

?`ÒW_bYf'_f]h]g]Yfh'`YYfY FY[]Yfi b[gVUb_.'K c'g]bX'X]Y'A]b]ghYf3

6i bXYghU[gdfÀg]XYbh]b'?`ÒW_bYf'_f]h]g]Yfh'X]Y'gWXk UWXY DfÀgYbn'XYf'FY[]Yfi b[']a 'DUf'Ua Ybh'i bX'ZcfXYfh A U» bU\a Yb'ni f'J YfVYqqYfi b["



F][Už'@Yhh`UbX'!'6i bXYghU[gdfÀg]XYbh]b'\dagrama'\]U'?`\OW_bYf'\Uh
_\OMFn']W\dagrama'\6YXYb_Yb'\]bg]W\h']W\dagrama'\Ai Z][Yb'\5Vk YgYb\Y]h'j cb
A]b]ghYf]bbYb'i bX'A]b]ghYfb']a '8 Yi hgW\Yb'\6i bXYghU['[YÀi » Yfh''
\dagrama'\dagram

G]Y 'gW\`À[h'j cfž'XUgg'k À\fYbX 'YXYf'D`YbUfg]hni b['a]bXYghYbg nk Y]'6i bXYga]b]ghYf]bbYb 'cXYf'6i bXYga]b]ghYf'Ubk YgYbX'gY]b

gc``hYb"'?`ÒW_bYf'ZcfXYfh'ni XYa 'A U» bU\a Ybž'i a 'Y]bY
XUi Yf\UZhY'i bX'k]f_gUa Y'J YfhfYhi b['XYf'6i bXYgfY[]Yfi b[']b
XYb'G]hni b[Yb'XYg'6i bXYghU[Yg'g]W\Yfni ghY``Yb"'ONJ K Q
VYf]W\hYhž'XUgg']\fY'?f]h]_'HY]`'Y]bYf'VfY]hYfYb'8]g_i gg]cb'ØVYf'X]Y
Fc``Y'XYf'9I Y_i h]j Y'i bX'X]Y'J YfUbhk cfh`]W_Y]hYb']a 'dc`]h]gW\Yb
DfcnYgg']gh"

=bhYfbUh]cbU`Y`Ni gUa a YbUfVY]h`ghÀf_Yb

K À\fYbX'?`ÒW_bYf'Ui Z'XUg'bUh]cbU`Y'Dc`]h[YgWXY\Yb'Zc_i gg]Yfhž VY`Yi WXhYh'X]Y'6i bXYghU[gdfÀg]XYbh]b'6AfVY`6Ug'UbXYfY 5gdY_hY'XYf'dUf`Ua YbhUf]gWXYb'JYfUbhk cfhi b["'G]Y'k]fX'Ua '&' "i bX'&("'C_hcVYf'Ub'XYf'?cbZYfYbn'XYf'DUf`Ua YbhgdfÀg]XYbhYb']b F][Už'@Yhh`UbXž'hY]`bY\a Ybž'X]Y'g]WX'a]h'XYf'\dangle hYfbUh]cbU`Yb'?f]a! D`UhhZcfa 'VYgWXAZh][h''8]Y'?cbZYfYbn'n]Y`h'XUfUi Z'UVž'X]Y]bhYfbUh]cbU`Y'I bhYfghØhni b['ZØf'X]Y'I_fU]bY'ni 'VY_fÀZh][Yb'i bX X]Y'j O`_YffYWXhgk]Xf][Y'5bbYI]cb'XYf'?f]a 'Xi fWX'Fi gg`UbX']a\dangle \f'&\f'\&\f'\' bX'X]Y' \cdot \f'\' bX'X]Y' \cdot \f'\' bYb' \cdot \cdot \f'\' bY'\f' bY'\f' bX'\f'\' bX'\f'\' cbZYfYbn'n]b' \f'\' a \f'\' bX'\f'\' bY'\f'\' bX'\f'\' bX'\f'\' bY'\f'\' bY'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bX'\f'\' bY'\f'\' bY'\f'\' a \f'\' a \f'\' a \f'\' bY'\f'\' a \f'\' bY'\f'\' b''\f'\' a \f'\' bY'\f'\' a \f'\' bY'\f'\' a \f'\' a \f'\' bY'\f'\' a \f'\' b''\f'\' a \f'\' a \f'\' a \f'\' a \f'\' b''\f'\' a \f'\' a \f'\' b''\f'\' a \f'\' b''\f'\' a \f'\' b''\f'\' a \f'\' a \f'\' a \f'\' a \f'\' b''\f'\' a \f'\' a \f'\' a \f'\' a \f'\' b''\' a \f'\' a \f'\'

8]YgY:?cbZYfYbnYbig]bXijcbik YgYbh`]WXYfi6YXYi hi b[iZØfiX]Y Ni gUa a YbUfVY]hink]gWXYbiXYbiBUh]cbYbžijcfiU``Yai]ai?cbhYl h]bhYfbUh]cbU`YfifYWXh`]WXYfiBcfa Yb"i8]YiYfghYbiVY]XYb dUf`Ua YbhUf]gWXYbi;]dZY`hfYZZYbiXYfi?f]a!D`UhhZcfa iZUbXYbi&\$&&]bi?fcUh]Ybii bXi&\$&' i]biHgWXYWX]YbighUhhžik UgiX]YiUb\U`hYbXY [`cVU`Yi6Ygcf[b]giØVYfiX]Yi9bhk]W_`i b[Ybi]biXYfiFY[]cb i bhYfghfY]WXh"

8]Y'Fc``Y'XYg'6i bXYghU[Yg']b'XYf 5i »Ybdc`]h]_

8]Y'5i »Ybdc`]h]_']b'8Yi hgW\`UbX'ZÀ``h'hfUX]h]cbY``']b'XYb ?ca dYhYbnVYfY]W\'XYf'9IY_i h]j Y"'HfchnXYa '\Uh'XYf'6i bXYghU[A Ò[`]W_Y]hYbž'9]bZi gg'ni 'bY\a Yb"'Gc'_Ubb'XYf'6i bXYghU[Y]bYb'5i ggW\i gg'ZØf'Ui gk Àfh][Y'5b[Y`Y[Yb\Y]hYb'VYghY``Yb'i bX]gh'Ub'XYf'Ni gh]a a i b['VY]'J YfhfÀ[Ybž'X]Y'dc`]h]gW\Y'6Yn]Y\i b[YbfY[Y`bž'VYhY]`][h"8 Ug'; fi bX[YgYhn'fБfh]_Y`') - Ł'fY[Y`h'XUVY]'X]Y j Ò`_YffYW\h`]W\Y'J YfhfYhi b['XYg'6i bXYg'Xi fW\'XYb6i bXYgdfÀg]XYbhYb"'; `Y]W\nY]h]['gd]Y`h'XYf'6i bXYghU['Y]bY?cbhfc``Zi b_h]cb'i bX'k]f_h'ni bY\a YbX']b]h]Uh]j ']b'XYf5i » Ybdc`]h]_'a]hž']bgVYgcbXYfY'Xi fW\'X]Y'dfc'Y_h]j Y'A]hUfVY]h']b]bhYfbUh]cbU`Yb'dUf`Ua YbhUf]gW\Yb'JYfgUa a `i b[Yb"

8]YgY'JYfgUa a `i b[Ybž']b'XYbYb'A]h[`]YXghUUhYb'U_h]j
a]hk]f_Ybž'X]YbYb'XYf'GW\UZI b['j cb'HfUbgdUfYbn'i bX'XYa
5i ghUi gW\'j cb' \(\pi\)Zcfa Uh]cbYb'\ØVYf'bUh]cbU`Y'; fYbnYb'\]bk Y["
8]Y'À`hYghY']bhYfdUf`Ua YbhUf]gW\Y'JYfgUa a `i b[']gh'X]Y
\(\pi\)hYfdUf`Ua YbhUf]gW\Y'I b]cb'f\(\pi\)I \(\pi\)XYb'H\Ya Yb'XYf

JYfY]bhYb'BUh]cbYb'cf]Ybh]Yfh']gh"'8Uf\(\Overline{\Ov

8]Y'8]g_i gg]cb'i a 'X]Y'DfÀgYbn'XYf'FY[]Yfi b[ga]h[`]YXYf']a 6i bXYghU['i bX'X]Y']bhYfbUh]cbU`Y'Ni gUa a YbUfVY]h'g]bX YggYbh]Y``'ZØf'X]Y'GhÀf_i b['XYf'dUf`Ua YbhUf]gWXYb'Fc``Yž'gck c\`]a 'bUh]cbU`Yb'U`g'Ui WX']a ']bhYfbUh]cbU`Yb'?cbhYl h'''O6i bXYghU[Q\YVh'X]Y'6YXYi hi b['XYg'DUf`Ua Ybhg']b'XYf'5i »Ybdc`]h]_'\Yfj cfž i a 'Y]bY'Ua '8]U`c['cf]Ybh]YfhY'i bX'YZZY_h]j Y'Ni gUa a YbUfVY]h'ni ZÒfXYfb"

♣ 'Y]bYf'NY]hž']b'XYf']bhYfbUh]cbU`Y'< YfUi gZcfXYfi b[Yb']a a Yf _ca d`Yl Yf'k YfXYbž'V`Y]Vh'XYf'5i ghUi gWX 'nk]gWXYb'bUh]cbU`Yb DUf`Ua YbhYb'i bX'X]Y'U_h]j Y'HY]`bU\a Y'Ub']bhYfbUh]cbU`Yb': cfYb i bYf`Àgg`]WXž'i a 'Y]bYb'VYXYi hgUa Yb'9]bZi gg'Ui Z'X]Y 5i » Ybdc`]h]_'ni '[Yk À\f`Y]ghYb"

: Øf k Y]hYfY → Zcfa Uh]cbYb ni 'XYb']bhYfbUh]cbU`YbdUf`Ua YbhUf]gW\Yb'JYfgUa a `i b[Yb'i bX'XYb'5i Z[UVYb'XYg6i bXYghU[Yg']b'XYf'5i » Ybdc`]h]_ž'VYgi W\Yb'G]Y'X]Y'GY]hYb'j cbO6i bXYghU[Qi bX'ONJ K Q

8 YhU]`g	
JcfZU``	Gcbgh][Yg
Cfh	F][Už'@Yhh`UbX
EiY``Yb	• k k k "nj k "XY
	k k k "Vi b X Y ghU["X Y
	k k k "Vi b X Y ghU["X Y

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