

9]bVfØWλ Y`]b` ; Yfk ]gWλ . `Dc`]nY]`gi Wλ h  
NYi [ Yb`bUWλ `bÅWλ h`]Wλ Yb  
< Ui gX]YVghÅ\`Yb

⊕` ; Yfk ]gWλ `VY]`A U[ XYVi f[ `\_Ua` `Yg`ni `bÅWλ h`]Wλ Yb  
9]bVfØWλ Yb`]b`9]bZUa` ]`Yb\`Åi gYfž`k Å\`fYbX`X]Y`6Yk c\`bYf  
gWλ`]YZYb``Dc`]nY]`gi Wλ h`NYi [ Yb`

⊕`XYf`\_`Y]bYb` ; Ya Y]bXY` ; Yfk ]gWλ ž`X]Y`HY]`XYg`ž`f]Wλ ck Yf  
@UbXYg`i bX`i bk Y]hj cb`A U[ XYVi f[ ``]Y[ hž`k i fXYb`\_`Øfn`]Wλ`nk Y]  
9]bZUa` ]`Yb\`Åi gYf`N]Y`j cb`9]bVfYWλ Yfb``8]YgY`J cfZÅ``Y`k YfZYb  
b]Wλ h`bi f` : fU[ Yb`ni f`G]Wλ Yf\`Y]h`XYf`Xc fh`YVYbXYb`6Øf[ Yf`Ui ž  
gcbXYfb`j YfXYi h`]Wλ Yb`Ui Wλ`Y]b`VfY]hYfYg`DfcV`Ya ž`XUg`j ]Y`Y  
XYi hgWλ Y`GhÅXhY`VYhf]Zh`X]Y`Ni bU\`a Y`j cb  
K c\`bi b[ gX]YVghÅ\`Yb`

8]Y`B ÅWλ hY`]b` ; Yfk ]gWλ . `9]b`i b\`Y]a` ]Wλ Yf  
J cfZU``

⊕`XYf`B UWλ hj cb`8 cbbYfghU[ `Ui Z` : fY]hU[ `Yf`Ub[ hY`X]Y`Dc`]nY]  
Xi fWλ`Y]bYb`Ui Za` Yf\_gUa` Yb`5bk c\`bYf`Ui g`XYf`GhfU»Y`XYg`%`A U]  
?Ybbhb]g`ØVYf`XYb`9]bVfi Wλ`]b`XUg`B UWλ VUf\`Ui g``6Yi bfi` \][ YbX  
]ghž`XUgg`X]Y`6Yk c\`bYf`XYg`VYhfcZZYbYb`<Ui gYg`ni`X]YgYa  
NY]hdi b\_hž`k Å\`fYbX`X]Y`HÅhYf`i a` ]\`fY`K Yfh[ Y[ YbghÅbXY  
gWλ`]Wλ Ybž`h]YZi bX`ZYgh`gWλ`]YZYb`

8 Ug`J cf[ Y\`Yb`XYf`HÅhYf

8]Y`?`f]a` ]bY``Yb`j YfgWλ UZhYb`g]Wλ`Ni [ Ub[ `ni`XYb`<Åi gYfbž`]bXYa  
g]Y`Y]bY`HØf`Ui Z\`YVY`hYb``⊕`VY]XYb` : Å``Yb` \ ]bhYf`]Y»Yb`g]Y  
nU\`fY]Wλ Y`i bcfXbi b[ ž`k Å\`fYbX`g]Y`GWλ fÅb`\_Y`Xi fWλ k Ø\`hYb`i bX

6Uf[ Y`X`Yb`k YbXYhYb" 8 ]Y`Dc`nY]`gW`Ånh`XYb`Yb`ghU`bXYbYb  
GW`UXYb`Ui`ZY]bYb`a` ]h`YfYb`XfY]ghY``[ Yb`6YhfU[ ``8]Yg`]gh`Y]b  
U`Ufa` ]YfYbXYg`NY]W`Yb`ž`XUg`b]W`h`bi`f`X]Y`G]W`Yf`Y]h`XYf  
5bk`c`b`Yf`]b` : fU[ Y`ghY``h`ž`gc`bXYfb`Ui` W`X]Y` [ YbYfY``Y  
9b`hk` ]W`\_i` b[ `XYf`?`f]a` ]bU`]h`Å`h]b`\_`Y]bYb` ; Ya` Y]bXYb`k` ]Y` ; Yfk` ]gW`  
h`Ya` Uh]g]Yfh`

Nk` Y]hY`9]bVfi` W`gnYbY`i` bX`a` Ò[ `]W`Y  
; Ya` Y]bgUa` \_Y]hYb`

⇒ `F`U`a` Yb`XYf`9fa` ]h`i` b[ Yb`k` i` fXY`\_`Uf`ž`XUgg`X]Y`H`Å`hYf`b]W`h  
bi`f`Y]b`<`Ui`g`]a` `J`]g]Yf`U`h`hYb``9]b`nk`Y]hYf`J`cfZU``k`i`fXY`]b`XYf  
; UfhYb`ghfU`»`Y` [ Ya` Y`XYh`ž`k`c`Y`VYbZU``g`Y]b`9]bVfi` W`]b`Y]bYa  
9]bZJa` ]Y]b`U`i`g`ghU`h`ZUbX``9]b`Ui`Za`Yf`\_gUa`Yf`B`U`W`V`Uf`U`Ufa` ]YfhY  
X]Y`Dc`nY]ž`U`g`Yf`j`YfX`Å`W`h][ Y`5`\_h]j` ]h`Å`hYb`VYc`V`U`W`hYhY``9g  
VYghY`h`XYf`J`YfX`U`W`h`ž`XUgg`VY]XY`9]bVf`Ø`W`Y`j`cb`XYb`[ `Y]W`Yb  
H`Å`hYfb`VY[ Ub[ Yb`k`i`fXYb`ž`k`Ug`Ui`ZY]bY`cf[ Ub]g]YfhY  
J`cf[ Y`Y`bgk`Y]gY`\_`]bXYi`hYh`

8 ]Y`Dc`nY]`]gh`Ui`Z`<`]bk`Y]gY`Ub`[ Yk` ]YgYb`

8 ]Y`?`f]a` ]bU`dc`nY]`U`h`VYfY]hg`Gdi`fYb`Ub`XYb`H`U`h`c`fhYb`[ Yg]W`Yf`h`ž  
XcW`i`a`XYb`H`Å`hYfb`Ui`ZX]Y`Gdi`f`ni`\_`ca`a`Yb`ž`g]bX`g]Y`Ui`ZX]Y  
A`]h`\_`ZY`XYf`²`ZYb`h]W`\_Y]h`Ub`[ Yk` ]YgYb``NYi` [ Yb`ž`X]Y`j`YfX`Å`W`h][ Y  
DYfgcbYb`cXYf` : U`fnYi` [ Y`]b`XYf`B`U`W`h`XYf`9]bVf`Ø`W`Y`VYa`Yf`\_h  
`UVYb`ž`k`YfXYb`[ YVYhYb`ž`g]W`a` ]h`XYa`Dc`nY]fYj` ]Yf`\_f]W`ck`Yf  
@UbX`i`bhYf`XYf`HY`Y`Zcbbi`a`a`Yf`\$` -`&`%`#`&\$`\$`cXYf`dYf`9!A`U]`]b  
J`YfV]bXi`b[ `ni`gYhnYb`

K` ]W`h][ Y`⇒`d`]\_`Uh]cbYb`Z`Ø`f`X]Y  
; Ya` Y]bgW`UZh`

8Yf`J`cfZU``]b` ; Yfk` ]gW`]gh`b]W`h`bi`f`Y]b`]gc`]YfhYg`9fY][ b]gž  
gc`bXYfb`ghY`h`ghY``j`YfhfYhYbX`Z`Ø`f`Y]bY` [ f`Ø`»`YfY`D`fc`V`Ya`Uh]\_`ž`X]Y  
j`]Y`Y` ; Ya` Y]bXYb`]b`8Yi`hgW`\_`UbX`VYhf]Z`h``8]Y`G]W`Yf`Y]h]b`XYb  
Y][ YbYb`j` ]Yf`K`Å`bXYb`]gh`Z`Ø`f`j` ]Y`Y`A`YbgW`Yb`j`cb`nYbhfU`Yf  
6YXYi`hi`b[ ``J`cf`U``Ya` ]b``Å`bX`]W`Yb` ; YV]YhYb`ž`k`c`a`Ub`g]W`c`Zh`

U`g`HY]`Y]bYf`Yb[ Yb` ; Ya Y]bgWUZh`ZØ\`hž`\_ÖbbYb`gc`WXY`J cfZÄ`Y  
Y]b` ; YZØ\`XYf`I bg]WYf\Y]h`gWØfYb"

## 9]b`5i Zfi Z`ni f`K UWgUa \_Y]h

8]Y`9fY][ b]ggY`]b` ; Yfk ]gW`gc`hYb`UbXYfY`5bk c\bYf`XUni  
UbfY[ Ybž`UWgUa`i bX`k UWgUa`ni`gY]b`"8]Y`[ Ya Y]bgUa Y  
J YfUbnk cfhi b[ ž`X]Y`B UWVUfgWUZh`g]WYf`ni`U`hYbž`]gh  
YbhgWY]XYbX`"@YX][`]W`Xi fW`Y]b`k UWgUa Yg`5i [ Y`i bX`X]Y  
6YfY]hgWUZhž`VY]j YfXÄW h][ Yb`5\_hj ]hÄhYb`ni`U`bXY`bž`\_ÖbbYb  
gc`WXY`J cfZÄ`Y`Yj Ybhi Y`j Yf\]bXYfh`k YfXYb"

8YhU]`g

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