

# **MUSC2602**

A UhYf]U`g'UbX'Ghfi Whi fYg'cZA i g]W'

HYfa 'C bY''##'&\$&%

# 7ci fgY'Cj Yfj ]Yk

## GHJZ:7cbHJWh8YHJ]`g

#### 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWUh]cb	D\cbY
< Uff]gcb 7 c ``]bg	\"Wc``]bg4 i bgk "YXi "Ui	AU_Y'Uddc]bha Ybh		
		j ]U <sup>.</sup> Ya U]`		

#### @YWhi fYfg

B Ua Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWJh]cb	D∖cbY
< Uff]gcb '7 c``]bg	\"Wc``]bg4 i bgk "YXi "Ui	AU_Y'Uddc]bha Ybh		
		j ]UʻYa U]ʻ		

#### Hi hcfg

B Ua Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWJh]cb	D∖cbY
8Uj]X'HUmcf	gUa 4 i bgk "YXi "Ui	8 Uj ]X g\ci `X VY WcbHJWYX j ]U Ya XUj ]X"Ubh\cbm'HJ 4 [a U]`"Wca	*	

### GWXcc`7cbHJWhi±bZcfa Uhjcb

GWXcc``cZhXY`5fhg`UbX`AYX]U

Fcca ' %&ž@Yj Y`' žFcVYfhK YVghYf6i]X]b[fl %(Ł

D\cbY. 'f\$&Ł'-',) '(,) \*

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

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

 $\label{thm:constraint} $$HY'GWKcc``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'hc'FYgdYWZI``m5W_bck`YX[Y'h\Y'HfUX]h]cbU``7ighcX]Ubgžh\Y'6YXY[U``fPYbg]b[hcb'WJadigłž'; UX][U``fP]hmUbX'5fh'/`8Yg][b'7UadigYgŁ'UbX'h\Y'B[ibbUkU`dYcd'Y'f5ighfU`]Ub'8YZYbW': cfW'5WJXYam]b'7UbVYffUŁ'cZh\Y'`UbXg'k\YfY'YUWK'WJadig'cZIBGK']g`cWJhYX''$ 

# 7ci fgY 8YHJ] g

## 7 fYX]hDc]bhg\*\*

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

H\]g`WcfY`Wci fgY`YI hYbXg`h\Y`ghi XYbHg`\_bck `YX[Y`cZh\Y`a UhYf]U`gžghfi Wi fYgž'UbX`dfcWiggYg`cZhcbU` a i g]WVYmcbX`h\Y`Zci bXUh]cbU```Yj Y``j ]U`h\Y`ghi XmUbX`Udd`]WUh]cb`cZ\Ufa cb]WUbX`a Y`cX]WdfUWf]W'g`]b dcgh!% ) \$`Ufha i g]WWca dcg]h]cbz`Ug`k Y```Ug`ch\Yf`ghm`Yg`]bWi X]b[`dcdi `Uf`a i g]WUbX`Unn"`Ghi XYbhg`k ]`` XYj Y`cd`hYW\b]WU`\_bck `YX[Y`UbX`g\_]```]b`h\Y`UbU`mg]g`UbX`Udd`]WUh]cb`cZUddfcdf]UhY`a Y`cX]WUbX\Ufa cb]WY`UVcfUh]cbz'j c]WY!YUX]b[`z`UbX`a i g]WU`Zcfa "'9I YfW]gYg`]b`UXj UbWXX`Wca dcg]h]cbU``WfUZh dfcj ]XY`h\Y`ghi XYbhik ]h\`h\Y`cddcfhi b]hmhc`XYa cbghfUhY`h\Y]f`]b]h]Uh]j Y`UbX`WfYUh]j ]hmk ]h\]b`gY`YWhYX`ghm`Yg cZa i g]WU``H\Y`Wci fgY`XYj Y`cdg`WcfY`g\_]``g`]b`a i g]WJUbg\]d`UbX`h\Y`UV]`]hmhc`Udd`mh\YgY`]b`ch\Yf`UfYUg`cZ a i g]WU``dfUWfWY`UbX`fYgYUfW."

### 7 ci fgY @YUfb]b[ 'Ci hWca Yg

- %" a UghYf'\_bck `YX[Y'cZh\Y'a UhYf]U`g'žghfi Whi fYgž'UbX'dfcWYggYg'cZW\fca Uh]WhcbU``a i g]WUh'Ub UXj UbWYX``Yj Y`"
- ' " Udd`mh\Y]f`\_bck `YX[ Y`UbX`g\_]``g`]b`h\Y`i gY`cZW\fca Uh]Wa Y`cXmUbX`\Ufa cbmhc`h\Y`]XYbh]Z]WUh]cb UbX`WcbhYI hi U`]gUh]cb`cZ\_Ymdcgh\% ) \$`a i q]WU``k cf\_g"
- ("Udd`mth\Y]f`XYj Y`cd]b[ 'a i g]WU``\_bck `YX[Y`UbX`g\_]```fc`a i g]Wa U\_]b[ ž'k \Yth\Yf`]hVY`dYfZcfa ]b[ 'cf Wca dcg]b[ "
- ) "XYa cbghfuh/ 'WcfY'g\_]``g']b'a i g]WJubg\ ]dž']b'dufh]Wi `Ufža i g]W']h/fuWhzgWcfY'fYuX]b[ ž'UbX'h\Y dYfZcfa UbW/cZUXj UbW/X'W\fca Uh]W\Ufa cb]Wdf]bWJd`Yg"

# HYUW ]b[ 'GhfUhY[ ]Yg'

6A i gʻUbX`65`fA i gʻJWGh XjYgʻUbX`A i gjWGh XjYgʻ91 hYbgjcbŁgh XYbhgʻUhhYbX`Uʻk YY\_`mcbY!\ci f``YWh fYcbʻa i gjWh\YcfmUbX`\Ufa cbmʻUʻk YY\_`mcbY!\ci f`h hcfjU``cb`Ui fU``UbX`YUf!hfU]bjb[ ˈg\_j``gž'UbX`Uʻk YY\_`mcbY!\ci f``UVcfUhcfmcb`W\cfU``gjb[ jb[ ˈg\_j``g"

@YWi fYgʻ]bj c`j YʻWUggʻYl YfWjgYgʻ]bʻa i g]Wh\YcfmUbX`\Ufa cb]WUbU`mg]gʻ]bʻj Uf]ci gʻWca dcg]hjcbU` WcbhYl hgʻUbXʻUfYʻUi [a YbhYXʻk]h\ʻgci bXʻfYWcfX]b[gždck Yfdc]bhdfYgYbhJhjcbgžUbXʻWUggʻei ]nnYg"ʻ5i fU` hi hcf]Uʻgʻ]bj c`j YʻWUggʻUWjj ]hjYgž]bhYbg]j YʻXf]``gžUbXʻYl YfWjgYgʻ]bʻh\YʻUbU`mg]gʻcZgY`YWhYXʻa i g]WU` Yl Ua dʻYgʻXYg][ bYXʻhcʻXYj Y`cdʻUXj UbWYXʻUi fUʻ`dYfWYdhjcb"ʻ; fci dʻg]b[]b[']bʻh\Yʻ7\c]fʻ@UVcfUhcfm dfYgYbhgʻcddcfhi b]hjYgʻZcfʻh\YʻdfUWfJWJ``Udd`]WUhjcbʻcZUi fUʻ`g\_]``gʻ]bʻUʻdYfZcfa UbWYʻUbXʻWca dcg]hjcbU` WcbhYl hi

5ggYgga Ybh

""7 ca dcg]h]cb'5gg][ ba Ybh'U'g\cfh\\cappa dcg]h]cb']b'U'\\cap\cg\b'g\m\'g\ci `X'\Y'gi Va ]h\\X.'k cfh\' \$1 cZh\Y'hchU'a Uf\_'Zcf'h\Y'\\ci fg\": i fh\Yf'XYhU]`g'cb'\\cappa d`Yh]cb'UbX'gi Va ]gg]cb'cZh\Y'Ugg][ ba Ybhk ]``\VY a UXY'Uj U]`UV'Y'cb'A ccX'Y"

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

5ggYgga Ybh& 5i fU K cf\_g\cd fHi hcf]U'Ł

GhUfhiXUhY. Bch5dd`]WUV`Y

8YHJ]`g.

 $\label{eq:definition} Dcfh \hbox{$\mathbb{Z}^{\circ}$ if $U^{\circ}$ 9 I $YfW_g Yg.$ $$ cbY $'fUbgWf] $dh_cb'YI $YfW_g Y\check{z}'cbY $']b! $$ WUgg'Ui $fU^{\circ}$ h' gh'' $$ full $fU^{\circ}$ h' gh''$ 

K f]hhyb ZyyXVUW\_dfcj ]XyX Vmh hcf"

#### 5XX]h]cbU`'XYhU]`g.

 $HY'5i fU''K cf_g cd'DcfhZc']c'Wcbg]ghg'cZh\Y'Zc''ck]b['UggYgga Ybh']hYa g.$ 

%"5bU`mh]WU`5ifU``9IYfW]gY.`hc`VY`X]ghf]VihYX`]b`KYY\_''žXiY`hc`VY`giVa]hhYX`j]U`AccX`Y.`kcfh\`%\$i`cZh\Y`hc'U``aUf\_`Zcf`h\Y`WcifgY"

&"'=b!\WUgg'H\Ygh'\VUg\X'cb'h\Y'\Ui\f\U`'g\_]\"g'\X]g\W\gg\X']b'h\hcf]\U`g.'h\]g'\Yghk]\"\Y'\Y`\X']b'bcfa\U`'5i\f\U`\Hi\hcf]\U`.'k\cf\\'%\i\cZh\Y'\ch\\"a\Uf\_\Zcf'\\Y\\V!\\f\g\"

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

5ggYgga Ybh' . 5i fU`7\c]f fGh X]cŁ

GhUfhXUhY. Bch5dd`]WUV`Y

8YW]`g.

G][\hg]b[]b[ hYgh"

: YYXVUW\_dfcj ]XYX`VmfYgi `hZcf`hYgh'

#### 5XX]h]cbU`XYhU]`g.

 $H\Y'UggYgga\Ybh'Zcf'5i\ fU``7\c]f'Wcbg]ghg'cZU'G]b[\]b[\ 'HYgh'\Y'X']b'h\Y'bcfa\ U`'5i\ fU``7\c]f'Gh X]c'h]a\ Y. k\ cfh\Y'bch\Y'bch\Y'bch\Y'bch\Y'Wci\ fgY'''$ 

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

5ggYgga Ybh(. Aig]W@]hYfUh fY

GhUfhXUhY. Bch5dd`]WUV`Y

8YHJ]`g.

GY`ZIX]fYWYX`ghiXmik]h\`U`Z|bU``YIUa"

: YYXVUW\_dfcj ]XYX`VmfYgi `h'Zcf`Yl Ua

#### 5XX]h]cbU`XYhU]`g.

A i g]W@|HYfUh fY`]g`U`gY`Z\X]fY\HYX`gh Xmk ]h\]b`h\Y`A I G7`&\*\$&`7 ci fgY"`5``]ghcZk cf\_g`Zcf`gh XmXi f]b[HYfa '%z`&\$&\$z`]g`Uj U]`UV`Y`cb`A ccX`Y"`

5ggYgga Ybhi]gʻVUgYXʻcbʻUbʻ±b!WUggʻ9l Ua .`D`YUgYʻBchYʻh\Uhih\]gʻ9l Ua ʻk]```\Y`X`]bʻh\YʻGh X]cʻh]a Y. k cfh\'%) ∟ `cZh\Y`hchU`a Uf\_`Zcf`h\Y`Wti fgY"

: i fh\Yf`]bZcfa Uh]cb`cb`h\Y`A i g]W@]hYfUhi fY`gY`Z\X]fYWhYX`ghi Xm]g`Uj U]`UV`Y`cb`A ccX`Y"

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

#### 5 hyb XUb WY F Yei ]fYa Ybhg

5 thY b X U b WY "U h @Y W i f Y g ž H i hc f] U `g `U b X `G h X] c g `] g `a U b X U hc f m ] b `t h ] g `W c i f g Y " I b Y I W g Y X `U V g Y b W `Z f c a c f Y `h U b `&\$ i `c Z W U g g Y g `a U m f Y g i `h ] b `t h Y `U k U f X `c Z U `: U ] `; f U X Y "

@97HIF9.']b``YWifYg`mci`k]``UWIjY`mYb[U[Y`k]h\`WcfY`WcifgY`WcbHYbhH\Uhk]```\Y`d`mci`hc`UHU]ba YbhU a UghYfmcZh\Y`a UhYf]U`gžghfi WifYgž'UbX`dfcWYggYg`cZW\fca UhJWhcbU``a i g]WUhUb`UXj UbWYX``Yj Y``fl7@C%Z`UbX`hc`UbU`mgY`W\fca UhJW\Ufa cbmUbX`a Y`cXm]b`dcghl%)\$`a i g]WU``ghmYgž]bWlX]b[`dcdi`Uf`a i g]WU``dhn`fl7@C`&L''

 $\label{eq:higher_ham} \begin{array}{ll} \text{HI HCF} = & @ \text{`[b'h' hcf]U'g'mci'k ]} \text{```UWf]j Y'm'Yb[U[Y'k]h' WcfY'Wci fgY'WcbhYbh'h\Uhik ]```YbUV'Y'mci'hc'Udd'm mci f'a i g]\W\'g_]b'a i g]\W\bg\] <math display="block"> \text{b'a' i g']W''cZ} \text{UV} \text{UV} \text{`b'a' i g']W''bg'} \text{'b'a' i g']W''bg' b'Y'bh'Y'dYfZcfa UbW''cZ} \text{UV} \text{$ 

GHI  $8 \pm 0.7$ ]b 'ghi X]cg'mci 'k ]``'UWhji Y`mYb[ U[ Y'k ]h\ 'WcfY' Wci fgY 'WcbhYbhih\ Uhk ]``\Y`d'mci ''Udd`mmci f'Ui fU` UbX'h\ Ycfmg\_]`g'hc'a i g]Wa U\_]b[ 'hc'Vch\ 'dYfZcfa ]b[ 'UbX'Wca dcg]b[ 'ff' @C' ( Ł''

# 7 ci fgY GWX YXi `Y

#### J JYk 'WUqq'Ha YHUV'Y

#### Hla YHJV`Y

8 UhY	HmdY	7 cbhYbh
K YY_'%'%) ': YVfi Ufm!'%- : YVfi Ufm	@YWnifY	<ufa cbm@ywi="" fy.="" k="" ufmuh<br="" yvfi="" yxbygxum%+':="">&amp;"\$\$da 'hc'' "' \$da ž\Y`X cb`]bY"</ufa>
		7 cbh/bh =blfcXi Wjcb hc h\Y Wti fgYžUbX fYj ]g]cb cZ dfYj ]ci g \Ufa cb]WWtbW/dhgž]bWi X]b[ GYWtbXUfm 8 ca ]bUbhW\cfXgžGYWtbXUfm@YUX]b[ HcbY W\cfXgž UbX bcb! Xca ]bUbh+h\ W\cfXg"
	Hi hcf]U`	D@95G9BCH9.5IF5@HIHCF=5@G5B8 5IF5@7 <c∓ &"<="" -b="" fghi8€ł69;="" k99?="" td=""></c∓>
K YY_'&.'&&': YVfi Ufm!'&* : YVfi Ufm	@YWi fY	<ul><li>Ufa cbm@YWi fY. K YXbYgXUm&amp;( : YVfi UfmUh &amp;"\$\$da 'hc'' "' \$da ž\Y`X'cb']bY"</li></ul>
		7 cbhYbh 7 \fca Uh]W< Ufa cbm BYUdc`]hUb G]I h\ W\cfXgžUbX 5i [ a YbhYX G]I h\ W\cfXg`fDUfh%L"
		Gi[[YghYX`FYUX]b[.`7`YbX]bb]b['⁄'K YghHYIhVcc WXYW_hXY`≢XYI'Zcf'dU[Yg`fY`Uh]b['hc'hXY'[]jYb hcd]Wg"
	Hi hcf]U`	5 i fu`Hi lcf]u`. 'A cbXUm&&': YVfi UfmUh %"\$\$da !&"' \$da /UbX`Uh &"' \$da !("\$\$da ž`]b`K YVghYf'' \$*`f1Yj Y`'' Ł"
		7 cbhYbhʻ≢bhYfj U`fYW¢[b]hjcb/7 \cfX fYW¢[b]hjcb/G]b[]b['F \mh\a"

	Ghi X]c	A i g]W@]hYfUhi fY'F YdYfhc]fY.'J cWU`'%'GWXi VYfh '; fYhW.Yb'Ua 'Gd]bbfUXY'/'9f_Ob][''O% %(!%)/ ; cYh.YO/GWXi a Ubb.'6 [UZfWdY[WTWfBcg'%])/%(!%*Ł O% (\$/ <y]byo \$ua="" %""="" 'hc="" ('flyj="" 5```ghi="" 5i="" f]xum&*':="" fu`'7\c]f.':="" gh'uhhybx"<="" i="" th="" ufmuh'%\$"\$\$ua="" xybhg'a="" y`''="" yvfi="" yvghyf'''="" ł"="" ž']b'k=""></y]byo>
K YY_" ."%"A UfWX"!") A UfWX	@YWifY †	<ul> <li>&lt; Ufa cbm@YWi fY. K YXbYgXUm\$' A UfWX 'Uh &amp;"\$\$da 'hc'' "' \$da ž\Y`X'cb`]bY"</li> <li>7 cbhYbh '7\fca Uh]W&lt; Ufa cbm 'BYUdc`]hUb 'G]I h\ W\cfXgž5i [a YbhYX'G]I h\ 'W\cfXg'fD † %</li> </ul>

I		(%) - \$0/6fi \(\frac{W}{b}\)\(\frac{1}{2}\) \(\frac{1}{2}\)\(\frac{1}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}\)\(\frac{1}{2}\)\(\f
	Gh X]c	5i fU^7\c]f.: f]XUm%&AUfVX^Un%\$"\$\$Ua hc %"" \$Ua ž]b K YVghYf" ' (`f]Yj Y^" Ł"
		5```gh XYbhg`a i gh'UhhYbX"
K YY_^).^%)^A UfWX!^% A UfWX	@YWhifY	<pre><ufa "'="" \$da="" &"\$\$da="" 'hc''="" 'uh="" a="" cbm@ywh="" fy.="" k="" pre="" ufwx="" yxbygxum'%+="" ž\y`x'cb']by"<=""></ufa></pre>
		HU_Y!\ca Y`hYgh'%Xi Y"`@YWi fY`WcbhYbh'\(\overline{A}\)ca k YY_g`%' `hc`VY`hYghYX"
		7 cbh/bh 7 \fca UhjW< Ufa cbm F Yj ]g]cb cZWcffYWhgdY``]b[ cZ@YUX]b[ HcbY X]a ]b]g\YX +h\ W\cfXg" A cXi `Uhjcb j ]U'h\Y fY!gdY``]b[ cZh\Y @YUX]b[ HcbY8]a ]b]g\YX +h\ W\cfX fDUfh'\'
		Gi [[YghYX'FYUX]b[.'7`YbX]bb]b['/'K YghHYIhVcc WXYW_'hXY'+bXYI'Zcf'dU[Yg'fY`Uh]b['hc'hXY'[]jYb hcd]Wg"
	Hi htf]U`	5i fU^Hi lcf]U^AcbXUm%) A UfWX^Uh %"\$\$da!&"' \$da /UbX^Uh &"' \$da!("\$\$da z~]b~K YVgHYf~' \$*~fIYj Y^" z"
		7 cbh/bh 'G]b[]b[/F \mt\a / '7 UXYbW/g/7 \cfX fYWc[b]h]cb"
		A i g]W@ tYfUhi fY'F YdYffc]fY.'7\Ua VYf A i g]W'A.cnUfh'5'Sq(`WfCg[`fWf[`3?S\ad?), % O%+, - Q/'A Ygg]UYb.'CgSdfWfXadfZW7`VaXF[_W f] ]c`]bž'WUf]bYhž'WY``c'/'d]UbcŁ'O%(\$!%/6cc_cZ FYjY'Uh]cbg

		7 cbhYbh A cXi `Uhjcb'j ]U'h\Y'fY!gdY``]b['cZh\Y @YUX]b['HcbY'8]a ]b]g\YX'+h\'W\cfX'fDUfh&Ł"
		8]gW gg]cb cZ7 ca dcg]h]cb 5gg][ ba Ybh
		Gi [[YghYX'FYUX]b[.'7`YbX]bb]b[:7'K YghHYIhVcc WXYW_hXY'±bXYI 'Zcf'dU[Yg'fY`Uh]b['hc'hXY'[]j Yb  cd]Wg"
	Hi hcf]U`	5i fU``Hi hcf]U`.`A cbXUm&- `A UfVX``Uh %"\$\$da !&"' \$da /UbX`Uh &"' \$da !( "\$\$da ž`]b`K YVghYf'' \$*`f]Yj Y`'' Ł"
		7 cbh/bh A Y`cX]WX]WUh]cb/7 UXYbW/g/GWU`Yg"
		A i g]W@JhYfUhi fY'F YdYfhc]fY.'CdYfU.'JYfX].'>S FdSh[SfSž5Wh%UbX'DUfh%cZ5Wh&f]"Y"'idhch\Y : ]bU'YŁ'O%)'Q
	Gh X]c	5i fU``7\c]f.`: f]XUm\$&'5df]`
		81 9 HC H<9 95GH9F DI 6@=7 < C@=85M∑H<9F9 € BC 51 F5@ GHI 8€ 7 < C € H< € K 99? "
		D`YUgY`bchY`h\]g`GhX]c`h]aY`]g`fYd`UWX`VmU`ZbU` GhX]c`h]aY`cZ%\$"\$\$Ua`hc`%%" \$Ua`cb`:f]XUm'\$ 5df]`fKYY_`%%L"
K YY_', .') '5df]`'!'- '5df]`	@YWi fY	<ul><li>Ufa cbm@YWh fY. K YXbYgXUm\$+'5df]`Uh</li><li>&amp;"\$\$da 'hc'' "' \$da ž\Y`X'cb`]bY"</li></ul>
		7 cbhYbh A cfY 7 \fca UhjW\Ufa cbm Xca ]bUbh-h\W.cfXg UbX VYmcbX": i fh\Yf X]gW gg]cb cZ 7 ca dcg]h]cb 5 gg][ ba YbhUbX UbU mg]g cZh\Y i gY cZ \Ufa cbmUbX Zcfa ]b 7 \cd]bfg B cWh fbYg"
		Gi [[YghYX'FYUX]b[.'7`YbX]bb]b['/'K YghHYIhVcc WXYW_'h\Y'±bXYI'Zcf'dU[Yg'fY`Uh]b['hc'h\Y'[]j Yb hcd]Wg"
	Hi lcf]U`	5i fU``Hi hcf]U`. 'A cbXUm'\$) '5df]`
		81 9 HC H< 9 95 GH9 F DI 6@=7 < C@=85 MEH< 9 F 9 5 F 9 BC 51 F 5@ HI HC F =5 @G H< =6 K 99? "
	Gh X]c	5i fU``7\c]f. : f]XUm\$- '5df]``Un'%\$"\$\$Ua 'hc %%"' \$Ua ž`]b`K YVghYf'' ' ( 'f Yj Y`'' Ł"
W.NV. 1. 1212 1 7 1 7 1 7 1		5```gh XYbhg`a i gh'UhhYbX"
K YY_''%&'5df]`'!'%*	@YWifY	< Ufa cbm@YWh fY. K YXbYgXUm%( 5df]`Uh
5df]`		&"\$\$da 'hc'' "' \$da ž\Y`X`cb`]bY"

		7 cbh/bh H\Y``Uh/f'% h\`7 Ybh fm-K U[bYf'UbX YbX`Ygg'h/bg]cb'-K \Uhg'bYI h3'F Yj ]g]cb'UbX gi a a Ufm' Gi [[Ygh/X'FYUX]b[.'7`YbX]bb]b['/'K YghHYI h/cc WXYW_'h\Y'-\DXYI 'Zcf'dU[Yg'fY`Uh]b['hc'h\Y'[]j Yb hcd]Wg"
	Hi hcf]U`	5 i fu``Hi hcf]u`.`A cbXUm'&:5df]``Uh %"\$\$da !&"' \$da /UbX`Uh &"' \$da !("\$\$da ž`]b`K YVghYf`' \$*`f1Yj Y``' Ł" K f]hhYb`51 F 5@'H9GH`f%\$i `cZhchU``a Uf_`Zcf`h\Y Wci fgYŁ"
	Ghi X]c	A i g]W@ hYfUhi fY'F YdYfhc]fY.'C fW.YghfU`.6Yf]cn.' Ek_ bZa` [W8S` fSef[cgW%', '\$Q/' <u>F]W.UfX'GhfUi gg</u> .' F[^^7g'W' eb[WYWhe? Wook BoS`] e'0% - (!) Q" 5 i fU`'7\c]f.': f]XUm'%' 5df]`'Uh'%\$"\$\$Ua 'hc
K YY_'%\$.'%-'5df]`'!'&' 5df]`	@YVVi fY	%"" \$Ua ž]b K YVghYf" ' ( 'flYj Y`' Ł"  5```gh XYbhg a i gh'UhhYbX"  < Ufa cbm'@YWh fY. K YXbYgXUm'&%5df]``
	Hi hcf]U`	BC '@97 HI F 9'H< € 'K 99?  5 i fU' 'Hi hcf]U'. 'A cbXUm'% '5df] 'Uh %"\$\$da ! &"' \$da /UbX'Uh &"' \$da ! ("\$\$da ž]b'K YVghYf'' \$* f1Yj Y`' Ł"  7 cbhYbh 'A Y`cX]W8  WUh cb/dfYdUfUh cb'Zcf'G]b[ ]b[
		HYghz Sunn W.cfXg"  A i g]W@hYfUhi fY F YdYfhc]fY. Sunn. 7 ci bh6Ug]Yfg  ? UbgUg 7 ]hmGYj Yb @YghYf @YUdg \new 7 \]W K YVV  UbX \]g C fW.YghfUz ZYUhi f]b[ 9 \U: ]m[ YfU X 5!  H]q_Yhz 5!HUq_Yh /
	Gh X]c	H]a '< cd_]bg'"H\Y': UWY'cZ@cj Y"'fIfca 'U'Vi a . "I dcb'A m'7 Ua Y'"Ł" 5i fU''7\c]f.': f]XUm&' '5df]`

# FYgci fWyg

### DfYgWf]VYX F Ygci fWfg

A C C 8 @9. 'A UhYf]U`g`Zcf'h\]g`Wci fgY'k]```VY`ZfYei Ybhma UXY`Uj U]`UV`Y`hc`U```ghi XYbhg'j]U'h\Y`A ccX`Y Y@YUfb]b[ 'k YVg]hY. ``c[!]b`k]h\ mci f`ghi XYbh=8 `UbX`dUggk cfXžUbX`gY`YWhh\Y`A I G7 &\* \$&`&\$&\$\7 ci fgY''

Ghi XYbhgʻUfYʻYl dYWNYXʻhcʻa cb]hcfʻh\YʻA ccX`Yʻa cXi `YʻZfYei YbhimXi f]b[ 'HYfa 'Zcf']bZcfa UhjcbžWUggʻbchYgžfYj ]q]cbʻYl YfWlqYqžʻUbXʻUbmi dXUhYqʻcbʻUqqYqqa Ybhg"

D`YUgY`BchY.`U```UggYgga Ybh`]hYa gžk ]h\`h\Y`YI WYdh]cb`cZ]b!WUgg`hYghgža i ghiVY`gi Va ]hhYX`Zcf`a Uf\_]b[ j ]U`h\Y`A ccX`Y`k YVg]hY"

#### FYWca a YbXYX FYgci fWYg

 $< Ufa\ cbmHYI\ hVcc\_.\ 'h\ Y\ 'Zc\ `ck\ ]b[\ 'hYI\ hVcc\_k\ ]```VY'i\ gYX'Vmh\ Y\ 'YWhi\ fYf'h\ fci\ [\ \ci\ hU```cZh\ Y\ 'fA\ UhYf]U`g`UbX Ghfi\ Whi\ fYg'cZA\ i\ g]Wfi7\ ci\ fgYg'\ YfY'UhI\ BGK\ .$ 

H]hY. 'H\Y'A i g]MJUbfg'; i ]XY'hc'H\Ycfm'UbX'5bU'mg]g
5i h\cffg\{ '>UbY'D]dYf'7 'YbX]bb][ UbX'9`]nUVYh\ 'A Ufj ]b'K Ygh
Di V`]g\Yf. K "K "'B cfhcb'/ '7 ca dUbm'\(\dagger \)W
9X]hJcb. " fX'9X]hJcb
MYUf. '&\$%\* fl fX'9X]hJcb\(\dagger \) b'Y'Zfca 'h\Y'I BGK 6cc\_g\cd'Ug'U'\UfX'Wcdm\(\dagger \)cf'Ug'Ub'YVcc\_'Uh\\hd.\(\dagger \) cd'Ug'U'\Ugdl 3]X1 (\&-(--\\$)) ( 'fW]\(\dagger \)cb'fY6cc\_fii bXYf'8][ ]hU'
F Ygci fWYg"

Ghi XYbhgʻUfYʻghfcb[`mYbWci fU[YXʻhcʻa U\_Yʻi gYʻcZh\YʻhYl hVcc\_žY]h\Yfʻ\UgʻUʻ\UfXʻWcdmifdi fWkUgYXʻZfca h\Y`l BGK 6cc\_g\cdʻcfj U]ʻh\Y`l BGK @]VfUfmŁcfʻUgʻUbʻYVcc\_ʻfdi fWkUgYXʻZfca h\Y`di V`]g\Yffgʻk YVg]hYŁ''

D`YUgY`bchY.`fh\]g`hYI fVcc\_`]g`U`j U`i UV`Y`fYgci fWY`Zcf`U```ghi XYbhg`]b`A / G`7 ci fgYg`UbXž`]Zmci `di fW\UgY`U WcdmcZh\Y`Vcc\_žmci `k ]```U`gc`fYWY]j Y`]bZcfa Uh]cb`fZfca `fh\Y`Vcc\_`di V`]g\Yf£`fY[ UfX]b[ `UWWygg`hc`i gYZ `cb!`]bY`gi ddcfha UhYf]U`gž]bWi X]b[ `fh hcf]U`g`cb`WcbhYbhžei ]nnYgžUbX`fYWcfX]b[ g`cZa i g]WU``YI Ua d`Yg ]bWi XYX`]b`fh\Y`hYI fVcc\_"

# 7ci fgY 9j U`i Uh]cb UbX 8Yj Y`cda Ybh

Gh XYbhZYXVUW\_]gcbh]g'Wei fgY]g'[Uh\YfYX'dYf]cX]WU``m'UbX]g'U`k Umg'WUfYZ ``m'Webg]XYfYX`k ]h\
U'j ]Yk 'hc'UWf]b['cb']h'Webghfi Whj Y`mk \YfYj Yf'dcgg]V`Y": YYXVUW\_]g'[Uh\YfYX'Vmj Uf]ci g'a YUbg']bWi X]b[
h\Y'cWWJg]cbU``]bZcfa U``cb!`]bY'ei Ygh]cbbU]fY'UbX'j ]U'h\Y'a cfY'Zcfa U``A m9I dYf]YbW''Gi fj Ym'dfcWYgg
Wea d`YhYX'Uh'h\Y'YbX'cZYUW\'HYfa "

+b^``][\hcZdfYj]cig'ZYYXVUW\_'Zfca 'ghi XYbhg']b'h\]g'WcifgYža cfY'Ya d\Ug]g'\Ug'VYYb'd'UW'X'cb'dfcj]X]b[Yl Ua d'Yg'Zfca 'U'k]XYf'fUb[Y'cZa i g]\W\`ghm\Yg'k]h\]b'U```Wca dcbYbhg'cZh\Y'WcifgYž']b'cfXYf'hc'Zlfh\Yf Wcbgc`]XUhY'h\Y'ghi XYbhg'i bXYfghUbX]b['cZh\Y'WcifgY'WcbhYbhUbX']hg'fY`Yj UbW'hc'ghi XYbhghi Xm dfc[fUa g"'5`gcž'Zlfh\Yf'UhhYa dhg'\Uj Y'VYYb'a UXY'hc'Ybgi fY'h\Uhghi XYbhg'\Uj Y']bWfYUgYX'UWWygg'hc fYj]g]cb'a UhYf]U'gž'a UXY'Uj U]`UV'Y'j ]U'h\Y'A ccX'Y'k YVg]hY''

# Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

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

Image: Ybwei bhyfu'dfcv'ya k \yb'uhhya dhjb[ 'hc'gi va ]hmci f'Ugg][ ba Ybhh\fci [ \ 'Hi fb]h]bž'd'YUgY

Hy'Yd\cby'9| hy'fbu''Gi ddcfhcb'-', ) '' ' ' %cf'Ya U]''h\Ya 'cb'Y! hy'fbu'hy'hgi ddcfh4 i bgk "YXi "Ui "''Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY\_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY\_YbXg'fl \*) 'XUmg'U'mYUft"'=Z'mci
UfY'i bUV'Y'hc'gi va ]hmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\ 'Hi fb]h]b'mci 'a UmUdd'mZcf'Ub'Y! hy'bg]cbž'Vi hmci
a i ghfYhJ]b'mci f'h]W\_Yhbi a VYf'Zfca '9! hy'fbU''Gi ddcfhfU'cb[ 'k ]h\ 'Ubmch\Yf'fy'Yj UbhXcW a Ybhgt'hc
]bWi XY'Ug'Yj ]XYbW' 'hc'gi ddcfhmci f'Y! hy'bg]cb'Udd']WUh]cb"'=Zmci 'Ya U]''9! hy'fbU''Gi ddcfhmci 'k ]'`
Ui hca Uh]WJ'`mfYW']j Y'U'h]W\_Yhbi a VYfZ'Vi h]Zmci 'hY'Yd\cbY'mci 'k ]``bYYX'hc'gdYW]Z]WJ'`mUg\_'Zcf'cbY''
Hi fb]h]b'U'gc'dfcj ]XYg'i dXUhy'g'cb'h\Y]f'gmghYa 'ghUh' g'cb'Hk]hyf''

; YbYfU`mž'UggYgga YbhiHug\_g'a i ghVY'gi Va ]hhYX'Y`YVWfcb]\WJ``mij ]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ ba Ybh''=b']bgHJb\W'g'k \YfY'h\]g']g'bchdcgg]V`Yž']hk ]```VY'gHJhYX'cb'mci f'\\circ i fgY'g'A ccX`Y'g]hY'k ]h\U`hYfbUh]j Y'gi Va ]gg]cb'XYHJ]`g"

cfi]bZcfa Uhjcbicbi\ckihcigi Va ]hUgg][ ba Ybhgicbi]bYij ]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va ]hUgg][ ba Ybha ccXiY

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

D`U[]Uf]ga `]g`i g]b[ 'h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b[ 'h\Ya `Ug`mci f`ck b"`±hWJb`hU\_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b[ 'hc`UWW]XYbhJ``mWcdm]b[ 'Zfca `U`gci fWY`k ]h\ci hUW\_bck `YX[ Ya Ybh'

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

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$