

6Yfi Zgi bZÀ\][_Y]hgj Yfg]WXYfi b[. 'Gc gdUfYb'G]Y'f]WXh]['VY]'XYb'6Y]hfÀ[Yb'

9fZU\fYb'G]Yž'k]Y'G]Y'X]Y'?cghYb' \Rightarrow fYf 6Yfi Zgi bZÀ\][_Y]hgj Yfg]W\Yfi b['gYb_Yb'_ObbYb'i bX'k Y`W\Y : U_hcfYb'X]Y'6Y]hfÀ[Y'VYY]bZi ggYb"

$B]WXh^*Ub[Y[YVYb\check{z}^*8YihgWX^*UbX^*!^*8]Y]$

6Yfi Zgi bZÀ\][_Y]hgj Yfg]W\Yfi b['fb1 Ł'gd]Y`h'Y]bY'YbhgW\Y]XYbXY
Fc``Y'ZØf'X]Y'Z]bUbn]Y``Y'5Vg]W\Yfi b[']a '9fbghZU``"'G]Y'gW\Øhnh'j cf
XYb'Z]bUbn]Y``Yb': c`[Ybž'k Ybb'5fVY]hbY\a Yf'Ui Z[fi bX'j cb
?fUb_\Y]h'cXYf'I bZU``'b]W\h'a Y\f']b']\fYa '6Yfi Z'UfVY]hYb'_ObbYb"
8 UVY]'g]bX'X]Y'?cghYb'ZØf'Y]bY'6I !J Yfg]W\Yfi b['ghUf_'UV\Ab[][
j cb']bX]j]Xi Y``Yb': U_hcfYbž']bgVYgcbXYfY'j ca 'Ui g[YØVhYb
6Yfi Z"

 $K \]Y :: \ cW \ g : \ VYf] W \ hY hz _ ObbYb : X] Y : \ a \ cbUh] W \ Yb : 6Y] hf A [Y : ghUf_ j Uf]] Y f Y b " : 6Y] gd] Y : gk Y] gY : nU \ `h : Y] b Y : ? f Ub _ Y b g W k Y g h Y f : Y h k U : % $ 9 i fc : dfc : A cbUh : ZØf : Y] b Y : 6I ! F Y b h Y : j cb : %") $$: 9 i fc : V] g : ni a : 5 `h Y f j cb : * + : $U \ f Y b " : 9] b : 6 Ø f c Ub [Y g h Y ` `h Y f : \] b [Y [Y b : _ ca a h : a] h i b [Y Z A \ f : + $: 9 i fc : a cbUh `] W : X U j cb z : k A \ f Y b X : G h i X] Y f Y b X Y Y X] [`] W : Y h k U :) $: 9 i fc : nU \ `Y b : a Ø g g Y b " : 8] Y : < O \ Y : X Y f : D f A a] Y b k] f X : X i f W : X U g : V Y f i Z] W X : F] g] _ c z : X U g : 5 `h Y f : V Y] : J Y f h f U [g U V g W X ` i g g i b X : X] Y :] b X] j] X i Y ``Y : Y g i b X \ Y] h : V Y Y] b Z i g g h "$

9]bZiggXYg6YfiZgUiZX]Y?cghYb

 $8]Y `9]bghi Zib[`]b `j YfgWX]YXYbY `6Yfi Zg! `i bX `F]g]_c[fi ddYb `]gh YbhgWX Y]XYbX `ZØf X]Y `6Y]hfU[g\ O\ Y `XYf `6I !J Yfg]WX Yfi b["'< O\ YfY F]g]_Yb `ZØ\ fYb `ni `\ O\ YfYb `J Yfg]WX Yfi b[g_cghYbž k cVY] `a UbWX Y 6Yfi ZY `gc[Uf `b]WX h'j Yfg]WX YfVUf `g]bX `cXYf ``YX][`]WX `a]h \ c\ Yb F]g]_cni gWX `A[Yb 'j Yfg]WX Yfh k YfXYb `_ObbYb "'9]bY `, VYfg]WX h'ØVYf$

X]Y'j YfgW\]YXYbYb'F]g]_c[fi ddYb'nY][hž'XUgg'6Yfi ZY'k]Y'ŸfnhYi bX'5dch\Y_Yf']a 'b]YXf][Yb'F]g]_c!GdY_hfi a 'Y]b[Yghi Zh'k YfXYbžkÀ\fYbX'\UbXk Yf_`]W\Y'6Yfi ZY'k]Y'6Ui UfVY]hYf'i bX'8UW\XYW_YfU`g'<cW\f]g]_cVYfi ZY'[Y`hYb"'@Ui h'

VYfi Zgi b ZUY\][_Y]hgj Yfg]WX Yfi b[Yb!j Yf[`Y]WX "Wca 'k YfXYb 6Yfi ZY']b'gYWXg'<Ui dh[fi ddYb'Y]b[YhY]`h'j cb'G9<F'; Yf]b[Ya F]g]_c'fl fi ddY'5\E'V]g'\]b'ni 'b]WX h'j Yfg]WXYfVUfYb'6Yfi ZYb fl fi ddY':\E'"

8]Y'[YbUiY'9]bhY]`ib['_Ubb'Y'bUW\'JYfg]W\Yfib[g[YgY``gW\UZhjUf]]YfYb"'8UVY]'gd]Y`Yb'UiW\':U_hcfYb'k]Y'XYf'U_hiY``Y
; YgibX\Y]hgnighUbX'gck]Y'<cVVmg'Y]bY'Fc``Y"'6Y]gd]Y`gkY]gY
_ObbYb'f]g]_cVY\UZhYhY':fY]nY]hU_h]j]hÀhYb'cXYf'JcfYf_fUb_ib[Ybni'\O\YfYb'6Y]hfÀ[Yb'cXYf'gc[Uf'nif'5V`Y\bib['XYg'5bhfU[g
ZØ\fYb"'6Y]'Y]bYa'K YW\gY``XYg'6YfiZg'aigg'XYf'dchYbh]Y``Y
JYfg]W\YfYf']bZcfa]Yfh'kYfXYbž'XU'g]W\'XUg'F]g]_c'Yf\YV`]W\
j YfÀbXYfb'_Ubb"

H]ddg'ni f'Cdh]a]Yfi b[XYf'61!?cghYb

 $\label{thm:composition} I a `X]Y ?cghYb `ZØf`X]Y `61 !J Yfg]WX Yfi b[`ni `gYb_Yb ž`Ya d Z]Y \`h`Yg g]WX ž`ZfØ\nY]h][`Y]bYb `J YfhfU[`UVni gWX `]Y \(Yb '' \) \&D[YfY \\ J Yfg]WX Yfi b[gbY\a Yf`nU\`Yb ']b `XYf`FY[Y``b]YXf][YfY`6Y]hfÀ[Yž XU `XUg`F]g]_c `ZØf`J cfYf_fUb_i b[Yb '[Yf]b[Yf`]gh'' `Ni XYa `gc``hY `X]Y < Ô\Y `XYf`61 !FYbhY `fYU`]gh]gWX `Y]b[YgWX Ahnhi bX `U``Y`ni _ØbZh][Yb Z]bUbn]Y``Yb `6YXUfZY `VYfØW_g]WX h][h`k YfXYbž`]b_`i g]j Y `GhYi Yfb i bX `? fUb_Ybj Yfg]WX Yfi b[gVY]hfA[Yb'' I bUV\Ab[][Y J Yfg]WX Yfi b[ga U_`Yf`_ÔbbYb `XUVY]`\Y`ZYbž`dUggYbXY `5b[YVchY ni `Z]bXYb `i bX `ni `j Yf[`Y]WX Yb''$

VYfi Zgi b ZUY\][_Y]hgj Yfg]W Yfi b[!hYgh!j Yf[`Y]W "Wca Yf[ÀbnhžXUgg:XYf'I bhYfgWX]YX'nk]gWXYb'6fi hhc!'i b X'B Yhhc VY]hfU[YVYb ZU``g'YbhgWXY]XYb X']gh"'9]b'_`Y]bYf'I bhYfgWX]YX'nk]gWXYb X]YgYb'VY]XYb'6YhfÀ[Yb']gh'ZØf'XYb'JYfg]WXYfi b[g_i b XYb j cfhY]`\UZh"'8 UfØVYf'\]bUi g'gc``hY'Y]bY'i a ZUggYbXY'6YfUhi b[']b 5bgdfi WX'[Ybca a Yb'k YfXYbži a 'cdh]a U`Y JYfg]WXYfi b[g_cbX]h]cbYb'ni '[Yk À\f`Y]ghYb"

 $8]Y `6Yfi Zgi bZA`][_Y]hgj Yfg]WX Yfi b[`gWX Øhnh`b]WX h`bi f`5fVY]hYfi bX `5b[YghY``hYž·gcbXYfb`XYW_h`Ui WX `Ghi XYbhYbž·GWX Ø`Yfi bX < Ui gZfUi Yb`UV"`8 U\Yf`]gh`Yg`k]WX h][ž`bi f`Y]bYb`d UggYbXYb 5bV]YhYf`ni `k A`Ybž`XYf`X]Y`]bX]j]Xi Y``Yb`F]g]_Yb`i bX`X]Y dYfgÒb`]WX Y`G]hi Uh]cb`Ub[Ya YggYb`VYfØW_g]WX h][h"$

8 Y hU]`g	
Cfh	B]W\h'Ub[Y[YVYbž'8YihgW\`UbX
EiY``Yb	• k k k "Zc W g "X Y
	• k k k "VYfi Zgi bZUY\][_Y]hgj Yfg]WX
	Yfi b[Yb!j Yf[`Y]WX "Wca
	• k k k "VYfi Zgi bZUY\][_Y]hgj Yfg]WX
	Yfi b[!hYgh!j Yf[`Y]WX "Wca

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