

# **MDIA5030**

6fUbX'7i h fYg

GYa YghYf'Hk c''#'&\$%

### 7ci fgY Cj Yfj ]Yk

### GHJZ 7 cbHJWh8 YHJ]`g`

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWJhjcb	D\cbY
B]W.c`Ug F]W.UfXgcb		-	9	\$&'-',) *'))

#### GW.cc`7cbhJWh =bZcfa Uhlcb

Fcca " %&ž``Yj Y`" FcVYfhK YVghYf'6i ]`X]b[

D\cbY.'f\$&E'-',)'(,)\*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. \hdg.#gUa "Ufhg"i bgk "YXi "Ui

 $\label{eq:hamiltonian} $$HY'GWKcc``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'hc'FYgdYWM\cong \cong m5W_bck`YX[Y'h\Y'HfUX]hjcbU``7ighcX]Ubgžh\Y'6YXY[U'`fPYbg]b[hcb'WJadigŁž'; UX][U'`fP]hmUbX'5fh\/'8Yg][b'7UadigYgŁ'UbX'h\Y'B[ibbUkU`dYcd'Y'fbighfU`]Ub'8YZYbW': cf\W'5\WJXYam]b'7UbVYffUŁ'cZh\Y'`UbXg'k\YfY'YUW\'WJadig'cZIBGK']g`cWJhYX''$ 

### 5 hryb X Ub WY F Yei ] f Ya Yb hg

5 'ghi XYbh']g'Yl dYWYX'hc'UhhYbX'U```WUgg'WcbhUWi\ci fg'Zcf'U'ZJWY!hc!ZJWY'fl &: Ł'cf'V`YbXYX'Wci fgY'UbX Wca d`YhY'U```UWIji ]hiYg'Zcf'U'V`YbXYX'cf'Z ``mcb`]bY'Wci fgY"

5 'ghi XYbhik \c'Uff]j Yg'a cfY'h\Ub'%) 'a ]bi hYg'``UhY'a UmVY'dYbU`]gYX'Zcf'bcb!UhhYbXUbWY'''=Zgi W\'U'dYbU`hm ]g']a dcgYXž'h\Y'ghi XYbha i ghiVY']bZcfa YX'j YfVU``mUhih\Y'YbX'cZWUgg'UbX'UXj ]gYX']b'k f]h]b[ 'k ]h\]b'&(\ci fg"

⊒Uʻghi XYbhYl dYf]YbWrgʻ]`bYggža ]gUXj Ybhi fYʻcfʻch\YfʻcWW ff\bWrʻh\Uha U\_YgʻUVgYbWrʻzfca ʻU WUgg#UWfj ]hmi bUj c]XUV`YžcfʻYl dYWgʻhcʻVYʻUVgYbhZfca ʻUʻZcfh\Wca ]b[ ˈWUgg#UWfj ]hmžh\Ymg\ci `XʻgYY\_ dYfa ]gg]cbʻZfca ʻh\Yʻ7 ci fgYʻ5i h\cf]hmžʻUbXʻk \YfYʻUdd`]WUV`Yžh\Y]fʻfYei Yghg\ci `XʻVYʻUVWca dUb]YXʻVmUb cf][ ]bUʻcfʻWrfh]ZYX`WcdmcZUʻa YX]WU``Wrfh]ZWUhYʻcfʻch\YfʻZcfa ʻcZUddfcdf]UhYʻYj ]XYbWY''

5 '7 ci fgY '5 i h\cf]hma UmYI W gY 'U'ghi XYbhZca 'WUggYg'cf'UWfj ]hJYg'Zcf'i d'hc'cbY'a cbh\" < ck Yj Yfz'h\Ym a UmUgg][ b'UXX]hJcbU``UbX#cf'U'hYfbUhJ Y'HUg\_g'hc'Ybgi fY 'Wca d`]UbW\" '5 '7 ci fgY '5 i h\cf]hmWcbg]XYf]b[ 'th\Y [fUbhJb[ 'cZUVgYbW'a i ghVY'gUfJgZ]YX'U'ghi XYbhk ]```ghJ```VY'UV'Y'hc'a YYhh\Y'Wci fgY'g'`YUfb]b[ 'ci hWca Yg UbX#cf'j c'i a Y'cZ`YUfb]b[ "'5 'ghi XYbhgYY\_]b[ 'Uddfcj U``hc'VY'UVgYbhZcf'a cfY'h\Ub'cbY'a cbh\'a i ghUdd`m ]b'k f]hJb[ 'hc'h\Y'8YUb'UbX'dfcj ]XY'U``cf][ ]bU``cf'Wff]ZYX'gi ddcfhJb[ 'XcW a YbhUhJcb"

: cf'a cfY']bZcfa Uhjcb'UVci hih\Y'UhhYbXUbWY'dfchcWc`g']b'h\Y': UWY`hmicZ'5fhg'UbX'GcWjU`GWjYbWYg.'\hdg.#k k k "Ufhg"i bgk "YXi "Ui #W ffYbh!ghi XYbhg#UWUXYa ]W]bZcfa Uhjcb#dfchcWc`g![i]XY`]bYg#

.

### 5WUXYa]W±bZcfaUh]cb

: cf`YggYbh]U``ghi XYbh`]bZcfa Uh]cb`fY`Uh]b[ 'hc. 'fYei Yghg`Zcf`Yl hYbg]cb/fYj ]Yk 'cZa Uf\_g/cWW dUh]cbU``\YU`h\UbX`gUZYhm'Yl Ua ]bUh]cb'dfcWYxi fYg/gdYW]U``Wcbg]XYfUh]cb`]b'h\Y'Yj YbhcZ]``bYgg`cf`a ]gUXj Ybhi fY/ghi XYbh`Yei ]hmUbX`X]gUV]`]hm'UbX`ch\Yf`YggYbh]U``UWUXYa ]W]bZcfa Uh]cbž gYY`\hdg.#k k k "Ufhg"i bqk "YXi "Ui #W ffYbhqhi XYbhq#UWUXYa ]W]bZcfa Uh]cb#dfchcWc`q![i ]XY`]bYq#

### 7ci fgY 8YHJ] g

### 7 fYX]hDc]bhg '%'

### Gi a a UfmcZh\Y 7ci fgY

5 'VfUbX']g'U'Zi ]X'Ybh]mm-bYj Yf'Ybh]fY`m]b'Ub'cf[ Ub]gUh]cb'g'Wcbhfc`"'H\]g']g'VYWUi gY'W ghca Yfg'fck b' VfUbXg"'H\Y'VYghVfUbX'a UbU[ Yfg'h\YfYZcfY'gh XmdYcd`Y"'H\YmWcbg]XYf'VfUbXg']b'W `h fY'UbX'VfUbXg Ug'W `h fYg"'Bch\]b[ '\UddYbg'VmW\UbW\"'H\]g'Wci fgY'cZZYfg'mci 'h\Ycf]Yg'UbX'hYW\b]ei Yg'Zcf'gh Xm]b[ VfUbX'W `h fYg"'H\YgY'h\Ycf]Yg'UbX'hYW\b]ei Yg'k]``i `h]a UhY`ma U\_Y'mci 'U'VYhYf'VfUbX'a UbU[ Yf"

H\Y`WcifgY`dfcj]XYg`mci k]h\Y`cddcfhib]hmhc`XYjY`cdž\cbY`UbX`Wcbgc`]XUhY`X]gWJd`]bUfmg\_]``g`UbX\_bck`YX[Y`[U]bYX`]b`h\Y`Z]Y`Xg`cZDF`UbX`UXjYfh]g]b[ž`gdYWJZ]WU``m]b`fY`Uh]cb`hc`h\Y`dfUWf)WY`cZVfUbXaUbU[YaYbh!`k\]W\]g'U`W'bhfU``UgdYWfcZWcbhYadcfUfmDF`UbX`UXjYfh]g]b["

 $H\ [g'Wci\ fgY']g'k\ cfh\ \%''i\ b]hg'cZWfYX]hz'UbX']g'U'DfUWfW'DUh\ k\ Um'WcfY'gi\ V'YWh'Zcf'h\ Y'A\ UghYf'cZDF'UbX'5Xj\ Yfh]g]b["$ 

#### 5 hm Y WcbWi glcb c Zm lg Wci fgY m Y gh XYbhk l Y VY UV Y hc

- %" 8 Ya cbghfuh Y Wca dYh b W k ]h Wcbh Ya dcfufm V fub X a ubu[ Ya Ybhidfu W ] W g 'Ub X ghfuh [ ] Y g z ub X h Y 'UV ] ]hh c 'Udd mh ]g \_bck 'Y X [ Y ]b 'U fub [ Y c Zdfc Z y g ]cbu ' g Y h [b [ g " '
- &" 8Ya cbghfUhY`U`gci bX`i bXYfghUbX]b[`cZWcbhYa dcfUfmVfUbX`a UbU[Ya YbhWcbWfdhg`UbX d\]`cgcd\]Ygž'UbX`h\Y`WUdUWJmhc`Ya d`cmh\]g`\_bck`YX[Y`dfcXi Whj Y`m`]b`dfcZYgg]cbU``dfUWfJWY"
- '" 8 Ya cbghfUhY 'U'WUdUWJhm'Zcf']bXYdYbXYbh'UbX'Wc``UVcfUhJj Y']bei ]fmž'UbX'h\Y'UV]`]hm'rc 'YZZYWhJj Y`m Wcaai b]WUhY']XYUg'hc'U'fUb[Y'cZUi X]YbWYgž'i g]b['k f]hhYbz'cfU`'UbX'Ui X]c!j ]gi U``maYX]UhYX Wcaai b]WUhJcb"
- ("8 Ya cbglfUhY 'Ub' UV] `]lm Zcf 'WfYUh| Y 'h\ ]b\_]b[ 'UbX 'Wf]h|WU` fYZYWf|cb"
- ) " 8Ya cbgffUlY 'U'gci bX'i bXYfglUbX]b[ 'cZVch\ '`cWU``UbX'[ `cVU``]bXi glffm'WcblYI lbg']b'h\Y'Z]Y`Xg'cZDF ž UXi Yfrlq]b[ 'UbX'Wca a i b]WUllcb"

### HYUWX]b[ 'GhfUhY[]Yg'

Ghi XYbhg·k]``VY`dfcj]XYX`k]h\`h\Y`gWcdY`hc`XYjY`cdž\cbY`UbX`\cbY`UbX`Wcbgc`]XUhY`X]gWjd`]bUfmig\_]``g UbX`\_bck`YX[Y`[U]bYX`]b`h\Y`Z]Y`Xg`cZDF`UbX`UXjYffjg]b[ž'gdYWjZ]WU``m`]b`fY`Uhjcb`hc`h\Y`dfUWfjWY`cZVfUbX a UbU[YaYbh'

 $\label{thm:bck YX[Y'k]} $$H^[g'X]gW]d^[bUfm_bck YX[Y'k]^*VY'dcg]h]cbYX'U[U]bghhYY'WcbhYI hcZXYj Y`cda Ybhg']b'hYY'WcbhYa dcfUfm [`cVU``UbX'`cWU``a YX]U``UbXgWUdY''$ 

H\Y'Wci fqY'k ]``VY'HUi [\hij]U``YWh fYq'UbX'qYa ]bUfq"

5g/h,]g/]g/U/%&1 b]hcZ7fYX]hWtifgYžfYei]fYX/WtifgYkcf\_k]``fYZYWfih,]g/UVWtfX]b[`m'

### 5ggYgga Ybh

: cf:XYHJ]`YX`UggYgga Ybh]bZcfa Uh]cb'd`YUgY`fYZYf'hc'h\Y`Wci fgY'A ccX`Y`g]hY"

5```UggYgga Ybhg'a i ghVY`UhYa dhYX`]b`cfXYf'hc`dUgg'h\]g'Wci fgY''`

#### 5ggYgga Ybh'HUg\_g'

5ggYgga Ybh'hUg_	K Y][ \h	8iY'8UHY	Gh XYbh@YUfb]b[ Ci hWca Yg 5ggYggYX
K YY_`mW]b]WdfYgYbfUf]cbg	')	Bch5dd`]WUV`Y	%ž&Ž ž( ž)
9ggUm	(\$1	\$) #%\$#&\$% `\$, .\$\$`DA	%ž&Ž ž( ž)
6fUbX'Ui X]h	&) ı	&*#%\$#&\$% `\$, .\$\$`DA	%ž&Ž Ž( ž)

### 5ggYgga Ybh'8YhJ]`g

5ggYgga Ybh% K YY\_`mW]b]WdfYgYbhJh]cbg

GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\.') 'a ]bi hYg

8 YHJ] g. 'Ghi XYbhg'k] ```Wa d'YhY'gYj Yb'g\cfhdfYgYbhJh]cbg'cb'k YY\_`mhcd]Wg"'H\Y'hYUa g'cZ('fUgg][bYX YUWX'k YY\_E'k]```\Uj Y'hJa Y']b'WUgg'hc'dfYdUfY'U'dfYgYbhJh]cb'Zca '`YWhi fY'UbX'fYUX]b['a UhYf]U'"''9UWX k YY\_'mci f'hYUa 'Zcf'h\Uhk YY\_'k]``fYWY]j Y'U'a Uf\_'ci hcZ) "'Wci f'hYUa 'Zcf'h\Uhk YY\_'k]``'fYWY]j Y'h\Y gUa Y'a Uf\_'Vi hmci f'a Uf\_'k]``'VY'fYWcfXYX']bX]j ]Xi U``mUbX'mci f'hchJ''fci hcZ') E'k]``'Wca Y'Zfca 'U``h\Y a Uf\_g'UWX]Yj YX'Vmh\Y'X]ZZYfYbhHYUa g'mci 'k cf\_'k]h\'h\fci [\'h\Y'+'k YY\_g"Ghi XYbhg'k]`''fYWY]j Y'cfU` ZYYXVUW\_YUWX 'k YY\_'UbX']bX]WUhjj Y'a Uf\_g'Zcf'YUWX'Ugg][ba Ybhk YY\_`mh\fci [\'h\Y'@YUfb]b[ A UbU[Ya YbhGmghYa"

Gi Va ]gg]cb bchYg.FYZYf hc A ccX`Y

Hi fb]hjb gYhjb[. H\]g ]g bchU Hi fb]hjb Ugg][ ba Ybh

5ggYgga Ybh'& '9ggUm

GhUfh'XUhY.

@Yb[h\." ž\$\$\$ k cfXg

**8YHJ]**`g. '' *ž*\$\$\$`k cfX`YggUm''Gh XYbhg`k ]```fYWY]j Y`k f]hYb`ZYYXVUW\_`UbX`U`bi a Yf]\W\``[ fUXY"

Gi Va ]gg]cb bchYg.FYZYf hc A ccXY

Hi fb]h]b gYh]b[. `H\]g Ugg][ ba Ybh]g gi Va ]h\X h\fci [\ `Hi fb]h]b UbX gh XYbhg Xc bchgYY Hi fb]h]b g]a ]`Uf]hmfYdcfhg"

5ggYgga Ybh' . '6fUbX'Ui X]h

#### GhUfh'XUhY.

**@Yb[h**\."%\\$\$\$\kcfXg

 $8YhU]^*g. ^*\% \$\$^k \ cfXg''^H\ ]g^*]g^*h\ Y^*Z]bU^*UggYgga \ Ybh'hUg_''Gh \ XYbhg^k ]^*^fYWY]j \ Y^k \ f]hhYb^*ZYYXVUW_'UbX^*Ub \ a \ Yf]WU^*[fUXY''$ 

Gi Va ]gg]cb bchYg.FYZYfhc A ccX`Y

 $\label{eq:higher_problem} \mbox{Hi fb]h]b$^-gYhh]b[.^+H\]g$^-]g$^-bchU$^-Hi fb]h]b$^-Ugg][$ba$^+Ybh$^-$ 

## Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

 $Gh\ XYbhg\ UfY\ YI\ dYWMX\ hc\ di\ hh\ Y]f\ bua\ Yg\ UbX\ gh\ XYbhbi\ a\ VYfg\ cb\ Yj\ YfmdU[\ Y\ cZh\ Y]f\ Ugg][\ ba\ Ybhg\ ba$ 

Hi fb]h]b Gi Va ]gg]cb

- K cf\_'gi Va ]hhyx'%5'hc'% 'XUmg'UZhYf'h\Y'gh]di `Uhyx'XYUX`]bY'k ]``'VY'UggYggYX'UbX'ZYYXVUW\_dfcj ]XYX'Vi h'U'a Uf\_'cZnYfc'k ]``'VY'fYWcfXYX'''=Zh\Y'k cf\_'k ci `X'\Uj Y'fYWf]j YX'U'dUgg'a Uf\_'Vi h'Zcf h\Y'`'UhYbYgg'UbX'h\Y'k cf\_']g'U'Wca di `gcfm'Wci fgY'Wca dcbYbh'f\i fX`Y'fYei ]fYa Ybhz'U'gh XYbh'k ]`` VY'XYYA YX'hc'\Uj Y'a Yhh\Uh'fYei ]fYa Ybh/
- K cf\_'gi Va ]hhYX`&\$`cf`a cfY`XUmg`UZhYf`h\Y`gh]di `UhYX`XYUX`]bY`k ]```bchVY`UWW\dhYX`Zcf UggYgga YbhUbX`k ]```fYWY]j Y`bc`ZYYXVUW\_ža Uf\_'cf`[ fUXY"'=Zh\Y`UggYgga YbhHUg\_']g`U`Wca di `gcfm Wca dcbYbhcZh\Y`Wci fgY`U`gh XYbhk ]```fYWY]j Y`Ub`l bgUh]gZJWcfm: U]``fl : Ł`[ fUXY`Ug`U`fYgi `hcZ i bgUh]gZJWcfmdYfZcfa UbWY`]b`Ub`YggYbh]U``Wca dcbYbhcZh\Y`Wci fgY"

H\]g']bZcfa Uh]cb']g'U`gc'Uj U]`UV`Y'Uh

\hdg.#k k k "Uffg"i bgk "YXi "Ui #W ffYbhgh XYbhg#UWJXYa ]W]bZcfa Uhcb#dfchcWc`g![i ]XY`]bYg#

### GdYWJU`7cbq]XYfUhcb55dd`]WUhcbq

 $\label{thm:condition} $$Mci `WUb`Udd`m'Zcf'gdYW]U``Wcbg]XYfUh]cb`k \Yb`]``bYgg`cf`ch\Yf`W]fW a ghUbWfg`]bhYfZYfY`k ]h\`mci f UggYgga Ybh'dYfZcfa UbWf''$ 

G]W\_bYggža ]gUXj Ybhi fY'cf'ch\Yf'W]fW a ghUbWrg'VYmcbX'mci f'Wcbhfc``a Um

ł DfYj Ybhmci Zfca Wca d`Yhjb[ 'U'Wci fgY'fYei ]fYa Ybhž

ł? YYd mci Zfca 'UttYbX]b[ 'Ub'UggYggUV'Y'UWt] ]tmž

ł Ghod moi igi Va ]hh]b[ iUggYggUV Y k cf\_ Zcf U Wci fgYž

ł G][ b]ZJWUbhmiUZZYWimci fidYfZcfa UbWY]biUggYggUVYkcf\_žVYjhUiZcfa U`YbX!cZgYa YghYfiYl Ua ]bUhjcbžU WUggihYghžU`UVcfUhcfmhYghžU`gYa ]bUfidfYgYbhUhjcbicfiUbmch\YfiZcfa icZUggYgga Ybh'

cfilia fth Yfixyfuljgi]bify`uhjcbihciGdYWju`i7 cbg]XYfuhjcbi]bWi X]b[iiK \Ybihci5dd`mižii<ckihci5dd`mi`ubXiiGiddcfhjb[i8cWia Ybhuhjcbiid`YugYifyZyfihcih\YiGdYWju`i7 cbg]XYfuhjcbik YVghjY.ii\hdg.#ghiXYbhibgk "YXii"ui #gdYWju`iWcbg]XYfuhjcb

### 5 WUXYa ]W<cbYghmUbX D`U[ ]Uf]ga

D`U[]Uf]ga i]g`i g]b[ih\Yik cfXg`cf`]XYUg`cZch\Yfg`UbX'dfYgYbh]b[ih\Ya iUg`mci f`ck b"'=hWJb'hU\_Y'a Ubm Zcfa gžZfca iXY`]VYfUhY'W\YUh]b[ihc'UWW]XYbhU`mWcdm]b[iZfca iU'gci fWY'k]h\ci hUW\_bck iYX[Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga ]bhc'h\Y'Zc``ck]b[ WUhY[cf]Yg.

7 cdm]b[.'i g]b['h\Y'gUa Y'cf'j Yfmg]a]`Uf'k cfXg'hc'h\Y'cf][]bU`hYl h'cf']XYU'k]h\ci h'UW\_bck `YX[]b['h\Y gci fW'cf'i g]b['ei chUh]cb'a Uf\_g"'H\]g'U`gc'Udd`]Yg'hc']a U[Ygž'Ufh'UbX'XYg][b'dfcYWhgž'Ug'k Y``'Ug dfYgYbhUh]cbg'k \YfY'gca YcbY'dfYgYbhg'Ubch\Yf'g']XYUg'cf'k cfXg'k]h\ci h'WfYX]h'

⇒ Uddfcdf]UhY 'dUfUd\fUg]b[...7\Ub[]b[...7\Ub[]b[...7\Ub[]b[...7\Ub[]b[...7\Ub]b]b[...7\Ub]b]b[...7\Ub]b]b[...7\Ub]b]b[...7\Ub]b]b[...7\Ub]cfa CfXg`UbX`d\fUgYg`k\]'Y 'a cghmfYhJ]b]b[...h\Y`cf][]bU`gfi Wh fY 'UbX#cf'dfc[fYgg]cb`cZ]XYUg`cZh\Y`cf][]bU`žUbX`]bZcfa Uh]cb`k]h\ci hU\\\_bck`YX[Ya Ybh'H\]g`U`gc Udd`]Yg`]b`dfYgYbhUh]cbg`k\YfY`gca YcbY`dUfUd\fUgYg`Ubch\Yf'g`]XYUg`cf`k cfXg`k]h\ci h`WfYX]h`UbX`hc d]Y\\]b[...hc[Yh\Yf`ei chYg`UbX`dUfUd\fUgYg`]bhc`U`bYk`k\c`Yžk]h\ci h`Uddfcdf]UhY`fYZYfYb\\]b[..."

7 c``i g]cb.'k cf\_jb['k]h\ch\Yfg'Vi hdUgg]b['cZZh\Y'k cf\_'Ug'U'dYfgcb'g']bX]j ]Xi U``k cf\_"'7 c``i g]cb'U`gc ]bWi XYg'dfcj ]X]b['mci f'k cf\_'hc'Ubch\Yf'ghi XYbhVYZcfY'h\Y'Xi Y'XUhYžcf'Zcf'h\Y'di fdcgY'cZh\Ya d`U[]Uf]g]b['UhiUbmh]a Yž'dUm]b['Ubch\Yf'dYfgcb'hc'dYfZcfa 'Ub'UWUXYa ]WhUg\_ž'ghYU']b['cf'UWei]f]b[ Ubch\Yf'dYfgcb'g'UWUXYa ]Wk cf\_'UbX'Wcdm]b[']hz'cZYf]b['hc'Wca d'YhY'Ubch\Yf'dYfgcb'g'k cf\_'cf'gYY\_]b[ dUma YbhZcf'Wca d'Yh]b['UWUXYa ]Wk cf\_"

±bUddfcdf]UhY`W]hUh]cb.`7]h]b[ˈgci fWYg'k\]WX`\Uj Y`bchVYYb`fYUXžk]h\ci hUW\_bck`YX[]b[`h\Y`″gYWcbXUfm″gci fWY`Zfca 'k\]WX`\_bck`YX[Y`cZh\Ya`\Ug'VYYb`cVhU]bYX"

8 i d`]\W\r\cb`ffgY`Z\d`U[]\Uf]ga "Ł`gi Va]\r\b[`mci f`ck b`k cf\_ž]b`k \c`Y`cf`]b`dUffzk\YfY`]h\Ug`dfYj]ci g`m VYYb`dfYdUfYX`cf`gi Va]\r\X`Zcf`Ubch\Yf`UggYgga Ybhcf\\cki fgY`UhI\_BGK\_`cf`Ubch\Yf`i b]j Yfg]\r\d

7 cffYWnfYZYfYbWlb[ 'dfUWnWyg.

- DUfUd\fug]b[ ž'gi a a Uf]q]b[ ž'YggUmk f]hb[ 'UbX'ha Y'a UbU[ Ya Ybh
- 5ddfcdf]UhY'i gY'cZUbX'Uhtf]Vi h]cb'Zcf'U'fUb[Y'cZa UhYf]U`g']bWi X]b['hYl hž']a U[Ygž'Zcfa i `UY'UbX WbWYdhg"

±0X]j ]Xi U``Ugg]ghUbWr`]g`Uj U]`UV`Y`cb`fYei YghZfca `H\Y`@YUfb]b[ `7 YbhY`f<u>\hd.#k k k "`Wi bgk "YXi "Ui #</u>" Gh XYbhg`UfY`U`gc`fYa ]bXYX`h\UhWUfYZ ``hja Y`a UbU[ Ya Ybh]g`Ub`]a dcfhUbhdUfhcZgh XmUbX`cbY`cZh\Y ]XYbh]Z]YX`WUi gYg`cZd`U[ ]Uf]ga `]g`dccf`hja Y`a UbU[ Ya Ybh'`Gh XYbhg`g\ci `X`U``ck `gi Z]W]Ybhhja Y`Zcf fYgYUfW\žXfUZjb[ `UbX`dfcdYf`fYZYfYbW]b[ `cZgci fWrg`]b`dfYdUf]b[ `U``UggYgga Ybh']hYa g"

IBGK @]VfUfmU`gc`\Ugʻh\Y`9@G9`hcc``UjU]`UV`Y`hc`Ugg]ghmci`k]h\`mcif`ghiXmUhIBGK "'9@G9`]gXYg][bYX`hc`]bhfcXiVW`bYk`ghiXYbhg`hc`ghiXm]b[`UhIBGK`Vih]hWUb`U`gc`VY`U`[fYUhfYZfYg\Yf`Xif]b[`mcifqhiXm"

7 ca d'Yhlb[ 'h\Y'9@&9'hi hcf]U`'UbX'ei ]n'k ]`'YbUV'Y'mci 'hc.

٥

# 7ci fgY GWXYXi `Y

### <u>J]Yk 'WUgg'hja YHUV'Y</u>

## H]a YtUV`Y

8UhY	HmdY	7 cbhYbh	
K YY_'%'&' '>i `m!'&- '>i `m	@YWhifY	K \Uhi]g'U'VfUbX3	
K_YY_'&.'' \$'>i `mi!')	@YWhifY	H\Y`a UbU[Ya YbhcZU`VfUbX	
5i [igh	GYa ]bUf	±blfcXi W¶cbgʻUbXʻWci fgYʻcj Yfj ]Yk	
K YY_'' .'*'5i [i gh!'‰	GYa ]bUf	H\YcfmW]b]WdfUWjWYfib	
5i [i gh	@YWh fY	6fUbX <sup>*</sup> Ug <sup>*</sup> W <sup>*</sup> h fY	
K YY_'(.'%' '5i[igh!'%	GYa ]bUf	H\YcfmW]b]W%	
5i[igh	@YWn fY	6fUbXg`]b`W`hifY	
K YY_"):"&\$"5i[igh!"&*	GYa ]bUf	H\Ycfm'W]b]W&	
5i[igh	@YWn fY	H\Y`a U_]b[ 'cZU'VfUbX	
K YY_'*.'&+'5i[igh!'&	GYa ]bUf	H\Ycfm'W]b]W'	
GYdhYa VYf	@YWhifY	A U]bHJ]b]b[ 'U'VfUbX	
K YY_"+." "GYdhYa VYf"!"-	GYa ]bUf	H\Ycfm'W]b]W(	
GYdhYa VYf	@YWn fY	6fUbXg`]b`HfUbg]h]cb`cf`Wf]g]g	
K YY_', .'%\$'GYdhYa VYf'! %*'GYdhYa VYf	@YWi fY	A YX]UfjgUfjcb"! "h\Y"a YX]U"Ug"VfUbXg"UbX"VfUbXg a YX]U	
	GYa ]bUf	H\Ycfm'W]b]W)	
K YY_''%+'GYdhYa VYf'!	GYa ]bUf	H\YcfmW]b]W*	
&' 'GYdhYa VYf	@YWh fY	9j YfmVcXm\UgʻUʻVfUbX	
6fYU_, '&( 'GYdhYa VYf'! ' \$'GYdhYa VYf		Bc'WUggYg'h\]g'kYY_	
K_YY_"%\$."%"CWhcVYf"!"+	@YWh fY	: fca 'hci Wkdc]bh'hc Yl dYf]YbWYg	
C Whc VY f	GYa ]bUf	DfUWjWU`Wjb]W	
K YY_"%%", "C WhcVYf"!"%(	@YWh fY	: fca 'Wcbgi a Yfg'hc'Wca a i b]h]Yg	
C Whc VY f	GYa ]bUf	DfUW]WU`W]b]W	
K YY_"%&."%) "C WhcVYf"!	@YWn fY	6fUbXg^]b^h\Y^Z h fY. < c`X^cb^h][\hcf^[]j Y^]hUk Um3	
&%°CWhcVYf	GYa ]bUf	DfUWjWU``7`]b]W	
K YY_'%'.'&&'CWncVYf'! &,'CWncVYf	GYa ]bUf	: ]bU``DfU <b>W</b> ]WU``7`]b]W	

6cX]Yg'/ \*\DhYfZJWYg'&\$%\*

7 F *=*7 C G

7F=7CG'Dfcj]XYf'7cXY.'\$\$\$-,;