

7ci fgY'Cj Yfj]Yk

Ghuzz 7 cbhuWh8 Yhu]`g

'7cbj Ybcfg'

B Ua Y	9a U]`	5j U]`UV]`]lm	@cWUh]cb	D\cbY
>c\b`DYhYfgcb	"dYhYfgcb4 i bgk "YXi "Ui	H\i fgXUm	CZ]WY`%\$)ž @YjY``%ž`G]f FcVYfh KYVghYf 6i]`X]b[-',) (,+\$

"@YWhifYfg"

B Ua Y	9a U]`	5j U]`UV]`]lm	@cWJhjcb	D\cbY
>c\b`DYhYfgcb	3	‰"\$\$Ua!‰"\$\$da/ H\i fgXUm	CZZJWY*%\$)ž @YjY`*%žG]f FcVYfh KYVgHYf 6i]`X]b[-',) (, +\$

'Hi hcfg'

B Ua Y	9a U]`	5j U]`UV]`]m	@cWUh]cb	D\cbY
; Ycf[]U [.] @]_Ybg	["`i <u>_</u> Ybg4 i bgk "YXi "Ui	; Ycf[]U'g\ci`X'VY WcbHUWHYX'j]U'YaU]`"		

GWXcc~7cbhJWh~abZcfa Uhlcb

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

D\cbY. 'f\$&Ł'-',) '(,) *

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

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

 $\label{eq:hamiltonian} $$HY'GWCC``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7igtcX]Ubg\cong h\Y'6YXY[U'`fPYbg]b[tcb'WJadig\cong \cong m1]U'`fP]thubX'5fti/'8Yg][b'7UadigYg\cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7igtcX]Uby\cong m1b'7UbYYffU\cong \cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7igtcX]Uby\cong m1b'7UbYYffU\cong \cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7igtcX]Uby\cong m1b'7UbYYffU\cong \cong \cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7igtcX]Uby\cong m1b'7UbYYffU\cong \cong \con$

7ci fgY 8YHJ] g

7 fYX]hDc]bhg *

Gi a a UfmcZh\Y 7ci fgY

Gi VYWh5fYU. ? ge[U

H\]g`WcfY`Wci fgY`YI hYbXg`h\Y`ghi XYbHg`_bck `YX[Y`cZh\Y`a UhYf]U`gž`ghfi Whi 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]WdfUWh]W`g`]b dcgh\%) \$`Ufha i g]WWca dcg]h]cbž`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]cbžj c]W!Y`YUX]b[`ž'UbX`a i g]WU``Zcfa "'9I YfW]gYg`]b`UXj UbWYX`Wca dcg]h]cbU``WfUZh dfcj]XY`h\Y`ghi XYbhk]h\`h\Y`cddcfhi b]hmhc`XYa cbghfUhY`h\Y]f`]b]h]Uh]j Y`UbX`WfYUh]j]hmk]h\]b`gY`YWhYX`ghmYg cZa i g]WU``dfUWf)WY`UbX`fYgYUfW."

7 ci fgY @YUfb]b[Ci hWca Yg

- %" a UghYf"_bck`YX[Y'cZh\Y'a UhYf]U`gʻžghfi 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 g]WU``k cf_g"
- ("Udd`mih\Y]f`XYj Y`cd]b['a i g]WU``_bck `YX[Y`UbX`g_]```hc 'a i g]Wa U_]b[ž'k \Yh\Yf`]hVY`dYfZcfa]b['cf Wca dcg]b["
-) "XYa cbghfUhY`WcfY`g_]`g`]b`a i g]WJUbg\]dž`]b`dUfh]W``Ufža i g]W`]hYfUWhz`gWcfY`fYUX]b[ž`UbX`h\Y dYfZcfa UbWY`cZUXj UbWYX`W\fca Uh]W\Ufa cb]Wdf]bWJd`Yg"

HYUWX]b['GhfUhY[]Yg'

 $6A i g'UbX'65 fA i g]WGh X]Yg'UbX'A i g]WGh X]Yg'9l hYbg]cbŁgh XYbhg'UhhYbX'U'k YY_`mcbY!\ci f'`YWh fY cb'a i g]Wh\YcfmUbX'\Ufa cbm'U'k YY_`mcbY!\ci f'h hcf]U''cb'Ui fU`'UbX'YUf!hfU]b]b['g_]``gž'UbX'U'k YY_`m cbY!\ci f'``UVcfUhcfmcb'W\cfU``g]b[]b['g_]``g''$

@YWi fYg`]bj c`j Y`WUgg`YI YfWjgYg`]b`a i g]Wh\YcfmUbX`\Ufa cb]WUbU`mg]g`]b`j Uf]ci g`Wca dcg]hjcbU` WcbhYI hg`UbX`UfY`Ui [a YbhYX`k]h\`gci bX`fYWcfX]b[gždck Yfdc]bhdfYgYbhUhjcbgžUbX`WUgg`ei]nnYg":5i fU` hi hcf]U`g`]bj c`j Y`WUgg`UWIj]hjYgž]bhYbg]j Y`Xf]``gžUbX`YI YfWjgYg`]b`h\Y`UbU`mg]g`cZgY`YWhYX`a i g]WU` YI Ua d`Yg`XYg][bYX`hc`XYj Y`cd`UXj UbWYX`Ui fU``dYfWYdhjcb"; fci d`g]b[]b[`]b`h\Y`7\c]f`@UVcfUhcfm dfYgYbhg`cddcfhi b]hjYg`Zcf`h\Y`dfUWf)WU``Udd`]WUhjcb`cZUi fU``g_]``g`]b`U`dYfZcfa UbWY`UbX`Wca dcg]hjcbU` WcbhYI h'

5ggYgga Ybh

- D@95G9 BCH9.]b cfXYf hc fYWY]j Y U D5GG a Uf_ Zcf h\]g Wci fgYžghi XYbhg a i gha U_Y U gYf]ci g UhfYa dh'UhWca d`Yh]b['5@UggYgga YbhilUg_g"
- "GHI 89BHG 5F 9 F 9A \$\B898 "H<5H"H<9M"A | GH 57 < \$\D5GG "A 5F?": CF "H<9 < 5F A CBM 7CA DCB9BH" \$\B "CF89F" "HC 69 5K 5F 898 5 D5GG "A 5F?": CF "H<9 "CJ9F 5@A | G7 "&* \$\& 7C | FG9"": U] if Y "hc "UWX] Y j Y "U "DUgg "a Uf_ "Zcf" h\Y " < Ufa cbm Wca dcbYbh'a Um" YUX "hc "U'gh XYbh'f Y W"] j]b[Ub "cj Y f U"": U] "j; f UXY "Zcf" h\Y " A | G7 "&* \$\& 7 ci f g Y "
- '5 ```UggYgga Ybh']hYa gžk]h\`h\Y'YI WYdh]cb`cZ]b!WUgg`hYghgža i ghVY`gi Va]hhYX`j]U`A ccX`Y'': i fh\Yf XYhJ]`g`UVci hih\Y`gi Va]gg]cb`cZdUfh]W``Uf`UggYgga Ybh']hYa g`k]```VY`]ggi YX`Uhj Uf]ci g`h]a Yg`Vmh\Y fY`Yj Ubh'hi hcf`cf``YWhi fYf`]b`h\Y`A I G7 `&* \$&`A UhYf]U`g`UbX`Ghfi Whi fYg`cZA i g]W' `7 ci fgY''`D`YUgY`hU_Y YgdYW]U``bchY`cZXi Y`XUhYg`UbX`h]a Yg`Ug`@UhY`DYbU`h]Yg`UfY`Udd`]YX`Ui hca Uh]WU``mVmh\Y`A ccX`Y Gi Va]gg]cb`qmghYa `]a a YX]UhY`mUZhYf`h\Y`XYq][bUhYX`qi Va]gq]cb`ha Y`\Ug`dUgqYX''`

"A i g]W@hYfUhi fY '@]ghffgY`Z|X]fYWhYX 'ghi Xmz 'UbX'HYgh'U``]ghcZh\Y 'k cf_g'hc'VY'Yl Ua]bYX'h\]g gYa YghYf']g'Uj U]`UV`Y'cb'A ccX`Y'—gYY'h\Y'A I G7 '&*\$&'7 ci fgY'a cXi `Y"'

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8YHJ]`g. 'Dcfh**z**c`]c`cZ<Ufa cbmUbX`7 ca dcg]h]cb`9I YfW]gYg. 'kk c`g\cfh`]b!WUgg`hYghgž'UbX`cbY`Wca dcg]h]cb YI YfW]gY"K f]hhYb`ZYYXVUW_'dfcj]XYX`Vm`YWh fYf"

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

 $HY' < Ufa cbmDcfhZc^{c}C Wcbg]ghg^{c}CZhY^{c}C k]b[^{h}fYY^{c}UggYgga Ybh]hYa g.$

%"±0!7`Ugg`HYgh'%`\Y`X`]b`bcfa U``@YWn fY`h]a Yg`cb`A cbXUm`\$-`A UfW\`fK YY_`(Ł``k cfh\`%)ı `cZh\Y`hchU` a Uf_`Zcf`h\Y`Wti fqY"

&"'=b!7`Ugg`HYgh'&.'\Y`X`]b`bcfa U``@YWfi fY`h]a Yg`cb`A cbXUm'&\$`5df]``fK YY_'%\$L``k cfh\`%)ı 'cZh\Y`hchU` a Uf_'Zcf`h\Y`Wti fgY"

' "'7 ca dcg]hjcb'5gg][ba Ybh'U'g\cfh'Wca dcg]hjcb']b'U'W\cgYb'ghm\Y'g\ci `X'VY'gi Va]h\YX'Vm("\$\$da A cbXUm&+'5df]`'fK YY_'%\L'k cfh\'' \$1 'cZh\Y'hchU`'a Uf_'Zcf'h\Y'Wci fgY"': i fh\Yf'XYhU]`g'cb'Wca d`Yhjcb UbX'gi Va]gg]cb'cZh\Y'Ugg][ba Ybhk]``VY'a UXY'Uj U]`UV`Y'cb'A ccX'Y"

Gi Va]gg]cb`bchYg. ±0!WUgg`HYghg`k]```VY`Wca d`YhYX`Xi f]b[`bcfa U```YWf fY`h]a Y"`H\Y`Z|bU``7 ca dcg]h]cb Ugg][ba Ybha i ghVY`gi Va]hhYX`j]U`h\Y``]b_`cb`A ccX`Y"

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

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GhUfhXUhY. Bch5dd`]WUV`Y

8 YHU]`gg. 'DcfhZc`]c'cZ5i fU`'9| YfW]gYg. 'cbY'hfUbgWf]dh]cb'Y| YfW]gYž'cbY']b!WUgg'Ui fU`'hYgh'K f]hhYb'ZYYXVUW_dfcj]XYX'Vmh' hcf"

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

A'MIV'Y

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: i fh Yf'] b Z c fa Uh c b c b'h Y'A i g] W@] h Yf Uhi f Y'g Y'Z X] f Y W Y X'g h X m] g'Uj U] `UV`Y' c b'A c c X`Y'' A c c X`Y''' A c c X`Y'' A c X`Y'' A c X`Y'' A c C X`Y'' A c C X`Y'' A c C X`Y'' A c X`Y''' A c X`Y'' A c X`Y''' A c X`Y''' A c X`Y''' A c X`Y'' A c X`Y'' A c X`Y''' A

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

5 hmy b X Ub WY F Yei] f Ya Yb hg

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 `th] 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 `th U b `&\$ i `c Z W U g g Y g `a U m f Y g i `th] b `th 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''

 $HI HCF = 0 \ "]b'hi hcf]U'g'mci'k]```UWhj Y`miYb[U[Y'k]h\ WcfY'Wci fgY'WcbhYbh'h\ Uhik]```YbUV`Y'mci'hc'Udd`m mci f'a i g]\W]``g_]`g']b'a i g]\W]Ubg\]dz']b'dUfh]\W'`Uf'hc'a i g]\W']hYfUWhz'g\WcfY!fYUX]b[z'UbX'h\ Y'dYfZcfa Ub\W'cZUXj Ub\W'X'\W\ fca Uh\\W\ Ufa cb]\WUbX'a Y`cX]\Wdf]b\W]d`Yg'''ff' @C'') \E'\Mci'k]```U`gc'Yb[U[Y'k]h\ WcbhYbhfY`Uh]b[hc'h\ Y']XYb]hZ]\WUh]cb'UbX'\WcbhYlhi U']gUh]cb'cZ_Ymdcgh\%) \S'a i g]\W'\k cf_g'ff' @C'' \E''$

GHI 8 ± 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 fYg. A cbXUm%+': YVfi Ufm Uh- "\$\$Ua 'hc'%\$" \$Ua /UbX'Uh&"\$\$da 'hc'' " \$da ž']b K YVghYf'; %+"'
		7 cbh/bh =blfcXi Wfjcb hc h\Y Wti fgYžUbX fYj]g]cb cZ dfYj]ci g \Ufa cb]WWtbWYdhgž]bWi X]b['GYWtbXUfm 8 ca]bUbhW\cfXgžGYWtbXUfm@YUX]b['HcbY W\cfXgž UbX bcb! Xca]bUbh+h\ W\cfXg"BYk 'WtbWYdhg. 7 \fca Uh]W <ufa '5i="" 'w\cfxg"<="" [="" a="" cbm!="" h\="" td="" x'g]i="" ybh=""></ufa>
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		7 cbHYbh 7 \fca UHW< Ufa cbm BYUdc`]HUb G]I H\ W\cfXgžUbX a cfY k cf_ cb 5i [a YbHYX G]I H\ W\cfXg"
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		, , , , ,
		7 cbhYbh A cXi `Uhjcb'j]U'h\Y'fY!gdY``]b['cZ
		h\Y`@YUX]b[`HcbY`8]a]b]g\YX`+h\`W\cfX`fDUfh`%L"
		Gi [[YghYX'FYUX]b[.'7`YbX]bb]b[:/
		K YghiHYI Mcc WXYW_ihXY =bXYI ZcfidU[YgifY`Uh]b[
		hc"h\Y"[]jYb"hcd]Wg"
	Hi htf]U`	5ifU`Hihcf]U`g. AcbXUm&'AUfWX
•	1	· ·

	[BC:51 F5@HI HCF=5@G"H< +6"K 99?"
	Gh X]c	5i fU 7\c]f.: f]XUm&+ A UfW
		BC'51 F5@7 <c∓'ghl8€'h<€'k99?"< th=""></c∓'ghl8€'h<€'k99?"<>
K YY_'+.'' \$'A UfW\'!'' 5df]`	@YWhi fY	<pre><ufa "\$\$ua="" "'="" \$="" \$da="" \$ua="" %+"<="" '%\$"'="" ''="" ;=""]b="" a="" cbm@ywi="" cbxum'="" fyg.="" hc="" k="" pre="" ubx="" ufwx="" uh&"\$\$da="" uh-="" yvghyf="" ž=""></ufa></pre>
		7 cbh/bh 7 cbh/bh A cXi `Uhjcb j]U h\Y fY!gdY``]b[cZh\Y @YUX]b['HcbY 8]a]b]g\YX +h\ W\cfX fDUfh&t"8]gW gg]cb cZ7 ca dcg]h]cb 5gg][ba Ybh' 5bU`mg]g cZ7 \cd]b @aUfgd We"
		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 hcf]U`	5 i fU``Hi hcf]U`g. `A cbXUm' \$`A UfWX`Uh-"\$\$Ua `hc %\$"' \$Ua /UbX`Uh'%\$"' \$Ua `hc`%&"\$\$da ž`]b`K YVghYf '\$*"'
		7 cbhYbh A Y`cX]WX]WUh]cb/7 UXYbWYg/GWU`Yg"
		Aig]W@]hYfUhifY`FYdYfhc]fY.`CdYfU.`JYfX].`>S FdSh[SfSž5Wi%UbX`DUfh%cZ5Wi&`f]"Y"`id`hc`h\Y :]bU`YŁ'O%)'Q
	Gh X]c	5i fU``7\c]f.': f]XUm'\$' '5df]``Uh'&"' \$da hc`&"\$\$da ž]b`K YVghYf'' ' ("'
		5```ghi XYbhg`a i gh'UhhYbX"
K YY_', . '* '5df]`'! '%\$ '5df]`	@YWhi fY	<pre><ufa "="" "\$\$ua="" \$da="" \$ua="" %+"<="" 5df]`uh-="" ;="" a="" cbm@ywi="" cbxum\$*="" fyg.="" hc'%\$"'="" hc''="" pre="" ubx'uh&"\$\$da="" yvghyf="" ž']b'k=""></ufa></pre>
		7 cbh/bh A cfY 7 \fca Uh]W\Ufa cbm Xca]bUbh-h\

		$F[^{M7}g^{W7}]$ eb $[WYW]$ eb $[WYW]$ eb $[WYW]$ eb $[W]$ With BodS`] e $[W]$ - (!) Q"
7 \c]f.:f]XUm'% 5df]`"	(StitX)(cd i o	5i fU`7\c]f.: f]XUm%\$`5df]`"
		8D U ECTHO9 THEEL9 E'A (SCTSER 5550030 T86EJET QE : F =85M*DI 6@=7 '< C@=85M*ZH < 9F9 '5F9 =6 '5I F 5@7 < C =F 'GHI 8 € 'H < -6 'K 99?" D`YUgY 'bchY'h\]g'Gh X]c'h]a Y']g'fYd`UWYX'Vm'U'Z]bU`

5i

5df]`	%\$"' \$Ua /UbX`Uh`%\$"' \$Ua `hc`%&"\$\$da ž`]b`K YVghYf '\$*"' Aig]W@jhYfUhifY`FYdYfhc]fY.`5ighfU`]U.`7Uf J]bY.`7UZY 7cbWYfh]bc`O%,(Q`GW`h\cfdY.`?U_UXi`fZcf cfWXYghfUŁO%,,Q`AUfh]b`KYg`Ym!

FYgci fWyg

DfYgWf]VYX F Ygci fWyg

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 dYWYXʻhcʻa cb]hcfʻh\YʻA ccX`Yʻa cXi `YʻZfYei YbhimXi f]b['HYfa 'Zcf']bZcfa Uh]cbžʻWUggʻbchYgž fYj]q]cbʻYl YfW]qYqžʻUbXʻUbmi 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 fW/g

 $< 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

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

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

Image: Ybwb: bh/f'u'dfcv'ya k \yb'uhh/a dh/b['hc'gi va]hmci f'ugg][ba Ybhh\fci [\ 'Hi fb]h/bž'd'YugY

HY'Yd\cbY'9| h/fbu''Gi ddcfhcb'-',) '' ' ' %cf'Ya U] 'h\Ya 'cb'Yl h/fbu'h/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'mYUfŁ'' Image
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'Yl h/bg]cbž'Vi hmci
a i ghfYhJ]b'mci f'h/W_Yhbi a VYf'Zfca '9| h/fbU''Gi ddcfhfU'cb['k]h\ 'Ubmch\Yf'YY] UbhXcW a YbhgŁ'hc
]bWi XY'Ug'Yj]XYbW''hc'gi ddcfhmci f'Yl h/bg]cb'Udd']\WJh/jcb'' Image 'Ya U]''9| h/fbU''Gi ddcfhmci 'k]'`
Ui hca Uh/WJ'`mfYW']j Y'U'h/W_Yhbi a VYfž'Vi h]Zmci 'hY'Yd\cbY'mci 'k]'`'bYYX'hc'gdYW/ZWJ'`mUg_'Zcf'cbY''
Hi fb]h/b'U'gc'dfcj]XYg'i dXUh/g'cb'h\Y]f'gmghYa 'ghUh' g'cb'Hk]hYf''

; YbYfU``mž'UggYgga YbhiHug_g'a i ghVY'gi Va]hhYX'Y`YVWfcb]\W)``mj]U'Y]h\Yf'Hi fb]hjb'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`hYfbUhj Y'gi Va]gg]cb'XYHJ]`g''

cfi]bZcfa Uh]cbicbi\ckihcigi Va]hUgg][ba Ybhgicbi]bYij]UiA ccXiY.i\hdg.#gh XYbh'i bgk "YXi "Ui #\ck! qi Va]hUgq][ba Ybha ccXiY

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

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i±i\WbihU_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiW\YUh]b[ihciU\W]XYbhU`m\Wcdm]b[iZfca iUigci f\Wik]h\ci hiU\w_bck iYX[Ya Ybh'

IBGK [fcidgdu[]Uf]ga]bhch\yzc``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['U'ZYk'k cfXg'UbX'd\fUgYg'k\]Y 'a cghmfYhU]b]b['h\Y'cf][]bU`ghi Wh fY 'UbX#cf'dfc[fYgg]cb'cZ]XYUg'cZh\Y'cf][]bU`žUbX']bZcfa Uh]cb'k]h\ci hUW_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]YW]b['hc[Yh\Yf'ei chYg'UbX'dUfUd\fUgYg']bhc'U'bYk'k\c`Yžk]h\ci h'Uddfcdf]UhY'fYZYfYbW]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[`gcifWrg`k\]W\`\UjY`bchVYYb`fYUXžk]h\cihUW_bck`YX[]b[`h\Y`´gYWcbXUfm´gcifWrZfca`k\]W\`_bck`YX[Y`cZh\Ya`\Ug`VYYb`cVhU]bYX"

8 i d`]\WUh]cb`ffgY`Zd`U[]\Uf]ga "Ł gi Va]\h]b[`mci f`ck b`k cf_ž]b`k \c`Y`cf`]b`dUfhžk \YfY`]h\Ug`dfYj]ci g`m VYYb`dfYdUfYX`cf`gi Va]\hYX`Zcf`Ubch\Yf`UggYgga Ybhcf\Wci fgY`UhI BGK `cf`Ubch\Yf`i b]j Yfg]\m'

7 cffYWnfYZYfYbWlb['dfUWnWyg.

• DUfUd\fug]b[z'gi a a Uf]q]b[z'YggUmk f]hb['UbX'ha Y'a UbU[Ya Ybh

5 WUXYa]W = b Zcfa Uh cb.

: cf`YggYbhJU``gh XYbh`]bZcfa UhJcb`fY`UhJb['hc.

- fYei Yghg Zcf Yl hYbg]cb/
- `UhY`gi Va]gg]cbg`[i]XY`]bYg/
- fYj]Yk 'cZa Uf_g/
- I BGK '< YU`h\ 'UbX'GUZYhm'dc`]W[Yg/
- YI Ua]bUhcb dfcWXi fYg/
- gdYWJU``Wcbg]XYfUhJcb`]b`h\Y`Yj YbhcZ]``bYgg`cf`a]gUXj Ybh fY/
- gh XYbhYei]mUbX X]gUV]`]m/
- UbX'ch\Yf'YggYbhJU`'UWUXYa]W]bZcfa UhJcbž'gYY

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

•

∍a U[Y'7fYX]h

Gc`c'DYfZcfa UbWY'A U_]b['&\$%

7F = 7CG

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