

7 \ Ub Wb [`Y]W \ Y]h'ZOfXYfb.; ; ch \ U `Y \ fh
GW i `Yb `]a `GhUfhW Ub Wb!Dfc [fUa a

⊕; ch \ U `k i fXYb `XfY]; fi bXgW i `Yb `ZOf `XUg ` GhUfhW Ub Wb!
Dfc [fUa a `Ui g [YnY]W bYhž `XUg `7 \ Ub Wb [`Y]W \ Y]h `]a
6] `Xi b [ggmg hYa `ZOfXYfb `gc ``"

⇒ F U \ a Yb `Y]bYf `ZY]Yf `]W Yb ` , VYf [UVY `k i fXYb ` \ Yi hY `Ub `XfY]
; fi bXgW i `Yb `]b `; ch \ U `D `U `YhhYb `XYg ` GhUfhW Ub Wb!
Dfc [fUa a g `ØVYffY]W h `GhY `j YfhfYhYbX `ZOf `XYb `GW i `hfÅ [Yf
ØVYf [UV `K c `ZfUa `5VVÅžXYf `@Y]hYf `XYg `GhUUh]W Yb `GW i `Ua hYg
K Ygh \ Øf]b [Yb ž [Ya Y]bgUa `a]h `DYhYf `@Y]gbYfž `XYa
6Y] [YcfXbYhYb `XYf `GhUXh; ch \ U ž i bX `7 \ f]gh]Ub `<] `VYfhž `XYa
FYZfYbYb `ZOf; fi bXgW i `Yb `XYg `GW i `Ua hYgž `X]Y
5i gnY]W bi b [Yb " 8]Y `VYgW Yb `hYb `GW i `Yb `g]bX `X]Y `GhUUh]W Y
; fi bXgW i `Y ` 5bXfYUg `F Ym \ Yf `žX]Y `GhUUh]W Y; fi bXgW i `Y
@ Xk] [`6YW ghY]b `i bX `X]Y `GhUUh]W Y; fi bXgW i `Y ` DYhYf
5bXfYUg `< Ubgyb žXYfYb `GW i ` `Y]hYf]bbYb `? Uf]bU `6Ufi Z_Yž5b]hU
: fÒ]W `i bX `5bYhh `? fYi nU \ Yf!F ch \ `X]Y `D `U `YhhYb
Ybh [Y [YbbU \ a Yb"

8 Ug ` GhUfhW Ub Wb!Dfc [fUa a žXUg]a ` _ca a YbXYb `GW i `U \ f
&\$&(#&) `ghUfhYb `k]fXž `k i fXY `]bg `@VYb `[Yfi ZYb ž i a `X]Y
7 \ Ub Wb [`Y]W \ Y]h `]b `XYf `6] `Xi b [`ni `j YfVYggYfb " 8]Y `⊕]h]Uh]j Y
g]Y \ h `Y]bY `i a ZUggYbXY `FYZcfa `j cfž `X]Y `ØVYf `Z]bUb n]Y ` `Y `A]hhY `
 \]bUi g [Y \ h " ⊕gVYgcbXYfY `gc ` `Yb `i a ZUb [fY]W Y `⊕j Ygh]h]cbYb `]b
X]Y `6] `Xi b [g `UbXgW UZh [YhÅh] [h `k YfXYbž `X]Y `]bg [YgUa h `&\$
A] `]UfXYb `9i fc `ØVYf `Y]bYb `NY]hfUi a `j cb `nY \ b `⊕ \ fYb `i a ZUggYb"

: ØfXYfi b [`j cb `6] `Xi b [`i bX
7 \ Ub Wb [YfYW h] [_Y]h

⇒a`?Yfb`XYg`Dfc[fUa a`g`ghY`h`X]Y`⇒XYž`XUgg`Y]b`[YfYW`hYf
Ni [Ub[`ni`ei`U`hUh]j` \cW`k`Yfh][Yf`6]`Xi b[`b]W`h`bi`f`Y]bY` : fU[Y
XYf`Z]bUbn]Y`Yb`A`]hY`]gh"8 Ug` GhUfhW`UbW`b!Dfc[fUa a`n]Y`h
XUfUi`Z`UVž`gck`c`X]Y`@YfbVYX]b[i b[Yb`U`g`Ui`W`X]Y`gcn]U`Yb
i bX`Ya`ch]cbU`Yb`6YXØfZb]ggY`j`cb`GW`Ø`Yfb`ni`VYfØW`g]W`h][Yb"
8]Yg`gc`Xi`fW`X]Y` : ØfXYfi b[`dfcZYgg]cbY`Yf`HYUa`g]bbYf`U`V
XYf`GW`i`Yb`[YgW`Y`Yb"8 UXi`fW`k`]fX`g]W`Yf[YghY`hž`XUgg
@Y`fYfž`Gcn]U`UfVY]hYf`i bX`UbXYfY` : UW`_f`ÅZhY
ni`gUa`a`YbUfVY]hYbž`i a`X`Yb`]bX]j`]Xi`Y`Yb`6YXØfZb]ggYb`XYf
GW`Ø`Yf`[YfYW`h`ni`k`YfXYb"

9]b`k`YgYb`h]W`Yf`6YghUbXhY]`XYg`Dfc[fUa a`g`g]bX`X]Y
gc[YbUbb`hYb`7`UbW`b`Vi`X[Yhg"8]YgY`6i`X[Yhg`gc`Yb`Y]bY
ZYI`]V`Y` :]bUbn]Yfi b[`V]YhYbž`X]Y`Ub`X]Y`gdYn]Z]gW`Yb
5bZc`fXYfi b[Yb`i`bX` : Y[YVYb`Y]hYb`XYf`Y]bnY`bYb`GW`i`Yb
Ub[YdUggh`k`YfXYb`_Ubb"8]Yg`Yfa`Ø[`]W`h`GW`i`Ybž
a`U»[YgW`bY]XYfhY`@Øgi b[Yb`ni`Yb`hk`]W`_Y`b`i`bX`i`a`ni`gYmYbž`i`a
]`fYb`GW`Ø`Yfb`X]Y`VYgha`Ø[`]W`Y`i`bhYfghØ`hni b[`ni`V]YhYb"

⇒bj`Ygh]h]cbYb`]b`X]Y`Ni`_i`bZh`XYf`GW`i`Yb

8]Y`XfY]`Ui`g[YnY]W`bYhYb` : fi bXGW`i`Yb`]b` : ch`U`k`YfXYb`Xi`fW`
XUg` GhUfhW`UbW`b!Dfc[fUa a`i`bhYfghØ`hni b[`YfZ`U`fYbž`X]Y`Ui`W`
]b`nY]h[Ya`Å»Y`@Yfbi`a`[YVi`b[Yb`Z]Y»Yb`k`]fX"8]YgY
⇒bj`Ygh]h]cbYb`g]bX`b]W`h`bi`f`Ui`Z`X]Y`d`mg]gW`Y`⇒bZfUghfi`_hi`f
Ui`g[Yf]W`hYhž`gc`bXYfb`gc`Yb`Ui`W`]b]bc`j`Uh]j`Y`@Y`fa`Yh`c`XYb`i`bX
HYW`bc`c[]Yb`ZØfXYfbž`X]Y`XYb`i`bhYff]W`h`VYfY]W`Yfb"9g]ghY]bY
 : Y`Y[Yb`Y]h`ZØf`X]Y`GW`i`Ybž`g]W`bYi`ni`YfZ]bXYb`i`bX`XYb
5bZc`fXYfi b[Yb`XYf`a`cXYfbYb`6]`Xi`b[g`UbXgW`UZh`[YfYW`h`ni
k`YfXYb"

8 Ug`9b[U[Ya`Yb`hž`XUg`a`]h`XYa` GhUfhW`UbW`b!Dfc[fUa a`
Y]b`Yf[Y`hž`_Øbb`hY`U`g`k`]W`h][Yf`GW`f]h]b`F]W`h`i`b[`Y]bYf
]b`_i`g]j`YfYb`i`bX`[YfYW`hYfYb`6]`Xi`b[`VYhfUW`hY`h`k`YfXYb"⇒bXYa
6i`bX`i`bX`@AbXYf`ni`gUa`a`YbUfVY]hYbž`i`a`X]Y
<YfUi`gZc`fXYfi b[Yb`]a`6]`Xi`b[gk`YgYb`Ubni`[Y`Ybž`k`]fX`X]Y
 : fi bX`U[Y`ZØf`VYggYfY`@YfbVYX]b[i b[Yb`i`bX`7`UbW`b`ZØf`U`Y
GW`Ø`Yf]bbYb`i`bX`GW`Ø`Yf`[Y`Y[h`i`i`bUV`Åb[]j`cb`]`fYa

gc n]U`Yb`<]bhYf[fi bX"

K]W\ h][_Y]h`XYf`7\ UbW\ b [`Y]W\ \ Y]h`]b`XYf`
6]`Xi b[

8]Y` , VYf[UVY`XYf`D`U`_YhYb`gma`Vc`]g]Yfh`b]W\ h`bi`f`Y]bY`
5bYf`_Ybbi`b[`XYf`VYfY]hg`[`Y`Y]ghYhYb`5fVY]h`XYf`VYhY`][hYb`
GW\ i`Ybž`gcbXYfb`Ui`W\ `XYb`6Y[]bb`Y]bYg`
J Yf`À`bXYfi`b[gdfcnYggYgž`XYf`k`Y]hfY]W\ YbXY`5i`gk`]f`_i`b[Yb`\UVYb`
_Ubb`" `&`Y]bYf`NY]hž`]b`XYf`[YgY`gW\ UZh]W\ Y`i`bX`k`]fhgW\ UZh]W\ Y`
l`b[`Y]W\ \ Y]hYb`c`Zh`g]W\ hVUf`k`YfXYbž`b]a`a`h`XUg`H\Ya`U`
7\ UbW\ b [`Y]W\ \ Y]h`]b`XYf`6]`Xi b[`Y]bY`nYbhfU`Y`F`c``Y`Y]b"

⊖g[YgUa`h`nY][h`XUg`GhUfhW\ UbW\ b!Dfc[fUa`a`ž`k`]Y`k`]W\ h][`Yg`
]ghž`_cbh]bi`]Yf`W\ `]b`X]Y`6]`Xi b[`ni`]bj`Ygh]YfYb`i`bX`X]Y`
F`U`a`YbVYX]b[i`b[Yb`Z0f`YZZ`_hj`Yg`@YfbYb`ni`gW\ UZZYb`"8]YgY`
⊖]h]Uhj`Y`_0bbhY`Ub[Zf]gh][`XYf`GW\ `0ggY`gY]bž`i`a`X]Y`
6]`Xi b[g[YfYW\ h][_Y]h`]b`8Yi`hgW\ `UbX`Ui`ZY]b`bYi`Yg`B]j`YUi`ni`
\VYb`i`bX`g]W\ Yfni`ghY`Ybž`XUgg`_Y]b`?`]bX`Ui`Z[fi`bX`gY]bYf`
<Yf`_i`bZh`VYbUW\ hY`][h`k`]fX"

7\ UbW\ b [`Y]W\ \ Y]h`]a`6]`Xi b[ggmghYa

8Ug`GhUfhW\ UbW\ b!Dfc[fUa`a`ž`XUg`Ui`ZY]bY`VYggYfY`
7\ UbW\ b [`Y]W\ \ Y]h`]a`6]`Xi b[ggmghYa`UVn]Y`hž`]gh`VYgcbXYfg`
fY`Yj`Ubh`]b`XYf`\Yi`h][Yb`;`YgY`gW\ UZhž`k`c`gc n]U`Y`l`b[`Y]W\ \ Y]hYb`
g]W\ `c`Zh`]b`XYb`6]`Xi b[ga`0[`]W\ _Y]hYb`k`]XYfgd]Y[Y`b`"?"`]bXYf`Ui`g`
Y]b`_ca`a`Yb`ggW\ k`ÀW\ YfYb`;`Ua`j`]Yb`\UVYb`\Ài`Z[`k`Yb][Yf`
Ni`[Ub[`ni`ei`U`]hUhj`]\cW\ k`Yfh][Yf`6]`Xi b["Ghi`X]Yb`nY][Ybž`XUgg`
XYf`6]`Xi b[g\]bhYf[fi`bX`XYf`9`hYfb`Y]bYb`Yf`YV`]W\ Yb`9]bZi`gg`
Ui`ZYb`6]`Xi b[gYfZc`[`XYf`?]bXYf`\Uh`@Ui`hY]bYf`9f`YVi`b[`XYg`
GhUh]gh]gW\ Yb`6i`bXYgUa`hYg`\UhYb`]a``J\`f`&\$&&`fi`bX`%\$i` `XYf`
GW\ 0`Yf]bbYb`i`bX`GW\ 0`Yf`Ui`g`gc n]U`VYbUW\ hY`][hYb`
J Yf`À`h`b]ggYb`_Y]bYb`;`fi`bXgW\ i`UVgW\ `i`gg`"8]YgYg`Dfc[fUa`a`
gc``XUni`VY]hfU[Ybž`X]YgY`8]g`fYdUbn`ni`j`Yff]b[Yfb`i`bX`Y]bY`
[`Y]W\ k`Yfh][Y`6]`Xi b[`Z0f`U`Y`ni`[Yk`À`f`Y]ghYb"

:]bUb n]Y`Y`i b hY fghØhni b [ga YW Ub]ga Yb

8 Ug` ðj Ygh]h]cbgj c`i a Yb`j cb`&\$`A]`UfXYb`9i fc`ØVYf`Y]bYb
NY]hfUi a`j cb`nY`b` ð\ fYb`]gh`HY]`Y]bYg`i a ZUggYbXYb`5bgUhnYgž
i a`X]Y`6]`Xi b [g [YfYW h][`_]h`ni`ZØfXYfb`"8]Y`VYfY]h [YghY`hYb
A]hY`_`ØbbYb`ZØf`j YfgW]XYbY`Nk YW_Y`j Yfk YbXYh`k YfXYbž
XUfi bhYf`X]Y`F Ybcj]Yfi b [`j cb`GW i`Ybž`X]Y`GW UZ b [`X][`]hU`Yf
@Yfbi a [YVi b [Yb`i bX`X]Y`9]bghY`i b [`ni gÀh`]W Yf`@Y`f`fÀZhY"
ðgVYgcbXYfY`X]Y`i`ØfXYfi b [`a`i`h]dfcZYgg]cbY`Yf`HYUa gž`k]Y
ni a`6Y]gd]Y`GW i`dgmW c`c [Yb`i bX`Gcn]U`UfVY]hYfž`_`ØbbhY
d cg]hj Y`5i gk]f`_i b [Yb`Ui Z`X]Y`9bhk]W`_i b [`XYf`GW`Ø`Yf`\UVYb`" ð
Y]bYf`U`_hi Y`Yb`i a ZfU [Y`XYf`6YfhY`ga Ubb`Gh]Zhi b [`[UVYb`i`+` i
XYf`@Y`fYf`Ubž`XUgg`X]Y`i bhY fghØhni b [`ZØf`gc n]U`Y`i bX`Ya`ch]cbU`Y
6YXØfZb]ggY`]\fYf`GW`Ø`Yf`Yb hgW Y]XYbX`ZØf`XYfYb`gW i`]\gW Yb
9fZc`[`]gh"

GmghYa]gW Y`J YfÀbXYfi b [Yb`]a

6]`Xi b [gk YgYb

8 Ug`Dfc [fUa a`ZØfXYfh`b]W h`bi f`X]Y`Z]bUb n]Y`Y`i bhY fghØhni b [
XYf`GW i`Ybž`gcbXYfb`\Uh`Ui W`XUg`N]Y`ž`gmghYa]gW Y
J YfÀbXYfi b [Yb`]a`6]`Xi b [ggmg hYa`Y`fVY]ni ZØ\ fYb`"8 Uni`[Y`Øfh
Y]bY`BYi Ui gf]W hi b [`XYf`@Y`fd`ÀbYž`X]Y`j YfghÀf`_h`Ui Z`X]Y
]bX]j]Xi Y`Yb`6YXØfZb]ggY`XYf`GW`Ø`Yf`Y]b [Y`Yb`gc`Yb`"
6YgcbXYfg`]b`?`UggYb`a`]h`Y]bYf`\c`Yb`5bnU`U`Ub`?`]bXYfb`a`]h
A] [fUh]cbg`]\bhYf [fi bX`nY][`h]g]W`c`Zi`X]Y`B`chk YbX][`_]h`ZØf
X]ZYfYbn]YfhY`@Y`fa`Yh`cXYb`"9]bY`Ghi X]Y`XYf`8Yi hgW Yb
; YgY`gW UZh`ZØf`9fn]Y`i b [gk]ggYbgW UZh`VY`Y [hž`XUgg
X]ZYfYbn]YfhY`i bhYff]W hgUb gÀhY`ni`Y]bYf`g][`b]Z`_UbhYb
@Y]ghi b [gj YfVYggYfi b [`VY]`GW`Ø`Yf]bbYb`i bX`GW`Ø`Yfb`a`]h
A] [fUh]cbg`]\bhYf [fi bX`ZØ\ fYb`_`ØbbYb`"

9j U`i Uh]cb`XYg`Dfc [fUa a`g

I a`X]Y`K]f`_gUa`_]h`X`Yg`GhUfhW UbWb!Dfc [fUa a`g`ni
[Yk`À`f`Y]ghYbž`g]bX`fY [Y`a`À`][`Y`9j U`i Uh]cbga`U`b`U`a`Yb
i bYf`Àgg`]W`"8]YgY`gc`hYb`b]W h`bi f`X]Y`J`Yfk`YbXi b [`XYf`A`]hY`

ØVYfdfØZYbž'gcbXYfb'Ui W'XYb': cfhgWf]hh'XYf'GWØ'Yf']b'6Yni [Ui Z]\fY'gWi']gWYb'@Y]ghi b[Yb'i bX'gcn]U`Yb'?ca dYhYbnYb" Y\b']WY'6]'Xi b[gdfc[fUa a Y']b'UbXYfYb'@AbXYfbž'k]Y VY]gd]Y`gk Y]gY']b'GWk YXYb'cXYf':]bb'UbXž'\UVYb'[YnY][hž'XUgg _cbh]bi]Yf']WY'9j U'i]Yfi b['i bX'5bdUggi b['XYf'A U» bU\ a Yb'ZØf XYb'`Ub[Zf]gh][Yb'9fZc`['YbhgWY]XYbX'g]bX"8]Y'9]bVYn]Y\i b['j cb @Y\ f_fÅZhYbž'9`hYfb'i bX'GWØ'Yfb']b'X]YgYb'9j U'i Uh]cbgd fcnYgg _ØbbhY'ni gÅhn']W'XUni 'VY]hfU[Ybž'XUg'Dfc[fUa a 'VYXUfZg[YfYW h ni '[YghU'hYb'i bX'Ubni dUggYb"

5i gV`]W_

8 Ug' GhUfhW UbW' b!Dfc[fUa a 'V]YhYh'Y]bY'j]Y'j YfgdfYWYbXY A Ò[`]W_Y]hž'VYghY\YbXY'6]'Xi b[gVUff]YfYb'UVni VUi Yb"8]Y ?ca V]bUh]cb'Ui g'Z]bUbn]Y`Yf'l bhYfghØhni b['i bX'gmghYa]gWYb J YfÅbXYfi b[Yb'_ØbbhY']b'XYb'_ca a YbXYb'»\fYb'XUni 'ZØ\ fYbž XUgg'a Y\ f'GWØ'Yf]bbYb'i bX'GWØ'Yf'X]Y'7\UbW'Ui ZY]bY YfZc`[fY]WY'gWi']gWY'@Ui ZVU\b'Yf\U'hYb"9g'V'Y]Vh'UVni k UfhYbž k]Y'X]Y'l a gYhni b[']b'XYb'_ca a YbXYb'»\fYb'YfZc`[Yb'k]fX'i bX k Y'WY'_cb_fYhYb'J YfÅbXYfi b[Yb']b'XYb'GWi'Yb'YffY]W h k YfXYb'_ØbbYb"

8 YhU]`g

6Ygi WYb'G]Y'i bg'Ui Z.'X]Y!bUW f]W hYb"bYh