf'HYYni VYfY]hi b['a]h'XYf'?i bgh'XYf'9bhgdUbbi b[_fYi nh"

9]b k U\fYg: Ygh ZØf X]Y G]bbY V]YhYh X]Y: ci f GYUgcbg F Ygcfh 6U`] Uh GUmUbžk c XUg GdU A YbØ G]Y Ui ZY]bY [Ughfcbca]gWXY 9bhXYW_i b[gfY]gY Xi fWX \ \Dix XcbYg]Yb a]hb]a a h" BUWX Y]bYf fY[YbYf]YfYbXYb Mc [U!GYgg]cb _ ObbYb G]Y g]WX]b Y]bY \Ufa cb]gWXY 6Y\UbX`i b[a]h`c_U`Yb; Yk ØfnYb ii bX '2 `Yb VY[YVYb ' Yf`YVYb 'G]Yžk]Y BY`_Ybž' \Dix [k Yf ii bX N]a h fYdUf]YfYbXY '9][YbgWX UZhYb 'VYg]hnYb ii bX '[`Y]WX nY]h]['X]Y 'GYY `Y VYfi \][Yb" , VYf XYb '6Y\UbX`i b[gh]gWX '\]bUi g 'OZZbYh XUg F Ygcfh gY]bY 'HØfYb ni 'Y]bYa 'Yl ei]g]hYb '6U`]bYg]gWX Yb '5VYbXYggYbž XUg fY[]cbU`'j Yfk i fnY`hY F YnYdhY ']b '[UbnYf DfUWX h'dfÀgYbh]Yfh"

8]Y'JYfV]bXi b['j cb'K Y``bYgg'i bX'?i `]bUf]_']gh'b]W\h'bi f'Y]bY bYi Y'5fh'ni 'YbhgdUbbYbž'gcbXYfb'Ui W\'Y]bY'A Ò[`]W_Y]hž'X]Y 5fca Yb'XYg'FY]gY`UbXYg'Ui Z'Y]bY'h]YZYfYž'VYXYi hi b[gj c``YfY

5 V Y b h Y i Y f 'ZØf' X] Y 'G] b b Y . 'K Y``b Y gg! C U g Y b ž X] Y 'a Y \ f 'U`g 'b i f '9 b h g d U b b i b ['V] Y h Y b

5b`XYb`I ZYfb`XYg`hØf_]gV`Ui Yb`K UggYfg`]b`XYf`a U`Yf]gW\Yb FY[]cb`6U`]'`]Y[hXUg':]j Y`Ya Ybhg`FYhfYUhžY]b`CfhžXYf`b]W\h bi f`X]Y`GYY`Y`bÀ\fhž`gcbXYfb`Ui W\`X]Y`G]bbY`UbfY[h''<]Yf`hUi W\gh Xi `Y]b`]b`Y]bY`K Y`hž`]b`XYf`hfUX]h]cbY``Y`VU`]bYg]gW\Y`<Y]`_i bgh`Ui Z a cXYfbY`K Y``bYgg!?cbnYdhY`hf]ZZh''`6Y]`Y]bYa `U_i gh]gW\Yb?`Ub[VUXž`i a [YVYb'j cb`Ødd][Yf`BUhi fž'j YfgW\a]`nh`XUg FUi gW\Yb`XYf`6`AhhYf`a]h`gUbZhYb`A Y`cX]Ybž`X]Y`ni `Y]bYf`h]YZYb]bYfYb`Fi\Y`ZØ\fYb''8]Y`J]Y`nU\``Ub`6Y\UbX`i b[Ybž'j cbYbYfYb'Fi\Y`ZØ\fYb''8]Y`J]Y`nU\``Ub`6Y\UbX`i b[gdfc[fUa a Ybžg]bX`XUfUi Z`Ui g[Y`Y[hž`XY]bYb`?ÒfdYf`ni `fYj]hU`]g]YfYb`i bX`XY]bY

I bX k Ybb Xi XUW hYghž XUgg K Y``bYgg bi f'Ui Z'9bhgdUbbi b[gYhnhYž XUbb _ca a buW ; fYYWYž]b X]Y gdY_hU_i `Àf'[Y`Y[YbYb H\Yfa Yb'] cb'GdU / 'K Y``bYgg F YhfYUh Zfca 'B Uhi fU`` < ch Gdf]b[g']b'@ci hfU_]" <]Yf'_Ubbgh Xi 'b]W h'bi f']b'a]bYfU`\U`h][Ya K UggYf'fY`UI Ybž gcbXYfb'Ui W 'Ub'5VYbhYi fYfhci fYb'hY]`bY\a Yb" A UW 'Y]bY'Ui ZfY[YbXY'K UbXYfi b[']b'X]Y'bU\Y[Y`Y[YbYb C`]j Yb\U]bY'i bX'[Yb]Y» Y'VY]'Y]bYa '?cW_i fg'X]Y'5fca Yb'XYf [f]YW]gW Yb'? ØW Y"8i k]fgh'b]W h'bi f'`YfbYbž'k]Y'a Ub'XUg dYfZY_hY'A ci ggU_U'ni VYfY]hYhž gcbXYfb'Ui W 'X]Y'; Y\Y]a b]ggY XYg'hfUX]h]cbY``Yb'9ggYbgž'XUg'? ÒfdYf'i bX'; Y]gh']b'9]b_`Ub[Vf]b[hžYbhXYW_Yb"

; YbUi gc gdUbbi b[g[Y`UXYb]ghY]b 5i ZYbh\U`h]a '6`i Y '@U[ccbGdU]b '=g`UbX": Ugn]b]Yfhj cb 'XYf UhYa VYfUi VYbXYb '?i `]ggY 'XYf YbX`cgYb '@Uj UZY`XYf'i bX'; `YhgWXYfž']gh'X]YgYf 'GdU'a Y\f'U`g'bi f Y]b 'C fh'ni f '9bhgdUbbi b["'BUWX 'Y]bYa 'Ui g[]YV][Yb '6Ygi WX 'XYf VYfØ\a hYb 'V`Ui Yb '@U[i bY'_Ubbgh'Xi 'X]WX 'ni 'Y]bYf'Ui ZfY[YbXYb K UbXYfi b['Ui Z'XYa 'bU\Y[Y`Y[YbYb'Ji`_Ub'Ui ZfUZZYb"'GhY``X]f j cfž'XUg'k Ufa Y'K UggYf'Ui Z'XY]bYf'<Ui h'ni 'gdØfYbž'k À\fYbX'Xi [`Y]WXnY]h]['XY]b'</p>
Yfn ZØf'X]Y '5VYbhYi Yf'XYf'B Uhi f'ÒZZbYgh" C XYf dfcV]YfY'Y]bY'XYf'Y]bn][Ufh][Yb'K Y``bYgg!5bk YbXi b[Yb'Ui gž'X]Y

Ui Z'XYf'\Y]`YbXYb'?fUZh'j cb'[Ych\Yfa U`Yb'EiY``Yb'VUg]YfYbž VYj cf'Xi 'X]W\'VY]a '5VYbXYggYb'a]h'Zf]gW\Ya '`c_U`Ya '@Ua a 'i bX ZUb[Zf]gW\Ya ':]gW\'ghÀf_Yb'_Ubbgh"

#D: **JdUb:[]Vh:Yg:X]Y:VYfØ\a hYb:Fmc_Ubgž:hfUX]h]cbY:`Y

; Ugh\Ai gYfž:]b:XYbYb:XUg:K Y:`bYgg!9f`YVb]g:Xi fWX:_i `hi fY``Y

9`Ya YbhY:VYfY]WXYfh'k]fX":6Ygi WXY:Y]b:Fmc_Ub:]b:XYb:6Yf[Yb

j cb:<U_cbY:i bX:Yf`YVY:X]Y:<Ufa cb]Y:j cb:nYb!]bgd]f]YfhYf

A YX]hUh]cb:i bX:Y]bYa :?U]gY_]!8]bbYfž:XUg:X]Y:YI nY:`YbhY:?i bgh

XYf:'UdUb]gWXYb:?ØWXY:j Yf_OfdYfh":BUWX:Y]bYa :YbhgdUbbYbXYb

6UX:]b:Y]bYa :fchYb:CbgYb:hUi WXgh'Xi :Y]b:]b:X]Y:?i `]bUf]_:j cf:Cfhž

k c:'YXY:GdY]gY:gcf[ZÀ`h][:bUWX:*J\fYgnY]hii bX:FY[]cb:Ui g[Yk À\`h

k]fX":8]Y:a U[]gWXY:JYfV]bXi b[:j cb:_i `]bUf]gWXYa ; Yb]Y:i bX

gd]f]hi Y:`Yf:9bhgdUbbi b[:V]YhYhY]b::YghZØf:U``Y:G]bbY"

 $C\ V'\ Ui\ Z'XYf'Gi\ WXY'bUWX'Y]bYf'h]YZ[\ fY]ZYbXYb'9fZU\ fi\ b[\ 'cXYfY]bZUWX'bi\ f'XYa'8fUb[\ z'XUg'5``hA[`]WXY'\]bhYf'g]WX'ni '`UggYb' X]YgY'K Y``bYgg!CUgYb'g]bX'b]WXh'bi f'FØW_ni [\ gcfhYz'gcbXYfbUi\ WX'DZcfhYb'ni f'9bhXYW_i\ b['bYi\ Yf'<cf]ncbhY'''G]Y'V]YhYb'X]f'Y]bUi\ ZfY[\ YbXYg'Gd]Y``a\]h'XYb'9`Ya\ YbhYb'i\ bX'\OZZbYb'X]Y'HØf'ni i\ bj\ Yf[\ Ygg`]WXYb'9f`YVb]ggYbz'X]Y'\ K\ Y]h'\ØVYf'V`c\ Y'9bhgdUbbi\ b[\ \]bUi\ g[\ Y\Yb''\]$

GhY``X]f'j cfžXi ``Aggh`XYb 5``hU[`\]bhYf`X]f'i bX`hUi WkghY]b']bY K Y`hž']b XYfFi \Y'i bX'; Ybi gg'< UbX']b' < UbX'[Y\Yb"'\delta XYb yffhY \wideh Yb X]ygYf'9fXY c ZZYbVUfhg]Wk Y]bY [YghY \wideh Yb X]ygYf'9fXY c ZZYbVUfhg]Wk Y]bY [Ubn bYi Y 8]a Ybg]cb XYf'9bhgdUbbi b[ž'X]Y b]Wkh'bi f'XY]bY G]bbY'j YfnUi VYfhž'gcbXYfb'Ui Wk XY]bYb'; Ui a Yb'j Yfk Ò\bh''CV Xi ']b'Y]bYa '`i I i f]ÒgYb 'GdU'XYb'; YgWka U\wideh fY[]cbU'Yf ? Ogh']Wk_Y]hYb 'YbhXYW_gh'cXYf']b'Y]bYf'hfUi a \UZhYb'CUgY 5VYbhYi Yf'Z\wideh f'YohXYW_gh'cXYf']b'Y]bYf'hfUi a \UZhYb'CUgY 5VYbhYi Yf'Z\wideh f'YohYhY)bY '9]b`UXi b[ž'X]Y 'GYY`Y'VUi a Y`b'ni `UggYb'i bX'bYi Y'9bYf[]Y'ni 'hUb_Yb'''K U[Y'XYb'GWkf]hh'i bX'Z]bXY XY]bYb'dYfgÒb`]WkYb'F \wideh W_ni [gcfhž'XYf'k Y]h'a Y\f']gh'U`g'bi f'Y]b Cfh'XYf'Fi \Y'''6Y[]bbY'XY]bY'FY]gY'ni 'XYb'VYghYb'K Y``bYgg! C UgYb'k Y`hk Y]h'i bX'Yf'YVYž'k]Y'9bhgdUbbi b['ni 'Y]bYa i bj Yf[Ygg`]WkYb'5VYbhYi Yf'k]fX'''8Y]bY'5i gnY]h'k UfhYh'bi f XUfUi Zž'YbhXYW h'ni 'k YfXYb'

6Ygi WXYb'G]Y'i bg'Ui Z'Y]bY!fY]gY"XY