

9a ch]cbU`Y`A cXYbgW\Ui . 5`Ub 6U``Yhg\cZYf`k]Xa Yh'?c``Y_h]cb`gY]bYa j YfghcfVYbYb`6fi XYf`A Ufj]b

H]hY`. `A cXYXYg][bYf`5`Ub`6U``Yhg\cZYf`k]Xa Yh`gY]bY
?c``Y_h]cb`XYa j YfghcfVYbYb'6fi XYf`A Ufj]b`5a
8cbbYfghU[UVYbX`dfÀgYbh]YfhY`XYf`BUW\k i W\g!8Yg][bYf
5`Ub`6U``Yhg\cZYf`]a `FU\a Yb`XYf`6Yf`]bYf`: Ug\]cb`K YY_
gY]bY`: fØ\^U\f#Gca a Yf`&\$&(`?c``Y_h]cb"`8cW\X]YgY
A cXYbgW\Ui `k Uf`b]W\h'bi f`Y]b`8YVØhzgcbXYfb`Ui W\Y]b
Ya ch]cbU`Yf`A ca Ybh`ZØf`X]Y`: Ua]`]Y`6U``Yhg\cZYf`i bX`]\fY
: fYi bXY"`5`Ub`6U``Yhg\cZYf`]gh'bÀa`]W\`XYf`Øb[YfY`6fi XYf
XYg'j YfghcfVYbYb`I bhYfbY\a Yfg'A Ufj]b`6U``Yhg\cZYfzXYf
j cf`XfY]`*J\fYb`VY]`Y]bYa `hfU[]gW\Yb`5i hci bZJ```i a g'@YVYb
_Ua "`8]Y`9I!: fYi bX]b`j cb`A Ufj]bz`GW\Ui gd]Y`Yf]b`@ bU
GW\k Y][Yfz'i bhYfghØhnhY`]\fYb`Y\Ya U`][Yb`GW\k U[Yf`VY]
X]YgYf`VYgcbXYfYb`A cXYbgW\Ui "`8]Y`J YfUbghU`hi b[`ZUbX`]b
Y]bYf`Wcc`Yb`: UVf]_\U``Y`]b`: f]YXf]W\g\U]b`ghUhhi bX`XUg
A chhc`XYf'/ Ua d\Y``]d/

H]hY`. 'A cXYXYg][bYf'5`Ub'6U``Yhg\cZYf'k]Xa Yh'gY]bY'?c``Y_h]cb XYa 'j YfghcfVYbYb'6fi XYf'A Ufj]b

5a '8cbbYfghU[UVYbX'dfÀgYbh]YfhY'XYf'BUW\kiW\g!8Yg][bYf 5`Ub'6U``Yhg\cZYf']a 'FU\a Yb'XYf'6Yf`]bYf': Ug\]cb'K YY_gY]bY : fØ\'U\f#Gca a Yf'&\$&('?c``Y_h]cb"'8cW\'X]YgY'A cXYbgW\Ui'k Uf b]W\h'bi f'Y]b'8YVØhž'gcbXYfb'Ui W\'Y]b'Ya ch]cbU`Yf'A ca Ybh'ZØf X]Y': Ua]`]Y'6U``Yhg\cZYf'i bX']\fY': fYi bXY"'5`Ub'6U``Yhg\cZYf']gh bÀa `]W\'XYf'Øb[YfY'6fi XYf'XYg'j YfghcfVYbYb'I bhYfbY\a Yfg A Ufj]b'6U``Yhg\cZYfž'XYf'j cf'XfY]'\\\fYb'VY]'Y]bYa 'hfU[]gW\Yb 5i hci bZU``i a g'@YVYb'_Ua "'8]Y'9I!: fYi bX]b'j cb'A Ufj]bž GW\Ui gd]Y`Yf]b'@ bU'GW\kY][Yfž'i bhYfghØhnhY']\fYb'Y\Ya U`][Yb GW\k U[Yf'VY]'X]YgYf'VYgcbXYfYb'A cXYbgW\Ui'"

8]Y'JYfUbghU`hi b['ZUbX']b'Y]bYf'Wcc`Yb': UVf]_\U``Y']b
: f]YXf]WXg\U]b'ghUhh'i bX'XUg'A chhc'XYf'A cXYbgWXUi '`Ui hYhY.
9f]bbYfi b[Yb'ghYfVYb'b]Y'' \display XYf'YfghYb'FY]\Y'gU\(\text{y}\) Yb'@i bU\(\text{z}\)]\fY'GWXk YghYf'9a a U'i bX']\fY'A i hhYf'8 UbU\(\text{z}\)X]Y'U``Y'a]h'Hf\(\text{A}\)b'XYb'5i [Yb'gU\(\text{y}\)Yb'''@i bU'\UhhY']\fYa 'j YfghcfVYbYb'9I!: fYi bX
VYfY]hg'ni 'gY]bYa '\(\text{x}\)''; YVi fhghU['Ui Z'\displayhU[fUa 'f\(\text{Q}\)\fYbXY'K cfhY
[Yk]Xa Yh'i bX'GWXk Ufn!k Y]\(\text{y}\)!: chcg'Ui g'['\text{Q}\)\'\']WXYb'NY]hYb
[YhY]`h''

: Øf'gY]bY'?c``Y_h]cb'\Uh'5`Ub'6U``Yhg\cZYf'gY]bYa '6fi XYf'Y]bY
VYgcbXYfY'K]Xa i b['ni _ca a Yb'`UggYb"'9]b'bcghU`[]gW\Yg
9`Ya Ybh'n]Yfh'Y]b][Y'XYf'?c``Y_h]cbgghØW_Y. 'XUg'; Yg]W\h'gY]bYg
6fi XYfg'A Ufj]b'Ui Z'G]`VYf!?b`OdZYb"'8]Y'?b`OdZY'k i fXYb'Ui g
YW\hYa 'G]`VYf'[YZYfh][h'i bX']b'Ni gUa a YbUfVY]h'a]h'Y]bYa
; c`XgW\a]YX'\Yf[YghY``h'''G]Y'g]bX''YXcW\'b]W\h'Ui Z'XYb'YfghYb
6`]W_'Yfg]W\h']W\'i bX'k i fXYb'XYnYbh']b'Y]b][Y'D]YW\'g
Y]b[YUfVY]hYh'

8]Y?c``Y_h]cb`VYghY\h'Ui g`&, 'GhØW_Ybž'X]Y`5`Ub`6U``Yhg\cZYf
]bbYf\U`V'j cb`bi f'j]Yf'A cbUhYb`Ybhk cfZYb`\Uh"'GY]bY`\dgd]fUh]cb \c`hY`Yf'g]W\`XUVY]'j cb`gY]bYa '6fi XYf"'9f'_ca V]b]YfhY`XYb GhfYYhk YUf!Ghm`Y'Ui g']\fYf'HYYbU[YfnY]h'a]h'Y]bYa 'Y`Y[UbhYb @cc_"'8]Y`A cXYbgW\Ui 'Z]bUbn]YfhY`i bX`cf[Ub]g]YfhY`Yf [Ya Y]bgUa 'a]h': fYi bXYb`i bX': Ua]`]Y"

 $6 YgcbXYfg'ibhYfghØhnYbX'ghUbX'@ibU'GWk Y][Yfg'AihhYf'8 UbU'Ub5`Ub'6U``Yhg\cZYfg'GY]hY'''G]Y'VYnY]WkbYh']\b'U`g'Y]bYb'gY\f'Yb[Yb:Ua]`]YbZfYibX'ibX'VYhcbhYž'XUgg'Yf']\f'gY\f'Ua'<YfnYb'`]Y[h''5`Ub'gY]'k]Y'Y]b'Gc\b'ZØf'g]Y'ibX'g]Y'VYkibXYfY'gY]bY'8]gn]d`]bibX'9\f[Y]n][_Y]h']b'gY]bYa'' 4 b[Yb'5`hYf''$

8]Y'AcXYbgW\Ui'k Uf'Y]b'[fc>Yf'9fZc`['ibX'Ui W\'HcdacXY`GhYZUb]Y';]Yg]b[Yf'`]YZ'ZØf'X]Y' 6U``Yhg\cZYf!AcXYbgW\Ui''5iZ
XYa:`mYf'XYf':Ug\]cb!G\ck:ZUbX'g]W\'Y]bY'fØ\fYbXY'6chgW\UZh
jcb'5`Ub'6U``Yhg\cZYfž']b'XYf'Yf'VYhcbhYž'XUgg'9f]bbYfib[Yb']b
ibgYfYb'<YfnYb'jYfUb_Yfh'V`Y]VYb'ibX'k]W\h][Y'GdifYb\]bhYf`UggYb'''>XYg'?`Y]Xib[gghØW_']b'gY]bYf'?c``Y_h]cb'gd]Y[Y`YX]YgYb'\DX'Y]jXiU`]gaig'k]XYf'ibX'Yf]bbYfY'ibg'XUfUbž'XUgg'YXY

 $\label{eq:final_system} FY]gY`]b`i bgYfYa `Y]bn][Ufh][Yb`@YVYb`k]Y`_Y]bY`UbXYfY`]gh"$

A]h'X]YgYf'VYgcbXYfYb'?c``Y_h]cb'\Uh'5`Ub'6U``Yhg\cZYf'gY]bYa j YfghcfVYbYb'6fi XYf'A Ufj]b'Y]b'VYfØ\fYbXYg'8Yb_a U`'[YgYhnh" 8Ybb'cVk c\``A Ufj]b'gY]b'[UbnYg'@YVYb'bcW\'j cf'g]W\'\UhhYž k YfXYb'X]Y'9f]bbYfi b[Yb'Ub']\b'b]Ya U`g'ghYfVYb"

8 YhU]`g

6Ygi WXYb G]Y i bg Ui Z. a Y]b!VYf `]b "bYh