

9]b 5 V Y b X 'a]h 'i gh]b 'H]a V Y f`U_Y. GW k Y]bghY][Y f 'i b X 'i Ubcj]ã 'ZY]Y fb ']b A Øb W Y b

6Ugh]Ub 'GWk Y]bghY][Yf'i bX'5bU' j Ubcj]ã'[YbcggYb'Y]bYbfca Ubh]gWkYb'5VYbX'VY]' j gh]b'H]a VYf`U_Y']b'A ØbWkYb'i bXk i fXYb'dYfgÒb`]Wk'VY[fØ»h"

9]b i bj Yf[Ygg`]WXYf'5VYbX']b A ØbWXYb Ua '&%"'5i [i gh'&\$&(.'8Ug dfca]bYbhY'Gdcfh!HfUi a dUUf'6Ugh]Ub GWXk Y]bghY][Yf'i bX'5bU j Ubcj]ā [Ybcgg'Y]b '?cbnYfh'j cb 'j gh]b 'H]a VYf`U_Y']b 'XYf C`ma d]U\U``Y"'8]YgYf'5b`Ugg'Vch'Y]bYfgY]hg'Y]bYk]``_ca a YbY 5i gnY]h'ZØf'XUg'DUUfž'XUg']b 'XYf'2 ZZYbh`]WX_Y]h'cZh'U`g'6Y]gd]Y``ZØf Y]bY'[Yi b[YbY': Ua]`]YbVU`UbgY'[]`h"

6Ugh]Ub'GW\kY]bghY][YfžY]b'Y\YaU`][Yf': i » VU``dfcZ]'i bX
K Y`ha Y]ghYfžgck]Y'gY]bY': fUi ž'X]Y'HYbb]g]_cbY'5bU'\ddot Ubcj]ãž
gU» Yb']b'XYb'VYghYb'FY]\Yb'X]fY_h'j cf'XYf'6Ø\bY"'5i Z']\fYb
gcn]U`Yb'A YX]Yb'hY]`hYb'g]Y'9]bXfØW_Y'j cb'XYf'J YfUbghU`hi b['i bX
`]Y» Yb']\fYb': Ubg'k]ggYbž'k]Y'gY\f'g]Y'XYb'5VYbX'[YbcggYb"'8]Y
@Y]XYbgW\UZh'ZØf'X]Y'A i g]_'k Uf'XUVY]'ØVYfU``'gdØfVUf"
GW\kY]bghY][Yf'\UhhY'k\A\fYbX'XYg'?cbnYfhg'gY]bYb'5fa '`]YVYj c``
i a '5bU'[Y`Y[h'i bX'VY]XY'gUb[Yb'Ybh\i g]Ugh]gW\a]h"

$9]b < O \setminus Ydi b_h XYg 5VYbXg$

6YgcbXYfg'Ui ZfY[YbX'k i fXY'Ygž'U`g'¾ gh]b'H]a VYf`U_Yž'k À\fYbXYf'Y]bYb'gY]bYf'<]hg'dYfZcfa hYž'6Ugh]Ub'GWk Y]bghY][Yf']b'XYf A Yb[Y'Yf_UbbhY"'♣b'Y]bYf'gdcbhUbYb'; YghY'VY[fØ» hY'Yf'XYb:i»VU``ghUf'a]h'Y]bYa'<UbXgWk`U[ž'k Ug'ZØf'5i ZfY[i b[']aDi V`]_i a 'gcf[hY"'8]YgYg'i bYfk UfhYhY'HfYZZYb'gWk UZZhY'b]Wk h'bi fY]bY'Yb[YfY'JYfV]bXi b['nk]gWkYb'XYa'K Y`hghUf'i bX'XYa

8]Y'[Ya Y]bgUa Yb'9f`YVb]ggY'g]bX'ZØf'GW\kY]bghY][Yf'i bX

j Ubcj]āž'X]Y'gY]h'&\$%*'j Yf\Y]fUhYh'g]bX'i bX'XfY]'GÒ\bY'\UVYbž
b]W\h'bi f'Y]b'NY]W\Yb']\fYf'@]YVY'ni f'A i g]_ž'gcbXYfb'Ui W\'Y]bY
k]W\h][Y'; Y`Y[Yb\Y]hž'i a 'NY]h'ZØf'g]W\'gY`Vgh'ni 'Z]bXYb"'8Yf
5i ZYbh\U`h']b'6UmYfb'i bX'X]Y'A Ò[`]W_Y]hž'?cbnYfhY'ni 'VYgi W\Ybž
[YVYb'XYb'VY]XYb'DUUfYb'X]Y'A Ò[`]W_Y]hž'Ui W\'U`g'9\YdUfhbYf
i bX'b]W\h'bi f'U`g'9`hYfb'U_h]j 'ni 'gY]b"

K Y]hYfY a i g]_U`]gWXY 9f`YVb]ggY

8 Yf '6 Ygi W. 'VY] '* gh]b 'H]a VYf `U_Y' k Uf 'b] W. h'XUg 'Y]bn][Y a i g]_U`]gW Y '9fY][b]gž'XUg 'XUg 'DUUf']b 'X]YgYa 'Gca a Yf 'Ub`cW_hY'' '? Øfn`]W. '\UhhYb 'g]Y 'Ui W. 'Y]b '? cbnYfh'j cb '5 XY`Y']b 'A Øb W. Yb VYgi W. h'' '8]YgY '9b hg W. Y]Xi b['j YfXYi h`]W. hž'XUgg 'X]Y 'VY]XYb 'X]Y _i `hi fY``Yb '5b[YVchY']\fYf' < Y]a UhghUXh'U_h]j 'bi hnYb 'i bX'XUVY]]\fY'Y][YbYb '\DhYfYggYb']b 'X]Y : Ua]`]YbnY]h'Y]bVf]b[Yb'''9g']gh b]W. h'bi f'Y]b 'NY]W. Yb 'ZØf'X]Y 'h]YZY 'J YfV]bXi b['nk]gW. Yb']\bYbž gcbXYfb 'Ui W. 'Y]b 'gW. ObYg'6Y]gd]Y``XUZØfž'k]Y 'k]W. h]['Yg']ghž'U`g DUUf'NY]h'ZØfY]bUbXYf'ni 'gW. UZZYb''

± XYf gWkbY```YV][Yb K Y`h XYg Gdcfhg i b X XYf A i g]_žk c Fi \a c Zh j Yf[Àb[`]Wk]ghž V]YhYb X]YgY VYgcbXYfYb 5 VYbXY Y]bY k]``_ca a YbY 5 Vk YWkg`i b["'9g Yf]bbYfh XUfUbž XUgg Ui Wk GhUfg A ca YbhY XYg'; Ybi ggYg i b X XYf : fYi XY]a 'Df]j UhYb gi Wk Yb" 8]YgY '9f`YVb]ggY '_ÒbbYb Y]bYb [fc» Yb I bhYfgWk]YX a UWk Ybž VYgcbXYfg]b Y]bYf NY]hž]b XYf ÔZZYbh`]Wk Y 'J Yfd Z]Wk hi b[Yb c Zh X]Y dYfqÒb`]Wk Y 'NY]h ØVYf`U[Yfb"

$9]b 6]W_{}]b hYf X]Y ? i]ggYb$

± Y]bYfj Yf`Agg`]WXYb'?i`hi f`XYf`6Yf]WXhYfghUhhi b['ØVYf`GhUfg Z]bXYb'gc`WXYdYfgÒb`]WXYb'9]bV`]W_Y'VY]': c``ck Yfb'[fc» Yb 5b_`Ub["'G]Y'\i a Ub]g]YfYb'X]Y'[fc» Ufh][Y'K Y`h`XYg`Fi \a g'i bX V]YhYb'Y]bY'JYfV]bXi b['nk]gWXYb'XYb'Dfca]bYbhYb'i bX']\fYb 5b\Àb[Yfb"'Gc`WXY'A ca YbhY'nY][Ybž'XUgg'i bUV\Àb[]['j cb DYfgÒb`]WX_Y]h'cXYf'GdcfhUfh'X]Y'i b]j YfgY``Y'@]YVY'ni f'A i g]_ A YbgWXYb'ni gUa a YbVf]b[hii bX'XUgg'VYgcbXYfY'5VYbXY'k]Y X]YgYf'XUg'@YVYb'VYfY]WXYfb"'9g']gh'b]WXh'bi f'Y]b'k Y]hYfYg'?Ud]hY`]a '@YVYb'j cb'6Ugh]Ub'i bX'5bUž'gcbXYfb'Ui WX'Y]b'NY]WXYbž'XUggž Y[U`'k]Y'VYgWXÀZh][h'g]Y'g]bXž'X]Y'NY]h'ZØf'X]Y'Y][YbYb @Y]XYbgWX UZhYb'b'b]Y'ni '_i fn'_ca a Yb'gc``hY'"

6Yn]Y\ib[nk]gWXYb GdcfhibX Aig]_

 $8]Y'JYfV]bXib['nk]gWXYb'Gdcfh'ibX'Aig]_']gh'gY]h'`Ub[YaVY_Ubbh''5h\`YhYb'ibX'Aig]_Yf']bgd]f]YfYb'g]WX'[Y[YbgY]h]['ibX'nY][Yb'cZh'À\b`]WXY'@Y]XYbgWXUZh'ibX'<]b[UVY'ni']\fYf'?ibgh''JYfUbghU`hib[Yb'k]Y'?cbnYfhY'n]Y\Yb'b]WXh'bif'Aig]_`]YV\UVYfUbž'gcbXYfb'UiWX'Gdcfh'Yfž'X]Y'UVgY]hg']\fYf'VYfiZ]WXYbJYfdZ]WXhib[Yb'Y]bY'5ignY]h'giWXYb''8]Y'GmaV]cgY'nk]gWXYbX]YgYb'VY]XYb'6YfY]WXYb'\Uh'j]Y`Y'[YaY]bgUaY':Ubg\Yfjcf[YVfUWXhž'X]Y'gckc\``GdcfhYfY][b]ggY'U`g'UiWXAig]_cbnYfhY'VYgiWXYb''$

 $: \emptyset f'6 Ugh]Ub'GWkkY]bghY][Yf'ibX'5bU' \neq Ubcj] \tilde{a}'VYXYihYh'Y]b$ $?cbnYfhVYgiWk'b]Wkh'bif'IbhYf\U'hib[\check{z}'gcbXYfb'UiWk'Y]bY$ $; Y`Y[Yb\Y]h\check{z}'] \land fY' = \hat{b}hYfYggYb'ni'hY]`Yb''K]Wkh][Yaig] = \hat{b}gY']b'Y]bYf'GhUXh' \land [bhYf`UggYb'cZhbUWk \land U'h][Y'9]bXf\OW_Y\check{z}'X]Y']b'XYb'gcn]U`Yb'AYX]Yb'jYfVfY]hYhkYfXYb\check{z}'kc': Ubg'XUg'9f`YVb]g']b'9WkhnY]h'hY]`Yb' = ObbYb''$

GhUh]gh]_ ni f?cbnYfhVYgi WX]b 8 Yi hgWX `Ub X

?cbnYfhVYgi W.Y']b'8Yi hgW.`UbX'YfZfYi Yb'g]W.`[fc»Yf'6Y`]YVh\Y]hž i bX'X]Y'H] W_Yh_j Yf_Ài ZY'nY][Yb'Y]bYb'ghYh][Yb'5bgh]Y["'@Ui h'Y]bYf

Ghi X]Y'j cb'A i g]_]bXi ghf]Y"XY'k i fXYb']a '\\\f'&\\$&\@VYf'\%+
A]``]cbYb'?cbnYfhVYgi W\Yf'fY[]ghf]Yfhž'k Ug'Y]bYb'5bgh]Y['j cb'\%)
I ']a 'JYf[`Y]W\'ni a 'Jcf'\U\f'XUfghY``h"'8]Y'J]Y`ZU`h'XYf
Ub[YVchYbYb'5Whgž'j cb'Dcd'\@VYf'Fc_'V]g'\]b'ni '_`Ugg]g\\Yb
?cbnYfhYbž'hfÀ[h'ni f'\c\Yb'BU\\ZfU[Y'VY]"

6YgcbXYfg']b'; fc»ghÀXhYb'k]Y'A ØbWXYbž'k c'Y]bY'`YVYbX][Y?i `hi fgnYbY'\YffgWXhž'j YfnY]WXbYb'J YfUbghU`hi b[gcfhY'Y]bYb_cbghUbhYb'Ni ghfca 'j cb'6Ygi WXYfb"'8]Y'HY]`bU\a Y'Ub?cbnYfhYb'V]YhYh'b]WXh'bi f'a i g]_U`]gWXYb'; Ybi ggž'gcbXYfb'Ui WXX]Y'A Ò[`]WX_Y]hž'g]WX'a]h'; `Y]WX[Yg]bbhYb'ni 'j YfbYhnYb'i bXVYgcbXYfY'9f`YVb]ggY'ni 'hY]`Yb"

2 _cbca]gWXY 6YXYi hi b['XYf A i g]_]bXi ghf]Y

 $8]Y `A i g]_]b Xi ghf]Y `hfÀ[h `g][b]Z]_Ub h `ni f `K]fhg W `UZh `]b `8 Yi hg W `Ub X VY]" `@Ui h `X Ya `6i b X Y gj Y f V Ub X `A i g]_]b Xi ghf]Y `fb J A <math>\pm$ Y fk]fhg W UZh Y h `X]Y `6 f Ub W Y `Â\ f`]W `A]``]Uf X Y b `9i f c `i b X `V]Y h Y h h Ui g Y b X Y `j c b `5 f V Y]hg d `A hn Y b " J c b `X Y b `A i g]_Y f b `Ø V Y f `X U g h Y W \ b]g W Y `D Y f g c b U ` V]g `\]b `ni ` X Y b `J Y f Ub g h U `h Y f b `g]b X `j]Y `Y 5 _h Y i f Y `]b `X]Y g Y f `X m b Ua]g W Y b `\Delta X i gh f]Y `h A h][" `8]Y `@]j Y ! J Y f Ub g h U `h i b[Y b ž `k]Y `? c b n Y f h Y ž `gh Y ``Y b `Y]b Y b `k] W h][Y b `H Y]` X]Y g Y f `k] f h g W UZh`] W Y b `5 _h J j]h A h Y b `X U f "

A]h'XYf'Ni bU\a Y'Ub'@]j Y!9j Ybhg'i bX'Hci fbYYb'\UVYb'g]W\'Ui W\
X]Y'I a gÀhnY']a 'H]W_Yhj Yfhf]YV'Yf\O\h''J]Y`Y'?Øbgh`Yf'gYhnYb'Ui Z
Ui g[YXY\bhY'Hci fYbži a ']\fY'5`VYb'ni 'dfca chYbž'k Ug'b]W\h'bi f
a i g]_U`]gW\ž'gcbXYfb'Ui W\'k]fhgW\UZh`]W\'YbhgW\Y]XYbX']gh'''8]Y
DfÀgYbn'j cb'Gdcfh`Yfb'VY]'gc`W\Yb'9j Ybhg'i bhYfghfY]W\h'ni XYa
X]Y'_i `hi fY``Y'6YXYi hi b['XYf'A i g]_']b'XYf'; YgY``qW\UZh''

6 Ygi WX Yb 'G]Y 'i bg 'Ui Z. 'b!U["XY