### Dca dUbc<sup>6</sup>YUWX<sup>7</sup>cbg]XYfg<sup>6</sup>c<sup>X</sup>A cj Y.<sup>5</sup> BYk<sup>D</sup>C<sup>]</sup>WY<sup>8</sup>YdUfha Ybh3

#### DcadUbc`6YUW\`]g`YId`cf]b[`fYYghUV`]g\]b[`]hg`dc`]WY XYdUfhaYbh`UZhYf`&\*`mYUfg`k]h\`6GCž`Xf]jYb`Vm`f]g]b[`Wcghg UbX`Wcaaib]hm`WcbWYfbg"



Dca dUbc '6YUWX žil G5 '! 'H\Y '7 ]hm cZ Dca dUbc '6YUWX ']g 'gh]ff]b[ i d'Wcbj YfgUh]cbg UVci h`Uk 'YbZcfWYa Ybhž'Ug cZZ]W]U`g Yl d`cfY 'h\Y dcgg]V]`]hm cZ'fY!YghUV`]g\]b[ 'U``cWU``dc`]WY 'XYdUfha Ybh UZhYf a cfY 'h\Ub 'hk c'XYWUXYg 'i bXYf 'h\Y '6fck UfX 'G\Yf]ZZ g 'C ZZ]WY fbGC E'''H\Y 'dfcdcgU``Wca Yg Ua ]X 'YgWU`Uh]b[ 'WcbWYfbg cj Yf 'f]g]b[ Wcghg Uggc W]UhYX 'k ]h\ '6GC g 'gYfj ]WYgž k \]WX '\Uj Y 'gi f[ YX 'Zfca `) ' 'a ]``]cb ']b '&\$ && 'hc 'Ub 'Ubh]W]dUhYX '` +&'', 'a ]``]cb ']b '&\$ &\* '''H\]g Z]bUb W]U``ghfU]b 'UWWci bhg 'Zcf'cj Yf '\U`Z'cZ'h\Y 'W]hm g 'Ubbi U``hUI fYj Ybi Yž'dfca dh]b[ 'fYg]XYbhg 'UbX'W]hm Wca a ]gg]cbYfg 'hc 'fY! Yj U`i UhY 'h\Y'Wca a i b]hm g'di V`]WgUZYhm bYYXg''

Hi bXfU'?]b[ž'U'Dca dUbc'6YUW\'fYg]XYbh'UbX``cWU``Vi g]bYgg ck bYfž']g'Ua cb['h\cgY'k \c'VUW\_'h\]g']b]h]Uh]j Yž'fYWU``]b[ ZUj cfUV`Y`]bhYfUWh]cbg`k]h\`dUgh`W]hm`cZZ]VWfg"`<ckYjYfž'h\Y g]hiUh]cb`]g`bch`k]h\cih`]hg`X]gU[fYYaYbhg"`7]hm`7caa]gg]cbYf F\cbXU`G][Yfgcb!9Uhcb`ghUbXg`Z]fa`m`U[U]bgh`Wihh]b[`h]Yg`k]h\ 6GCž`k\]`Y`ch\Yf`Wcaa]gg]cbYfgž``]\_Y`5iXfYm`:Yg]\_ž`\UjY`jc]WYX WcbWYfbg`fY[UfX]b[`h\Y`ghUhY`cZ`6GC`ZUW]`]h]Yg"`AUmcf`FYI`<UfX]b UW\_bck`YX[Yg`6GC g`Wcbhf]Vih]cbg`Vih`UXa]hg`h\Y`W]hm`bYYXg`hc Wcbg]XYf`Vch\`Wcghg`UbX`gYfj]WY``YjY`g`]b`Ubm`dchYbh]U``hfUbg]h]cb"

# : YUg]V]`]hm'Ghi Xm']b'h\Y'K cf\_g

H\Y`Wjhm`]g`gYh`hc`\_]W\_`cZZ`U`ZYUg]V]`]hm`ghi Xm`h\Uh`k]````Um`h\Y [fci bXk cf\_`Zcf`UggYgg]b[`h\Y`j ]UV]`]hm`cZ`U`Dca dUbc`6YUW\ Dc`]WY`8YdUfha Ybh"`7]hm`cZZ]WjU`g`UfY`YmY]b[`h\Y`dfcgdYWh`cZ \]f]b[`U`Wcbgi `hUbh`k \c`WUb`h\cfci [\`m`Yj U`i UhY`h\Y ]bZfUghfi Whi fYž`dYfgcbbY``bYYXgž`UbX`cj YfU```Wcghg`UggcWjUhYX k]h\`h\]g`YbXYUj cf"`H\YfY g`bc`fi g\/'X]gWi gg]cbg`cb`h\Y ZYUg]V]`]hm`UfY`cb[c]b[`ž`UbX`bc`WcbWfYhY`XYWjg]cbg`\Uj Y`VYYb a UXY`mYh"`5`a YYh]b[`]g`g`UhYX`Zcf`H\i fgXUm`hc`fYj]Yk`Wcbgi `hUbh dfcdcgU`gž`k \]W\`k]``\Y`d`ghYYf`h\Y`bYI h`ghYdg`]b`h\]g`XYWjg]cb! a U\_]b[`dfcWYgg"

DYa Vfc\_Y`DUf\_ž`1 gh'U`ghcbY g`h\fck `Uk Um`Zfca `Dca dUbc`6YUW\ž dfcj ]XYg`U`fYWYbh`YI Ua d`Y`cZ`k \Uh`gi W\`U`g\]Zh`a Um`YbhU]`"`5ZhYf VfYU\_]b[`Uk Um`Zfca `6GC ``Ugh`mYUfž`DYa Vfc\_Y`DUf\_`\Ug`ZcW gYX cb`]a dfcj ]b[`Wca a i b]hm`fY`Uh]cbg`UbX`Ya Yf[YbWn`fYgdcbgY`Vi h \Ug`ZUWYX`]bWfYUgYX`Wcghg`h]YX`hc`YghUV`]g\]b[`]hg`ck b`dc`]WY ZcfWY''`H\Y`Wca d`YI ]hm`cZ`gi W\`U`hfUbg]h]cb``cca g``Uf[Yž`mYh cZZ]W]U`g`UfY`cdh]a ]gh]Wh\Uh`U`hU]`cfYX`UddfcUW\`Wci`X`m]Y`X`a cfY YZZYWh]j Y`di V`]WgUZYhm`gc`i h]cbg"

# 7ca a i b]hml: ]fgh: cWi g

Hifb]b[`UkUmZfca`U``cb[!ghUbX]b[`fY`Uh]cbg\]d`k]h\`6GC`ZiY`g eiYgh]cbg`UVcih`bch`fgh`Z]bUbWYgž`Vih`U`gc`Wcaaib]hm`XmbUa]Wg" =b``][\h`cZ`f]g]b[`Wf]aY`fUhYg`UbX`W\Ub[]b[`gcW]U```UbXgWUdYgž DcadUbc`6YUW\`a][\h``cc\_`hckUfXg`]bbcjUh]jY`dc`]W]b[ ghfUhY[]Yg"`H\Y`: M&)`7caaib]hm`Dc`]W]b[`8YjY`cdaYbh`ff7D8Ł A]Wfc[fUbhg`dfc[fUa`cZZYfg`ZibX]b[`cddcfhib]h]Yg`Zcf``Uk

8 Y hU]`g	
Cfh	Dca dUbc 6YUWX žIG5

Hc fYUX a cfY UVci h h Y cb [ c]b [ X]gW gg]cbg fY [ UfX]b [ U dchYbh]U`dc`]WYXYdUfha Ybh`]b`Dca dUbc`6YUWXžj]g]h<sup>•</sup>76G<sup>•</sup>BYk g UbX<sup>•</sup>@cWU<sup>•</sup>%\$<sup>•</sup>BYkg"<sup>•</sup>:cf<sup>•</sup>h\cgY<sup>•</sup>]bhYfYghYX<sup>•</sup>]b<sup>•</sup>Wcaaib]hm<sup>•</sup>dc<sup>•</sup>]W]b[ UXjUbWaYbhgžWXYW\_cihh\Y7CDGA]Wfc[fUbhgDfc[fUa"

### $XY^{V}W fUhY"$

: cfi dXUhYgž'\_YYd'Ub'YmY'cb'`cWU``a YYh]b[g'UbX'dfcdcgU`gž'Ug h\Ym'k]```q\UdY'h\Y'bUffUh]jY'cZ``Uk 'YbZcfWYa Ybh']b'Dca dUbc 6YUW\"`H\Y`WcbjYfgUh]cb`]q`'igh'VY[]bb]b[```k]``h\Y`W]hm'YaVfUW\ WW.Ub[Yžcf'a][\h']h'\c`X'cbhc'h\Y'`cb[!ghUbX]b['dUfhbYfg\]d'k]h\ 6GC 3 H]a Y k ``hY``Ug`fYq]XYbhg`UbX`cZZ[W]U`g`U`]\_Y Wcbh]bi Y hc

### dfcg'UbX'Wcbg"

5g'X]gW gg]cbg'i bZc`XžDca dUbc'6YUW\'ghUbXg'Uh'U'WfcggfcUXg" G\ci`X`h\Y`W]hm`W\ccgY`hc`dUfh`kUmg`k]h\`6GCž`ghU\_Y\c`XYfg ahfYagʻh\Y`Ym`k]``VY'Ybai f]b[ 'h\Uh'di V`]WauZYhm`fYa U]ba'U Wc``UVcfUh]i Y'YZZcfh'k ]h\'Wjh]nYbg'd`Um]b['Ub'UWh]i Y'fc`Y"': cf'bck ž h\Y`dUh\`ZcfkUfX`fYaU]bg`ibWffhU]b`Ug`W]hm`cZZ]W]U`g`kY][\`h\Y

Wcaaib]hmi]qqiYq'UbX``Uk 'YbZcfWYaYbhbYYXq"'+hibXYfqWcfYq h\Y`]a dcfhUbWY`cZ`ZcghYf]b[`dUfhbYfg\]dg`k]h\]b`bY][\Vcf\ccXg UbX'hUW\_`]b['WXU``Yb[Yg``]\_Y'Xfi['X]ghf]Vi h]cb'UbX'\ca Y`YggbYgg "U```cZ'k \]W\ Wci `X'VY'd]j chU``]Z'Dca dUbc'6YUW\ ghYdg'Zcfk UfX k]h\`]hg`ckb`dc`]WY`XYdUfhaYbh"`H\Y`\cdY`]g`h\Uh`U``cWU`]nYX UddfcUWX k ci X bch i ghfYU``cWUhY fYgci fWg Vi h'U`gc fYbYk Wcaaib]hm`hfigh`UbX`Yb[U[YaYbh`]b`diV`]WgUZYhm"

#### cZZ]W¥fg"

YbZcfWYa YbhU[YbW]YgU]a ]b[ hc Yb\UbWY Wca a i b]hm fY`Uh]cbg UbX'Yb[U[Y'cWU'g']b'gUZYhm']b]h]Uh]jYg''7UhY[cf]Yg'Zcf'dchYbh]U'ZibX]b[']bWiXY'dfc'YWhg'ZcWigYX'cb']adfcj]b['h\Y']aU[Y'cZ dc`]\\ZidfYjYbh]b['j]c`Ybh'\\f]aYž'UbX'\\fYUh]jY`m'fY\\fi]h]b[

 $H = \frac{1}{2} X Y f U^{1} b h U h U h V x d U g n Y g d f c Y W h g h U h U X X f Y g V c h$ 

8 Y hU]`g	
EiY``Yb	● k k k "WW gbYk g"Wca
	• k k k "`c WU`%\$"Wca
	• Wcdg"igXc∧"[cj

# 6Ygi WXYb'G]Y'i bg'Ui Z.'a Y]b!k ]Yb"bYh