

7ci fgY Cj Yfj]Yk

GHJZ:7cbHJWh'8YHJ]`g

7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]lm	@cWUh]cb	D\cbY
7 fU]['F cVYfhg	₩fcVYfhg4 i bgk "YXi "Ui	D`YUgY`Ya U]``Zcf Uj U]`UV]`]hm	79(%	-',)((*(

GW.cc`7cbHJWh =bZcfa Uhlcb

<u>9b[]bYYf]b[:Gh:XYbhGi:ddcfhGYfj]WYg</u>:-H\Y:Bi:WYi:g'!'Ybfc`a Ybhž'dfc[fYgg]cb'WXYW<u>g</u>ž'WUg\'fYei:Yghgž Wti:fgY']ggi:Yg'cf'dfc[fUa!fY`UhYX'ei:Yf]Yg'

<u>9b[]bYYf]b['€Xi glf]U`'HfU]b]b[</u> --'€Xi glf]U`'lfU]b]b['ei Ygh]cbg'

<u>I BGK "Gh Xm5VfcUX"</u>—"gh XmUVfcUX"gh XYbhYbei]f]Yg fZcf"]bVci bX gh XYbhgŁ

I BGK '91 WXUb[Y'-ghi XYbhYl WXUb[Y'Ybei]f]Yg'flcf']bVci bX'ghi XYbhgŁ'

LBGK : i h fy Gh XYbh - dch bh U gh XYbh Ybei]f]Yg Y"["UXa]gg]cbgž ZYYgž dfc[fUa gž WfYX]h lf UbgZYf

D\cbY.

fŽ*%%L-',),)\$\$ -BiWYiqGhXYbh<iV

fŽ*%%&L'-',) '+**%'-'9b[]bYYf]b['=bXi ghf]U`'HfU]b]b['

fž*%%&£'-',) " %+-'-1 BGK "Ghi Xm5VfcUX"UbX"1 BGK "91 WXUb[Y"fZcf"]bVci bX"ghi XYbhg£"

7ci fgY 8YW] g

$I b h c Z 7 f Y X h^*$

Gi a a UfmcZh\Y 7ci fgY

 $\label{eq:decomposition} Dfc \Upsilon W g k \] ```] bj c \] \Upsilon g a \ U ``` [fci dg `c Zgh XYbhg `k cf_] b[``Ug `U 'hY Ua 'hc 'Wca d `YhY 'h Y 'XYg] [b `UbX 'Yl YW h] cb 'c Z g Y YWhY X 'h Ug_g `] b `Gi fj Ymjb[``UbX '; YcgdUh] U ``9 b[]b YYf] b["'Hcd] Wg `a Um VY 'WUXUghf U ``gi fj Ymg ž f Ya ch Y g Y bg] b[`UbU `mg] g `c Zh Y 'Ybj] f cba Ybh Z ca 'g UhY ``] hY `] a U[Yg ž X] [] hU ``d \chc [f Ua a Yhf] Wa Udd] b['h Ug_g ž g Yhhjb ['i d 'U'df Y W] g Y `[Yc XYh] W Wcb f c ``b Yhk cf_ ž h Y 'i g Y `c Zd f Y W] g Y '; B G G 'h Y W b] ei Yg ž W c ``Y W f cb 'c Z X Uh U Z cf Ub X X Y g] [b 'c Z U '; $= G 'g mgh Ya ž U'df Y W] g Y 'Yb [] b Y Yf] b['gi fj Ym cf 'h Y 'X Yj Y `cda Ybh Ub X 'Ub U'mg] g `c Z U [Ycgd Uh] U ``X Uh U V Ug Y `c Z U 'f Y [] cb " G hi X Y b hg 'a Um V Y 'f Yei] f Y X 'hc 'Uh Y b X 'Ub `c Z W Ua di g `Z] Y `X 'k cf_ f g i fj Y m W Ua d L cf 'f Y [i `Uf `X Um If] dg 'hc 'Ub `c Z W Ua di g `Z] Y `X 'g] h Y `Ub X 'df Y g Y b hh Y 'f Y gi `hg `c Z h Y] f `[f ci d 'df c 'Y W i] b `U k Y `` k f] h Y b 'h Y W b] W ``f Y dc f h Ub X `] b X] [] Xi U `'df Y g Y b h Uh c g 'hc 'h Y '[f ci d ''] f 'c i d ''df ` Y W i] b `U ` k Y `` k f] h Y b 'h Y W b] W ``f Y dc f h Ub X `] b X] [] Xi U `'df Y g Y b h Uh c g 'hc 'h Y '[f ci d ''] f '$

7 ci fgY 5]a g

H\Y`cVYWIJ Yg`cZh\Y`Wci fgY`UfY`hc`VfcUXYb`UbX`XYYdYb`mci f`_bck`YX[Y`UbX`YI dYf]YbW`cZXUhU
UWei]g]hJcb`UbX`gi fj Ym]b[`]bghfi a YbhUhJcbž'ZJY`X`a Yh\cXgž'UbX`gi fj Ym]b[`gcZhk UfYž'VmWcbXi WIJb[`mci f
ck b`gi fj Ymg`Uh'U`g]hY`fYa chY`Zfca 'h\Y`I B`GK `WUa di g`cf`cb`]h'i H\Y`U]a `]g`hc`]bj c`j Y`mci `]b`a UbU[Ya Ybh
UgdYWng`cZZJY`X`gi fj Ymgž'fYdcfhik f]hJb[`Ug`k Y```Ug`[U]b]b[`a cfY`YI dYf]YbW'`]b`a YUgi fYa Ybhž'ZJY`Xk cf_
XYg][bž'UbX`UbU`mg]gž'UbX`hc`[]j Y`mci `WcbZJXYbW']b`mci f`UV]`]mmhc`Xc`gi fj Ymg`cZU`hmdY`h\Uh'mci `a Umbch
\Uj Y`XcbY`VYZcfY`Uh'I b]j Yfg]hmcf`]b`Ya d`cma Ybh'

 $H\g Wci fgY \g U \WdghcbY \Wci fgY \b mci f XY[fYY"$

7ci fgY @YUfb]b[Ci hWca Yg

5 ZYfgi WWggZ ``mWcad`Yh]b['h\]g WcifgYžmci g\ci`X VY UV`Y hc.

@YUfb]b['Ci hWca Y	95 GHJ[Y %7ca dYHYbW]Yg
%":5dd`mgi fj Ym]b[#{YcgdUh]U``_bck `YX[Y``YUfbhgc`ZJf`]b`h\Y	

HYUW]b['GhfUhY[]Yg'

 $8 \] \ ZYfYbhihmdYg`cZdfc'YWfg`k\] \ ``VY`cZZYfYX`YUVX`mYUf''`H\]g`mYUf`k\ Y`k\] \ ``hfmhc'dfcXi\ WY`Ub'Ui\ [\ a\ YbhYX`fYU`]hm$

5ggYgga Ybh&::]bU``f\bX]j]Xi U`\EFYdcfh'UbX`dfYgYbrUh]cb

5 hhyb XUb WY F Yei]fYa Ybhg

Ghi XYbhgʻg\ci `X`UhhYbX`U```h\Y`gW\YXi `YX`dfc^YWhUWhjj jhjYg

7 ci fgY GWX YXi `Y

8 i f]b['th\Y'k YY_'%'WUggžghi XYbhg'k]``'VY'[]j Yb'th\Y'UXj]WY'cb'th\Y'XYhU]`g'Zcf'th\Y'dfcYWh''H\Y'ghi XYbhg'k]``Zcfa' [fci dg'Zcf'th\Y'dfcYWh'fY`UhYX'UWhjj]h]Yg'tc'dYfZcfa']b'K YY_''%zgc'a U_Y'gi fY'mci 'UhYYbX'''

H\Y'f]a YfUV'YX'WUgg`]g`H\i fgXUm- Ua `cbk UfX'YUW\k YY_`]b`79&\$%"'H\Y'(!\ci f`f]a Yg`ch`]g`]bfYbXYX`gc h\Uhmci `WUb`Xc`Z]Y`Xk cf_`UbX`cf`XUfU`UbU`mg]g`Zcf`f\]g`dfcYWicb`gca Y`XUmg`fbchbYW\ggUf]`mYj Yfmk YY_Ł k]h\ci h`]bfYffi df]cbg`Zfca `ch\Yf`WUggYg"'C ZWci fgY`mci `UfY`YbWci fU[YX`fc`gdYbX`gca Y`ch\Yf`f]a Y`cb a YYf]b[gž\WU`W``Uf]cbgžfYdcfhk f]f]b[žYfW'8Yg\f]df]cbg`cZh\Y`dfcY\wgžg]fY`d\cfcg`UbX`a Udgž'</G Zcfa gžYfW'žk]```VY`X]g\W ggYX`Uhf\Y`WUgg`a YYf]b[`]b`K YY_`%"

H\Y'Z\Y'X'gi fj Ymg'UbX'a Udd]b['UWfj] jhjYg'k]``VY'WcbXi WfYX'Ug'[fci d'k cf_"'Ghi XYbhg'k]h\]b'U'[fci d'Xc'bch bYW'ggUf]`mU``Xc'h\Y'gUa Y'HUg_g'': cf'Yl Ua d'Yz'cbY'ghi XYbha][\hiH_Y'cb'a UbU[Ya YbhXi hjYg'UbX cf[Ub]gY'`c[]ghjWg'k\]'Y'ch\Yf'ghi XYbhg'WcbW'bhfUhY'cb'XYg][bz'dfYlZ]Y'Xk cf_'WU'W 'Uh]cbg'UbX dfYdUfUh]cbgz'YhW''=n]g'i d'hc'h\Y'[fci dg'hc'Ybgi fY'U``ghi XYbhg'Wcbhf]Vi hY'Uddfcdf]UhY`mz'Ug'X]gW ggYX']b 9B; ; %\$\$\$"'H\Y'Wci fgY'WccfX]bUhcf'a Um'Ugg][b'X]ZZYfYbha Uf_g'hc']bX]j]Xi U``ghi XYbhgz'Uh'h\Y]f'X]gWfYh]cbz VUgYX'cb'ghi XYbhdYfZcfa UbW'']b'h\Y'Z]Y'X'k cf_'UbX']b'h\Y'WUgg'X]gW gg]cbg"

Gi fj YmGhcfY 9ei]da Ybh

Ghi XYbhgik]g\]b[ihciWc``YWhgi fj YmYei]da YbhZrca ih\Yigi fj YmghcfYia i ghi[]j YiUiXYhU]`YXik f]hhYb``]ghcZ fYei]fYa Ybhgihcih\Y]figi dYfj]gcfiUhi`YUghcbYiXUmVYZcfYi]ngifYei]fYXii gYžcfia cfYiUgigdYWZJXXiVmdfcYWhgi dYfj]gcfiZfiZfYXihf]dg"iH\YfYi]gibcidYfgcbidYfa UbYbhm]bih\Yigi fj YmghcfYigcighi XYbhgik]```bYYXihc cf[Ub]gYiha YgicZWc``YWhcbiUbXifYhi fbicZYei]da YbhWUfYZ ``m''H\Yigi dYfj]gcfik]```bchVYiUV`YihciWca YUbXi[ciZfcaih\Yight]YzfeiYbhmXif]b[ih\YiXUmcfiUhq\cfhbchWV'''

Dfc YWh5. 5i [a YbhYX F YU]mmUh@|thY 6Um \$2YWh]ci g 8]qYUqYq 7 Ya YhYfm

H\]g'dfc^\Wik]``VY'gi dYfj]gYX'Vm7fU]['FcVYffg"'H\Y'@|thY'6Um]bZ\W|ci g'X]gYUgYg'Wa Yt\fm]g'U'ei U]bt\fi b!Xck b'c'X'g]t\']bg]XY't\Y'? Ua Um6ct\UbmB Ut\cbU``DUf_"'=\figdYU_g'tc'U'f]\W.'\]gtcfmcZgYtt\Ya Ybt\]b GmXbYm''=\fik Ug't\Y'ftU[]\WVi f]U`'g]t\'' tc'a Ubmj]\W]a g'cZ]bZ\W|ci g'X]gYUgYg'\Zca 't\Y'bYUf\mDf]b\W''< Ybfm \cgd]t\U`'k\]g'bck 'U'f\Yg]XYbt\]U`'gi Vi f\"''J]g]tcfg'tc't\Y'bUt\]cbU`'dUf_U'Y'c\Zt\'b'gi fdf]g\X'k\Yb't\Ym gti a V'Y'i dcb't\]g'\Wa Yt\YfmUbX']\bff][i YX'Ug'tc'k\m]t\]g'\t\YfY'UbX']\g'\t\g'\t\g'' \lg\t\fu\g\Y'f\YbX\Yf'gca Y'cZt\\Y'[fUj YgtcbYg'i bf\YUXUV'Y'''H\]g'dfc^\WtigYY_g'tc'df\Yg\Yfy Y'gca Y'cZt\]g'\]gtcfm UbX'XYj Y`cd'Ub'YUgm\tc!i gY'5F 'Yl dYf]\Yb\W'cb'U'd\cbY'Udd't\Ut\Wb'VY'i gYX'Vmj]g]tcfg'YUg]\m-'dYf\Udg k]t\'U`E F'\WcXY''

Gca Y`cZh\Y`[fUj YghcbYg`UfY`dfca]bYbhz`Vi higca Y`UfY`Wcj YfYX`Vm[fUgg`UbX`j Y[YhUh]cb":H\Y`a ci bXg WUb`gh]```VY`gYYb"`Ghi XYbhg`k]```]bj Ygh][UhY`h\Y`i gY`cZ; DF`hc`XYhYfa]bY`h\Y``cWUh]cb`cZgca Y`gi V!gi fZJWV [fUj Y`g]hYg"

5XX]h]cbU``mžghi XYbhg`k]``i bXYfhU_Y`U`WUXUghfU``gYUfWk`Zcf`Vci bXUfmYj]XYbWY`UbXžk]h\`h\Y`U]X`cZUb

]bXi ghfmYl dYfhž'WcbXi WhU'WUXUghfU``gi fj YmcZh\Y`ci hYf'Vci bXUfmcZh\Y`WYa YhYfm''H\]g`\Ug`VYYb XYgWf]VYX`Ug`\Uj`]b[`'U```h\Y`Y`Ya Ybhg`cZU`fi fU``WUXUghfU``gi fj Ymž`]b`h\Y`W]hm'

DfcdcgYX hJg_g JggcWJUhYX k]h\ h\]g dfc YWh

- %" Ghi XYbhgʻk]```WcbXi WhU``]hYfUhi fYʻfYj]Yk 'cb'h\Y`\]ghcfmcZh\Y`WYa YhYfm'UbX`Df]bWY`< Ybfm'< cgd]hU` Zcf'WcbhYl h'
- &" Ghi XYbhg'k]```U`gc'i bXYfhU_Y'U'fYj]Yk 'cZYl]gh]b['5F#JF'dfc'YWg']b'gi fj Ym]b[#Yb[]bYYf]b['UbX']qha Yh\cXc`c[]Yq'UbX'qcZhk UfY#\UfXk UfYfYei]fYX"
- ' " Ghi XYbhg`k]```h\Yb`a U_Y`U`g]hY`UggYgga Ybh`UbX`k \Uhk]```VY`fYei]fYX`hc`fYU`]gY`h\]g`dfc`YWh`Gca Y Wcbg]XYfUh]cb`cZYI]gh]b[`[YcgdUh]U``XcW a Ybhgʻgi W\`Ug. '=7 GA `GD%f] %"+'/ 'j &"&±ZGi fj Ymcf ; YbYfU`'g`8]fYWh]cbg`bc"`%z`&z`(z̆+z̆- / `%&z̆; 85`hYW\b]\W\``a Ubi U``k]```\Y`d`]bZcfa 'h\Y`gi fj Ym XYq][b"
- ("8YjY`cd`U`d`Ub`hc`WcbXi Whh\Y`gi fj YmžhYghYei]da Ybhži bXYfhU_Y`h\Y`gi fj YmUbX`dfYdUfY WUdh fYX`XUhU`]b`U`qi]hUV`Y`Zcfa Uh"
-) "DfYdUfY 'h\Y'XUhUVUgY cZ]bgWf]dh]cbg 'hc'Wfcgg fYZYfYbWY k]h\'h\Y'[YcgdUh]U``XUhU`WUdh fY"
- *" I bXYffU_Y`U`WUXUglfU`gYUfW\žG7 \(\frac{1}{2}\) G`gYUfW\`UbX`YI Ua]bY`d`Ubg`Zcf`WUXUglfU`g]hY`j]g]h'
- +" @YUfb gi]hUV`Y`5F gcZk UfY`UbX`hfmhc`WcXY`Ub`]bhYfZUWY`Zcf`U`d\cbY`5dd"
- , " HYghi5dd
- " K f]hY dfc YWhfYdcfh"

 $\label{eq:fibed} \textit{flB} \ \textit{dabaeWW} \ \textit{fSe}] \ \textit{e} \ \textit{LSk} \ \textit{UZS`YWVWbWV[`Ya`U[dJg_efS`UWe}$

DfcdcqYX'k YY_!Vmk YY_'UWhji]hjYq.

Bch'rh\ygy'k yy_!Vmk yy_'Uwhj jhyg'k j```]_y`mW.Ub[Y'Uhh\y'U[fyyx'X]gWfyhcb'cZh\y'[fci d"'Gh XYbhg'k j`` byyx'hc'ZJa j']Uf]gy'h\ya gy'j yg'k jh\rh\y'Wcbhyl hcZh\y'dfc YWrh\y'WcbWdhcZUi [a Ybhyx'fyU']hmUg']h a][\hUdd`mhc'gi fj Ym]b[#Yb[]byyf]b['Ubx'h\y'Vi j'X]b['V`cW_g'cZh\]g'dfc YWhc'Xyj y`cd'Ub'Ui [a Ybhyx fyU`]hmUdd`]WUhjcb'Zcf'i gy'Vmh\y'[YbyfU`di V`]W'5'a cfy'hfUX]hjcbU`'WUXUghfU`'gi fj Ymk j``'Vy']bWi Xyx'Ug dUfhcZh\]g'dfc'YWhug'k y``'''

K YY_'% '91 d`UbUhjcb'cZdfc'YWgž'U[fYYX'X]j]g]cb'cZfYgdcbg]V]`]h]Ygž'dfYdUfUhjcb'cZXcW'a YbhUhjcb'fK < // Gžhja Y'g\YYhgŁž'XYg_hcd'fYWcbbU]ggUbW'ž'dfYdUfUhjcb'Zcf'XYg][b'cZgi fj Ymgž'VY[]b'`]hYfUhi fY'fYj]Yk 'cb Ui [a YbhYX'fYU`]hmYl Ua d`Yg']b'gi fj Ym]b[#Yb[]bYYf]b['UbX'h\Y'j Uf]ci g'Y'Ya Ybhg'bYYXYX'hc'fYU`]gY'gi W\U'dfc'YWh'; i YghdfYgYbhUhjcb'k]h\']bXi ghfmYl dYfh'

 $\begin{array}{l} \textbf{K. YY_'\&. '7 cbh}bi \ Y \ ``]hYfUhi \ fY \ `fYj \]Yk \ ``UbX'YI \ hfUWhfY`Yj \ UbhgYWhcbg ``Ug'dYfhU]bg'hc'h\ Y 'XYg][\ b'cZh\ Y'gi \ fj \ YmhUg_'' \ 8 \]gW \ gg 'VYghgcZhk \ UfY 'hc'i \ gY 'Zcf'5dd'XYj Y`cda YbhUbX'k \ cf_'VUW_k \ UfXg'hc 'XYhYfa \]bY 'VYghXUhU Zcfa Uhhc 'ZUW]]hUhY'h\ Y'Z \ bWhcbU']mh'6Y[]b'WUXUghfU``gYUfW\ 'Zcf'dfc YWhUbX'XYj Y`cd'h]a YhUV`Y'cZU```HUg_g Zcf'h\ Y'hYfa \ ''DfYdUfY'Zcf'q]hY'j \]g]h']b'k YY_'' \ ''$

K YY_" . `J]g]h@|thY 6UmWa YhYfmUbX`dYfZcfa `fYWbbU]ggUbW" '9gtUV`]g\ `gca Y`Wbtfc``UbX`WbcfX]bUhY Zcf'h\Y`di fdcgYg`cZh\]g`gi fj Ymf]Y`Wa !`Yj Y``UWW fUWn]g`gi ZZWYbtŁ'

Gh XmK YY &%	5ggYgga Ybh	±bX]j]Xi U``GY`Z15ggYgga Ybh
Bcj Ya VYf'!'&(
Bcj Ya VYf		

F Ygci fWYg DfYgWf]VYX F Ygci fWYg

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

D`YUgY`fYZYf`hc`h\Y`A ccX`Y`dU[Y`cZh\Y`Wci fgY`Zcf`Z fh\Yf`[i]XUbW\`cb`UggYgga Ybhigi Va]gg]cb"

I BGK `\Ug`U`ghUbXUfX``UhY`gi Va]gg]cb`dYbU`hmcZ

•)ı 'dYf'XUmž'Zcf'U``'UggYgga Ybhg'k \YfY'U'dYbU'hm'Udd`]Ygž'WUddYX'Uh'Zjj Y'XUmg'f1%&\$`\ci fg\z'UZhYf k\]WX'U'ghi XYbhWUbbchgi Va]h'Ub'UggYgga Ybhž'UbX'bc'dYfa]hhYX'j Uf]Uh]cb"

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

 $6 \ Yk \ UfY \ "5b" Ugg][\ ba \ Ybh'h \ Uh']b \ XYg" d`U[\]Uf]g YX \ 'a \ UhYf]U \ "k \] \ "fYWY]j \ Y \ "U" \ ": \ U] \ "ž \ UbX" ghi \ XYbhg" k \ \ "c$

5WUXYa]W±bZcfaUhjcb

:]bU`'91 Ua]bUh]cbgA

b

