

# 8]Y @ÀbXYfž X]Y k]f Ua a Y]ghYb gY\Yb k c``Yb

Hfchn'i bgYfYf'VYghYb'D'ÀbY'\UVYb'k]f'Yg'YhnhYg'\\fb]YbUW\5Zf]\_U'[YgW\UZh"A]h'YfbYi hYb'D'ÀbYbž'XYb'?cbh]bYbhbUW\ibgYfYf'U\_hi Y'`Yb'FY]gY'Xi fW\Gf]'@Ub\_U'i bX'6i fa Uni 'VYgi W\Ybž'ZUbXYb'k]f'i bg']b'Y]bYf']bhYfYggUbhYb8]g\_i gg]cb'k]YXYf.K Ybb'G]Y'bi f'ZØbZ'@\bXYf'gY\Yb\_ObbhYbž'VYj cf'G]Y'ghYfVYbž'kY'W\Y'k\AfYb'XUg3'8]YgY:fU[Y'ghY``hY'i bg'j cf'Y]b'j]Y``\_b]ZZ][YfYg'8]'Yaa U'U`g'X]Y@\bXYfž'X]Y'k]f'Ua'kYb][ghYb'gY\Yb'kc``Yb"'6Y]'gc'j]Y`\fb[YVch'aighYb'k]f'VY]'i bgYfYb'9bhgW\Y]Xi b[YbfØW\_g]W\hg`cg'gY]b''K]f'\UVYb'\_Y]bY'@\bXYf'Uig[Yk\A\`hž'X]Yk]f'VYfY]hg'VYgi W\h'\UVYbž'i bX'Ui W\'\_Y]bY'ghUUhYb`cgYb;YV]YhY'fh"'6"X]Y'5bhUf\_h]g\L''NkY]'i bgYfYf' Ua d\Y'`]d/

Hfchn'i bgYfYf'VYghYb'D`ÀbY'\UVYb'k]f'Yg'`YhnhYg'\*J\f'b]Y'bUW\5Zf]\_U'[YgW\UZZh"'A]h'YfbYi hYb'D`ÀbYbž'XYb'?cbh]bYbh'bUW\i bgYfYf'U\_hi Y``Yb'FY]gY'Xi fW\'Gf]'@Ub\_U'i bX'6i fa U'ni VYgi W\Ybž'ZUbXYb'k]f'i bg']b'Y]bYf']bhYfYggUbhYb'8]g\_i gg]cb k]YXYf.'K Ybb'G]Y'bi f'ZØbZ'@ÀbXYf'gY\Yb'\_ÒbbhYbž'VYj cf'G]Y ghYfVYbž'kY'W\Y'kÀfYb'XUg3

8]YgY:: fU[Y'ghY``hY'i bg'j cf'Y]b'j]Y``\_b]ZZ][YfYg'8]`Ya a U'U`g'X]Y @AbXYfž'X]Y'k]f'Ua 'kYb][ghYb'gY\Yb'kc``Yb"'6Y]'gc'j]Y`'5b[YVch a i gghYb'k]f'VY]'i bgYfYb'9bhgW\Y]Xi b[Yb'fØW\_g]W\hg`cg'gY]b"

K ]f`\UVYb`\_Y]bY`@ÀbXYf`Ui g[Yk À\`hž`X]Y`k ]f`VYfY]hg`VYgi W\h\UVYbž`i bX`Ui W\`\_Y]bY`ghUUhYb`cgYb`; YV]YhY`fh"`6"`X]Y
5bhUf\_h]gŁ"`Nk Y]`i bgYfYf`@ÀbXYf`ØVYfgW\b]hhYb`g]W\`fBYdU``i bX
?UbUXUŁŽ'U`gc`k À\`hYb`k ]f`Yk Y]`g`Y]b`k Y]hYfYg`Ui gž`i a
]bg[YgUa h`%\$`ni `a UW\Yb"

8]Y'fYgi`h]YfYbXY'@]ghY'V]YhYh'Y]bY'gc`]XY'\dagd]fUh]cb'ZØf'i bgYfY
ni \_ØbZh][Yb'FY]gYb''K Ybb'X]Y'@ÀbXYf'b]W\h'ØVYf'U``Y'9W\_Yb'XYf
K Y`h'j YfghfYi h'k ÀfYbž'k ÀfYb'k]f'j]Y``Y]W\h'j Yfgi W\h'[Yk YgYbž
Y]bY'[fc»Y'FY]gY'XUfUi g'ni 'a UW\Yb'''@Y]XYf'a UW\h'X]Y'^2 \_cbca]Y
\_Y]bYb'G]bbž'UVYf'k]f'\_ObbYb'hfÀi a Yb'

# ? ]Ug 9b hg W Y ] X i b [ Y b

Hi f\_a Yb]ghUb

±W. ZfYi Y.a ]W. gW.cb.gY]h.Y]b][Yb.\*IJ\fYb.XUfUi Zž.8Yfk YnY.]b Hi f\_a Yb]ghUb.ni gY\Yb":5i W. VY\_Ubbh.U`g.XUg.Hcf.ni f'< Ò``Yž VfYbbh.X]YgY.`cXYfbXY': Yi YfgW.`i W.h.gY]h.ZUgh.) \$.\*IJ\fYb"

'U`h1 @ÀbXYfž'X]Y'k]f'Ua 'a Y]ghYb'gY\Yb'kc``Yb Hi f\_a Yb]ghUb 2 HfUi a nY]h

5a 'FUbX'X]YgYg'gi ffYU`Yb'?fUhYfg'ni 'ghY\Ybž'ghY\h'[Ubn'cVYb Ui Z'a Y]bYf'FY]gY!K i bgW\`]ghY"

#### ? UbUXU

? UbUXU ']gh'Y]bYg'X]YgYf'@ÀbXYfž'j cb'XYbYb'YXYf'XYb\_hž'XUgg']W\
Yg'[YgY\Yb'\UVYž'UVYf']W\'\UVY'Yg'b]W\h'[YhUb"'GY]bY'ghUf\_Y

\(\pu\Zf\Ughfi \_hi f'i bX'gY]bY'VYbY]XYbgk YfhY'G]W\Yf\Y]hgV]\'Ubn
a UW\Yb'Yg'ni 'Y]bYa 'XYf'C fhYž'X]Y'G]Y'gY\Yb'\_\ObbYbž'k Ybb'G]Y
Yhk Ug'\(\hat{A}\)hYf'i bX'\Ub'\VYgh]a a hYb'?ca \(Zcfh'\[Yk\O\\bh'g]\bX''\)

 $\label{eq:continuity} $$ U^h1 = 8 Yf^ZUbhUgh]gWXY^A h''^5g[UfX^]gh^Y]bYf^XYf^gWX ObghYb^6Yf[Y]$ 

 $8 \ Ug^{\ }Y] \gg hz^{\ }W \wedge k \wedge fY \wedge Ua \wedge GcXYb^{\ }nYfghOfhz^{\ }k \wedge Ybb^{\ }]W \wedge ? UbUXU^{\ }b]Y$   $gY \wedge Yb^{\ }k \wedge gfXY''^{\ }W \wedge a \wedge gY \wedge Yb^{\ }b \wedge gY \wedge Yb^{\ }gY \wedge Yb^{\ }gY \wedge Yb^{\ }a \wedge gY \wedge Yb^{\ }hgY^{\ }bY \wedge gY \wedge Yb^{\ }hgY^{\ }b \wedge gY^{\ }hgY^{\ }hgY^{$ 

@YgYb'G]Y'a Y\f'ØVYf'?UbUXU

#### A cb[c`Y]

9g'[]Vh'bi f'k Yb][Y'@ÀbXYfž'X]Y'g]WX'gc'k]`X'i bX'XfUa Uh]gWX UbZØ\`Yb'k]Y'X]Y'A cb[c`Y]"'GY]bY'gWXfcZZYb'K Y]hYb'i bX Bca UXYbj Ò`\_Yf'g]bX'ZUgn]b]YfYbXž'i bX'gY]bY'UV[Y`Y[YbY'@U[YjYfgdf]WXh'X]Y'5V[YgWX]YXYb\Y]hž'X]Y'Ub'YXYa '9bhXYW\_Yf\YfnYbnYffh"

'U`h1 @ÀbXYfž'X]Y'k]f'Ua ``]YVghYb'gY\Yb'a ÒW\hYbž'X]Y A cb[c`Y] 2 HfUi a nY]h

→W. 'a OWW hY 'X]Y 'VYfØWW h][ hY 'K ØghY'; cV]'gY\Yb'i bX'X]Y
a cb[c`]gWXY'GhYddY'Yf\_i bXYb"'5i WX'X]Y'DZYfXY\_i `hi f'XYg'@UbXYg
n]Y\h'a ]WX 'Ubž'XYbb']WX '`]YVY'X]YgY'; YgWX OdZY' 'gY]'Yg'Y]b''1 b[Yf
6c W\_ž'XYf'g]WX 'Ub'XYb'NØ[Y`b'fY]Vhž'cXYf'Y]bY'fi \][Y'Ghi hY'Ui Z
Y]bYa 'gUbZhYb'GhfY]Zni ["'FY]hYb']b'XYf'a cb[c`]gWXYb'GhYddY']gh
Y]b'HfUi a "

 $@YgYbG]YaY\fVYfX]YAcb[cY]$ 

# Ÿh\]cd]Yb

'U`h1 YfhU'U`Yž'X]Y'U\_h]| ghYb'J| `\_UbY 2 HfU| a nY]h

→W. ZØ\`Y`a]W\`ni '9fhU'5`Y`\]b[Ync[Ybž'bUW\XYa']W\`XYb`A ci bh MUgi f']b'J Ubi Uhi 'VYgi W\h'\UVYž'nk Y]ZY``cg'XUg'VYghY FY]gYYf`YVb]gž'XUg']W\'Y`\UhhY"

9fhU'5`Yžk Ug']b'XYf'`c\_U`Yb'5ZUf!GdfUWXY' fUi WXYbXYf'6Yf[VYXYi hYhž']gh'b]WXh'bi f'\cWXYI d`cg]j ž'gcbXYfb'a ]h'HYa dYfUhi fYb j cb'V]g'ni '(+'...7'ff%, '.... Ł'Ui WX'Y]bYf'XYf'hfcW\_YbghYbž b]YXf][ghYb'i bX'\Y]» YghYb'CfhY'XYf'9fXY'''K Ug'k]``a Ub'a Y\f'j cb Y]bYa 'nk Y]k ÒWX][Yb'5i gZi ['j cb'ni '< Ui gY'Ui g3

@ $YgYbGYaY\f'\emptysetVYf'\ddot{Y}h\cdYb$ 

#### GUa V]U

GUa V]U']gh'Y]bYg'j cb'nk Y]'@ÀbXYfbž']b'XYbYb'X]Y''Y[YbXÀfYb J]\_hcf]UZÀ``Yž'XYf'[fÒ» hY'K UggYfZU``'XYf'K Y`hž'VY\Y]a UhYh'g]bX"GUa V]Ug'; Y[YbghØW\_ž'G]a VUVk Yž'V]YhYh'a Y\f
DUbcfUa UUi gg]WXhgdi b\_hYž'UVYf'YfghYfYg'V]YhYh'Y]bYb'bÀ\YfYb Ni [Ub['ni 'XYb'K UggYfZÀ``Yb'gck]Y'X]Y'A Ò[`]WX\_Y]hž']b'XYb VYfØ\a hYb'8Yj]`g'Dcc``Y]bni hUi WXYb"

'U`h1 @ÀbXYfž'X]Y'k]f'Ua ``]YVghYb'gY\Yb'a ÒW\hYb GUa V]U 2 HfUi a nY]h

8]YgY'j]Y`Zchc[fUZ]YfhY'GhY``Y'Ua 'FUbX'XYf'K UggYfZÀ``Y Yfa Ò[`]W\h'Yg'UVYbhYi Yf`i gh][Yb'GW\k]a a Yfbž'bi f'k Yb][Y'A YhYf j cb'XYf'GhY``Y'YbhZYfbhž'Ub'XYf'XUg'K UggYf'ØVYf'X]Y'K UggYfZÀ``Y qhØfnhž'Y]b'6UX'ni 'bY\a Yb"

BUWX 'ZUgn]b]YfYbXYb'6Ygi WXYb']b'; i ``Zcgg']b'=g`UbX'i bX'=[i Uggi]b'6fUg]`]Yb'V]b']WX'g]WXYfž'XUgg'J]Whcf]U'[YbUi gc'VYY]bXfi W\_YbXk ÀfY"

## DYhYfg'9bhgWXY]Xib[Yb

#### BUa ]V]U

⇒W. `\UVY`a ]W. 'j cf'j ]Y`Yb`⇒U\fYb'j cb'k Y]hYa `]b'BUa ]V]U'j Yf`]YVhž bUW. XYa `]W. 'Y]bY'5i gghY``i b[ 'ØVYf'X]Y'G\_Y`Yhh\_ØghY'[ YgY\Yb\UhhY"'8Ug'; YV]Yh`]gh'ØVYfgÀh'a ]h'a Ugg]j Yb'K U`\_bcW.Ybž fcghYbXYb'GW.]ZZgk fUW\_gž'hchYb'DZUbnYb'i bX'[ Y`Y[ Ybh`]W.Yb:i » gdi fYb'j cb'K ØghYb\_fYUhi fYbž'X]Y`Xf]b[ YbX'BU\fi b[ VfUi W.Yb"'8]Y'; Y[ YbX']gh'gc'k ]`Xž'XUgg'?\c]gUb!6i gW.a ÀbbYf Ui g'XYa '@UbXYg]bbYfYb'g]Y' XUg'@UbXž'XUg'; chh']a 'Ncfb YfgW.UZZYb`\Uh'[ YbUbbh'\UVYb"

'U`h1 @AbXYfž'X]Y`k ]f`Ua 'a Y]ghYb`gY\Yb`k c``Yb`BUa ]V]U
& 2 HfUi a nY]h

9hk Ugʻk Yb][Yfʻa cfV]XYʻ]ghʻX]YʻB Ua ]V!K ØghYžʻX]Yʻ]WXʻ[YfbY Zchc[fUZ]YfYžʻgY]hʻ]WXʻj cfʻj ]YʻYbʻ\J\\fYbʻni a 'YfghYbʻA U`ʻY]bY 5i ZbU\a Yʻ]\fYfʻ]\_cb]gWXYbʻ@UbXgWXUZhʻ[YgY\Ybʻ\UVY"8]Y gWXfcZZYbʻG]`\ci YhhYbʻgY]bYfʻ6Ài a Yʻj cfʻY]bYa 'i bj YfgWXÀa hYb V`Ui Ybʻ<]a a Y`i bXʻY]bYfʻ`YVYbX][YbʻK ØghYʻgWXUZZYbʻY]bY gi ffYU`Yʻ8]gbYmlGnYbYžʻj cbʻXYfʻG]Yʻg]WXʻb]Yʻ[Ubnʻg]WXYfʻg]bXžʻcVg]YʻYWXhʻ]gh"

@ $YgYbG]YaY\fBUa]V]U$ 

#### BYdU`

'U`h1 @ÀbXYfž'X]Y'k]f'Ua 'a Y]ghYb'gY\Yb'kc``Yb'

≯bgY]hg'XYg'9j YfYgh']gh'XUg'U``[ Ya Y]bY'<]a U`UmU!; YV]Yh'Y]b

HfUi a 'ZØf'K UbXYfYf'i bX'V]YhYh'Y]b][ Y'XYf'gW\ÒbghYb

@UbXgW\UZhYb'XYf'K Y`h"'8Ug'K UbXYfb'Ui Z'XYa '5bbUdi fbU'7]fW']h
ghY\h'Ui Z'a Y]bYf'K i bgW\`]ghY'b]W\h'K Y]h'\]bhYf'XYa '9j YfYgh"
</pre>

@YgYb G]Y a Y\f ØVYf B YdU`

## ? ]f]VUh]

8 Ugʻ]ghʻY]bYʻ5fhʻ5i gfY]» Yf"ʻ9gʻ\Uhʻk YXYfʻX]YʻgW\fc ZZYb @UbXgW\UZhYbʻbcW\`X]Yʻk Y]hYbʻ5i gg]W\hYbʻa Y]bYfʻUbXYfYb K U\`a Ò[`]W\\_Y]hYbžʻUVYfʻYgʻ]ghʻg]W\Yf`]W\`Y]bYfʻXYfʻgW\ÒbghYb CfhY`XYfʻ9fXY"

'U`h1 ?]f]VUh]']gh'Y]bYf'XYf'Ua '\Ài Z][ghYb'ZU`gWX Ui g[YgdfcWXYbYb'@AbXYfbUa Yb 2 HfUi a nY]h

#W `\ UVY `a ]WW `Ui Z`i bgYfYf`FY]gY `&\$%( `ØVYf`gY]bY `±bgY`b `]b `XYb
GØXdUn]Z]\_\_'j Yf`]YVh"'?]f]VUh] `gWXY]bh'Y]bY `bUhØf`]WXY `9fk Y]hYfi b[
Y]b][ Yf`XYf`Ui » Yf[ Yk Ò\b`]WXYb `GWX Òb\Y]hYb 'j cb `GUa cUž`Hcb[ Už
F Ufchcb[ U`i bX`: fUbnÒg]gWX!Dc`mbYg]Yb `ni `gY]b"

9gʻ]ghʻY]bYgʻXYfʻUaʻk Yb][ghYbʻVYgi W\hYbʻ@ÀbXYfʻXYfʻK Y`hž'k Ug\cZZYbh`]W\ii bVYfØ\fhYʻGhfÀbXYʻa]hʻ\YfjcffU[YbXYbʻGW\bcfW\Y`!ibX`HUi W\aÒ[`]W\\_Y]hYbʻVYXYi hYh°

 $@YgYbG]YaY\f @VYf?]f]VUh]$ 

#### ; fÒb`UbX'fl8ÀbYa Uf\_Ł

; fÒb`UbX']gh'Ui g'gc'j ]Y`Yb'; fØbXYb'j Yf`cW\_YbX'''GY]bY'\_Uf[Yb@UbXgW\UZhYbž'UV[Y`Y[YbYb'; Ya Y]bXYb'i bX'XYf'Ni [Ub['ni f K ]`Xb]g'g]bX'ZØf'XYb'9bhXYW\_Yf']b'a ]f'i bk ]XYfghY\`]W\"

"U`h1 26Ygi W\Yb G]Y ; fÒb`UbX

#W 'V]b'gY\f'XUfUb']bhYfYgg]Yfhž'XYb'5fWh]W7]fWY'HfU]`a ]h'gY]bYf
UhYa VYfUi VYbXYb'GW\Ob\Y]h'ni 'Yfk UbXYfb'i bX'j ]Y``Y]W\h'gc[Uf
]b'X]Y': i » ghUd ZYb'a Y]bYg'Yk ][Yb'GW\k Ufa g': f]Xh'c Z'B UbgYb'ni
hfYhYb"'8]YgYf'[fc» Y'9bhXYW\_Yf'ZØ\fhY'XUg'HYUa 'Ubž'XUg'%, , ,
ni a 'YfghYb'A U``XUg'♣bYfY'; fÒb`UbXg'Xi fW\ei YfhY'i bX'X]Y'♣bgY`
Ui Z'@Ub[`Ui Zg\_]Yfb'Xi fW\ei YfhY"'8]Yg'k Uf'j cf'gY]bYa
FY\_cfXj Yfgi W\ž'XYb'BcfXdc``ni 'YffY]W\Yb'f%, -'!-\*Ł'i bX'gY]bYa
: f]YXYbgbcVY`dfY]g'f%- &&Ł"

@YgYb'G]Y'a Y\f'ØVYf'; fÒb`UbX

#### BYi gYY`UbX

8]Yg'k Uf'a Y]bY'nk Y]hY'K U\``bUW\'? UbUXUž'XUg'Ui Z'XYf'@]ghY'j cb?]U'ghY\h"BYi gYY`UbX']gh'Y]b'@UbX'a ]h'UhYa VYfUi VYbXYf@UbXgW\UZh'i bX'J]Y`ZU`h"'Jcb'6Yf[Yb'i bX'GYYb'V]g'\]b'ni 'K À`XYfbi bX'<Ò\`Yb'V]YhYh'X]YgYg'UV[Y'Y[YbY'@UbX'\Yfj cffU[YbXYK UbXYf!'i bX'?`YhhYfa Ò[`]W\\_Y]hYb"

'U`h1 @AbXYfž'X]Y'k]f'Ua ``]YVghYb'gY\Yb'a ÒW\hYb' BYigYY`UbX 2 HfUi a nY]h

A Y]bY'K U\``ZØf'BYi gYY`UbX'i bhYf[ fÀVh'X]Y'FY[ Y`b'Y]b'k Yb][ ž'XU k ]f'Yg'VYfY]hg'VYgi W\h'\UVYbž'UVYf'Y]b'UW\hghØbX][ Yf Nk ]gW\Ybghcdd']b'5i W\_`UbX'nÀ\`h'\_Ui a ž'U`gc'k À\`Y']W\'Yg hfchnXYa °

@YgYb'G]Y'a Y\f'ØVYf'BYi gYY`UbX

@Y]hV]`X.`8fYUa gh]a Y