

GWXihn'jcf'?YiWX\ighYb.'GhY][YbXY':À``Y [YZÀ\fXYb'6UVmg'ibX'F]g]_cdUh]YbhYb

9bhXYW_YbG]YX]Y'U`Ufa]YfYbXYb'8UhYb'nia'5bgh]Y['XYf?Yi W\\ighYbYf_fUb_i b[Yb']b'8Yi hgW\`UbXž'a]h'ØVYf%-"\$\$\$: À``Yb'V]g'C_hcVYf'&\$&("'9fZU\fYb'G]Y'j cb'8f": Y`]I;]YVY`ž'k Ufia'X]YgY'\DZY_h]cbg_fUb_\Y]hž'j cf'U``Ya'ZØf6UVmg'i bX'J cfYf_fUb_hY'[YZÀ\f`]W\']ghž'i bX'k Y`W\Y'Fc``Y\DX'i b[ga Ò[`]W_Y]hYb'gd]Y`Yb"GW\ØhnYb'G]Y'g]W\'i bX'\DX\'i b[ga Ò[`]W_Y]hYb'gd]Y`Yb"







5`Ufa gh]a a i b[']b '8 Yi hgW\ `Ub X $^{\circ}$ 8]Y '? Yi W\\i ghYb Z\ ``Y ghY][Yb 'i bUi Z\ Of`]W\ 'Y]bY 'VYXfc\ `]W\ Y 'G]hi Uh]cbž X]Y 'g]W\ VYfY]hg 'ni 'Y]bYa 'a Ugg]j Yb '; Ygi bX\Y]hgf]g]_c 'Ybhk]\ \w_Y\ `h\Uh'\\, \VYf'\%-\"\$\$\$ '9f_fUb_i b[Yb 'k i fXYb 'V]g 'C_hc VYf' \&\$&(j YfnY]W\ bYhž'i bX 'X]Y 'NU\ `Yb 'k UW\ gYb 'k Y]hYf $^{\circ}$ \=a 'J Yf[`Y]W\ 'XUni [UV 'Yg 'nk]gW\ Yb '\&\$\%' i bX '\&\$\%-\ '\A\f\]W\ 'Xi fW\ gW\ b]hh\]W\ 'bi f Yhk U'\%\"&\$\\$':\ \A\``Y''\8]Y '`YhnhYb '\\J\fY3'Bi f'X\ØfZh][Y''\ "('\ \&:\ \A\``Y']a [YgUa hYb '\\J\f\ \&\$\&'\ 'K Ug'ghY\\W_h\\]bhYf'X]YgYa \VYgcf[b]gYffY[YbXYb '\5bgh]Y[3

?Yi W\i ghYbž'Ui W\`VY_Ubbh'U`g'DYfhi gg]gž']gh'Y]bY`\cW\]bZY_h]ÒgY 5hYa k Y[gYf_fUb_i b[ž'X]Y'j cfk]Y[YbX'Xi fW\`XUg'6U_hYf]i a 6cfXYhY``U'dYfhi gg]g'Ui g[Y`Ògh'k]fX"'8Yf'BUa Y'gY`Vgh'`Y]hYh'g]W\Ui g'XYa '@UhY]b]gW\Yb'UV'i bX'VYXYi hYh'gc'j]Y`'k]Y' ghUf_Yf

<i ghY b "'8]YgYf'VY``YbXYž'ei À`YbXY'<i ghYb'_Ubb'K cWXYb
Ub\U`hYb'i bX']gh'XUg'a Uf_UbhYghY'Gma dhca 'X]YgYf
\Y]a hØW_]qWXYb'?fUb_\Y]h"</pre>

8]YI fgUWXYb ZØf XYb 5bgh]Y[

 $8f'': Y`]I ;]YVY`ž'7 \YZUfnh'XYf'?fUb_Yb \Ui g\m[]YbY`Ua `< Y`]cg \\ I b]j Yfg]hAhg_`]b]_i a `K i ddYfhU`ž'\Uh'X]Y`U`Ufa]YfYbXYb`NU\`Yb i bhYf'X]Y`@ dY`[Ybca a Yb''`9f'g]Y\h'a Y\fYfY`; fØbXY`ZØf'X]YgYb XfUa Uh]gW\Yb`5bgh]Y[.` K]f'Yf'YVYb`Y]bYb`5i Z\c`YZZY_h'bUW\`XYf 7cfcbU!DUbXYa]Y''`K A\fYbX`XYf'@cW_Xck bg'j Yfa]YX`a Ub`XYb ?cbhU_hz'k cXi fW\X]Y`5bghYW_i b[Yb`XfUgh]gW\`ni fØW_[]b[Yb'' $\fYhnh`\c`Yb`g]W\X]Y`4bZY_h]cbYb`ei Ug]'bUW\` "$

Ni gàhn`]WX 'ghY``h';]YVY``ZYgh.' GY`Vgh'VY]'\c\Yf'=a dZei chY'_ca a h Yg']b'9i fcdU'U``Y'XfY]'V]g'ZØbZ'\J\fY'ni 'Y]bYa '5bgh]Y['XYf DYfhi gg]gnU\`Yb"'9g']gh'k U\fgWXY]b`]WX\Z'XUgg'Ui WX'XUg']a _ca a YbXYb'\J\fY]bY'Fc``Y'gd]Y`Yb'k]fX" 'Ni XYa '_ObbhY'X]Y j YfVYggYfhY'8]U[bcgh]_'Xi fWX'D7F!HYghg'XUni 'ZØ\fYb\Z'XUgg'\Yi hY a Y\f': À``Y'YfZUggh'k YfXYb'U`g']b'XYf'JYf[Ub[Yb\Y]h"

9a U]`°

; $YZU\f'Z\emptysetf'6UVmg'ibX'JcfYf_fUb_hY$

8]Y'[fÒ» hYb'JYf`]YfYfg]bX'X]Y'>Øb[ghYb°'6YgcbXYfg
[YZÀ\f`]WX'k]fX'Yg'ZØf'GÀi[`]b[Y'ibhYf'gYWXg'AcbUhYbž'X]Y'cZh
_Y]bY'hmd]gWXYb'GmadhcaY'nY][Yb"'GhUhhXYggYb'Xfc\Yb']\bYb
'YVYbgVYXfc\`]WXY'5hYagh]``ghÀbXY°' 9g'_caah'ni
?cad`]_Uh]cbYbž'X]Y']a'?fUb_Yb\Uig']bhYbg]jaYX]n]b]gWX
VY\UbXY`h'kYfXYb'aØggYbž'kUfbh'XYf'9IdYfhY''
<]fbgWXÀX][ib[Yb'XifWX'GUiYfghcZZaUb[Y`'_ObbYb'[fUj]YfYbXY:c`[Yb'\UVYb''Y]bY'gWXcW_]YfYbXY'FYU`]hÀh°

8 Ug'F]g]_c']gh'VYgcbXYfg'\cW\'ZØf'i b[Y]a dZhY'GÀi [`]b[Y'gck]Y: fØ\[YVcfYbY'cXYf'?]bXYf'a]h'5hYa kY[gYf_fUb_i b[Yb'k]Y
5 gh\a U"'<Ài Z][Y': c`[YYf_fUb_i b[Yb'g]bX'@ b[YbYbhnØbXi b[Yb'bhnØbXi b[Yb''GY`hYbž'UVYf'a Ò[`]W\'g]bX'gc[Uf

 $8]Y `[ihY'BUWKf]WKh `?YiWK ighYb `]gh'VY \setminus UbXY`VUf``A]h'5bh]V]ch]_Uk]Y `7`Uf]h \setminus fca mW]b `cXYf'5n]h \setminus fca mW]b `_Ubb `X]Y `=bZY_h]cb `YZZY_h]j VY_Aa dZh'k YfXYbž'j cfUig[YgYhnhž'X]Y `6Y \ UbX`ib[`VY[]bbh fYWKhnY]h]["'8]Y `5bghYW_ib[gZ\A\][_Y]h'_Ubb `UiZ'Z\ØbZ'HU[Yjh_\Øfnh'k YfXYbž'k Ybb `X]Y `H\YfUd]Y `Zf\Ø\nY]h][`Y]b[Y`Y]hYh'k]fX ž Yf`AihYfh';]YVY`"$

8]Y = dZi b[']gh'XYf'GW\ `ØggY``ni f'DfÀj Ybh]cb "G]Y 'V]YhYh'Y]bYb gc `]XYb 'GW\ i hn'j cf'gW\ k YfYb '?fUb_\Y]hgj Yf`Ài ZYbž'Ui W\ k Ybb [Y]a dZhY 'DYfgcbYb 'XYb '9ffY[Yf'k Y]hYf\]b 'ØVYfhfU[Yb'_ObbYb" A]h'ØVYf'-\$'DfcnYbh'=\alpha dZei chY'i bhYf'? `Y]b_]bXYfb'_Ubb'a Ub YfZfYi `]W\ Y'NU\ `Yb'j cfk Y]gYbž'UVYf'X]Y = dZa = ØX][_Y]h'VY] 9fk UW\ gYbYb']gh'Y]b 'Yfbghni bY\a YbXYg'DfcV`Ya "' 8]Y'=\alpha dZi b[gc``hY'Ui Z[YZf]gW\ h'k YfXYbž'i a 'g]W\ 'gY`Vgh'i bX'[YZ\\ \fXYhY DYfgcbYb'ni 'gW\ ØhnYb ž'UddY``]Yfh'XYf'5fnh"

±0.5bVYhfUW\hiX]YgYf'VYXfc\`]W\Yb'G]hi Uh]cb']gh'<UbXY`b'[YZfU[h°8]Y'; Ygi bX\Y]hgVY\ÒfXYb'a ØggYb'Yhnh'U``Y'5bghfYb[i b[Ybi bhYfbY\a Ybž'i a 'X]Y'JYfVfY]hi b['j cb'?Yi W\\i ghYbY]bni XÀa a Yb'i bX']bgVYgcbXYfY'X]Y'[YZÀ\fXYhYb'; fi ddYb'ni gW\ØhnYb°

<Y`]cg' '9]b'U_h]j Yf'; Ygi bX\Y]hgX]Ybgh`Y]ghYf.'<Y`]cg']gh
b]W\h'bi f'Y]b'; Ygi bX\Y]hgX]Ybgh`Y]ghYfž'gcbXYfb'Y]b
GW\`ØggY`U_hYi f']a'; Ygi bX\Y]hggmghYa'a]h'ØVYf'%&+"\$\$\$
A]hUfVY]hYbXYb'i bX', \$'?`]b]_Yb']b'8Yi hgW\`UbX"'=a'*\J\f'&\$&'
Yfn]Y`hY'XUg'I bhYfbY\a Yb'ØVYf'%&'A]``]UfXYb'9i fc'I a gUhn"'A]h
Y]bYa'_`UfYb': c_i g'Ui Z'\c\Y'a YX]n]b]gW\Y'Ei U`]h\h'i bX
HfUbgdUfYbn'\Uh'<Y`]cg'g]W\'XYa'GW\i hn'XYf'; Ygi bX\Y]h'XYf
6Yj O` Yfi b['i YfgW\f]YVYb"</pre>

: Øf:: fU[Yb'cXYf' \pm bZcfa Uh]cbYb'ghY\h' \pm bYb' \pm bYg'6U`_ck ž DfYggYgdfYW\Yf]b'VY]'< Y`]cgž'[YfbY'ni f'JYfZØ[i b[.'HY`YZcb.'Ž(-%) &) (++, (') ž'9!A U]`.'dfYggY4\Y`]cg![Ygi bX\Y]h"XY"

8 Y hU]`c

6Ygi WXYb G]Y i bg Ui Z. a Y]b!VYf`]b bYh