

K]Y FY]gYbXY ni a 'GWX i hn'XYg'; fYUh 6Uff]Yf FYYZ'VY]hfU[Yb'_ObbYb

I bgYfY`H]ddgž'k]Y`G]Y`ni a `GW\i hn`XYg`; fYUh`6Uff]Yf`FYYZž'XYf [fÒ» hYb``YVYbXYb`Ghfi _hi f`XYf`9fXYž'VY]hfU[Yb`_ÒbbYb

8 Ug; fYUh'6Uff]Yf'FYYZ']b'5i ghfU`]Yb']gh'Y]b'BUhi fgW\Uhn'i bX I B 9G7C!K Y`h_i `hi fYfVY"'9g']gh'XUg'[fÒ» hY'F]ZZgmghYa 'XYf'9fXY i bX'i a ZUggh'-\$\$'-bgY`bž'\&"-\$\$'F]ZZY'a]h'(\$\$'?cfU``YbUfhYbž'\%")\$\$:]gW\UfhYb'i bX'("\$\$\$'K Y]W\h]YfUfhYb^''9g']gh'Ui W\'VYXfc\h"

 $= \frac{1}{2} \left(\frac{1}{2} \right) + \frac$

GhY][YbXY'K UggYfhYa dYfUhi fYb'VY`UghYb'?cfU``Ybž'XU'g]Y'Yl hfYa Ya dZ]bX`]W\'Ui Z'HYa dYfUhi fgW\k Ub_i b[Yb'fYU[]YfYb"'8]Yg'ZØ\fh ni f'?cfU``YbV`Y]W\Yž'Y]bYa 'DfcnYggž'VY]'XYa 'X]Y'?cfU``Yb'k Y]» k YfXYbž'bUW\XYa 'g]Y'X]Y']b']\fYa '; Yk YVY'`YVYbXYb gma V]ch]gW\Yb'5`[Yb'j Yfhf]YVYb'\UVYb"8]Y'5`[Yb'`]YZYfb'V]g'ni -\$'i 'XYf'9bYf[]Y'XYf'?cfU``Y"; YV`Y]W\hY'?cfU``Yb'`YVYb'k Y]hYfž VY[]bbYb'UVYf'bUW\XYa '6`Y]W\Yb'ni 'j Yf\i b[Yfb"

8]Y'Dfc[bcgY'g]Y\h'XØghYf'Ui gž'k Yg\U`V'bUW\\U`h][Yf'Hci f]ga i g k]W\h][Yf'XYbb''Y']gh'' <]Yf'hY]`Yb'k]f' \oplus Zcfa Uh]cbYb'XUfØVYfž'k]Y G]Y'X]Y'5i gk]f_i b[Yb' \to fYg'6Ygi W\g'fYXi n]YfYb'i bX'ni a 'GW\i hn XYg'; fYUh'6Uff]Yf'FYYZ'VY]hfU[Yb'_ \to 0bbYb''

%"'K À\`Yb'G]Y'Ò_c!nYfh]Z]n]YfhY FY]gYj YfUbghU`hYf

8 Yf 6 Ygi W. XYg F]ZZg Xi fW. j YfUbhk cfhi b[gVYk i gghY A YYfYghci f]ga i gi bhYfbY\a Yb]gh Y]bY [i hY A Ò[`]W._Y]hž X]Y 6 Ya Ø\i b[Yb i a XYb GW\i hn ni i bhYfghØhnYb " 9g]gh k]W. h][g]W. Yfni ghY ``Ybž XUgg XYf j cb =\bYb [Yk À\ hY 5bV]YhYf j cb 9 Wchci f]ga '5 i ghfU`]U nYfh]Z]n]Yfh]gh"

2 _chci f]ga i gʻ]ghʻÒ_c`c[]gWX 'bUWX\U`h][YfʻHci f]ga i gʻa]hʻXYa
< Ui dhUi [Yba Yf_'Ui ZʻXUgʻ9f`YVYbʻj cbʻBUhi f[YV]YhYbžʻX]YʻXUg
J YfghÀbXb]gžʻX]YʻK YfhgWXÀhni b['i bXʻXYbʻGWXi hnʻj cbʻl a k Y`hʻi bX
?i `hi fʻZÒfXYfb"' '² _chci f]ga i gʻ5i ghfU`]Yb</pre>

K Ybb'G]Y'g]W\'ZØf'Y]bYb'j cb'9Wchci f]ga '5i ghfU`]U'nYfh]Z]n]YfhYb5bV]YhYf'YbhgW\Y]XYbž'_ÒbbYb'G]Y'g]W\Yf'gY]bž'XUgg'Yf'j ca; `cVU`'Gi ghU]bUV`Y'Hci f]ga '7ci bW]`'fl GH7Ł'U`g'bUW\\U`h][Y]b[Yghi Zh'k]fX"

'U`h1 GW\i hn'XYf'; fYUh'6Uff]Yf'FYYZ'7cfU`'9IdYX]h]cbg 25h`Ug'/6cchg'7cfU`'9IdYX]h]cbg'g]bX'j cb''9Wchcif]ga '5i ghfU`]U'nYfh]Z]n]Yfh

K]f`\UVYb`i bg`ZØf`7cfU``9IdYX]h]cbg`ZØf`Y]bY`_`Y]bY`9IdYX]h]cb nia; fYUh`6Uff]Yf`FYYZYbhgW\]YXYb"`NYfh]Z]n]YfhY`6YhfY]VYf`k]Y 7cfU``9IdYX]h]cbg`[Y\Yb`kY]gY`a]h`FYggcifW\b`i ažhfU[Yb`nia I a k Y`hgWki hn`VY]ž`\Y`ZYb``c_U`Yb; Ya Y]bgWkUZhYb`i bX]bZcfa]YfYb'?i bXYb'ØVYf'X]Y``c_U`Y`I a k Y`h'i bX`XUg A YYfYg`YVYb"

6YhfY]VYfž'X]Y'VY\Ui dhYbž'nYfh]Z]n]Yfh'ni 'gY]bž'gc``hYb''Ui Z']\fYf K YVg]hY'fk]Y'\]YfŁ'Y]bYb'BUW\kY]g'ØVYf'X]Y'5__fYX]h]Yfi b[YfVf]b[Yb''K Ybb'X]Yg'b]W\h'[YZ|bXYb'kYfXYb'_Ubbž'gY]Yb'G]YXUfUi Z'j cfVYfY]hYhž': fU[Yb'ni 'ghY``Ybž'n"'6"'k Ug'hi b'g]Yž'i a ']\fY 5i gk]f_i b[Yb'Ui Z'XUg'`c_U`Y'^2 _cgmghYa 'ni 'a]b]a]YfYb3

&"'JYfkYbXYb'G]Y'kYb][Yf'D`Ugh]_

9]bY'XYf'[fÒ» hYb'6YXfc\ib[Yb'ZØf'A YYfYg`YVYk YgYb']gh'D`Ugh]_"
A]h'ØVYf'ZØbZ'6]``]cbYb'GhØW_Ybž'jcb'XYbYb'VYfY]hg'Ub[Ybca a Ybk]fXž'XUgg'g]Y'ibgYfY'CnYUbY'jYfgW\aihnYbž']gh'X]Y'FYXin]Yfib[ibgYfYg'D`Ugh]_jYfVfUiW\g'']bgVYgcbXYfY'jcb'9]bkY[Ufh]_Y`bk]Y': `UgW\Yb'ibX'Ghfc\\U`aYb''ZØf'XYb'IakY`hgW\ihnibYf`Agg`]W\"

' "'BY\a Yb'G]Y'Ub'7]h]nYb'GW]Ybh]gh! Dfc[fUa a Yb'hY]`

9g'[]Vh'Y]bY'k UW\gYbXY'NU\``j cb'BUhi fgW\i hngh]Zhi b[Ybž K c\`hÀh][_Y]hgcf[Ub]gUh]cbYbž'BUh]cbU`dUf_g'i bX i a k Y`hZfYi bX`]W\Yb' < chY`gž'X]Y 6Øf[Yfk]ggYbgW\UZh`Yfdfc[fUa a Y']a '; fYUh'6Uff]Yf'FYYZ Xi fW\ZØ\fYb"'8]YgY'Yfa i h][Yb'FY]gYbXYž'U_h]j 'ni a '`Ub[Zf]gh][Yb GW\i hn'XYg'F]ZZg'VY]ni hfU[Yb"

'U`h1 K]ggYbgk YfhYg'ØVYf'XUg'; fYUh'6Uff]Yf'FYYZ']b 5i ghfU`]Yb 25h`Ug'/ '6cchg'7]h]nYb'GW]Ybh]gh!Dfc[fUa a Y Yfa i h][Yb'FY]gYbXYž'Y]bY'U_h]j Y'Fc``Y']a 'BUhi fgW\i hn'ni ØVYfbY\a Yb

I bhYf']\bYb'g]bX'7cfU`K UhW\ibX'9mY'cb'h\Y'FYYZz'X]Y'g]W\
XUfUi Z'j Yf`UggYbz'XUgg'6Ygi W\Yf'; DG![YhU[[hY'6]`XYf'i bX'J]XYcg
j cb'?cfU``YbV`Y]W\Yz'[YghfUbXYhYb'K]`Xh]YfYb'i bX'UbXYfYb
6YcVUW\hi b[Yb'\cW\`UXYbz'X]Y'\Y`ZYbz'BUhi fgW\i hndfc[fUa a Y
VY]']\fYf':cfqW\i b['i bX'5fVY]h'ni i bhYfghØhnYb"

(": fY]k]``][YbUfVY]h`]b`Y]bYa F]ZZgWi hndfc^Y_h

G]Y '_ObbYb 'bc W 'Y]bYb 'GW f]hh'k Y]hYf'[Y\Ybž']bXYa 'G]Y 'g]W Y\fYbUa h`]W ']b'A YYfYggWi hndfc 'Y_hYb 'Yb[U[]YfYb" '8]Y '; fYUh 6Uff]Yf'F YYZ': ci bXUh]cb'j YfZØ[h'ØVYf'Y]bY'i a ZUb[fY]WXY'i bX k UW gYbXY '@]ghY'j cb'Cf[Ub]gUh]cbYbž'VY] 'XYbYb'g]W ; `Y]W [Yg]bbhY'ZfY]k]``]['ZØf'; fi ddYbU_h]j]hÀhYb'a Y`XYb'cXYf']b]\fYf': fY]nY]h'8 UhYb'gUa a Y`b'i bX'ni f'GUW Y'VY]hfU[Yb'_ObbYb"

9]b][Y'Dfc'Y_hY'VY]b\U`hYb'gc[Uf'Y]bYb'HUi W_i fgž'k Ug'g]Y'ni Y]bYf']XYU`Yb'A $\hat{O}[`]W$ _Y]h'a UW\hž'VY]a 'GW\i hn'XYg'F]ZZg'ni \Y`ZYbž'k \hat{A} \fYbX'G]Y'\\\fYnYfh]Z[n]Yfi b['UV\c`Yb"

) "'GWX Ui Ybž'Zchc[fUZ]YfYbž'UVYf'b]Ya U`g UbZUggYb

8 Ugʻgc``hYʻgY`Vghj YfghÀbX`]WXʻgY]bžʻUVYfʻk]fʻ\UVYbʻgc[Uf HUi WX`Y\fYfʻ]bʻUbXYfYbʻ@ÀbXYfbʻYf`YVhžʻX]YʻX]YgYʻ[c`XYbYʻFY[Y` [YVfcWXYbʻ\UVYb"'CVʻG]YʻgWXk]a a YbžʻgWXbcfWXY`bʻcXYf hUi WXYbž'k]XYfghY\YbʻG]YʻXYa '8 fUb[žʻX]Yʻ< UbXʻUi gni ghfYW_Yb ?cfU``Yb`VYghY\Yb`Ui g`HUi gYbXYb`j cb`Dc`mdYb```k]bn][Y`H]YfYž X]Y`5bYa cbYb`i bX`Ei U``Yb`À\bY`b``X]Y`i b[`Ui V`]W\`Ya dZ]bX`]W\ g]bX"'8]YgY`_ÒbbYb`Xi fW\`Y]bZUW\Yg`6YfØ\fYb`cXYf`Xi fW\ 5i Zk]fVY`b`j cb`GYX]a YbhYbž`X]Y`g]Y`Yfgh]W_Yb`_ÒbbYbž`UV[YhÒhYh k YfXYb"

'U`h1 GW\ØhnYb`G]Y`XYb`?cfU``Yb[UfhYb`XYg'; fYUh'6Uff]Yf
FYYZ 25h`Ug'/ '6cchg'?cfU``Yb`VYghY\Yb`Ui g'HUi gYbXYb'j cb
Dc`mdYbž'X]Y`i b[`Ui V`]W\'Ya dZ]bX`]W\'g]bX

5 Wk hY b 'G]Y 'VY]a 'HUi Wk Yb']b 'F]ZZgmghYa Yb'VYgcbXYfg'XUfUi Zž Y]bYb'bYi hfU`Yb'5i Zhf]YV'ni 'ØVYbž'i bX'UWk hYb'G]Y']a a Yf'Ui Z' \Rightarrow fY: `cggYbž'i a 'XUg'5i Zk]fVY`b'j cb'GYX]a YbhYb'ni 'a]b]a]YfYb"

* "'K À\`Yb'G]Y'Y]bYb'f]ZZg]WXYfYb GcbbYbgWXi hn

8 Yf; YgYhnYbhk i fZ'j YfV]YhYh'XYb'J Yf_Ui Z'j cb GcbbYbgWki hna]hhY`bž'X]Y'X]Y'7\Ya]_U`]Yb'CI mVYbncb'i bX C Wh]bcl Uh'Ybh\U`hYbž'j cb'XYbYb'K]ggYbgWkUZh`Yf'gU[Ybž'XUgg'g]Y ni f'?cfU``YbV`Y]WkY'VY]hfU[Yb"'8]YgY'7\Ya]_U`]Yb'_ObbYb'g]Wk Ybhk]W_Y`bXY'?cfU``Yb'UVhOhYbž'X]Y'?cfU``YbV`Y]WkY'j YfghAf_Yb i bX'[YbYh]gWkY'GWkAXYb'Ub'?cfU``Yb'i bX'UbXYfYb A YYfYg`YVYk YgYb'j Yfi fgUWkYb"

A]hh`Yfk Y]`Y`[]Vh`Yg`Y]bY`k UW\gYbXY`NU\``f]ZZg]W\YfYf GcbbYbgW\i hna Uf_Ybž`X]Y`Ui Z`X]YgY`gW\ÀX`]W\Yb`\\\\\hghc ZZY j Yfn]W\hYb`i bX`gc`ni a `GW\i hn`XYg`; fYUh`6Uff]Yf`FYYZ`VY]hfU[Yb"

+ " K À\ `Yb `G]Y bUW \U`h][Y A YYfYgZfØW hY

G]Y '_ObbYb 'ni a 'GW\i hn'XYg'; fYUh'6Uff]Yf'FYYZ'VY]hfU[Ybž']bXYaG]Y 'Yhk Ug'gcf[ZÀ`h][Yf'ØVYf'X]Y '5fh'XYf'A YYfYgZfØW\hY bUW\XYb_Ybž'X]Y 'G]Y 'YggYb"', VYfZ]gW\i b[']gh'Y]b'[fc\gamma Yg'DfcV`Ya]b'XYb'K Y`ha YYfYbž']bgVYgcbXYfY']b'F]ZZgmghYa Ybž'XU\Yf']gh'X]Y J Yfa Y]Xi b['j cb'A YYfYgZfØW\hYb'Ui\gamma Yf\U`V'XYf'GU]gcb'Y]bY A O[`]W\gamma Yhž'ni '\Y`ZYb"

9g``c\bh`g]W\ž'5i ghfU`]Ybg`@Y]hZUXYb`ZØf`bUW\\U`h][Y A YYfYgZfØW\hY`ni ``YgYbž'i a \rightarrow bYb`ni '\Y`ZYbž'Y]bY`Zi bX]YfhY 5i gk U\``Ub`A YYfYgZfØW\hYb`ni 'hfYZZYb"

, "'CXYf'[Uf'_Y]bY'

 $G]Y _ObbhYb `bc WX `Y]bYb `GWX f]hh`k Y]hYf`[Y\Yb`i bX : `Y]gWX`i bX :]gWX `[Ubn`Ui g` \Rightarrow fYf`9fb\A\fi b[`ghfY]WXYb"`9]bY`_Øfn`]WX Xi fWX [YZØ\fhY`Ghi X]Y``Y[h`bU\Yž`XUgg`X]Y`JYfa Y]Xi b[`j cb : `Y]gWX`i bX`A]`WXdfcXi _hYb`XYf` [fO`> hY`9]bnY`k Y[`]ghž`i a `\Rightarrow fY I a k Y`hUi gk]f_i b[Yb`Ui Z`XYb`D`UbYhYb`ni `fYXi n]YfYb"$

9]bY'j Y[UbY'9fbÀ\fi b[']gh'k U\fgW\Y]b`]W\'XYf'[fÒ» hY'K Y[ž'i a \Rightarrow fY'5i gk]f_i b[Yb'Ui Z'XYb'D`UbYhYb'9fXY'ni 'fYXi n]YfYbž'b]W\h bi f'HfY]V\Ui g[UgYž'gcbXYfb'Ui W\'[`cVU'Y'J YfgUi Yfi b[ž 9i hfcd\]Yfi b[ž'@UbXbi hni b['i bX'K UggYfj YfVfUi W\"'9g']gh k Y]hUi g'[fÒ» Yfž'U`g' \Rightarrow fY': `Ø[Y'Y]bni gW\fÀb_Yb'cXYf'Y]b 9`Y_hfcUi hc'ni '_Ui ZYb'' ' \approx gYd\'DccfYž'I b]j Yfg]hm'cZ'C I ZcfXž'I ?

- "'? Ui ZYb 'G]Y '_Y]bY '? cfU``YbdfcXi _hY

GWX`]Y»`]WX`hfÀ[h'XYf'?Ui Zj cb'?cfU``YbgWXa i W_'i bX'UbXYfYb 5fhYb'j cb'?cfU``Yb!Gci j Yb]fg'bi f'ni a 'FØW_[Ub['XYf ?cfU``YbgmghYa Y'Ui Z'XYf'[UbnYb'K Y`h'VY]"'J Yfa Y]XYb'G]Y'X]YgY DfcXi _hYž'i a 'XUg'; fYUh'6Uff]Yf'FYYZ'ni 'gWXØhnYb" @cbY`m'D`UbYh'5i ghfU`]U']gh'Y]b'i a ZUggYbXYf'FY]gYZØ\fYf'ZØf'XUg @UbXž']XYU`'ZØf'X]Y'Yb][Ybž'X]Y'gckc\`'X]Y'k]W\h][ghYbGY\Ybgk ØfX][_Y]hYb'Yf_i bXYb'U`g'Ui W\'kYb][Yf'VYZU\fYbYGhfU»Yb'bY\aYb'a ÒW\hYb"

@Y]hV]`X.~5h`Ug~/~6cchg

.

8 Y hU]`c

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