

ARTS3571

5Xj UbWX GdUb]g\ 6

GYa YghYf'Hk c''#'&\$%

7 ci fgY Cj Yfj]Yk

GHJZZ7cbHJWh8YHJ]`q

7cbj Ybcfg

| B Ua Y | 9a U]` | 5j U]`UV]`] m | @cWUh]cb | D\cbY |
|---------------------------------|--------|---|----------|-------------------------------|
| < YbUf'J JWYbhY! 7 f]gh' VU` | | Hi YgXUmg'‱" \$'hc ‰" \$'cf'Vm Uddc]bha Ybh | 6fck b | d`YUgY WcbHJWhVm Ya U]` |

GW.cc`7cbhJWh =bZcfa Uhlcb

GWkcc`cZ<iaUb]hJYgUbX@Ub[iU[Yg

@cWUhcb. 'GWkcc' CZZWYž'Acfj Yb'6fck b'6i] X]b[ž'@YjY' &ž &),

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9a Ul`.'\U`4 i bgk "YXi "Ui

5 h Y b X U b W F Y e i] f Y a Y b h g

5 qh XYbh]q Yl dYWYX hc UhYbX U``WUqq WcbhUWi\ci fq Zcf U ZUW!hc! ZUW! fl & L'cf V YbXYX Wci fqY UbX Wca d`YhY'U```UWhjj]hjYg'Zcf'U'V`YbXYX'cf'Zl ``micb`]bY'Wci fgY"

5 'gh XYbhk\c'Uff]j Yg'a cfY'h\Ub'%) 'a]bi hYg'`UhY'a UmVY'dYbU`]gYX'Zcf'bcb!UhhYbXUbWY"'-Zgi W\'U'dYbU`hm]g^]a dcgYXžh\Y^gh XYbha i ghVY^]bZcfa YX^j YfVU``mUhh\Y^YbX`cZWUgg^UbX`UXj]gYX^]b^k f]h|b[^k]h\]b^&(\ci fg"

ZUʻqh XYbhYl dYf[YbWYq']`bYqqža]qUXj Ybh fYʻcfʻch\YfʻcVW ffYbW h\Uha U_YqʻUVqYbW Zfca ʻU Wugg#JWnjj]mmi buj c]XUV`Yžcf`Yl dYWng hc VY`UVgYbhZfca `U`Zcfh\Wca]b[`Wugg#JWnjj]mmzh\Ymg\ci `X`gYY_ dYfa]gg]cb Zfca 'h\Y'7 ci fgY'5i h\cf]mž'UbX'k \YfY'Udd`]WUV`Yž'h\Y]f'fYei Yghg\ci `X'VY'UWWca dUb]YX'VmUb cf][]bU`cf`WfflZYX`WcdmcZU'a YX]WU`WYfhlZWJhY`cf`ch\Yf`Zcfa 'cZUddfcdf]UhY`Yj]XYbWY"

5 7 ci fqY 5 i h\cf|lma UmYl W qY U qhi XYbh2fca WUqqYq cf UWlij |h|Yq Zcf i d hc cbY a cbh\" < ck Y j Yfz h\Ym a Um'Ugg][b'UXX]hcbU`UbX#cf'U`hYfbUh]j Y'hUg_g'hc'Ybgi fY'Wca d`]UbWY"'5'7 ci fgY'5i h\cf]miWcbg]XYf]b['h\Y [fubh]b[cZuvgYbWraighvYguh]gZjYX'u'gh XYbhk]```gh]```vY'uv`Y'hc'a YYhh\Y'WcifgY'g``Yufb]b[cihWcaYg UbX#cf'j c'i a Y'cZ'YUfb]b["'5 'gh XYbhgYY_]b['Uddfcj U'hc'VY'UVgYbhZcf'a cfY'h\Ub'cbY'a cbh\'a i qhUdd`m]b'k f]h]b['hc'h\Y'8YUb'UbX'dfcj]XY'U```cf][]bU``cf'Wfh]ZYX'gi ddcfh]b['XcW a YbhUh]cb"

: cf'a cfY']bZcfa Uhlcb'UVci hih\Y'UhhYbXUbWY'dfchcWc`q']b'h\Y': UW\`hmcZ5fhq'UbX'GcWjU` GWYbWrg. \httq.#k k k "Uffig"i bgk "YXi "Ui #W ffYbhgh XYbhg#UWJXYa]W]bZcfa Uhjcb#dfchcWc`g![i]XY`]bYg#

5 WUXYa]W = b Zcfa Uhich

: cf`YggYbhJU``ghi XYbh`]bZcfa UhJcb`fY`UhJb[`hc.`fYei Yghg`Zcf`Yl hYbg]cb/fYj]Yk `cZa Uf_g/cWW dUhJcbU``\YU`h\UbX`gUZ/hm/Yl Ua]bUhJcb'dfcWXi fYg/gdYVJU``Wcbg]XYfUhJcb`]b`h\Y`Yj YbhcZ]``bYgg`cf`a]gUXj Ybhi fY/ghi XYbhYei]hmUbX`X]gUV]`]hm/UbX`ch\Yf`YggYbhJU``UWUXYa]W]bZcfa UhJcbž gYY`\hdg.#k k k "Ufhg"i bgk "YXi "Ui #W ffYbhghi XYbhg#JWUXYa]W]bZcfa UhJcb#dfchcWc`g![i]XY`]bYg#

7ci fgY 8YW] g

7 fYX]hDc]bhg**

Gi a a UfmcZh\Y 7 ci fgY

K]h\ a cfY h\ Ub'(+\$ a]``]cb'bUhj Y'GdUb]g\ 'gdYU_Yfg']b'&%'Wci blf]Ygz'h\]g'"XYYd'X]j Y"'Wci fgY'k]``YbUV'Y mci 'hc'Wca a i b]WJhY'UhiUb'UXj UbWYX'`Yj Y``Zcf'h\cgY'k]g\]b['hc'lfUj Y'z'k cf_'cf'ghi Xm]b'h\YgY'Wci blf]Yg" Mci 'k]```XYj Y'cd'\][\`mYZYWfj Y'gdYU_]b[zfYUX]b['UbX'k f]h]b['g_]``g'h\fci [\'U'k]XY'j Uf]YhmcZdfUWfWJ' hUg_g"'J cWJVi `UfmUbX'[fUa a UhjWJ'`glfi Wi fYg'UfY'dfYgYbhYX']b'h\Y'WcbhYl hcZW'`hi fU`mfY`Yj Ubh]ggi Yg']b h\Y'GdUb]g\`gdYU_]b['k cfX'UbX'mci f'`YUfb]b['k]```VY'Yb\UbWYX'k]h\ 'cb`]bY'Wca dcbYbhg'XYg][bYX'hc a U_Y'`Ub[i U[Y'UWei]g]h]cb'ZJghYf'UbX'a cfY'YZZJWJYbh'

5ggYgga Ybh

5ggYgga Ybh'HUg_g'

| 5ggYgga Ybh'hUg_ | K Y][\h | 8iY'8UhY | Gh XYbh@YUfb]b[CihWca Ygʻ5ggYggYX |
|-------------------------------|----------|---------------------------------------|---------------------------------------|
| FYUX]b[#K f]h]b[| &\$I | k YY_`%``]b`WUgg | %Z Ž) |
| ; fUa a Uf'E i]n' | ' \$ı | k YY_'* 'UbX''‰ | &ž) |
| C fU ^{**} | &\$I | : fca 'k YY_'('hc'k YY_'- | %ž&ž(|
| Cb`]bY#UiX]cj]giU`'dcfh7c`]c' | ' \$1 | gYY ⁻ A ccX ⁻ Y | %ž&Ž |

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5ggYgga Ybh% FYUX]b[#K f]h]b[

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@Yb[h\.'(\$\$!)\$\$'kcfXg'fYUX]b['UbX'(\$\$'kcfXg'kf]h]b[

 $8YhJ] \hat{g}. \hat{g$

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

 $\pm 0.k YY_-\% \text{ 'mci f''}YW \text{ fYf'k]'''WcbXi WhiUb''UggYgga YbhcZmci f''fYUX]b['UbX'k f]h]b['UV]`]h]Yg'''H\]g$

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

5ggYgga Ybh' . CfU`

GhUfh'XUhY. 'k YY_'(

@Yb[h\. ' \$'a]bi hYg'l '* 'gYgg]cbg

8YHJ]`g. `C b`]bY`WcUW\]b[`" \$`a]bi hYg`dYf`* 'gYgg]cbg"'Ghi XYbhg`k]```gdYU_žXYVUhY`UbX`]bhYfUWh]b GdUb]g\"'C fU``]bhYfUWh]cb`k]```VY`fYWcfXYX`UbX`[fUXYX`UWWcfX]b[`hc.`ei U`]hmcZgdc_Yb`GdUb]g\`UbX`i gY`cZ Uddfcdf]UhY`X]gWci fqY": YYXVUW_ij]U`]bX]j [Xi U``Wca a Ybhq`UbX`fi Vf]W

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

D`YUgY'bchY'h\UhCb`]bY'WcUW\]b['ghUffg']b'k YY_'('UbX'Z]b]g\`]b'k YY_'-"HchU`bi a VYf'cZgYgg]cbg'*' f%k YY_mgYgg]cb'l'*'k YY_gt"GYY'A ccX'Y'Zcf'Z fh\Yf'XYhU]`g"

Hi fb]hb gYhb[. H\]g]g bchU Hi fb]hb Ugg][ba Ybh

5ggYgga Ybh(. Cb`]bY#Ji X]cj]gi U`dcfhZc`]c

GHUfhXUhY. gYY A ccX`Y

@Yb[h\.JUf]Yg

8 YHJ]`g. ``fGY`ZUWWggŁ`"'@Yb[h\`UbX`HJg_g`j UfmYUW\`k YY_`fl cfi a žE i]nž5i X]cj]gi U`ž'HYl HŁ'"6Yhk YYb`%\$ UbX`%) `a]bi HYg`dYf`k YY_`hc`Wca d`YhY`]b`mci f`ck b`Hja Y`XYj Y`cd]b[``]gHYb]b[``g_]``gž'k f]hjb[`cf fYUX]b[": YYXVUW_cb`]bYž']bX]j [Xi U``Wca a Ybhgž'UbX`]b!WUgg`X]gW gg]cb"

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

Cb`]bY'DcfhZc`]c.'

5i X]cj]gi U``UWhj]h]Yg. K Y][\h&) ı 'hc'Wa d'YhY') 'Ui X]c!j]gi U``ei]nnYg"H\]g'UggYgga Ybh]g'VUgYX'i dcb `]ghYb]b['Wa dfY\Ybg]cb'Zfca 'Ui X]cj]gi U``a UhYf]U`"5g'dUfhcZh\Y'Wti fgYžgh XYbhg'a i ghgdYbX'cbY'\ci f dYf'k YY__']b'h\Y]f'ck b'hja Y'XYj Y`cd]b['`]ghYb]b[žfYUX]b[žk f]hjb['g_]``gžgY`YWhjb['a UhYf]U``Zfca 'h\Y Ui X]cj]gi U``a UhYf]U``k]h\]b'A ccX'Y"H\]g'UWhjj]h]Yg'k]```VY'Uj U]`UV`Y'Zcf', 'XUmg'hc'UWWYgg'Ubmh]a Y'mci k]g\""Bc'`UhY'gi Va]gg]cbg'hc'VY'U``ck YX"

DfY! ``YWi fY`UWij]Yg.`)ı `hc`Wca d`YhY`UbX`gi Va]hh\Y`k YY_`mdfY``YWi fY`UWij]h]Yg"H\]g`UWij]h]Yg`UfY bchUj U]`UV`Y`ZcfYI hYbg]cb`fYei Yghg`

Hi fb]hb qYhb[. H\]q]q bchU Hi fb]hb Uqq][ba Ybh

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

Gh XYbhg UfY Yl dYWYX hc di hh\Y]f bUa Yg UbX gh XYbhbi a VYfg cb Yj YfmdU[Y cZh\Y]f Ugg][ba Ybhg"

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

; YbYfU`mž'UggYgga YbhitUg_g'a i ghVY'gi Va]hhYX'Y`YWfcb]WU``mj]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ba Ybh''=b']bghUbWfg'k \YfY'h\]g']g'bchdcgg]V`Yž']hk]```VY'ghUhYX'cb'mci f'Wci fgY'g'A ccX`Y'g]hY'k]h\U`hYfbUh]j Y'gi Va]gg]cb'XYhU]`g"

@UhY 5ggYgga Ybh'DYbU`h]Yg

Gh XYbhgʻUfYʻfYgdcbg]V`YʻZcfʻh\Yʻgi Va]gg]cbʻcZUggYgga YbhhUg_gʻVmh\YʻfYei]fYX`XUhYgʻUbXʻhJa Yg" 8YdYbX]b[ˈcZh\Y`YI hYbhcZXY`Um]bʻh\Yʻgi Va]gg]cbʻcZUbʻUggYgga YbhhUg_ʻdUghh\Y`Xi Y`XUhY`UbXʻhJa Yž

- K cf_'gi Va]hhyx'%5'hc'% 'XUmg'UZhYf'h\Y'gh]di `Uhyx'XYUX`]bY'k]``'VY'UggYggYX'UbX'ZYYXVUW_dfcj]XYX'Vi h'U'a Uf_'cZnYfc'k]``'VY'fYWcfXYX'''=Zh\Y'k cf_'k ci `X'\Uj Y'fYWf]j YX'U'dUgg'a Uf_'Vi h'Zcf h\Y'`'UhYbYgg'UbX'h\Y'k cf_']g'U'Wca di `gcfm'Wci fgY'Wca dcbYbh'f\i fX`Y'fYei]fYa Ybhz'U'gh XYbh'k]`` VY'XYYA YX'hc'\Uj Y'a Yhh\Uh'fYei]fYa Ybh/
- K cf_'gi Va]hhYX`&\$`cf`a cfY`XUmg`UZhYf`h\Y`gh]di `UhYX`XYUX`]bY`k]```bchVY`UWWdhYX`Zcf UggYgga YbhUbX`k]```fYWY]j Y`bc`ZYYXVUW_ža Uf_'cf`[fUXY"'=Zh\Y`UggYgga YbhHUg_']g`U`Wca di `gcfm Wca dcbYbhcZh\Y`Wci fgY`U`gh XYbhk]```fYWY]j Y`Ub`l bgUh]gZJWcfm: U]``fl : Ł'[fUXY`Ug`U`fYgi `hcZ i bgUh]gZJWcfmdYfZcfa UbWY`]b`Ub`YggYbh]U``Wca dcbYbhcZh\Y`Wci fgY"

H\]g']bZcfa Uh]cb']g'U`gc'Uj U]`UV`Y'Uh

\hdg.#k k k "Uffg"i bgk "YXi "Ui #W ffYbhghi XYbhg#UWUXYa]W]bZcfa Uhcb#dfchcWc`g![i]XY`]bYg#

GdYWJU`7cbg]XYfUhJcb5dd`JWUhJcbg

 $\label{thm:condition} $$Mci `WUb`Udd`m'Zcf'gdYW]U``Wcbg]XYfUh]cb`k \Yb`]``bYgg`cf`ch\Yf`W]fW a ghUbWfg`]bhYfZYfY`k]h\`mci f UggYgga Ybh'dYfZcfa UbWf''$

G]W_bYggža]gUXj Ybhi fY'cf'ch\Yf'W]fW a ghUbWrg'VYmcbX'mci f'Wcbhfc``a Um

ł DfYj Ybhmci Zfca Wca d`Yhjb['U'Wci fgY'fYei]fYa Ybhž

ł? YYd mci Zfca "UthYbX]b["Ub UggYggUV`Y UWt]j]tmž

ł Ghod moi igi Va]hh]b[iUggYggUV Y k cf_ Zcf U Wci fgYž

ł G][b]Z]WUbhmiUZZYWhmci fidYfZcfa UbWli]biUggYggUVYkcf_žVYj]hiUiZcfa U`YbX!cZgYa YghYfYl Ua]bUh]cbžU WUggihYghžU`UVcfUhcfmhYghžUigYa]bUfidfYgYbhUh]cbicfiUbmich\YfiZcfa icZUggYgga Ybh'

: cfZ fhYfXYhJ)gJbfYYhJcbhcGdYVJU`7cbg]XYfUhJcbJbWiX]b[''K

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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"'\lefi\Wb'hU_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b['hc`UVW]XYbhU`mWcdm]b['Zfca `U`gci f\W' k]h\ci hUW_bck `YX[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'

±DUddfcdf]UhY`dUfUd\fUg]b[.'W\Ub[]b['U'ZYk'kcfXg'UbX'd\fUgYg'k\]`Y`acghmfYhJ]b]b['h\Y`cf][]bU`ghfi WhifY`UbX`]bZcfaUh]cb`k]h\ci hUW_bck`YX[YaYbh'H\]g'U`gc'Udd`]Yg`]b'dfYgYbhUh]cbg'k\YfY`gcaYcbYdUfUd\fUgYg`Ubch\Yf'g`]XYUg`cf'kcfXg'k]h\ci hWfYX]h''±iU`gc'Udd`]Yg`hc'd]YW]b['hc[Yh\Yf'ei chYg'UbXdUfUd\fUgYg`]bhc'U'bYk'k\c`Yžk]h\ci hfYZ/fYbW]b['UbX'U'ghi XYbh'g`ck b'UbU`mg]g`hc'Vf]b['h\Y`aUhYf]U`hc[Yh\Yf''

7 c``i g]cb. 'k cf_]b['k]h\ 'ch\ Yfg'Vi h'dUgg]b['c\Z'h\ Y 'k cf_'Ug'U'dYfgcb'g']b\X]j]\Xi U``k cf_"'7 c``i g]cb'U`gc]b\Wi XYg'dfcj]\X]b['mci f'k cf_'hc'Ubch\ Yf'ghi XYbh\ VYZcfY'h\ Y 'Xi Y 'XUhYzcf'Zcf'h\ Y' di fdcgY'cZh\ Ya d`U[]\Uf]g]b['Uh\Ubmh]a Yz'dUm]b['Ubch\ Yf'dYfgcb'hc'dYfZcfa 'Ub'U\WUXYa]\Wh\Ug_z'ghYU']b['cf'U\\ello i]f]b[Ubch\ Yf'dYfgcb'g' U\WUXYa]\Wk cf_'Ub\X'\ello dm]b[']hz'c\ZYf]b['hc'\\ello a d`YhY'Ubch\ Yf'dYfgcb'g' k cf_'cf'gYY_]b[d\ubara Ybh\Zcf'\\ello a d`Yh\beta d`Yh\beta \underset \

±bUddfcdf]UhY`W]hUh]cb.`7]h]b[ˈgci fW/gˈk \]WX`\Uj Y`bchVYYb`fYUXžk]h\ci hUW_bck`YX[]b[ˈh\Y`″gYWcbXUfm″gci fW/Zfca k \]WX`_bck`YX[Y`cZh\Ya`\Ug'VYYb`cVhU]bYX"

8 i d`]\WUh]cb`ff`gY`Zld`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`UqqYqqa Ybhcf\Wci fgY`UhI_BGK_`cf`Ubch\Yf`i b]\Yfq]\m"

7 cffYWhfYZYfYbWb[dfUWhWyg.

• VYHYfa UbU[Ymcifh]a Y

| I | |
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|-------------|-----------|--|
| | Hi M@UV | Ei]n'&'[fUa1/2h]WU'" |
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| | | DfYdUfUWji b 9bgUmc ZjbU` |
| _ | Hi hcf]U` | Bc``YWhifU'YgHJ'gYaUbU" |
| &, 'CWhcVYf | | |
| | | 9``hYghZjbU``gY```YjU'U'WUVc'XifUbhY``U'hihcf£U" |

FYgci fWyg

DfYgWf]VYX F Ygci fWYg

 $\label{eq:KYVg} $$KYVg]hYg']b'@YUfb]b['D`UhZcfa'fAccX`YL$

 $H\]g'Wci\ fgY'i\ gYg'A\ ccX`Y'Ug'U'fYgci\ fW''WbfY'k\ \ YfY'ghi\ XYbhg'WUb'UWWgg'U'k\]XY'gY`YWf]cb'cZa\ UhYf]U`g$