# **PTRL6012**

8f]``]b[ 'AiX'!': cfai`Uh]cbž'GY`YWh]cb'UbX'AU]bhYbUbW

HYfa 'H\fYY''##'&\$&\$

## 7ci fgY<sup>\*</sup>Cj Yfj ]Yk

## GHJZZ:7cbHJWh:8YHJ]`g

### 7cbj Ybcfg

| B Ua Y                   | 9a U]`                 | 5j U]`UV]`] <b>m</b> | @cWUh]cb       | D\cbY      |
|--------------------------|------------------------|----------------------|----------------|------------|
| N\]I ] <sup>.</sup> 7\Yb | n\]I]W4 i bgk "YXi "Ui | , ,                  |                | Ž*%'&'-',) |
|                          |                        |                      | @Yj Y``&ž"H9H6 | ) % &      |

### GWXcc``7cbHJWhʻ±bZcfa Uh]cb

GW.cc``cZA]bYfU`g`UbX`9bYf[mFYgcifWygC`X'AU]b'6i]`X]b[ž@YjY`'%ž%)-'f?%) ŁIBGK'GM8B9MBGK'&\$)&'5IGHF5@-5

H. 'Ž\*%'f&Ł'-',)')\$\$\* 9.

## 7ci fgY 8YHJ] g

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

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

H\Y`Wci fgY`Wcj Yfg`h\Y`Zc``ck ]b[ `UgdYWg.`H\Y`Z bXUa YbhU``df]bW]d`Ygž'Wca dcg]h]cb`UbX`UXX]h]j Yg`cZ Xf]``]b[ `Zi ]Xg"`7 `Um\W.Ya ]ghfm'`Dc`ma Yf`UbX`Udd`]WUh]cbg`]b`Xf]``]b[ `Zi ]Xg"`A i X`k Y][ \hXYhYfa ]bUh]cb`UbX \WJ`W``Uh]cbg"`A i X`Z]`hfUh]cb`UbX`a i X`WU\_]b[ `dfc\Wgg"`5D=a i X`dfcdYfh]Yg"`7\Ya ]\WJ``UbU`mg]g`]b\Wi X]b[ d<ž'U`\_U`]b]\mž'\W``cf]XY`\Wcb\WbhfUh]cbz'k UhYf`\UfXbYggžgUbX`\WcbhYbhz'a i X`fYhcfh\UbX`a Yh\m`YbY`V`i YhffUh]cbg"`A i X`gmghYa `XYg][ b`Zcf'\Wcbhfc``cZZcfa Uh]cb`XUa U[ Y`UbX`k Y``\VcfY`ghUV]`]\m'

5gʻdUfhcZh\YʻWci fgYžgh XYbhgʻk ]``gh XmUXX]hJcbU`hcd]Wgʻh\fci [\'U'dfcYWh`'8Yg][bʻa i Xʻdfc[fUa ʻZcfʻUb YI hYbXYXʻfYUW\`XYj Y`cda Ybhk Y``"'=bʻh\Y`dfcYWbʻgh XYbhgʻUfYʻfYei ]fYXʻhc WUffmci h`]hYfUhi fYʻgi fj Ymž dYfZcfa 'k Y``VcfYʻghUV]`]miUbU`mg]gžʻUbX`XYg][bʻa i Xʻdfc[fUa ʻh\fci [\'U'WUgYʻgh Xm'': ]bU``dfcYWhifYdcfh UbX`dfYgYbhUhJcb`]gʻfYei ]fYX"

#### 7ci fgY 5]a g

H\]g`Wci fgY`k]```YbUV`Y`ghi XYbhg`hc`UWei]fY`Z bXUa YbhU``\_bck`YX[Y`cZXf]``]b[`Zi]Xg`UbX`hc`Udd`mh\Yh\Ycfmhc`h\Y`XYg][bžYjU`i Uh]cb`UbX`cdh]a]nUh]cb`cZXf]``]b[`Zi]X`dfc[fUa"

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

%" 8 Yg][ b`UbX`Yj U`i UHY`Xf]``]b[ 'Zi ]X`dfc[ fUa 'i bXYf`gdYW]Z]Wk Y```WcbX]h]cbg" &" DfYdUfY`UbX`HYghXf]``]b[ 'Zi ]Xg`UWWcfX]b[ 'hc`5 D=gHUbXUfXg" ' " C dh]a ]nY`Xf]``]b[ 'Zi ]Xq`hc`WcbHc``Zcfa Uh]cb`XUa U[ Y`UbX`k Y``VcfY`gHUV]`]hm'

#### HYUWX]b[ 'GhfUhY[]Yq'

D`YUgY fYZYf hc h\Y ]bZcfa Uh]cb ]b A ccX`Y

 $\label{eq:higher} \mbox{Hi fb]h]b "gYhh]b[ . "H\]g"]g"bch"U"Hi fb]h]b"Ugg][ ba Ybh$ 

5ggYgga Ybh). Dfc YWh

 $8YHJ]^*g. 8Yg][b^*aiX^*dfc[fUa^*Zcf^*Ub^*YIHYbXYX^*fYUWX^*XYjY^*cdaYbhkY^*"^*H\Y^*gdYWJZJWUH]cb^*cZh\Y^*dfcYWhk]^*VY^*fY^*YUgYX^*cb^*KYY_*)"$ 

Gi Va ]gg]cb bchYg.A ccX`Y`Cb`]bY`Gi Va ]gg]cb

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

5ggYgga Ybh\*.: ]bU`9l Ua

8 YW] g.

 $5 \text{ 'k c'' ci fg'cb''} \text{bY'ei ]n'k ]``VY' c'X'k ]h \text{ }b'h Y'Yl Ua' dYf]cX''; i ]XY`]bYg'Zcf' Y'd]b[ 'h Y'dfYdUfUh]cb'Zcf'h Y'Yl Ua'' dYf]cX''; i ]XY`]bYg'Zcf' Y'd]b[ 'h Y'dfYdUfUh]cb'Zcf'h Y'Yl Ua''' i ]XY`]bYg'Zcf' Y'Y'' i ]XY`]$ 

Gi Va ]gg]cb bchYg.A ccX`Y ei ]n

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

## 5 https://bxubwww.Fyei]fYaYbhg

 $\hbox{Ghi XYbhg'UfY'ghfcb[`m'YbWc'i fU[YX'hc'UhhYbX'U```WUggYg'UbX'fYj]Yk'``YWhfY'fY'WcfX]b[g''' } \\$ 

## 7ci fgY'GWXYXi `Y

### J]Yk 'WUgg'hja YHUV'Y

## H]a YtUV`Y

| 8 UHY  | Hmd Y | 7 cbh/bh   |
|--|-------|--|
| K YY_'%''%('GYdhYa VYf'!<br>%''GYdhYa VYf    | Hcd]W | 7\!%=blfcXiWNjcb/7\!&7`Um7\Ya]glfm   |
| K YY_'&.'&%GYdhYa VYf'!<br>&)'GYdhYa VYf     | Hcd]W | 7\!&`7`Umi7\Ya]ghfmy'`7\!' 'Dc`maYf`7\Ya]ghfm                                  |
| K YY_'' .'&, 'GYdhYa VYf'!<br>&'C WcVYf      | Hcd]W | 7\!' 'Dc`ma Yf`7\Ya ]glfm  |
| K YY_'(.') 'C WcVYf'!'-<br>C WcVYf           | Hcd]W | 7\!('A i X'Dfc[fUa   |
| K YY_').'%&'CWcVYf'!'%*<br>CWcVYf            | Hcd]W | <b>7\!(</b> '8f]`]b[': `i ]X': ]`\fU\\]cb                                      |
| K YY_'*.'%-'CWcVYf'!'&'<br>CWcVYf            | Hcd]W | <b>7∖!)</b> '5D≟A i X'DfcdYfħjYg   |
| K YY_'+.'&*'CWvcVYf'!'' \$<br>CWvcVYf        | Hcd]W | <b>7∖!)</b> '5D≓A i X'DfcdYfhjYg   |
| K YY_', .`&Bcj Ya VYf'!`*<br>Bcj Ya VYf      | Hcd]W | 7 \!* `A i X`GmghYa g'Z`HfYUha Ybhg`Zcf`GdYWJZJW <c`y<br>7 cbXJhJcbg"</c`y<br> |
| K YY_''- 'Bcj Ya VYf'!<br>% 'Bcj Ya VYf      | Hcd]W | 7 \! + 'C ]`'6 UgYX'A i X  |
| K YY_'%\$.'%*'Bcj Ya VYf'!<br>&\$'Bcj Ya VYf | Hcd]W | 7\!, 'C ]`'6UgYX'A i X   |

### FYgci fW/g

DfYgWf]VYX F Ygci fWYg

BchUj U]`UV`Y

FYWca a YbXYX FYgci fWYg

Bch'Uj U]`UV`Y

#### 7ci fgY 9j U'i Uhjcb UbX 8Yj Y'cda Ybh

5 hih. Y YbX cZYUW. Wci fgYz'U``ghi XYbhg`k]``\Uj Y h. Y cddcfhi b]hmhc Wca d`YhY 'U'Wci fgY Yj U`i Uh]cb Zcfa "H\YgY 'Ubcbma ci g`gi fj Ymg`\Y`d`i g`i bXYfghUbX mci f`j ]Yk g`cZh. Y 'Wci fgYžmci f``YWhi fYfg`UbX h. Y 'Wci fgY a UhYf]U`g" K Y 'UfY 'Wcbh]bi ci g`m`]a dfcj ]b[ 'ci f`Wci fgYg`VUgYX cb 'ghi XYbhZYYXVUW\_žUbX mci f`dYfgdYWh] Y ]g`j U`i UV`Y"

 $: YYXVUW\_]g`[]j Yb`j]U`\underline{htdg.#ghi XYbh'i bgk "YXi "Ui #a mYl dYf]YbW."UbX`mci `k ]```VY`bch]Z]YX`k \Yb`h\]g`]g Uj U]`UV`Y`Zcf`mci `hc`Wca d`YhY"$ 

K Y'U'gc'YbWci fU[Y'U``ghi XYbhg'hc'g\UfY'Ubm'ZYXVUW\_'h\Ym\Uj Y'Ubm'h]a Y'Xi f]b['h\Y'Wci fgY'—']Zmci\Uj Y'U'WcbWfbžd'YUgY'WcbhUWii g']a a YX]UhY'm'

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

H\Y'GWkcc``\Ug'XYj Y`cdYX'U'[i]XY`]bY'hc'\Y`d'mci'k\Yb'gi Va]hh]b['U'Wci fgY'Ugg][ba Ybh'

K Y YbWci fu[ Y 'mci 'hc 'fYhJ]b 'U 'WcdmcZYj YfmlUgg][ ba Ybhigi Va ]h\YX 'Zcf' UggYgga Ybh'Zcf'mci f'ck b 'fYWcfX Y]h\Yf']b `\UfXWcdmcf'Y`YWfcb]WZcfa "

5```UggYgga Ybhg'a i gh'\Uj Y'Ub'UggYgga YbhWcj Yf'g\YYh'UhhUW\YX"

#### @UhY Gi Va [gg]cb cZUb 5gg][ ba Ybh

: i ```a Uf\_g`Zcf`Ub`Ugg][ ba Ybh'UfY`cb`mdcgg]V`Y`k \Yb`Ub`Ugg][ ba Ybh']g`fYV\Y]j YX`Vmh\Y`Xi Y`XUhY''`

K Y'i bXYfgHJbX'h\UhiUhih]a Yg'mci 'a Umbch'VY'UV'Y'hc'gi Va ]hiUb'Ugg][ ba Ybh'cb'h]a Yž'UbX'h\Y'GW\cc``k ]``UWWca a cXUhY'UbmZJ]f'UbX'fYUgcbUV'Y'YI hYbg]cb"'K Y'k ci `X'fYWca a YbX'mci 'fYj ]Yk 'h\Y'I BGK 'GdYWJU` 7 cbg]XYfUh]cb'[i]XY`]bYg'—'gYY'gYWfJcb'VY'ck "

@UhY`gi Va ]gg]cb`k ]``bchVY`UVWYdhYX`UbX`k ]``VY`Wcbg]XYfYX`Ug`bc`gi Va ]gg]cb"

### GdYWJU`7cbg]XYfUhJcb

 $\label{thm:condition} $$ Mc_i Wb_i d_m Z_f gdYW_i u^* Wcbg_i XYfUh_i cb_h fci_[ \ \ \underline{H}Y_B_i WY_i g_G_h XYbh_< i_V_k \ Yb_i^* bYgg_cf_ch_Yf W_i w_a ghUbW_g_i bhYfZ_fY_k ]_h `mc_i f_UggYgga YbhdYfZ_fa UbW_g_G_i y_bYgg_a ]_gUX_j Ybh_fY_cf_ch_Yf W_i w_a ghUbW_g_VYmcbX_mc_i f_Wcblfc_a Um$ 

- DfYj Ybhmci Zfca Wca d`Yhlb[ 'U'Wci fqY fYei ]fYa Ybh
- ? YYd 'mci 'Zfca 'UthYbX]b[ 'Ub'UggYggUV'Y'UWhj ]tm
- Ghodimoi igi Va ]hhlb[ 'UggYggUV'Y'k cf 'Zcf'U'Wci fgY
- G][ b]ZJWJbhmUZZYWimci f'dYfZcfa UbWY]b'UggYggUV'Y'k cf\_ž'VY']h'U'Zcfa U`'YbX!cZgYa YghYf Yl Ua ]bUh]cbž'U'WUgg'hYghž'U'`UVcfUhcfmhYghž'U'gYa ]bUf'dfYgYbhUh]cb'cf'Ubmch\Yf'Zcfa 'cZ UggYgga Ybh

K YʻUg\_ʻh\Uhmci 'd`YUgY WcbhUWh\Yʻ7 ci fgYʻ7 cbj Ybcfʻ]a a YX]UhY`mcbWYʻmci '\Uj Y`Wca d`YhYX'h\YʻgdYW]U` Wcbg]XYfUh]cbʻUdd`]WUh]cbžbc``UhYf'h\UbʻcbY`k YY\_`Zfca 'gi Va ]gg]cb"

A cfY XYHJ]  $\dot{g}$  cb  $\dot{g}$  dYWJU  $\dot{w}$  bg]XYfUh]cb  $\dot{w}$  bb  $\dot{v}$  Y  $\dot{z}$  ci bX  $\dot{u}$  b  $\dot{k}$  k k  $\dot{g}$  h  $\dot{x}$  Y bh'i bgk  $\ddot{y}$  Xi  $\ddot{u}$  i  $\ddot{y}$  dYWJU  $\dot{w}$  bg]XYfUh]cb

#### Gh XYbhGi ddcfh

H\Y`I b]j Yfg]miUbX`h\Y`: UW`mdfcj ]XY`U`k ]XY`fUb[Y`cZgi ddcfhgYfj ]Wyg Zcf`gh XYbhgž]bWi X]b[.

- @|VfUfmlfU|b|b[ 'UbX'gi ddcfhgYfj |WYg'! 'k k k "`]VfUfm'i bgk "YXi "Ui
- I BGK '@YUfb]b[ '7 YblfY'! 'k k k "'Wi bgk "YXi "Ui
- 7 ci bqY``]b[ 'gi ddcfh! 'k k k "Wti bqY``]b[ "i bqk "YXi "Ui

9ei ]HUV`Y'@YUfb]b[ 'GYfj ]WYg'U]a g'hc'dfcj ]XY'U``gh XYbhg'k ]h\'U'ZYYY'UbX'WcbZ]XYbh]U`'gYfj ]WY'h\Uh dfcj ]XYg'dfUWf]WU`'gi ddcfhhc'Ybgi fY'h\Uh'mci f'\YU`h\'WcbX]h]cb'XcYgbfhiUXj YfgY`mUZZYWhmci f'gh X]Yg'''\\htda.##ah XYbh'i bak "YXi "Ui #Y`a

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

 $5 ```A ]b]b[ "9b[ ]bYYf]b[ "ghi XYbhg"UfY"fYei ]fYX"hc "Wca d`YhY"U"ghi XYbhXYWUfUh]cb" Zcf"UWUXYa ]W]bhY[ f]hm k \]W. ]g"ci h]bYX']b"h\Y"Ugg][ ba YbhWcj Yf"g\YYhg""6mg][ b]b[ "h\]g"XYWUfUh]cbž"mci "U[ fYY"h\Uh'mci f"k cf_"]g mci f"ck b"cf][ ]bU"k cf_"$ 

⊋mci 'bYYX'gca Y'UXX]h]cbU``gi ddcfhk]h\ 'mci f`k f]h]b[ 'g\_]``gž'd`YUgY'WcbhUWh\Y'@YUfb]b[ '7 YbhfY'cf'j]Yk gca Y'cZh\Y'fYgci fWg'cb'h\Y]f`k YVg]hY. 'k k k "`Wi bgk "YXi "Ui "'H\Y'@YUfb]b[ '7 YbhfY']g'XYg][ bYX'hc'\Y`d mci ']a dfcj Y'mci f'UWUXYa]Wk f]h]b[ 'UbX'Wca a i b]WUh]cb'g\_]``g"'Gca Y'ghi XYbhg'i gY'h\Y'7 YbhfY'gYfj]W/g VYWUi gY'h\YmUfY'Z]bX]b[ 'h\Y]f'Ugg][ ba Ybhg'U'W\U``Yb[ Yžch\Yfg'VYWUi gY'h\Ymk Ubhhc']a dfcj Y'Ub'U`fYUXm gi WW/ggZ ``UWUXYa]WdYfZcfa UbW\"

## 5 WUXYa ]W + DZcfa Uh]cb

## 7 ci fgY F Ygi `hg

: cf<sup>'</sup>XYfU]<sup>'</sup>g<sup>'</sup>cb<sup>'</sup>I BGK <sup>'</sup>UggYgga Ybh'dc<sup>'</sup>]Whž'd<sup>'</sup>YUgY<sup>'</sup>j ]g]h '<u>k k k "gh XYbh'i bgk "YXi "Ui #UggYgga Ybh</u>

 $\pm gca\ Y']bgHUbW'g'mci\ f'Z]bU``Wci\ fgY'fYgi\ `hia\ Um'VY'k\ ]h\ Y`X'UbX'bch'fY'YUgYX'cb'h\Y'I\ BGK 'd`UbbYX'XUHY'' H\ ]g']g']bX]WUHYX'VmU'Wci\ fgY'[\ fUXY'fYgi\ `hicZY]h\ Yf.$ 

• @9 '-']bX]\WUhYg'mci '\Uj Y'bch\Wca d'YhYX'cbY'cf'a cfY']hYa g'cZUggYgga Ybh/cf

- VfcUXVUbX'WcbbYWfjcb'f&) \* '\_V]h#gYWcf'ZUghYfŁ
- UV]]mhc'j ]Yk 'ghfYUa ]b['j ]XYc'f\][\'cf'`ck 'XYZ]b]h]cb'l BGK 'HJ 'cdh]cbgŁ

A cfY ]bZcfa Uh]cb UVci hgmghYa 'fYei ]fYa Ybhg ]g Uj U] UV Y UhKkk mgh XYbh'i bgk "YXi "Ui #a ccX Y! gmghYa!fYei ]fYa Ybhg

.

### 5 WWYgg]b[ '7ci fgY'A UhYf]U`g'H\fci [\'AccX`Y

7 ci fgY'ci h]bYgžgi ddcfna UhYf]U`g`UfY'i d`cUXYX`hc`A ccX`Yž'h\Y'i b]j Yfg]lmighUbXUfX`@YUfb]b[ A UbU[ Ya Ybh'GmghYa 'f@A GŁ"'+b`UXX]r]cbžcb!`]bY`Ugg][ ba Ybh'gi Va ]gg]cbg`UfY`a UXY'i g]b[ 'h\Y Ugg][ ba Ybh'XfcdVcl 'ZUVJ']lmdfcj ]XYX`]b'A ccX`Y"'5```Ybfc``YX'gh XYbhg`UfY`Ui hca Ur]VW\`m]bWl XYX`]b

| K Y'UW_bck `YX[Y'h\Y'6YXY[U``dYcd`Y'k\c'UfY'h\Y'ffUX]h]cbU``W gfcX]Ubg'cZh\Y'`UbXg'cb'k\]W\'I BGK<br>?Ybg]b[fcb'WJa di g']g'`cWJhYX" |
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