

; YVfUhYbY'GWXU`hi b[Yb'VY]'XYb'6]hWc]b! A]bYfb

F UgWX 'ghY][YbXY'Ghfca dfY]gY'gc``hYb'ZØf
?fmdhck À\fi b[ggWX ØfZYfY]bY'gWX `YWX hY'B UWX f]WX h'gY]bž
cXYf3'8 Ug'6ci h]ei Y! ≠bj Ygha Ybh\Ui g'?i fcg'5ggcW]UhYg
[`Ui Vh'X]Ygž'bUWXXYa 'Yg'X]Y']b'XYb'I G5'bch]YfhYb

A]WfcghfUhY[m'i bX'F]ch'6`cW_WXU]b'`YYfj Yf_Ui Zh'\Uhž'cVk c\`
Yg'Y]b'_i fnZf]gh][Yf'6]hWc]b!6i ``Y']gh''A]bYf' \UVYb'Y]b
[fc» Yg'DfcV`Ya 'Ok]h\QX]Y'ghY][YbXYb'9bYf[]Y_cghYbž'i bX
XUg'k]fX']b'UVgY\VUfYf'NY]h'b]WXh'j YfgWXk]bXYb ž'gU[hY
HUbWfYX]'7cfXYfcž'7\]YZ'9I YW'h]j Y'VY]'?i fcg'a]h'G]hn']b
@cbXcb''' 8Yf'Ga Ufh'HfUXY'k ÀfY'Y]b'Di h!HfUXYž'XYf']a
Xf]hhYb'Ei UfhU`'Ui g`Ài Zh'''Oy`YWhf]W]hmQ8]Y'DfY]gY'k YfXYb']a
Gca a Yf']b'X]Y'<Ò\Y'gWXbY``Ybž'i bX'XUg'k]fX'ni 'b]YXf][YfYb
K UWXghi a ga Uf[Yb'ZØf'X]YgY'I bhYfbY\a Yb'ZØ\fYb'' 'K Ug
k]Y'Y]b'`c[]gWXYf'<UbXY``/ Ua d∧Y``]d/

FUgWX 'ghY][YbXY'Ghfca dfY]gY'gc``hYb'ZØf'?fmdhck À\fi b[ggWXØfZYf Y]bY'gWX`YWXhY'BUWXf]WXh'gY]bž'cXYf3'8Ug'6ci h]ei Y!

#bj Ygha Ybh\Ui g'?i fcg'5ggcW]UhYg'[`Ui Vh'X]Ygž'bUWXXYa 'Yg'X]Y']b
XYb'I G5'bch]YfhYb'A]WfcghfUhY[m'i bX'F]ch'6`cW_WXU]b
`YYfj Yf_Ui Zh'\Uhz'cVk c\``Yg'Y]b'_i fnZf]gh][Yf'6]hWc]b!6i ``Y']gh"'

A]bYf' \UVYb'Y]b'[fc» Yg'DfcV`Ya 'Ok]h\QX]Y'ghY][YbXYb 9bYf[]Y_cghYbži bX'XUg'k]fX']b'UVgY\VUfYf'NY]h'b]W\h
j YfgW\k]bXYb ž'gU[hY'HUbWfYX]'7cfXYfcž'7\]YZ'9IYW'h]j Y'VY]
?i fcg'a]h'G]hn']b'@cbXcb'' 8Yf'Ga Ufh'HfUXY'k ÀfY'Y]b'Di h!HfUXYŽ
XYf']a 'Xf]hhYb'Ei UfhU`'Ui g`Ài Zh''O9`YWhf]W]hmQ8]Y'DfY]gY'k YfXYb']a
Gca a Yf']b'X]Y'<Ò\Y'gW\bY``Ybži bX'XUg'k]fX'ni 'b]YXf][YfYb
K UW\ghi a ga Uf[Yb'Z\OfX]YgY'I bhYfbY\a Yb'Z\O\fYb''

 $\label{eq:K-bound} K Ug'k]Y'Y]b'`c[]gWkYf'< UbXY``_`]b[hz'_Ubb'g]Wk''YXcWk''U`g$

; `ØW_ggd]Y``Yfk Y]gYbž'XYbb`k Ybb`Yg`i a `X]Y`DfcXi _h]cbg_cghYb j cb`?fmdhc`[Y\hž'k]ggYb`k]f'j]Y`Yg`b]W\h"

8]Y'Xi fW\gW\b]hh`]W\Yb'DfcXi _h]cbg_cghYb'XYf'6]hWc]b!A]bYf k Y`hk Y]h'g]bX']b'XYb'`YhnhYb'nk Y]'K cW\Yb'i a 'ZUgh'Y]b': ØbZhY` [Ygi b_Ybž'gW\Ahnh'DA cf[Ub"'BUW\XYa 'X]Y'; YgUa h_cghYb'XYf DfA[i b['U'Wc]b']gh'Ui Z'Yhk U'%) "\$\$\$'8c``Uf'[YZU``Yb"'I bX'gY]h 5bZUb['XYg'J\\fYg'gW\Y]bYb'X]Y'Ua 'k Yb][ghYb'YZZ]n]YbhYb'A]bYf Ui g'XYa 'Gd]Y``Ui gni ghY][Yb"'

8 Yf 5 bgUhn j cb DA cf[Ub V YghY\h X Uf]bž 6]hWc]b k]Y Y]bY K UfY ni VY\Ub XY`b i bX ; fYbn_cghYb ZØf X Ug A]b]b[Ubni k Yb XYb" 8]Y j Yfk Yb XYhY : cfa Y`ghUa a h'Ui g Y]bYa DUd]Yf Ui g XYa JU\f &\$%, ž X Ug j cb 5 X Ua < UmYg j cb XYf < Y Vf A]gWX Yb I b]j Yfg]h Ah Yfi gU`Ya j Yf Z Uggh k i f XYž X YggYb ? cghYb Ubb U\a Yb Y]bgh Y]bY gY\f i b[YZ A\fY I bhYf[f YbnY ZØf X Yb A Uf_hdfY]g ``]Y Z YfhYb.

| '5XUa '< UmYg

I a 'ni 'Y]bYf'; YgUa hnU\``ni '[Y`Ub[Ybž'b]a a h'*DA cf[Ub'XYb U_hi Y``Yb'A Uf_hdfY]gž'X]Y'<Ug\!FUhY'i bX'X]Y'GW\k]Yf][_Y]hi bX ZØ\fh'g]Y'XUbb'Xi fW\'X]Y'<UmYg!A Yh\cXY' 'cVk c\``XYf'6fc_Yf Y]bfÀi a hž'XUgg'gY]b'nYbhfU`Yf'*bdi hž'\$ž\$) '` 'dfc'_K \Ghfca _cghYbž']a a Yf'bi f'Y]bY'JYfa i hi b['gY]b'_Ubb'''GY]b 6YbW\a Uf_ž'XYf'8][]Wcbca]gh'6]hWc]b'9`YWhf]W]hm'7cbgi a dh]cb \bXYI ž'Ybh\]Y`h'A]hhY'&\$&\$'_Y]bY'GW\Ahni b['XYf

< UfXk UfYYZZ]n]Ybn'a Y\f"'8]Y'5bU`mghYb'a ØggYb'bi b'Y]bY'NU\`
Ui g'XYa '7Ua Vf]X[Y'6]hWc]b'9`YWhf]W]hm'7cbgi a dh]cb' =bXYI 'XYf
I b]j Yfg]hÀh'7Ua Vf]X[Y'ni fØW_Ybhk]W_Y`bž'XYf'X]Y'hÀ[`]WXY
Ghfca `Ugh'XYf'6`cW_WXU]b'UVgWXÀhnh</pre>

G]WX UI ZY]bY 5bbU\a Y ZØfY]bYb XYfk]WXh][ghYb ±bdi hg $XYf^A bb[!?cghYb^ni^!] Yf^UggYbž^lghYbXYi^h][b]Wh^lXYU^"$ $8UYggg]WYXcWiaYbYgck]Wh][YJUf]UVY\UbXYh$ ibX`X]Y`Ghfca _cghYb`Y]bnY`bYf`A]bYf`\ÀiZ][`UiZ V]`UhYfU`Yb'JYfY]bVUfib[Yb'a]h'GhfcadfcXinYbhYb VUg]YfYbž'VYghY\h'ZØf'df]j UhY'A]bYf'cZh'k Yb]['5bfY]nž $X]YgY?cghYbcZZYbniY[Yb"5fWUbYFYgYUfWX\Uh]$ [YgW\AhnhzXUggVOfgYbbch]YfhYA]bYf]bBcfXUaYf]_Uk]Y 7 cfY GWJY bh|Z|WŽ A UfUh\cbž F]chž < i h', 'i bX '6]hZUfa g Ghfca cghYbink]gWXYbi&(iibXi(\$ilG!8c``UfidfciAK\ cXYf'\$ž\$&('ibX'\$ž\$('IG!8c``Uf'dfc'_K\'\UVYbž'VUg]YfYbX Ui Z'XYb'bYi YghYb'ÒZZYbh`]W\Yb'C ZZYb`Y[i b[Yb"'K À\fYbX $X]Yg^{T}XUfUi Z^{T}]bXYi hYhz^{T}XUgg^{T}i bgYfY^{T}5bbU^{a} Y^{T}ZØf^{T}X]Y$ Ghfca cghYbicbi\$ž\$) I G8idfci K \ ZØfiX]Yi Yf[Ub[YbYb \U\fY \Y\fYhk Ug'ni \cW\ gY]b _ObbhYž'_Ubb Yg'Y]bXYi h][Yf\YV`]W\Y`GW\k Ub_i b[Yb`[YVYb"

 $8 \ Yf'; \ fi \ b \ X' Ugh]b \ XYI \ XYI \ hYh'Ui \ Z'Y]b \ Yb \ 'Ubbi \ U']g] \ Yfh \ b' F \ \emptyset \ W_[\ Ub[\ XYg'B \ Yhnj \ YfVfUi \ WXg'j \ cb'' \% \$' HK \ '5b \ ZUb['$i \ b]'Ui \ Z'fi \ b \ X'-' 'HK \ \]b'' \ $\ b nk \]g \ WX \ Yb' \ Uh'g] \ W 'X] \ Y' < Ug \ !F UhY'j \ cb'' 6]h \ b' _Ui \ a j \ Yf \ b \ XYfh'' \ 8 \ Ug' XYI \ hYh 'Yb hk \ YXYf' XUfUi \ Z' \]b \ Z' XUgg' \ X] Y' \ A \]b \ Yf'] \ Yf \ Ua' \ k \ Yb \][ghY b' \ YZZ]n] \ Yb hY b' \ 5b \ U[Yb' Ui \ g' XYa \ 'J \ Yf_Y \ f'n] \ Y \ Yb' c XYf \ XUgg' \ X] Y' _cghY b[\ \emptyset bgh][\ YfY b' 6 YhfY] \ VYf' \ X] Y' ? Ud \ Un] h \ h' Yf \ \ O\ h \ \ UVY b \ Z'g\ X' \ i \ gqZc \ [Yfh' \ \DA .' \]$

8]Yg'Yf]bbYfh'Ub'X]Y'YfghY'<À`ZhY'XYg'*J\fYg'&\$%, ž'XU'XYf FØW_[Ub['XYf'6]hWc]b!DfY]gY'Ui Z'cXYf'gc[Uf'[Yf]b[ZØ[][i bhYf'i bgYfY'GW\Àhni b['XYf'DfcXi_h]cbg_cghYb'a]h'Y]bYf GhY][Yfi b['XYf'Xi fW\gW\b]hh`]W\Yb'9ZZ]n]Ybn'XYf'A]b]b[! <UfXk UfY'i bX'b]W\h'a]h'Y]bYa'FØW_[Ub['XYf'<Ug\!FUhYb j YfVi bXYb 'k Ufž'V]g'X]Y' < Ug\!F UhYb 'gW\`]Y» `]W\
ni fØW_[]b[Yb '9bXY '&\$%, "'5`g'X]Y' < U`V]Yfi b['XYf'6]hWc]b!
6`cW_VY`c\bi b[Yb ']a 'A U] '&\$&\$'X]Y 'DfcXi _h]cbg_cghYb
YZZY_h]j 'j YfXcddY`hYž'fYU[]YfhYb 'X]Y 'A]bYf'fY`Uh]j 'gW\bY``
a]h'Y]bYf'?ca V]bUh]cb 'Ui g'Y]bYf'9ZZ]n]YbnghY][Yfi b['XYf
A]b]b[! < UfXk UfY 'i bX'Y]bYf'FYXi n]Yfi b['XYf' < Ug\!FUhYbž
k Ug'YZZY_h]j ']a d`]n]YfhYž'XUgg'k Yb][Yf'YZZ]n]YbhY'F][g
cZZ]bY'[Ybca a Yb'k i fXYb'NY]h"'8 Ug'bÀW\ghY
< U`V]Yfi b[gYfY][b]g'k]fX'k U\fgW\Y]b`]W\']a 'A U]'&\$&(
ghUhhZ]bXYb'i bX'_ObbhY'Y]bY'À\b`]W\Y'8 mbUa]_
Ui Zk Y]gYb"

9gʻ]ghʻUi W. 'Yfk À\bYbgk YfhžʻXUggʻX]YʻGW. Àhni b[YbʻXYfʻA]b]b[!?cghYbʻnk UfʻX]Yʻi bhYfYʻ; fYbnYʻZØfʻ6]hWc]bʻV]`XYbʻ_ÒbbYbžʻUVYf k Ugʻk]f_`]WXʻnÀ\`hžʻ]ghʻX]YʻGh]a a i b[.

. .

@Ui h: DA cf[Ub'a UWX Yb'V OfgYbbch]YfhY'6Yf[VUi i bhYfbY\a Yb fi bX'&\$'DfcnYbh'U``Yf'6Yf[VUi U_h]j]hÀhYb'Ui g"'8]YgY I bhYfbY\a Yb'gc``hYb'ØVYf'? Ui Z_fUZhž'Y]bYb'VYggYfYb'Ni [Ub['ni :]bUbna]hhY`b'i bX'Y]bYb'Ui g[YdfÀ[hYfYb', VYf`YVYbg]bgh]b_h j YfZØ[Yb'i bX'U`g'?cb_i ffYbhYb'a]h'\UbXk Yf_`]WXYb 6Yf[VUi Z'chhYb'_cb_i ff]YfYb'' 'XcWX'XYf'A Uf_h'\Uh'b]WXh'j]Y` J YfhfUi Yb']b']\fY': À\][_Y]h'[YnY][hž'X]Y'?cghYb_i fj Y'bUWX'i bhYb ni 'VYk Y[Yb'i bX'XYb'?fmdhc!K]bhYf'ni 'ØVYfghY\Yb''

8]Y'Ub'XYf'BUgXUe'bch]YfhYb'7cfY'GW]Ybh]Z]Wz'A UfUh\cb'i bX'F]ch g]bX']a 'V]g\Yf][Yb'*J\fYgj Yf`Ui Z'U``Y'i a 'ZUgh', \$'DfcnYbh Y]b[YVfcW\Ybz'i bX'j]Y`Y'6YhfY]VYf'\UVYb']\fY'FYgYfj Yb'j Yf_Ui Zhz Ybhk YXYf'i a 'X]Y'6Yhf]YVg_cghYb'ni 'Z]bUbn]YfYb'cXYf GWXi `XYbj YfdZ]WX hi b[Yb'ni 'YfZØ``Yb"

?i fcg'5ggcW]UhYg'\Uh'gY]bY'K YhhY'[Y[Yb'I G!6]hWc]b!A]bYf'U`g FYU_h]cb'Ui Z'X]Y'9f\c`i b['XYg'?fmdhca Uf_hYg']b'XYf

j Yf[Ub[YbYb 'K cWX Y 'ni gUa a Yb 'a]h'XYb 'Øb[ghYb '5bZÀ``Yb Yf\Ò\hYf'J c`Uh]`]hÀh'VY]'X][]hU`Yb 'J Yfa Ò[Ybgk YfhYb ni fØW_[YZU\fYb"'6]hWc]b '_ObbhY'g]WX ']a '@Ui ZY 'XYg'Gca a Yfg'bcWX j YfXcddY`bž'VYj cf'Yg'V]g'9bXY 'XYg'*J\fYg'Ui Z'%"\$\$\$'` 'ZÀ``hž'gU[h 7cfXYfcž'XU']bgh]hi h]cbY``Y'5b`Y[Yf'i bX'<YX[YZcbXg'a]h'fY]bYb?fmdhca UbXUhYb'Ui g'Hc_Yb'a]h'_`Y]bYfYf'CVYf[fYbnY'\YfUi g i bX'ni 'XYb'[fÒ» YfYb'BUa Yb'k YWXgY`b"' 5VYf'k Ybb'XUg']a d`]n]hY i bX'fYU`]g]YfhY'J c`i a Yb'XYf'Cdh]cbYb']b'X]YgYa '6YfY]WX'g]b_hžk YfXYb'k]f'XYb'<UbXY``k U\fgWXY]b`]WX'k]YXYf'YfÒZZbYb"

EiY``Y.::]bUbW]U``H]a Yg

8 Y hU]`g

6Ygi WXYb'G]Y'i bg'Ui Z.'_fmdhc!bYk g"Uh