7ci fh'6`cW_g'7cbhfcj Yfg]U`: `cf]XU =a a][fUh]cb'@Uk . '5'GYhVUW_'Zcf I h\a Y]Yf



: `cf]XUžI G5 !! \dot U'bchUV`Y'`Y[U``XYj Y`cda Ybhž'U'^i X]W]U`
UddYU`g'Wci fh'\Ug'i d\Y`X'Ub']b^i bWh]cb'dfYj Ybh]b[:: `cf]XU'Zfca
YbZcfW]b['U'Wcbhfcj Yfg]U``]a a][fUh]cb'`Uk "'H\]g'fi `]b[']g'XfUk]b[
Udd`Ui gY'Zfca 'UXj cWUWm'[fci dg'Ug']h'W'fhU]`g'h\Y'YbZcfWYa Ybh'cZ
G6!(ž'U'`Uk 'h\Uh'k ci `X'Wf]a]bU`]nY'i bXcW'a YbhYX']a a][fUbhg
YbhYf]b['h\Y'ghUhY''Gi W\'U'`Uk '\UX'][b]hYX'\YUhYX'X]gW'gg]cbg
fY[UfX]b['ghUhY'j Yfgi g'ZYXYfU``]a a][fUh]cb'Ui h\cf]hm"

 $H Y T "G" T c i fh c Z 5 d d Y U g Z c f h Y W h T f W h b 5 h U b h U g i d d c f h Y X U b Y U f f i b [h h U h V c W Y X h Y Y b Z c f W a Y b h c Z h g U k ž U [f Y Y] b [k] h h Y U g g Y g g a Y b h h h U h : c f] X U g G 6! (k U g f) _ Y m$

dfYYa dhYX'Vm'ZYXYfU``]a a][fUh]cb'fY[i `Uh]cbg": `cf]XU'5hhcfbYm; YbYfU``&Ja Yg'I h\a Y]Yf`\UX'UddYU`YX'Zcf'U'ghUm'cb'h\]g hYa dcfUfm']b'\bWh]cbz'Vi h'h\Y'Wci fh'gk]Zh`m'XYb]YX'\]g'fYei Yghz dc]bh]b['ci h'h\Uh'\Y'ZU]`YX'hc'a YYh'YggYbh]U``Wf]hYf]U"'H\]g fY'YWh]cb'k Ug'bch'cb`m'U'`Y[U``gYhVUW_'Vi h'U`gc'U'a ca Ybh'cZ WY`YVfUh]cb'Zcf'a Ubm'UXj cWUWm'[fci dgz']bWi X]b['h\Y'5a Yf]WUb 7]j]``@\YYfh]Yg'I b]cb'f57@ \text{\mathbb{E}}'5\W\text{\mathbb{E}}\text{

@Uk DUggYX 5a]X 7cbhfcj Yfgm

I h\a Y]Yf g'UhhYa dh'hc'bUffck 'h\Y'gWcdY'cZ'h\Y']b' bWh]cb'ZUWYX gWfi h]bmž'YgdYW]U``mik \Yb'h\Y'Wci fh'ZUj cfYX'U'VfcUXYf'Udd`]WUh]cb h\Uh'YI hYbXg'h\Y']b' bWh]cb'hc'U````Uk 'YbZcfW'a Ybhž'fUh\Yf'h\Ub ' gh'ghUhY'UhhcfbYmg"'H\Y'UddYU`g'Wci fh g'XYW]g]cb'hc'VfcUX`m Udd`m'h\Y']b' bWh]cb'Ya d\Ug]nYX'U'g][b]Z]WUbh']bhYfYgh'Vm'h\Y ZYXYfU`'[cj Yfba Ybh']b']a a][fUh]cb'a UhhYfg"'H\]g'fYdYh]h]j Yhi gg`Y'VYhk YYb'ghUhY']bhYfYghg'UbX'ZYXYfU`'Ui h\cf]hm'\Ug'VYWca YU'd]j chU`'`Y[U`'VUhh`YZ]Y`X"

K \ Uh'@]Yg'5\YUX3

$$\label{eq:hamile_ham} \begin{split} &\text{H}\Y\text{``Ub}XgWUdY\text{`}Zcf\text{`}]a\ a\][\ fUh]cb\text{``Uk}\text{`']b\text{`:}\text{`cf}]XU\text{''}]g\text{`W}\ ffYbh\text{`mii}\ bXYf\\ &\text{]bhYbgY\text{'}gWfi h]bm\text{''}\text{5}g\text{``Y}[\]g\text{`Uhcfg}\text{`Ub}X\text{``Y}[\ U\text{``fYdfYgYbhUh]j\ Yg\text{'}[\ fUdd\text{`Y}\ k\]h\text{`h}\ Y\text{'}]a\ d\text{`}]WUh]cbg\text{'c}Z\text{'h}\]g\text{'fi}\text{`}]b[\ \check{z}\text{'}]h\text{`UddYUfg\text{'h}\ Uh\text{'h}\ Y\text{'}Zi\ hi\ fY\text{'c}Z}\\ &\text{G6!}(\ \text{``}\ \text{Ub}[\ g\text{'}]b\text{`U\text{'}dfYWUf]ci\ g\text{'}}\text{VU\text{`Ub}WY}\check{z}\text{'gYfj}\]b[\ \text{``Ug\text{'}U\text{'}fYa\]bXYf\text{'c}Z\text{'h}\ Y\\ &\text{VfcUXYf\text{'bUh]cbU}\text{``Wcbj\ YfgUh]cb\text{`Ufci}\ bX\text{'}]a\ a\][\ fUh]cb\text{'dc}\text{`]Wm\text{''}}\\ &\text{``cf}]X]Ubg\text{'k}\]\text{```i\ bXci\ VhYX\text{`m'VY'k\ UhW\}]b[\ \text{`WcgY\text{`m'Ug\text{'h}\]g\text{``Y}}[\ U\text{`}}\\ &\text{XfUa\ U\text{'i}\ bZc\text{`Xg}"} \end{split}$$

8 Y hU]`g	
Cfh	: `cf]XUž'l G5
EiY``Yb	Z`cf]XUdc`]h]Wg"Wca
	• k k k "VW gb Y k g"Wca
	• k k k "hUa d UV Um" Wca

6 Ygi W Yb 'G]Y 'i bg 'Ui Z 'a Y]b!k]Yb "b Yh