

8]Y'+'VYghYb'5i gg]W\hgdi b_hY'XYg'HU^ A U\U\']b'5[fUž'=bX]Yb

9]bY'Ni gUa a YbZUggi b['XYf'+'VYghYb'5i gg]Wkhgdi b_hY'Ui Z'XYa HU^A U\U`ži a 'Y]bn][Ufh][Y'i bX']_cb]gWkY'5i ZbU\a Yb'XYg gWkÒbghYb'; YVÀi XYg'XYf'K Y`h'ni 'a UWkYb''K c'G]Y'\]b[Y\Yb_\ObbYbži a 'j YfgWk]YXYbY'DYfgdY_h]j Yb'XYg'HU^A U\U`']b'5[fUž \ddot X]Ybž'ni 'Yf\U`hYb"

→W 'Yf]bbYfY'a]W 'bcW '[YbUi 'Ub'XUg'YfghY'A U`ž'U`g']W 'XUg'HU^
A U\U`'gU\"'8]Y'K U\f\Y]h']ghž'XUgg']W 'a]W ']b'5[fU'VYZUbXž'bi f
i a 'Yg'ni 'ØVYfdfØZYb"'8YbbcW 'k Uf']W 'ni bÀW gh'g_Ydh]gW "
? ÒbbhY'Yg'k]f_`]W 'gc'[fc» Ufh]['gY]bž'cXYf']gh'Yg'bi f'Y]bY'k Y]hYfY
Hci f]ghYbZU``Y3

⇒W. 'V]b 'a]f 'g]W. Yfž 'XUgg']W. 'XUa]h 'b]W. h 'U``Y]b 'V]b 'i bX 'XUgg'j]Y `Y
UbXYfY 'X]Y '[`Y]W. Y 'UbZÀb[`]W. Y 'A Y]bi b['hY]`Yb " @UggYb 'G]Y 'a]W.
⇒ bYb 'YXcW. 'gU[Ybž 'XUgg']W. 'j cb 'XYa 'YfghYb 'A ca Ybh'Ubž 'U`g']W.
X]YgY 'k Y]» Y 'A Ufa cf_i ddY`'j ca '5i gg]W. hgdi b_h'Ua ': `i ggi ZYf
Ui g'gU\ž'gdfUW. `cg'k Uf"

9gʻ]ghʻgWk]Yf][ž'X]YʻGW Òb\Y]hʻXYgʻHU^A U\U``ni ʻVYgW fY]VYbž VYgcbXYfgʻZØfʻFY]gYbXYʻk]Yʻa]W\ž'X]Yʻg]W\ʻbcfa U`Yfk Y]gYʻUb K UggYfZÀ``YbʻcXYfʻ]bʻXYbʻ6Yf[YbʻUi Z\U`hYbžʻUbghUhhʻXYfʻ5i gg]W\h Ui ZʻY]bʻ; YVÀi XYʻbUW\ni ^U[Yb"ʻ5`gcʻØVYf`UggYʻ]W\ʻYgʻVYggYfʻXYb @hYfUhi fYI dYfhYbʻi bX'n]h]YfYʻXYbʻGW\ÒdZYfʻXYgʻA Ui gc`Yi a gž G\U\`\J\\Ub.

8]Y'GW\Ob\Y]h'XYg'HU^A U\U```Àggh'X]Y'GcbbY'i bX'XYb'A cbX HfÀbYb'Ui g']\fYb'5i [Yb'Z]Y»Yb"

'U`h1 85G'H5>A5<5@'JCA'F9GH5IF5BH'857<'+B'5; F5 +B8+9B2

8]Y'i bj Yfn]WX hVUfY'FY]gYfYggci fWY'ZØf =bX]Yb

'I `h]a Uh]j Y'%!A cbUhg! \pm X]Yb!FY]gYfci hY' '9ggYbh]Y``Y'DUW_`]ghY ZØf' \pm X]Yb

6YghY '5i gg]W h'Ui Z'XUg'HU^A U\U`'j cb'Y]bYa < chY`

G]Y 'a $\grave{O}W$ hY b 'X]Y 'GW\ $\grave{O}b$ \ Y]h 'XYg 'HU 'A U\ U` 'j cb '\(\Righta\) fYa 'Y][YbYb < chY \ VU_cb 'Ui g 'Yf\YVYb3'I bhYb 'q]b X 'X]Y 'Hcd! C dh]cbYb ']b '5[fU"

• < chY`? Ua U` '8]Yg']gh'Y]bY'[fc»Ufh][Y'Cdh]cb

ZØf @Yi hYžX]Y Y]b < chY`a]h Y]b Ya [fc > Ufh][Yb
5i gg]WX hgdi b_h Ui Z X Ug HU^A U \ U`gi WX Yb " 9g
`]Y[h bi f k Yb][Y \ i b X Yfh A YhYf j ca 'HU^
YbhZYfbh i b X j YfZØ[h ØV Yf Y]b Y 8 UWX hYff UggY
i b X Y]b F YghUi f Ubh"

- xYmg'<cghY` 'K Ybb'G]Y'bUWX'Y]bYa
 6UW_dUW_Yf!<cghY`]b'5[fU'a]h'Y]bYa
 5i gg]WX hgdi b_h'Ui Z'XYa '8 UWX 'XYg'HU\'A U\U`gi WXYbž'_ObbhY'X]Yg'XUg'F]WXh][Y'gY]b"'9g'[]`h
 U`g'Y]bYg'XYf'VYghYb'<cghY`g']b'5[fU'ZØf
 5ha cgd\ÀfYž'@U[Y'i bX'5i gg]WXh"
- N]['NU['<cghY` '=\W\ '\UVY`N]['NU['VYfY]hg
 cVYb 'Yfk À\bhž'UVYf'ZU``g'G]Y'Yg'j YfdUggh
 \UVYbž'X]YgY' → b[g'j YfUbghU`hYb 'bÀW\h`]W\Y
 K UbXYfi b[Yb 'ni 'Y]bYa '[Y\Y]a Yb 'HU^A U\U`!
 5i gg]W\hgdi b_hž'XYf'bi f'ZØf'N]['NU[!; ÀghY
 ni [Àb[`]W\']gh"'GW\Ui 'g]Y'X]f'Ub°

'U`h1 H5 > A 5 < 5 @ 2'8 9 F '? F C B D 5 @ 5 G H ' B ' 5 ; F 5 ' B 8 = 9 B 2

8]Y'+'VYghYb'5i gg]W\hgdi b_hY'XYg'HU^ A U\U`.'K c'G]Y'XUg'HU^]b'5[fU'gY\Yb _ObbYb

BUWX Zc`[YbX'Z]bXYb'G]Y'a Y]bY'@]ghY'XYf'VYghYb'5i gg]WX hgdi b_hYXYg'HU^A U\U`ž'XUa]h'G]Y'Y]b][Y'Y]bn][Ufh][Y'DYfgdY_h]j Yb'X]YgYgib[`Ui V`]WXYb'A Ui gc`Yi a g'Zchc[fUZ]YfYb'_ÒbbYb"

5a '9bXY'X]YgYg'6Y]hfU[g'\UVY']WX'Ui WX'Y]bY'_i fnY Ni gUa a YbZUggi b['Y]b][Yf'XYf'VYghYb'<chY`g'i bX 8UWXfYghUi fUbhg'ni gUa a Yb[YghY``hž'i a 'Y]bYb'6`]W_'Ui Z'XUg'HU^ A U\U``ni 'k YfZYb"

%"Jca =bbYfYb XYg HU^A U\U`!; Y`AbXYg

6Y] k Y]hYa ']gh'XYf'VYghY'K Y[ž'XUg'HU^A U\U`ni 'gY\Ybž'Yg'Ui g bÀW\ghYf'BÀ\Y'j ca '; Y`ÀbXY'Ui g'ni 'Yf`YVYb"'I ba]hhY`VUf'bUW\XYa '8i fW\gW\fY]hYb'XYf'di fdi ffchYb'HcfY'cZZYbVUfh'g]W\'XUg'HU^A U\U`cXYf'X]Y' ?fcbY'XYf'DU`ÀghY 'i bhYf'Y]bYa 'gma a Yhf]gW\YbžfYZY_h]YfYbXYb'HY]W\"'8Yf'9]bhf]hh'ni a 'HU^A U\U`']gh'Yhk Ug'hYi YfžUVYf'Yg'`c\bh'g]W\'Ui Z'YXYb': U``"

G]Y '_ObbYb 'X]Y 'DU`Ugh[ÀfhYbž'X]Y 'HYffUggYb 'Ua ': `i ggi ZYf'i bX 'X]Y UhYa VYfUi VYbXY 'A Ufa cfZUggUXY 'Yf_i bXYbž'k Ybb 'G]Y 'X]Y 'Ghi ZYb \]bUi ZghY][Yb"'J ca '=bbYfYb 'XYg'HU^Ui g'Yf\U`hYb 'G]Y 'Ui W\ 'Y]bYb 6`]W_'Ui Z'XUg'; fUVž']b 'XYa 'gY]b 'GW\ OdZYf. 'G\U\ '*J\Ub 'i bX 'gY]bY @]YV`]b[gZfUi /'A i a hUn'A U\U`k YfXYb 'VY][YgYhnh"

$$\label{eq:hilling} \begin{split} &\text{H]dd.} \text{ '9]b 'Ui g[YnY]W bYhYf'5i gg]W hgdi b_h'Ui Z'XUg'HU^A U\U`'Ui Z XYa '; Y`AbXY'VYZ]bXYh'g]W 'i bhYf'XYb'fchYb'HØfYb'XYf'A cgW YY fb]`X'i bhYbŁ"'8]YgYf'VYZ]bXYh'g]W 'Ui Z'XYf'`]b_Yb'GY]hY'XYg'HU^z k Ybb'G]Y'g]W ']\a 'j ca '9]b[Ub['b\A\Yfb" \\ \end{split}$$

U`h1 $\pm 8 = 9B$ '%'A CB5H'F9 $\pm 69D$ @5Bž'H5>'A 5<5@'5; F5 2 HU^'A U\U` j cb'XYf'DU`Ugha cg\\XYY

8 Yb_Yb'G]Y'XUfUbž'XUgg'X]Yg'a]h'a Y\f'U`g'*ž) 'A]``]cbYb
6 Ygi W\Yfb''YXYg'\J\f'\DX]Ybg'VY`]YVhYghY'Hci f]ghYbUhhfU_h]cb']gh'
G]Y'_ObbYb'U`gc'Y]bY'n]Ya `]W\Y'5i ZghY``i b['ZØf'Y]bY'9]bhf]hhg_UfhY
ni a 'GcbbYbUi Z[Ub['Yfk UfhYb"'I bhYb'\UVY']W\'Y]bY
_cghYb[Øbgh][Y'Hci f'Xi fW\'XUg'HU'\!; Y`\AbXY'j Yf`]b_hz'X]Y'Y]b
H]W_Yh'VY]b\U`\hYhz'gcXUgg'G]Y'X]Y'K UfhYgW\`Ub[Y'\ØVYfgdf]b[Yb
_\ObbYb"

 $\label{eq:continuous} $$ VYfgdf]b[YbG]YX]YKUfhYgWX`Ub[Y.HU^AU\U`!9]bhf]hhg_UfhYibXFY]gY`Y]hYf$

 $HU^A U U^!NY]hYb."$ \$^A]bi hYb^j cf^GcbbYbUi Z[Ub["i bX" \$

A]bi hYb buW GcbbYbi bhYf[Ub['fl dXUhYg'\]Yf ØVYfdfØZYbŁ

9]bhf]hh. '%%\$\$ 'Fid]Yb 'ZØf'5ig`ÀbXYf'ibX') \$ 'Fid]Yb 'ZØf' \pm bXYf'' fŽ &\$\$ 'Fid]Ybž'ia 'XUg'< Uidha Uigc`Yia 'ni 'gY\YbŁ U`h1 H5>A 5<5@5I GG=7< HGDI B? H'J C A 'D5@5GH; 9@YB89 2

&"'6`]W_'Ui Z'XYb': `i gg'HU^A U\U`jcb'XYf'MUaibU

8 Y f `\]b X i]gh]g W X Y `H Y a d Y `` b Y V Y b `X Y a `` H U 'ž `V Y _ U b b h `U `g `H Y 'c A U \ U ` U m U `7 \ \ c h U `A U b X] f ž `]gh 'j] Y `` Y] W h `Y] b Y f `X Y f `V Y _ U b b h Y g h Y b U `h Y f b U h]j Y b `5 i gg] W hgd i b _h Y `U i Z `X Y a `` H U ^ A U \ U ` `] b `5 [f U "

I a `\]Yf\Yf`ni `[Y`Ub[Ybž'a ØggYb`G]Y`bi f`Ub`XYb`Ògh`]W\Yb`HcfYb XYg`; Y`ÀbXYg`Ybh`Ub[`]b`F]W\hi b[`:`i gg`[Y\Yb"`GcVU`X`G]Y`Ua MJa i bU`Ub[Y_ca a Yb`g]bXž'k YfXYb`G]Y`gcZcfh`ZYghghY``Ybž k Ufi a `Yg`Y]b`gc`[fc» Ufh][Yf`5i gg]W\hgdi b_h`ZØf`XUg`HU^A U\U`]gh"

CVk c\`'Yg'Y]bYb'\c\Yb'NUi b'nk]gW\Yb'XYa ': `i gg'i bX'XYa DU`Ugh[Y`ÀbXY'[]Vhž'_ObbYb'G]Y'XYbbcW\'Y]bY'[fc» Ufh][Y'5i gg]W\h [Yb]Y» Yb'i bX'Y]b][Y'ZUbhUgh]gW\Y'5i ZbU\a Yb'XYg'i b[`Ui V`]W\Yb A Ufa cfk i bXYfg'j ca ': `i ggi ZYf'Ui g'a UW\Yb"

; $cc[Y'AUdg'D]b.^{+}5igg]WAhgdib_h'HU^MUaibU$

"U`M1 H5>A5<5@5| GG=7<HGD| B?H'5A "< \pm 8| !H9A D9@2": @ GG M5A| B85 \pm 5; F5 2

' "GY\Yb G]Y XUg HU^A U\U`j ca 'A Y\hUV 6U[\

8 Yf'A Y\hUV'6U[\ž'ØVYfgYhnh'U`g' A cbXgWXY]b[UfhYb ž']gh'Y]b j]YfgY]h][Yf'; UfhYb_ca d`Yl ž'XYf'g]WX'X]fY_h'[Y[YbØVYf'XYa 'HU^A U\U`'Ui Z'XYf'UbXYfYb'GY]hY'XYg': `i ggYg'MUa i bU'VYZ]bXYh''

8 Y f'A Y\hUV'6U[\']gh'Y]b'k Y]hYfYf'VY`]YVhYf'5i gg]Wkhgdi b_h'XYg HU^A U\U`ž'Ub'XYa 'G]Y'XfUa Uh]gWkY'FYZYI]cbYb'i bX kibXYfgWk`ObY'; UfhYbjcfXYf[fØbXY'gY\Yb'_ObbYb" I a 'ni a 'A Y\hUV'6U['ni '[Y`Ub[Ybž'a ØggYb'G]Y'i a 'XUg': `i ggi ZYf\Yfi a [Y\Ybž']b'F]W\hi b['BcfXYb'[Y\Yb'i bX'X]Y'GhfUW\Ym'6f]X[Y\ØVYfei YfYb"'8 Ubb']gh'Yg'Y]b'k Y]hYfYf'&!?]`ca YhYf!GdUn]Yf[Ub[ni fØW_'bUW\'GØXYb'Ybh`Ub['XYf'MUa i bUž'V]g'G]Y'XYb'A Y\hUV6U[\'YffY]W\Yb"'5`hYfbUh]j' _\ObbYb'G]Y'j cb'ØVYfU``'fi bX'i a 'XUg HU^Y]bY'F]_gW\U'ZØf'Yhk U'%) \$'Fi d]Yb'dfc'DYfgcb'bY\a Yb"

 $NY]hYb.^*.$$^V]g^&\%.$$^I \f$

9]bhf]hh '&\$\$ 'Fi d]Yb 'ZØf'5i g`ÀbXYf'i bX '%) 'Fi d]Yb 'ZØf']bX]gW\Y 9]b\Y]a]gW\Y U`h1 H5>A 5<5@'5| G'89A 'A 9<H56'65; < '+B'5; F5ž'+B8+9B 2

("'U[fU'Zcfh'hU^a U\U`'Ui gg]WX hgdi b_h

8]Y'Ua 'nk Y]h\Ài Z][ghYb'VYgi WkhY'GY\Ybgk ØfX][_Y]h'j cb'5[fU']gh XUg'5[fU': cfh"'CVk c\`'Yg'k Y]h[Y\YbX'j cb'gY]bYa A Ufa cfk i bXYf'Y]bYg'GWk YghYfXYb_a U`g'VYgWk UhhYh'k]fXž'[]`h Yg'U`g'Y]bYg'XYf'VYY]bXfi W_YbXghYb': cfhg']b' \$X]Yb"

8 Ugʻ5[fU': cfh']gh'Y]bY'a cbi a YbhU`Y': Yghi b[ž'X]Y'Y\Yf'U`g A]b]ghUXh'XYbb'U`g': Yghi b['VYgWXf]YVYb'k YfXYb'_Ubb"'GY]bY VYY]bXfi W_YbXYb'DU`ÀghYž'5i gV`]W_Yž'±bbYb\ÒZY'i bX'HYa dY` YfghfYW_Yb'g]WX'ØVYf'Yhk U'- ('<Y_hUf'bYVYb'XYa 'MJai bU!: `i ggž Yhk U'&'?]`ca YhYf'j ca 'HU^YbhZYfbh"

K]Y`ni `Yfk UfhYbž`]gh`XUg`5[fU`: cfh`Y]bYf`XYf`VYghYb`CfhYži a
Y]bYb`5i gg]W\hgdi b_h`Ui Z`XUg`HU^A U\U``ni `VY_ca a Yb"'≠bbYf\U`V
XYf`: Yghi b[`[]Vh`Yg`a Y\fYfY`5i gg]W\hgdi b_hYž`XUfi bhYf
XY_cfUh]j Y`: YbghYfž'6U`_cbY`i bX`HØfa Y"

 $\begin{tabular}{ll} $VYfgdf]b[YbG]YX]YKUfhYgWX`Ub[Y.5[fU'<U`VhU[Yghcif'jcb5]fU':cfh'ibX'HU^AUVU` \end{tabular}$

 $NY]hYb.^{**}.\$\$^{*}V]g^{*}\%,.\$\$^{*}I\ \ \ f$

U`h1 5[fU': cfh'5i gg]W\hgdi b_h'H5>A $5<5@K=9'JCA'5; F5': CFH=88=9B'; 9G9<9B 26`]W_'Ui Z'XUg'HU^A U\U`'j ca '5[fU': cfh$

) "'J cb'Y]bYa '8UW\WUZA'cXYf'< chY`

9]bY'XYf'VYghYb'A Ò[`]W_Y]hYbž'X]Y'DfUW\h'XYg'HU^A U\U`ni [Yb]Y»Ybž']gh'j cb'Y]bYa 'XYf'j]Y`Yb'8 UW\WUZÅg'i bX'<chY`g']b'5[fU Ui g"'K À\fYbX'U``Y'i a `]Y[YbXYb'; YgW\ÀZhY'VY\Ui dhYbž'XYb VYghYb'HU¹5i gg]W\hgdi b_h'ni 'V]YhYbž'g]bX'Y]b][Y'cZZYbg]W\h`]W\VYggYf'U`g'UbXYfY"

5a '5bZUb['X]YgYg'6Y]hfU[g'\UVY']W\ 'Y]bYb '5VgW\b]hh'[Yk]Xa Yhžia 'X]Y 'VYghYb'8 UW\fYghUi fUbhg'i bX'<chY`hYffUggYb'ni]XYbh]Z]n]YfYbž'j cb'XYbYb'Ui g'a Ub'XUg'HU^A U\U`'gY\Yb'_Ubb" A Y]b': Uj cf]h']gh'XUg'<chY`'? Ua U`"

8 UgʻGWX ObYʻXUfUbʻ]ghžʻXUggʻYgʻhUhgÀWX`]WXʻj]Y`Yʻ j YfghYW_hY

¾ k Y`Yb '[]VhžʻX]Yʻ[fc» Ufh][Yʻ5i gV`]W_YʻUi ZʻXUgʻHU^V]YhYbžʻc\bY

X]YʻHci f]ghYbghYi Yf!Fi d]YbʻVYfUddYbʻni ʻa ØggYbʻʻGWXUi YbʻG]Y

g]WXʻX]YgYʻU`gcʻi bVYX]b[hʻUbžʻk À\fYbXʻG]Yʻ]bʻ5[fUʻg]bXʻʻ

U`h1 85GʻH5>A5<5@ʻJCAʻF9GH5I F5BHʻ857<′-Bʻ5; F5

-B8-9B 26`]W_ʻUi ZʻXUgʻHU^AU\U`j ca ʻFYghUi fUbhʻXYgʻ<chY`gʻGU]

DU`UWY

*"'6`]W_'Ui Z'XUg'HU^A U\U`'j ca ': `i gg'MUa i bU

C_Umž'X]YgYf'GhUbXdi b_h'ni a 'HU^A U\U`']gh'Yhk Ug'UbXYfg'i bX Yhk Ug'i a ghf]hhYb"'=\W 'V]b'a]f'g]W\Yfž'XUgg'j]Y`Y'j cb'=\bYbž'X]Y X]Yg'`YgYbž'XUg']_cb]gW\Y'GcbbYbUi Z[Ub[gZchc'Ub'6cfX'Y]bYg Fi XYfVcchg'Ui Z'XYa 'MJa i bU!: `i gg'[YgY\Yb'\UVYbž'a]h'Y]bYf [fc> Ufh][Yb'HU^A U\U`!?i `]ggY"

8]Y'K U\f\Y]h']ghž'XUgg'HU^A U\U`!: `i ggVcchY'Ui g G]W\Yf\Y]hg[fØbXYb'Y][Ybh`]W\']``Y[U``g]bX"'BUW\'Y]b'k Yb][FYW\YfW\Y']a '=bhYfbYh'\UVY']W\'YXcW\'ZYgh[YghY``hž'XUgg'Yg]a a Yf'bcW\'a Ò[`]W\']ghž'k Ybb'Ui W\'f]g_Ubh"

 $8\,U^*]WX^*k~\grave{A}\fYbX^*a~Y]bYf^*NY]h^*]b^*5[~fU^*_Y]b^*f]g]_cVYfY]hYg^*6cch$

 $Z]bXYb^-cbbhY\check{z}^-Ubb^-]WX^- \Rightarrow bYb^-X]Y^-8YhU]^*g^-Y]XYf^-b]WX^-h^-UbV]YhYb^-UbYb^-Y^-C[-Y]b[-YVYhhYh\check{z}^-XYf^-XUg^-HU^-A_-UV^-]WX^-YXcWX^-Y]bYb^-Y^-c[-Y]b[-YVYhhYh\check{z}^-XYf^-XUg^-HU^-A_-UV^-]UV^-DYbYb^-YVb]g^-YYb]g^-YYb]g^-YYb^-UbYb^-Y^-Ub^-Y^-Ub^-$

+"'GYWfYh'Gi bgYh'HU^A U\U\'5i gg]W\hgdi b_h'f\notingf \Rightarrow AghY'XYg'N]['NU['< cghY\'g\noting \text{BY}'\text{SY} \text{BY}'\text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\text{SY} \text{BY}'\t

8 Yf``YhnhY`Di b_h`Ui Z`X]YgYf`@]ghY`XYf`VYghYb`5i gg]W\hgdi b_hY`Ui Z XYa `HU^A U\U``]gh'a Y]b`dYfgÒb`]W\Yf': Uj cf]h"`I a `\]Yf\Yf`ni [Y`Ub[Ybž'a ØggYb`G]Y'; Ugh']a `N][`NU[`<cghY``]b`5[fU`gY]b"

5i Z[fi bX Y]b][Yf `c_U`Yf : Ua]`]Ybj YfV]bXi b[Yb `\UVYb X]Y 6Yg]hnYf XYg `N][`NU['< cghY `g `Ni [Ub['ni 'Y]bYa 'U`hYb Hi fa a cbi a Ybh Ybh`Ub['XYg : `i ggYg `MUa i bUž XUg Y]b][Y `XYf VYghYb '5i gg]W\hYb 'Ui Z `XUg `HU ^A U\U` ']b '5[fU 'V]YhYh" '8]YgYf 5i gg]W\hgdi b_h XYg `HU ^A U\U` 'VYZ]bXYh `g]W\ 'Ui Z 'df]j UhYa '@UbXž gc XUgg 'G]Y 'c\bY']\fY '<]`ZY 'b]W\h hni a '5i gg]W\hgdi b_h [Y`Ub[Yb ObbYb"

K À\fYbX'a Y]bYf'`YhnhYb'FY]gY'bUW\'\\DX]Yb'k i fXY'a]f'j cb'nk Y]
j YfgW\]YXYbYb'FY]gYbXYb'[YgU[hz']W\'gc``Y']a 'N]['NU[
ØVYfbUW\hYb"'6Y]XY'Yfk À\bhYbz'XUgg'Yg'Y]b'A i gg'gY]z'k Ybb'a Ub
VYXYb_hz'k]Y'[fc > Ufh][']\f'[Y\Y]a Yf'5i gg]W\hgdi b_h']gh"

 $\label{eq:nulling} N)[\ ``NU[\ ``V]YhYh'hÀ[\ ``]WX `K UbXYfhci fYb'i bX \\ GcbbYbi bhYf[\ Ub[\ gUi \ gZØ[\ Y'ni \ a \ `5i \ gg]WX hgdi b_h'HU^A U\U``Ubž i bX'k Ybb'G]Y'X]Y'5fh'j cb'DYfgcb'g]bXž'X]Y'[\ YfbY']b'<cghY`g \\ \emptyset VYfbUWX hYhž'XUbb'_Ubb']WX' \Rightarrow bYb'k Åfa ghYbg'Ya dZY\`Ybž'\]Yf'ni \\ \emptyset VYfbUWX hYb'' $$

6i WXYb'G]Y'Yhnh'N][NU['<cghY`5[fU

"U`M1 H5>A5<5@GCBB9BIBH9F; 5B; "JCA"N≒ "N5; "<CGH9@G97F9H"J=9K "DC-BH2

Ni gUa a Yb ZUggi b[. '8]Y 'V YghYb 'F YghUi fUb hg a]h '6`]W_ 'Ui Z'X Ug 'HU 'A U\U`

BUWXXYa ']W 'bUW 'XYa 'VYghYb'8UW fYghUi fUbh'a]h'6`]W_'Ui Z'XUg HU^A U\U`']b'5[fU'[Ygi W\h'\UhhYž'YbhXYW_hY']W\'X]YgY'k Yb][Yb ik Y`Yb"'9]b][Y'XUj cb'k UfYb'`c_U`Y'9a dZY\`i b[Ybž'k À\fYbX Y]b][Y']W\'cb`]bY'[YZ|bXYb'\UVY'i bX'Y]bY'bi f'ni ZÀ``]["

GUb]mU!DU`Ugh8Yf'GUb]mU!DU`Ugh']gh']b'5[fU'U`g'Y]bYf'XYf'VYghYbCfhY'VY_Ubbhž'ia'XUg'HU^AU\U`ni'gY\Yb"'9g']gh'YhkUg'bcVY`žUVYf'X]Y'AU\`nY]hYb'g]bX'b]W\h'ni'hYiYf'fWU"''\$\$'Fid]Yb'dfcDYfgcbŁ"

A i a hUn'7UZY; U``Yfm'8]YgY'YfghY']gh'Yhk Ug'hYi Yfž'V]YhYh'UVYf a Y]bYf'A Y]bi b['bUWX'Y]bYb'XYf'VYghYb'5i gg]WXhgdi b_hY'Ui Z'XUg HU^A U\U`'j cb'Y]bYa 'FYghUi fUbhXUWX'Ui g"'CVk c\`'Yg'Yhk Ug k Y]hYf'j ca 'HU^YbhZYfbh']ghž'g]bX'X]Y'5i gg]WXhYb'i bhYfVfcWXYb i bX'n]Ya `]WX'gdY_hU_i `Àf"

<chY``GU]`DU`UWY \(\frac{4}\)\ \(\frac{1}{2}\) \(\frac{1}

K Ugʻ]ghʻj cfʻXYa ʻHU^ni ʻgY\Yb3ʻ

A $\grave{O}W$ hYb 'G]Y 'gd UfYb 'i b X '_Y]b Y '9]b hf]hhg_UfhY 'V Y n U\ `Yb 3 '@Y]X Yf \ Uh'a Ub 'Ui Z[fi b X 'X Y f' [fc » Yb 'A Ui Y f' j c f' X Ya 'HU^j c b 'Ui » Yb b]W\ h'k]f_`]W\ 'j]Y `'G]W\ h'Ui Z'X]Y ': fc b h''

K]Y'G]Y'YXCW\']b'X]YgYa '5fh]_Y`'[YgY\Yb'\UVYbž'[]Vh'Yg'j]Y`Y CfhYž'Ub'XYbYb'G]Y'Y]bYb'[fc»Ufh][Yb'5igg]W\hgdib_h'Yf\U`hYb _\ObbYbž'c\bY'XUZØf'ni 'VYnU\`Yb"'K Ybb'a Ub'XUg'gU[hž'[]Vh'Yg k]f_`]W\'_Y]bYb'9fgUhn'XUZØfž'X]YgYg'YfghUib`]W\Y'K ibXYf'jcb]bbYf\U`V'XYg'; Y`ÀbXYg'ni 'gY\Yb"

5 i W\ '\]Yf']gh'XYf'VYghY'K Y[\check{z} Y]b'H]W_Yh'ni 'Vi W\ Yb'i bX'X]Y'`Ub[Y GW\ `Ub[Y'ni 'j Yfa Y]XYb \check{z} ']a 'J cfUi g'cb`]bY'ni 'Vi W\ Yb"

$A Y \setminus f = bX Y b F Y g Y Z \emptyset \setminus f Y f i b X 6 c [g$

 $5bXYfbZU``gž'k Ybb'G]Y'Yg'[YgWkUZZh'\setminus UVYbž'Ui Z'k Y]hYfY'HU^A U\setminus U`!\\ 5i gg]Wkhgdi b_hY'ni 'ghc'' Ybž'X]Y'\]Yf'b]Wkh'Ui Z[YZØ\fh'g]bXž'`UggYbG]Y'Yg'i bg'i bVYX]b[h'k]ggYb''$

A 9-B 9 ? 5 A 9 F 5 I B 8 : C H C 5 I G F G H I B ;

- Gd]Y[Y``cgY'?Ua YfU.'7Ubcb'F)
- 8 fc \ bY. '8 > A Uj]WDfc '&
- ' * \$!; fUX!5Wh]cb!?Ua YfU. '=bghU' * \$ 'CbY'L &
- @UbXgW\UZhgcVY_h]j . '7 Ubcb'F: '%)!') 'a a 'Z#&", @
- 5``fci bX!CVY_h]j . '7Ubcb'F: '&(%\$) 'a a 'Z#(@
- HY`YcVY_h]j . 7 Ubcb F: '%\$\$) \$\$ a a 'Z#Z#(ž) + ž%'@
- @Ub[Y'5_h]cbgghUb[Y.'=bghU' *\$'=bj]g]V`Y'Dc`Y'fbi``YhH]a YŁ
- @UbXgWXUZhg`]bgYbZ]`hYf.'< cmU'7]fW'`Uf'Dc`Uf]nYf
- ?Ua YfUfi W_gUW_. :: !Ghcd H]`cdU
- $\bullet @]YV`]b[gZchcniVY\Of.\DYU_`8Yg][b`7UdhifY`7`]d \\$

9]bY'@]ghY'a Y]bYf'Ya dZc\`YbYb': chcUi gfØghi b['fY]bgW\`]Y»`]W\ k Ug']W\'VYbi hnY'i bX'k Ufi a Ł'Z]bXYgh'Xi ']b'a Y]bYa '@Y]hZUXYb'ZØf?Ua YfUUi qfØghi b['ZØf'X]Y'FY]qY"

K Ybb 'G]Y 'Y]bYg 'XYf': chcg'Ui Z'X]YgYf'K YVg]hY 'j Yfk YbXYb
a ÒW hYbž'VYgi W Yb 'G]Y 'V]hhY 'a Y]bY '@]nYbn]Yfi b[ggY]hYž'i a
\YfUi gni Z]bXYbž'k]Y"'→W 'j Yf_Ui ZY 'Ui W 'dfcZYgg]cbY``Y
?i bghXfi W_Yž'VYgi W Yb 'G]Y 'a Y]bYb 'Df]bh'GhcfY 'cXYf'_cbhU_h]YfYb
G]Y 'a]W 'X]fY_h'ZØf'Nc``UVnØ[Y'j cb'6]`XYfb'Ui Z'K Y'GYY_'HfUj Y`"
U`h1 2

5i Z'D]bhYfYgh3

K Ufi a gdY]WXYfb G]Y X]Y gYb $\operatorname{@Y}$]hZUXYb b]WX h Z Øf gd A hYf ni XYb +

VYghYb'5i gg]W\hgdi b_hYb'Ui Z'XYa 'HU^A U\U\3'K Ybb'G]Y'K Y'GYY_ HfUj Y`'Ui Z'D]bhYfYgh'Zc`[Ybž'V`Y]VYb'G]Y'a]h'U`''XYb'bYi Yb FY]gYZØ\fYfb'i bX'6\c[g'Ui Z'XYa '@Ui ZYbXYb"

D=B '9G': C@ 9'A =

п

8 Y hU]`c

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