

?`Y]XYfcfXbib['XYf'6`UiYb'AcgWXYY'ibX H]ddg'ZØf'XYb'9]bhf]hh

6]`XYf`i bX`FUhgW\`À[Yžk Ug`XYf`?`Y]XYfcfXbi b[`XYf`6`Ui Yb A cgWXYY`Ybhgdf]W\hi bX`k Ug`b]W\h''`9bh\À`h'H]ddg`ni f`VYghYb FY]gYnY]hii bX`k Ug`dUgg]Yfhžk Ybb`G]Y`Ub_ca a Yb`6Y]a Xf]hhYb`cXYf`j]Y``Y]W\hj]YfhYb`A U`ž'U`g`]W\`DYhYfg`9`hYfb`hfUZž j YfVfUW\hY`]W\`%\$`A]bi hYb`XUa]hž'a]W\`XUfØVYf`ni `Àf[Yfbž XUgg`a Y]b`CVYfhY]``ni `b]YXf][`k Uf"`DYhYf`j YfXfY\hY`X]Y 5i [Yb"`AY]bY`A i hhYf`hfÀ[hi a '<]a a Y`g`K]``Yb`h]YZYf [YgW\b]hhYbY`CVYfhY]`Y°` '\\X\``UW\hYžk UfZ'Y]bY`Ghf]W_^UW_Y ØVYf`i bX`k c``hY`[Y\Yb"'GY]bY`: Ua]`]Y`]gh`ni a '; `\ØW_'j]Y```]VYfU`Yf`U`g`a Y]bY"`AY]bY`6YgW\Y]XYb\Y]hgbYi fcgY``Y]b \VYfV`Y]VgY``a Y]bYfa i g`]a]gW\Yb`K i fnY`b````Àggh`a]W\\YXYg`A U`ž'k Ybb`]W\`a Y]bY`A i hhYf`VYgi W\Yž'U``Yg \/ Ua d\Y``]d/

6]`XYf'i bX'FUhgW\`À[Yž'k Ug'XYf'?`Y]XYfcfXbi b['XYf'6`Ui Yb A cgW\YY'Ybhgdf]W\h'i bX'k Ug'b]W\h'''9bh\À`h'H]ddg'ni f'VYghYbFY]gYnY]h'i bX'k Ug'dUgg]Yfhž'k Ybb'G]Y'Ub_ca a Yb

6Y]a 'Xf]hhYb'cXYf'j]Y``Y]W\h'j]YfhYb'A U`ž'U`g']W\'DYhYfg'9`hYfb'hfUZž j YfVfUW\hY']W\'%\$'A]bi hYb'XUa]hž'a]W\'XUfØVYf'ni 'Àf[Yfbž'XUgg a Y]b'CVYfhY]`'ni 'b]YXf]['k Uf"

 $DYhYf'j \ YfXfY \ hY'X]Y'5i \ [Yb''' \ A \ Y]bY'A \ i \ hhYf'hfÀ[h'i a '<]a \ a \ Y`g \ K \]``Yb'h]YZYf' [YgWXb]hhYbY'C VYfhY]`Y°$

A Y]bY'6YgW\Y]XYb\Y]hgbYi fcgY'''Y]b', VYfV`Y]VgY`'a Y]bYf a i g`]a]gW\Yb'K i fnY`b'''`Àggh'a]W\''YXYg'A U`ž'k Ybb']W\'a Y]bY A i hhYf'VYgi W\Yž'U``Yg'ni gUa a YbghYW_Ybž'k Ug'b]YXf][Yf']gh'U`g Y]b DZUffYf_fU[Yb"K Ybb G]Y XUg k]ggYbžk YfXYb G]Y j YfghY\Ybžk Ufi a ']WX k À\fYbX i bgYfYf'`YhnhYb FY]gY bUWX =ghUbVi ``k Y[Yb XYf'?`Y]XYfcfXbi b[XYf'6`Ui Yb A cgWXYY i bX XYf'XUa]h j YfVi bXYbYb 9h]_YhhY]b 5i ZfY[i b['k Uf"

I a 'ni _ØbZh][Yb'6Ygi WXYfb'ni '\Y`ZYbž'Yg'f]WXh]['ni 'a UWXYbž \UVYb'k]f'Y]bYb'@Y]hZUXYb'ni f'?`Y]XYfcfXbi b['XYf'6`Ui Yb A cgWXYY'ni gUa a Yb'a]h'Y]b][Yb'U``[Ya Y]bYb'H]ddg'ZØf'XYb 9]bhf]hh'ni gUa a Yb[YghY``h"

? `Y]XYfcfXbi b['6`Ui Y'A cgWXYY

- : fUi Yb 'gc ``hYb ']\fY '5fa Yž '6Y]bY 'i bX '< UUfY 'VYXYW_Yb " 9b hgW Y]XYb 'G]Y 'g]W\ 'ZØf '`c W_Yf 'g]hnYbXY '? `Y]Xi b[ž'X]Y b]W\ h'Ub ' \Rightarrow fYf': cfa '\ UZhYh'' @Y[[]bg'j Yfa Y]XYb"
- A AbbYf'gc``hYb']\fY'6Y]bY'VYXYW_Yb"'9bhgW\Y]XYb'G]Y
 g]W\'ZØf'`cW_YfY'?`Y]Xi b['i bX'j Yfa Y]XYb'G]Y
 I bhYf\Ya XYb'i bX'K YghYb

'U`h1 6`Ui Y!A cgW\YY!8fYggWcXY!i bX!H]ddg' '% 2

 $GY]Yb G]Y [Yk Ufbhž XUgg X]Y 6YUa hYb YXYb 6Ygi W Yf VYi fhY]Yb i bX k Ybb G]Y X]Y ? Y]XYfcfXbi b[XYf 6`Ui Yb A cgWXYY fhi h'hi hŁ b]WXhY]b \ U`hYbž k YfXYb G]Y [YVYhYbž g]WX a]h Y]bYa GWX U`ž F c W_ c XYf Y]bYf F c VY 'ni VYXY W_Ybž X]Y A cgWXYY _cghYb`cg j Yf Y]\ h''$

'U`h1 6`Ui Yf!A cgWXYY!8fYggWcXY!i bX!H]ddg!A Ubb!FcW_ 2

Ni a '; `ØW_'\UVYb'DYhYf'i bX']W\XX]Y'A i ghYfi b['VYghUbXYb"'→W\hfi ['Y]bY'[fUi Y'K UbXYf\cgY'i bX'Y]b'`cgYg'gW\k UfnYg'Hcd
ni gUa a Yb'a]h'Y]bYa 'GW\U`"'DYhYf'hfi ['Y]bY'[fUi Y'K UbXYf\cgY
i bX'Y]b'k Y]» Yg'<Ya X"'K Ybb'G]Y'g]W\j cf\Yf'j Yfhi gW\Ybž'V`Y]Vh
→\bYb'X]Y'8Ya Øh][i b['XYg'I fhY]`g'YfgdUfh"

² ZZbi b[gnY]hYb XYf 6`Ui Yb A cgWX YY

8]Y'6`Ui Y'A cgW.YY']gh'hÀ[`]W.'[YÒZZbYh'i bX'ZØf'U``Y'6Ygi W.Yf_cghYb`cg"'Hci f]ghYb'_ÒbbYb'YXcW.'k À\fYbX'XYf'a Y\fa U`g hÀ[`]W.'ghUhhZ]bXYbXYb'; YVYhY'b]W.h'VYgi W.Yb.

- : U'f'fla gU_'Ui Z'HØf_]gWkk'NkY]'Ghi bXYb'j cf GcbbYbUi Z[Ub[
- Hi i fl ØbY Ł A cf[YbXÀa a Yfi b[
- Ni \f'fPû`YŁ'A]hhU[
- 5gffl_]bX]ŁBUWa]hhU[
- A U[\f]V'fb_ Ua Ł'GcbbYbi bhYf[Ub[
- $=g\U'fMUhg\ L'?ifn'j\ cf'XYa'YhhhYb'@Wh'XYg'HU[Yg]$

8]Y; YVYhgnY]hYb;g]bX;Ub;GcbbYbUi Zi; bX;!i bhYf[Ub[[YVi bXYb i bX;AbXYfb;g]W;XU\Yf;]a ;@Ui ZY;XYg;\J\fYg"; VYfdfØZYb;G]Y;X]YU_hi Y``Yb; YVYhgnY]hYb;i bX;j Yfa Y]XYb;G]Y;6Ygi W;Y;();A]bi hYb j cf;i bX;' \$;A]bi hYb;bUW; 'YXYa;; YVYh"

6Ygi Wacf[Ybg

8]Y VYghY NY]h ZØf Y]b Yb '6 Ygi W 'XYf '6`Ui Yb 'A cgW YY ']gh nk]gW Yb XYa 'A cf[Yb[YVYh fHi `i Ł i b X 'X Ya 'A]hhU[g[YVYh fNi \ fŁ" 'G]Y a ØggYb 'k U\ fgW Y]b`]W ']a a Yf bc W '&\$!' \$ 'A]bi hYb 'UbghY\ Ybž UVYf 'X Ug ']gh V YggYf 'U`g 'Ua 'B UW a]hhU[ž k Ybb 'X]Y A YbgW Yba UggYb 'Ua 'gh Af_gh Yb 'g]b X"

'U'h1 6'Ui Y!A cgWXYY!8fYggWcXY!i bX!H]ddg''' (2

JYfa Y]XYb G]Y : fY]hU[Y

9gʻ]ghʻYfk À\bYbgk YfhžʻXUggʻG]YʻU`gʻA i gʻ]a ʻYXYfnY]hʻX]Yʻ6`Ui Y A cgW\YYʻVYgi W\Ybʻi bXʻUbʻXYbʻ; YVYhYbʻhY]`bY\a Ybʻ_ÒbbYb"

5bZU\fhijca <]ddcXfca

8 Yf'VYghY'K Y[žia 'X]Y'UhYa VYfUi VYbXY'5fW\]hY_hi f'XYf'6`Ui Yb A cgW\YY'ni 'gY\Ybž']ghž'g]W\']\f'j ca '<]ddcXfca 'fK YghgY]hY'XYf A cgW\YYŁ'Ui g'ni 'bÀ\Yfb"'Hci f]ghYb'a ØggYb'gck]Ygc'X]Y'[`Y]W\Y F]W\hi b['VYbi hnYbžia 'X]Y'A cgW\YY'ni 'VYhfYhYb"

- 'U`h1 2

6YUW hYb 'G]Y ž XUgg 'g]W 'XYf 'Hci f]ghYbY]b[Ub['j cb 'XYa 'ZØf ; `Ài V][Y 'fYgYfj]YfhYb 'i bhYfgW Y]XYh '' G]Y 'k YfXYb 'ni Yfgh'Ui Z'XYb 5bVYhYfY]b[Ub['ghc » Yb ž 'U `gc 'ZU\fYb 'G]Y 'a]h 'XYa 'b À W ghYb 'Zcfh'' fl c`[Y 'Y]b ZUW 'XYb 'Hci f]ghYb ž 'Xi '_Ybbgh'g]Y 'j cb 'XYb 9]b\Y]a]gW Yb "Ł

 $J\ Yfa\ Y]XYb\ G]Y\ YXYb\ ZYf\ \Rightarrow bYb\ 9I\ dfYgg!\ 9]b\ hf]hh\ Ub\ V]Y\ hY\ h'\ ghY\ X]WX\ ghUhhXYggYb\ Y]b\ ZUWX\]b\ X]Y\ K\ UfhYgWX\ Ub\ Y''\ 9g\ a\ U[\ ``Ub\ Ui\ ggY\ Yb\ Z'UVYf\ Yg\ VYk\ Y[\ h'g]WX\ gWX\ bY``'''$

5``[Ya Y]bY'9h]_YhhY

- 8]Y'6`Ui Y'A cgW\YY']gh'Y]b'Cfh'XYf'5bVYhi b[ž'gY]Yb'G]Y U`gc'fi \]['i bX'fYqdY_hi c``"
- G]Y a \emptyset ggYb $\stackrel{\cdot}{\rightarrow}$ fY GW\i \Y Ui gn]Y\Yb i bX]b Y]bY

Xi fWkg]Wkh][Y'D'Ugh]_hØhY''Y[Yb'fk]fX'_cghYb'cg'ni f JYfZØ[ib['[YghY``hŁ"'G]Y'_ÒbbYb'X]Y'HUgWkY'YbhkYXYf a]hbY\aYb'cXYf']b'Y]bYa'_'Y]bYb'@cWk']b'XYf'AcgWkYY 'UgqYb"

- G]Y'_ÒbbYb']b'XYf'6`Ui Yb'A cgWXYY'Zchc[fUZ]YfYbž'UVYf gWXU`hYb'G]Y'≒fYb'6`]hn'Ui g"
- : chc[fUZ]YfYb^G]Y^_Y]bY^A YbgW\Yb^VY]a^; YVYh^cXYfk À\fYbX^g]Y^]\fY^K UgW\i b[Yb^Xi fW\ZØ\fYb"
- K YfZYb'G]Y'[YVfUi WkhY'D`Ugh]_hØhYb']b'X]Y'XUZØf
 j cf[YgY\YbYb'A Ø``hØhYb'Ua '5i g[Ub["
- ; YVYb 'G]Y 'X]Y '? cd ZVYXYW_i b[Yb 'VY]a 'J Yf`UggYb 'XYa X]Ybgh\UVYbXYb 'DYfgcbU` ni fØW_"
- 8 Y f'9]b hf]hh']b'X]Y'6`Ui Y'A cgWXYY']gh'ZfY]'fhfchn'ØVYf'ZØbZA]'`]cbYb'6Ygi WXYfb'dfc'*JJ\f°ŁŽ'XU\Yf']gh'Y]bY'_`Y]bY
 GdYbXY'k]``_ca a Yb"'G]Y'_ÒbbYb'X]Yg'Ub'XYb
 5i g[Ub[ghØfYb'hi b"

8 Ug'K YgYbh`]WXY

K Ug. 6Ygi W\ XYf6`Ui Yb A cgW\YY]b =ghUbVi `žHi f_Ym"

K c. 'K]f'ØVYfbUW\hYhYb']a 'G]f_YW]'A Ubg]cb'<chY`']b'XYf'5`hghUXh j cb'=ghUbVi `'i bX'k UfYb'UVgc`i h'VY[Y]ghYfh'j cb'X]YgYa ' \Rightarrow k Y`'j cb Y]bYa '<chY`"'9g'`]Y[h']b'Y]bYf'a U`Yf]gW\Yb'GhfU» Yž'X]Y'gck c\`Y]bY'C UgY'XYf'Fi \Y'UVgY]hg'XYf'A UggYb'U`g'Ui W\XX]Y'BÀ\Y'ni XYb'[fÒ» hYb'GY\Ybgk ØfX][_Y]hYb'XYf'GhUXh'V]YhYh"'8]Y'6`Ui Y A cgW\YY'i bX'5mUgcZmU'fk U[]U'Gcd\]UŁ'g]bX'bi f'%\$'; Y\a]bi hYb YbhZYfbh°

K]f'k UfYb'UVgc`i h'j YfnUi VYfh'j cb'5fUnž'XYf'i bg'a]h'Y]bYa VfY]hYb'@ÀW\Y`bž'nk Y]'HUggYb'hØf_]gW\Ya 'HYY'i bX'j]Y`Yb FUhgW\`À[Yb'ni f'D`Ubi b['i bgYfYg'5i ZYbh\U`hg'VY[fØ» hY"

- 'U`h1 2

- 'U`h1 2
- 'U`h1 2
- 'U`h1 2
- 'U`h1 2
- 'U`h1 2
- 'U`h1 2
- 'U`h1 2

I bgYf'N]a a Yf'k Uf'gi dYf'_ca ZcfhUVY`i bX'XUg': fØ\ghØW_'gi dYf
'YW_Yf'fdfcV]YfYb'G]Y'X]Y'a]h'7\]`]'ØVYfnc[YbYb'?ÀgYVÀ``WXYbŁ"
5b'i bgYfYa ``YhnhYb'HU['a i gghYb'k]f'j cf'XYa ': fØ\ghØW_
Ui ZVfYWXYb'i bX'5fUn'VYghUbX'XUfUi Zž'XUgg'k]f'Y]b
: fØ\ghØW_gdU_Yh'a]hbY\a Ybž'k Ug'k]f'Ui Z'i bgYfYf'FY]gY'bUWX
=na]f'gY\f'ni 'gWXÀhnYb'k i gghYb"'K]f'k ØfXYb'gcZcfh'k]YXYf'Xcfh
ØVYfbUWXhYb"

K Ubb. '8]Y 'VYghY 'FY]gYnY]h 'ZØf' ⊕hUbVi ``]gh 'XYf': fØ\`]b['fA Àfn 'V]g A]hhY '≯ b]Łž'k Ybb 'XUg'K YhhYf'[Ya À»][hi bX 'X]Y 'HU[Y '`Ub['g]bX" 6YUW hYb 'G]Y ž'XUgg 'Yg'j cf'U``Ya ']a '5df]`'Y]b 'cXYf'nk Y] 'HU[YfY[bYb '_Ubb" 'K]f 'VYgi W hYb '9bXY 'A U]'i bX '\UhhYb 'Y]bYb 'HU[5i gk UgW i b["

8]Y`UbXYfYb`HU[Y`k UfYb`YXcW\`\Yff`]W\"`8Yf`<YfVgh`fGYdh"!C_h"Ł]gh`X]Y`nk Y]hVYghY`FY]gYnY]h"`8Yf`Gca a Yf`]gh`\Y]» 'i bX`ØVYfZØ``hžk À\fYbX`XYf`K]bhYf`_U`h'i bX`fY[bYf]gW\`gY]b`_Ubb"

K]Y. '8]Y '6`Ui Y 'A cgWX YY ']gh'ZfY]'ni [Àb[`]WX 'i bX'_Ubb'j ca 'G]f_YW]
A Ubg]cb' < chY``Ui g'bUWX 'Y]bYa '_i fnYb'GdUn]Yf[Ub['YffY]WX h
k YfXYb"'K Ybb'G]Y'k Y]hYf'YbhZYfbh'k c\bYbž'_ÒbbYb'G]Y' =ghUbVi `g
ni j Yf`Àgg][Yg'I!6U\b!GmghYa 'bi hnYbž'i a 'g]WX'Zcfhni VYk Y[Yb"
HUI]g'g]bX'`Y]WX h'j YfZØ[VUfž'UVYf'k]f'\UVYb'Yg'j cf[Ync[Ybž'X]Y
k Y]hUi q'V]``][YfY'I!6U\b'ni 'VYbi hnYb"

=ghUbVi``\Uh'JYfV]bXib[Yb'ni a Y\fYfYb']bhYfbUh]cbU`Yb
: `i[\AZYb"'6i WXYb'G]Y'ØVYf'G_mgWUbbYf'ni 'XYb'VYghYb'DfY]gYb"

<]bk Y]g. 5i Z[fi bX XYf %b[ghYb I bfi \Yb]b Hi f_Ym YgYb G]Y j cf \Rightarrow fYa `6Ygi W\ X]Y : 7C!FY]gY\]bk Y]gY"

K]f'YadZY\`Yb'XYb'7Ydh]Wg'5``!±b!CbY'

 $\begin{tabular}{ll} K & $[f'Ya dZY'Yb'XYb'7Ydh]Wg'5'Yl $= !CbY' $= hYfbUh]cbU'HfUjY' \\ 5XUdhYf'''9g'Z b_h]cb]Yfh']b'ØVYf'&$$'@AbXYfb'ibX'HYff]hcf]Yb'ibX \\ & $_Ubb'V]g'ni'gYWxg'; YfAhY'['Y]WxnY]h]['UiZ'UXYb'' \\ \end{tabular}$

@Y]hV]`X. 5h`Ug'/ 6cchg

•

.

8 YhU]`g

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