

### A ]`ZcfX`Gci bX`Ui g`E i YYbghck bž`GØX]bgY` BYi gYY`UbXg

9]b gWk bY``Yfž UVYf bØhn`]Wk Yf FY]gY ZØ\ fYf ZØf X]Y Yb][ Ybž X]Y Y]bY FY]gY j cb E i YYbghck b ni a 'A ]`ZcfX Gci bX d`UbYb" K ]Y G]Y \]Yf\Yf \_ca a Ybžk Ug G]Y Yfk UfhYhi bX ]bgd]f]YfYbXY: chc [ fUZ]Y j cb Y]bYa 'XYf gWk ÒbghYb: 'cfXY XYf K Y`h" 8 Yf j YfZØ\ fYf]gWk Y 'A ]`ZcfX Gci bX" GhY``Yb 'G]Y 'g]Wk j cfž G]Y 'ZU\ fYb 'Xi fWk 'bYV`][ Y: 'cfXYžk À\ fYbX 'YbX`cgY K UggYfZÀ``Y ni 'VY]XYb 'GY]hYb 'X]Y '?`]ddYb 'Ui g 'XYa '\$ fU \]bi bhYfghØfnYb" K Ug k ÀfYžk Ybb ']Wk '\$ bYb 'gU[ Yb 'k ØfXYž XUgg 'G]Y 'X]YgY GnYbYb 'a ]hYf`YVYb \_ObbhYbž ]bXYa 'G]Y ']b Y]bYb 'gWk bY``Yb '6i g j cb 'E i YYbghck b 'bUWk 'A ]`ZcfX 'Gci bX gdf]b[ Yb3' \D`X]YgYa '@Y]hZUXYb 'a OWk hY ]Wk '\D`Yb Yb' VY] 'XYf D`Ubi b[ '\D`Xf Yf FY]gY 'ni a 'A ]`ZcfX 'Gci bX \\Y`ZYbž']bXYa ']Wk \\ / Ua d\XY``]d/

9]b 'gW\ bY``Yfž'UVYf'bØhn`]W\ Yf'FY]gYZØ\ fYf'ZØf'X]Y Yb][ Ybž'X]Y 'Y]bY FY]gY'j cb'Ei YYbghck b'ni a 'A]`ZcfX'Gci bX'd`UbYb"'K]Y'G]Y \]Yf\Yf'\_ca a Ybž'k Ug'G]Y'Yfk UfhYh'i bX']bgd]f]YfYbXY': chc[ fUZ]Y j cb'Y]bYa 'XYf'gW\ ObghYb': 'cfXY'XYf'K Y`h"

8 Yf'j YfZØ\fYf]gW\Y'A ]`ZcfX`Gci bX"'GhY``Yb`G]Y`g]W\'j cfž`G]Y`ZU\fYb
Xi fW\'bYV`][Y': ^cfXYž'k À\fYbX`YbX`cgY`K UggYfZÀ``Y'ni 'VY]XYb
GY]hYb'X]Y'?`]ddYb'Ui g'XYa '\$\f\U'\]bi bhYfghØfnYb"'K Ug'k ÀfYž
k Ybb']W\'\=\bYb'gU[Yb'k ØfXYž'XUgg'G]Y'X]YgY'GnYbYb'a ]hYf`YVYb
\_\ObbhYbž']bXYa 'G]Y']b'Y]bYb'gW\bY``Yb'6i g'j cb'Ei YYbghck b
bUW\'A]`ZcfX'Gci bX'gdf]b[Yb3

#### K ]Y \_ca a h a Ub ni a A ] ZcfX Gci bX3

8]YYb][Yb'a]h'Y]bYa 'J Ub'cXYf': U\fnYi ['\_ObbYb'X]fY\_h'ni a Gci bX'ZU\fYb"'G]Y'a ØggYb'YXcW\'i a 'XYb'@U\_Y'HY'5bUi '\Yfi a i bX'Xi fW\'BUh]cbU'dUf\_g'ZU\fYb"'8]Y': U\fh']gh'ZUgh'&) \$'\_a '`Ub[i bX'G]Y'k YfXYb'Ui Z'YXYb': U``'ZØf'a Y\fYfY': chc[Y`Y[Yb\Y]hYb Ub\U`hYb'k c``Yb"

G]Y'dUgg]YfYb'; `YhgWXYfž'K UggYfZÀ``Yž'5i gg]WXhgdi b\_hY'i bX Yd]gWXY'K UbXYfa Ò[`]WX\_Y]hYb"'8]YgYf'HY]``BYi gYY`UbXg'ZØ\`h g]WX'Ubž'U`g'k ÀfY'Yf'X]fY\_h'j cb'XYf'@Y]bk UbX'[Y\_ca a Yb"'9g XUi Yfh'i b[YZÀ\f'('Ghi bXYb'a]h'XYa '5i hcž'i a 'A]`ZcfX'Gci bX'j cb E i YYbghck b'Ui g'ni 'YffY]WXYb"'K Ybb'G]Y']\b'U`gc'Ui Z'Y]bYa HU[YgUi gZi ['gY\Yb'a ÒWXhYbž'gc``hYb'G]Y'VYggYf'ZfØ\Ui ZVfYWXYb"

GcVU`X'G]Y']a 'A ]`ZcfX'Gci bX'J ]g]hcf'7YbhfY'Ub\_ca a Ybž'\_ÒbbYbG]Y'X]Y'7\UbWY'bi hnYbž'g]W\'Y]bYb'D`Uhn'Ui Z'XYb'[ YgW\ÀZh][ Yb6cchYb'ni 'Yf[ UhhYfbž'cXYf'Y]bZUW\' $\Rightarrow$ f'H]w\_Yh']a 'JcfUi g'cb`]bY Vi W\Yb"

 $6 YghYf`DfY]g`ZØf`Y]b`?fYi nZU\backslash fhh]W\_Yh.`DfY]g`dfØZYb$ 

5`hYfbUh]j '\_ObbYb'G]Y'Y]bY'[UbnhÀ[][Y'?ca V]bUh]cb'Ui g'6i g'i bX ?fYi nZU\fh'VY]'; Yh'Mci f'; i ]XY'Vi W\Ybž'XYf'[Øbgh][ghYb'i bX'Ua VYghYb'VYk YfhYhYb'Hci f'ni a 'A]`ZcfX'Gci bX'j cb'Ei YYbghck b Ui g"

6YghYf'DfY]g'ZØf'Y]bYb'HU[YgUigZi['a]h'6ig'ibX'?fYinZU\fh DfY]g'dfØZYb

 $5i \text{ } \text{Y} \text{f} \text{X} \text{Y} \text{a} . \text{`J} \text{Y} \text{f} \text{d} \text{U} \text{g} \text{g} \text{Y} \text{b} \text{`G} \text{]Y} \text{`b} \text{]W} \text{h'a} \text{Y} \text{]b} \text{Y} \text{b} \text{`E} \text{ i} \text{Y} \text{b} \text{ghck} \text{b} \text{!} \text{F} \text{Y} \text{]g} \text{Y} \text{Z} \text{\emptyset} \text{\f} \text{Y} \text{f} \text{i} \text{b} \text{X} \text{'a} \text{Y} \text{]b} \text{Y} \text{b} \text{`I} \text{b} \text{h} \text{Y} \text{f} \text{\_i} \text{b} \text{Z} \text{h} \text{g} \text{Z} \text{\emptyset} \text{\f} \text{Y} \text{f} \text{`Z} \text{\emptyset} \text{f} \text{$\text{f} \text{Y} \text{b} \text{`I} \text{b$ 

5a 'VYghYb'cf[Ub]g]YfhY'HU[YgUigZ`Ø[Y'nia A]`ZcfX'GcibX'jcb'EiYYbghckb'a]h'XYa 8]Y Yb][Ybž'X]Y 'b]W\h'XYb'@Iig'Y]bYg'Y][YbYb'HfUbgdcfha]hhY`g\UVYbž'\_ObbYb'Y]b'A]`ZcfX'GcibX!DU\_Yh'jcb'EiYYbghckbYfkYfVYb"'9g'[]Vh'\_Y]bYb'AUb[Y`Ub'FY]gYjYfUbghU`hYfbž'X]YaY]ghYb'V]YhYb'À\b`]W\Y'DU\_YhY'Ubž'X]Y'cZh'X]YgY`VY'6cchgZÀ\fYUa': ^cfX'bY\aYb'fA]`ZcfX'GcibX']gh'Y][Ybh`]W\'Y]b': ^cfXž'\_Y]bGcibXŁ"

 $8 \ Y \ f' < Ui \ dhi \ bh Y \ fg W \ ] \ Y \ X' \ k \ ] \ fX' \ XY \ f' \ 6 i \ g' g Y \ ] \ b \ Z \ Y \ f' \ G \ ] \ Y' \ X' \ b \ Y \ b \ Y \ b \ Y \ b \ Y \ b \ Y \ b' Y \$ 

5VYf'i a '=\bYb'XUg'JYfXcddY`b'ni 'YfgdUfYbž']bXYa 'G]Y'X]YgY`VY FY]gY'ØVYf'Y]bYb'hYi fYfYb'A]hhY`ga Ubb'Vi WXYbž'j Yf`]b\_Y']WX i bhYb'Ui Z'X]Y'VYghYb'a]h'XYb'VYghYb'DfY]gYb" U`h1 A]`ZcfX'Gci bX'K UggYfZU``'Ui Z'Y]bYa 'HU[YgUi gZi ['j cb Ei YYbghck b 2 ; Øbgh][ghY'?ca V]bUh]cb'Ui g'6i g'i bX'?fYi nZU\fh'%+-'`

 $8 ] Yg'] gh'X] Y'Hci fž'X] Y'] WX'[YVi WX h'\UVYž'U`g'] WX'ni a 'YfghYb'A U`a Y] bY'FY] gY'j cb'Ei YYbghck b'bUWX'A ]`ZcfX'Gci bX'cf[Ub]g] YfhY f] WX'V] b'gY] hXYa 'a Y\fa U`g'i bUV\Àb[]['ni f<math>\emptyset$ W\_[Y\_Y\fh\t''8] Y FY] gY'k ] fX'j cb'FYU``&i fbYmg'Xi fWX [YZ $\emptyset$ \fh\t'XYf'VY`] YVhYghYb'i bX [ $\emptyset$ bgh] [ghYb'Cdh] cb'Z $\emptyset$ f'X] YYb] [Yb\t'X] Y'c\bY': U\fnYi ['] b Ei YYbghck b'Ubg\Agg] ['g] bX''

 $6]g```Yi``hY``k @fXY`]W\``X]YgY``Cdh]cb``XYb``a Y]ghYb``FY]gYbXYb Ya dZY``Ybž``XU``X]Y``FY]gY``j ]Y```V]```][ Yf`]gh``U``g``X]Y``a Y]ghYb``UbXYfYb'' 8 Uf@VYf``\]bUi g``\à``h`XYf``6i g``Ub``Y]b][ Yb``a U``Yf]gW\Yb``CfhYb``]a : ^cfX``UbX!BUh]cbU``dUf_ž`i a ``g]W\``X]Y``6Y]bY``ni ``j YfhfYhYb``i bX``X]Y Yd]gW\Yb``GY\Ybgk @fX][ _Y]hYb``XYf``FY[ ]cb``ni ``gY\Yb''$ 

 $?Y]b[fiddYb!JUb7?fYinZU\fh.&&.$ 

: Øf`X]Y Yb][ Ybž`X]Y`X]Y`GW\ Ob\Y]h`XYg`: ^cfXg`VY]`Y]bYa
HU[ YgUi gZi [ 'j cb`E i YYbghck b`Ui g`Yf`YVYb`a OW\hYbž`c\bY`g]W\
k ]Y`Y]b`Hci f]gh`ni 'ZØ\`Ybž`]gh`X]Yg`Y]bY`[ fc» Ufh][ Y`Cdh]cb"'8]YgY

 $?`Y]b[fiddYbhcifYb`kYfXYb'jcb`$J\f`ni`$J\f`VY`]YVhYf'ibX`V]YhYbY]b'dYfg\donormal{Ob}`]WXYfYg'9f`YVb]g''$ 

 $8 ]Y Y d]gWX ghY C dh]cb. < U`VhA [][Yf'<Y`]_cdhYfZi [...8Yf'DfY]g j Uf]]Yfh'Y'bUWX GU]gcbž'_`]W_Yb'G]Yž'i a 'X]Yg'ni 'ØVYfdfØZYb''$ 

 $: \varnothing f^*X]Y \Upsilon b][Yb^*ibhYf^* \Rightarrow bYb\check z^*X]Y^*A]^*ZcfX^*GcibX^*a]h^*Gh]^*gY^Yb^*ibX^* = \Delta f^*Y]bYb^*HU[^*]b^*Y]bYa^*6ig^*jYfgWkYbXYb^*a \( \Delta W hYb\check z^* = \Delta b hY^*X]Yg \\ \Rightarrow f^*H]W_Yh^*gY]b^*'8]YgY^*Cdh]cb^*]gh^*Y]b^*Yd]gWkYg^*\U^*VhA[^*][Yg \\ 5VYbhYiYf^*UV^*EiYYbghckb^*z^*XUg^*G]Y^*a]h^*XYa^*< Y^*]_cdhYf^*\varnothing VYf^*X]Y^*: ]cfX^*UbX!6Yf[Y^*Z\Delta hYf^*\Delta VY]b^*\U^*hYh^*UiW^*Y]bY^*?fYinZU^*fh^*ibX^*Y]bYb^*< Y^*]_cdhYf^*bUWk^*EiYYbghckb^*U^*hYh^*UiWk^*Z^*]a^*A]^*ZcfX^*GcibX^2$ 

#### 9]bY 6cchgZU\fh Xi fW A ] ZcfX Gci bX

Nk Y]ZY``cg`\UVYb'6Ygi W\Yf'j ca '8YW\_'Y]bYg'XYf'j ]Y`Yb ? fYi nZU\fhgW\]ZZY'Ui g'X]Y'VYghY'5i gg]W\h'Ui Z'XYb'A ]`ZcfX'Gci bX" K Ybb'G]Y'X]Y'cVYb'[YbUbbhYb'HU[YgUi gZØ[Y'i bhYfbY\a Ybž']gh X]Yg']bVY[f]ZZYb"'K Ybb'G]Y'YXcW\=fYb'Y][YbYb'HfUbgdcfh'j cb Ei YYbghck b'ni a 'A ]`ZcfX'Gci bX'\UVYbž'gY\Yb'G]Y'g]W\'i bhYb'X]Y Cdh]cbYb'ZØf'X]Y'VYghYb'6cchgZU\fhYb'Ub"

DfYa ]i a !?fYi nZU\fh'Ui Z'Y]bYa '; `UgXUWX!?UhUa UfUb.'+\*'`

 $8 ] YgYg`]gh`XYfnY]h`fUVUhh]Yfh`i bX`gY\f`VY`]YVhž`XU`Yg`bi f`k Yb][ hYi fYf`]gh`U`g`X]Y`[ fÒ» YfYb`Hci f]ghYbVcchY"`K Ybb`G]Y`bUW\`Y]bYa DfYa ]i a !9f`YVb]g`Ui Z`A ]`ZcfX`Gci bX`ni `Y]bYa `[ Øbgh][ Yb`DfY]g gi W\Ybž`]gh`X]Yg`<math>\Rightarrow$ fY`VYghY`K U\`"

BUhi f\_fYi nZU\fh. \*\* - \*\*

8]YgY'?fYi nZU\fh'k]fX'j cb'FYU`'&i fbYmg'Ub[YVchYbž'XYf'k c\` VY`]YVhYghYb'6cchgcdh]cb'Ui Z'A]`ZcfX'Gci bX"'8]YgYf'DfY]g'[]`h'bi f ZØf'X]Y'6cchgZU\fhž'G]Y'a ØggYb'U`gc'gY`Vgh'\]Yf\Yf'ZU\fYb"

K À\fYbX'G]Y'XYb': 'cfX'\]bi bhYfZU\fYbž'k YfXYb'G]Y'NYi [ Y Y]b][ Yf'Yd]gW\'hcgYbXYf'K UggYfZÀ``Yž'k]`XYf'FcVVYbž'X]Y'g]W\'Ui Z

XYb: Y`gYb`gcbbYbži bX`XYg`VYfØ\a hYb`A]hfY`DYU\_ž`XYf`Xi fW\X]Y`K c`\_YbXYW\_Y`fU[h"U`h1 2 U`h1 YbhgdUbbh`g]W\`VY]`A]`ZcfX`Gci bX 2

J9FK5B8H9'DCGH." \*'VYghYb'5\_h]j]hÀhYb']b'EiYYbghckbž BYiqYY'UbX'

# K Ubb ']gh'X]Y 'VYghY 'F Y]gYnY]h'ZØf'X]Y : ^cfX`UbXg3'

A ]`ZcfX`Gci bX`ghY\h`bcfa U`Yfk Y]gY`Ui Z`XYf`@]ghY`XYf
a Y]ghVYgi W\hYb`GØX]bgY`b`BYi gYY`UbXg"`5VYf`[]Vh`Yg`k]f\_`]W\
Y]bY`VYghY`FY]gYnY]h`ZØf`XYb`A]`ZcfX`Gci bX3`A]h`Y]bYf
Xi fW\gW\b]hh`]W\Yb`A\f`]W\Yb`B]YXYfgW\`U[ ga Yb[ Y`j cb`ZUgh`\*) \$\$
a a `f\) &`Nc``\L`[]`h`Yg`U`g`XYf`ZYi W\hYghY`VYk c\bhY`Cfh`]b
BYi gYY`UbX"`9g`]gh`Ui W\`Y]bYg`XYf`ZYi W\hYghYb`Ui Z`XYf`[UbnYb
K Y`h°

8]Y a Y]ghYb @Yi hYžX]Y XYb A ] ZcfX Gci bX j cb E i YYbghck b Ui g VYgi WX YbžYf YVYb ni a ]bXYghY]b V]ggWXYb FY[Yb" K Ybb G]Y XUg gU[Ybžk YfXYb Y]b dUUf GWX Ui Yf Ui Z = fYf? fYi nZU\fh XYb Gi bX \ ]bi bhYf X]Y Yb][Yb VY[Y]ghYfbžX]Y XYb YbX`cgYb Ghfca hYa dcfAfYf K UggYfZA``Y a ]hYf YVYb a OWX hYb"
U`h1 A ] ZcfX!Gci bX j ca E i YYbghck b!K UggYfZU```i bX !FY[YbVc[Yb 2
K A\fYbX Yg XUg [UbnY \*J\f ØVYf n]Ya `]WX bUgg ]ghž g]bX X]Y \Y]» YghYb A cbUhY ]a `Gca a Yf j cb \*Jbi Uf V]g : YVfi Uf" = b X]YgYf NY]h \_ObbYb X]Y `HYa dYfUhi fYb V]g ni \*&+ ; fUX 7Y `g]i g YffY]WXYb" 8]Y \_Ø\ `YfYb K ]bhYfa cbUhY g]b \_Yb `Ui Z V]g ni '%) ; fUX 7Y `g]i g"

5i Z[ fi bX:XYf:VYghÀbX][ Yb:FY[ YbZÀ``Y:i bX:XYf'a À» ][ Yb:< ]hnY
[ ]Vh'Yg'\_Y]bY:VYghY:NY]hži a 'A ]`ZcfX:Gci bX:ni 'VYgi WXYb"'9g
\_ca a h'[ Ubn:XUfUi Z:Ubž'k Ug'a Ub:gY\Yb'a ÒWXhY"'=WX:dYfgÒb`]WX
VYj cfni [ Y:X]Y:: fØ\`]b[ ga cbUhY:ZØf:VYggYfY
K UbXYfa Ò[`]WX\_Y]hYb'Ui Z:XYf'GØX]bgY`"
U`h1 A ]`ZcfX!Gci bX!K UggYfZÀ``Y 2
U`h1; `YhgWXYf']b'XYb'K YghZ'cfXYb 2

## A Y\f'BYi gYY`UbX'FY]gYZØ\fYf'i bX =bgd]fUh]cb'ZØf'5VYbhYi Yf

#W. \cZZYžXUgg = bYb X]YgY ? i fnUb Y]hi b[ [YZU`Yb \Uhžk]Y G]Y
XYb A] `ZcfX Gci bX j cb E i YYbghck b Ui g Yf YVYb \_ ObbYb " K Ybb
G]Y `]b BYi gYY `UbX fY]gYb i bX a Y\f FY]gY! i bX
5VYbhYi Yf]bgd]fUh]cb Z]bXYb a OWXhYbžgWXUi Yb G]Y g]WX V]hhY
Y]b][Y a Y]bYf UbXYfYb 6 `c[!Dcghg i bhYb Ub"

'U`h1 K YgYY\_hfUj Y``D]bhYfYgh'A ]`ZcfX'Gci bX'Ui g'E i YYbghck bž BYi gYY`UbX 2

п

8 Y hU]`c

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