# Dr Mark Griffiths on gambling: RightCasino.com interview



8f`A Uf\_; f]Z[h\g`cb`; Ua V`]b[.`F ][\h7Ug]bc`=bhYfj ]Yk

gambling and addiction.

# Full transcript

F][\h7Ug]bc. <]"HcXUmkYfY]bHYfj]Yk]b['8fAUf\_; f]Z]h\g'UhBchh]b[\Ua'HfYbhIb]jYfg]hm''>ighhc'ghUfhig'cZAUf\_ž=kUg \cd]b['nci'Wci`X`Vf]YZmigiaaUf]gY'h\Y\_]bXg'cZfYgYUfV\'nci'Xc"

8f; f]Z]h.g. C\_Uni'=j Y gdYbhih.Y ``Ughih.YbhingYj Yb nYUfg ghi Xn]b[ [ [ Ua V ]b[ "A ma U]b UfYUg QUj YQcc\_YX UhdfcV Ya [ Ua V ]b[ "B chih.Uh=a `Ubh]![ Ua V ]b[ ]b h.Y g ][ \hYgh'C Vj ]ci g`m=h.]b\_ h.Y [ Ua ]b[ ]bXi ghfmUbX k Y Ug fYgYUfVX Yfg g\ci X VY VebVVffbYX UVci hih.cgY k \YfY [ Ua V ]b[ `UZYVMg h.Y]f`]j Ygž h.Y]f Z]bUbVVgž Yj Yfnth.]b[ `h.UhdYcd Y Xc'''=h.]b\_ k \Uhg Ua Un]b[ `]b h.]g Vei bhfm]g h.UhdYcd Y cZYYb dYfVV]j Y a Y Ug VY]b[ `di V ]WYbYa mbi a VYf cbY VYVUi gY =fYgYUfVX dfcV Ya [ Ua V ]b[ "Mrh a mZ]YbXg h.UhfYgYUfVX dfcV Ya `Xf]b\_]b[ žbc cbY Yj Yf UVWV gYg h.Ya `cZVY]b[ `Ubh]!Xf]b\_]b[ "

 $H \setminus YfY [g \cup VV i h fY ]b h ]g \forall e h h h V = h V = h h V = h V$ 

F][\h7Ug]bc. K cbXYfZ ```K Y``žk Y j Y hci WXYX cb'ei ]hY U Z/k WcfY dc]bhg cZh\Y ]bhYfj ]Yk gc ``Yhg hfmUbX``]ghh\cgY cbY VmcbY''

Watch RightCasino.com's editor, Joe Attard, interview academic and gambling expert, Dr Mark Griffiths.

In the course of a long discussion, Dr Griffiths speaks about gambling in the media, in British culture, on social media platforms, in traditional casinos and in legislature. He also describes the psychological appeal of particular games and clears up misconceptions about problem

Bck 'Ug'=gUnž DUi ``8YW\_Yfz'h Y 'YX]hcf'cZh Y '8U]'mA U]``]g Webg]gH/bhm/YY]b[`\_]bX'cZUbh]![ Ua V`]b[ 'UbX'=a 'gi fY'h Uhg'k \mU`ch cZUbh]![ Ua V`]b[ 'ghcf]Yg'[ Yh]bhc'h Y '8U]'mA U]`'H \UhXcYgb hghcd'a Y Zca 'VY]b[ ']bHYfj ]Yk YX 'Vmh Ya 'VYWi gY'=']\_Y hc [ Yha m dc]bhUWfcgg"'6i hU[ U]b [Znci '`cc\_'UhU``h Y ghcf]Yg'=dYfgcbU`m\Uj Y 'VYYb ]bj c'j YX'k ]h 'h Y '8U]'mA U]`cj Yf'h Y `UghmYUfz bYUf'mU``cZh Ya ']bj c'j Y h ]b[ g``]\_Y [ Ua V`]b[ 'j ]U`: UWYVcc\_'UbX']hg'U``UVci hhfm]b[ 'hc 'dc]bhci hh Uha ]``]cbg'cZk ca Yb cf VX]XfYb 'UfY [ c]b[ 'hc \Uj Y 'dfcV'Ya g'k ]h 'h ]g'UVMj ]mi'CZWei fgY'=bYj Yf'gU]X 'h UhUhU``Vi hcZWei fgY'cbY'ei chY 'Wb 'VY 'hU\_Yb ci hcZWebhYl hhc 'UMb U`mgY```h UhdUff]W' Uf'ghcfm'

F][\h7Ug]bc.`H\Y`dfcV`Ya`]g`hc`ghYYf`Uk UmZfca`UbmUdcVU`ndh]Wdfcd\Yg]Yg"

F][\h7Ug]bc.`C\_Unžk\mXc`nci`h}]b\_`[Ua V]]b[`]g`gc`\YUj]`mXYa cb]gYX`k\Yb`Uf[`i UV`ma cfY`XYghfi Vh]j`Y`j][Vh"g``]\_Y`U`Vc\c` UbX`f b\_`ZccX`YgVUdY`h\Y`gUa Y``Yj Y`cZgWfi h]bmVmh\Y`a YX]U3

8f; f]Z]h.g. =UVh U`mX]gU[fYY'k]h h.UH'=Xcb h\*ghfYgYUfVX]b [Ua V]b['UXX]VHcbg''=fYgYUfVX]b a cghVY\Uj]ci fU`UXX]VHcbg ]bWI X]b['h]b[g``]\_Y'j]XYc [Ua Y'UXX]VHcbžYI YfV]gY'UXX]VHcbžgYI 'UXX]VHcbžGYI 'UXX]VHcb''A mk cf\_hci VXYg'cb'h]b[g``]\_Y'cVYg]mH'=k Ug dUfhcZh Y'[cj Yfba Ybhg'k cf\_]b['[fci d'cb'gYXYbHUfmVY\Uj]ci f''

=b HYfa g cZk \UhVta Yg ci h]b h Y dUdYfg =VUb HY ``nci bck cVYg]hm]g cbY cZh cgY h ]b[g h Uh]g f ghUg Ua VUgHYX Ug [Ua V]b["=Xcb hVY]Yj Y h Uh[Ua V]b[]g XYa cb]gYX Ubma cfY"C Vj ]ci g`m=h ]b\_a cghdYcd Y UVVY dhh UhU Vt \c` k \Yb hU\_Yb hc UVVY gg ]g dfcV Ya Uh]W A cghdYcd Y \_bck h UhU Vt \c` ]g dcHYbh]U `mUb UXX]VHj Y Xfi ["

Bck  $h UhXcYgb ha YUb h Uhk Yg (ci Xb hVY Xc]b[ ]h' = a YUb = Xf]b_UVt (c''' = cj Y Xf]b_]b[ UVt (c''' = h)b_a cghdYcd Yk (c dUffU_Y UVh U'm']_Y h UhdUff]W Uf UVhjj ]h' 6i h = bck <math>h UhU ga U^dfcdcff]cb cZh Y dcdi Uhjcb [Yh]bhc ffci VY k ]h ]h'; Ua V]b[ ]g Ubch Yf cbY cZh cgY Vt bgi a dhjj Y VY (Uj ]ci fg''@]_Y UVt (c``]hg ]bX cZgcV]U`mVt bXcbYXzgcV]U`mUVhY dhYX Vi h k (Yb hU_Yb hc UVhY gg VUb `YUX hc dfcVYa g''6i h = h ]b_a cghdYcd Y g Vt bVY dhjcb cZUVt (c`]ga UbX (Yfc]b UXX]Vhjcb j Yfgi g h ]b[ g``]_Y [Ua V]b[ UXX]Vhjcb ]g h Uh = h ]b_UVt (c``UbX (Yfc]b a ][ (hVY gYYb Ug a cfY a YX]VU`mY[]h]a UhY h Ub [Ua V]b[ ''= h ]b_ ''a CghdYcd Y g''b Ug'a cfY a YX]VU`mY[]h]a UhY h Ub [Ua V]b[ '''= h ]b_ 'h YfY UfY gca Y dYcd Y ci hh YfY h Uhk ci X dfcVUV mgUmh Uh[Ua V]b[ ']g h UhdYfgcb g ck b ZUi 'h' = hg Xi Y hc k YU_k ]``cf k (UhYj Yf UbX h YmXcb hh ]b_ ]hg U[ Ybi ]bY dfcVYa "$ 

6i h=k ci X Uf[ i Y ]g h Uh h gh ]\_Y U Wc \ c ž [ Ua V ]b[ ]g cbY cZh cgY UWg ]h Yg 'h YfY UfY ]bX]j ]Xi U f]g\_ZUWcfg Vi hh Y k Um h Uh [ Ua V ]b[ ]g a Uf\_YhYX cf UXj Yff]gYXžh Y k Umh Y [ Ua Yg UfY UVb U`mXYg][ bYX UbX XYj Y cdYX XcYg a YUb h Uh j i bYfUV Y UbX gi gWrdh]j Y ]bX]j ]Xi U g WUb [ Yh]bhc dfcV Ya g"

 $F = [ h7 Ug] bc. C_Un'rK mXc nci h] b_hYa YX] U = [ uddUfYbhmi bk ]^] b[ hc fY[ UfX [ Ua V] b[ ] b a cXYfUh] cb Ug U Y[ ] ha UhY Zcfa cZYbhYffU] ba YbhYK m] gb h] hk ]^] b[ hc hU_Y h UhghUbVY3$ 

8f; f]Z]h\g. 5[U]b = k ci XX]gU[fYY h\Uh]h]gb hk]`]b[ hc hU\_Y h\UhghUbVY'' = h]b\_ h\YfY UfY cUXg UbX cUXg cZ[Ua V]b[ ghcf]Yg Ug = gUmVi ha cghcZh\Ya hYbX hc VY a cfY bY[Uh]j Y VYVØi gY = VY ]Yj Y h\Uhgk \Uhh\Ymh\]b\_ k]``gY```dUdYfg cfk \UhdYcd Y

\UddYbg`hc`[Ua V`]b[`]b`U`fYWYgg]cb"`Gca Y`dYcd`Y`Uf[i Y`h\UhVYVUi gY`]hg`U`fYWYgg]cb`h\YfY g`bchU``chcZa cbYmUfci bX`gc dYcd`Y`hfmhc`a UI ]a ]gY`h\Y]f`\_]bX`cZZ]bUbV]U``ci hUmVmUVMi U``m[Ua V`]b[`UbX`hfm]b[`hc`k ]b`a cfY`a cbYmVYVUi gY`h\YmVUb h[Yh]h h\fci [\`h\Y]f``cV"

: cf ch Yf dYcd Y VYVWi gY h Ym\Uj Yb h[ cha i VX a cbYm[ Ua V]b[ ]g Ub UVMj ]hmh\Uhk ci X`i ghXfcd ci hcZh Y]f \_]bX cZ`Y]gi fY fYdYfhc]fY VYVWi gY h YmVUb hUZcfX hc Xc ]h'A m[ i Ygg ]g Vch h cgY h ]b[ g VWbVY`YUVX ch Yf ci h' < ck Yj Yf ]Znci `cc\_ UhZcf ]bghUbVY h Y bi a VYf cZbYk `Vcc\_ a U\_Yfg h Uh\Uj Y gdfi b[ i d ]b h Y `UghV¢i d`Y cZnYUfg XcYg gi [ [ Yghh Uh[ Ua V]b[ ]g cbY cZ h cgY h ]b[ g h Uha ][ \hVY fYVYgg]cb dfccZVi h]hXcYgb hgYYa `hc VY bY[ Uh]j YmUZYVWX Vmh Y fYVYgg]cb"

 $F ][ \h7 Ug]bc. < Uj ]b[ gU]X h Uhzh Uha ][ \hj Yfmk Y``VY hfi Y ]b h Y 1 ? "K Y j Y XcbY U gYdUfUhY ghi Xm k Y `cc_YX UhhfUj Y hc @Ug J Y[ Ug UbX h Ymj Y hU_Yb Ub UVgc`i hY bcgYX]j Y g]bWY h Y [ `cVU` fYWYgg]cb ]b &$$, "#iXcYg gYYa hc ]bX]WUhY h UhWUg]bc hc i f]ga ]Znci ``]_Y ]gb hfYWYgg]cb dfccZ]b h Y k Umh UhdYf Udg$ 

8f; f]Z]h.g.  $C \ Zh \ YfY g \ U \ X$ ]ZY fY b \VY b \VY]b[ nci \_bck Zh \Y YI Ua d \Y c Z @Ug \J Y[Ug'' = k Ybhc @Ug \J Y[Ug ]b >i b \Y Ub \X = hc\_k \C \Y c Za m ZJa ]mhc 7 U \YgUf g \Ch \Y \Z 7 U \YgUf g \DU'U \Y'' Ub \X k \Y g \U' \X'' h \YfY''' \H \Y h \]b[ U \ci hh \Uhc \Z \Veci fg \Y h \Uh \Veci fg \Y h \Veci fg \Y h \Uh \Veci fg \Y h \Veci fg \Y h \Uh \Veci fg \Y h \Yeci fg \Yeci fg

F][\h7Ug]bc. C\_Unž Ughei Ygh]cb UVci ha YX]U Wzj YfU[Y"

 $F ][ \h7 Ug]bc. K \UhXc nci a U_Y cZa YX]U ci hYhyžgi VX Ug H\Y Gi bžh UhVébXYa b [Ua V]b[ ]b ]hy Véj YfU[Y Vi hgUbVh]cb ]hUg U Vi g]bYgg cddcfhi b]hmVmfi bb]b[ U V]b[ c d UhZcfa 3 -gb hh}]g A ghV UhUbh \ndcVh]gn3$ 

8f; f]Z]h g. C\_Unžk Y``]hg A ghhchU`m\ndcW[]f]WU'''5bmbYk gdUdYf h Uhg Ubh]![Ua V`]b['UbX h Yb UVh U`mdfcZ]hg Zica 'dYcd Y [Ua V`]b['Y]h Yf h fci [\'h Y]f k YVg]hY cf h fci [\'gca Y\_]bX cZh Y]f dfcXi Vh]g A gh '=WUb hh ]b\_cZUbch Yf k cfX ch Yf h Ub \ndcW[]gn'

 $\label{eq:F} F \cite[ \har Uhk Ug k \black Y \cite[ har V \cite[ har$ 

F][\h7Ug]bc. Bck kYfY[c]b[ hcUg\_UZYk ei Ygh]cbgUVci h[UaV]b[ UbX'dcdi UfW'hifYždUfh]W/Ufm]b'6f]hU]b"K \UhXc'nci ZYY`]g'i b]ei Y'UVci h[UaV]b[ W'hifY]b'h\Y'I b]hYX'?]b[Xca 3

8f; f]Z]h\g. Hc`VY`\cbYghž=a`j Yfm`i W\_mh\Uh=HUj Y``Ufci bX`h\Y`k cfX`UbX`=gYY``chg`cZX]ZYfYbh[Ua V`]b[`W`h fYg`UbX`= k ci`Xb hUWh U``mgUm6f]HU]b`]g`i b]ei Y`]b`Ubmk Un'i F][\h7Ug]bc. FYU``n8

8f; f]Z]h\g.=h\]b\_h\YdYf\Ydh]cbZca UVfcUX]gh\Uh6f]hU]b\UgUkUngVYbUbUh]cbcZ[UaVYfg"

8f; f]Z]h.g. Bck žnYg"H\Y`a cgh]bhYfYgf]b[`UbX`a cghdfcZci bX`VXUb[Y`h\Uh=jY`bch]WYX`g]bWY`=VUa Y`hc`h\]g`UfYU`k Ug`k \Yb`h\Y bUf]cbU``chYfmk Ug`]bhfcXi WYX`]b`% - ("KY`gi XXYb`m\UX`Ub`UWfj]]mhh\Uhhk c`h\]fXg`cZh\Y`6f]f]g\`di V`]Wk YfY`[Ua V`]b[`cb" 9j Yb`h\ci [\`a cghdYcd`Y`]Znci `gUmhc`h\Ya`Xc`nci `[Ua V`Y3`H\Ym``gUmbc"5bX`gUmXc`nci `d`Umh\Y``chYfmUbX`h\YmgUmnYg" =hg`ei ]HY`cVj ]ci g`h\YfY`]g`U\_]bX`cZa ]ga UHW VYhk YYb`dYcd`Y`j ]Yk ]b[`d`Unjb[`h\Y``chYfmUg`U`Zcfa`cZ[Ua V`]b["

6*i* hk \Uhih\Y`chtYfmX]X`]g`]ha UXY`[Ua V`]b[`a cfY`gcV]U`mUVVVdhUVY'''=ha UXY`]ha cfY`gcV]U`mV&bXcbYX`UbX`k \Uhinci`[ chk Ug h\]g`\_]bX`cZXf]džXf]džXf]džXf]džXf]d`ZYVW'H\Y`chtYfmVUa Y`]b`UbX`cZV&i fgY`]a a YX]UHY`mh\Y`ZccHVU``dc``g`UbX`h\Y`V]b[ c`k YfY`VUg]VU``m gUnjb[`nci j Y`HU\_Yb`gca Y`cZci f`Vi'ghca Yfg`Uk Un'i`Nci fY`bch`Yht]b[`i g`UXj Yff]gY`cb`HY`Yj ]g]cb''K Y j Y`[ chhc`\Uj Y`Ub`Yei U` d`Unjb[`Z]Y`X''`Gc`h\Y`[ cj Yfba Ybh]b`HYfa g`cZ`]VYfU`]gUh]cb`UbX`XYfY[ i`Uh]cb`U`ck YX`V]b[ c`UbX`ZcCHVU``dc``g`hc`UXj Yff]gY`]b`df]bh a YX]Už'fUX]cZ'HJ "

H\Yb`cZV&i fgY`mci jY`[chch\Yf`dUfhg`cZh\Y`]bXi ghfmgUn]b[`\Ub[`cb`U`a ]bi hY"`K \mUfY`gVfUhVX`VUfXg`VY]b[`UXj Yfh]gYX`]b`h\Y

a [XXYCZ7cfcbUh]cb GhfYYh3 Mci 'h,Y'< ca Y'C Z]WY', Uj Y'A ghgU]Xž'h,Y', UfX'Zcfa g'cZ[Ua V']b[ 'UfY'h,cgY'k, ]MX', Uj Y',][, 'cf fUd]X'ghU\_]b[ ''K Y```gWUhWX', WUfXg', WUb', Uj Y',][, 'cf fUd]X'ghU\_]b[ ''Nci fY'U'fYUXmU``ck ]b[ 'h, Uhhc', VY', UXj Yff]gYX', Yj Yfm, U'ZUb \ci f'cb'+U'gc'k, mWUb hk Y'UXj Yff]gY', ci f'dfcXi Whg3

CZV/cifgYih,]g``YXih,Ybihcih,Y; UaV]b[`5V/kiH\YfYikYfY'aUbmžaUbminYUfg'cZdYcd'Y``]\_Y'amgY'ZVY]b[`]bhYfj]YkYX'UVcih jUf]cig'UgdYV/kg'cZh,]b[g''; UaV]b[`bck`=h,]b\_]g'U'\][\`mgcV]UV`mUV/VYdhUV`Y'UV/kjj]mt'CZV/cifgY'bck`k]h,`cb`]bY

Bck h\Yh\]b[ UVci hh\]g]gh\Uha mUhhhi XY]g]Znci fYU[Ua VYfUbXnci kUbhhc[Ua VY cb gca Yh\]b[žnci g\ci X`\Uj YU` h\Y]bZfa Uhjcb i d'Zcbhhc a U\_YUb]bZfa YXVKc]VYUVci hk\Yh\Yfnci fY[c]b[ hc d'Umcf bch'

 $Bck := a gi fY k \setminus Yb := hU_``UhYf UVci h \setminus ck `UbX k \setminus mgca Y dYcd Y VYVca Y UXX]WhYXz'h YfY ]g ei ]hY WYUfYf Ub UggcV]Ufjcb$  $VYhk YYb dfcV Ya [Ua V]b[`UbX ]] YX cXXg VYhjb[`hYfa ]bU'g''6i hk Y \Uj Y hc hU_Y h Y dc]bhh Uh]hg bchh Y [Ua Y ]hgY ]z ]hg \ck$  $h cgY [Ua Yg UfY XYg][ bYX'' = ``Wca Y hc h Uh UhYf cb ]b h Y ]bhYfj ]Yk VYWU gY = _bck k Y fY [c]b[`hc Wcj Yf h Uh'$ 

F][\h7Ug]bc.`H\Ub\_`mci`jYfmaiVX``=b`mcif`fYgYUfVXžk\Uh\UjY`mci``YUfbYX`UVcihX]ZYfYbh[UaV`]b[`XYac[fUd\]Mg3`5fY dYcd`Y`cZU`VWfffU]b`U[Y`cf`[YbXYf`]bVI]bYX`hc`[UaV`Y`cb`VWfffU]b`[UaYg3

8f; f]Z]h\g. =h\]b\_k\Yb'kY``cc\_UhUbnth]b[`hc`Xc'k]h\'h\Y`XYac[fUd\]Mg`cZ[UaV]b[`]g'h\Uhk\UhkY`\_bck`]g'h\Uh]hX]ZYfg QfcaQW`hifY`hc`W`hifY'''<YfY`]b'h\Y'I?`k\UhkY`hYbX`hc`Z]bX`]g'h\Uhh\Y`cb`mUMj]]mnh\Uhg`d`UmYX`acfY`Vmk caYb'h\Ub`aYb`]g V]b[c''H\YfY`UfY`hkc`UMj]]f]Yg```chhYf]Yg'UbX`gWUHWX`VWfXg```h\UhUfY`d`UmYX`YeiU``mVmaYb`UbX`k caYb''`9j`Yfmg]b[`Y`ch\Yf UMj]]mnHybXg`hc`VY`d`UmYX`acfY`VmaYb`h\Ub`k caYb''

< Uj ]b[ gU]X h\Uh=h\]b\_ h\cgY \_]bXg cZX]ZYfYbWYg VYhk YYb h\Y [ Ua Yg UfY [ c]b[ hc X]a ]b]g\ cj Yf h\Y nYUfg UbX k ] ``VYVta Y U V[h`]\_Y U'Vt\c`": cfminYUfg U[ c`a cgha Yb XfUb\_"' =hk Ug`a cghma Yb h\Uhk YfY U'Vt\c`]Vt[vC\c]Wg" B ck `k \Uhk Y`gYY ]g`f ghUg`a Ubm k ca Yb Xf]b\_ Ug`a Yb" H\Y cb`mX]ZYfYbWY ]g h\Y hmdYg cZXf]b\_g h\UhdYcd`Y HYbX hc [ YhUXX]/WYX hc UbX =h\]b\_ h\]g ]g k \Uhk ]``\UddYb ]b [ Ua Y ]b[ "=h\]b\_ k \Uhg \UddYb]b[ bck `h\YfY g`U`fYU`di g\ hc Vf]b[ Zcf]bghUbWY k ca Yb hc d`Umcb`]bY V]b[ c" K Y \_bck `h\Uhk ca Yb`cj Y d`Un]b[ ``Zh]b\_ c k \Uhh\Y cb`]bY Z]fa g`\Uj Y XcbYžh\Ymj Y XVVJXY k Y Xcb hk Ubhc U]YbUHY \UZcZci f dcHYbhJU` Wighca Yfg" Gc k \mXcb hk Y`Vf]b[ `h\Ya ]bhc [ Ua Y3K Y \_bck `h\Ym`]\_Y d`Un]b[ `cZ]bY UbX Vf]b[ `Ub cb`]bY X]a Ybg]cbž U`ck `h\Ya `hc WXUhhc YUVX ch\Yf" A U\_Y]h\_]bX cZU gcV]U` I b"

6i hcZV&i fgY ]b Wfa g`cZcb`]bY ]g`hUhh\Y [ Ua Yg`HYbX hc VY U`chZJgHYf" H\Y Yj YbhZYei YbWh]g`\][ \Yf" H\YfY ]g`UWh U`mU a cfY`dcHYbf]U`Zcf`dYcd`Y hc XYj Y`cd`dfcV`Ya g`]b`h\cgY \_]bXg`cZcb`]bY Ybj ]fcba Ybhg`VYWi gY`cZh\Y`Yj YbhZYei YbWh'K Y`U'gc \_bck `hUha Yb`\_]bX`cZ[ fUj ]hUHY`a cfY`hck UfXg`g\_]``!VUgYX`[ Ua Yg`UbX`k ca Yb`HYbX`hc`dfYZYf`VXUbVW!VUgYX`[ Ua Yg"6i hU[ U]b h`]g`]g`W`h fU`"Bck `]b`h`]g`Vei bhfmZcf`]bghUbWYzk Y`UfY`h`Y`cb`mVei bhfm]b`h`Y`k cfX`k \YfY`a Yb`UfY`a cfY``\_Y`mhc`d`Umg`ch a UWX]bYg`h`Ub`k ca Yb''Nci `[ c`hc`a cghch`Yf`d`UWYg`UbX`]hdfYhma i VX`]g`Yei U`]b`HYfa g`cZh\Y`bi a VYf`cZa U`Yg`UbX`Zd`a U`Yg [ Ua V`]b[``gUm]b`5a Yf]WU`cb`U`g`cha UVX]bYg"`H\Y`h`]b[``UVci hci f`g`cha UVX]bYg`cj Yf`\YfY`cZVei fgY`]g`h`Uhk Y`UfY`h`Y`cb`m Vei bhfm]b`h`Y`k cfX`h`UhUWh`U`m\Uj Y`g`cha UVX]bYg`h`UhXcb hi gY`U`fUbXca`bi a VYf`[ YbYfUhcf`UbX`Zcf`dYcd`Y`h`Uh\_bck`k \Uh h`YmfY`Xc]b[``h\YfY`]g`U`ga U``Y`Ya YbhcZg\_]``]b`d`Un]b[``U`6f]hjg\`g`cha UVX]bY"`DYcd`Y`Wb``]hYfU``mk UHVX`h\Y`a UVX]bY`Z``i d k ]h`ch`Yf`dYcd`Y g`a cbYnž'h`Yb`Vea Y`]b`UbX`UMh`U`m[Yhh`Y`dUmci hZca`]h'

F][\h7Ug]bc. C\_Uni< ck ]g'hY]bWYUgY]b'hY'bi a VYFcZWYYVf]hmYbXcfgYa Ybhg'UZYWfjb['hY'[Ua V]b[']bXi ghfn&HU\_Y'G\UbY K UfbY g'UZ]]Uh]cb'k]h\,,, WUg]bc"FUmK]bghcbg'j c]WYcj YFZcF6Yh'\*)"8cYg'hY'ZUWhh\UhU\_bckb'Z[[ifY']g'cdYb'mYbXcfg]b[ [Ua V]b[žgUmcb'HY'Yj]g]cb'cf'hY'=bHYfbYhž'h\fci[\jUf]cig'a YX]U'cihYhg'a U\_Y'[Ua V]b['gYYa'UWWYdhUV'Y3

8f; f]ZIN.g. 7YfNJb`mWY`YVf]hmYbXcfgYaYbh]b`UbmUfYU`cZgY``]b[`gcaYN.]b[`]g`gYYb`hc`VY`gcaYN.]b[`N.Uhk]``Vf]b[`N.Y`dibNYfg ]b`cf`Vf]b[`N.Y`VinYfg`]b`gcaY`kUn'i`Hc`VY`\cbYghZfag`kci`Xb`hgdYbX`\ibXfYXg`cZN.cigUbXg`cZdcibXg`dUn]b[`dYcd`Y`hc`Xc`]h ]ZN.YmX]Xb`hN.]b\_]h\UX`Ub`YZYVN'Bck`k]N.[UaV`]b[`]hWUb`kcf\_j`YfmkY``Zcf`nci`UbX`]hWUb`UVNiU`m[c`fYU`mkfcb["

H\Y`a cghWUgg]WWUgY`k \YfY`U`WY`YVf]mik Ug`i gYX`k \YfY`UVMi U`mfYgi`HYX`]b`dYcd`Y`\Uj ]b[`U`Xck bhi fb`]b`[Ua V`]b[`]g`k \Yb 6]`m7cbbc``mUXj Yff]gYX`h\Y`bUh]cbU``chhYfm'5hh\Y`h]a Y`\Y`k Ug`di fd`Y`VYUfXYX''<Y`k Ug`gca YVcXmh\Uhk Ug`]b`U`gYf]Yg`cZ V&a a YfV]U`g`k Ubh]b[`dYcd`Y`hc`d`Um`chhYfm'K \Uh7Ua Y`chZci bX`]b`h\Y]f`fYgYUfVX`k Ug`h\UhmYgž'h\YfY`k Ug`\][\`fYWź[b]gUV]]hm UbX`\][\`fYWU``Zcf`h\Y`UXj Yff]g]b[`WUa dU][`bg`Vi h]hUMn'U`mdi hdYcd`Y`cZk Ubh]b[`hc`[Ua V`Y`cb`h\Y]f`dfcXi Vhg''

Bck cVj]cig`mdYcd`Y``\_Y`G\UbY`K UfbY`UbX`,,, "W&a`]g`I\UhiI\YmfY`Ifm]b[`Ic`dcfffUmU`dUff]W`Uf`]aU[Y'''<YfYg`gcaYVcXmI\Uh ]g`kY``\_bckb`U``UfcibX`I\Y`kcfXž`]bHYfbUI]cbU``gHUfžc\_Un8`+hg`VUg]WU``mgUm]b[`]Znci`W&aY`hc`,, `nci fY`]XYbI]Zn]b[`k]h G\UbY`K UfbY`Ug`Ub`]bX]j]XiU`''=b`YZZYWinci fY`Ifm]b[`Ic`gUm=kUbhIc`VY`gcaYI\]b[``]\_Y`G\UbY`K UfbY''5`giWWYggZ``aUb`k\cg kYU`I\nz`[chU`VYUiI]Z``[]fZ]YbXžYIWZYIW

FUmiK ]bghcb"=Znci ``cc\_`Uh\]a `]b`hYfag`cZh\Y`hnd]/WD`gdcfhg`VYhhYf`h\YmdfcVUV`mVXcgYb`FUmVYVUigY`\Yg`[chih\Uh\_]bX`cZ fY[]cbU``X]U`YVMz@cbXcb`UVWVYbH`<Yg`VUg]/VU``m>cY`DiV`]W]b`hYfag`cZ\ck`\Y`V&aYg`UV%cgg`Vih\Yg`VYYb`]bV%YX]V`m giVWYggZ``"

 $H \setminus Y$  ]b d'UmVYh]b[`a Uf\_Yh]g h Y ZUghYgh[fck ]b[`a Uf\_Yh]b h ]g V&i bhfm'K \c'UfY'h Y a cghgi VMYggZ `Z]fa g3'=hg'6Yh'\*) "9j Yb a mhk Y j Y nYUf'c X gcbžf][ \h3 K \Yb k Y fY k UhVX]b[`U'gdcfhg a UhVX bck žk \UhXcYg \Y Xc3'<Y'hf]Yg hc`[i Ygg'k \UhF Um K ]bghcb g`VYh]g`[c]b[`hc VY Xi f]b[`h\Y \UZ]a Y'''<Y ``[c`=VYh\Y g`[c]b[`hc gUmh\UhF ccbYmg & hc %gVefY'h\Y bYI h[cU''' H\Uh \Ug VYVea Y`gc YbXYa ]Wh\UhYj Yb`a mck b'hYYbU[Y VX]XfYb fYVe[b]gY'\]a žfYVe[b]gY'k \Uh\Y g`Xc]b['''Gc'h\YmfY'Ub ]a dcfhUbhdUfh'

Bck Zcfigca YidYcdiYiN YfY UfY U'k Ungi[c]b[ihciVYWYYVf]]]YgiN Uhdi hh\Ya icZZ[Ua V]]b[icb U'dUff]Wi UfidfcXi VhUbX U'gciN YfY UfYiN]]b[gik \Yb h]b[gi[ci\cff]Vinik fcb["K Yi\UXiN YiYI Ua diYiZcf]]bghUbWYž7 \ifWX]``ibgi fUbWY UbXik Yi\UXiJ]WF YUj Ygik \c k UgiN Yij c]WYcj Yf"H\Yb \Yik UgiXcbY ZcfiXf]]b\_Xf]]j]b["CZWci fgY VY]b[i]]b h\Yi]bgi fUbWY Zffa 'h\Yi7 \ifVX]``k YfY'dUn]]b[ici hcb VUffUMV][XYbhg"H\YmVci Xb h\Uj Yi]a 'UgiN Yij c]WY Ubna cfY"

H\YfY g'U'k Ung'U'h.]b[`]b'hYfa g'cZfYdi hUh]cb'a UbU[Ya Ybh'H\YfY g'Ub'c'X'W]WXÅ'h\UhfYdi hUh]cb'hU\_Yg'U``]Zyh]a Y'hc'Vi ]X'i d'Vi h U'gYWcbX'hc'XYghfcm'K \YbYj Yf'nci [YhUbm\_]bX'cZWY`YVf]hmYbXcfgYa Ybhg'nYg'h\YmWbb'\Uj Y'U'fYU`\U'c'YZYWhZcf'U'k ]Zgca Yh\]b[`[cYg'k fcb['h\Yb'h\Uha Vh Wh Vh KYb']

 $F = [NF7Ug]bc. F = [NF8ck k Y fY = c]b[ hc a cj Y cbhc U dfYhm Nchhcd] V2 YgdYV]U m]b cb ]bY = [Ua V]b[ UbX h Uhg gcV]U d'Uh]b[ cf gcV]U = [Ua V]b[ ": cf i gYfg gcV]U = [Ua V]b[ ]g gYfj ]W g k NfY nci = [U]b fYU VUg i g]b[ gcV]U a YX]U d'UhZcfa g"Gc dcdi Uf [Ua Yg UfY dc_YfZV]b[ czg chg UbX gc cb UbX gc Zcfh "GcV]U = [Ua V]b[ ]g UfY Uh]j Y mbYk d Ybca Ybcb" < ck Xc nci ZYY h Uh]h k ] XYj Y cd3 8 c nci h ]b_ ]hk ] fYa U]b ]a ]hYX hc fY Uh]j Y mZYk gYfj ]W g cf XcYg gcV]U d'UmfYdfYgYbhh Y Z hi fY cZcb ]bY [Ua V]b[ 3$ 

8f; f]Z]h.g. `=h.]b\_``cc\_]b[`UhgcV]U``[Ua V`]b[`Yj YfnVcXmg'k UHW]b[`Yj YfnVcXmY`gY`Uhh.Y`a ca Ybh'K \Yb`6]b[c`: fYbnmk Ug `Ui bWXYX`]b`5i [i gh&\$%&`U`a cghYj YfmgYWcf`Ug``cc\_]b[`hc`gYY`k \Yh.Yf`h.]g`dUff]W`Uf`[Ua Y`k Ug`[c]b[`hc`hU\_Y`cZcb`h.Y : UWYVcc\_`d`Uhzcfa "

 $Bck := cc_YX UhU WinghU VU UbX gUmk \setminus Uh = h ]b_ ]g [c]b[ hc \setminus UddYb ]b h Y I h fY Vi h = h ]b_ h Y ]ggi Y ]g UVh U mV][ [Yf h Ub gcV]U [Ua V]b[ #gcV]U [Ua ]b[ "K \setminus Uh]g \setminus UddYb]b[ cZVci fgY ]g h UhU a cghYj YfmUfYU h Uhnci k cf_ ]b bck dYcd Y UfY hm]b[ hc a cbYh]gY h Y]f dfcXi Vhg "K \setminus Uhk Y fY gYY]b[ bck ]g Vcbj Yf[ YbVV VYh YYb chg cZX]ZYfYbhd Uhcfa g" = k Ug k f]h]b[ 'Uff]VYg hYb mYUfg U[ c @ \YfYQ=k Ug dfYX]Vh]b[ 'h Uh[ Ua V]b[ 'Yea dUb]Yg k YfY [c]b[ hc ghUfhi g]b[ 'j ]XYc[ Ua Y hYVK bc c[ m'H \Uhj ]XYc[ Ua Y W V b c dUb]Yg k YfY [c]b[ hc \UhdYb]b[ 'hc \UhdYb]b[ 'hc \UhdYb] [b[ 'Uff]V]b[ 'bc h Y]f [Ua Y ]b c h Y]f [Ua Y UbX h Uhg ghUfh]b[ 'hc \UhdYb]$ 

Bck hc a Y h ]g ]g U dghWkc c[]WU a UghYfghfc\_Y" H Y ]XYU h Uhnti [ YhdYcd Y hc dUmZcf j ]fhi U W ffYbWhht h Yb d UmU [ Ua Y UbX k Y \_bck h Uha ]`]cbg cZdYcd Y Xc ]h' = Z = k Ug gUnjb[ 'h Y \_]bX cZbYI hh ]b[ 'hc UXX cb ]g `cc\_žnti j Y `VYYb `Vi njb[ 'U``'h ]g j ]fhi U `W ffYbWhitk Y WUb [ ]j Y nti 'Ub cddcfhi b]hnbck hc 'UWh U`mi gY nti f 'fYU `Vi ffYbWhiUbX nti 'a ][ \h'Yj Yb `Vmi g]b[ j ]fhi U `Vi ffYbWhinti '\_bck 'nti j Y `cghih Uha cbYm' H \YfY g bc 'k UmcZ[ Yhjb[ ']hVUW\_" 6i hcZWti fgY Vf]b[ ]b[ ]b fYU`[ Ua V ]b[ ždYcd Y \Uj Y h Y 'WUbWY hc 'k ]b h UhVUW\_"

 $Bck k \setminus Uhg V]nUffY ]g k \setminus Yb nci gYY h ]b[g`]_Y D? F k \setminus c ghUffYX \setminus Uj ]b[j] fhi U`UWW ggcf]Yg h UhdYcd Y Wei X Vi m'Gc k \setminus ]Y dYcd Y k YfY d`Unjb['dc_Yf nci Wei X Vi m'WYX] g hc \Uj Y dYcd Y Vi mUVe \c`k \]Y Ufci bX h Y hUVY" H ]g ]g \UddYb]b[']b U` Zfa g cZcb ]bY [Ua ]b['gcV]U`[Ua ]b[' h Y j] fhi U`UWW ggcfma Uf_Yh]g k cfh a ]`]cbg UbX a ]`]cbg" H \]g ]g U'W gY k \YfY dYcd Y k (YfY dYcd Y k ff dYcd Y Vi mUVe \c`k ]]Y Ufci bX h Y hUVY" H ]g ]g U'W gY k \YfY dYcd Y k (YfY dYcd Y Vi mUVe \c`k ]bY [Ua ]b[' gcV]U`[Ua ]b[' h Y j] fhi U`UWW ggcfma Uf_Yh]g k cfh a ]`]cbg UbX a ]`]cbg" H \]g ]g U'W gY k \YfY dYcd Y k (YfY dYcd Y k ff dYcd Y k (YfY dYcd Y k )]b [' hnd Yg cZWch ]b['' H ]g Wei X YUg] mVY hUbgZ ff YX hc cb ]bY dc_Yf fcca g Zcf ]bghUbW k \YfY nci WYUHY nci f Uj UhUf UbX nci [YhdYcd Y hc ghUfhid Um]b[''$ 

K \Uhk Y j Y [ch]g U g]hi Uh]cb h\Uh]Zk Y k Ubhhc Vf]b[ ci hU [Ua V]b[ dfcXi Wbzk Y WUb i gY cbY cZh YgY Zch]b h Y Xccf hYW\b]ei Yg hc [YhdYcd Y k \c UfY U fYUXm[Ua ]b[ UbX d Un]b[ Zcf ZYY UbX d Un]b[ Zcf dc]bhgžk Y WUb U gc cZyf h Ya cddcfhi b]h]Yg hc [Ua V Y Ug k Y``' CZVci fgY k \UhWca dUb]Yg UfY ghUfh]b[ hc Xc ]g d Umh\Y [Ua Y Zcf ZYY Vi hk ]b fYU a cbYm

5[U]bUWUgg]WZcch]bh\YXccfHYW\b]eiY]g[Yhhjb[dYcdYZJa]]Ufhch\Y[UaY"; Yhhjb[dYcdY]bUbcf[g\_g]hiUhjcbk\YfY h\YmWUbdUmZcfbch]b[UbXdcHYbhjU`mk]bdf]nYg"K\Ybh\Ymk]bdf]nYg'K\YbYmZYY`[fYUh'H\UhfY]bZcfWg'h\Ya"

H\Y`k \c`Y`h\]b[`UVci h\i a Ub`VY\Uj ]ci f`]g`k Y`UVbi U``mghcd Yb[U[]b[`]b`VY\Uj ]ci f`i b`Ygg`k Y`[YhV&bghUbhmfYk UfXYX Zcf`]h' Bck `Yj YfmgcV]U`[Ua Y`h\Uh=VUb`h\]b\_`cZZca `7UbXm7fi g\`h\fci [\`hc`HYI Ug`<c`X`9a `Dc\_Yf`]g`U`[Ua Y`h\Uhg`Z``cZ fY]bZcfWfa YbhUbX`fYk UfXg"Bck Zcf`a cghdYcd`Y`h\Uhk]``fYgi`h]b`dYfg]ghYbhd`UmUbX`Zcf`U`ga U``a]bcf]hmdYfg]ghYbhd`Uma][\h `YUX`hc`dfcV`Ya g"

5gʻUʻdgmVXc`c[]gh=WUb`gYY`\ck`dgmVXc`c[]WU``HYVXb]ei YgʻWUb`VY`YId`c]HYX`UbX`Uʻga U``dfcdcff]cb`cZdYcd`Y`h\UhUfY j i `bYfUV`Y`UbX`gi gWYdf]V`Y`WUb`VY`gi W\_YX`]bhc`h\UhUbX`XYj Y`cd`dfcV`Ya g"`Bck`h\Uhg`U`\_]bX`cZa cfU``ei Ygf]cb`k \Yh\Yf`nci g\ci`X`VY`Xc]b[`h\Uhcf`bchVi kk Y`[Yhh\Uh]b`U``k U`\_g`cZ`]ZY"

Bck not f VUg]Wei Ygh]cb. ]g gcV]U [ Ua V ]b[ [ c]b[ hc hU\_Y cZ3 H\Y Ubgk Yf k Y A ghXcb h\_bck nYhVi ha m[ i Ygg ]g h Uhnot fY [ c]b[ hc gYY a cfY UbX a cfY Webj Yf[ YbWY A ghVYhk YYb [ Ua ]b[ UbX [ Ua V]b[ Ubnk Uni H\YfY ``VY ``chg a cfY cddcfhi b]h]Yg Zcf dYcd Y k ]h ]b [ Ua ]b[ Ybj ]fcba Ybhg hc \Uj Y U `]hhY Zi hhYf UbX h YfY ``VY ``chg a cfY [ Ua V ]b[ Ybj ]fcba Ybhg zgcffmU ``cha cfY [ JxYc[ Ua Y Ybj ]fcba Ybhg h Uhk ]``ghUfhhc ]bhfcXi WY h cgY [ Ua V ]b[ `hodY Y Ya Ybhg'' H\Y \_]bX cZWUbb]VU ]gUh]cb cZU``h YgY Zf ]Y Xg"

 $K \setminus Yb = ghUffYX fYgYUfVX]b[`VUW_]b`%, *``%, + = k Ug fYgYUfVX]b[`[Ua V]b[`UXX]Wfjcb"9Ufmb]bYhJYg`=ghUffYX Xc]b[$  $j ]XYc[Ua Y`UXX]Wfjcb"H\Yb%-(`=bhYfbYhUXX]Wfjcb"Bck j ]XYc![Ua ]b[ž[Ua V]b[ž=bhYfbYhhXYmj Y`U``V&a V]bYX"9j YfmVcXm$  $VUb Xc]hcb'h Y`gUa Y`XYj ]WY"=fYa Ya VYf]b%-$`hU_]b[`UVci hgca Yh]b[`=WU``YX'h Y`HYYdi HYf'h UhdYcd'Y`VUff]YX`Ufci bX$  $k ]h 'h Ya 'h UhhX YmV&i 'X`d\cbY`cbz'h UhhX YmV&i 'X`Xc'Yj YfmhX]b[`]b'HYfa g`cZk \UhU`W&a di HYf'W&i 'X`Xc"Hc'k UhWX HYYj ]g]cb"=$  $gU]X`nci _bck 'a UmVY`cbY`cZh YgY'k ci `X`VY`Uj U]`UV`Y`]b'ZJmcf'U`\i bXfYX`nYUfg`Ha Y"=hg`VUg]WU`mhU_Yb'hk YbhmmYUfg'Zcf'h]g$  $HY0Kbc`c[`mhc`VY'h\YfY"$ 

 $DYcd'Y'HJ_U'ci h=bHYfbYh[Ua V]b['Yj Yb'hUhbck']g'i ghUb'cVgc'YHY'HYfa''K Y fY'HJ_]b['UVci hfYa cHY'[Ua V]b['hUhWUb'VY XcbY'cb'UbmHUV'Yhz'Ubma cV]'Yz'UbmXYj ]MY''5bncbY'[chcb']bY WUdUV]]mhhUhg'']b_YX'i d'hc'U'gcV]U'bYhk cf_]b['d'Uhzfa'UbX nci 'WUb'UXj Yff]gY'hc'dYcd'Y'cb'hY'a cj Y''H\Y'VUg]Wfi'Y'cZh\i a V']g'k \YfY'nci ']bWfYUgY'UVWYgg]V]]hmbchcb`mXc'nci ']bWfYUgY'hY'bi a VYf'cZfY[i'Uf'igYfg'cZUb'UVMj]]mmVi hnci ']bWfYUgY'hY'bi a VYf'cZdfcV'Ya g'Ug'k Y``''K \UhkY'bYX'cZWci fgY']g'U'_]bX cZgcV]U''fYgdcbg]V]]hm]bzHughfi VMi fY']b'd'UMY'UgY'hY'bi a VYf'cZdfcV'Ya g'Ug'k Y``''K \UhkY'bYX'cZWci fgY']g'U'_]bX cZgcV]U''fYgdcbg]V]]hm]bzHughfi VMi fY']b'd'UMY'Ub'\Y'b' i g'k]h\'h\cgY'j i'bYfUVY'UbX'gi gWfdf]V'Y']bX]j ]Xi U'g''=fYU`mk]g\'=$ 

gcVJU a YXJU d'Uhzcfa žk Yh Yf ]hg Ub cb`]bY fc Yd'Unjb[ [Ua Yžcf'k Yh Yf]hg U gJhY `]\_Y, , , "Wea ]g h Uhk Y WUb Zc `ck Yj Yfm gJb[ YWJW" 9j Yfmg]b[ Y'h ]b[ h Uhh Y [Ua V'Yf XcYg": fca 'h Y a ca Ybhh Ym`c[ cbhc h Y g]hY hc h Y a ca Ybhh Ym`c[ cZ'

 $\pm$  h UhgYbgY ]b hYfa g cZhfUbgdUfYbWhWta dUb]Yg \Uj Y h UhXUhU UbX =VY ]Yj Y h Ymg\ci X VY i g]b[ 'h UhXUhU hc cVj ]ci g m dfchYWhd UnYfg UbX hc a ]b]a ]gY \Ufa "  $\pm$  hYfa g cZh Y ]a dUWhcb d UnYfg h Ya gY j Yg k Y ``h Y hk c dcg]h]cbg h Uhnci \Uj Y =h ]b\_ Vch cZh Ya 'UfY \_]bX cZj ]UV Y" H\YfY g dfcVUV mch Yf \_]bX cZ 'k Y ``=Xcb hh ]b\_ h YmUfY h Y cb mhk c cdh]cbg" H\YfY Wti X VY ch Yf h ]b[ g ]b hYfa g cZk \Uh\UddYbg ]b hYfa g cZdYcd Y g VY\Uj ]ci fg" 5g =gUnž Zcf nci b[ ghYfg =h ]b\_ 'h UhgcV]U 'VtbX]h]cb]b[ h Uh\UddYbg k ]h [ Ua Yg ]h cc\_g j Yfm]bbcW ci g Vi hcZWti fgY k \Yb nci 'UXX U'a cbYmY Ya Ybhcbhc ]hZcf U'ga U ``a ]bcf]hm]h Wb VYWta Y gca Yh ]b[ 'h Uhg U'dfcV'Ya 'nc'h Ya "

K Y\_bck 'h\Uhinci h\`]b`UbX`cZh\Ya gY`j Yg`UfY`U`j i`bYfUV`Y`[fci d"'K \Yh\Yf`]hg`U`Vt\c``i gYžVJ[UfYhY`i gYži bXYfU[Y`gYl ž [Ua V`]b["'H\YgY`UfY`U``k\Uh=k ci`X`VU``U``]ZYghmY`Vil ghYf`cZf]g\_mVY\Uj ]ci fg`h\UhVX]XfYb`cf`UXc`YgVYbVY`ghUfhkc`Yb[U[Y`]b" K \Yb`nci`Z[bX`U`dfcV`Ya`[Ua V`Yf`nci````dfcVUV`mU`gc`Z[bX`gca YVcXmh\Uhg`hU\_]b[`]``]M]hXfi [gžghUfhXf]b\_]b[`U`Vt\c``YUf]Yfž Yb[U[]b[`]b`i bXYfU[Y`gYI`YUf]Yf'

 $\begin{aligned} & \text{Melling} W = \frac{1}{2} \left[ \frac{1}{2} - \frac{1}$ 

F][\h7Ug]bc.`C\_Um'Gc`bck`=a`[c]b[`hc`Ug\_nci`U`ZYk`eiYgh]cbg`UVcihd\ng]\WD`\Wg]bcg`]b`6f]hU]b"`K \Uh]g`ncifj]Yk`cb 6f]h]g\`\Wg]bcg`VfUb\W]b[`cih]bhc`JY[Ug`ghm`Y`Y]gifY`UbX`YbhYfhU]baYbh\Vcad`YIYg3`<ck`Xc`nci`ZYY`h\Y`6f]h]g\`\Wg]bcg Q\UjYQYjc`jYX`Ug`U`gc\V]U`gdU\Yr3

8f; f]Z]h\g. H\Y cb`mghUbWY h\YfY`]g`\YfY`k \YfY`=a ``i WmVYWUi gY`=hfUj Y``U``cj Yf'h\Y k cfX`UbX`=gYY``chg`cZWUg]bcg`U``cj Yf h\Y`k cfX''K \Yb`a m]bhYfbUh]cbU``j ]g]hcfg`V&a Y`cj Yf`\YfY`UbX`=\Uj Y`hc`hU\_Y`h\Ya`hc`U`6f]h]g\`WUg]bcz`B chh]b[`\Ua`\YfY`k Y j Y [chZ]j Y`WUg]bcg''K Y fY`UWh`U``mj Yfm`i Wn'iK Y`\Uj Y`ci hg]XY`@cbXcb`=h\]b\_`h\Y`V][[Yghdfcdcff]cb`cZVUg]bcg`ci hg]XY`cZ @cbXcb''`H\YmWUbbchVY`]Yj Y`\ck`ga U``ci f`WUg]bcg`UfYž`\ck``]a]hYX`]h]g`]b`hYfa g`cZk \Uhnci `WUb`Xc`]b`ci f`WUg]bcg''

CZV¢i fgY`]ZkY`kUbhhc`V¢a dYhY`cb`h\Y`]bhYfbUh]cbU``ghU[Y`UbX`Vf]b[`]b`h\Y`\_]bX`cZ5hUbh]W7]hmcf`@Ug`JY[Ug`hndY`Yl dYf]YbVNY kY fY`[c]b[`hc`\UjY`hc`fUX]VU``mVXUb[Y`ci f`VUg]bc`ghfi Vhi fY`VYVUi gY`Uhh\Y`a ca YbhYj Yb`h\Y`V][[YghcbYg`nci `V¢i`X`Z]hhk Ybhm cf`h\]fhmcZh\Ya`]bhc`U`hnd]VU``hndY`@Ug`JY[Ug`hndY`VUg]bc"

 $Bck \ cVj \ ]ci \ gmk \ Uhh Y; \ Ua \ V']b[ \ 5VhX]Xzh Uhk \ Ug \ UghY d \ Zcf a \ Y']b \ h \ Y \ f][ \ hX]fYVh \ cb \ ]b \ UgY \ bgY \ h \ UhVUg] \ bcg \ VYVU a \ Y' \ U' \ d'UVV \ k \ YfY' \ dYcd \ Y' \ [ \ c \ hc \ xc \ chy \ cZX]ZyfY \ bhh \ ]b[ \ g'' Bck \ =[ \ c \ =bck \ dfc \ VUVm[ \ c \ hc \ a \ mVUg] \ bc \ cbW' \ Yj \ Yfmg]] \ a \ cbh \ g'' \ =Xc \ ]h \ Ygg$ 

; Ua '7 UfY''K Y'XYg][bYX'N Y]F'gcV]U`fYgdcbg]V]`]hmdc`]Wff'=N,]b\_'N Y'@UVcif[cjYfbaYbhX]XbhkUbhhc`Vf]b[']b'U'gidYf'VUg]bc UbX`\UjY``cUXg`cZdYcd`Y`YbX]b['id'k]N dfcV`Yag''H\YmVXcgY'N Y'g]NY'UbX'N Y'cdYfUhcfg'N Uhk ci`X`\UjY'N Y'VYgh ]bZfUghfiVhffY`]b'Nfag`cZd`UnYf'dfchYVhjcbž`\Ufa`a]b]a]gUf]cb'UbX`gcV]U`fYgdcbg]V]`]hm'

= $k Ug j Yfmdfci X hc VY dUfhcZh UhV]X UbX Yj YfncbY h ci [\h]hk ci X [c hc 6 UVV_dcc`cf]hk ci X [c hc G \YZ]Y X cf k \UhYj Yf"=h k Ybhhc A UbVX YghYf UbX =h ]b_ dYcd Y UVh U`mX]X fYUX h Y V]Xg UbX h Ymh ci [\hUVci hh Y `cb[ Yf hYfa dgnVXc!gcV]U`]a dUVhg cZVUg]bcg"$ 

 $Bck = \hbar jb_Uhgca Y dc ]bhUbm[cj Yfba Ybh]g [c]b[ hc fYU]gY ]Zk Y k UbhdYcd Y hc Wca Y hc 6f]hU]b UbX k Y k Ubhhc Wca dYhY cb hX Y ]bhYfbUh]cbU ghU[Y]g hUhk Y fY [c]b[ hc \Uj Y hc \Uj Y gi dYf WUg]bcg" DYcd Y Xc `]_Y hc [Ua V Y" Bck k \Uhi=j Y gU]X ]g h Uh k \Uhinci Xcb h \Uj Y ]g gi dYf WUg]bcg Vi ] hf][ \h]b h Y WYbhfY cZU hck b" C bY cZh Y h ]b[ g h Uh6 UW_dcc `h ]b[ g h UhUfY [ c]b[ U[ U]bghh Y]f V]X k Ug h Uhh Y WUg]bcc k \YfY ]hk Ug [ c]b[ hc VY d'UWYX k Ug ]b cbY cZh Y a cghgcW]U `mXYdf]j YX UfYUg"$ 

: cfaYnci `\UjY'hc`\UjY`Ub`ci hcZhck b`h`]b[`h\UhdYcd`Y`\UjY'hc`aU\_Y`U`XYX]/WhYX`XYV]g]cb`h\Uhh\Ymk Ubhhc`[c"`Bck`k\Yb`= [c'hc`@Ug`JY[Ugžc\_Um=a ``i W\_mh\Uh=[c'h\YfY`Zcf`UWUXYa]/WfYUgcbg`Ug`kY```6Ug]/Wi``ma cghdYcd`Y`h\Uh[c'hc`@Ug`JY[Ug'h\Ym \_bck`h\Uhh\YmfY`[c]b[`h\YfY'hc`[UaV`Y''K\Yb`nci`kU`\_`]bhc`U`VWg]bcžnci`\_bck`h\Uhnci fY`[c]b[`hc`[UaV`Y''DYcd`Y`\UjY aUXY`U`dfY!Vcaa]haYbhz`U`dfYj]ci g`XYV]g]cb`h\Uhg`k\Uhh\YmfY`[c]b[`hc`Xc"

Gc jb Wfa g cZh jg Wti bhfm=Wb gYY XYZb]HY mU Z hi fY 7 cbgYfj Uhjj Y cf @UVci f [ cj Yfba Ybh]bhfcXi Vijb[ 'a UniVY Zci f hc g]l gi dYf Wbg]bcg UWfcgg h Y Wti bhfmUg gca Yh jb[ 'h Uhk ]``Vf]b[ 'jb hci f]ghg UbX UVhi U`mk ]``VY gca Yh jb[ 'h Uhk ]``fY[ YbYfUHY gca Y cZ h cgY UfYUg"

 $5g = gU[XZ = a bchUbh]![Ua V]b[]bhYg][ HYghUbX]Znci ]_YZ]ZhYfYgU k \UhWUb nci WU]B = ZhYfYgU XYg]fYZcfdYcdYhc [Ua VYUbXhYmk Ubhhc[Ua VYcbhcgYhndYgcZh]b[g] k \mXckY\UjYgca UbmdYcdY[c]b[hc@UgJY[Ug36YWUigY]$ 

<ck Yj Yf 'N YfY 'UfY 'W ffU]b`mdfYX]gdcg]b[ ZUW/cfg" K Y\_bck 'N YfY 'UfY [ YbYh]WUbX 'V]c`c[ ]WU`ZUW/cfgžc\_Un& K \Yh Yf`]hg 'U`g`ch a UWX]bY`d`UnYf`cf`k \Yh Yf`]hg`\cfgY`fUWY`[ Ua V`Yf`Zcf`]bgHUbWY`]Znci `\Uj Y`U`dUff]W' 'Uf`gYhcZ[ YbYh]Wa Uf\_Yfg" 'H\YfY g`U`[ YbY VU``YX 'N Y`8F 8&`[ YbYžbch`]b[ 'hc`Xc`k ]N`GHUf`K Ufg`Vi h]hg`cbY`cZh\YgY`[ YbYg'NUh]g`]a d`]WUhYX`]b`U``chcZ]a di`g]j Y VY\Uj ]ci fg"

: cf]bghUbWY U fYU`mWUgg]Wghi Xmk Ug XcbY VUW\_]b h Y % - \$g" #ig\ck YX h UhVUg]WU`m) \$\[ cZdUh\c`c[]WU`[Ua V`Yfg`\UX h]g dUff]W/Uf[YbYh]Wj Uf]UbhUbX h Uh&) | cZbcb!dUh\c`c[]WU`[Ua V`Yfg`\UX h]g dUff]W/Uf[YbYh]Wj Uf]Ubh'H\YfY`UfY hk c ]a d`]WUh]cbg Zica 'h Uh'C bY ]g h UhYj Yb ]Znoi `\Uj Yb h[chh\Y [YbYžnoi a ][\hgh]``VYV&a Y U'dfcV`Ya [Ua V`Yf VYVUi gY ) \$\[ cZ dfcV`Ya [Ua V`Yfg`X]Xb h\Uj Y`h]g [YbYh]Wj Uf]Uh]cb" #iU'gc g\ck g h UhYj Yb ]Znoi j Y [chh]g [YbYh]Wj Uf]Ubh]hXcYgb ha YUb h Uhnoi fY`Ui hca Uh]WU`m[c]b[ hc VYW&a Y U'dfcV`Ya [Ua V`Yf"H\YfY`UfY`chg`cZch\Yf`ZJWhcfg`Ug`k Y``UbX`cZW&i fgY`=a j Yfm a i WX ]bhYfYghYX]b k \UhUfY h Y ch\Yf`dgmVXc`c[]WU`Zghfi WhifU`Zg]hi Uh]cbU`ZJWhcfg`h UhXYj Y`cd"

Bck 'k \Yb']hWta Yg'hc'g`cha UW\]bYg'nci `\YUf'h.]g'd\fUgY'h.Uhg`cha UW\]bYgžZ]I YX`cXXg`VYh]b['HYfa ]bU`gžj ]XYc``chhYfm HYfa ]bU`gž'dc\_Yf`a UW\]bYg`]b`5i ghfU`]Už'dYcd`Y`i gY'h.]g'd\fUgY'h.Uhh\YmfY'h\Y`WfUV<u>V</u> WtW]bY`cZ[Ua V`]b["'K \Uhh\Yma YUb`Vm h.Uh]g'h.Uhh\YfY'g'U`\][\`UggcV]Uh]cb`VUg]WU``mVYhk YYb'g`cha UW\]bYg'UbX`dfcV`Ya`[Ua V`]b["

 $Bck = k fchY U dUdYf h ]g nYUf UbX = k fchY h UhVUg]WU mh Y malY cZ[Ua Y ]g ]ffY Yj Ubh]b hYfa g cZXYj Y cd]b[ UXX]Wg cb" DYcd Y h ci [ h ck Wci X mci gUmh UhA Uf_3 H YfY g U h ]g Yj ]XYbWY h Uh]g ei ]hY WYUf m]h Ug hc Xc k ]h [ Ua Y" = gU]X bc ]hg bchhc Xc k ]h h Y g hc Xc k ]h h Y g hf W ufUUWYf]gh]Wg"$ 

K \Uha mfYgYUfVX cb`g`cha UVX]bYg`\Ug`g\ck b`]g`h\Uhh\Y`g]b[`Y`a cgh]a dcffUbhZUVkcf`]b`hYfa g`cZk \Yh\Yf`dYcd`Y`XYj Y`cd`U dfcV`Ya `cf`bcH`=Znœi fY`h\Uhj i `bYfUV`Y`cf`gi gVVdh]V`Y`dYfgcb'''=Znœi j Y`[chh\UhV]c`c[]VU`[YbYh]WdfYX]gdcg]h]cb'''=Znœi `\Uj Y`U dUff]Wi`Uf`gYhcZdgnVXc`c[]VU`VXUfUVWf[gh]Vgž'h`Y`V][[Yghg]b[`Y`ZUVkcf`h\Uhk]``X]VhUhY`k \Yh`Yf`nœi `VYVca Y`UXX]VHYX`hc`U dUff]Wi`Uf`[Ua Y`]g`Yj Yb`ZfYei YbVmcZh`Y`UVMj]]hm'K \Uh=a YUb`Vmh\Uh]g`h\Uhhmd]VU``g`cha UVX]bY`]b`U`di V`nœi `VVb[Ua V`Y hk Y`j Y`h]a Yg`U`a]bi HY`cb`U`hmd]VU``di V`g`cha UVX]bY''

$$\begin{split} HU_Y h Y bull cb'' chtyfm' Nci' Wub cb'm[Ua VY cf'Uh YUgh 2] bX ci hh Y fYgi h] Znci' [Ua VY hk ] MY U'k YY_cb'h Y bull cb'' chtyfm'$$
=j Y bYj Yf a YhUbn VcXmUXX] MYX hc'h Y bull cb'' chtyfm' Nci' Wub hVYV ca Y UXX] MYX hc gca Yh ] b['h Uhnci' fY cb'mfYk UfXYX 2cf $hk ] MY U'k YY_'' Nci' Wub Vi m'chg'cZh] W_Yhgž Vi hnci' Wub cb'm2] bX ci hh Y fYgi'h cZnci f [Ua VY hk ] MY U'k YY_''' b Ygg'nci' fY gca Y$  $V] nUffY dYfgcb'h Uh [Yhg'U'Vi nn Zca' UVhi U'mVi n] b['h Y 'chtyfmi] W_Yh] b UbX cZ] hg Y Z'] g nci' Wub hVYV ca Y UXX] MYX hc'U$  $X] gW cbh] bi ci g [Ua V] b['UVhjj] [m'H \Uhg k \m=j Y bYj Yf V ca Y UVhcgg'Ubn VcXmUXX] MYX hc'ZchU'' cfgYfUMY [Ua V] bY c'h Yf m ci' Wb [U ch'Y fm'h' 6i hk \Uhnci' H'bX hc'2] bX ] g h UhUVhjj ] hYg''_L Y \cfgYfUMY [Ua V] b['cf''] b'Ucf'' ff' h ch'Y U'k YY_''' b'U'k YY_'''' b'Y ff' V ca Y UVhcgg'Ubn VcXmUXX] MYX hc'U cfgYfUMY [Ua V] b['cf''] b'UbX U[U] b'UbX U[U] b'UbX U[U] b'UbX U[U] b''' h YmUfY h Y UVhjj ] hyg h UhHYbX hc VY df cV Ya Uhjv''$ 

Bck  $hYh ]b[]g dYcd Y \Uj Y cc_YX Uhh Y fYgYUfW UbX gU]X k Y ]bX k \Uhnt i ]bX ]b U h Y fYgYUfW gh X]Yg ]g h Uhg ch$  $a UW ]bYg \Uj Y U \][ \ Uggc V]Uhcb k ]h dfcV Ya [ Ua V ]b[ "DYcd Y gUmk Y"]ha i ghVY h Y [ Ua Y h Yb"6i hh Y h ]b[]g = Vei X$ XYg][ b mti h Y gUZ/ghg cha UW ]bY ]b h Y k cfX UbX =[ i UfUbhYY bc cbY k ] Yj Yf VYVea Y UXX]VhYX ht ]h H Y cb mh ]b[ =k ci X $C ]g i ghVX Ub[ Y h Y ghfi Vhi fU WUfUVhYf]gh]Vg UbX a U_Y gi fY h UhdYcd Y Vei X cb mdfYgg h Y Vi http://k YY_"Bc cbY$ k ] Yj Yf VYVea Y UXX]VhYX htt h Y g cha UW ]bY"

Bck 'noti 'gUm=a][\hVY'VY]b['ZUWH]cig"'6i hh\Y'h]b[']g'=Vci X'XYg][b'noti 'hY'a cghUXX]VHj Y`chHYfm[UaY''KY'VUb'hU\_Y'hY' `chHYfm[UaY'Ug']h]g'bck z'h\Y'V]!kYY\_'m[UaY'UbX']bghYUX'cZ\Uj]b['h\Y'XfUk'YjYfmhk]WY'U'kYY\_'kY``\UjY'h\Y'XfUk 'YjYfmhk c a]bi HYg"'Bck 'h\YfY'UfY'[UaYg`]\_Y'h\UH'=hg'VU`YX'?]bc']b'h\Y'IG''H\Ym\UjY'U'ZUghUVHjcb``chHYfmXfUk'k\YfY'h\Y'XfUkg'UfY YjYfmhk c'a]bi HYg"'H\YmfY'cZHYb'd`UnYX']b'dcghcZJWYgžgi dYfaUf\_Yhg''=VUb'HY``noti 'bck'dYcd`Y'h\Uhd`Umh\cgY'hndYg'cZ[UaYg Xc'XYjY'cd'dfcV'Yag']Znoti fY'j i 'bYfUV'Y'cf'gi gWY'dH]V'Y''

Gc ]hg bchill Y [ Ua Y" =hg bchilo XYa cb]gY 2] YX cXXg VYhijb[ 'HYfa ]bUg cf hc XYa cb]gY g`cha UWL]bYg" =hg UVci hill Y ghfi WhifU VLUFUWHYf]gh]Wg cZ\ck 'noi 'XYg][ b"=Znoi 'XYg][ b 'VUg]WU`mU`\][ \ 'Yj Ybh2Yei YbWhi[ Ua Y UbX'h\UhWUb VY U`chhYfnžUbX'h\UhWUb VY U'g`cha UVL]bY"=Znoi fY j i `bYfUV Y cf gi gWrdh]V Y h\YfY g'U`\][ \ f]g\_ 'noi 'k ci `X`XYj Y`cd U'dfcV`Ya 'k ]h\ h\UhdUff]W/ Uf dfcXi Wh

8f; f]Z]h.g. 9I UVIni H.Y.Y Y YbhZYei YbVIni YfY Wib VY h.]fhmcf Zcfimilja Yg U a ]bi H''' =fYa Ya VYf ''h.]g ]g U'hi Y ghcfmUVIn U'ni  $\pm 0\% - *$  a mk cf\_k Ug i gYX ]b h.Y 8i MX DUf]Ua Ybhic XYV]XY k \Yh.Yf g'cha UVX]bYgzh Y gd]b cZh Y fYY `g\ci X VY h fYY dc]bh Zj Y cf'h fYY dc]bhg]! 'gYVebXg VYWi gY Uhi Y 'lja Y cVj ]ci g'm< c``UbX \UX'; i ]XYfg h Yb ]bghYUX cZ9i fc'' 6i hcZVei fgY h Y a UVX]bY ]bXi ghmk UbhYX ]hic 'VY h fYY dc]bhZj Y gYVebXg 'VYWi gY cVj ]ci g`mh UhhYbh cZU gYVebX ]b hYfa g'cZh Y 'a cbYmh Ym VIIb a U\_YZ'h Y ZUghYf nci 'a U\_Y h Y fYY `gd]b h Y a cfY a cbYmnci 'a U\_Y ]b 'h Y YbX'' 6YVIVi gY U` 'h cgY Hybh g'cZU gYVebX UXX i d'k \Yb nci 'lja Yg ]hVmh Y h ci gUbXg UbX h ci gUbXg cZg cha UVX]bYg lja Yg 'h Y bi a VYfg cZd UnYfg d'Unjb[ 'h Ya 'Yj Yfmg]b[ 'Y XUmUWicgg h Y mYUf''H\Uhg A ghU Hybh cZU gYVebX''

6i h`\_Y`nci `gUnž'=jY`gYYb`cb`]bY`g`cha UVX]bYg`VWb [Ua V`Y`h`]fhmcf`Zcfhmh]a Yg`U`a ]bi hY" Bck `]Znci `h]Y`i d`Yj YbhZfYei YbVh k ]h``\][\`UVMVygg]V]]hm'iGc`h`Y`h`]b[`kY`U`gc`\_bck`UVci h]g`h`UhdfcV`Ya`[Ua V`]b[`]g`jYfma i VX`fY`UhYX`hc`h`Y`cddcfhi b]n]Yg`hc [Ua V`Y`k]h`]b`U`dUff]Wi`Uf`UfYU"`Gc`]Znci jY`[chU`\][\`Yj YbhZfYei YbVhiUVh]j]hmk]h`U`\][\`mUVMYgg]V`Y`dfcXi Vhzh\cgY`hc ZUMcfg`U`cbY`]Znci fY`j i`bYfUV`Y`cf`gi gWYdh]V`Y`\UjY`Ua U^cf`]a dUVh]b`hYfa g`cZXYjY`cd]b[`U`dfcV`Ya"

KY\_bck 'h\UhU[U]bž=^{gh[UjYmci 'h\YYIUadYVYZcfY"'H\Y`\][\YghdfYjUYbVY'cZdfcV`Ya [UaV]b[ ]b'h\YkcfX`]g'@Ug JY[Ug'VYVUigY`]hg'h\Y`acghgUhifUHYX`Ybj]fcbaYbhUbX`]hg`[ch[UaV`]b[`dfcXiVM'CZV&ifgY'bck`kYU``\UjY`@Ug'JY[Ug`]bcif Zfcbhfcca`]b'HYfag`cZh\Y'HUV`YhgžacV]`Ygž=bHYfbYhH\UhkY`[UaV`Y`cb"KYjY`[chH\fYY'h\cigUbX`cb`]bY`[UaV`]b[`g]HYg'h\UhkY VUb`[c'hc`UhU`dig\`cZU`ViHhcb"'9ZYVMjjY`mkYbck`Xc`\UjY'h\Uh\][\`UMVYgg]V]]hm'i

Bck [Znci UXXYX Ubch Yf ghfi VhifU VXUfUVHYf]gh]W2 UW\_dchg]nY2 k Y \_bck 'h Uh\i [Y'UW\_dchg [YhdYcd Y hc [Ua VY]b 'h Y 2]fgh d'UWF" H\Uhg U'ghfi VhifU 'VXUfUVHYf]gh]Wh Uh]g'i gi U`mUggcV]UHYX k ]h. UVei ]g]h]cb"; Yhh]b[ 'dYcd Y hc [Ua VY'' K Y \_bck 'cb fc``cj Yf k YY\_g'cb 'h Y `chhYfmZUf'a cfY'dYcd Y [Ua VY k \Yb 'h YfY g'U'fc``cj Yf k YY\_" Gc ]Z=k UbhYX hc XYg][b nci 'h Y a cgh UXX]Wh] Y'UVh]j ]hm=X'XYg][b nci 'U'g`cha UVX]bY 'h Uh\Ug'U'VXUbWY cZk ]bb]b[ 'U'a ]`]cb'dci bXg'dYf gd]b ]b'U'\][\`mUVWYgg]V'Y UfYU"

CZV/cifgY'k \YfY'Xc'nociZ]bX'h\cgY'h\]b[g3'NciZ]bX'h\Ya']b'@Ug'JY[Ugz'5hUbh]W7]hm'KYfY'hU\_]b['UVcihg]hiUh]cbU`UbX ghfiVhifU`ZUVhcfg'Vca]b['hc[Yh\Yf''H\Yb'nocighUfhhc'h\fck]b``chg'cZch\Yf'h\]b[g''

K Y fYWYbhmX]X U fYj ]Yk UbX k Y Zci bX cj Yf gYj YbhmX]ZYfYbhghfi Wh fU WXUfUWWYf]gh]Wg k ]h ]b U g cha UWX]bY" 5bch Yf fYU m ]a dcffUbhcbY ]g gca Yh ]b[ 'h Uhk Y WU``dgmWXc`c[ mcZh Y bYUf'a ]gg" =b U``g cha UWX]bYgža cghgWfUhWX WUfXgž]b ZJWha cgh [ Ua Yg`\Uj Y k \Uhk Y WU``bYUf'a ]gg`YI dYf]YbWYg" Hnd]WU``mcb U g`cha UWX]bY h Y fYY`g UfY ``]bYX i d` ``gcffm'H\Y fYY`g UfY h YfY UbX ]Znci `a UhWX h fYY Zi ]hgma Vc`g`]b U``]bYžk ]b U df]nY" F YY`gd]bg ``Ya cb" F YY`gd]bg ``Ya cb" F YY`gd]bg ``Ya cb 'i ghUVcj Y cf i ghVY`ck 'h Y dUm`]bY UbX h Uhg U bYUf'a ]gg"

 $H \setminus Y \land Jb[$  k  $Y Zci b X ]b a mfYgYUfW Zcf ]bghUbWYZ]b a mck b fYgYUfW = i gYX \nc a YUgi fY dYcd Y g \YUfhfUhYg k \]Y \h Ymk YfY$  $<math>UVh U \mathcar{m} [Ua V]b[$  "K Y i gYX \nc [ Yhh Ya \nc \h]b\_Uci X k \]Y \h Ymk YfY [Ua V]b[ "K \UhVWa Y \h fci [ \ j YfmVYUfmZca \h Uh]g  $h UhdYcd Y [ YhUfci gYX bchcb \mbox{mk} \Yb h Ymk cb Vi hUgc k \Yb h YmYI dYf]YbVYX \h YgY bYUf a ]ggYg" Cf k Y Ugc Zci bX$  $[ Ua V Yfg ghUfhhc WfYUhY bYUf a ]ggYg h Ya gY j Yg" Gc ]Z = di hU a UhVX Z]Z = di hU VYhcb \nca cffck \h Uh9b[ `UbX UfY [ c]b[ \nc VYUh$  $; Yfa UbmUbX ]hYbXg i d VY]b[ `cbY!b]` UbX ]hk Ug U dYbU \mmh Uhk Ug [ ] Yb \nc ; Yfa Ubm'5 g U \UfX!VtfY [ Ua V'Yf = a ][ \hgUm=$  $k ci X \Uj Y k cb a ma cbYm]Zh UhfYZfYY \UXb h[ ] Yb h Uhgh d]X XYWg]cb ]b h Y g]| mgYj Ybh a ]bi H \nc Uk UfX U dYbU \mm = h fb$  $k \Uhk Ug WYUfmU`cg]b[ Yl dYf]YbWrz = j U]XUhY UbX = h fb ]h]bhc U cbY k \YfY = k ci X \Uj Y k cb ]Zbch ]b[ \UddYbYX"$ 

Gc h Y ei Ygh]cb =a 'U'k Ung Ug\_YX VmdYcd Y k \mXc [ Ua V Yfg Vebg]ghYbhm[ Ua V Y ]Zh YmfY VebghUbhm`cg]b[ 3; Ua V Yfg Xcb h VebghUbhm`cgY"; Ua V Yfg WebghUbhmbYUf mk ]b UbX h UhbYUf mk ]bb]b[ []g d \ng]c c []WU`mfY]bZcfV]b[ "`H\Uhg k \mg`cha UWX]bYg UfY h Y dYfZYWhYI Ua d Y cZ[ ]j ]b[ ``chg UbX ``chg cZbYUf a ]gg YI dYf]YbWfg" H\YmfY dfYdfc[ fUa YX hc Xc h Uh' GWUHWX WUfXg ]b hYfa g cZh Y k Umh YmfY XYg][ bYX"

5bmh]aYnci gWUWX cZU gWUWX WUFXnci a][\hgWUWX cZh\Yv&) ei]Xžv&) žnci \UjYUbch\YfZcifh\]b[ghcgWUWX cZ \cd]b['h\Uhv&) k]``WaY`id''=hXcYgbhWaY`id`Vihnci gh]``ZY`hUfcigYX'h\Uhnci bYUfmk cbcb'h\Uh'Gc'h\Uhg'U'WUgg]W k\Yb'nci jY`[ch\][\`YjYbhZYeiYbWnUbX'nci Weid`Y`]hk]h\bYUf'a]gg'UbX'h\Yb'nci 'UXX`]b'h\YgcibXg'cZh\YWe]bg'Xfcdd]b[ ]bhc'h\Y'hUnžh\UhUWeigh]Wik\Yf\Yf`]hg'aig]Wd`Um]b['cf'k\UhYjYf''

5 ``h\YgY'h\]b[g`\UjY'Ub]a dUVh]b HYfa g`cZVXUb[]b[`ncif`dgnVXc`c[n'i: cf`]bgHUbVYž=X]X'U``chcZfYgYUfVX`]b'h\Y``UHY'- \$g`YUfm &\$\$\$g`cb'h\Y`G]a dgcbg`g`cha UVX]bYg'' < YfY`]g'h\]g``k\Uh\UddYbYXžk\Yb'=Z]fghgHUfHYX`fYgYUfVX]b[`h\Y`g`cha UVX]bYg`]Znci`cc\_YX`Uhh\Y`bUa Yg`cZg`cha UVX]bYg`VUW\_]b'%, \*``%, +žh\Ymk YfY`WU``YX'h\]b[g``]\_Y'7Ug\`Dc]bhž'7Ug\`@]bYž'5VHjcb`6Ub\_ž D][[m6Ub\_žA cbYm6Y`H'H\YgY`UfY`U``bUa Yg`h\Uhgi [[YgHYX'h\]g`]g'k\YfY`nci`VVIb`[Yha cbYmZca žbchk\YfY`nci`VVIb``cgY`]h'H\YfY`k YfY`bUa Yg`k\YfY`=k ci`X`VU``UVci ghJVU``mUhhfUVhjjY`bUa Yg`B]Zm:]Zmz`BUi [\hm6i hB]WfžFYY``: i b`gdY``YX`F!9!9!@'

Bck 'h ]b[g']\_Y'h Uhih Y ]bZi YbW cZgci bXZih Y ]bZi YbW cZVé ci fZih Y Yj Yb ZiYei YbWz cdYfUlj Y VébX]fjcb]b["K \Uhi=a 'gUnjb[ ]g'h Uhi ``'h YgY 'h ]b[g'h Y cb'mfYU `X]ZYfYbW VYlk YYb j ]XYc[Ua Yg'UbX'g'cha UW\]bYg'k YfY 'h Y g\_]```Yj Y `UbX'h Y ZJVlih UhcbY ]g'd'UnYX Zcf'dc]bhg UbX cbY ]g'd'UnYX Zcf'a cbYn'i  $\pm$  ZJVlii'y Yfm\UfX VéfY g'cha UW\]bY'd'UnYf ''fYa Ya VYf cb'U'md]VU'g'ch a UV\[]bYZ]Znei [c']bhc U'di V'h Y'a cghinei 'WUb'k ]b ]g'a UnVY v+\$"  $\pm$ g' 4 gh]b]b]b]db]hy]a U`mga U``Wéa dUfYX he'a cghicZih Y [Ua V]b[YZ]Znei [c']bhc U'di V'h Y'a cghinei 'WUb'k ]b ]g'a UnVY v+\$"  $\pm$ g' 4 gh]b]bY'd'UnYfg Xc bchd'Umhe'k ]b'a cbYn'i H\Ymd'Um k ]h 'a cbYmfUh\Yf 'h Ub Zcf']hUbX'h Y]f'k \c'Y'd\]'cgcd\m]g'he ghUmcb'h Y'a UN\]bY'Ug'cb['Ug'dcgg]V'Y i g]b[''h Y 'YUghUa ci bhcZ a cbYmfUh\Yf 'h Ub Zcf']hUbX'h Y]f'k \c'Y'd\]'cgcd\m]g'he ghUmcb'h Y'a UN\]bY'Ug'cb[''Ug'dcgg]V'Y i g]b[''h Y 'YUghUa ci bhcZ a cbYmfUh\Ufng ]XYbf]VU' he'k \Uhi ]XYc[Ua Y'd'UnYfg'Xc'''H\Ymdi hh\Y]f''' k \Yb'=k Ug'd'Un]b[''GdUWf'  $\pm$ j UXYfg'UbX'; U'U m=X'di h a m%\$`dYbWf']b'UbX'=k ci 'X gYY \ck'''cb[''=Wéi 'X'a U\_Y'h UhiYb'dYbWf'`'Ugh'G'cha UN\]bY'd'UnYfg Xc''h Y'gUa Y'h ]b['''H\Ymk U\_ ]bhc Ub'UfWUXY'k ]h 'v\$\$'''5 [ccX XUm]g'k \Yb'h Yma U\_Y'h Uhv%\$'dci bX ``UghZ]j Y \ci fg'''5 'VUX XUm]g'k \Yb'h Uhv%\$'dci bX [cYg']b'Hyb'a ]bi H'g'''C\_Un\$

Bck 'h\Y'h]b['UVci hg`cha UW\]bY d`UnYfg`UbX'j ]XYc[Ua Y'd`UnYfgž]b'g`cha UV\\]bYg'h\Y'a cbYm]g'U'k UmcZ\_YYd]b['gWtfY" K\Yb'=hU\_YX'UVci hh\]g']XYU'cZj ]XYc[Ua Y'd`Un]b['VY]b['U'bcb2]bUbV]U`Zcfa 'cZ[Ua V`]b['zcVj ]ci g`m=VWa Y Zca 'U'k cfX k\YfY`=\UX'gdYbhZci f`mYUfg'fYgYUfV\\]b['[Ua V`]b['UbX'h\Yb'fYU`]gYX'h\YfY'k YfY Wta a cbU`]h]Yg']b'h\Y'dgmV\\c`c[mcZ j ]XYc[Ua Y'd`Un]b[''=X]Xb hVta Y'Uh]hZca 'h\Ych\Yf'k Um'

Bck cZWci fgY [Ua V]b[ UbX [Ua ]b[ ]g ghUff]b[ hc Wcbj Yf[ Y"5``h Y \_]bX cZdgnWXc`c[ ]WU``hYVXb]ei Yg h UhUfY i gYX ]b hYfa g cZ fYdYhJhj Y d`Um]b j ]XYc[ Ua Yg UfY i gYX ]b g`cha UVX]bYg" F ][ \h7 Ug]bc. =gi ddcgY h\Uhg`L !6cl "

8f; f]Z]h g. M/g YI UWhm' =h'i ghcdYfUhYg cb'cdYfUh]b['WebX]h]cb]b["H\Uhg YI UWhmk \Uh]h]g"=Z=k Ubh "h Y h ]b[']g'h UhYj Yb k ]h bYUf'a ]ggYgžh Ym\Uj Y hc VY UhU WffHU]b "Yj Y" Gca Y cZa mWe "YU[ i Yg ]b 7 UbUXU'h YmZci bX ci hh Y cdh]a i a 'dYfWrbhU[ Y Zef bYUf'a ]ggYg hc k cf\_ ]g VYhk YYb UVci h' +i hc (&i "H\]b[']g ]Znci [YhbYUf'a ]ggYg U``h Y h]a Y ]hg U V]h`]\_Y Wimk c Z'Mci \_bck 'h Uhinci 'bYj Yf'k ]b" 6i hk \Uhh YmXc ]g "]\_Y Ub cdh]a i a "Yj Y" 5fci bX UVci hU h.]fXž'i ghcj Yf'U'h ]fX cZh]a Yg nci [YhU bYUf'a ]gg ]g Ybci [\ hc \_YYd nci d'Um]b['U[ U]b UbX U[ U]b"

Bck j ]XYc[ Ua Yg k cf\_ cb h Y gUa Y df]bV]d Y"H Ym[ ]j Y nti U chcZbYUf k ]bb]b[ YI dYf]YbWrg" =gUmh Y dgnWkc c[ ]W ZYY ]b[ g ]b Wfa g cZk \UhdYcd Y ZYY k \]Y h YmfY d Unjb[ g cha UW ]bYg cf j ]XYc[ Ua Yg gYYa hc VY j Yfmg]a ]Uf" H Y VcXmg d ng]c c[ m ]b Wfa g cZUfci gU k \]Y nti fY d Unjb[ cf YgWdY UbX fY UI ]b[ žXY!ghfYgg]b[ "H YgY UfY U Vta a cbU ]f]Yg h Uhnti ZbX" H Uhg k \m=Xc Ug a i W cb j ]XYc[ Ua Y UXX]Wfcb Ug =Xc cb g chg bck "=h ]b\_ ]b Wfa g cZk \Uhg \UddYb]b[ k ]h nti b[ gHfg ]g h YmfY d fc Uu ]b[ žXY!ghfYgg]b[ "Ch YgW UfY U Vta a cbU ]f]Yg h Uhnti ZbX" H Uhg k \m=Xc Ug a i W cb j ]XYc[ Ua Y UXX]Wfcb Ug =Xc cb g chg bck "=h ]b\_ ]b Wfa g cZk \Uhg \UddYb]b[ k ]h nti b[ gHfg ]g h YmfY dfc VUV mbck d Unjb[ a cfY [ Ua Yg h Ub [ Ua V ]b[ https://tex.cb/g Chg Wb mYUfg U[ c nti k ci X \Uj Y [ chU ga U ``dfcdcff]cb d`Unjb[ g chg UbX Vi njb[ gWUHW WUfXg YHW K Y j Y [ ch`Ygg \UddYb]b[ bck `UbX h YmfY dfc VUV md`Unjb[ a cfY g cV]U [ Ua Yg UbX a cfY j ]XYc[ Ua Yg VYWI gY h Uhg k \Uhh YmWb Xc Uh \car{Y}"

F][\h7Ug]bc. C\_Um'A cj]b[UkUmZca`g`chg`bck"6`UW\_UW\_UbX`fci`YhhY`fYaU]b`h\Y`a cghdcdi`Uf`WUg]bc`[Ua Yg"<ck`Xc`nci UWMci bhZcf`h\Y]f`dcdi`Uf]hmZca`U`dgnWXc`c[]WU`dYfgdYWhjY3K\Uh[fUh]ZWUhjcbg`Xc`h\YmcZYf`[Ua V`Yfg3

8f; f]Z]h.g. H\Y Z]fghh,]b[`=\Uj Y hc gUm]g h\UhdYcd Y hU\_UVci hh\Y dgmV&c`c[mcZ[Ua V`]b[`UbX fYU``mh\YfY`]gb hU dgmV&c`c[m cZ[Ua V`]b[`VYVUi gY h\Y dgmV&c`c[mcZd`Un]b[`U`g`cha UV&]bY`]g hchU``mX]ZYfYbhh\Ub h\Y dgmV&c`c[mcZd`Un]b[`dc\_Yfžk \]W\]g [U hchU``mX]ZYfYbhh\Ub h\Y dgmV&c`c[mcZd`Un]b[`dc\_Yfžk \]W\]g hchU``mX]ZYfYbhh\Ub h\Y dgmV&c`c[mcZd`Un]b[`fci `YhY''

 $F ci YhhY cVj ]ci g`nž = d`Umfci YhhY UbX = bYj Yf d`Umfci YhhY hck ]b`a cbYn'i: cf`a Y`]hg`UVci ha Ul ]a ]g]b[`h.Y`Ua ci bh=a dfYdUfYX hc`cgY'' Hnd]/WD`m=a YUb ]b`h.Y`Wg]bc`\YfYž = [chc`a m; U`U`7 Ug]bc'' H\Ymgh]``\Uj Y ZJzmidYbVY`VX]dg'' Hnd]/WD`mk \Uh= Xcž = ``di hv)`k cft\cZZJzmidYbVY`VX]dg`U``cj Yf h.Y`VcUfX'' = j Y`dfcVUV`m[chhk c'h.]fXg`cZh.Y`bi a VYfg`V&j YfYXžc_Un8`Bck 'h.Uh ghfUhY[ma YUbg'h.UhVUg]/WD`mk ]h.``f ghv&$`=VWb`i gi U``ma U_Y`h.Uh`Ughtk c'cf`h.fYY`\ci fgžc_Un8`H\Uhg'k \Uh=Xc'''=hfinhc a Ul ]a ]gY`d`Un'i'C WWg]cbU``m=j Y`CchY`h.UhghfUhY[mUbX'=j Y``cghYj Yfnth.]b[`]b`ZJZYYb`a ]bi hYg'''K \Yb`=j Y``cghZj=j Y``cghUbX'= ghcd`d`Um]b[''$ 

Bck hY dgmWXc`c[mcZd`Unjb['dc\_Yf"CVj]cig`mdc\_Yfž'V`UW\_UW\_hYgY`UfY`[UaYg`h,Uh]

`*m*i= \ H

VXUa d]cbg\]dg`U[U]b`UbX`U[U]b`UbX`U[U]b`]Z]hk Ugb hU`[Ua Y`cZg\_]```Bck`cVj]ci g`mh\YfY`UfY`VXUbVY`Y`Ya Ybhg`]b`hYfa g`cZh\Y VWfXg`h\Uhnoi fY`XYU`hUbX`h\Uhg`k\Uhnoi Xc''H\Y`dgmVXc`c[m]g`d`Um]b[`k]h\`h\Y`\UbX`h\Uhnoi jY`VYYb`XYU`H'

6i hV`UW\_UW\_žk \Uh=Z]bX`Ua Un]b[`]g`h\Uhk \Yb`9Xk UfX`H\cfdY`k fchY`\]g% \*&Vcc\_ cb`\ck`hc`k]b`UhV`UW\_UVX`g\ck YX VUg]MU`m]Znci fY`U`[ccX`WUfX`Vei bhYf`nci`\UX`U`VYhhYf`cXXg`k]bb]b[`h\Ub`h\Y`WUg]bc"Bck`cZVei fgY`k \Yb`nci`[YhWUfX

CZWci fgY ]Znoci jY [chUb i b]a]NYX Ua ci bhcZa cbYmi ghVYN]b[ cb VUg]WU`mXci VY hY Ua ci bhYUWX h]a Y noci k]`Yj Ybhi U`m [Yhnoci f`a cbYmVUW\_UbX`a cfY''6i hnoci Wci X`VY``]NYfU`m]bhc \i bXfYXg cZh ci gUbXg cZdci bXg VYZcfY Xc]b[ h\Uh'=Znoci k YfY [Ua V]b[ Y`Yj Yb cf'hk Y`j Y`h]a Yg`]b U`fck UbX]hk Ug [c]b[ U[U]bghnoci "'=hg Ua Un]b[ ]Znoci ghUfhUhcbY UbX Xci V`Y ]hž Xci V`Y ]hž Xci V`Y`]h\ck `ei ]W\_mh\Y`a cbYm[ cYg`i d"

K ]h fci YhhY Zcfa Yž]h]gb hUVci hk ]bb]b[": cfa Y ]hg UVci hhU\_]b[ dUfhUbX a UI ]a ]g]b[ a mZ b k \]Y =a Xc]b[ ]h 5[ U]bžU fYU`m[ ccX YI Ua d`Y & UgQ]b GhcW\_\c`a k \YfY k Y U``[ ch[ ]j Yb U`\i bXfYX ? fcbU" 9j YfmVebZ/fYbWY XY Y[ UHY k Ug [ ]j Yb U \i bXfYX ? fcbU hc d`Um]b h Y 7 Ug]bc 7 cga cdc`k \YfY k Y k YfY ghUn]b[ "5hh\Y YbX cZh\Y b][ \h=VUa Y ci hUbX =\UX gca Yh]b[ `\_Y Zci f`\i bXfYX UbX ZZm? fcbU gca Yh]b[ UVci hv (\$ d`i g" H\Uhk Ug U Vea d`YHY Vcbi g" =VUa Y ci hU k ]bbYfž YgdYV]U`m VYVUi gY ]hk Ugb hYj Yb a ma cbYmc ghUfhk ]h " =k Ug U Vgc i H`mVf]`]Ubh

6i hfci `YhhY`]g`U`W¢a d`YhY`mX]ZZYfYbhdgmW&c`c[ m"Gca Y`dYcd`Y`A`ghd`Umih,Y`bi a VYfg"`Gca Y`dYcd`Y`A`ghd`Umih,Y`W¢`ci fg" Gca Y`dYcd`Y`UfY`A`ghU``UVci hih,Y`bi a VYfz`h,Y]f``i W\_mbi a VYf`cf`k \UhYj Yf"6i hih,Uhg`W¢a d`YhY`mX]ZZYfYbhdgmW&c`c[ mih,Ub dc\_Yf`VYWUi gY`cVj ]ci g`mih,YfY`g`bc`g\_]``]b`fci `YhhY`k \UhgcYj Yf"

F][\h7Ug]bc. Mci a Ybh]cbYX'h\Y [Ua V`Yfg`ZU``UMh'i7ci X`mci ei ]W\_`mYI d`U]b`k \Uhg`a YUbhVmh\]g`UbX`\ck`]hUZZYMbg`d`UhYfg cb`U`dgmWkc`c[]MU```Yj Y`3

8f; f]Z]h\g. =Xcb hVY`]Yj Y`Ubm[Ua V`]b[``=Xcb hh\]b\_`UbmZcfa cZ[Ua V`]b[`g\ci X`VY`VUbbYX`i b`Ygg`h\YfY`]g`gV]Ybh]Z]W

g\ci X'bYj Yf'VY'i gYX']b'UXj Yfhg"

Bck '=a 'U'VY']YjYf'N Uhk Y``]jY']b'U [fck b!i dža Uhi fY'gcV]Yhm' =dYfgcbU`mVY']YjY'N UhN Y [Ua V']b[']bXi ghfmg\ci 'X`\UjY'U f][\hhc'a Uf\_YhUbX'UXjYff]gY'N Y]f'dfcXi Vhg'Vi h]hg\ci 'X`VY'XcbY']b'U'k UmN Uh\_]bX'cZ'cc\_g'UhgV]Ybh]ZJWYj]XYbWY'Zcf UggcV]JUf]cbg'cZdfcV'Ya g'k]N 'N cgY'dUff]W'Uf'UMJj]]Yg'': cf']bghUbVY'N YfY g'bc'Yj]XYbVY'N UhN Y 'B Uh]cbU`@chYfmVUi gYg'Ubm dfcV'Ya g'UhU``fYU``m'Nci '[YhN Y'cXX'dYfgcb'N Uha UmVY'gdYbXg'hcc'a i VK']b'HYfa g'cZh Y'Ua ci bhcZh]W\_Yhg''6i hfYU``mN YfY g\ci `Xb hVY'' =a `\Uddmhc'gYY'N Y'bUh]cbU``chYfmUXjYff]gYX']b'N Y'a ]XX'Y'cZ7 cfcbUh]cb'GhfYYH'=hg'U'X]gWebh]bi ci g'Zcfa 'cZ UVhJj]hmN UhXcYgb hHYbX hc'WI gY'dfcV'Ya g''=\UjY'a cfY'dfcV'Ya g'Zcf']bghUbWY'\Uj]b['gWUWX WUfXg'UXjYff]gYX''

Bck =k fch/ hc h, Y \ca Y cZJW UbX =gUJX hc h, Ya =j Y 4 ghgYYb nci f bYk XYZbJrJcb cZk \UhU \UfX Zcfa cZ[Ua V]b[ ]g UbX Vm h, UhXYZbJrJcb gWUHWX WUfXg UfY U \UfX Zcfa cZ[Ua V]b[ mYhnci fY UXj YffJgJb[ ]hth fci [ \Yj Yfmdfc[fUa cb +J ]b U hnd] WU bJ[ \h'H\Ymk fchY VUW\_ hc a Y UbX gUJXž 8 YUF 8 f; f]ZZh gž h, Ub\_ nci Zcf nci f YhYf" =WUb Uggi fY nci 'h, UhgWUHWX WUfXg UfY bch U \UfX Zcfa cZ[Ua V]b[ fYgdYYhUV Y ci hYhg" Gc =k fchY VUW\_ UbX gUJX XcYg h, Uha YUb nci 'W i X di h U fci 'YhY k \YY`]b HYgVc ]hgi XXYb mVYVca Yg U gcZhZcfa cZ[Ua V]b[ 3 CZVci fgY h, YmXJXb hVch, Yf hc Ubgk Yf h, UhdUff]W Uf cbY"

 $H \setminus Y [XYU H Uhk \setminus YfY noi `gY```gca YH ]b[`XYZ]bYg k Uh]g U \setminus UfX cf gcZhZcfa `cZ[Ua V]b[`]g``i X]Wici g''`6i h]b HYfa g cZUXj Yff]g]b[ k Y j Y bck [chU g]h Uh]cb VYVUi gY cZH Y ; Ua V]b[`5VhH Uhg H Y cbY a U cf X]ZYfYbWY dYcd Y k ]```Uj Y fYU]gYX Zca 'h Y ; Ua V]b[`5VhH Uhg H Y cbY a U cf X]ZYfYbWY dYcd Y k ]```Uj Y fYU]gYX Zca 'h Y ; Ua V]b[`5Vh]g H Uhh Y ZYYXca 'hc 'UXj Yff]gY `cUXg cZX]ZYfYbHZcfa g cZ[Ua V]b[`UVHj ]hm]g k [XYgdfYUX bck '' Znoi `g]hXck b hcb][`hz]Zh YfY g bchU ZcHVU``a UhVX cb HJ k \Uhnoi ```[Yh]g H UhVYZcfY HYb c WcW_`cUXg cZUXj Yffng Zcf cb]bY `V]b[ c 'h Yb UZYf HYb c WcW_`cUXg cZUXj Yffng Zcf cb]bY `VUg]bcg `UbX cb]bY dc_Yf''C Vj ]ci g`mHUf[ Yh]b[`k ca Yb VYZcfY H Y HYb c WcW_`k UHYfg\YX _]bX cZh ]b[`UbX a Yb UZYf H Y HYb c WcW_`k UHYfg\YX ''$ 

=b UXi `hdfc[fUa a ]b[`=\Uj Yb h[chU`dfcV`Ya žc\_Un& 6i ha m\_]Xg bck žh\YmfY hnd]WU``mi d`i bh]`b]bY c WcW\_ž=Xcb hh\]b\_ h\Ym g\ci `X`VY`Vca VUfXYX`k ]h\ UXj Yfng'''=Xc'h\]b\_ ]b hYfa g`cZUXj Yfn]g]b[`UbX`a Uf\_Yh]b[`]g h\Uh]hWb VY`UXj YfngYX hc UXi `hg`]b

 $k m dYcdYgYa hch]b_hUhhYUhhhYUhhhYdYcdY=gdYU_hcgUmkYZhYmjYWU gYX]hhYagYjYg''< ck]ghUhXZfcdYgdYUhZfca gcaYcbYk \c[cYgg_]]b[UbXVfYU_ghY]fY[3$ 

 $H \setminus Y dc]bh]g nci j Y di hnci fgY Z]b U dcg]h]cb k \setminus YfY gca Yh ]b[ a YX]WU`m \setminus Ug [cbY k fcb[ `VYWU gY nci `UfY ]b U \setminus ][ \setminus !f]g_g]h Uh]cb'''K Y gh]``HYUhga c_Yfg Zcf `VUbVYf'''K Y gh]``U Ve \c`]Vg'' Nci `Vei `X`Uf[ i Y U``h cgY UfY gY Z]bZ]VHYX hc gca Y YI hYbhVi h h YfY XcYg gYYa `hc `VY h ]g _]bX cZX]ZYfYbWY VYhk YYb dYcd Y g dYfWYdh]cbg cZ[ Ua V ]b[ `Wea dUfYX hc ch Yf hndYg cZdchYbh]U` UXX]Wh] Y UVh]j ]hm'i 6i h=k ci `X`Uf[ i Y h Uhh YfY UfY Veghg hc h Y W]a ]bU` gnghYa Zhc h Y \YUh `gnghYa `Vi ha cghcZh Ya `f gh[ c i bbch]WYX 'VYVUi gY h YmfY `WUggYX Ug gca Yh ]b[ `YgY''$ 

5[U]bž=kUgʻigh[c]b['hc`gUm=jY`kf]hhYb``cUXg`cZUff]WYg`Zcf``Y[U`aU[Un]bYg`YhW"UbX`=jY`UddYUfYX`]b`Wéifhg'U'biaVYf`cZU hJaYg`cb'h\Y`VY\U'ZcZ]bX]j]XiU'g`k\c`\UjY`U'[UaV]b['dfcV`Ya"CbY`cZh\Y`h]b[g'h\UhWéaYg'h\fci[\`h\YfY`]g`]ZncifY`]b UbX`ncigUm=X]X`h]g`VYWUigY`=\UX`Ub`U'Wé\c``dfcV`Ya`cf`=X]X`h]g`VYWUigY`=\UjY`U'[UaV]b['dfcV`Ya"GUn]b['nci`\UjY`Ub U'Wé\c``dfcV`Ya`[Yhg`nci'U`][\hYf`gYbHYbWY"

Gc U[U]b ]ZdYcd Y \Uj Y [chWe!XYdYbXYbWhUbX k Y cZYb Z]bX h Uh[Ua V Yfg gca Yh]a Yg \Uj Y dfcV Ya g k ]h. U We\c`UbX b]Weh]bY UbX ch Yf h ]b[g"=Znoci dfYgYbh]h]b h UhWf]a ]bU`g]h Uh]cb h Uh]hg gca Yh ]b[ 'h UhVUg]WU`mU A X[Y cf U A fm i bXYfghUbXg ]g h Uhnoci fY [j] Yb a cfY `Yb]YbWhhA Ub ]Z]hg hc Xc k ]h [Ua V ]b[ "5[ U]b h Uhg h Y ]XYU h Uhgca Yh]a Yg ]hg U \]XXYb UXX]Mgcb ]g h UhVYVUi gY ]hg bch ]h \Ug VYYb a YX]WU`mfYVe[ b]gYX bck `Vi hgh]``]b U Vei fng]hi Uh]cb ]hXcYgb h[YhhA Y gUa Y \_]bX cZk Y][ \hUg ]Znoci j Y [chUbchA Yf UXX]Mg Y hmdY cZdfcV Ya "

F][\h7Ug]bc. `C\_Um'>i ghhc Z[b]g\ž]b`nci f`k f]h]b[g`nci `gUmh\UhcdYfUhcfg`g\ci `X`di fgi Y`W'h]b[`YX[Y`dfchcV&`g`hc`Ybgi fY d`UmYf`dfchYWfcb''`7 ci `X`nci `Vf]YZmci h]bY`nci f`j ]g]cb`Zcf`U`ZU]fz`gcWJU`mfYgdcbg]V`Y`UbX`gi ghU]bUV`Y`[Ua V`]b[`]bXi ghfn8

8f; f]Z]h.g. K Y``=Xcbh\_bck k \Yh.Yf a mj ]g]cb]g gi ghU]bUV`Y'' =j Y fYgYUfVXYX h.]g`UfYU`Zcf`gc``cb[`bck`UbX`=ghUfhYX`hU\_]b[ UVci hfYgdcbg]V`Y`[Ua V`]b[`VUW\_]b`h.Y`a ]X!% - \$g`UbX`dYcd`Y`\UXb hYj Yb`\YUfX`cZh.]g''8]Xb hYj Yb`\_bck`h.Y`k cfXg fYgdcbg]V`Y`[Ua V`]b[`cf`gcW]U`fYgdcbg]V]`]mnk]h.]b`h.Y`[Ua V`]b[`]bXi ghfm!

Bck cZWci fgY mci WUb h[YhUb cdYfUh]b[``]WYbgY i b`Ygg mci fY`g\ck]b[žUh`YUgh]b h\]g Wci bhfmi b`Ygg mci fY`g\ck]b[`k\Uh mci fY`Xc]b[`]b`HYfa g`cZVY]b[`gcV]U`mfYgdcbg]V`Y`]b`HYfa g`cZd`UnYf`dfcHYWfjcb`UbX`\Ufa`a]b]a]gUh]cb"

=jYgdYbha i W\cZamfYWYbhfYgYUfW\Hfm]b[ hcUXjcWUhYh\YfYUfYh]b[gh\UhcdYfUhcfgWUbXchc\Y`dd`UnYfgaU\_Y`]bZcfaYX W\c]WYg"H\YmWUb`\Y`dd`UnYfg'h\Uh[Yh]bhc'hfciV`Y"Mci WUb`\Y`dd`UnYfg'bch]bhc'hfciV`Y`Vih[]jYh\Ya`h\Y\_]bX`cZk\Uh=WU`` U`\_]bX`cZgYUhVY`hUddfcUW\`VmU``ck]b[`h\Ya`hc`gYh`]a]hg`cf`HYadcfUf]`mYIWiXY'h\YagY'jYg`Zca`U`[UaV`]b[`g]hiUh]cb" 6Ug]WU``mhc`YadckYf'dYcd`Y``VUg]WU``mhc`[YhdYcd`Yhc`dfY!Wcaa]hUVcih\ck`aiW\'h\YmkUbhhc`[UaV`Y`]b`HYfag`cZh]aY UbX`acbYm

KY jY bok [chh\Y HYW\bc`c[mcZWtifgY`dUff]W/`Uf`mih\fci[\k]h\cb`]bY`kY jY [chVY\Uj]cifU`HfUW\_]b[`XUHU"KY`WUb`UWhU`m Xc`h\UhcZ]bY"KY jY [chbck`U`WtidY`cZWtibHf]YgžBcfkUmUbX`GkYXYb`Vch\]bHfcXiWYX`d`UHYf`WUfXgžk\]W\`aYUbg`h\UhUbm Zcfa`cZ[UaV]b[`UWfj]]mmh\YmXc`h\Ym\UjY`hc`g\ck`h\Y`d`UHYf`WUfX"`6Ug]WU``m]h`c[g`YjYfnth\]b[`h\Uhnci`Xc"`H\fci[\ VY\Uj]cifU`HfUW]b[``=\_bck`]hg`\_]bX`cZ6][``6fch\Yf!]g\`Vih]hg`h\YfY"`CbWY`[UaV`Yfg`fYU`]gY`]hg`h\YfY`hc`UWhU``mdfcHYWhh\Ya UbX`hc`\cdYZ```m]bHYfjYbY`k\Yb`dYcd`Y`UfY`[Yht]b[`]bhc`HciVY"

Bck ]b h]g Vei blfmk Y i ghXcb h hY ]XYU cZUb =8 WlfX ]g bchgca Yh]b[ hUhg j Yfmdcdi Uf" A m[ i Ygg ]g ]Zk Y hf]YX hc ]blfcXi Wr hY d UhYf WlfX \YfY glfU][ \hUk UmhUhi ghk ci Xb h\UddYb"K Y \Uj Y hc Xc h]b[ g ]b ghU[ Yg" =h]b\_ k \Uhg \UddYb]b[ bck ]g hUhYj YfmgYWlcf ]b h]g Vei blfm\Ug ]hg ck b ]bX cZVeXY cZVebXi Wi]b hYfa g cZk \Uhh\Ymg\ci X Xc ]b hYfa g cZY]h Yf hYfa g cZ[ Ua Y XYg][ b"

: cf]bghUbWY cbY cZh,Y dfcXi Whg h,Uh=XYj Y cdYX ]g h,Uhk Y \Uj Y cj Yf h,]fhmWta dUb]Yg k cfXk ]XY i g]b[ ]h 5 hcc`WU`YX; Ua ; i UfX" H\]g VUg]WU`mUggYggYg h,Y f]g\_]bYgg cZU [ Ua Y VUgYX cb h,Y ghfi Wh fU`WLUfUWWf]gh]Wg h,Uh\Uj Y VYYb XYg][ bYX ]bhc h,Uh[ Ua Y" Gc Wta dUb]Yg \Uj Y U VUg]WU`mU hfUZ]W ][ \hgnghYa "'=hk ci `X VY h,Y fYXžnY``ck žcf [ fYYb UVci hk \Yh,Yf H,Uh dfcXi Whh,YmfY [ c]b[ hc di hci h]b h,Y a Uf\_Yh]g `]\_Y mhc VY dfcVYa Uh]Whc U f]g\_mcf j i `bYfUVY gi gWfdh]V Y ]bX]j [Xi U"

7 ca dUb]Yg WUb H\Yb a U\_Y U XYW]b]cb UVci hk \YH\Yf H\Ymk Ubhhc WXUb[Y H\Y WXUfUWWf]bh]Wbz]Znci ``\_Y hc a U\_Y ]hgUZYf'