

7\]bU'V`Y]Vh'VY]a 'G\Ub[f]!@U'8]U`c['ZYfb' 'I G5'gW\`U[Yb'5`Ufa'

5a '' %" A U] '&\$&) 'k Uf XYf 'W]bYg]gW Y JYfhY]X][i b[ga]b]ghYf 'b]W h Ui Z XYa 'G\Ub[f]!@U!8]U`c[ž k À\fYbX 'GdUbbi b[Yb 'a]h XYb 'I G5 'ni bY\a Yb"



 $G]b[UdcfY\check{z}^*G]b[Udif^!^5a" \%"^AU]^*\&\$\&) "bU\a Yb^*X]Y \\ GdUbbi b[Yb^*nk]gWYb^*XYb^*I G5" bX^*7\]bU^*Ub^*Y]bYa "_f]h]gWYb \\ Di b_h^*ni "^8Yf^*W_]bYg]gW_Y^*J_YfhY]X][i b[ga]b]ghYf^8cb[^*j b^*k Uf b]W_h^*ni a "G\Ub[f]!@U^*8]U^*c[^*]b^*G]b[Udif^YfgW_]YbYb\check{z}^*k Ug^*U^*g^*Y]b \\ U^*Ufa]YfYbXYg^*NY]W_Yb^*[Yk_YfhYh^*k_i fXY"^*8]Yg^*a_Uf_]Yfh^*XUg^*YfghY \\ A_U^*gY]h^*&\$\%-\check{z}^*XUgg^*Y]b^*W_]bYg]gW_Yf^*J_YfhY]X][i_b[ga]b]ghYf^b]W_h \\ Ub^*X]YgYa_*k_]W_h][Yb^*fY[]cbU^*Yb^*:cfi_a_hY]^*b]a_a_h\check{z}^*5i_ggW_^0ggY \\ Ui_Z[fi_bX^*j_cb^*7CJ_8!\%-^*]b^*XYb^*J_YfYb^*&\$&$'i_bX^*&\$&\%'b]W_h \\ VYf@W_g]W_h][h^*'^7]bU^*YbhgUbXhY^*ghUhhXYggYb^*Y]bY^*8Y^*Y[Uh]cb^*a_]h \\ J_YfhfYhYfb^*b]YXf][YfYf^*FÅb[Y"$

I G!J YfhY]X][i b[ga]b]ghYf^DYhY^< Y[gYh\^bi hnhY^X]Y^; Y^Y[Yb\Y]hžia~X]Y^Xfc\YbXY^a]^]hÀf]gWXY^6YXfc\i b[~Xi fWX^7\]bU

\Yfj cfni \YVYb" → gY]bYf 5bgdfUW\Y'k]Yg Yf Ui Z'X]Y a]`]hÀf]gW\Yb
, Vi b[Yb 7\]bUg fi bX i a 'HU]k Ub gck]Y Ui Z'Nk]gW\YbZÀ``Y]a

GØXW\]bYg]gW\Yb A YYf \]b i bX VYgW\f]YV X]YgY 'U`g dfcU_h]j Y

6Y`Àgh][i b['XYf B UW\VUfb" < Y[gYh\ 'UddY``]YfhY 'Ub 'Ug]Uh]gW\Y

B Uh]cbYbž]\fY 'J YfhY]X][i b[gUi g[UVYb 'Yf\YV`]W\ 'ni 'Yf\Ò\Ybž
i bX 'j Yfk]Yg 'Ui Z'8 Yi hgW\`UbXg '9b[U[Ya Ybhž') ı 'XYg

6fi hhc]b`UbXgdfcXi _hg 'ZØf'J YfhY]X][i b['Ui qni [YVYb"

9fk Ufhi b[Yb Ub X]Y Ni gUa a YbUfVY]h

I b[`Ui V`]WX`]bhYfYggUbhY`; YgdfÀWXY`ZUbXYb`nk]gWXYb`<Y[gYh\i bX`gY]bYa `WX]bYg]gWXYb`5a hg_c``Y[Ybž'8cb[`\$bž'ghUhhž'X]Y`Ua FUbXY`XYg`G\Ub[f]!@U`8]U`c[g`[YZØ\fh`kifXYb"`9g`kUf`XUg`YfghYdYfgÒb`]WXY`HfYZZYb`XYf`VY]XYb`A]b]ghYf`gY]h`&\$&&ž`kUg`X]Y8f]b[`]WX_Y]h`XYf`G]hiUh]cb`ibhYfghfY]WXh"`@Uih`GYb]cf`7c`cbY``KiE]Ubž'GdfYWXYf`XYg`WX]bYg]gWXYb`JYfhY]X][ib[ga]b]ghYf]iagž'kUfXUg`HfYZZYb`dcg]h]jž'dfU_h]gWX`ibX`_cbghfi_h]j "`H\YaYb`k]Y`X]Y6Yn]Y\ib[Yb`nk]gWXYb`XYb`VY]XYb`A]`]hÀfgž'HU]kUbž'XUgGØXWX]bYg]gWXYAYYf'ibX`X]Y`I_fU]bY!?f]gY`kifXYb`Y]b[Y\YbXYfÖfhYfh"

9]b 'VYa Yf_Ybgk YfhYf'Di b_h'k Uf'X]Y'8]g_i gg]cb'ØVYf'X]Y 9]bf]Wk hi b['Y]bYf'5fVY]hg[fi ddY'ZØf'?f]gYb_ca a i b]_Uh]cbž'X]Y HY]`'XYf'ni _ØbZh][Yb'dc`]h]gWk Yb'?ca a i b]_Uh]cbgj YfY]bVUfi b[Yb]gh"'8]Yg'nY][h'XYb'K]``Yb'VY]XYf'GY]hYbž'XYb'8]U`c[Ui ZfYWk hni Yf\U`hYbž'hfchn'XYf'VYghY\YbXYb'GdUbbi b[Yb"'8cb[\Rightarrow b'ZcfXYfhY'X]Y'I G5'Ui Zž' ZU`gWk Y'G][bU`Y 'Ub'hU]k UbYg]gWk Y I bUV\\Ab[][_Y]hg_f\AZhY'ni 'i bhYf`UggYb'i bX']\fY' : Y\`Yf' 'ni _cff][]YfYb"

A]`]hÀf]gW\Y'5i gY]bUbXYfgYhni b[Yb']a GØXW\]bYg]gW\Yb'A YYf

8]Y'Gcf[Yb'i a 'X]Y'a]`]hÀf]gW\Y'9I dUbg]cb'7\]bUg'bY\a Yb'ni ž
]bgVYgcbXYfY']a 'GØXW\]bYg]gW\Yb'A YYfž'k c'7\]bU'bUW\'k]Y'j cf
i a ghf]hhYbY'; YV]YhY'a]`]hUf]g]Yfh"'=b'Y]bYa '_Øfn`]W\Yb'J cfZU``
k i fXYb'X]Y'I G5'ni a 'nk Y]hYb'A U`'Ui g[YgW\`cggYbž'k Y]`'7\]bU'U`g

 $\label{eq:figures} FYU_h]cb`Ui~Z`X]Y`A~]`]hUf]g]Yfi~b[~X]YgYf`FY[~]cb`Xi~fW.~X]Y`I~G5\\ [~Y[~Yb`X]Y`FY[~Y`b`j~YfghO`»~hž`gcXUgg`7~]bU`b]W.~h`Ua~~F~]a~dUW\\ A~UbOj~Yf`hY]`bY\a~Yb`_Ubb"`8~Ug`I~G!J~YfhY]X][~i~b[~ga~]b]ghYf]i~a~`\Uh~ZYgh[~YghY``hž`XUgg`7~]bU`FU_YhYb`ni~f`GW.]ZZgUVk~Y\f`i~bX~Y`Y_hfcb]gW.Y`GhOfgYbXYf`Ui~Z`XYb`GdfUh`m!~bgY`b`ghUh]cb]Yfh`\Uh"$

7\]bYg]gWXY'JYfhfYhYfž'XUfi bhYf'XYf'8]d`ca Uh'K Ub['M]ž VYnY]WXbYhYb'XYb'5i ggWX`i gg'U`g' gY\f'i b_cbghfi _h]j 'i bX VYhcbhYbž'XUgg'7\]bUg'a]`]hÀf]gWXY'5_h]j]hÀhYb'XYf GY`Vghj YfhY]X][i b['X]YbhYb"'K Ub['k]Yg'XUfUi Z'\]bž'XUgg'X]Y 5_h]j]hÀhYb'7\]bUg'U`g'FYU_h]cb'Ui Z'X]Y'a]`]hÀf]gWXYb', Vi b[Yb XYf'I G5']b'XYf'FY[]cbž']bgVYgcbXYfY'Ui Z'; i Ua 'i bX'<Uk U]]ž YfZc`[Yb"

 $8]Y \cdot 9fY][b]ggY \cdot nY][Yb \cdot X]Y \cdot ?ca d \cdot YI]hAh \cdot XYf \cdot 6Yn]Y \setminus ib[Yb \cdot nk]gWXYb XYb \cdot VY]XYb \cdot [cvu \cdot Yb \cdot AAW hYb \cdot ibX \cdot XYb \cdot ghY][YbXYb \cdot 8fi w_ \cdot UiZ \cdot X]Y FY[]Yfi b[Yb \cdot XYf \cdot FY[]cb z \cdot X]Y \cdot G]WXYf \setminus Y]hg \cdot U[Y \cdot Yfbgh \setminus UZh \cdot ni VYk YfhYb"$

8 Y hU]`g	
J c f ZU``	Gcbgh][Yg
Cfh	G]b[UdcfYžG]b[Udif
EiY``Yb	• k k k "U`^UnYYfU"Wca
	• kkk"gWad"Wca
	• k k k "k Y`h"XY

6 Ygi W Yb 'G]Y 'i bg 'Ui Z 'b!U["bYh