

B UhØf`]W\`gW\`Ob. `5 B B 9A 5F ⇒9`6² F @=B 8
i bX`5`YI UbXfU`A Uf]U`@UfU`j Yfy]bh

9bhXYW_Yb`G]Y`X]Y`?ccdYfUh]cb`nk]gW\Yb`5 B B 9A 5F ⇒
6² F @=B 8`i bX`5`YI UbXfU`A Uf]U`@UfU`ž`X]Y`bUhØf`]W\Y
GW\`Ob\Y]h`i bX`B UW\`U`h][`_Y]h`ZY]Yfh"

7U`k`f`b`hgk

5 B B 9A 5F ⇒9`6² F @=B 8 ž`XYf`J cffY]hYf`]a`6Yfy]W\`bUW\`U`h][`Yf
B Uhi`f`_cga`Yh]_ž`\Uh`Y]bY`VYXYi`hYbXY`DUfhbYfgW\UZh`a`]h`XYf
fYbca`a`]YfhYb`GW\Ui`gd]Y`Yf]b`5`YI UbXfU`A Uf]U`@UfU
VY_Ubbh[`Y[`YVYb`"8]YgY`Ni`gUa`a`YbUfVY]h]ghj`cb`Y]bYa
[`Ya`Y]bgUa`Yb`N]Y`[`YdfÄ[`h`XUg`6Yk`i`gghgY]b`ZØf`bUhØf`]W\Y
GW\`Ob\Y]h`i bX`bUW\`U`h][`Y`DfU`h]_Yb`]b`XYf`?cga`Yh]_VfU`bW\Y`ni
gW\`ÄfZYb"

8]Y`9bhgW\Y]Xi`b[`ž`5`YI UbXfU`A Uf]U`@UfU`U`g`;`Yg]W\h`XYf`A Uf`_Y
ni`k`Ä`\Ybž]gh`Y]b`ghfUhY[`]gW\Yf`GW`f]hž`i`a`Y]bY`VfY]hYfY
²`ZYb`h]W\`_Y]h`ZØf`X]Y`D\]`cgcd\]Y`j`cb`6² F @=B 8`ni`[`Yk`]bbYb`"
B]W\`Ug`@]bXbYfž`7c!79C`XYf`6Öf`]bX`;`a`V<ž`Yf`_`ÄfhY.`K`]f`g]bX
VY[`Y]ghYfhž`5`YI UbXfU`A Uf]U`@UfU`U`g`bYi`Yg`;`Yg]W\h`i`bgYfYf
A Uf`_Y`VY[`fØ»Yb`ni`XØfZYb`" `@UfU`g`Ui`h\Yb]gW\Y`5i`gghfU`\`i`b[
gck`]Y`]\f`ghUf`_Yg`9b[`U[`Ya`Yb]h`ZØf`i`a`k`Y`hZfYi`bX`]W\Y`DfU`h]_Yb
\Ufa`cb]YfYb`dYfZY`_h`a`]h`XYf`J]g]cb`j`cb`6² F @=B 8 ž`X]Y`?fUZh`XYf
B Uhi`f`ni`bi`hYbž`i`a`A`Yb]gW\Yb`ni`a`GhfU`\`Yb`ni`Vf]b[`Yb"

9]bY`XYf`nYbhfU`Yb`9][`YbgW\UZhYb`j`cb`5 B B 9A 5F ⇒9`6² F @=B 8`]gh
]\fY`Ub[`Ä`\f][`Y`HfUX]h]cbž`X]Y`?fUZh`XYf`B Uhi`f`a`]h
k`]ggYbgW\UZh]W\Yf`9i`dYfh]gY`ni`j`YfV]bXYb`"8]YgY`?ca`V]bUh]cb
Yfa`Ö[`]W\h`Yg`XYa`i`bhYfbY`a`Ybž`DfcXi`_hY`ni`Yb]k`]W\Y`bž`X]Y
b]W\h`bi`f`Y`ZY`_h]j`g]bXž`gcbXYfb`Ui`W\`]a`9]b`_Ub[`a`]h`XYb

\ÒW ghYb`Ò_c`c []gW Yb`GhUbXUfXg`ghY\Yb"A]hØVYf`&, \$
Yb[U[]YfhYb`A]hUfVY]hYfb`Yb`hk]W_Y`h`XUg` : Ua]Y]Ybi bhYfbY\`a Yb
]a`GWk Ufnc U`X`DfcXi`_hYž`X]Y`k`Y`hk`Y]h[YgW`Àhnh`k`YfXYb`
6² F@B8`]gh`ghc`n`XUfUi`Zž`]a`_U\`f`%-`-`[Y[fØbXYh`k`cfXYb`ni`gY]b
i`bX`gY]h\Yf`Y]bY`a`U» [YV`]W`Y`F`c`Y`]a`_6YfY]W`XYf
BUhi`f_cga`Yh]_`Y]bni`bY\`a`Yb`"

8]Y`J`YfV]bXi`b[`j`cb`BUhi`f`i`bX K`]ggYb`gW`UZh

8]Y`D\`]cgcd\]Y`j`cb`5BB9A`5F`⇒`6² F@B8`VYfi`h`Ui`ZY]bYf
gcf[Z`h][Yb`5i`gk`U\`b`Uhi`fVY`UggYbYf`F`c\`ghc`ZY`i`bX`Y]bYf
k`]ggYb`gV`Ug]YfhYb`<`YfghY`i`b["8`Yf`5bgUhnž`HfUX]h]cb`a`]h
⇒bcj`Uh]cb`ni`_ca`V]b]YfYbž`_ca`a`h`b]W`h`bi`f`XYb`DfcXi`_hYb
ni`[i`hYž`gcbXYfb`gh`À`f`h`Ui`W`XUg`J`Yfhf`Ui`Yb`XYf`J`YfVf`Ui`W`Yf`]b
X]Y`A`Uf`_Y`"5`g`Df`Àg]XYb]b`X`Yf`X`Yi`hgW`Yb`:`]`a`U`UX`Ya`]Y`]gh
5`Yi`UbXf`U`A`Uf]U`@Uf`U`Y]bY`dfca`]bYb`hY`DYfg`Øb`]W`_Y]hž`X]Y`ZØf`XUg
Gcfh]a`Yb`h`XYf`A`Uf`_Y`k`]fVhž`XUg`Ui`Z`B`UW`U`h][`_Y]h`i`bX
K`]f_gUa`_Y]h`Ui`g[Yf]W`hYh`]gh`"

@Uf`U`dYfg`Øb`]W`Xf`ØW`h`]\`fY`J`cfZfYi`XY`Ui`Z`X]Y`?`ccdYfUh]cb`Ui`g.
⇒W`ZfYi`Y`a`]W`gY\`f`Ui`Z`X]Y`Ni`gUa`a`Yb`UfVY]h`a`]h`5BB9A`5F`⇒
6² F@B8`žY]bYf`A`Uf`_Y`ž`X]Y`ZØf`k`]f`_i`b[gj`c`Y`BUhi`f_cga`Yh]_`
ghY\`h`i`bX`Ui`Z`b`UW`U`h][`Yb`Df]bn]d]Yb`V`Ug]Yfh`" ⇒fY
,`VYfnYi`[i`b[ž`XUgg]bbYfY`i`bX`Ai`»`YfY`GW`Øb`Y]h`<`UbX`]b`<`UbX
[Y\Ybž`d`Uggh`dYfZY`_h`ni`X`Yb`K`YfhYb`j`cb`6² F@B8`"

8]Y`A`Uf`_Y`\`Uh`Yg`[YgW`UZhž`g]W`_`]b`Y]bYa
k`Yh`VYk`YfVg]bhYbg]j`Yb`A`Uf`_h`ni`VY\`Ui`dhYb`i`bX`XYb`bc`W`_]\`fYb
Yh\]gW`Yb`;`fi`bX`g`Àh`Yb`hfYi`ni`V`Y]VYb`"8]Y`_cb]bi`]Yf`]W`Y
⇒bcj`Uh]cbg`_fUZh`i`bX`XUg`9b[U[Ya`Yb`h`ZØf`Ò_c`c []gW`Y
B`UW`U`h][`_Y]h`a`UW`Yb`6² F@B8`ni`Y]bYa`A`U»`ghUV`]b`XYf
BUhi`f_cga`Yh]_Vf`Ub`W`Y`"8]Y`DfcXi`_hY`k`YfXYb`b]W`h`bi`f`ZØf`]\`fY
E`i`U`]h`h`[YgW`Àhnhž`gcbXYfb`Ui`W`ZØf`]\`fY`gcn]U`Y`J`Yf`Ub`hk`cfhi`b[ž
X]Y`XUg`i`bhYfbY\`a`Yb`Yfbgh`b]a`a`h`"

9]b`6`]W`_`Ui`Z`X]Y`GW`Ui`gd]Y`Yf]b

5`YI UbXfU`A Uf]U`@UfU`]gh`b]W`h`bi f`Z0f`]\fY`gW`Ui gd]Y`Yf]gW`Yb
: A`\[_Y]hY`b`VY`_Ubbh`z`gcbXYfb`Ui W`X`Z0f`]\f`Ubgdfi W`gj c``Yg
9b[U[Ya`Ybh`]b`XYf`:]`a`VfUbW`Y`"G]Y`\"Uh`]b`nU`\fY]W`Yb
]bhYfbUh]cbU`Yb`DfcXi`_h]cbYb`a`]h[Yk`]f`_hi`bX`gcf[h`a`]h`]\fYf
Df`AgYbn`XUZ0f`z`XUgg`k`]W`h][Y`H`Y`a`Yb`k`]Y`B`UW`\U`h][_Y]hi`bX
[YgY`gW`UZhi]W`Y`J`YfUbhk`cfhi`b[`]a`]; Ygdf`A`W`V`Y]VYb`"@UfU`YVh
a`]h`]\fYa`A`Ubb`z`XYa`G`W`Ui`gd]Y`Yf`GUa`F`]Ym`z`i`bX`]\fYa`Gc`\b`]b
6Yf`]b`i`bX`gY`hnh`g]W`Y`Y]XYbgW`UZhi]W`X`Z0f`H`Y`a`Yb`Y]b`z`X]Y`]f`Ua
<YfnYb``]Y[Yb"

8]YgY`DUf`hbYfgW`UZhi`nk`]gW`Yb`5BB9A`5F`9`6²`F`@B8`i`bX
5`YI UbXfU`A Uf]U`@UfU`_0bbhY`b]W`h`bi f`]fY`Yk`Y`][Yb`A`Uf`_Yb
gh`A`f`_Yb`z`gcbXYfb`Ui W`X`Y`5i`Za`Yf`_gUa`_Y]h`Ui`Z`X]Y`6YXY`i`hi`b[
j`cb`B`Uhi`f`_cga`Yh]_`Yb`_Yb`" `b`Y]bYf`K`Y`h`z`]b`XYf`J`YfVfUi`W`Yf
ni`bY`a`Yb`X`Ui`Z`B`UW`\U`h][_Y]h`UW`hYb`z`_0bbhY`X]YgY
Ni`gUa`a`YbUfVY]h`Y]b`A`cXY``Z0f`UbXYfY`i`bhYfbY`a`Yb`]a
?cga`Yh]_VYfY]W`X`UfghY``Yb"

9]b`bYi`Yg`?`Ud]hY``Z0f`B`Uhi`f`_cga`Yh]_

A`]h`XYf`?`ca`V]bUh]cb`Ui`g`XYf`9fZU`\fi`b[Yb`j`cb`5BB9A`5F`9
6²`F`@B8`]b`XYf`B`Uhi`f`_cga`Yh]_`i`bX`XYa`9]bZi`gg`j`cb`@UfU`]b`XYf
I`bhYf`\U`hi`b[gVfUbW`Y`z`_Ubb`X]YgY`DUf`hbYfgW`UZhi`X`Uni`VY]hfU[Yb`z
XUg`6Yk`i`gg`hgY]b`Z0f`i`a`k`Y`h`z`fYi`bX`]W`Y`DfU`_h]_Yb`]b`XYf
?cga`Yh]_`ni`Yfk`Y]hYfb`"9g`V`Y]Vh`UVni`k`UfhYb`z`k`]Y`g]W`X]YgY
?ccdYfUh]cb`]b`XYb`_ca`a`YbXYb`A`cbUhYb`Yb`hk`]W`_Y`b`k`]fX`i`bX
k`Y`W`Y`bYi`Yb`DfcXi`_hY`g]Y`a`0[`]W`Yfk`Y]gY`\Yfj`cfVf]b[Yb
_0bbhY`"G]W`Yf`]gh`z`XUgg`VY]XY`GY]hYb`[fc»Yg`b`hYfYggY`Ub`Y]bYf
bUW`\U`h][Yb`i`bX`YfZc`[fY]W`Yb`Ni`gUa`a`YbUfVY]h`\UVYb`z`X]Y`X]Y
;`fi`bX`U[Yb`XYf`6fUbW`Y`VYY]bZi`ggYb`_0bbhY"

8]Y`D`\]`cgc`d`\]Y`j`cb`5BB9A`5F`9`6²`F`@B8

8]Y`A`Uf`_Y`5BB9A`5F`9`6²`F`@B8`j`Yf`_0fdYfh`gY]h`]\fYf`; f0bXi`b[
%-`)-`XUg`Df]bn]d`z`XUgg`G`W`0b`\Y]h`Xi`f`W`X]Y`?`fUZhi`XYf`B`Uhi`f
Yb`hghY`\Yb`_Ubb`"I`bhYf`XYf`@]hi`b[`j`cb`5bbYa`Uf]Y`@]bXbYf`z`XYf
;`f0bXYf]b`z`k`i`fXYb`X]Y`YfghYb`B`Uhi`f`_cga`Yh]_`dfcXi`_hY
Yb`hk`]W`_Y`h`z`X]Y`b]W`h`bi`f`k`]f`_gUa`z`gcbXYfb`Ui`W`

i a k Y`hZFYi bX`jW`k UfYb"8 Ug`l bhYfbY\`a Yb`Y[h[fc»Yb`K Yfh
XUfUi Z`bUW\`U`h][Y`F c\`ghcZY`Ui g`V]c`c[]gWYa`5bVUi`ni
j Yfk YbXYbž`i a`X]Y` ; Ygi bX\`Y]h`XYf`J YfvfUi W`Yf`i bX`XYb`GW`i hn
XYf`2`_cgmghYa`Y`ni`[Yk`A`f`Y]ghYb"

; Ya`Y]bgUa`a`j]hY]bYa`HYUa`j`cb`K`]ggYbgW`UZh`Yfb`UfVY]hYh
6² F`@B8`_cbh]bi`]Yf`]W`XUfUbž`]bbcj`Uh]j`Y` : cfa`Y`b`ni`Ybhk`]W`Y`bž
X]Y`X]Y`<`Ui`hdZY[Y`fYj`c`i`h]cb]YfYb"8`]Yg`[YgW`]Y`h`b]W`h`bi`f
Xi`fW`X`Yb`9]bgUhn`b`U`h`Øf`]W`Yf`f`b`U`hgghc`ZY`ž`gcb`XYfb`Ui`W`X`i`fW
X]Y`a`d`Ya`Ybh]Yfi`b[`i`a`k`Y`h`VYk`i`gghYf`DfU`h]_Yb`j`cb`XYf
J`YfdUW`i`b[`V]g`ni`f`@]YZYfi`b[``5`g` : Ua`]]Ybi`bhYfbY\`a`Yb`nY][`h
6² F`@B8`Y]b`ghUf`_Yg`9b[U[Ya`Ybh`ZØf`Y`h`]gW`Y`K`YfhYž`X]Y`X]Y
A`Uf`_Y`j`cb`Ub`XYfYb`5bV]YhYfb`]a`6YfY]W`X`Yf`?`cga`Yh]_`UV`YVYb"

B UW\`U`h][`_Y]h`i`bX`BUhi`f`_cga`Yh]_`]a`HfYbX

f`XYf`\`Yi`h][Yb`NY]h`k`]Xa`Yb`g]W`ni`bY\`a`YbX`a`Y`f`J`YfvfUi`W`Yf`
XYf`Gi`W`Y`bUW`bUW\`U`h][Yb`i`bX`bU`h`Øf`]W`Yb`DfcXi`_hYb" `@Ui`h
Y]bYf`l`a`ZfU[Y`XYg`A`Uf`hZc`fgW`i`b[gi`bhYfbY\`a`Ybg`B]Y`gYb`Ui`g
XYa``X`f`&`\$`%`[YVYb`+`i`XYf`A`]`Yb]U`g`Ubž`XUgg`g]Y`VY]a`?`Ui`Z
j`cb`?`cga`Yh]_`dfcXi`_hYb`Ui`Z`bUW\`U`h][Y`5gdY`_hY`UW`hYb"8`]Y
HYbXYbn`ni`i`a`k`Y`h`ZFYi`bX`jW`Yb`DfcXi`_hYb`]gh`b]W`h`bi`f`Y]b
j`cfØVYf[Y`Y`bXYf`HfYbXž`gcb`XYfb`gd]Y[Y`h`Y]b`k`UW`gYb`XYg
6Yk`i`gghgY]b`ZØf`Ø`c`c[]gW`Y`i`bX`[Ygi`bX\`Y]h]W`Y` : fU[Yb`k`]XYf"

9]b`k`Y]hYfYf`5gdY`hž`XYf`X]Y`BUW`ZfU[Y`bUW`BUhi`f`_cga`Yh]_`
UbhfY]Vhž`]gh`XYf`K`i`bgW`X`Yf`J`YfvfUi`W`Yf`ž`gW`A`X`]W`Y
7\`Ya`_]U`]Yb`]b`]\fYb`DZY[YdfcXi`_hYb`ni`j`Yfa`Y]XYb"8`]Y
GUi`VYf`_Y]hž`X]Y`HfUbgdUfYbn`XYf`f`b`U`hgghc`ZY`i`bX`X]Y`9]b\`U`hi`b[
\`c`\Yf`l`a`k`Y`h`ghUbXUfXg`gd]Y`Yb`Y]bY`YbhgW`Y]XYbXY`F`c`Y`VY]a
?`Ui`ZYbhgW`Y]X"8`]YgY`HfYbXg`j`Yfgh`A`f`_Yb`XUg`9b[U[Ya`Ybh`j`cb
A`Uf`_Yb`k`]Y`5BB9A`5F`9`6² F`@B8`ž`DfcXi`_hY`]a`9]b`_`Ub[`a`]h`XYf
BUhi`f`ni`Ybhk`]W`Y`b`i`bX`[`Y]W`nY]h][`X]Y`6YXØf`Zb]ggY`X`Yf
a`cXYfbYb`?`cbg]a`YbhYb`ni`VYfØW`g]W`h][Yb"

8Yf`9]bZ`i`gg`j`cb`5`YI`UbXfU`A`Uf]U`@UfU`Ui`Z
X]Y`A`Uf`_Y

5`YI UbXfU`A Uf]U`@UfU`Vf]b[h`b]W`h`bi f`]\fYb`VYfØ\`a hYb`B`Ua Yb`]b
X]Y`DUf`hbYfgW`UZh`gcbXYfb`Ui W`X`Y]bY`ghUf`_Y`Y`h\]gW`X`Y
, VYfnYi [i b["5`g`dfca]bYb`hY`:] [i f`]b`XYf`:]`a VfU`bW`X`Y`\U`h`g]Y
g]W`X`b]W`h`bi f`Xi fW`X`]\fY`G`W`Ui gd]Y`_i bgh`Y]bYb`B`Ua Yb
[Ya U`W`h`z`gcbXYfb`Ui W`X`U`g`J`cfV]`X`ZØf`B`U`W`\U`h][`_Y]h`i bX
j YfU`b`hk`cf`hi b[gVYk`i gghYg`<UbXY`b" `ΔfY`Df`ÅgYbn`k`]fX`X]Y
G]W`hV`Uf`_Y]h`i bX`XYb`9]bZi gg`j`cb`5`B`B`9A`5F`→`6²`F`@`B`8
Yfk`Y]hYfb`ž`]bgVYgcbXYfY`]b`?`fY]gYb`ž`X]Y`K`Yf`h`Ui`Z`Y`h\]gW`X`Y`i`bX
bU`W`\U`h][`Y`Df`c`Xi`_`hY`Y`Y`[`Yb`"

8i fW`X`]\fY`U`_h]j`Y`F`c`Y`]b`XYf`XYi`hgW`X`Yb`:]`a`U`_`U`X`Y`a`]Y`ZØf`X`Y`f`h`
g]Y`X]Y`?`i`h`i`f`i`bX`XYb`?`i`bghgY`_`h`c`f`]b`8`Yi`hgW`X`U`b`X`ž`k`Ug`X`Ug
5b`]Y[`Yb`j`cb`6²`F`@`B`8`ž`Ui`W`X`g`c`n]U`Y`J`YfU`b`hk`cf`hi`b[`ni`h`f`U[`Yb`ž
i`bhYfghfY]W`X`h"8]YgY`G`mbYf[`]Y`nk`]gW`X`Yb`]\fYf`DYfg`Ø`b`]W`X`_Y]h`i`bX
XYb`l`bhYfbY`a`Yb`gk`Yf`hYb`j`cb`6²`F`@`B`8`]gh`b]W`X`h`bi`f`ZØf`X]Y
A`Uf`_Y`j`cb`J`cf`hY]ž`gcbXYfb`Ui`W`X`ZØf`X]Y`6`c`hgW`X`U`Zh`Y]bYf
VYk`i`gghYfYb`@YVYb`gk`Y]gYž`X]Y`g]Y`VY]XY`j`Yf`h`f`Y`h`Y`"

8]Y`DUf`hbYfgW`U`Zh`nk`]gW`X`Yb`5`B`B`9A`5F`→`6²`F`@`B`8`i`bX`5`YI`UbXfU
A`Uf]U`@UfU`]gh`g`ca`]h`Y]b`ghUf`_Yg`6Y]gd]Y`X`U`ZØf`ž`k`]Y`A`Uf`_Yb`i`bX
≠X]j`]Xi`Yb`ni`gUa`a`YbUfVY]hYb`_Ø`bbYb`ž`i`a`d`c`g]h]j`Y
J`Yf`Å`b`X`Y`f`i`b[`Yb`]b`XYf`:]`YgY`g`W`X`U`Zh`i`bX`XYf`l`a`k`Y`h`ni`VYk`]f`_Yb`"

8YhU]`g

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