

8]Y'<Ua a Yf'GdJ['g]Y[hY'j YfX]Ybh'a]h'*.&'VY]a 'HG7'<Ua a i bX'n]Y\h']bg'J]YfhY`Z]bU`Y'XYg'Dc_U`g'Y]b"'9]b'ghUf_Yg HYUa gd]Y`'YbhgWX]YX'XUg'8YfVm"

8]Y'A UbbgW\UZhgUi ZghY``i b['j cb'HfU]bYf'?Uf'!<Y]bn'N]Y`]bg_]'k]Yg
]a 'J Yf[`Y]W\'ni a 'j cf\Yf][Yb'Gd]Y`'ZØbZ'ŸbXYfi b[Yb'Ui Z'' 8 Ug
k Uf'Y]b'\cW\j YfX]YbhYf'G]Y["'8]Y'\si b[g'\UVYb'Yg'bUW\'XYf
B]YXYf`U[Y'Ua 'GcbbhU['\Yi hY'[Ubn'cfXYbh`]W\'[Ya UW\h ž'gU[hY N]Y`]bg_]"'9f'Yf_UbbhY'Ubž'XUgg'XYf'HG7'_Y]b'gW\k UW\Yf'; Y[bYf']b
XYf'?fY]g`][U']ghž'i bX'Yg'k Uf'ZØf'X]Y'<Ua a Yf'GdJ['b]W\h
gY`Vghj YfghÀbX`]W\ž'XYb'G]Y['Y]bni ZU\fYb"

I bfi \][Yf'Gd]Y'j Yf'Ui Z

6U```gY\f`gW\`YW\h`Ui g[Ygd]Y`h ž`ghY``hY`N]Y`]bg_]`ZYghž`k À\fYbX XUg`YfghY`Hcf`Y]b`[i hYg`6Y]gd]Y``ZØf`X]Y`5Vgh]a a i b[`]b`XYf C ZZYbg]j Y`XUfghY``hY"

8 Ug·% \$ 'Z]Y``VYfY]hg·]b·XYf·UW\hYb·A]bi hY"@YUbXfc·9`V]b[
VYX]YbhY·Hf]ghUb·Ni a VfcW_'Ui Z'fYW\hgž'XYf'XYb·6U```dfÀn]gY
ni fØW_gd]Y`hYž'gcXUgg·Ni a VfcW_'Z'UW\']bg·Hcf·hfUZ''8cW\'X]YgYf
J cfgdfi b['\]Y`h'b]W\h'`Ub[Y'Ubž'XYbb'bi f'nk Y]'A]bi hYb·gdÀhYf
[`]W\'A]fUWGU\]b·ZØf'XYb·HG7'< Ua a 'Ui g"'9]b·j YfXYW_hYf'GW\i gg
j cb·GU\]b·k i fXY'j cb·\$Jb`DUgga Ubb'b]W\h'f]W\h]['ZYgh[Y\U`hYbž
k Ug'XYa '; Ugh[YVYf'5i Zhf]YV'[UV"

K]WX h][Y'HcfY'i bX'Y]b'9'Za YhYf

8]Y'<Ua a Yf'GdJ['nY][hY'YXcW\']\f'GY`VghVYkigghgY]b'ibX
gcf[hY'jcf'XYf'<U`VnY]h'ZØf'_`UfY'JYf\À`hb]ggY"'\bYf\U`V'jcb'bif
XfY]'A]bihYb'Zc`[hYb'nkY]'HcfY.'Nia VfcW_'Yfn]Y`hY'XUg'&.%'fl*"Ł
bUW\'Y]bYa 'EiYfdUgg'jcb'5a Uf'<ig]W*k\A\fYbX'<ig]WgY`Vgh']b
XYf'', "'A]bihY'Uig'_ifnYf'8]ghUbn'nia''.%'hfUZ''BUW\'XYf'DUigY
gW\]Yb'Yg'nib\AW\gh*z'U`g'_\ObbhY'XYf'HG7'nif@W__caayb*z
bUW\XYa'GW\]YXgf]W\hYf'<YbXf]_'AUUn'Y]bYb'<UbXY`ZaYhYf
[Y[Yb'X]Y'<Ua aYf'GdJ['jYf\Ab[hY"'\=\fU\]a'GUf]a'Ub*zXYf
Hcf\@hYf'XYg'HG7*z'_cbbhY'XYb'YfghYb'JYfgiW\'jcb'A]\U^cj]W
nk Uf'UVkY\fYb*z'UVYf'VY]a'nkY]hYb'GW\igg'k Uf'Yf'a'UW\h`cg*z'k Ug
XYb'Gd]Y`ghUbX'UiZ'(.%'Yf\O\hY"

 $8 \ Yf' HG7'[UV''YXcWX'b]WXh'Ui Z'i bX'j Yf_ØfnhY'Xi fWX'=ga U]`'I mgU`']b XYf') - "'A]bi hY'Ui Z'&.(ž'k Ug'XYa'; Ugh[YVYf' < c \omega Zbi b[Yb'[UVž'XUg Gd]Y`'bcWX'ni 'XfY\Yb''8cWX'X]Y'?cbX]h]cb'XYf' < Ua a Yf'GdJ['k Uf YbhgWXY]XYbXž'i bX'g]Y'a UWXhYb'a]h'k Y]hYfYb'HcfYb'U``Yg'_`Uf''' \omega b 9f_Y`]b['hfUZ']b'XYf'+* "'A]bi hY'bUWX'Y]bYa'Ei YfdUgg'j cb'7f]g'C'c i bX'gYhnhYb'XYb'GWX`i ggdi b_h'A]\U^cj]Wa]h'Y]bYa VYY]bXfi \w_YbXYb'Gc`c`Ui Z$

8]Y`*.&!B]YXYf`U[Y`XYg`HG7`< Ua a 'j YfXYi h`]W\h`X]Y`8]ZZYfYbnnk]gW\Yb`XYb`VY]XYb`A UbbgW\UZhYb`i bX`nY][hž`XUgg`X]Y`< Ua a YfGdJ['g]W\`Ui Z`XYa 'f]W\h][Yb`K Y[`VYZ]bXYh"`8]Y`bÀW\ghY`5i Z[UVY[Yb`XYb`Hi G`K]YgW\Yf\ÒZYb`k]fX`ZØf`X]Y`< Ua a Yf`GdJ['Y]bY

bYi Y'< YfUi gZcfXYfi b['XUfghY``Ybž'k c'g]Y'nY][Yb'_ÒbbYbž'XUgg g]Y'bUWX'Y]bYa 'gc`]XYb'Dc_U`Ui ggd]Y``k Y]hYf\]b'Ui Z'?i fg'g]bXž'i a X]Y'bÀWXghYb'Fi bXYb'ni 'YffY]WXYb"

9]b 6`]W_ ']b 'X]Y 'b À WX ghY 'F i b X Y

8]Y'<Ua a Yf'GdJ['\Uh'a]h'X]YgYf'@Y]ghi b['VYk]YgYbž'XUgg'g]YUi W\'bUW\'Y]bYf'B]YXYf`U[Y'ni f@W_ca a Yb'_Ubb"'8Yf': c_i g'Ui ZHYUa UfVY]h'i bX'X]Y': À\][_Y]hž']b'_f]h]gW\Yb'A ca YbhYb'nifYU[]YfYbž'g]bX'kYfhj c``Y'9][YbgW\UZhYbž'X]Y'g]Y']b'X]Y'bÀW\ghYFi bXY'XYg'Dc_U`g'a]hbY\aYb'kYfXYb"'8]Y'bÀW\ghYb'K cW\YbkYfXYb'XYi h`]W\'a UW\Ybž'cV'g]Y'XYb'GW\ki b['Ui g'X]YgYaVYY]bXfi W_YbXYb'G]Y['a]hbY\aYb'_ObbYbž'i a']a'8YfVm'[Y[YbXYb'Hi G'K]YgW\Yf\OZYb'YfZc`[fY]W\'ni 'gY]b"'8]Y'JcfZfYi XY'Ui ZX]YgYg'HfYZZYb']gh'VYfY]hg'gdØfVUfž'i bX'X]Y': Ubg'g]bX'[YgdUbbhž cV']\fY'AUbbgW\UZh'XUg'\c\Y'B]j YUi 'YfbYi h'UVfi ZYb'_Ubb"

@Y]ghi b[XYf < Ua a Yf GdJ[]a Dc_U`

8]Y'<Ua a Yf'GdJ['nY][h']b'XYf'U_hi Y``Yb'GU]gcb']b'XYf'@UbXYg`][UY]bY'VYY]bXfi W_YbXY': cfa 'i bX'\Uh'bi b'X]Y'bÀW\ghY'Fi bXY']a

Dc_U``XYg': i >> VU``_fY]gYg'I bbU!<Ua a 'YffY]W\h''8Yf'*.&!G]Y[

[Y[Yb'HG7'<Ua a 'VY`Y[hž'XUgg'XUg'HYUa 'hfchn'XYf

gW\k Ub_YbXYb'@Y]ghi b[Yb']b'XYf'@][U'XUg'DchYbn]U``\Uhž'Ui W\']b

YbhgW\Y]XYbXYb'Gd]Y`Yb'ni '[`AbnYb"'8]Yg'_ObbhY'Y]b

YbhgW\Y]XYbXYf': U_hcf'ZØf'X]Y'A cfU`'i bX'XYb'Ni gUa a Yb\U`h'XYf

A UbbgW\UZh'gY]bž']bgVYgcbXYfY'bUW\'Y]bYf'B]YXYf`U[Y']b'XYf

`YhnhYb'DUfh]Y'[Y[Yb'=\VYbVØfYb"

 $\label{eq:continuous_continuous$

GhUh]gh]gWXY'5bU`mgYb'ni f'HYUa `Y]ghi b[

GhUh]gh]_Yb'_ObbYb'cZh'5i ZgWX\i gg'ØVYf'X]Y'@Y]ghi b['Y]bYf
A UbbgWX UZh'[YVYb"'=a 'U_hi Y\Yb'Dc_U\gd]Y\igu\\a Ubž'XUgg'X]Y
< Ua a Yf'GdJ ['b]WXh'bi f'a Y\f'HcfY'Yfn]Y\hYž'gcbXYfb'Ui WX'Y]bY\\O\YfY'GWXi gg[YbUi][_Y]hii bX'6U\`VYg]hnei chY'Ui Zk]Yg"'Gc\WXY?YbbnU\\Yb'g]bX'YbhgWXY]XYbXžii a 'X]Y': cfhgWXf]hhY'Y]bYg'HYUa g
ni 'VYk YfhYb'i bX'ghfUhY[]gWXY'9bhgWXY]Xi b[Yb'ZØf'ni _ØbZh][Y
Gd]Y`Y'ni 'hfYZZYb"

± XYf'j Yf[Ub[YbYb'GU]gcb'Yfn]Y`hY'X]Y'< Ua a Yf'GdJ[']b'%\$']\fYf
'YhnhYb'Gd]Y`Y']a 'Dc_U`']bg[YgUa h'&' 'HcfY"'8]YgY'NU\`Yb
j Yf`Y]\Yb'XYa 'HYUa 'GY`Vghj YfhfUi Yb'i bX'nY][Ybž'XUgg'a Ub'X]Y
C ZZYbg]j Y'_cbh]bi]Yf`]W\'j YfVYggYfb'_Ubb"'Ni XYa ']gh'X]Y'6]`Ubn
XYf`YhnhYb'Gd]Y`Y']b'XYf'@][U'YVYbZU``g'Y]b'±bX]_Uhcf'ZØf'XYb
U_hi Y``Yb': cfa ghUbX'i bX'X]Y'DfcnYggj YfVYggYfi b[Yb']a '?UXYf"

JYf[Ub[YbY'9fZc`[Y']a 'Dc_U`k YhhVYk YfV

 $8]Y' < Ua \ a \ Yf'GdJ ['_Ubb'Ui Z'Y]bY'YfZc`[fY]WXY'; YgWX]WX hY']a \\ Dc_U`'XYg': i >> VU``_fY]gYg'ni fØW_V`]W_Yb''' <math>\Rightarrow$ 'XYf'GU]gcb'&\$%, #&\$%-YffY]WX hY'XUg'HYUa 'XUg' < U`VZ]bU`Y'i bX'j Yf`cf'Yfgh']a \\ YbhgWXY]XYbXYb'Gd]Y`'[Y[Yb'Y]bYb'\O\Yf_`Ugg][Yb'; Y[bYf'' Gc`WXY'9fZU\fi b[Yb'Zcfa Yb'X]Y' \Rightarrow XYbh]hÀh'Y]bYf'A UbbgWXUZh'i bX a ch]j]YfYb'X]Y'Gd]Y`Yfž']b'k]WXh][Yb'Gd]Y`Yb']\f'6YghYg'ni '[YVYb''

9]b '6`] W_{-}]b 'X]Y 'J Yf[Ub[Yb\Y]h'nY][hž XUgg 'X]Y 'A UbbgW\UZh]b 'XYf 'YhnhYb '8 Y_UXY 'a Y\fYfY 'Dc_U`YfZc`[Y 'ZY]Yfb '_cbbhYž 'k cXi fW\g]W\ 'Y]bY 'HfUX]h]cb 'XYg '9fZc`[Yg'i bX 'XYf'K YhhVYk YfVgZ\\][_Y]h Ybhk] W_{-} Y 'hY "'Gc`W\Y '9fZc`[Y'g]bX 'YbhgW\Y]XYbXž'i a ''1 b[Y 'HU`YbhY ZØf X]Y 'A UbbgW\UZh'ni 'VY[Y]ghYfb 'i bX 'X]Y '5bn]Y\i b[g_fUZh'XYg 7`i Vg']b 'XYf FY[]cb'ni 'gh\f_Yb"

6 Ygi WX Yb 'G]Y 'i bg 'Ui Z. 'b!U["XY