

HfU[]gWXYf'I bZU``']b'5]bX`]b[. A chcffUXZU\fYf'gh]fVh'bUWX'?c``]g]cb'a]h HfU_hcf

9]b * *! 'À\f][Yf 'A chcffUXZU\fYf 'ghUfV 'hfU[]gW\ 'bUW\ 'Y]bYa Ni gUa a Ybghc » 'a]h 'Y]bYa 'HfU_hcf ']b '5]bX `]b[ž 'GW\ k UVYb"

9]b 'hfu[]gW\Yf'JcfZU```YfY][bYhY'g]W\']b'5]bX`]b[žY]bYf'; Ya Y]bXY
]a '@UbX_fY]g'5]W\UW\!: f]YXVYf[ž'VY]'XYa 'Y]b'A chcffUXZU\fYf'VY]
Y]bYa 'Ni gUa a Ybghc» 'a]h'Y]bYa 'HfU_hcf'ghUfV"'8Yf'I bZU``
YfY][bYhY'g]W\ž'U`g'XYf'(,!'À\f][Y'HfU_hcfZU\fYf'Ui Z'Y]bY'GhfU»Y
Y]bVc['i bX'XUVY]'XYb'j cb'fYW\hg'_ca a YbXYb'**!'À\f][Yb
A chcffUXZU\fYf'ØVYfgU\"'HfU[]gW\Yfk Y]gY'VYgU»'XYf
A chcffUXZU\fYf'JcfZU\fhž'k Ug'X]Y'G]hi Uh]cb'bcW\'XfUa Uh]gW\Yf
a UW\hY"

8]Y?c``]g]cb`ZUbX`Ub`Y]bYf`VY`YVhYb`?fYi ni b[`ghUhhži bX`hfchn U``Yf`Jcfg]W\hga U\\a Yb`_cbbhY`XYf`A chcffUXZU\fYf`b]W\h\a Y\f`fYW\hnY]h][`fYU[]YfYb"`9f`Yf`]hh`VY]`XYa `Ni gUa a Ybghc\\`gc gW\k YfY`JYf`Yhni b[Ybž`XUgg`Yf`bcW\`Ub`XYf`I bZU``ghY``Y'j YfghUfV" 8]Yg`k]fZh`Y]b`GW\`U[`]W\h`Ui Z`X]Y`JYf_Y\fgg]W\Yf\Y]hž`VYgcbXYfg a ``\AbX`]W\Yb`FUi a ž`k c``UbXk]fhgW\UZh`]W\Y: U\fnYi [Y`\\Ai Z][`X]Y GhfU\\Yb`bi hnYb"

$8]Y <]bhYf[fØbXY XYg I b[`ØW_g$

8]Y'Dc`]nY]'\Uh']b']\fYb'9fa]hhìi b[Yb'ZYgh[YghY``hž'XUgg'XYf'XYfHfU_hcfZU\fYf'VY]a '5VV]Y[Yb'b]W\h'[YbØ[YbX'5W\h'Ui Z'XYbJYf_Y\f'[YUW\hYh'\Uh''Gc`W\Y'I bZ\h``Y'g]bX']b'`\AbX`]W\Yb'; YV]YhYb_Y]bY'GY`hYb\Y]hii bX'j YfXYi h`]W\Yb'X]Y'Bchk YbX][_Y]hž'XUg6Yk i gghgY]b'ZØf'JYf_Y\fgg]W\Yf\Y]hini 'gW\AfZYbž'gck c\``i bhYf5i hcZU\fYfb'U`g'Ui W\'i bhYf'XYb': U\fYfb'j cb'`UbXk]fhgW\UZh`]W\Yb

8]YgYg'l b[`ØW_'\Uh'b]W\h'bi f'XUg'@YVYb'XYg'A chcffUXZU\fYfg VYYbXYhž'gcbXYfb'\]bhYf`Àggh'Ui W\'Y]bY'hfUi YfbXY'; Ya Y]bgW\UZh'' 8]Y'GhfU» Yb'j cb'5]bX`]b['g]bX'[YfUXY']b'XYb'k Ufa Yb'A cbUhYb j c```j cb'A chcffUXZU\fYfbž'X]Y'X]Y'`\ÀbX`]W\Y'@UbXgW\UZh'[Yb]Y» Yb a ÒW\hYb'''8]Y': c`[Yb'gc`W\Yf'I bZ\'Y'g]bX'b]W\h'bi f']b'XYf'JYf`i gh XYg'@YVYbg'ni 'gY\Ybž'gcbXYfb'Ui W\']b'XYf'HfUi Yf'i bX'XYa GW\a Yfnž'XYb'5b[Y\Of][Y'i bX': fYi bXY'Yf`Y]XYb'a ØggYb''

FYU_h]cb'XYf'6Y\OfXYb'i bX'XYf; Ya Y]bgW\UZh

BUWX 'XYa 'J cfZU```Ài » YfhYb 'g]WX '`c_U`Y 'J YfhfYhYf'i bX

Cf[Ub]gUh]cbYb 'ni f'J Yf_Y\fgg]WX Yf\Y]h" *bgVYgcbXYfY

`UbXk]fhgWX UZh`]WX Y '6Yhf]YVY 'k i fXYb 'Ui Z[YZcfXYfhž'ni gÀhn`]WX Y

GWXi `i b[Yb 'ZØf'HfU_hcfZU\fYf']b '9fk À[i b['ni 'n]Y\Yb"'9g'k i fXY

Ui WX 'XUfØVYf'bUWX[YXUWX hž'HYa dc`]a]hg']b 'XYf'BÀ\Y'j cb

`UbXk]fhgWX UZh`]WX Yb 'GhfU» Yb 'ni 'ØVYfdfØZYbž'i a 'X]Y 'G]WXYf\Y]h

ZØf'U``Y'J Yf_Y\fghY]`bY\a Yf'ni 'Yf\Ò\Yb"

8 Ugʻ6Yk i gghgY]bʻZØfʻX]YʻF]g]_Ybʻ]aʻGhfU» Ybj Yf_Y\fʻa i gg
[YgWkÀfZhʻk YfXYbžʻUi Wkʻ]aʻ<]bV`]W_ʻUi ZʻX]Yʻi bnÀ\`][YbʻgWkÒbYb
5 i gZʻØ[Yž'X]Yʻa]hʻA chcffÀXYfbʻ]bʻXYfʻFY[]cbʻi bhYfbca a Yb
k YfXYb"ʻA chcffUXZU\fYfʻg]bXʻcZhʻj Yf`Yhn`]WkYfʻU`gʻ5 i hcZU\fYfžʻk Ug
gc`WkYʻI bZÀ``YʻbcWkʻhfU[]gWkYfʻa UWkh"·8]Yʻ6Y\ÒfXYbʻfi ZYbʻXU\Yf
XUni ʻUi ZžʻVYgcbXYfgʻ]aʻGca a Yfžʻk Ybbʻj]Y`YʻA chcffUXZU\fYf
i bhYfk Y[gʻq]bXžʻVYqcbXYfgʻi a q]Wkh][ʻni 'ZU\fYb"

±b 'Y]bYa 'gc `WX Yb': U```g]bX 'Ui WX 'X]Y 'J Yfg]WX Yfi b[Yb'[YZcfXYfhž g]WX 'a]h'XYb 'VYhfc ZZYbYb': Ua]`]Yb 'Ui gY]bUbXYfni gYhnYb 'i bX 'Y]bY Ya dUh\]gWX Y 'i bX 'Ub[Ya YggYbY 'I bhYfghØhni b['Ubni V]YhYb"'8 Yf a YbgWX`]WX Y '5 gdY_h'gc ``hY 'b]WX h'j Yf[YggYb'k YfXYbž'XYbb'\]bhYf YXYa 'I bZU```ghY\Yb'b]WX h'bi f'NU\`Ybž'gcbXYfb'Ui WX 'GWX]W_gU`Y i bX 'Ya ch]cbU`Y '6Y`Ughi b[Yb"

8]Y; YZU\fYb]a 'GhfU» Ybj Yf_Y\f'k YfXYbcZhi bhYfgW\Ahnh" A chcffUXZU\fYf'VYbOh][Yb'k Yb][Yf'D`Uhn'i bX'_ObbYb'gW\bY```]bX]Y'G]W\h'j cb'UbXYfYb: U\fnYi [Yb'Y]bXf]b[Yb"'8U\Yf']gh'Yg'ZØfHfU_hcfZU\fYf'i bYf`Agg`]W\ž'X]Y'5i [Yb'cZZYb'ni '\U`hYb'i bX'Ui Z\YfUbbU\YbXY'Nk Y]fAXYf'ni 'UW\hYbž'XU'X]YgY'hYbXYbn]Y``gW\bY``Yf'U`g'`UbXk]fhgW\UZh`]W\Y'A UgW\]bYb'i bhYfk Y[g'g]bX"

 $8]Y `6YhfUWk hi b[`X]YgYg `hfU[]gWk Yb `I b ZU``g`X]Ybh`U`g`Y]bXf]b[``]Wk Y \\ 9f]bbYfi b[`XUfUbž`X]Y `J Yf_Y\fgg]Wk Yf\Y]h`Yfbgh`ni `bY\a Yb"`8]Y \\ HfU[`OX]Y `_ObbhY `j Yfa Y]XVUf`[Yk YgYb`gY]bž`k Ybb`X]Y \\ [fi bX`Y[YbXYb`G]Wk Yf\Y]hgj cf_Y\fi b[Yb`i bX`XUg`6Yk i gghgY]b \\ ZØf`X]Y `J cfZU\fh`Y]b[Y\U`hYb`k cfXYb`k ÀfYb"`<math>\mathscr{A}$ [``]Wk Y`5 i Z_`Àfi b[i bX`8]g_i gg]cb`ØVYf`G]Wk Yf\Y]h`Ui Zi bgYfYb`GhfU» Yb`_ObbhY`XUni VY]hfU[Ybž`XUgg`gc`Wk Y]b`J cfZU```]b`Ni _i bZh'j Yfa]YXYb`k]fX"

<]bhYf[fi bX'XYf'JYf_Y\fgg]WXYf\Y]h']b 8 Yi hgWX`UbX</pre>

±0.8 Yi hgWX`UbX`g]bX`J Yf_Y\fgi bZÀ``Y`Y]bY`VYXYi hYbXY`I fgUWXY
ZØf`J Yf`Yhni b[Yb`i bX`HcXYgZÀ``Y"`@Ui h`XYa `GhUh]gh]gWXYb
6i bXYgUa h`g]bX`]a `∀J\f`&\$&%`]bg[YgUa h`&"+' * `A YbgWXYb`VY]
J Yf_Y\fgi bZÀ``Yb`i a g`@YVYb`[Y_ca a Yb"`8 Ua]h`nY][h`g]WXž`XUgg
hfchn`]bhYbg]j Yf`6Ya Ø\i b[Yb`i a `X]Y`J Yf_Y\fgg]WXYf\Y]hž`k]Y
Xi fWX`5i Z_`Àfi b[g_Ua dU[bYb`i bX`hYWXb]gWXY`J YfVYggYfi b[Yb
Ub`: U\fnYi [Ybž`X]Y`; YZU\fYb`Ui Z`XYb`GhfU»Yb`k Y]hYf\]b`dfÀgYbh
g]bX"

9]b 'nYbhfu'Yf '5gdY_h']b 'XYf'I bZU``ghUh]gh]_']gh'X]Y 'Fc``Y'j cb
Nk Y]fUXZU\fYfb"'A chcffUXZU\fYf'g]bX']a 'JYf[`Y]WX 'ni 'UbXYfYb
JYf_Y\fghY]`bY\a Yfb'VYgcbXYfg'[YZÀ\fXYhž'XU'g]Y'k Yb][Yf
GWXi hn'VY]'?c``]g]cbYb'\UVYb"' \dangle XYb'`YhnhYb'\d\\fYb'\Uh'X]Y
5bnU\`'XYf'hÒX`]WXYb'I bZÀ``Y'i bhYf'A chcffUXZU\fYfb']b
8Yi hgWX`UbX'ni [Ybca a Ybž'k Ug'X]Y'Bchk YbX][_Y]h'j YfghÀf_hž
G]WXYf\Y]hga U> bU\a Yb'i bX'5i Z_`Àfi b['ni ']bhYbg]j]YfYb"'8]Y
Dc`]nY]'Ya dZ]Y\`hž'XUgg': U\fYf'gck c\``Ui Z']\fY'Y][YbY'G]WXYf\Y]h
U`g'Ui WX'Ui Z'X]Y'j cb'UbXYfYb'UWXhYb'i bX'VYgcbXYfg'Ui Z'X]Y
J cfZU\fhgfY[Y`i b[Yb'UWXhYb"

$GhUh]gh]_Yb^ibX^iU_hiY^Y^9bhk]W_ib[Yb]$

9]bY'5bU'mgY'XYf'U_hi Y'`Yb'JYf_Y\fgghUh]gh]_Yb'nY][hž'XUgg'X]Y
a Y]ghYb'JYf_Y\fgi bZà``Yž']b'XYbYb'A chcffUXZU\fYf']bj c`j]Yfh
g]bXž'Xi fWX'XUg'A]ggUWXhYb'j cb'J cfZU\fhgfY[Y`b'j Yfi fgUWXh
k YfXYb"'=a '*J\f'&\$&\$'k UfYb', "(\$\$'A chcffUXi bZà``Y'a]h
DYfgcbYbgWXUXYb']b'8Yi hgWX`UbX'fY[]ghf]Yfh'k cfXYbž'k cVY]'Yhk U
*\$\$'A chcffUXZU\fYf'hÒX`]WX'j Yfi b[`ØW_hYb"'8 Ug'ghY``h'Y]bYb
VYgcf[b]gYffY[YbXYb'HfYbX'XUf'i bX'k Y]gh'Ui Z'X]Y'Xf]b[YbXY
Bchk YbX][_Y]h'\]bž'X]Y'JYf_Y\fgg]WXYf\Y]h'ZØf'A chcffUXZU\fYf
Xi fWX'[Yn]Y'hY'A U» bU\a Yb'ni 'j YfVYggYfb"'

Ni `X]YgYb `A U» bU\a Yb `[Y\ÒfYb `i bhYf `UbXYfYa `j YfghÀf_hY ; YgWk]bX][_Y]hg_cbhfc ``Yb `i bX `X]Y =a d`Ya Ybh]Yfi b[`j cb j Yf_Y\fgVYfi \][YbXYb `A U» bU\a Yb `]b `f]g]_cVY\UZhYhYb 6YfY]W\Yb "`Ni XYa `gd]Y`h`X]Y : U\fgWi `i b[`Y]bY `YbhgW\Y]XYbXY $Fc``Y. `Y]b `Yf\Ò\hYg`6Yk i gghgY]b `ZØf`; YZU\fYb `i bX`[Ygi bXY F]g]_ck U\fbY\a i b[`_ObbYb `XUni `VY]hfU[Ybž'I bZÀ``Y`ni j Yff]b[Yfb"$

$<]ghcf]gWXY`DUfU``Y`Yb`ibX`]\fY`FY`YjUbn$

9]b'À\b`]W\Yg'AighYfk]Y'XUg'\Yih][Y'_Ubb']b'XYf

JYf_Y\fg[YgW\]W\hY'VYcVUW\hYh'k YfXYbž']bgVYgcbXYfY']b'XYb
%-, \$Yf'ibX'%--\$Yf'\J\fYbž'U`g'X]Y'5bnU\`'XYf'JYf_Y\fghchYb']b
8YihgW\`UbX'XfUaUh]gW\'Ubgh]Y["'8]Yg'ZØ\fhY'ni'Y]bYf'FY]\Y'jcb
FYZcfaYbž'XUfibhYf'ghfYb[YfY':U\fdfØZ|b[Yb'ibX'X]Y'9]bZØ\fib[XYg'Dib_hYgmghYag']b':`YbgVif[ž'ia'f]g_UbhYg':U\fjYf\U`hYb'niU\bXYb"'8]YgY'AU»bU\aYb'\UVYb'g]W\'U`g'YZZY_h]j'Yfk]YgYbž'ia
X]Y'IbZU``nU\`Yb'ni'fYXin]YfYb"

8 Yf'\Yi h][Y'J cfZU``Yf]bbYfh'XUfUbž'XUgg'hfchn'X]YgYf': cfhgW\f]hhY k Y]hYf\]b'gW\k Yfk]Y[YbXY'I bZÀ``Y'[YgW\Y\Ybž'cZh'Ui Z[fi bX'j cb a YbgW\`]W\Ya 'J YfgU[Yb"'8 Yf'J Yf[`Y]W\`nY][hž'XUgg'_cbghUbhY 5 i Z_`Àfi b['i bX'dfÀj Ybh]j Y'A U» bU\a Yb'i bYf`Àgg`]W\'g]bXž'i a À\b`]W\Y'HfU[ÒX]Yb']b'XYf'Ni _i bZh'ni 'j Yfa Y]XYb"

6 Ygi WX Yb 'G]Y 'i bg 'Ui Z. 'X]Y!bUWX f]WX hYb "b Yh