

: $\emptyset \setminus fYf'ni \ XYb A i b [U^*]': U^*g' \ 5h \setminus Yfhcb HUV^Y`Ub Xg#7U]fbg$

Jc``ghÀbX][Yf'K UggYfZU``ZØ\fYf'ni a '6Ygi W. 'XYf'Aib[U``]
: U``g`]b`XYb`5h\Yfhcb`HUV`Y`UbXg`cVYf\U`V'jcb`7U]fbg`]a
\c\Yb`BcfXYb'jcb`EiYYbg`UbX"'9bh\À`h'U``Ygž'k Ug`G]Y
k]ggYb'a ØggYbži a 'X]YgYb'k Yb]['VY_UbbhYb'K UggYfZU```]a
CihXccf'9Xi WUh]cb'7YbhfY'ni 'VYgi W.Yb"Aib[U``]: U``g`]gh
Y]b'[fc»Yf'K UggYfZU```]b'XYb'5h\Yfhcb'HUV`Y`UbXgžYhk U'%
GhibXY'ibX'(\$'A]bihYb'jcb'7U]fbg'YbhZYfbh"'9g`[]Vh
a Y\fYfY'9VYbYb'ni 'Yf_ibXYbž'k cVY]'X]Y'\ÒWXghY'Y]bY
_iai`Uh]jY': U``\Ò\Y'jcb'+) 'AYhYfb'UiZkY]gh"'8Ua]h']gh'Yf
Y]bYf'XYf'[fÒ»hYb']b'XYf'Ia[YVib[*8]YgYf'ibhYfgWXY]XYh
g]WX'YXcWX'Y]b'kYb]['jcb'XYb'UbXYfYb'K UggYfZÀ``Yb']b'XYf
BÀ\Y'jcb'7U]fbgž'XU'Yf'g]WX']b'Y]bYa'/Uad^\Y``]d/

Jc``ghÀbX][Yf'K UggYfZU``ZØ\fYf'ni a '6Ygi W\`XYf'Aib[U``]': U``g']b XYb'5h\Yfhcb'HUV`Y`UbXg'cVYf\U`V'jcb'7U]fbg']a '\c\Yb'BcfXYb jcb'EiYYbg`UbX"'9bh\À`h'U``Ygž'k Ug'G]Y'k]ggYb'a ØggYbž'i a X]YgYb'k Yb]['VY_UbbhYb'K UggYfZU``']a 'CihXccf'9Xi WUh]cb 7YbhfY'ni 'VYgi W\Yb"

Aib[U``]': U``g']gh'Y]b'[fc» Yf'K UggYfZU``']b'XYb'5h\Yfhcb HUV`Y`UbXgž'Yhk U'%'GhibXY'ibX'(\$'A]bihYb'jcb'7U]fbg'YbhZYfbh'' 9g'[]Vh'a Y\fYfY'9VYbYb'ni'Yf_ibXYbž'kcVY]'X]Y'\ÒW\ghY'Y]bY _iai`Uh]jY': U``\Ò\Y'jcb'+)'AYhYfb'UiZkY]gh''8Ua]h']gh'Yf'Y]bYf XYf'[fÒ» hYb']b'XYf'Ia[YVib[*

8]YgYf'i bhYfgWXY]XYh'g]WX'YXcWX'Y]b'k Yb]['j cb'XYb'UbXYfYb K UggYfZÀ``Yb']b'XYf'BÀ\Y'j cb'7U]fbgž'XU'Yf'g]WX']b'Y]bYa K]`XYfbYgg'FYhfYUh'7ca d`Yl'VYZ]bXYh''5VYf'_Y]bY'Gcf[Yž'X]Y 9][YbhØa Yf'XYg'@UbXYg'Yf`Ui VYb'6Ygi WXYfbž'XYb'K UggYfZU`` _cghYb`cg'ni 'VYg]WXh][Yb°

K]Y _ca a ha Ub ni XYb A i b[U``]: U``g3

I a 'ni 'XYb'A i b[U``]': U``g'ni '[Y`Ub[Ybž'VYbÒh][Yb'G]Y' \Rightarrow f'Y][YbYg 5i hc'cXYf'HfUbgdcfha]hhY`"'K Ybb'G]Y'j cb'7U]fbg'_ca a Ybž']gh'Yg Y]bY'n]Ya `]W\'`Ub[Yž'%\$\$'?]`ca YhYf'`Ub[Y': U\fh'Xi fW\'X]Y 5h\Yfhcb'HUV`Y`UbXg"'G]Y'_ÒbbYb' \Rightarrow f'; DG'Ui Z'XYb'D]b'i bhYb f]W\hYb"

5i Z'XYa 'DU`a Yfghcb'<][\k Um'a ØggYb'G]Y'fYW\hg'Ui Z'X]Y'\dag bWh]cb FcUX'UVV]Y[Yb"'8]Yg']gh'Y]bY'i bVYZYgh][hY'GhfU» Yž'X]Y'g]W\'Yhk U &'?]`ca YhYf'ZcfhgYhnhž'VYj cf'g]Y'XUg'Aib[U``]': U``g'CihXccf 9Xi WUh]cb'7YbhfY'YffY]W\h"

 $G]Y'_\grave{O}bbYb'\triangleq f'5i\ hc'Ui\ Z'XYa\ 'DUf_d`Uhn'ghY\Yb'`UggYb'i\ bX'Xi\ fWXUg'7UZÅ'a]h'< c`nhYffUggY'ni f'GhfU» Y'[Y\Ybž'X]Y'ni 'XYb K UggYfZÅ``Yb'ZØ\fh''; `Y]WX'ni '\\eq\fYf'FYWX\hYb'gY\Yb'G]Y'X]Y'YfghY K UggYfZU``_Ug_UXY''$

; Y\Yb'G]Y'X]YgY'GhfU» Y'%) 'A]bi hYb'`Ub['k Y]hYf'i bX'dUgg]YfYbG]Y'Y]b][Y'; `Y]WX[Yk]WXhg\]bXYfb]ggYž'V]g'G]Y'Y]bY'GUW_[UggYYffY]WXYb"'<]Yf'gY\Yb'G]Y'Y]b'GWX]`Xž'XUg'X]Y'F]WXhi b['ni f<Ui dhYVYbY'XYf'A i b[U``]!: À``Y'UbnY][h"

- 'U`h1 A | B: 5@=465| 7 < 2
- 'U`h1 A | B; 5@4K 5GG9F: 5@9GHFCAG7<B9@9B 2
- 'U`h1 A | B; 5@=: 5@G'C| H8CCF'98| 75H€B'79BH9F 65@5B79'G9-@ 2

?`cc_"Wca

K Ug'G]Y'Ub'XYb'A i b[U``]': U``g'Yfk UfhYh

 $8]Y VY] k Y]hYa VYY]bXfi W_YbXghY 9VYbY VY] XYb A i b[U``] : U``g]ghX]Y i bhYfghY 9VYbY "CVk c\``Yg g]W b]W hi a Y]bYb$

gYb_fYW\hYb 'HfcdZYb'\UbXY`hž'_Ubb'X]Y 'GhfÒa i b['Y]bY'_fUZhj c``Y GnYbY'YfnYi [Ybž']bgVYgcbXYfY'VY] 'ghUf_Ya 'FY[Yb"

9g'k]fX'[YgU[hž'XUgg'XYf'_i a i `Uh]j Y': U```X]YgYg'5VgW\b]hhg'+)
A YhYf'VYhfÀ[h"5``YfX]b[g'gU\'Yg'Yhk Ug'_ØfnYf'Ui gž'j]Y``Y]W\h'*\$
A YhYf'k ÀfYb'Yhk Ug'[YbUi Yf"'I bUV\Àb[]['XUj cb']gh'Yg'Y]b
VYY]bXfi W_YbXYf'K UggYfZU```i bX'Ui Z'YXYb': U```Y]bYb'6Ygi W\
k Yfhž'k Ybb'G]Y'gck]Ygc'bUW\'A]``UU'A]``UU'fY]gYb"

@Y]XYf'[]Vh'Yg'Ub'X]YgYa 'K UggYfZU```b]W\h'j]Y`'; Y`Y[Yb\Y]h'ni a GWk]a a Ybž'XU'XYf'Ni [Ub['ni a '; fi bX'j YfgdYffh']gh"

J9FK5B8H9."?f]qhU``_Uq_UXYb'p'K]bX]b'ZÀ``h

 $GWkbUVY`h]YfY`ibX'; `Ø\kØfaWkYb`Ub`XYb$ A $ib[U``]': U``g`YbhXYW_Yb$

I bg'k i fXY'Ui W\'[YgU[hž'XUgg'a Ub'Ua': i » 'XYg'K UggYfZU``g; `Ø\k Øfa W\Yb'gY\Yb'_Ubb"'K Ybb'g]Y'YXcW\'Xcfh'k UfYbž'k Uf'Ygni '\Y``ž'i a 'g]Y'ni 'gY\Ybž'U`g'k]f'Xcfh'k UfYb"

9]b\Y]a]gW\Y`\UVYb`Ui W\`Yfk À\bhž`XUgg`k]`XY`GW\bUVY`h]YfY`]b XYb`: `ØggYb`]b`i bX`i a `XYb`K UggYfZU```\Yfi a ``YVYb"`K Ybb`G]Y`Yg gW\UZZYbž`Y]bYb`ni `YbhXYW_Ybž`g]bX`G]Y`Y]b`[`ØW_`]W\Yf`6Yqi W\Yf"

A i b [U``]!: À``Y'K YhhYf'i b X'?`]a U

8]Y'Aib[U``]': U``g'ibX'XUg'U``[YaY]bY'A]``UU'A]``UU!; YV]Yh``]Y[YbUiZ'Y]bYf'<Ò\Y'jcb'ØVYf', \$\$'AYhYfb']b'XYb'ZYiW\hYb'HfcdYb'jcbBcfX!EiYYbg`UbX"'8UXifW\'YbhghY\h'Y]b'Y]bn][Ufh][Yg'?`]aUž'XUgaUbW\aU``V]g'ni'%\$';fUX'_Ø\`Yf']gh'U`g'Ub'XYf'?ØghY"

8]Y`\c\Yb`i a `]Y[YbXYb`;]dZY``XYg`K ccfccbccfUb!BUh]cbU`dUf_gž Y]bgW\`]Y»`]W\`XYg`\`OW\ghYb`6Yf[Yg`j cb`EiYYbg`UbX/`A h`6Ufh`Y : fYfYž'YfnYi [Yb`X]W\hY`FY[Ybk c`_Ybž'X]Y`XUg`[UbnY`*J\\f`ØVYf _cbghUbhY`FY[Yb[ØggY`j Yfi fgUW\Yb"`+DZc`[YXYggYb`\UVYb`X]Y K UggYfZA``Y`]b`XYf`I a [YVi b[`]a a Yf`Y]bY`UbghAbX][Y`?fUZh`i bX GhfÒa i b["

U`h1 A | B; 5@=: Y`@@9`75\FBGž'A\=@5`A\=@5`K\5GG9F: Y`@@9\2

$7U]fbgTbhYf_ibZhgZ\emptyset\fYf^Kc^{\prime}\emptyset VYfbUWhYb$

D`UbYb`G]Y`Y]bY`FY]gY`bUW\`7U]fbg`i bX`ZfU[Yb`g]W\ž`k c`G]Y`g]W\b]YXYf`UggYb`gc``Yb3`I bhYb`\UVY`]W\`Y]b][Y`XYf`VYghYb`Cdh]cbYb]b`XYf`BÀ\Y`j cb`7U]fbg`9gd`UbUXY`Ui Z[Y`]ghYh"`=W\`\UVY`Ui W\Y]bYb`i a ZUggYbXYb`I bhYf_i bZhgZØ\fYf`ZØf`7U]fbg`gck]Y`Y]bYbi a ZUggYbXYb`I bhYf_i bZhgZØ\fYf`ZØf`Dcfh`8ci[`Ug`[YgW\f]YVYb"

7fmghU`Vfcc_'F]`Ym' 'K Ybb'G]Y'bUW\'@'lig'ibX'@U[Y'gi W\Ybž']gh XUg'7fmghU`fVcc_'F]`Ym'ibgW\`U[VUf"'8]Yg']gh'XUg'VYghY')!GhYfbY! FYgcfh']b'7U]fbg'ibX'V]YhYh'UVgc`ih'U``Ygž'kUg'G]Y'jcb'Y]bYa 7fmghU`Vfcc_!FYgcfh'YfkUfhYb"

H]dd.; Y\Yb'G]Y'Ui Z'YXYb': U```ni 'FcWWc g'6Uf'Ui Z'XYf'Gd]hnY'XYg 7fmghU`Vfcc_'F]`Ymž'i a 'Y]bYb'[fc»Ufh][Yb'6`]W_'ØVYf'7U]fbg'ni [Yb]Y»Yb°

U`h1 A ÀXW\Yb`VY]a 'GcbbYbVUXYb']a '7fmghU`Vfcc_'F]`Ym`FYgcfh]b'7U]fbg 2

 $FmX[Yg`FYgcfh' `8]YgYg`< chY``V]YhYh`Y]b`\Yfj cffU[YbXYg`DfY]g! \\ @Y]ghi b[g!JYf\\`A`hb]g`ZØf`Y]bYb`Yd]gW\\Yb`5i ZYbh\\U`h'ni `Y]bYa$

UbghÀbX][Yb'DfY]g*8]Y'@U[Y']gh'dYfZY_hž']b'XYf'BÀ\Y'XYf
9gd`UbUXY'i bX'j YfZØ[h'ØVYf'XfY]'Gk]a a]b[dcc`gž'nk Y]
HYbb]gd`ÀhnYž'Y]bYb'K \]f`dcc`ž'Y]b':]hbYggWVbhYf'i bX'gc[Uf'Y]b
dfY]g[Y_fÒbhYg'FYghUi fUbh"

U`h1 FM8; 9G'9GD@5B589'F9GCFH'&'75\FBG\Z'K C'|BH9F?|B:H NI '6@9\69B 2

:]hnfcm=g`UbX:FYgcfh: 'K Ybb:G]Y:`]YVYf:Ui Z'Y]bYf:XYf:a U`Yf]gWXYb =bgY`b:XYg; fYUh:6Uff]Yf:FYYZ:ØVYfbUWXhYb:a ÒWXhYbž:g]bX:G]Y:]a :]hnfcm=g`UbX:FYgcfh:[YbUi:f]WXh]["'K À\fYbX:G]Y:\]Yf:Y]bYb HU[YgUi gZi ['i bhYfbY\a Yb'_ÒbbYbž:Ya dZY\`Y']WX:Xf]b[YbXž:X]Y BUWXh:ni 'j YfVf]b[Ybž:XUa]h:G]Y:a Y\f:NY]h:\UVYbž:XUg:F]ZZž:X]Y ?cfU``YbghfÀbXY:i bX:X]Y:K UbXYfk Y[Y:]a 'FY[Ybk U`X:ni Yf_i bXYb"

U'h1 : ± 1 NFCM ± 6 05B8F9GCFH2

;]``][Ub g'6UW_dUW_Yfg' '8]Y'VYghY'6UW_dUW_Yf!Cdh]cb'ZØf'Y]bY hc``Y'5ha cgd\AfY']b'7U]fbg']gh;]``][Ub g'6UW_dUW_Yfg"'8Ug'`]Y[h XUfUbž'XUgg'X]YgYg'Y]bYb'Gk]a a]b[dcc`ž'Y]bY'? `]a UUb`U[Yž'Y]bY _ca d`YhhY'?ØWXY'i bX'Y]bYb'[fc»Ufh][Yb'; Ya Y]bgWXUZhgVYfY]WX\Uhž'i a 'UbXYfY'FY]gYbXY'ni 'hfYZZYb"

'U'h1 ; =@= 5BG'657?D57?9F'F9GCFH 2

J YfdUggYb 'G]Y 'b]W\ h'X]Y 'i a `]Y[YbXYb K UggYfZÀ``Y '

Gi WXYb'G]Y'bUWX'k Y]hYfYb'K UggYfZÀ``Yb']b'XYf'BÀ\Y'j cb'7U]fbg3
J YfdUggYb'G]Y'b]WXh'5i ghfU`]Ybg'a Y]ghZchc[fUZ]YfhYb'K UggYfZU``/
A]``UU'A]``UUž'cXYf'a Y]bY'VY]XYb'dYfgÒb`]WXYb': Uj cf]hYb/
B UbXfcmU': U``q'i bX'HWXi dU`U': U``q"

- 'U`h1 B5B8FCM5!: Ÿ@@9žK 5GG9F: Ÿ@@9'+B'75+FBGžK CC FCCBCCF5B!B5H+€B5@D5F?!
 - K 5GG9F: Ÿ@@9 2B5B8FCM5!: Ÿ@@9
- 'U`h1 H7<| D5@5': 5@@Gž'K 5GG9F: Ÿ@@9'+B'75 ≠ BGž'8+9 69GH9B'75 ≠ BG': 5@@Gž'75 ≠ BG'5HHF5? H € B9Bž'NI HIB 2 H7<| D5@5!: Ÿ@@9

@9G9B G=9 89B J C @@GH \ddot{Y} B 8 = 9B K 5GG9F : 5 @@ $_{\circ}$ < F 9F J C B

75 ≠ BG. 8 = 9.69GH9B K 5GG9F: Ÿ@@9 = B.89F BŸ<9 JCB 75 ≠ BG

K Y]hYfY 5fh]_Y`ni K UggYfZÀ``Yb'i bX 5VYbhYi Yfb']b'7U]fbg

K Ybb'⇒bYb'X]YgY'?i fnUb`Y]hi b['ni a '6Ygi W 'XYf'Ai b[U``]!: À``Y
[YZU``Yb'\Uhž'gW\Ui Yb'G]Y'g]W\'i bVYX]b[h'Y]b][Y'a Y]bYf'UbXYfYb
FY]gYZØ\fYf'Ub"'→W '\UVY'Ui gZØ\f`]W\'ØVYf'FY]gYb'i bX'5VYbhYi Yf
]b'i bX'i a '7U]fbg'[YgW\f]YVYbž'U`gc'V]b']W\'g]W\Yfž'XUgg'G]Y'Yhk Ug
BYi Yg'Z]bXYb'k YfXYb°

"U`h1 A i b[U``]'7fYY_': U``g'5h\Yfhcb'HUV`Y`UbXg'7U]fbg 2 "

8 Y hU]`q

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