

@]WX hYbZY`g`YbhXYW_Yb.'5`hghUXhž'; Ybi gg i bX'BUhi fYf`YVb]ggY

9bhXYW_Yb'G]Y'X]Y'W\Ufa UbhY'5`hghUXh'j cb'@]W\hYbZY`gž [Yb]Y»Yb'G]Y'_i`]bUf]gW\Y'<][\`][\hg'i bX'Yf`YVYb'G]Y _i`hi fY``Y'9j Ybhq'' \Rightarrow f'dYfZY_hYf'5i ZYbh\U`h'Yfk UfhYh'G]Y°



K]`_ca a Yb']b'@\W\hYbZY`gžXYf'j YfghY\w_hYb'DYf`Y'C\VYfZfUb_Ybg'\
8]YgY'\W\Ufa UbhY'GhUXhz'i a [YVYb'j cb'gUbZhYb'<\Ø[Y`b'i bX\
fY]\(YbXYb': `\ØggYbz']gh'XYf']XYU`Y'F\Ø\W_ni [gcfh'Z\Øf'U``Yz'X]Y'gck c\`\
X]Y'Fi\Y'XYf'BUhi f'U`g'Ui \W\XYb'Di `g'Y]bYf``YVYbX][Yb\\\ ; Ya Y]bg\W\UZh'gi \W\Yb''A]h']\fYf'a U`Yf]g\W\Yb'5`hghUXhz'X]Y'j cb\
nUi VYf\UZhYb': U\W\k\Yf_\Ai gYfb'i bX'\]ghcf]g\W\Yb'8Yb_a A`Yfb\
[YdfA[h']ghz'V]YhYh'@\W\hYbZY`g'Y]b'Y]bn][Ufh][Yg'9f`YVb]g'Z\Øf\\\ ; Yg\W\]\W\hg]bhYfYgg]YfhY'i bX'?i `hi fZfYi bXY'''9[U`z'cV'Xi 'Y]bYb\
[Ya \Øh`]\W\Yb'6i a a Y``Xi f\W\X]Y'GhfU\(YbXY''BUhi f'fi bX'i a 'X)Y\
@\W\Y'YbhXY\W_Yb'cXYf'X]Y'VYY]bXfi \W_YbXY'BUhi f'fi bX'i a 'X]Y\
GhUXh'Yf_i bXYb'a \O\W\hYgh'''@\W\hYbZY`g'\Uh'Z\Øf''YXYb'Yhk\Ug'ni

V]YhYb"

 $\pm b \cdot X] Y g Y a \cdot 5 f h] _ Y \cdot b Y \setminus a \cdot Y b \cdot k \cdot] f \cdot X] W \cdot a \cdot] h \cdot U i \cdot Z Y] b Y \cdot 9 b h X Y \underline{W}_i \cdot b [g h c i f X i f W X \cdot X] Y \cdot G h U X h Z \cdot V Y [`Y] h Y b \cdot X] W \cdot X i f W X \cdot X] Y \cdot ; Y g W X] W X h Y Z \cdot n Y] [Y b \cdot X] f X] Y \cdot V Y g h Y b \cdot _ i `] b U f] g W X Y b \cdot <] [\ ` `] [\ h g \cdot i \ b X \ `` U X Y b \cdot X] W \cdot Y] b Z X] Y J] Y ` n U \ `` U b \cdot _ i ` h i f Y \ `` Y b \cdot J Y f U b g h U ` h i \ b [Y b \cdot i \ b X \ : f Y] n Y] h a \ O [`] W _ Y] h Y b \cdot n i \ ` Y f ` Y V Y b \ " \ @ U g g \cdot i \ b g \cdot [Y a \ Y] b g U a \ ` X] Y G W \ A h n Y \ i \ c b \cdot @ W h Y b Z Y ` g \ Y b h X Y \ W _ Y b \ "$

9bhXYW_i b['XYf'a U`Yf]gW\Yb'5`hghUXh'j cb @]W\hYbZY`g

8]Y'5`hghUXh'j cb'@]W\hYbZY`g']gh'Y]b'k U\fYg'¾k Y`']b'CVYfZfUb_YbžXUg'Y]bY'W\Ufa UbhY'A]gW\ib['Uig'; YgW\]W\hYž'?i`hif'ibX
'YVYbX][Yf'HfUX]h]cb'V]YhYh''6Y]'Y]bYa 'GdUn]Yf[Ub['XifW\'X]Y
gW\a U`Ybž'[YdZUghYfhYb'; UggYb'k YfXYb'6Ygi W\Yf']b'Y]bY
UbXYfY'NY]h'j YfgYhnhž'k À\fYbX'g]Y'ZUgn]b]YfYbXY'6Uik Yf_Y'ibX
a U`Yf]gW\Y'D`ÀhnY'YbhXYW_Yb"

 $\label{eq:localized-state-st$

9]b'k Y]hYfYg'<][\`][\h']gh'X]Y'Gh"'A Uf]Yb'?]fWXYž'X]Y'Ui Z'Y]bY `Ub[Y'; YgWX]WXhY'ni fØ W_V '] W_h h''A]h']\fYa ']a dcgUbhYb'?]fWXhi fa ž XYf'k Y]h'ØVYf'X]Y'8ÀWXYf'XYf'5`hghUXh'\]bUi gfU[hž']gh'g]Y'Y]b a Uf_UbhYg'K U\fnY]WXYb"'8]Y'?]fWXY'VYgh]WXh'b]WXh'bi f'Xi fWX']\fY 5fWX]hY_hi fž'gcbXYfb'Ui WX'Xi fWX'X]Y'dfÀWXh][Yb'5`hÀfY'i bX'X]Y VYY]bXfi W_Y bXYb'; `UgZYbghYfž'X]Y'V]V`]gWXY'GnYbYb'XYhU]`fY]WX XUfghY``Yb"

9]b'_`Y]bYf'5VghYW\Yf'ni 'XYb'[i hYb'U`hYb': UW\k Yf_\ λ i gYfb `c\bh'g]W\ž'X]Y'Ybh`Ub['XYf'GhfU» Yb'ghY\Yb'i bX'; YgW\]W\hYb'Ui g

j Yf[Ub[YbYb '*J\f\i bXYfhYb 'YfnÀ\ `Yb"'J]Y`Y'X]YgYf' < Ài gYf'g]bX
`]YVYj c```fYghUi f]Yfh'i bX'VY\YfVYf[Yb'\Yi hY'Y]b`UXYbXY'7UZÅgž
_`Y]bY'@ÀXYb'i bX'?i bgh[U`Yf]Yb"'6YgcbXYfg'X]Y'
: UW k Yf_ghfU» Y'j Yfa]hhY`h'Y]b'VYgcbXYfYg'; YZØ\``ZØf'X]Y
; YgWX]WXhY'i bX'HfUX]h]cb'@]WXhYbZY`g'i bX'`ÀXh'ni a 'JYfk Y]`Yb
i bX'GhÒVYfb'Y]b"

9]b'hc``Yg'9f`YVb]g']gh'XYf'6Ygi WX 'XYg'@]WX hYbZY`gYf
GWX`cgghi fa ž'XYf'a]h'gY]bYb'ØVYf'' \$'A YhYfb'<Ò\Y'Y]bYb
Ui g[YnY]WXbYhYb'6`]W_'ØVYf'X]Y'[YgUa hY'GhUXh'i bX'X]Y
i a `]Y[YbXY'@UbXgWXUZh'V]YhYh''8]Y'ghY]`Yb'Ghi ZYb'_ÒbbYb'Y]bY
_`Y]bY'<YfUi gZcfXYfi b['XUfghY``Ybž'UVYf'X]Y'5i gg]WXh'k]fX'X]Y
A Ø\Y'gWXbY``'VY`c\bYb'''9g']gh'Ui WX']bhYfYggUbh'ni 'k]ggYbž'XUgg
XYf'Hi fa 'i fgdfØb[`]WX'U`g'HY]`'Y]bYf'6YZYgh][i b[gUb`U[Y'YfVUi h
k i fXY"

 $B\ UhOf`]W\ gd]Y`h`X]Y`B\ Uhi\ f`Y]bY`[fc > Y`Fc``Y`]b`@]W\ hYbZY`g"`8]Y \\ 5`hghUXh``]Y[h`X]fY_h`Ub`XYf`FY[b]hnž`Y]bYa`a U`Yf]gW\Yb`:`i ggž XYf`g]W\ dYfZY_h`ZOf`YbhgdUbbhY`GdUn]Yf[Àb[Y`Ub`gY]bYb`I ZYfb UbV]YhYh"`8]Y`Ui g[YnY]W\bYhYb`FUX!`i bX`K UbXYfk Y[Y`Ybh`Ub[XYg':`i ggYg`g]bX`]XYU``ZOf`Y]bYb`: Ua]`]YbUi gZ`i [`cXYf`Y]b fca Ubh]gW\Yg`D]W_b]W_"$

8]Y'5`hghUXh']gh'b]W\h'bi f'Y]b'Cfh'j c``Yf'; YgW\]W\hY'i bX'?i`hi fž gcbXYfb'Ui W\'Y]b'`YVYbX][Yf'HfYZZdi b_h"'@c_U`Y'; YgW\ÀZhYž [Ya Øh`]W\Y'; Ugh\Ài gYf'i bX'cf][]bY``Y'6ci h]ei Yb'`UXYb'XUni 'Y]bž XUg'j c``Y'GdY_hfi a 'XYf'Zf\Ab_]gW\Yb'; UghZfYi bXgW\UZh'ni [Yb]Y»Yb"'9]b'6Ygi W\']b'Y]bYa 'XYf'hfUX]h]cbY``Yb'K]fhg\\Ai gYf']gh Y]b'A i ggž'i a 'X]Y'fY[]cbU`Y'?ØW\Y'ni 'dfcV]YfYb"

 $6 YgcbXYfg`Yfj cfni YVYb`]gh`X]Y`FY[]cbU`Yg`< UbXk Yf_ž`XUg`]b @]WkhYbZY`g`Y]bY``Ub[Y`HfUX]h]cb`\Uh"`<]Yf`k YfXYb`_i bghj c`` [YZYfh][hY`DfcXi _hYž`k]Y`n"6"`X]Y`VYfØ\a hYb`@]WkhYbZY`gYf ?cfVk UfYbž`Ub[YVchYbž`X]Y`g]Wk`]XYU``U`g`Gci j Yb]f`Y][bYb"`8]Yg g]bX`b]Wkh'bi f`DfcXi _hYž`gcbXYfb`Ui Wk`?i bghk Yf_Yž`X]Y`X]Y \UbXk Yf_`]WkYb`: Å\][_Y]hYb`XYf`9]b\Y]a]gWkYb`nY][Yb"$

 $8] Y `5 `hghUXh'j cb'@] W hYbZY `g'V] YhYh'Y] b Y'dYfZY_hY'?i`] ggY'ZØf$

: chc[fUZYb"'8]Y'A]gW\ib['Uig'hfUX]h]cbY``Yf'5fW\]hY_hifz [YdZ'UghYfhYb'GhfU»Yb'ibX'V`Ø\YbXYb'6`iaYbVYYhYb'gcf[h'ZØf j]Y`Y'[fc»Ufh][Y'Ach]jY"'9[U`ž'cV'aUb'Y]b'DfcZ]!:chc[fUZ']gh'cXYf Y]bZUW\ibif'a]h'XYa'GaUfhd\cbY'Y]b'dUUf'gW\ObY GW\bUddgW\ØggY'aUW\Yb'aOW\hYž'X]Y'5hhfU_h]j]h\h'XYf'5`hghUXh k]fX'b]W\h'Ybhh\higW\Yb"

±b '@|W\ hY b ZY `gž'k c 'HfUX]h]cb 'Ui Z'A c XYfbY 'hf]ZZhž'[]Vh'Yg']a a Yf Yhk Ug'B Yi Yg'ni 'YbhXYW_Yb"'9]b '6i a a Y`'Xi fW\'X]Y '5`hghUXh']gh Y]b 'i bj Yf[Ygg`]W\ Yg'9f`YVb]gž'XUg'gck c\`'9]b\Y]a]gW\Y'U`g'Ui W\ 6Ygi W\Yf'VY[Y]ghYfh"'9g']gh'b]W\ h'bi f'XYf'C fhž'i a 'X]Y'; YgW\]W\ hY ni 'VYk i bXYfbž'gcbXYfb'Ui W\'Y]bY'A Ò[`]W_Y]hž']b'X]Y'\Yfn`]W\Y ; Ya Y]bgW\UZh'X]YgYf'ZfÀb_]gW\Yb'GhUXh'Y]bni hUi W\Yb"

: Øf`k Y]hYfY`±bZcfa Uh]cbYb`ni `@]W\hYbZY`g`i bX`gY]bYb GY\Ybgk ØfX][_Y]hYbž'VYgi W\Yb`G]Y`X]Y`cZZ]n]Y``Y`K YVgY]hY` `]W\YbhZY`g"XY"

9]b 6`]W_]b X]Y <]ghcf]Y. GY\Ybgk ØfX][_Y]hYb i bX 8 Yb_a À`Yf

9]b 'V Ygcb X Y f Y g' <][\ `][\ h']gh X Ug 'G W \ `c gg '@] W h Y b Z Y `g ž X Ug ']a %' "' $\frac{1}{3}$ \ f\ i b X Y fh Y f V Ui h' k i f X Y "' 9g 'gh Y \ h' Ui Z Y]b Y a '__`Y]b Y b ' < Ø[Y ` i b X 'V]Yh Y h' Y]b Y b ' V Y Y]b X f i W_Y b X Y b '6`] W_ Ui Z X]Y 'I a [Y V i b ["'8] Y A]g W \ i b ['Ui g 'f ca Ub]g W Y f 'i b X '[ch]g W Y f '5 f W \]h Y_h i f 'a U W h X Ug G W `cgg 'ni 'Y]b Y a 'Z Ugn]b]Y f Y b X Y b 'C f h ž i a 'a Y \ f 'Ø V Y f 'X] Y 5 f W \]h Y_h i f 'Y b Y f '9 d c W Y 'ni 'Y f Z U \ f Y b "'9]b Y '6 Y g] W h][i b ['X Y g G W `cgg Y g' [] V h' \ b Y b 'ni X Y a '9]b V `] W_Y ']b ' X] Y ; Y g W \]W h Y 'X Y f

9]b k Y]hYfYg k]Wk h][Yg 8 Yb_a U``]gh X]Y 'Gh"! \approx \ Ub b Yg!?]f Wk Y ž X]Y 'b]Wk h b i f 'Uf Wk]hY_hc b]gWk 'ØVYfn Yi [Yb X ']gh ž 'gc b XYfb 'Ui Wk 'Y]b Y n Yb h f U`Y 'F c ``Y ']b 'XYf 'f Y`][]Òg Yb '; Yg Wk]Wk h Y '@]Wk h Yb ZY `g 'gd]Y `h Y " 8]Y '?]f Wk Y ž 'X]Y ']a '%("' \Rightarrow U\f\i b XYfh 'Yf V Ui h k i f XY ž ']gh 'Y]b k i b XYf V Uf Yg '6 Y]gd]Y ``ZØf 'X]Y 'gd Àh [ch]g Wk Y '6 Ui _i b gh "' 8]Y _i b gh j c ``Yb '; `Ug ZYb gh Yf i b X 'X]Y 'Y]b X f i W_g j c ``Yb '5 `h Àf Y 'n]Y \ Yb gc Zc fh 'X]Y '5 i Za Yf_g Ua _Y]h XYf '6 Y g i Wk Yf 'Ui Z 'g] Wk 'i b X 'V]Yh Yb 'Y]b Y Zf]Y X`]Wk Y '5 ha c gd \ Àf Y "

 $= \text{NYbhfi a "XYf'5"hghUXh'Z]bXYb'G]Y'XUg'F Uh\ Ui g'@]W\ hYbZY`gžY]b'; YVÀi XYŽ'XUg'cZh'U`g'XUg'<Yfn'XYf'GhUXh'VYgW\ f]YVYb'k]fX" \\ 8 Ug'F Uh\ Ui g']gh'Y]b'\Yfj cffU[YbXYg'6Y]gd]Y`'ZØf'X]Y \\ FYbU]ggUbW'UfW\]hY_hi f'i bX'VY\YfVYf[h'j]Y`Y'VYXYi hYbXY ghÀXh]gW\Y'JYfUbghU`hi b[Yb'gck]Y'5i gghY``i b[Yb''8]Y': UggUXY']gh a]h'gW\\ObYb': fYg_Yb'j Yfn]YfhZ'X]Y'; YgW\]W\ hYb'Ui g'XYf ; YgW\]W\ hY'@]W\ hYbZY`g 'YfnÀ\`Yb''$

K Ybb'G]Y'Ub'XYf'; YgW]W hY'XYf'? YfUa]__i bgh']bhYfYgg]Yfh'g]bXž gc``hYb'G]Y'XUg'8Yi hgW Y'? YfUa]_a i gYi a 'b]W h'j YfdUggYb"' \ddot X]YgYa 'A i gYi a 'k]fX'X]Y'9bhk]W_`i b['XYf'? YfUa]__i bgh']b@W hYbZY`g'i bX'XYf'i a `]Y[YbXYb'FY[]cbYb'Xc_i a Ybh]Yfh"'JcbXYf'_`Ugg]gW Yb'V]g'ni f'a cXYfbYb'? YfUa]_'[]Vh'Yg'Y]bY'J]Y`nU\`j cb'9I dcbUhYbž'X]Y'X]Y'\UbXk Yf_`]WXY'HfUX]h]cb'XYf'GhUXh j YfUbgW Ui `]WXYb"

9]b'k Y]hYfYg'ZUgn]b]YfYbXYg'8Yb_a U``]gh'X]Y'

K UggYfgWX`cggUb`U[Yž'Y]b'\]ghcf]gWXYg'9bgYa V`Yž'XUg'X]Y
6YXYi hi b['j cb'K UggYf'U`g'@YVYbgei Y``Y'ZØf'X]Y'GhUXh

XYa cbghf]Yfh"'<]Yf'_ObbYb'G]Y'X]Y'U`hYb'6fØW_Yb'i bX

K UggYf[fÀVYb'VYg]WXh][Ybž'X]Y'Y]bgh'ni f'J YfhY]X][i b['i bX

K UggYfj Yfgcf[i b['XYf'GhUXh'X]YbhYb"

Ni gÀhn`]WX 'g]bX'X]Y'FYghY'XYf'GhUXha Ui Yf'bcWX'[ih'Yf\U`hYbžibX'G]Y'_ObbYb'Y]b][Y'XYf'Y\Ya U`][Yb'GhUXhhcfY'Yf_ibXYb"8]YgY', VYffYghY'V]YhYb'Y]bYb'Y]bn][Ufh][Yb'9]bV`]W_']b'X]Y JYfhY]X][ib['ibX'GhUXhd`Ubib['XYg'A]hhY`U`hYfg'ibX'g]bX']XYU`Y CfhY'ZØf'Y]bYb'VYfi\][YbXYb'GdUn]Yf[Ub[ž'kÀ\fYbX'a Ub'X]YkibXYfVUfY'5igg]Wkh'UiZ'X]Y'5`hghUXh'[Yb]Y»h"

GY\Ybgk ØfX][_Y]h	6Ui nY]h	6YgcbXYf\Y]hYb
GWX`cgg'@]WXhYbZY`g	%' "'\\f\i bXYfh	6`]W_'Ui Z'X]Y
		la[YVib[ž
		5fWk]hY_hi f!; Ya]gWk
Gh"! ∞ \ UbbYg!?]fWXY	%("`划\f\i bXYfh	GdÀh[ch]gWXY
		6Ui_i bghž
		; `UgZY b ghY f
FUh\Uigʻ@]W\hYbZY`g	FYbU]ggUbW	: fYg_Ybž'_i `hi fY``Y
		JYfUbghU`hib[Yb
8 Yi hgWX Yg	JUf]]YfYbX	?YfUa]i bghj cb
?YfUa]_aigYia		JYf[Ub[Yb\Y]h [.] V]g
		; Y[Ybk Ufh
K UggYfgWX`cggUb`U[A]hhY`U`hYf	K UggYf[fÀVYbž
Υ		6fØW_Yb
FYghY'XYf	A]hhY`U`hYf	<]ghcf]gW\Y
GhUXha Ui Yf		GhUXhhcfYž
		GdUn]Yf[Àb[Y

5VgWX`]Y» YbX'`Aggh'g]WX 'gU[Ybž'XUgg'@]WX hYbZY`g'a]h'gY]bYb
nU\`fY]WXYb'GY\Ybgk ØfX][_Y]hYb'b]WX h'bi f'Y]bY'FY]gY'k Yfh']ghž
gcbXYfb'Ui WX'j]Y`Y'A Ò[`]WX_Y]hYb'V]YhYhž']b'X]Y'gdUbbYbXY
; YgWX]WXhY'i bX'?i `hi f'XYf'FY[]cb'Y]bni hUi WXYb"'¾XYg
A cbi a Ybh'YfnÀ\`h'gY]bY'Y][YbY'; YgWX]WX hY'i bX'hfÀ[h'XUni 'VY]ž
XUg'9fVY'X]YgYf'WX Ufa UbhYb'GhUXh``YVYbX]['ni '\U`hYb"'9[U`ž'cV
G]Y'5fWX]hY_hi fž'; YgWX]WX hY'cXYf'Y]bZUWX'X]Y'GWX Òb\Y]h'XYf'GhUXh
gWX ÀhnYb''@]WX hYbZY`g'\Uh'ZØf'YXYb'YhK Ug'ni 'V]YhYb"

? i `]bUf]gW\Y'<][\`][\hg.'; Yb]Y \gg Yb']b@]W\hYbZY`g

@JWX hY b ZY`gž`X]Y `GhUXh`XYf`gWX ÒbYb`U`hYb`; UggYbž`V]YhYh`Ui WX`Y]bY: Ø``Y`Ub`_i`]bUf]gWXYb`9f`YVb]ggYbž`X]Y`; Ui a YbZfYi XYb

j YfgdfYWXYb"'8]Y'FY[]cb']gh'VY_Ubbh'ZØf']\fY'hfUX]h]cbY``Y
ZfÀb_]gWXY'?ØWXYZ'X]Y'g]WX'Xi fWX'Zf]gWXYZ'gU]gcbU`Y'Ni hUhYb'i bX
\Yfn`]WXY'Ni VYfY]hi b['Ui gnY]WXbYh"'+b'XYb'j]Y`Yb'FYghUi fUbhg
i bX'7UZÅg']b'XYf'GhUXh'Yfk UfhYh'X]WX'Y]bY'gdUbbYbXY'A]gWXi b[
Ui g'fY[]cbU`Yb'GdYn]U`]hÀhYb'i bX'a cXYfbYb'+bhYfdfYhUh]cbYb"

9]b UVgc`i hYgʻA i ggʻk À\fYbXʻXY]bYgʻ5i ZYbh\U`hgʻ]bʻ@]W\hYbZY`gʻ]gh X]Yʻ_cghVUfYʻ: $fÀb_]gW$ \Yʻ6fUhk i fgh"`8]YgYʻXYZh][YʻK i fgh'k]fX hfUX]h]cbY``ʻj ca '; f]```gYfj]Yfhʻi bXʻ]ghʻY]bʻVY`]YVhYfʻGbUW_ʻ]bʻXYf [YgUa hYbʻFY[]cb"ʻC Zhʻk]fXʻg]Yʻa]hʻY]bYa 'GhØW_ʻZf]gW\Ya '6fch i bXʻY]bYfʻ\Ui g[Ya UW\hYbʻGYbZgc»Yʻ[YbcggYb"`NU\`fY]W\Yʻ_`Y]bY \Rightarrow V]ggYʻ]bʻXYfʻ5`hghUXhʻV]YhYbʻX]YgYʻGdYn]U`]hÀhʻUbžʻi bXʻYgʻ]gh gW\kYfžY]bYa 'j Yf`cW_YbXYbʻ8i Zh'ni 'k]XYfghY\YbžXYfʻUi gʻXYb ; f]``qʻqhfÒa h"

: Øf'@]YV\UVYf'j cb'GØ» gdY]gYb']gh'XYf': fÀb_]gWX Y'5dZY`_i WX Yb Y]b'UVgc`i hYg'A i gg"'A]h'gUZh][Yb'ŸdZY`b'Ui g'XYf'FY[]cbžY]bYf Vi hhf][Yb'HY][_fi ghY'i bX'Y]bYa '< Ui WX'j cb'N]a h']gh'X]YgYf ?i WXYb'Y]bY'YWX hY': fYi XYž']bgVYgcbXYfY']b'XYb'_Ø\`Yb <YfVgha cbUhYb"'6Ygi WXY'Y]b'?UZZYY']b'XYf'5`hghUXhž'i a 'Y]b'GhØW_ Zf]gWX'[YVUW_YbYb'5dZY`_i WXYb'ni 'dfcV]YfYbž'j]Y``Y]WXh'gc[Uf VY[`Y]hYh'j cb'Y]bYf'HUggY'Xi ZhYbXYa '?UZZYY'cXYf'HYY'"

; Yf]W\h	6YgWkfY]Vib[K cini iZ]bXYb
: fÀb_]gW\Y	8 Y Zh][Y; f]``k ØfghYž	∍a V]ggYibX
6fUhk i fgh	cZh'a]h'6fch'ibX	; f]``ghÀbXY`]b'XYf
	GYbZ	5`hghUXh
GW Ài ZY`Y	@Ub[gUa [Y[UfhY	HfUX]h]cbgfY]WXY
	GWkkY]bYgWki`hYf	FYghUifUbhg
	a]h˙? bÒXY`b	

8]Y; Ughfcbca]YgnYbY']b'@]W\hYbZY`g']gh'YXcW\'b]W\h'bi f'j cb
hfUX]h]cbY``Yf'?ØW\Y'[YdfÀ[h''=a a Yf'a Y\f'_fYUh]j Y'?ÒW\Y
YI dYf]a Ybh]YfYb'a]h'bYi Yb'FYnYdhYb'i bX'_ca V]b]YfYb'`c_U`Y
DfcXi _hY'a]h']bhYfbUh]cbU`Yb'9]bZØggYb'''HUdUg!6Ufgž']hU`]Yb]gW\Y
FYghUi fUbhg'i bX'Ug]Uh]gW\Y'?ØW\Yb'\UVYb']\fYb'D`Uhn'[YZ|bXYb
i bX'V]YhYb'Y]bY'VfY]hY'5i gk U\``ZØf'YXYb'; YgW\a UW_"

K Ybb'Xi 'Y]b': Ub'j cb'K Y]bYb'V]ghž'gc``hYgh'Xi 'i bVYX]b[h'X]Y': fUb_Ybk Y]bY'dfcV]YfYbž'X]Y']b'XYb'bU\Y[Y`Y[YbYb K Y]bVYf[Yb'dfcXi n]Yfh'k YfXYb"'J]Y'Y'XYf'K Y]b`c_U`Y']b'XYf
I a [YVi b['`UXYb'X]WX'Y]bž'`c_U`Y'K Y]bY'ni 'dfcV]YfYbž'gY]'Yg'VY]
Y]bYf'K Y]bdfcVY'cXYf'ni 'Y]bYa '_Ògh`]WXYb'9ggYb"'6YgcbXYfg'X]Y
K Y]» k Y]bY'XYf'FY[]cbž'k]Y'G]`j UbYf'cXYf'A Ø``Yf!H\i f[Ui ž'g]bX
VY_Ubbh'ZØf']\fYb'Zf]gWXYbž'Zfi WXh][Yb'7\UfU_hYf"

 $: \emptyset f Y]b ii bj Yf[Ygg`]WXYg'_i `]bUf]gWXYg'9f`YVb]g'V]YhYh'@]WXhYbZY`g Ui WX `nU\`fY]WXY'fY[Y`a À»][Y'JYfUbghU`hi b[Ybž'k]Y'ni a '6Y]gd]Y`XUg' < YfVghZYgh'cXYf'XYb'K Y]\bUWXhga Uf_hž'k c'`c_U`Y 5bV]YhYf']\fY'GdYn]U`]hÀhYb'dfÀgYbh]YfYb''' <]Yf'_Ubbgh'Xi 'b]WXh bi f'\Yfj cffU[YbXYg'9ggYb'[Yb]Y»Ybž'gcbXYfb'Ui WX'X]Y'ZfÒ\`]WXY 5ha cgd\ÀfY'i bX'X]Y'\Yfn`]WXY'; UghZfYi bXgWXUZh'XYf @]WXhYbZY`gYfYfYVYb''$

CV:Xi: bi b:Y]bYb:[Ya Øh`]WXYb:5VYbX:]b:Y]bYa::XYf:hfUX]h]cbY``YbK]fhg\Ai gYf:j YfVf]b[Yb:cXYf:Y]bYb:GbUW_:i bhYfk Y[g:[Yb]Y»Yba OWXhYghž:@]WXhYbZY`g:\Uh:ZØf:YXYb:Yhk Ug:ni::V]YhYb":@Ugg:X]WXjcb:XYf:J]Y`ZU`h:i bX:XYa:; YgWXa:UW_:XYf:ZfAb_]gWXYb:?ØWXYjYfnUi:VYfb:i bX:YbhXYW_Y:X]Y:_i `]bUf]gWXYb:; Y\Y]ab]ggY:X]YgYfWXUfa:UbhYb:GhUXh°

BUhi f'di f. K UbXYf! i bX FUXZU\fa Ò[`]WX_Y]hYb

@]W\hYbZY`gž`Y]b[YVYhhYh`]b`X]Y`a U`Yf]gW\Y`@UbXgW\UZh`XYg

cVYfZfÀb_]gWXYb'8Yi hgWX`UbXgž'V]YhYhY]bY': Ø``Y'j cb
A Ò[`]WX_Y]hYb'ZØf'BUhi fZfYi bXYž'K UbXYfYf'i bX'FUXZU\fYf"'8]Y
FY[]cb']gh'VY_Ubbh'ZØf']\fY'UhYa VYfUi VYbXYb'K À`XYfž'gUbZhYb
<Ø[Y``i bX'[`]hnYfbXYb'; Yk ÀggYfž'X]Y'g]WX'dYfZY_h'ZØf'Ci hXccf!
5_h]j]hÀhYb'Y][bYb"'=b'X]YgYa '5VgWXb]hh'ghY``Yb'k]f'=\bYb'Y]b][Y
XYf'VYghYb'K UbXYf!'i bX'FUXZU\fa Ò[`]WX_Y]hYb'fi bX'i a
@]WXhYbZY`g'j cf"

9]b UVgc i hYg' <][\ i][\ h']gh'XYf'@]W hYbZY `gYf B Uhi fYf`YVb]gk Y[\check{z} XYf'G]Y'Xi fW\ 'X]Y'\Yff`]W\Y': `cfU'i bX': Ui bU XYf'I a [YVi b['ZØ\fh''8]YgYf'Fi bXk Y[']gh'Yhk U'%\$'?]`ca YhYf'`Ub[i bX'Y][bYh'g]W\ '\Yfj cffU[YbX'ZØf': Ua]`]Yb'a]h'?]bXYfb \check{z} XU'Yf]bhYfYggUbhY'GhUh]cbYb'V]YhYh \check{z} X]Y'XUg'K]ggYb'ØVYf'X]Y'BUhi f gd]Y`Yf]gW\'j Yfa]hhY`b''G]Y'_ObbYb'k i bXYfgW\ObY'5i gV`]W_Y'Ui Z X]Y'i a `]Y[YbXYb' < Ø[Y`'[Yb]Y\Yb'i bX'j]Y``Y]W\h'gc[Uf'Y]b'dUUf\Y]a]gW\Y'H]YfY'VYcVUW\hYb''

- 8 Ui Yf. "WU" ("Ghi bXYb
- @Ab[Y.'%&'_a
- $GWX k]Yf][_Y]hg[fUX. A]hhY`$

FUXZU\fYf'_ca a Yb']b'@]W\hYbZY`g'YVYbZU``g'Ui Z']\fY'?cghYb"'8]Y'
FibXY'ia 'XYb'A U]b'V]YhYh'Y]bY'\Yfj cffU[YbXY'; Y`Y[Yb\Y]hž
X]Y'GW\Ob\Y]h'XYf'FY[]cb'Ui g'Y]bYf'UbXYfYb'DYfgdY_h]j Y'ni
YbhXYW_Yb"'8]YgY': U\ffUXhci f'ZØ\fh'Ybh`Ub['XYg'A U]bg'i bX'Xi fW\
a U`Yf]gW\Y'K Y]bVYf[Y"'8]Y'GhfYW_Y']gh'Yhk U'' \$'?]`ca YhYf'`Ub[
i bX']gh'ZØf'FUXZU\fYf'U``Yf'GW\k]Yf][_Y]hq[fUXY'[YY][bYh'

K Yf`bcW\`a Y\f`5VYbhYi Yf`gi W\hž`gc``hY`X]Y`**A ci bhU]bg]XY HfU]`g**`Ui gdfcV]YfYbž`X]Y`U`g`X]Y`VYghYb`HfU]`g`ZØf`A ci bhU]bV]_]b[

]b`XYf`FY[]cb`[Y`hYb"`<]Yf`Z]bXYb`G]Y`gdUbbYbXY`GhfYW_Yb`ZØf YXYg`B]j YUi ž'j cb`Y]bZUW\Ya '; Y`ÀbXY`V]g`\]b`ni \YfUi gZcfXYfbXYb`5VZU\fhYb"`8]YgY`HfU]`g`g]bX`]XYU`ž'i a 'g]W\`a]h : Ua]`]Y`i bX': fYi bXYb`]b`XYf`BUhi f`ni 'j Yf[bØ[Yb"

FcihY	@Àb[Y	GWk]Yf][_Y]hg[fUX
@]WX hY b ZY `gY f	%\$ '_a	@Y]W\ h
BUhi fYf`YVb]gk Y[
: fÀb_]gWXYf	%&`_a	A]hhY`
; YV]f[gk Y[
FibXY'ia 'XYb'AU]b	' \$`_a	@Y]W\ h
A ci bhU]bg]XY HfU]`g	JUf]YfYbX	GWXk]Yf][

9]b '_ØfnYfYfž'UVYf'YVYbgc 'gW\ ÒbYf'K Y[']gh'XYf'<]fgW\ ZY`Xk Y[ž XYf'G]Y'Xi fW\ 'X]Y'K]YgYb'i bX'K À`XYf'fi bX'i a 'X]Y'GhUXh'Z \emptyset \ fh" 8]YgYf'Yhk U') '?]`ca YhYf'`Ub[Y'Fi bXk Y[']gh']XYU`'Z \emptyset f'Y]bYb YbhgdUbbhYb'GdUn]Yf[Ub[']b'XYf'BUhi f'i bX'Y][bYh'g]W\ 'dYfZY_h Z \emptyset f'Y]bYb'BUW\ a]hhU['a]h'XYf': Ua]`]Y'cXYf': fYi bXYb"'8]Y'GhfYW_Y]gh``Y]W\ h'VY[Y\VUf'i bX'V]YhYh'nU\`fY]W\ Y'D]W_b]W_d`ÀhnY"

 $: \varnothing f ``U`````YbYž'X]Y `[YfbY`X]Y ``@UbXgW\UZh'dYf`9!6]_Y `Yf_i bXYbž'[]VhYg`nU\`fY]W\Y`FUXjYf`Y]\Y`]b`XYf`GhUXh"`9!6]_Yg`Yfa Õ[`]W\Yb`\Ab[YfY`Hci fYbž'gY`Vgh'Z\Øf`kYb][Yf`hfU]b]YfhY`FUXZU\fYf"`8Yf <\AbX`Yf`j cf`Cfh`V]YhYh'b]W\h'bi f`@Y]\ZU\fnYi [Y`Ubž'gcbXYfb`[]VhUi W\`b\Øhn`]W\Y`H]ddg`ni `XYb`VYghYb`Fci hYb`i bX`j YfghY_hYbGW\AhnYb`]b`i bX`i a `@]W\hYbZY`g"$

5V[YgY\Yb'j cb'XYb'cZ]n]Y``Yb'K UbXYf!'i bX'FUXk Y[Yb'[]Vh'Yg nU\`fY]W\Yž'k Yb][Yf'VY_UbbhY'DZUXYž'X]Y'g]W\']XYU``ZØf
9f_i bXi b[Yb'UVgY]hg'XYf'<Ui dhghfU»Yb'Y][bYb"'9]b\Y]a]gW\Y
ZfYi Yb'g]W\'cZhž']\fY': Uj cf]hYb'ni 'hY]`Ybž'X]Y'b]W\h'bi f
`UbXgW\UZh`]W\'gW\Òb'g]bXž'gcbXYfb'Ui W\']bhYfYggUbhY'\]ghcf]gW\Y
Di b_hY'Ui Z'XYa 'K Y['V]YhYb"

?i fn'[YgU[hž'X]Y'I a [YVi b['j cb'@]W\hYbZY`g']gh'Y]b'k U\fYg
DUfUX]Yg'ZØf'B Uhi f`]YV\UVYf'i bX'V]YhYh'Y]bY'VfY]hY'DU`YhhY'Ub
K UbXYf!'i bX'F UXZU\fa Ò[`]W_Y]hYbž'X]Y'gck c\``ZØf'5bZÀb[Yf'U`g
Ui W\'ZØf'YfZU\fYbY'5_h]j]ghYb'[YY][bYh'g]bX"'9g'[]Vh'_Y]bYb

?i`hi fY``Y'9j Ybhg.: Ygh]j U`g'i bX J YfUbghU`hi b[Yb XUg'[UbnY >U\f

@]W\hYbZY`gž`Y]bY`GhUXhž`X]Y`a]h`]\fYf`W\UfaUbhYb`5`hghUXh`ibXXYf`ia[YVYbXYb`BUhif`VYnUiVYfhž`V]YhYh`UiW\`Y]b`UiZfY[YbXYg_i`hifY``Yg`@YVYb"`8Ug`[UbnY`\\f`ØVYf`Z]bXYb`\]Yf`nU\`fY]W\Y\YghJjU`g`ibX`JYfUbghU`hib[Yb`ghUhhž`X]Y`gckc\``9]b\Y]a]gW\Y`U`gUiW\`6YgiW\Yf`Ubn]Y\Yb"`8]YgY`9jYbhg`g]bX`Y]b`kibXYfVUfYfKY[ž`ia`X]Y`HfUX]h]cbYb`ibX`X]Y`?i`hif`XYf`FY[]cb`ni`Yf`YVYb"

 $9]b <][\ \][\$

9]b k Y]hYfYg VYXYi hYbXYg 9fY][b]g]gh XUg GWX Ài ZYf`U!: Yghž XUg]b XYf FY[Y`]a \div \\f \[YZY]Yfh k]fX i bX Y]bY _i \]b Uf]gWXY; YghY Ub X]Y fY[]c bU Y ? ØWXY XUfghY ``h" <]YfVY] XfY\h g]WX U ``Yg i a \div XUg hfUX]h]c bY ``Y GWX Ài ZYf`UžY]b gUZh][Yf GWX k Y]bYVfUhYbž XYf a]h GUi Yf_fUi h i bX ? `O` Yb gYfj]Yfh k]fX" 8]YgYg : Ygh n]Y\h; ci fa Yhg i bX : Ua]`]Yb [`Y]WXYfa U Yb Ubž X]Y VY] @j Y!A i g]_ i bX i bhYf\U`hqUa Yb 5_h]j]hÀhYb ni gUa a Yb_ca a Yb _ObbYb"

8]Y'GhUXh'ZY]Yfh'Ui WX'XUg'K Y]bZYghž'XUg'a Y]gh']a '5i [i gh ghUhhZ]bXYh'i bX'X]Y'K Y]b`]YV\UVYf'Ubn]Y\h'' <]Yf'_ÒbbYb'6Ygi WXYf]b'X]Y'K Y`h'XYf'ZfÀb_]gWXYb'K Y]bY'Y]bhUi WXYbž'VY[`Y]hYh'j cb Y]bYf'5i gk U\`'Ub'_Ògh`]WXYb' < ÀddWXYb'Ui g'`c_U`Yb'Ni hUhYb'''8Ug : Ygh'V]YhYh'Y]bY'\Yfj cffU[YbXY'; Y`Y[Yb\Y]hž'g]WX'a]h'UbXYfYb K Y]b`]YV\UVYfb'ni 'j YfbYhnYb'i bX'a Y\f'ØVYf'X]Y'K Y]bdfcXi _h]cb

K À\fYbX'XYf'K Y]\bUW\hgnY]h'j YfnUi VYfh'XYf'K]bhYfa Uf_h'X]Y
GhUXh'a]h'ZYgh']W\Yf'6Y'Yi W\hi b['i bX'gh]a a i b[gj c``Yf
8Y_cfUh]cb"'<]Yf'V]YhYb'nU\`fY]W\Y'Gh\bXY'\UbX[Ya UW\hY
; YgW\Yb_Yž'?i bgh\UbXk Yf_'i bX'hfUX]h]cbY``Y
K Y]\bUW\hg`YW_YfY]Yb'Ub"'9]b'<][\`][\h'g]bX'X]Y'`]j Y'[Ygi b[YbYb
K Y]\bUW\hg`]YXYf'i bX'X]Y'?Ufi ggY``g'ZØf'X]Y'?`Y]bYb"'8Yf
K]bhYfa Uf_h']gh'Y]b'k i bXYfVUfYf'Cfhž'i a 'X]Y'ZYgh`]W\Y
5ha cgd\AfY'ni '[Yb]Y»Yb'i bX']b'XUg'K Y]\bUW\hg[YZØ\`
Y]bni hUi W\Yb"

9j Ybh	AcbUh	<][\`][\hg
: `YWX ha Uf_h	A U]	?cfVZÒW\hbYfž@jY!
		Aig]_
GWAi ZYf`U!: Ygh	Gca a Yf	HfUX]h]cbY``Yf
		GWk Y]bYVfUhYbž
		@j Y!I bhYf\U`hi b[
KY]bZYgh	5i [i gh	: fÀb_]gW\Y
		K Y]bYžfY[]cbU`Y
		GdY]gYb
K]bhYfa Uf_h	8YnYa VYf	KY]\bUW\hg[YgW\Yb
		_Y ž˙ZY gh`]W\ Y
		5ha cgd\ÀfY

9[U`žcV`G]Y`?ibghž?i`]bUf]_`cXYf`Y]bZUW\`X]Y``c_U`Y`?i`hif
gW\AhnYbž`@]W\hYbZY`g`\Uh`ZØf`^YXYb`Yhk Ug`ni`V]YhYb"\8]Y
nU\`fY]W\Yb: Ygh]j U`g`V`Y]VYb`b]W\h'bifY]b`ZYghYf`6YghUbXhY]``XYg
@YVYbg`XYf`GhUXhžgcbXYfb`V]YhYb`Ui W\`Y]bY`kibXYfVUfY
A O[`]W_Y]hža]h`XYb`A YbgW\Yb`j cf`Cfh`]b`?cbhU_h`ni`hfYhYb`ibX
X]Y`; UghZfYibXgW\UZh`XYf`FY[]cb`ni`Yf`YVYb"

9]b'k Y]hYfYg'Ya dZY\`Ybgk YfhYg'9j Ybh']gh'XYf'HU['XYf'cZZYbYb HØf']b'XYb'`c_U`Yb'K Y]b[ØhYfbž'XYf'ØV`]W\Yfk Y]gY']a 'GYdhYa VYf ghUhhZ]bXYh"'8]Yg']gh'X]Y'dYfZY_hY'; Y`Y[Yb\Y]hž'i a 'a Y\f'ØVYf'XYb K Y]bVUi ']b'XYf'FY[]cb'ni 'YfZU\fYb'i bX'X]Y'_Ògh`]W\Yb'K Y]bY X]fY_h'j ca '9fnYi [Yf'ni 'dfcV]YfYb"'CZha U`g'_ca V]b]YfYb'X]Y K Y]b[ØhYf'X]Y'J Yf_cghi b[Yb'a]h': Ø\fi b[Yb'Xi fW\X]Y

@JWX hY b ZY`gʻ]ghʻUi WX ʻghc`nʻXUfUi ZžʻXUgʻ@JWX hY b ZY`gYf

GcaaYfZYgh]j U``ni ʻj YfUbghU`hY b žʻXUgʻ]bʻXYfʻFY[Y``]a ˈ¾`]
ghUhhZ]bXYhʻi bXʻY]bʻUVk YWXgY`bXYgʻDfc[fUaaʻUigʻAig]_žʻH\YUhYf
i bXʻHUbnʻV]YhYh''8]YʻJ YfUbghU`hi b[ʻn]Y\hʻ? Øbgh`YfʻUigʻXYf
[YgUahYbʻFY[]cbʻi bXʻXUfØVYfʻ\]bUigʻUbʻi bXʻgWXUZZh'Y]bY

D`UhhZcfa ZØfʻ_fYUh]j Yʻ8UfV]Yhi b[Ybž'X]YʻXUgʻ_i `hi fY``Yʻ@YVYbʻXYf
GhUXhʻVYfY]WXYfb"

I a 'g]W\Yfni ghY``Ybž'XUgg'G]Y'_Y]b'9j Ybh'j YfdUggYbž'Ya dZY\`Y
]W\Z'X]Y'cZZ]n]Y``Y'K YVg]hY'XYf'GhUXh'ni 'VYgi W\Yb'\]Yfž'k c'G]Y
U_hi Y``Y'\DZcfa Uh]cbYb'ni 'VYj cfghY\YbXYb'JYfUbghU`hi b[Yb
Z]bXYb'_ObbYb"'8Ug'[YgUa hY'\J\f'ØVYf'V]YhYh'@]W\hYbZY`g'Y]bY
J]Y`nU\`'j cb'A O[`]W_Y]hYbž'X]Y'fY]W\Y'?i `hi f'i bX'XUg'`YVYbX][Y
; Ya Y]bgW\UZhg`YVYb'ni '[Yb]Y\Yb"

$H]ddg'ZØf'XYb'dYfZY_hYb'5iZYbh\U`h.$ $IbhYf_ØbZhY'ibX'5igZ`Ø[Y$

@JWX hY b ZY `gž Y]b `WX Ufa UbhY g `GhÀ X hWX Y b `]a `< Y fnY b `C VY f Zf Ub _Y b gž V]Y hY h Y]b Y `J]Y `nU\ ` 'j cb `A O[`]WX _Y]hY b ž i a `\[\Rightarrow\] fY b `5 i ZY b h\ U `h i bj Y f[Y gg`]WX `ni `[Y ghU`hY b "`C V `G]Y `b UWX `Y]b Y a `fca Ub h]g WX Y b K c WX Y b Y b X Y ž Y]b Y a `: Ua]`]Y bi f`Ui V `c X Y f `Y]b Y a `. 9 f`Y V b]g `ZØ f : fY i b X Y `g i WX Y b ž @]WX hY b ZY `g `\ Uh `ZØ f `Y X Y b `Y hK Ug `ni `V]Y hY b "`\=a : c`[Y b X Y b `Z]b X Y b `G]Y `Y]b][Y `H]d d g `ZØ f `X]Y `V Y g hY b `I b hY f _Ø b Z hY i b X `5 i q Z Ø[Y `]b `i b X `i a `@]WX hY b ZY `q"

$I bhYf_\emptysetbZhY^]b^0$ JWX hYbZY`g

 $8]Y `K U ` `XYf `f] W `h] [Yb `I b hYf_i b Zh `] gh `Yb hg W `Y] XYb X `ZØf `= `fYb \\ 5 i ZYbh `U`h" `= b `@] W `hYb ZY `g `[]Vh `Yg `Y] b Y `VfY] hY `DU `YhhY `j cb , VYfb UW hi b [ga Õ[`] W _Y] hYb ž `X] Y `j Yfg W]Y XYb Y `6 i X [Yhg `i b X J cf`] Y VYb `VYX] Yb Yb "$

< chY`g. : Øf'FY]gYbXYž'X]Y'? ca Zcfh'i bX
 5bbY\a`]W_Y]hYb'gi W\Ybž'g]bX'X]Y'< chY`g']a
 GhUXhnYbhfi a 'Y]bY'\Yfj cffU[YbXY'K U\`"'< chY`g'k]Y'XUg'

- DYbg]cbYb ii bX ; Ugh\ ÒZY. K Yf Y]bY ZUa]`]ÀfY 5ha cgd\ÀfY VYj cfni [hž Z]bXYh]b XYb nU\ fY]WXYb DYbg]cbYb ii bX ; Ugh\ ÒZYb]b XYf I a [YVi b[Y]bYb ZfYi bX]WXYb 9a dZUb["J]Y Y XUj cb V]YhYb hfUX]h]cbY Y ZfÀb_]gWXY? ØWXYŽ X]Y XYb 5i ZYbh\U`h bcWX [Ya Øh`]WXYf a UWXh"
- : Yf]Ybk c\bi b[Yb.: Øf``Àb[YfY'5i ZYbh\U`hY'cXYf'ZØf; fi ddYb'g]bX': Yf]Ybk c\bi b[Yb']XYU`"'G]Y'V]YhYb'Y]bY \Y]a]gW\Y'5ha cgd\ÀfY'i bX'a Y\f': `YI]V]`]hÀh'VY]a '9ggYb i bX'D`UbYb'j cb'5i qZØ[Yb"
- 7 Ua d]b[.'BUhi fZfYi bXY'_ObbYb'Ui Z'Y]bYa 'XYf
 7 Ua d]b[d`AhnY']b'XYf'I a [YVi b['ØVYfbUW\hYb"
 NY`hd`AhnY'cXYf'K c\ba cV]`ghY``d`AhnY'g]bX'Y]bY
 [fc» Ufh][Y'A O[`]W_Y]h\(\frac{x}{2}\)X]Y'BUhi f'ni '[Yb]Y» Yb'i bX'XYb
 Zf]gW\Yb'@ Zh'ni 'Uha Yb"

9a dZc\`YbY'5i gZ`Ø[Y']b XYf'l a [YVi b[

- 6i f['@]WX hY b ZY `g. '8]YgY '\]ghcf]gWX Y '6i f[']gh'bi f'Y]bYb
 _i fnYb 'GdUn]Yf[Ub['j cb 'XYf'GhUXh'YbhZYfbh"; Yb]Y » Yb 'G]Y
 X]Y '5i gg]WX h'Ui Z'X]Y I a [YVi b['i bX'YfZU\fYb'G]Y 'a Y\f
 ØVYf'X]Y'; YgWX]WX hY 'XYf'FY[]cb"
- J YghY '7cVi f[.'9]b" \$!a]bØh][Yf": U\fnY]h"j cb
 @W\hYbZY`g"Vf]b[h"G]Y"ni f"J YghY '7cVi f[ž"Y]bYf"XYf
 VYY]bXfi W_YbXghYb": Yghi b[Yb'8Yi hgW\`UbXg"'8]Y
 UhYa VYfUi VYbXY'5fW\]hY_hi f"i bX'X]Y"A i gYYb"j cf"Cfh
 q]bX'Y]b"YW\hYg"<][\`][\h"
- : fÀb_]gWXY'GWXkY]n. '9]b 'DUfUX]Yg'ZØf'K UbXYfYf'i bX
 B Uhi f`]YV\UVYf"'8]YgY'k i bXYfgWX ObY'FY[]cb'V]YhYh'Y]bY
 J]Y`nU\`'j cb'K UbXYfkY[Ybž'_`Y]bYb'8 OfZYfb'i bX
 a U`Yf]gWXYb'5i gV`]W_Yb"
- $6]cX]jYfg]hAhg!NYbhfia '@]WAhYbZY`g. '9]b 'Cfh'Z<math>\emptyset$ f

: Ua]`]Yb'i bX'BUhi fZfYi bXYž'i a 'a Y\f'ØVYf'X]Y': `cfU'i bX : Ui bU'XYf'FY[]cb'ni '`YfbYb"' ♣bhYfU_h]j Y'5i gghY``i b[Yb i bX'9f`YVb]ggY'a UWXYb'XYb'6Ygi WX'`Y\ffY]WX'i bX i bhYf\U`hqUa "

$5_h]j]hAhYb'jcf'Cfh$

 $5V[YgYYb'] cb'XYb'5i gZi [gn]Y`Yb'[]Vh'Yg'Ui WX'j]Y`Y'5_h]j]hÀhYb]b'@]WXhYbZY`g'gY`Vghž'X]Y'=\fYb'5i ZYbh\U`h'VYfY]WXYfb'_ÒbbYb.$

- FUXhci fYb. '8]Y 'GhUXh'i bX']\fY'l a [YVi b['V]YhYb'Y]b'[i h Ui g[YVUi hYg'FUXk Y[YbYhn"'A]YhYb'G]Y'Y]b': U\ffUX'i bX Yf_i bXYb'G]Y'X]Y'a U'Yf]gWXYb'@UbXgWXUZhYb'i bX \]ghcf]gWXYb'8 OfZYf']b'XYf'l a [YVi b["
- GhUXhZØ\fi b[Yb. @UggYb G]Y g]WX j cb Y]bYa
 GhUXhZØ\fYf X]Y j YfVcf[YbYb GWX ÀhnY @]WX hYb ZY `g `nY][Ybž
 X]Y → bYb 'VY] Y]bYa 'GY`VghVYgi WX 'a Ò[`]WXYfk Y]gY
 Ybh[Y\Yb 'k ØfXYb"
- ?i bgh! i bX < UbXk Yf_Yfa Àf_hY. ** bUWX *** J\ fYgnY]h _ ObbYb G]Y ``c_U`Y `?i bgh! i bX < UbXk Yf_ga Àf_hY VYgi WXYbž'X]Y b]WX h'bi f'DfcXi _hYž'gcbXYfb 'Ui WX 'Y]bYb 9]bV`]W_']b'X]Y fY[]cbU`Y '?i `hi f'V]YhYb"</p>
- 6cchghci fYb 'Ui Z'XYf'FY[b]hn.'; Yb]Y» Yb'G]Y'Y]bY
 YbhgdUbbYbXY'6cchgZU\fh'Ui Z'XYf'FY[b]hn"'8]Y
 JYfV]bXi b['j cb'K UggYf'i bX'BUhi f']gh'Y]b'dYfZY_hYf'K Y[ž
 i a 'ni 'YbhgdUbbYb'i bX'X]Y'l a [YVi b['ni '[Yb]Y» Yb"

H]ddg ZØf X]Y D`Ubi b[

I a 'XUg'6YghY'Ui g' \Rightarrow fYa '5i ZYbh\U`h']b'@]W\hYbZY`g'ni 'a UW\Ybž XYb_Yb'G]Y'Ub'Zc`[YbXY'D`Ubi b[gh]ddg.

- : fØ\ 'Vi W\ Yb. ' ± gVYgcbXYfY'k À\ fYbX'XYf' < cW\ gU]gcb g]bX'X]Y'I bhYf_ØbZhY'gW\ bY``'Ui g[YVi W\ h"'D`Ubi b[']a J cfUi g']gh'i bYf`Àgg`]W\"
- ² ZZY b h`]WX Y f`J Y f_Y\f. `Bi hnh`X]Y `[i hY b`J Y fV]b Xi b [Y b ni `OZZY b h`]WX Y b`J Y f_Y\fga]hhY`b ž`i a `X]Y `I a [Y Vi b [`ni Y f_i b X Y b ž`c \ b Y`Ui Z`Y]b `5i hc`Ub [Y k]Y g Y b`ni `g Y]b"

A]h'X]YgYb'H]ddg']a '<]bhYf_cdZ'ghY\h' \Rightarrow fYa 'dYfZY_hYb'5i ZYbh\U'h]b'@]W\hYbZY`g'b]W\hg'a Y\f']a 'K Y[Y"'9[U`ž'cV'G]Y'X]Y'BUhi f Yf_i bXYbž'X]Y'`c_U`Y'?ØW\Y'[Yb]Y \Rightarrow Yb'cXYf'Y]bZUW\'bi f YbhgdUbbYb'a ÒW\hYbž'@]W\hYbZY`g'\Uh'U``Ygž'k Ug'G]Y'VfUi W\Ybž i a 'Y]bY'k i bXYfVUfY'NY]h'ni 'j YfVf]b[Yb"

8 YhU]`g

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