

8f"'5b[Y`c': UgWY. BYi Y'5bgÀhnY'ni f 6Y_Àa dZi b['j cb'=a dZj Yfk Y][Yfi b['

8f"5b[Y`c: UgWYž'<ia Vc`Xh!Gh]dYbX]Uh'Ub'XYf'l b]j Yfg]hÀh 9fZi fhž'YfZcfgW\h'=a dZj Yfk Y][Yfi b['i bX ; Ygi bX\Y]hgj Yf\U`hYb'V]g'&\$&*"



9fZi fhž'8 Yi hgW\ `UbX'! K Ug'[]Vhg'BYi Yg'Ui g'XYf

K]ggYbgW\ UZhg`UbXgW\ UZh3'5a '%"'** `]'&\$&' '\Uh'8 f"'5b[Y`c': UgWY
gY]bY'5fVY]h'U`g'<ia Vc`Xh!Gh]dYbX]Uh'Ua '**bgh]hi hY'Zcf'D`UbYhUfm
<YU`h\ '6Y\Uj]ci f'f\b6\!XYf'I b]j Yfg]h\h'9fZi fh'Ui Z[Ybca a Yb"'9f
k]fX'g]W\ 'V]g'9bXY'&\$&* 'a]h'XYa 'H\Ya U']bX]j]Xi Y``Yg

F]g]_cj Yfgh\hXb]g'Ui gY]bUbXYfgYhnYbZ'k cVY]'gY]bY'GW\k Yfdi b_hY
]b'XYf'*a dZ] Yfk Y][Yfi b[Z'XYa 'i bUb[Ya YggYbYb'9]bgUhn'j cb
5bh]V]ch]_U'i bX'XYf'JYfk YbXi b['`Y]ghi b[gghY][YfbXYf
A YX]_Ua YbhY'`]Y[Yb"'8]Y'6Yk Y[i b[']b'X]YgYb'6YfY]W\Yb'\Uh']b
XYb'`YhhhYb'*\J\fYb'ni [Ybca a Yb'i bX']gh'j cb'[fc*Yf
[YgY``gW\UZh`]W\Yf'FY`Yj Ubn"'8]Y'I b]j Yfg]h\h'9fZi fh'VYf]W\hYh\Z
XUgg': UgWY'ni j cf'Ub'XYf'I b]j Yfg]h\h'7c]a VfU'gck]Y'XYa
CVgYfj Uhc]fY'F\[A[]cbU`XYf'I b]j Yfg]h\h'7c]a VfU'gck]Y'XYa

K]Y 8 f": UgW gY Vgh VYgW fY]Vhž [Y\hYg]\a XUfi a žk]f_gUa Y
K Y[Yni Z]bXYbži a a]h ⇒ dZG_Ydh]_Yfb ni _ca a i b]n]YfYb" ⇒
F U\a Yb XYg 9I !Dfc Y_hg → HGI J 5 L Ybhk]W_Y`hY Yf VYfY]hg
HfU]b]b[gdfc[fUa a Y ZØf a YX]n]b]gW Yg: UW dYfgcbU`ži a `VYggYf
Ui Z'X]Y 5b`]Y[Yb i bX Ÿb[ghY X]YgYf DUh]Ybhi]bbYb Y]bni [Y\Yb"
8 Ug Ya dUh\]gW Y K]XYf`Y[i b[g[YgdfÀW]a `?cbhYl hij cb
⇒ dZnÒ[Yf`]W _Y]hi bX `U`hYfbUh]j Yf A YX]n]b `ghY\h`XUVY]`]a
NYbhfi a `gY]bYf k Y]hYfYb : cfgW i b["`8]YgY `9f_Ybbhb]ggY `_ÒbbhYb
VYgcbXYfg k]W h][`gY]bž XU Ghi X]Yb k]Y X]Y XYg A UI !D`Ub W_!

→ bgh]hi hg nY][Ybž XUgg Yhk U %, i XYf 6YZfU[hYb]b '9i fcdU V]g
Gca a Yf &\$& Ub[UVYbž b]W h [Y]a dZh ni `gY]bž k cVY]`g][b]Z]_UbhY
I bhYfgW]YXY nk]gW Yb XYb Y]bnY`bYb @AbXYfb VYghY\Yb"

9]b 6]W_ Ui Z X]Y = a d ZV Y fY]hgW UZh]b 9i fc d U

8]Y = dZVYfY]hgWW UZhij Uf]]YfhighUf_']bbYf\U`V'9i fcdUg"'6YgcbXYfg
Ui ZZÀ``][']gh'X]Y 'b]YXf][Y = dZei chY']b'CghYi fcdUi bX'XYb
VU`h]gWX Yb '@ÀbXYfb" = Fi a Àb]Yb'Yhk U``]Y[h'g]Y'VY]'[YfUXY
Y]ba U``&, i ž'k À\fYbX'A U`hU'a]h'ØVYf'-) i 'X]Y'\ÒW ghY = dZei chY
Ui Zk Y]gh"'8]Y'Ghi X]Y'XYg'A UI!D`UbW_! = bgh]hi hg'a UWXh'Ui WX'_`UfY
I bhYfgWX]YXY']b'XYf'= dZVYfY]hgWX UZh'bUWX'6]`Xi b[gb]j YUi ž'5`hYf
i bX'k]fhgWX UZh`]WXYf'G]hi Uh]cb'XYi h`]WX"'Gc'`Y\bYb'VY]gd]Y`gk Y]gY
DYfgcbYb']a ii bhYfYb'9]b_ca a Ybgj]YfhY``\Ài Z][Yf'Y]bY'= dZl b[
UV'U`q'qc`WXY']b'VYqgYfYb'Z|bUbn]Y``Yb'JYf\À`hb]qqYb"

K]Y 'ghY\h'Yg'i a 'X]Y 'F c``Y 'XYg']bX]j]Xi Y``Yb $F [g]_cj \ YfghÅbXb]ggYg3'9g'[]Vh'Ghi \ X]Ybž'X]Y 'VY`Y[Ybž'XUgg'XUg
[YZØ\`hY'F]g]_c'Y]bY'Ybcfa Y'Fc``Y'gd]Y`h''K Å\fYbX'XYf'<math>\pm$ bZi YbnU! $DUbXYa \]Y'&\$$-`\UVYb'j]Y`Y'A YbgWXYb'hfchn'K]ggYbg'ØVYf
9f_fUb_i b[gf]g]_Yb'i bX'a Õ[`]WXY'gWX K YfY'J Yf`Ài ZY'b]WXh
[Y]a dZhž'Ui g'5b[gh'j cf'XYb'<math>\pm$ a dZghcZZYb'''8]YgY'Ghi X]Ybž'X]Y'i bhYf $UbXYfYa \ 'a \]h'8UhYb'j cb') \&\$'Ghi \ X]YfYbXYb'Xi fWX[YZØ\fh
k i fXYbž'nY][Yb'Ui Zž'XUgg'XUg'[YZØ\`hY'F]g]_c'Y]bYf'<math>\pm$ a dZi b[$gc[Uf'X]Y' \pm a \ dZVYfY]hgWXUZh'Yf\YV`]WX'gYb_Yb'_Ubbž'gY`Vgh'k Ybb
XUg'F [q]_c'Y]bYf'5bghYW_i b['U`g'\cWX'k U\f[Ybca a Yb'k]fX''$

cfgWxib[a]h]bhYfbUh]cbU`Ya 5bgUhn

8f": UgWY d`UbhžgY]bY: cfgWki b['a]h'I bhYfghØhni b['j cb'DUfhbYfb Ub'XYf'I b]j Yfg]hÀh'@]a U'k Y]hYf'Ui gni VUi Yb'i bX']b'DYfi '8 UhYb'ni gUa a Y`b"' \delta Y]bYf'VYfY]hg'UV[YgWk `cggYbYb'Ghi X]Y'ni f'?`]a U! 5b[gh'_cbbhY'Yf'YfZc`[fY]Wk' a]h'9fZi fhYf': cfgWkYbXYb ni gUa a YbUfVY]hYbžk Ug'XYb']bhYfbUh]cbU`Yb'5i ghUi gWk'i bX'X]Y JYfbYhni b['ZÒfXYfh"

, VYf'X]Y': cfgWki b['\]bUi g'k]fX': UgWY'Ui Wk'XYf'@Y\fY'Ub'XYf
I b]j Yfg]hÀh'9fZ fh'Y]b'; Yg]Wkh'[YVYb'i bX'Y]bY'dfUl]gcf]Ybh]YfhY
J YfUbghU'hi b['ni f'K]ggYbgWkUZhgd\]`cgcd\]Y'UbV]YhYb"'9f'Vf]b[h
XUa]h'Zf]gWkY'DYfgdY_h]j Yb'i bX'Y]b'[i hYg'< ÀbXWkYb'ZØf'X]Y
k]Wkh][Yb': fU[Yb'XYf'K]ggYbgWkUZh'a]h']b'X]Y'FY[]cb'H\Øf]b[Yb"
=\Wk'ZfYi Y'a]Wk'XUfUi Z\(\frac{\fr

Ni gUa a Yb[YZUggh'XØfZYb'k]f'[YgdUbbh'gY]b'Ui Z'X]Y'9f_Ybbhb]ggY i bX'=a di `gYž'X]Y'X]Y': cfgWki b['j cb'8f"'5b[Y`c': UgWY'a]h'g]Wk Vf]b[Yb'k]fX"'8]Y'H\Ya Ybž'X]Y'Yf'UbdUW_hž'g]bX'\cWkU_hi Y``'i bX VYhfYZZYb'i bg'U``Y'X]fY_h"

8YhU]`g	
Cfh	9fZifhž8YihgWX`UbX
EiY``Yb	• k k k "i b]!YfZi fh"XY
	• k k k "a d["XY
	• k k k "b\W]"b`a "b]\"[cj

6Ygi WXYb G]Y i bg Ui Z. b!U["bYh