

F c hhk Y]`'Y b hX Y W_Y b . '5 `hghU X hž': Ughb U W h i b X '_i `]b Uf]g WX Y '<][\ `][\ hg

9bhXYW_Yb^G]Y^Fchhk Y]`.^\]ghcf]gWkY^5`hghUXhz`gdUbbYbXY : UghbUWkhz`_i `]bUf]gWkY^? Ògh`]Wk_Y]hYb^i bX : Ua]`]YbUi gZ`Ø[Y^^Y]b^FY]gYZØ\fYf^ZØf^; Yb]Y»Yf^i bX 5VYbhYi Yf`i gh][Y^

K]``_ca a Yb`]b`Fchhk Y]`žY]bYf`WXUfa UbhYb`GhUXh`]a `< YfnYb`j cb 6UXYb!K ØfhhYa VYf[žX]Y`cZh`]a `GWXUhhYb`XYf`[fÒ» YfYb`BUWXVUfb ghY\hž`UVYf`Y]bY: Ø``Y`j cb`GWXÀhnYb`ni `V]YhYb`\Uh"`A]h`]\fYf \]ghcf]gWXYb`5`hghUXhž`X]Y`a]h`a]hhY`U`hYf`]WXYa :: `U]f`i bX`[i h Yf\U`hYbYb'; YVÀi XYb`VYY]bXfi W_hž``ÀXh`Fchhk Y]``XUni `Y]bž`X]Y ZUgn]b]YfYbXY'; YgWX]WXhY`i bX`?i `hi f`X]YgYf`FY[]cb`ni YbhXYW_Yb"`9[U`ž`cV`G]Y`Y]b`@]YV\UVYf`j cb`HfUX]h]cbYb`g]bX`cXYf Y]b`: Y]bgWXa YW_Yfž`XYf`Ui Z`XYf`Gi WXY`bUWX`bYi Yb`_i`]bUf]gWXYb 5VYbhYi Yfb`]ghž`Fchhk Y]``\Uh`ZØf`YXYb`Yhk Ug`ni `V]YhYb"

± X]YgYa '5fh]_Y`'bY\a Yb'k]f'G]Y'a]h'Ui ZY]bY'Ui ZfY[YbXY'FY]gY Xi fW 'F chhk Y]`g'7]hm'i bX'I a [YVi b["'G]Y'YfZU\fYb'a Y\f'ØVYf'X]Y < Ò\Ydi b_hY'XYf'F chhk Y]`Yf': UghbUW hž'X]Y'b]W h'bi f 9]b\Y]a]gW Yž'gcbXYfb'Ui W '6Ygi W Yf']b']\fYb'6Ubb'n]Y\h''?i`]bUf]gW '\Uh'X]Y'FY[]cb'Y]b][Yg'ni 'V]YhYb''j cb'\Yfn\UZhYb VUX]gW Yb'GdYn]U`]hÀhYb'V]g'\]b'ni 'gØ» Yb'@YW_YfY]Yb"'8 UfØVYf\]bUi g'k YfXYb'k]f'i bg'XYb'UhYa VYfUi VYbXYb'BUhi fYf`YVb]ggYb]a 'bU\Y[Y`Y[YbYb'GW k Ufnk U`X'k]Xa Ybž'k c'YbX`cgY K UbXYfk Y[Y'i bX'a U`Yf]gWXY5i gg]W hYb'Ui Z'G]Y'k UfhYb"

8 c W 'X Ug']gh'bc W 'b]W h'U``Yg° 'F c hhk Y]`g'?i bgh! i b X '?i `hi fgnYbY nY][h'g]W ']b 'gY]bYb'j]Y`Yb'A i gYYb'i b X '; U`Yf]Ybž'X]Y'X]Y'GhUXh'ni Y]bYa '_fYUh]j Yb'A]hhY`di b_h'a UW Yb": Øf': Ua]`]Yb'[]Vh'Yg gdUbbYbXY'5i gZi [gn]Y`Yž'X]Y'; fc "i b X'?`Y]b'[`Y]W Yfa U "Yb UbgdfYW Yb" @UggYb'G]Y'i bg'[Ya Y]bgUa ']b'X]Y'J]Y`ZU`h'i b X

 $GWN Ob Y]h F chhk Y] g Y]bhUi WN Yb 'i b X X]Y ; Y Y]a b]ggY X]YgYf ZUgn]b]YfYb X Yb 'GhUXh Yb h\ Ø``Yb 'Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yb '' Yg '[]Vh'j]Y ``ni 'Yb hX Y W_Yb '' Yb '$

$9bhXYW_ib[XYf']ghcf]gWXYb'5`hghUXh'jcbFchhkY]`$

8]Y'5`hghUXh'j cb'Fchhk Y]`']gh'Y]b'k U\fYg'¾k Y`']a 'GØXYb
8Yi hgW\`UbXg'i bX'VY[Y]ghYfh'6Ygi W\Yf'a]h']\fYa 'W\Ufa UbhYbž
[i h'Yf\U`hYbYb'\]ghcf]gW\Yb'9fVY"'; Y`Y[Yb']a '<YfnYb'XYf'GhUXhž
V]YhYh'Fchhk Y]`g'5`hghUXh'Y]b'ZUgn]b]YfYbXYg'9bgYa V`Y'Ui g
a]hhY`U`hYf`]W\Yf'5fW\]hY_hi fž'[YdZUghYfhYb'GhfU»Yb'i bX
`YV\UZhYb'D`ÀhnYbž'X]Y'X]Y'; YgW\]W\hY'XYf'GhUXh'`YVYbX]['k YfXYb

9]bił GW a i W_ghØW_ł XYf5`hghUXhi]gh XUgʻVYY]b Xfi W_Yb XY F Uh\ Ui gž XUgʻ]a [ch]gW YbʻGh]`YfVUi hik i fXY"A]higY]b Ya a Uf_UbhYbʻ9f_Yfii b XiXYbʻ_i bghjic``YbʻJYfn]Yfi b[Ybʻ]gh YgʻY]b VY`]YVhYgʻ: chcach]j "'*XYgʻ8YhU]`ž jicb XYbʻY`Y[UbhYbʻ: YbghYfb V]gʻni XYbʻZUfVYbZfc\Ybʻ: UggUXYbž YfnÀ\`h'Y]bY`Y][YbY; YgW]W hYʻi b XʻZØ\fh XYbʻ6Ygi WXYfʻ]bʻX]YʻJYf[Ub[Yb\Y]h XYf GhUXh'ni fØW_"

9]b'k Y]hYfYf'<Ò\Ydi b_h']gh'XYf'GWk UfnY'Hi fa ž'Y]b
, VYfV`Y]VgY`'Ui g'XYa '%' "'IJ\f\i bXYfh"'9f']gh'b]Wkh'bi f'Y]b
K U\fnY]WkYbž'gcbXYfb'Ui Wk'Y]b'5i gg]Wkhgdi b_hž'j cb'XYa 'Ui g
a Ub'Y]bYb'UhYa VYfUi VYbXYb'6`]W_'ØVYf'X]Y'8ÀWkYf'XYf'GhUXh
i bX'X]Y'i a `]Y[YbXYb'@UbXgWkUZhYb'[Yb]Y»Yb'_Ubb"'6Y]'[i hYa
K YhhYf']gh'XYf'5i gV`]W_'V]g'ni a 'GWkk Ufnk U`X'i bX'XYb'5`dYb
a Ò[`]Wkž'k Ug'Y]bYb'i bj Yf[Ygg`]WkYb'9]bXfi W_'\]bhYf`Àggh"

8]Y Yb[Yb; UggYb XYf5 hghUXhg]bX [YgÀi a hij cb \]ghcf]gWXYb < Ài gYfbž X]Y c Zha]h Vi bhYb 6 i a Yb [YgWXa ØW_hg]bX" <]Yf _Ubb a Ub [Ya Øh] WX Ybh`Ub[gWX `YbXYfbž _`Y]bY; YgWX À ZhY ii bX 6ci h]ei Yb Yf_i bXYb cXYf]b Y]bYa XYf j]Y `Yb 7 UZÅg Y]bY DUi gY Y]b Y[Yb "HUi WXYb G]Y Y]b Y [Xb "C_U`Y ?i `hi f i bX [Yb]Y » Yb G]Y Y]bY HUggY ? UZZYYž k À\fYbX G]Y XUg HfY]VYb ii a 'g]WX `\Yfi a VYc VUWX hYb"

9]b'VYgcbXYfYg'<][\`][\h']gh'X]Y'GhUXha Ui Yfž'X]Y'Fchhk Y]`'j cb
XYf'5i »Ybk Y'h'gWXØhnhY"'HY]`Y'X]YgYf'\]ghcf]gWXYb'6YZYgh][i b[
g]bX'bcWX'[i h'Yf\U`hYb'i bX'_ObbYb'VYg]WXh][h'k YfXYb"'9]b
GdUn]Yf[Ub['Ybh`Ub['XYf'A Ui Yf'j Yfa]hhY`h'b]WXh'bi f']bhYfYggUbhY
9]bV`]W_Y']b'X]Y'GhUXh[YgWX]WXhYž'gcbXYfb'V]YhYh'Ui WX'Y]bY'fi \][Y
5Vk YWXg`i b['j ca 'GhUXh`YVYb"

I a 'XYb'VYghYb', VYfV']W_'ØVYf'X]Y'5`hghUXh'ni 'VY_ca a Ybž Ya dZ]Y\`h'Ygʻg]W\ž'Ub'Y]bYf'[YZØ\fhYb'Hci f'hY]`ni bY\a Yb"8]YgY Hci fYbʻg]bX']bZcfa Uh]j 'i bX']bhYfYggUbhž'XU'`c_U`Y'9I dYfhYb gdUbbYbXY'; YgW\]W\hYb'Ui g'XYf'JYf[Ub[Yb\Y]h'YfnÀ\`Yb"8]Y : Ø\fi b[Yb'XYW_Yb'b]W\h'bi f'X]Y'UfW\]hY_hcb]gW\Yb'<][\`][\hg'UVž gcbXYfb'VY`Yi W\hYb'Ui W\'X]Y'_i `hi fY``Yb'5gdY_hY'i bX HfUX]h]cbYbž'X]Y'Fchhk Y]``ni 'Y]bYa 'VYgcbXYfYb'Cfh'a UW\Yb"

9]b k Y]hYfYg ZUgn]b]YfYbXYg 9`Ya Ybh`XYf 5`hghUXh`]gh`X]Y HYa d`]bYf_UdY``YžY]bY _`Y]bYžUVYf Y]bXfi W_g j c``Y`?]fW\YžX]Y Y]bYb 6`] W_i]b 'X]Y fY`][]ÒgY ; YgW\]W\hY F chhk Y]`g V]YhYh' 18]Y _`Y]bYbž'Vi bhYb : YbghYf i bX 'X]Y fi \][Y 5 ha cgd \AfY a UW\Yb Y]bYb 6Ygi W\`\]Yf VYgcbXYfg ``c\bYbgk Yfh'' 8]Y ? UdY``Y]gh'b]W\h bi f Y]b C fh`XYf 5bVYhi b[ž gcbXYfb Ui W\ Y]b VYgcbXYfYg 6Y]gd]Y` ZØf X]Y ?i bgh'i bX 5fW\]hY_hi f XYg A]hhY`U`hYfg''

Fchhk Y]`g`5`hghUXh`]gh`Ui W\`ZØf`]\fY`łJYfUbghU`hi b[Ybł`VY_Ubbh" 6YgcbXYfg`]a `Gca a Yf`Z]bXYb`nU\`fY]W\Y`: YghY`i bX`A Àf_hY`ghUhhž X]Y`X]Y`GhfU» Yb`a]h`@YVYb`i bX`: UfVY`ZØ``Yb"`<]Yf`_ÒbbYb 6Ygi W\Yf`b]W\h`bi f`X]Y`_i `]bUf]gW\Yb`? Ògh`]W_Y]hYb`XYf`FY[]cb dfcV]YfYbž`gcbXYfb`Ui W\`\UbX[YZYfh][hY`DfcXi _hY`i bX`Gci j Yb]fg Yfk YfVYb"

Ni gàhn`]WX []Vh'Ygʻ]b`XYfʻ5`hghUXhij]Y`Yʻ_`Y]bY; àfhYbii bX`D`àhnYž X]Yini a `JYfk Y]`Yb'Y]b`UXYb"`8Yfʻfca Ubh]gWXY'**A Uf_hd`Uhn**i]ghiY]b VY`]YVhYfʻHfYZZdi b_hžʻXYfʻcZhij cbʻGhfU»Yba i g]_Yfbii bX'?Øbgh`Yfb VY`YVh`k]fX"'<]Yf`_Ubbia Ub'Y]bYbʻ5dYf]h]Z`[Yb]Y»Ybii bX`XYa `YV\UZhYb`HfY]VYbini gY\Yb"

: Øf'?i bgh!i bX'; YgW\]W\hg]bhYfYgg]YfhY'`c\bh'g]W\'Y]b'6Ygi W\'XYg GhUXha i gYi a gž'XUg'g]W\']b'Y]bYa 'XYf'\]ghcf]gW\Yb'; YVÀi XY #bg[YgUa h'V]YhYh'X]Y'\]ghcf]gW\Y'5`hghUXh'j cb'Fchhk Y]`'Y]bY
Y]bn][Ufh][Y'A]gW\i b['Ui g'; YgW\]W\hYž'?i `hi f'i bX'@YVYbgZfYi XY"
CV'VY]a '9f_i bXYb'XYf'_`Y]bYb'; UggYbž'VY]a '; Yb]Y» Yb'XYf
`c_U`Yb'?ØW\Y'cXYf'VY]a '6Yk i bXYfb'XYf'VYY]bXfi W_YbXYb
5fW\]hY_hi f' 'Fchhk Y]`g'5`hghUXh']gh'Y]b'Cfhž'XYf'i bj Yf[Ygg`]W\Y
9]bXfØW_Y'\]bhYf`Aggh'i bX'ni a 'JYfk Y]`Yb'Y]b`AXh'': Øf'k Y]hYfY
#DZcfa Uh]cbYb'ØVYf'X]YgY'k i bXYfgW\ObY'GhUXh'VYgi W\Yb'G]Y'X]Y'
c ZZ]n]Y``Y'K YVgY]hY'j cb'Fchhk Y]`"

8]Y < O\Ydib_hY XYf Fchhk Y]`Yf: UghbUW\h

 $8]Y F chhk Y] Yf: Ughb UWk hi]gh Y]b Zuf VYb Zf c Yg ii b X YV V UZh Yg Gd Y_hU_Y Zi X Ug 'A Yf] Wk HUi g Yb X Yij cb 'A Yb g Wk Yb 'Ub n] Y \h'' 8] Yg Y Hf U X]h]c b Zi X] Yih] Y Zi]b 'X Yf'; Yg Wk] Wk h Yi X Yf 'Gh U X hij Yf kii fn Yihi]gh Zi Yfgh f Y W_hig] Wk 'Ø V Yf a Y V f Yf Y K c Wk Yb Zi]b 'X Yb Yb 'X] Yi 6 Yk c Vb Yf i b Xi 6 Ygi Wk Yfi]b 'Y] b Yi K Yihij c 'Yyf 'A Ug_Yb Zi Aig]_ ii b Xi Zf O Vi] Wk Yf : Y] Yf b 'Y] b hUi Wk Yb '' 8] Yi: Ughb U Wk h Zi X] Yink] g Wk Yb 'X Ya' 8 c b b Yfgh U[j cf '5 g Wk Yfa] hhk c Wk ii b Xi X Ya': Ug Wk] b [g X] Yb gh U[i [YZY] Yf hik] f X Zi Ygh [Yik Ub X Yihi X] Yi V] gh cf] g Wk Yi Gh U Xhijb 'Y] b 'd i 'g] Yf Yb X Yg : Ygh [Yik D X Y'']$

8]Y'JcfVYfY]hi b[Yb'ZØf'X]Y'Fchhk Y]'Yf': UghbUWkh'VY[]bbYb'cZh gWkcb'AcbUhY']a 'JcfUi g"'JYfgWk]YXYbY'BUffYb[fi ddYbž'X]Y'Ui g 6Øf[Yfb'XYf'GhUXh'i bX'XYf'I a [YVi b['VYghY\Ybž'k]Xa Yb'g]WkXYa '9bhk i fZ'i bX'XYf'<YfghY'`i b[']\fYf'_cghVUfYb'?cghØa Y" 8]YgY'5i gUfVY]hi b[Yb'nY]WkbYb'g]Wk'Xi fWk'`YVYbX][Y': UfVYbž j]Y'ZÀ`h][Y'AUhYf]U`]Yb'i bX'cZha U`g'Ui Wk'dcfnY``UbY; Yg]Wk hga Ug_Yb'Ui gž'X]Y'; YgWk]WkhYb'Ui g'XYf'HfUX]h]cb'i bX'?i `hi f'XYf'FY[]cb'YfnÀ\`Yb"

9]b'< \dot{O} \Ydi b_h'XYf': UghbUW\h']gh'XYf'hfUX]h]cbY``Y'I a ni [ž'XYf']b XYf'FY[Y``Ua :: UgbUW\hgX]YbghU['ghUhhZ]bXYh"'8]YgY'gdY_hU_i `ÀfY DUfUXY'n]Y\h'g]W\'Xi fW\'X]Y'Yb[Yb'; UggYb'XYf'5`hghUXh'Fchhk Y]`g i bX'VY[Y]ghYfh'\$\dangle\$ b['i bX'5`h"'8]Y'BUffYb[fi ddYb'n]Y\Yb'a]h

8]Y'BUffYbZ][ifžX]Y']b'FchhkY]`Y]bY'VYgcbXYfY'Fc``Y'gd]Y`hž']gh
XYf'FchhkY]`Yf'NibZhbUff"'GY]b'aUg_Yb\UZhYg'; Yg]W\hž'_caV]b]Yfh
a]h'Y]bYa'UiZkYbX][Yb'?cghØaž'fYdfÀgYbh]Yfh'X]Y'HfUX]h]cb'ibX
XYb'<iacf'X]YgYf'VYgcbXYfYb'NY]h"'5`g'HY]``XYf':Y]Yf`]W_Y]hYb
Yf\À`h'XYf'NibZhbUff'X]Y'k]W\h][Y'5iZ[UVYž'XYb'GW\UhhYb'XYf
Gcf[Yb'VY]gY]hY'ni'gW\]YVYb'ibX'X]Y'AYbgW\Yb'ni'Y]bYa
ibVYgW\kYfhYb':Y]Yfb'ni'Yfaih][Yb"'

8 c W 'X]Y : Ughb U W h']b 'F c hhk Y]`']gh 'b] W h b i f 'U i Z' X Y b '[fc » Y b I a n i ['Zc_i gg]Y fh '' K À\fY b X 'X Y f ': Y ghhU[Y 'Z]b X Y b 'n U \ `fY] W Y J Y f U b gh U h i b [Y b 'gh U h ž' X]Y 'gc k c \ `' ZØf '9]b \ Y]a]g W Y 'U `g 'U i W 'ZØf H c i f]gh Y b 'c ZZ Y b 'g]b X "' A Ò[`] W _Y]h Y b 'i a ZUgg Y b.

- ?cghØa VÀ``Y` 8]YgY'6U``gU`cbg'g]bX'Y]bY'[fc»Ufh][Y
 ;Y`Y[Yb\Y]hž']b'X]Y'ZYgh`]WXY'5ha cgd\ÀfY'Y]bni hUi WXYb
 ibX'g]WX']b'_fYUh]jY'?cghØa Y'ni '_`Y]XYb"
- GhUXhZØ\fib[Yb**GdYn]Y**Y*: Ø\fib[Yb*k YfXYbUb[YVchYbžia 'X]Y*; YgWX]WXhY*XYf*: UghbUWXh*niYf*Ài hYfb*i bX*XYb*6Ygi WXYfb*Y]bYb*9]bV*]W_*]b*X]Y6fÀi WXY*ni**[YVYb**
- ?i bgh\UbXk Yf_Yfa Àf_hY` '8]Yg`g]bX`CfhYž`Ub`XYbYb
 `c_U`Y`?Øbgh`Yf`]\fY`K Yf_Y`dfÀgYbh]YfYb`i bX`j Yf_Ui ZYbž
 j cb`A Ug_Yb`V]g`\]b`ni `\UbX[YZYfh][hYb`Gci j Yb]fg"

8]Y'JYfV]bXi b['ni f'FY[]cb'nY][h'g]W\'b]W\h'bi f']b'XYb
: Ygh`]W_Y]hYbž'gcbXYfb'Ui W\']b'XYf'FY[]cbU`]hÀh'XYf'GdY]gYb'i bX
; YhfÀb_Yž'X]Y'k À\fYbX'XYf': UghbUW\h'gYfj]Yfh'k YfXYb"'Hmd]gW\Y
; Yf]W\hY'i a ZUggYb'j YfgW\]YXYbY'K i fghl'i bX'?ÀgYgcfhYbž'X]Y
ni gUa a Yb'a]h'`c_U``[YVfUi hYa '6]Yf'[YbcggYb'k YfXYb'_ObbYb"
6Ygi W\Yf'_ObbYb'Ui W\': UgbYhg_ØW\`Yž'Y]b'hfUX]h]cbY``Yg'; YVÀW_ž
dfcV]YfYbž'XUq'gdYn]Y``ni 'X]YgYf'NY]h'ni VYfY]hYh'k]fX"

 $8\,]Y\,F\,c\,hhk\,Y\,]\,Y\,f\,:\,Ughb\,U\,W\,h\,'\,]gh\,'\,b\,]\,W\,h\,'\,b\,i\,f\,'\,Y\,]b\,'\,:\,Y\,gh\,'\,Z\!\emptyset f\,'\,X\,]Y\,'\,5\,i\,\left[\,Y\,b\,z\,\right]$

gcbXYfb`Ui W\`ZØf`X]Y`C\fYb"8]Y`ZYgh`]W\Y`A i g]_`fY]W\h'j cb
hfUX]h]cbY``Yb`A ÀfgW\Yb`V]g`\]b`ni 'a cXYfbYb`?`Àb[Ybž'X]Y`Ui g
XYb`: YbghYfb`XYf`j]Y`Yb`HUj YfbYb`i bX`7UZÅg`gW\U``Ybž'X]Y`XYb
FUi a 'i a 'XYb`A Uf_hd`Uhn`Y]bbY\a Yb"'8]YgY`ZYgh`]W\Y
; YfÀi gW_i`]ggY`]gh`Y]b`i bj Yfn]W\hVUfYf`6YghUbXhY]``XYf
: UghbUW\h'i bX`hfÀ[h'ni f`U``[Ya Y]bYb`Gh]a a i b[`VY]"

± XYb \ Yi h][Yb \ NY]hYb \ Uh X]Y \ F c hhk Y] \ Yf : Ughb UW h \ Ui W \ Y]b Y k]W h][Y \ F c \ Y \]b \ XYf \ Ya Y]b gW UZhgV] \ Xi b [" : Ua] \]Yb \ Z : fYi b XY i b X \ B UW V Ufb \ _ca a Yb \ ni gUa a Yb \ Z i a \ X]Y \ : Y]Y fhU[Y \ ni \ ZY]Y fb \ Z \]\ fY \ HfUX]h]c b Yb \ k Y]hY fni [YVYb \ i b X \ X Ug \ c _ U \ Y \ 6 fUi W \ hi a \ Ua \ @YVYb \ ni \ \ U \ hYb \ "8]YgY \ Ni gUa a Yb _ Øb ZhY \ hfU[Yb \ X Uni \ VY] \ Z \ XYb gc n]U \ Yb \ Ni gUa a Yb \ U \ h']b \ F c hhk Y] \ `ni \ gh\ f_Yb \ i b X \ Y]b \ ; Y \ ZØ\ \ XYf \ Ni [Y\ Of][_Y]h \ ni \ Yfn Yi [Yb "

9]b 'VYgcbXYfg'VYY]bXfi W_YbXYf'5gdY_h'XYf'Fchhk Y]'Yf': UghbUWk h]gh'X]Y 'HY]'bU\a Y'XYf'\$ [YbX"'J]Y'Y'' h b[Y'@Yi hY'Yb[U[]YfYb'g]Wk U_h]j ']b 'XYb 'B UffYb[fi ddYb'i bX'Vf]b[Yb'Zf]gWkYb'K]bX']b 'X]Y hfUX]h]cbY``YfYb': Y]Yf`]Wk_Y]hYb"'8 UXi fWk'YbhghY\h'Y]bY'A]gWki b[Ui g'5`h'i bX'BYi \check{z} ']b'XYf'X]Y'HfUX]h]cb'[Yk U\fh'V`Y]Vh \check{z} 'ni [`Y]Wk UVYf'Ui Wk'a cXYfbY'9]bZØggY'9]bni ['\U`hYb"'8]YgY'XmbUa]gWkY9bhk]\w_`i b['nY][h'g]Wk'b]Wk h'bi f']b'XYb'?cghØaYb \check{z} 'gcbXYfb'Ui Wk |b'XYf'5fh'i bX'KY]gY \check{z} k]Y'X]Y': Y]Yf`]Wk_Y]hYb'[Yd`Ubh'i bX Xi fWk[YZØ\fh'kYfXYb"

8]Y'Fchhk Y]'Yf': UghbUWkh']gh'a Y\f'U`g'bi f'Y]bY': Y]Yf' 'g]Y']gh'Y]b
: Ygh'j cb'; Ya Y]bgWkUZhž'?i `hi f'i bX'HfUX]h]cb"'K Yf'X]Y
; Y'Y[Yb\Y]h'\Uhž'k À\fYbX'X]YgYf'ZYgh`]WkYb'NY]h']b'Fchhk Y]`'ni
gY]bž'gc``hY'i bVYX]b[h'Ub'XYb': Y]Yf`]Wk_Y]hYb'hY]`bY\a Yb"
K Y]hYfY'\DZcfa Uh]cbYb'i bX'U_hi Y``Y'HYfa]bY'g]bX'Ui Z'XYf
cZZ]n]Y``Yb'K YVgY]hY'XYf'GhUXh'Fchhk Y]`"XY'ni 'Z]bXYb"

?i`]bUf]gWXY'; YbØggY']b'Fchhk Y]`i bX I a [YVi b[

Fchhk Y]`ž'U`g'Y]bY'XYf'À`hYghYb'GhÀXhY'6UXYb!K ØfhhYa VYf[gžV]YhYh'b]W\h'bi f'Y]bY'fY]W\Y'; YgW\]W\hY'i bX'VYY]bXfi W_YbXY 5fW\]hY_hi fž'gcbXYfb'Ui W\'Y]bY'j]Y`ZÀ`h][Y'_i`]bUf]gW\Y

@UbXgW\UZhžX]Y`gck c\``6Yk c\bYf`U`g`Ui W\`FY]gYbXY`VY[Y]ghYfh" 8]Y`FY[]cb`]gh`VY_Ubbh`ZØf`]\fY`hfUX]h]cbY``Yb`; Yf]W\hYž``c_U`Y GdYn]U`]hÀhYb`i bX`Y]bY`Z`cf]YfYbXY`; Ughfcbca]YgnYbY"'<]YfYbXYW_Yb`G]Yžk Ug`X]Y`FY[]cb`_i `]bUf]gW\`ni `V]YhYb`\Uh°

9]bY'XYf'VY_UbbhYghYb'8Y`]_UhYggYb'Ui g'Fchhk Y]`']gh'X]Y'
Fchhk Y]`Yf'K i fgh"'8]YgY'\Yfn\UZhYb'K i fghk UfYb'k YfXYb'j cb
`c_U`Yb'A Yhn[Yfb'[YZYfh][h'i bX'g]bX'Y]b'5i gXfi W_'XYf
\UbXk Yf_`]WXYb'HfUX]h]cb"'=XYU`'ni a 'DfcV]YfYb'g]bX'X]Y
j YfgWX]YXYbYb'GcfhYbž'XUfi bhYf'X]Y'Fchhk Y]`Yf'A Yhhk i fgh'i bX
X]Y'Fchhk Y]`Yf'@UbXk i fghž'X]Y'VY]XY'dYfZY_h'ni 'Y]bYa '; `Ug
fY[]cbU`Ya'K Y]b'cXYf'6]Yf'dUggYb"

B]Wkhini ij Yf[YggYbig]bXiX]YiA Ui `VfcbbYfi? ÀgYžiX]Yi]biXYf
I a [YVi b[idfcXi n]Yfhik YfXYb"i8]YgYi? ÀgYgcfhYbi\ Ufa cb]YfYb
k i bXYfVUfia]hiXYfi`c_U`YbiK i fghii bXig]bXicZhiUi ZiXYb
GdY]gY_UfhYbiXYfiFYghUi fUbhgii bXi; Ugh\ ÒZYini iZ]bXYb"i8]Y
?ca V]bUh]cbiUi gik Øfn][Ya i? ÀgYii bXiXYZh][YbiK i fghk UfYbigcf[h
ZØfiY]bii bj Yf[Ygg`]WkYgi; YgWka UW_gYf`YVb]g"

HfUX]h]cbY``Y'; Ugh\Ài gYf'i bX'a cXYfbY FYghUi fUbhg

±b 'F c hhk Y]``[]Vh'Yg'nU\`fY]WXY'[Ya Øh`]WXY'; Ugh\Ài gYf'i bX
a cXYfbY 'F YghUi fUb hgž'X]Y 'gck c\``hfUX]h]cbY``Y'U`g'Ui WX'_fYUh]j Y
; Yf]WXhY'UbV]YhYb"'<]Yf'g]bX'Y]b][Y'XYf'VY`]YVhYghYb'@c_U`Y.

- FYghUi fUbh'@Òk Yb. '9]b'hfUX]h]cbY``Yg'; Ugh\Ui g'a]h gWkÀV]gWkYf'?ØWkY'i bX'Y]bYf'Y]b`UXYbXYb'5ha cgd\ÀfY"
- Fchhk Y]`Yf`6fUi \Ui g. '6Y_Ubbh'ZØf`\Ui g[YVfUi hY'6]YfY i bX'Y]bY'[fc»Y'5i gk U\``Ub'`c_U`']bgd]f]YfhYb'GdY]gYb"
- 9ggn]a a Yf'Fchhk Y]`.'9]b'FYghUi fUbhž'XUg'g]WX'Ui Z
 _fYUh]j Yž'gU]gcbU`Y'?ØWXY'gdYn]U`]g]Yfh'\Uh'i bX'fY[]cbU`Y
 Ni hUhYb'j Yfk YbXYh"

8]Y'_i`]bUf]gWXYb'<Ò\Ydib_hY'jcb'FchhkY]`'g]bX'b]WXh'bif'UiZ FYghUifUbhVYgiWXY'VYgWXfÀb_h"'5iWX'X]Y'6UiYfbaÀf_hY'XYf FY[]cb'`UXYb'XUni'Y]bž'`c_U`Y'DfcXi_hY'ni'YbhXYW_Yb'ibX'X]fY_h VY]a '9fnYi [Yf'Y]bni _Ui ZYb"'<]Yf'Z]bXYb'G]Y'Zf]gWXYg'CVghž; Ya ØgYž'?ÀgYž'K i fghk UfYb'i bX'j]Y'Y'UbXYfY'?Ògh`]WX_Y]hYbž'X]YG]Y'a]h'bUWX'<Ui gY'bY\a Yb'cXYf'j cf'Cfh'[Yb]Y»Yb'_ÒbbYb"

K Y]b i bX 6]Yf Ui g XYf FY[]cb

8]Y'K Y]bfY[]cb'fi bX'i a 'Fchhk Y]`']gh'YVYbZU``g'VYa Yf_Ybgk Yfh'' 8]Y'K Y]b[ØhYf']b'XYf'I a [YVi b['V]YhYb'YI nY``YbhY'K Y]bYž]bgVYgcbXYfY'Ui g[YnY]W\bYhY'GdÀhVi f[i bXYf!'i bX'F]Yg`]b[! GcfhYb"'J]Y`Y'K Y]b[ØhYf``UXYb'ni 'K Y]bdfcVYb'Y]bž'k c'G]Y'X]Y K Y]bY']b'[Ya Øh`]W\Yf'5ha cgd\ÀfY'j Yf_cghYb'_ObbYb"

K Ybb'G]Y'6]Yf']YV\UVYf'g]bXž'gc``hYb'G]Y'i bVYX]b[h'XUg' Fchhk Y]`Yf'6]Yf'dfcV]YfYb"'8]Y'GhUXh'\Uh'Y]bY'`Ub[Y 6fUi hfUX]h]cbž'i bX'X]Y'`c_U`Y'6fUi YfY]'ghY``h'j YfgW\]YXYbY 6]YfgcfhYb'\Yfž'X]Y'g]W\']XYU``ni 'XYb'hfUX]h]cbY``Yb'; Yf]W\hYb _ca V]b]YfYb'`UggYb"'Jcb'<Y``Yg'V]g'8i b_`Ygž'\]Yf']gh'ZØf'YXYb ; YgW\a U\W_'Yhk Ug'XUVY]°

GØ» Y J Yfgi Wib [Yb

BUhØf`]WX '_ca a Yb'Ui WX 'X]Y'BUgWX_UhnYb'b]WX h'ni '_i fn"'Fchhk Y]`V]YhYh'Y]bY'J]Y`nU\`'j cb'?UZZYY\Ài gYfb'i bX'6ÀW_YfY]Ybž']b'XYbYbG]Y'X]Y'fY[]cbU`Yb'GØ» gdY]gYb'dfcV]YfYb'_ObbYb"'9]b'hmd]gWXYg gØ» Yg'; YVÀW_ž'XUg'G]Y'b]WXh'j YfdUggYb'gc``hYbž']gh'XYf'Fchhk Y]`Yf'6]VYfž'Y]b'@YV_i WXYbž'XYf'a]h'Y]bYf'gØ» Yb': Ø``i b[Ui g[YghUhhYh']gh''9f']gh'dYfZY_h'ZØf'XYb'BUWXa]hhU['ni 'Y]bYf'HUggY?UZZYY'cXYf'HYY"

9]b'k Y]hYfYg'<][\`][\h']gh'XUg'GW k Ufnk À`XYf'?]fgW hcfhYž'X]Y]b'j]Y`Yb'7UZÅg'Ub[YVchYb'k]fX"'8]YgY'_Ogh`]WXY'HcfhY']gh'b]WXhbifY]bY'; Ui a YbZfYi XYž'gcbXYfb'Ui WX'Y]bY'k U\f\UZh][Y5i[YbkY]XY'a]h']\fYb'GWX]WXhYb'Ui g'6]g_i]hž'GU\bY'i bX?]fgWXYb"

?i`]bUf]qWXYJYfUbqhU`hib[Yb'ibX:YghY

 $K Ybb G]Y X]Y _i `]bUf]gWX Y J]Y `ZU `h `F c hhk Y] `g `f]WX h][~Yf `YVYb \\$

a ÒW hYbž'd`UbYb'G]Y' → fY'FY]gY'i a 'Y]bYg'XYf'j]Y`Yb
_i`]bUf]gW Yb': Ygh]j U`gž'X]Y'fY[Y`a À»]['ghUhhZ]bXYb"

J YfUbghU`hi b[Yb'k]Y'XUg'Fchhk Y]`Yf'GhUXhZYgh'V]YhYb'X]Y

A Ò[`]WX_Y]hž'j YfgW]YXYbY'`c_U`Y'GdYn]U`]hÀhYb'ni 'dfcV]YfYb'i bX

]b'X]Y'`YVYbX][Y'5ha cqd\ÀfY'XYf'GhUXhY]bni hUi WXYb"

Ni gUa a YbZUggYbX``Àggh'g]W\'gU[Ybž'XUgg'Fchhk Y]``b]W\h'bi f'a]h \]ghcf]gW\Yb'GY\Ybgk \emptyset fX][_Y]hYbž'gcbXYfb'Ui W\'a]h'Y]bYf gdUbbYbXYb'_i `]bUf]gW\Yb'GnYbY'Ui Zk UfhYh''9[U`ž'cV'G]Y hfUX]h]cbY``Y'? \emptyset W\Y'cXYf'a cXYfbY' \oplus bhYfdfYhUh]cbYb'VYj cfni [Ybž\]Yf'Z]bXYb'G]Y'Ui Z'YXYb: U```Yhk Ugž'XUg' \oplus bYb'gW\a YW_h°

BUhi fYf`YVb]ggY`]a `GWXk Ufnk U`X`fi bX`i a Fchhk Y]`

 $8 \ Yf'GW\ k\ Ufnk\ U`X']gh'b]W\ h'bi\ f'Y]bY'XYf']_cb]gW\ ghYb \\ @UbXgW\ UZhYb'8 \ Yi\ hgW\ `UbXgZ'gcbXYfb'Ui\ W\ 'Y]b'k\ U\ fYg'DUfUX]Yg \\ ZØf'BUhi\ f`]YV\ UVYfZ'XUg'g]W\ 'X]fY_h'j\ cf'XYb'HcfYb'XYf \\ W\ Ufa\ UbhYb'GhUXh'Fchhk\ Y]`'YfghfYW_h''A]h'gY]bYb'X]W\ hYb \\ K\ A`XYfbZ'gUbZhYb'<0[Y`b'i\ bX'[`]hnYfbXYb'GYYb'V]YhYh'X]Y'FY[]cb \\ nU\`fY]W\ Y'A O[`]W_Y]hYbZ'X]Y'GW\ Ob\Y]h'XYf'BUhi\ f'ni\ 'Yf_i\ bXYb i\ bX'ni\ [Yb]Y\ Yb'''$

9]b'VY`]YVhYg'N]Y`ZØf'K UbXYfYf']gh'XYf'GWkk Ufnk U`X\cWkghfU» Yž Y]bY'a U`Yf]gWkY'Fci hYž'X]Y'g]Wk'Xi fWk'X]Y'FY[]cb'n]Y\h'i bX UhYa VYfUi VYbXY'5i gV`]W_Y'Ui Z'X]Y'i a `]Y[YbXYb'@UbXgWkUZhYb V]YhYh''8]Y'j YfgWk]YXYbYb'K UbXYfk Y[Y'V]YhYb'ZØf'YXYg :]hbYgg`Yj Y``Yhk Ug''9[U`ž'cV'Xi 'Y]bY'[Ya Øh`]WkY'K UbXYfi b['cXYf Y]bY'Ubgdfi Wkgj c``YfY'Hci f'gi Wkghž'XYf'GWkk Ufnk U`X'\Uh'ZØf YXYb'Yhk Ug'ni 'V]YhYb''Ni 'XYb'Ya dZY\`Ybgk YfhYb'K UbXYfi b[Yb [Y\ÒfYb.

- : Y`XVYf['FibXk Y[' '8]YgY'Hcif'fibX'ia 'XYb'\ÒW\ghYb 6Yf[']a 'GW\k Ufnk U`X'ZØ\fh'XifW\'ibVYfØ\fhY'BUhif'ibX Yfa Ò[`]W\h'UhYa VYfUiVYbXY'DUbcfUaUV`]W_Y"
- K i hUW gW `i W h '9]b'VYY]bXfi W_YbXYg'BUhi ffYgYfj Uhž XUg'g]W 'dYfZY_h'ZØf'Y]bY'UVYbhYi Yf`]W Y'K UbXYfi b['a]h UhYa VYfUi VYbXYb'5i gV`]W_Yb'Ui Z'X]Y'GW `i W h'Y][bYh"

6Yf[k UbXYfib['nia'<cWXZ]fgh''6]YhYh'ZUgn]b]YfYbXY
 5i gV`]W_Y'Ui Z'XYb'H]h]gYY'i bX'X]Y'k i bXYfVUfY'BUhi f'fi bX
 ia'X]Y'FY[]cb"

BYVYb`XYa 'K UbXYfb'[]Vh'Yg']a 'GWk Ufnk U`X`Ui Wk`nU\`fY]WkY FUXk Y[Yž'X]Y'g]Wk`\Yfj cffU[YbX`ZØf'A ci bhU]bV]_Yf'i bX [Ya Øh`]WkY`FUXZU\fYf'Y][bYb"'8]Y`FY[]cb`\Uh'Y]b`k Y]h`Ài Z][Yg BYhn'j cb`FUXk Y[Yb`Ybhk]W_Y`hž'XUfi bhYf'X]Y`GWk Ufnk U`X! FUXfci hYž'X]Y`X]f`X]Y`A Ò[`]Wk_Y]h`[]Vhž'X]Y`ZUbhUgh]gWkYb @UbXqWkUZhYb`]a 'Y][YbYb`HYa dc`ni 'YbhXYW_Yb"'

K Ybb'Xi 'XUg'K UggYf'`]YVghž'XUbb'g]bX'X]Y'j]Y`Yb'GYYb']a

GWk K Ufnk U'X'Y]bY'k i bXYfVUfY'A Ò[`]Wk_Y]hž'Y]bYb

YbhgdUbbYbXYb'HU['ni 'j YfVf]b[Yb"'8Yf'H]h]gYY'i bX'XYf

GWk'i WkgYY'g]bX'nk Y]'XYf'VY_UbbhYghYb'GYYbž'k c'5_h]j]hÀhYb'k]Y

GWk k]a a Ybž'GY[Y'b'i bX'6cchZU\fYb'gY\f'VY`]YVh'g]bX"'8Yf

H]h]gYY']gh'VYgcbXYfg'VYfØ\a h'ZØf'gY]b'[`Ug_`UfYg'K UggYf'i bX'X]Y

]Xm``]gWkY'I a [YVi b["'5b'XYb'I ZYfb'_Ubbgh'Xi 'Ui Wk'X]Y'Òfh`]WkY

; Ughfcbca]Y'[Yb]Y»Yb'i bX'_i`]bUf]gWkY'?Ògh`]Wk_Y]hYb'Ui g'XYf

FY[]cb'dfcV]YfYb"

: Øf:: Ua]`]Yb'[]Vh'Yg']a 'GWk Ufnk U`X'YXY'A Yb[Y'ni 'Yf`YVYb"
: fY]nY]hdUf_g'k]Y'XYf' 9i fcdU!DUf_ ']b'Fi gh'V]YhYb'Y]b
i a ZUggYbXYg'I bhYf\U`hi b[gdfc[fUa a 'ZØf'; fc»'i bX'?`Y]b"'<]Yf
_Ubbgh'Xi 'Ui ZfY[YbXY'5WkhYfVU\bZU\fhYb'Yf`YVYb'i bX']b'X]Y
K Y`h'XYf'ZUbhUgh]gWkYb'5hhfU_h]cbYb'Y]bhUi WkYb"'</pre>

9]b'k Y]hYfYg'<][\`][\h'g]bX'X]Y'j YfgWX]YXYbYb
B Uhi fYf`YVb]gdZUXYž'X]Y'gdYn]Y``ZØf'?]bXYf'i bX:: Ua]`]Yb
_cbn]d]Yfh'k i fXYb"'G]Y'_ca V]b]YfYb'GdU» i bX'6]`Xi b['i bX
ZØ\fYb'Xi fWX'X]Y'ZUgn]b]YfYbXY': `cfU'i bX': Ui bU'XYg
GWXk Ufnk U`Xg"'6YgcbXYfg'VY`]YVh'g]bX'X]Y'5VYbhYi YfdZUXYž'X]Y
]bhYfU_h]j Y'GhUh]cbYb'Ybh`Ub['XYg'K Y[Yg'V]YhYb"'<]Yf'YfZU\fYb
X]Y'6Ygi WXYf'gd]Y`Yf]gWX'a Y\f'ØVYf'X]Y'H]Yf!'i bX'DZUbnYbk Y`h
XYf'FY[]cb"

I a 'XYb'GW\k Ufnk U`X'VYggYf'_YbbYbni `YfbYbž'V]YhYb'j]Y`Y'`c_U`Y FY]gYZØ\fYf'[YZØ\fhY'Hci fYb'Ub"'8]YgY'Hci fYb'Yfa Ò[`]W\Yb'Ygž j YfghY W_hY 'GW\ Ob\Y]hY b 'i b X 'k Yb][Yf 'VY_Ub b hY 'K]b_Y``XYg GW\ k Ufnk U`XYg 'ni 'Yb hX Y W_Y b ž 'X]Y 'a Ub 'U``Y]b Y 'j]Y``Y]W\ h ØVYfgY\Yb 'k ØfXY"'G]Y 'fY]W\ Yb 'j cb '[YZØ\fhY b 'K Ub XYfi b[Yb 'V]g\]b 'ni 'Fi b XZU\fhY b 'a]h 'XYa 'A ci b hU]b V]_Y"

I bX k Ybb 'Xi 'bUW 'Y]bYa 'C fh'gi W ghži a 'Y]bZUW 'bi f'X]Y 'GYY 'Y VUi a Y`b 'ni '`UggYbž'[]Vh'Yg']a 'GW k Ufnk U`X 'j]Y 'Y 'Fi \Y! 'i bX 9bhgdUbbi b[gcfhY"'C V 'Ub 'Y]bYa 'fi \][Yb 'K U`XfUbXž'Ua 'I ZYf Y]bYg'[`]hnYfbXYb'GYYg'cXYf'Ui Z'Y]bYf'XYf'j]Y `Yb'@]W hi b[Ybž'X]Y B Uhi f'`ÀXh'XUni 'Y]bž']bbYni \U`hYb'i bX'X]Y'GW \Ob\Y]hYb'XYf I a k Y`h'ni '[Yb]Y» Yb"'

8]Y'JYfV]bXi b['j cb'5_h]j]hÀh'i bX'9f\c`i b['a UW\h'X]Y
BUhi fYf`YVb]ggY'fi bX'i a 'Fchhk Y]`'gc'VYgcbXYfg"'9[U`ž'cV'Xi 'Y]b
Ci hXccf!9bh\i g]Ugh'cXYf'Y]b'YbhgdUbbhYf'GdUn]Yf[Àb[Yf'V]gh.
8Yf'GW\k Ufnk U'X'k]fX'X]f'a]h'gY]bYb'VYY]bXfi W_YbXYb
@UbXgW\UZhYb'i bX'XYf'\Yff`]W\Yb'BUhi f'[Ubn'g]W\Yf
i bj Yf[Ygg`]W\Y'9f`YVb]ggY'V]YhYb"'

: Øf`k Y]hYfY`±bZcfa Uh]cbYb`ØVYf`XYb`GWk Ufnk U`X`i bX`X]Yia`]Y[YbXYb`5_h]j]hÀhYb`_Ubbgh`Xi 'X]Y`cZZ]n]Y``Y`K YVg]hY`GWk Ufnk U`X`Hcif]ga i g`VYgi W\Yb"

?ibghibX'?i`hif.'AigYYbibX'; U`Yf]Yb']b Fchhk Y]`

Fchhk Y]`ž'X]Y'À`hYghY'GhUXh'6UXYb!K ØfhhYa VYf[gž'V]YhYh'b]W\h'bifY]bY'VYY]bXfi W_YbXY'5`hghUXhž'gcbXYfb'Ui W\'Y]bY'J]Y`nU\`'j cb AigYYb'ibX'; U`Yf]Ybž'X]Y'X]Y'fY]W\Y'?ibgh!'ibX'?i`hif[YgW\]W\hYXYf'FY[]cb'k]XYfgd]Y[Y`b"'?ibgh`]YV\UVYf'ibX

?i `hi f]bhYfYgg]YfhY '_ca a Yb '\]Yf'Ui Z']\ fY '? cghYbž'k À\ fYbX'g]Y X]Y 'j]Y `ZÀ `h][Yb '5i gghY ``i b[Yb 'Yf_i bXYb"

 $9]b Yg : XYf `Yfj cfghY W Yb XghY b `A i gYYb `]b `F chhk Y]``]gh : XUg GhUXha i gYi a ž : XUg : g] W `]a ``]ghcf]g W Yb `5 `X]b [Yf `Ui g : VYZ]b XYh'' <]Yf `_ ObbYb `6 Ygi W Yf `]b : X]Y `; Yg W]W `hY : XYf `GhUXh : Y]b hUi W Yb ž X]Y `V]g `]bg `f Oa]g W Y `F Y] W `ni <math>f @ W_f Y$] W `h' : 8]Y `5 i gghY ``i b [Yb : g]b X gcf[Z\hat{A}`h]['_i fUh]Yfh `i b X `V]YhYb `9]b V`] W_Y `]b `j Yfg W]Y XYb Y NY]hd Yf]c XYb ž j cb `XYf `5 bh]_Y `V]g `ni f `B Yi nY]h'' `9]b `VYg cb XYf Yg <][\`][\h']gh : X]Y `GUa a `i b ['j cb `GU_f U`[Y[Ybgh \hat{A}b XYb `i b X ? i bghk Yf_Yb ž : X]Y `X]Y `Uf W]hY_hcb]g W Y `9bhk] W_`i b [`XYf `GhUXh j Yf Ubg W Ui `] W Yb''

9]b'k Y]hYfYf'k]Wkh][Yf'5b`Ui Zdi b_h']gh'X]Y'; Ò``Yf!?i bgh[U`Yf]Yž X]Y'XUg'K Yf_'`c_U`Yf'i bX'fY[]cbU`Yf'?Øbgh`Yf'dfÀgYbh]Yfh''<]Yf Z]bXYb'fY[Y`a À»]['K YWkgY`Ui gghY``i b[Yb'ghUhhž'X]Y']bbcj Uh]j YbnY]h[YbÒgg]gWkYb'?i bghgWkUZZYbXYb'Y]bY'D`UhhZcfa 'V]YhYb'''Jcb A U`YfY]'ØVYf': chc[fUZ]Y'V]g'\]b'ni '=bghU``Uh]cbYb''X]Y'; Ò``Yf!?i bgh[U`Yf]Y']gh'Y]b'_fYUh]j Yf'FUi a ž'XYf'ni a 'BUWkXYb_Yb'i bX GhUi bYb'UbfY[h''

9]b VYgcbXYfYg A Yf_a U`j cb Fchhk Y]``]gh'X]Y

J c[Y`VYcVUW hi b[gghUh]cb]a '<c\Yb ?fYi nYž'X]Y \Ufa cb]gW\`]b

X]Y I a [YVi b[']bhY[f]Yfh']gh" 8]YgY ``YVYbX][Y ?i bgh]bghU``Uh]cb

k i fXY [YgW\UZZYbž'i a 'XUg 6Yk i gghgY]b 'ZØf'X]Y \Y]a]gW\Y

J c[Y`k Y`h'ni 'gW\ÀfZYb'i bX'Y]b']bhYfU_h]j Yg '9f`YVb]g'ni 'V]YhYb"

6Ygi W\Yf'_ObbYb'b]W\h'bi f'XUg'?i bghk Yf_ [Yb]Y »Ybž'gcbXYfb

Ui W\X]Y ; Y`Y[Yb\Y]h'bi hnYbž'j YfgW\]YXYbY'J c[Y`UfhYb'ni

VYcVUW\hYb'i bX'a Y\f'ØVYf']\fY'@YVYbgk Y]gY'ni 'YfZU\fYb"

pAigYia #, U`Yf]Y`p`6YgWkfY]Vib[`p`6YgcbXYfY`AYf_aU`Y`p p !p

p'GhUXha i gYi a 'p'; YgW\]W\hY'Fchhk Y]`g'j cb'XYf'5bh]_Y'V]g'ni f
BYi nY]h'p'GU_fU`[Y[YbghÀbXY'i bX'?i bghk Yf_Y'p
p'; Ò``Yf!?i bgh[U`Yf]Y'p'D`UhhZcfa 'ZØf'`c_U`Y'i bX'fY[]cbU`Y'?Øbgh`Yf
p'FY[Y`a À»][Y'K YW\gY`Ui gghY``i b[Yb'p
p'Jc[Y`VYcVUW\hi b[qghUh]cb'p'+bhYfU h]j Y'+bqhU``Uh]cb'ni f

 $: \varnothing f : Ua]`]Yb : a]h??]bXYfb : g]bX:X]Y ? i bgh! i bX:? i `hi fUb[YVchYYVYbZU``g `UbgdfYW\YbX"`J]Y`Y `A i gYYb `V]YhYb : gdYn]Y```[YghU`hYhY : \varnothing\fi b[Yb : ZØf '\Øb[YfY '6Ygi W\Yf `Ubž '\ØVYfgd]Y`Yb '_ca d`Yl Y H\Ya Yb 'Ui Z'Y]bY i bhYf\U`hgUa Y i bX 'UbgdfYW\YbXY'K Y]gY"'9]b 6Y]gd]Y``\]YfZØf ']gh'X]Y `A i gYi a gYf`YVb]gZØ\fi b[<math>\check{z}$:X]Y '?]bXYfb Yfa $\check{O}[`]W\h\check{z}$:X]Y '5 i gghY``i b[Yb 'gd]Y`Yf]gW\ni 'Yf_i bXYb i bX [`Y]W\nY]h][']\fY '? fYUh]j]hÅh'ni 'YbhZU`hYb"

9]b'k Y]hYfYg'_i `hi fY``Yg'<][\`][\h']gh'X]Y'F chhk Y]`Yf'?i bghj YfY]bž XYf'fY[Y`a À»]['K cf_g\cdg'i bX'J YfUbghU`hi b[Yb'cf[Ub]g]Yfhž'i a _ \emptyset bgh`Yf]gW\Y'HU`YbhY'Ui g'XYf'FY[]cb'ni 'ZÒfXYfb'''<]Yf'\UVYb?i bgh]bhYfYgg]YfhY'X]Y'A Ò[`]W_Y]hž'gY`Vgh'U_h]j 'ni 'k YfXYbž'gY]'Yg Xi fW\'A U`!ž'NY]W\Yb!'cXYf': chc_i fgY'''

5V[YgY\Yb'] cb'XYb'AigYYb'ibX'; U`Yf]Yb'g]bX'UiW\'X]Y

ÒZYbh`]W\Yb'?ibgh]bghU``Uh]cbYb']b'Fchhk Y]`'Y]bYb'6YgiW\'k Yfh''

8]YgY'?ibghk Yf_Yž'X]Y'cZh'Ub'a Uf_UbhYb'CfhYb']b'XYf'GhUXh
d`Uhn]Yfh'g]bXž'Vf]b[Yb'X]Y'JYfV]bXib['nk]gW\Yb'\]ghcf]gW\Yf'ibX
nY]h[YbÒgg]gW\Yf'?ibgh'nia'5igXfiW_'ibX'a UW\Yb'X]Y'GhfU»Yb
j cb'Fchhk Y]`'ni'Y]bYf'`YVYbX][Yb'; U`Yf]Y']a': fY]Yb'''6YgcbXYfg
X]Y'G_i`dhifYb'fibX'ia'XYb'BYW_Uf'[Y\ÒfYb'ni'XYb
Y]bXfiW_gj c``ghYb'9`YaYbhYb'XYg'_i`hifY``Yb'GhUXhV]`XYg''

I bX'b]W\h'ni 'j Yf[YggYb. 'Fchk Y]`g''À\f`]W\Y'?i `hi fZYgh]j U`g'g]bX
Y]bY'k i bXYfVUfY'; Y`Y[Yb\Y]hž'X]Y'`c_U`Y'?i bghgnYbY'ni 'Yf`YVYb"
K À\fYbX'X]YgYf': Ygh]j U`g'k]fX'X]Y'GhUXh'ni 'Y]bYa '_fYUh]j Yb
NYbhfi a ž'XUg'? Øbgh`Yfž'A i g]_Yf'i bX'H\YUhYf[fi ddYb'Ui g'XYf
[YgUa hYb'FY[]cb'Ubn]Y\h''Gc`W\Y'9j Ybhg'ZÒfXYfb'XYb'5i ghUi gW\
i bX'Vf]b[Yb'bYi Y'=XYYb'i bX'DYfgdY_h]j Yb']b'XUg'_i `hi fY``Y
@YVYb'XYf'GhUXh''

8]Y?ca V]bUh]cb'Ui g'\]ghcf]gW.Ya '9fVYž'a cXYfbYa ?i bghgW.UZZYb'i bX'Y]bYf'`YVYbX][Yb'?i `hi fj YfUbghU`hi b[ggnYbY a UW.h'F chhk Y]`'ni 'Y]bYa 'ZUgn]b]YfYbXYb'N]Y``ZØf'?i bghl'i bX ?i `hi f]bhYfYgg]YfhY"'CV'Yg'g]W.'i a 'Y]bYb'YbhgdUbbhYb'6Ygi W.']b Y]bYa 'A i gYi a '\UbXY`h'cXYf'i a 'X]Y'U_h]j Y'HY]`bU\a Y'Ub'Y]bYa $\label{eq:cd'} K\ cf_g\cd'\ F\ chhk\ Y\]``V\]Y\ hY\ h'\ ZØf'\ Y\ XY\ b\ Y\ hk\ Ug'i\ b\ X\ ``A\ Xh'\ X\ Uni\ 'Y\]b\ z\ X\]Y\ '_fY\ Uh\]j\ Y\ 'GY\]hY\ 'X\ Y\ f'\ GhU\ Xh'\ ni\ 'Y\ b\ hX\ Y\ W_Y\ b''$

: Øf'k Y]hYfY' ≠ Zcfa Uh]cbYb'ØVYf'Fchhk Y]`g'?i bgh!'i bX
?i `hi fUb[YVchY'`c\bh'g]W\'Y]b'6`]W_'Ui Z'X]Y'cZZ]n]Y``Y'K YVgY]hY.'
fchhk Y]`"XY"'

5 i gZ`i [gn]Y`Y`ZØf`X]Y`[UbnY`: Ua]`]Y`]b`XYf FY[]cb`Fchhk Y]`

 $8]Y FY[] cb'fi bX'i a `Fchhk Y]``V]YhYh'nU\`fY]WXY'5i gZi [gn]Y`Yž'X]Y ZØf': Ua]`]Yb'YXYb'5`hYfg'UhhfU_h]j 'g]bX''CV'BUhi fž'5VYbhYi Yf cXYf'gdUbbYbXY'6]`Xi b[gUb[YVchY' `\]Yf']gh'ZØf'YXYb'Yhk Ug XUVY]'''<]Yf'g]bX'Y]b][Y'UVk YWXg`i b[gfY]WXY'i bX _]bXYfZfYi bX`]WXY'N]Y`Yž'X]Y'<math>\Rightarrow$ fYb'6Ygi WX']b'Fchhk Y]` i bj Yf[Ygg`]WX 'a UWXYb'k YfXYb''

%" 9f`YVb]gdUf_ Hf]dgXf]``

Bi f'Y]bY'_i fnY'5i hcZU\fh'j cb'Fchk Y]`YbhZYfbhž'VYZ]bXYh'g]W\'XYf' $9f`YVb]gdUf_`Hf]dgXf]``"8]YgYf': fY]nY]hdUf_`k i fXY'%- &-YfÒZZbYh'i bX'V]YhYh'ØVYf'%$$'5hhfU_h]cbYbž'XUfi bhYf'Ui ZfY[YbXY: U\f[YgW\AZhYž'X]Y'gck c\``ZØf'_`Y]bY'U`g'Ui W\'ZØf'[fc\'Y Y SVYbhYi Yf'i gh][Y'[YY][bYh'g]bX"'8]Y'JcfghY``i b[Yb'i bX'G\ck g']a DUf_`g]bX'Y]b'k Y]hYfYf'<<math>O$ \Ydi b_h'i bX'Vf]b[Yb'X]Y'[UbnY': Ua]`]Y ni a '@UW\Yb'i bX'GhUi bYb"

&"'H]YfdUf_'; c`X]b[Yb

BUhi fidi f ``XUg`]gh`XUg`A chhc`XYg`H]YfdUf_g`; c`X]b[Ybž`XYf`]bY]bYf`k i bXYfgW\ÒbYb`K U`X`UbXgW\UZh`Y]b[YVYhhYh`]gh'' <]Yf__ÒbbYb`X]Y`?]bXYf`Y]bY`J]Y`nU\``j cb`H]YfYb`\Ui hbU\`Yf`YVYbžXUfi bhYf.

- GWX UZY
- N]Y[Yb
-] O[Y.

8 Yf'DUf_'V]YhYh'gd]Y`Yf]gW\Y'@Yfba Ò[`]W_Y]hYb/'9]bnY`\Y]hYb ØVYf'X]Y'H]YfY'i bX'XYfYb'@YVYbgfÀi a Y'g]bX'Ui Z'GW\Ui hUZY`b Yf_`Àfh"'8]Y'[fc»nØ[][Yb'Gd]Y`VYfY]W\Y'a UW\Yb'Yg'a Ò[`]W\ž'XUgg ?]bXYf'g]W\'Ui ghcVYb'_ÒbbYb"

' "'K UW_Y`ghY]b'i bX'6UXYb!K ØfhhYa VYf[]gWXY 6i f[Yb

9]bY'K UbXYfi b['ni a 'K UW_Y`ghY]b']gh'Y]b'[fc*Ufh][Yg'Ci hXccf! 9f`YVb]g'ZØf'X]Y'[UbnY': Ua]`]Y"'8Yf'K UW_Y`ghY]b']gh'Y]b ZUgn]b]YfYbXYg'B Uhi fd\ \dot{A} bca Ybž'XUg'b]W\h'bi f'gdUbbYbX Ubni gY\Yb']ghž'gcbXYfb'Ui W\'Y]bY'\Yfj cffU[YbXY 5i gg]W\hgd`UhhZcfa 'V]YhYh''=\D'XYf'I a [YVi b['[]Vh'Yg'j]Y`Y'6i f[Ybni 'Yf_i bXYbž'XUfi bhYf'X]Y'6i f['<c\Ybnc``Yfb'i bX'X]Y'6i f[Nc``YfbžX]Y'fY]W\'Ub'; YgW\]W\hY'g]bX'i bX'gdUbbYbXY': \emptyset \fi b[YbUbV]YhYb"

("9IdYf]a YbhU 8Ug GW]YbWY 7YbhYf]b < Y] Vfcbb

9]b V]ggWXYb k Y]hYf k Y[ž UVYf]a a Yf bc W]bbYf\U`V Y]bYg
HU[YgUi gZi [g YffY]W VUfž]gh X]Y 9I dYf]a YbhU]b < Y]`Vfcbb"
8]YgYg]bhYfU_h]j Y GW]YbWY 7 YbhYf]gh dYfZY_h ZØf k]ggVY[]Yf][Y ?]bXYf i bX 9fk UWXgYbY [`Y]WXYfa U» Yb" 9]bY J]Y`nU\`j cb
9I dYf]a Ybh]YfghUh]cbYb i bX 5i gghY`i b[Yb ni H\Ya Yb k]Y
D\mg]_ž 6]c`c[]Y i bX HYWXb]_ ZÒfXYfh XUg @YfbYb Xi fWX Gd]Y`Yb"

) "'? `YhhYfk U`X Fchhk Y]`

 $: \emptyset f'UVYbhYi Yf'i gh][Y': Ua]`]Yb']gh'XYf'? `YhhYfk U`X'F chhk Y]`Y]bY'Ui ZfY[YbXY'A Õ[`]WX_Y]hž'NY]h']b'XYf'B Uhi f'ni 'j YfVf]b[Yb'' <]Yf'_ÕbbYb'X]Y'?]bXYf'i bX']\fY'9`hYfb']b'`i Zh][Yf'<Õ\Y']\fY ; YgWX]W_`]WX_Y]h'i bX']\fYb'A i h'hYghYb'''9g'[]Vh'j YfgWX]YXYbY DUfWci fgž'X]Y'Ub'X]Y': À\][_Y]hYb'j cb'j YfgWX]YXYbYb 5`hYfg[fi ddYb'Ub[YdUggh'g]bX'''G]WXYf\Y]h'k]fX'[fc*[YgWXf]YVYbži bX'U``Y'HY]`bY\a Yf'k YfXYb'[f\ØbX`]WX'Y]b[Yk]YgYbž'VYj cf'XUg 5VYbhYi Yf'VY[]bbYb' Ubb''$

* "AigYia XYg Fchhk Y] Yf A Ug_Yb i b X HUbnZYgh

: Øf'Y]bY'_i `hi fY``Y'6YfY]W\Yfi b['gcf[h'XUg'A i gYi a 'XYg
F c hhk Y]`Yf'A Ug_Yb'i bX'HUbnZYghYgž']b'XYa 'X]Y'HfUX]h]cb'XYf
: UghbUW\h'`YVYbX]['k]fX"' <]Yf'_ObbYb': Ua]`]Yb'j]Y`Yg'ØVYf'X]Y
6fÀi W\Yž'A Ug_Yb'i bX': YghY'XYf'FY[]cb'YfZU\fYb"'8Ug'A i gYi a
cf[Ub]g]Yfh'fY[Y`a À»]['K cf_g\cdg'i bX'J YfUbghU`hi b[Ybž'VY]
XYbYb'?]bXYf'gY`Vgh'_fYUh]j 'k YfXYb'_ObbYb"</pre>

+ "GdUn]Yf[Ub[Ybh`Ub[XYf6AfU

 $8 \ Ug`l \ ZYf`XYf`6 A fU`]gh`dYfZY_h`ZØf`Y]bYb`YbhgdUbbhYb`GdUn]Yf[\ Ub["5i \ Z`XYa `K \ Y[`_Ubb`X]Y`: Ua]`]Y`X]Y`BUhi f`[Yb]Y * Ybž`X]Y``c_U`Y : `cfU`i bX`: Ui bU`VYcVUW\hYb`i bX`Ua `K UggYf`gd]Y`Yb`cXYf d]W_b]W_Yb"`9g`[]Vh`nU\`fY]W\Y`K \ Y[\Yž`X]Y`G]Y`Xi \ fW\`a \ U`Yf]gW\Y @UbXgW\UZhYb`ZØ\\fYb`i \bX`nU\`fY]W\Y`Fi \\YncbYb`VY]b\\U`hYb"$

5i gZi [gn]Y`	9bhZYfbib[jcb	; YY][bYh'ZØf
	Fchhk Y]`	
9f`YVb]gdUf_	WU"'() '_a	: Ua]`]Yb a]h'?]bXYfb
Hf]dgXf]``		YXYb [·] 5`hYfg
H]YfdUf_; c`X]b[Yb	WU""&\$"_a	?`Y]b_]bXYf'i bX
		≯ [YbX`]WXY
?`YhhYfk U`X'Fchhk Y]`	j cf [·] Cfh	5VYbhYiYf`igh][Y
		: Ua]`]Yb
91 dYf]a YbhU	WU"', \$'_a	K]ggVY[]Yf][Y
		6Ygi WXYf

8]Y'A Ò[`]W_Y]hYb'ZØf: Ua]`]YbUi gZØ[Y']b'XYf'FY[]cb'Fchhk Y]` g]bX'j]Y`ZÀ`h]['i bX'UVk YW\g`i b[gfY]W\"'\XXYg'X]YgYf'N]Y`Y'V]YhYh X]Y'; Y`Y[Yb\Y]hž'[Ya Y]bgUa 'NY]h'ni 'j YfVf]b[Ybž'9f]bbYfi b[Yb ni 'gW\UZZYb'i bX'X]Y'bUhØf`]W\Y'gck]Y'_i `hi fY``Y'J]Y`ZU`h'XYf FY[]cb'ni '[Yb]Y\Yb"'9[U`ž'cV'G]Y'UWh]cbfY]W\Y'5VYbhYi Yf'cXYf YbhgdUbbYbXY'HU[Y']b'XYf'BUhi f'VYj cfni [Yb'']b'i bX'i a Fchhk Y]`'k YfXYb'G]Y'VYgh]a a h'ZØbX]["

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