



ARTS3054

H\Y'; Ym]b['cZK]gXca . 'Mci hž'@jYfUli fY 'UbX'hY
: cfa Uh]cb'cZhY'GY'Z

HYfa 'Hk c''##'&\$&%

7 ci fgY`Cj Yfj]Yk

GhJZZ'7 cbhJWw'8 YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWWhcb	D\cbY
>c\b'5Hf]X[Y	^Uhf]X[Y4 i bgk "YXi "Ui	6mUddc]bra Ybh	&&,	-',)`((, (

GW\cc`7 cbhJWw'8 Zcfa Uh]cb

GW\cc`cZHY'5frg'UbX'A YX]U

Fcca " %&ž@Y] Y"" žF cVYfhK YVghYf'6i]X]b[`f] %Ł

D\cbY. f\$&Ł-' ,) `(,) *

9a U]: [gUa 4 i bgk "YXi "Ui](#)

K YVg]h: [k k k "Ufng"i bgk "YXi "Ui #gUa](#)

H\Y`GW\cc`cZHY'5frg'UbX'A YX]U`k ci `X`_]Y`hc`F YgdYWwZ`m5W_bck`YX[Y`hY`HfUX]hcbU`7 i ghcX]Ubgž`hY'6YXY[U`fP`Ybg]b[hcb`WJa di gŁž; UX][U`f7]mUbX'5fhi' 8Yg][b'7 Ua di gYgŁ'UbX'hY'B [i bbUk U`dYcd`Y`f5i gLfU]Ub'8YZ'bwW : cfW'5WUXYa m]b'7 UbVYffUŁcZHY`UbXg'k \YfY YUW`WJa di g'cZI`BGK`]g`cWWhYX"

7ci fgY'8YHJ`g

7fYX]hDc]bHg`*`

Gi a a UfmicZ\hY'7ci fgY

Gc'dYfj Ugj] Y'g'hY'`Wca]b[!cZU[Y'g'rcfm']b'WcbhYa dcfUfmW`hi fY'h.Uh]hgYYa g'i b]j YfgU'/Ug'bUhi fU'UbX
cVj]ci g'Ug'[fck]b['i d']hgY'Z'<ck Yj Yfz'h]g'd'chgrfi Wfi fY'\Ug'U'\]g'rcfm']hYa Yf[YX']b'hY'Y][\hYybH
W'bh fnz'fcgY'hc'Xca]bUbVW']b'hY'b]bYhYbH'UbX'i bXYfk YbhU'dYf]cX'cZW]g]g'UbX'fUbgZcfa Uhc'b]b'hY
h'k YbhYh'z'Ug'bYk 'gcVU'UbX'dc']hVW'fYU']hYg'WU'Yb[YX'hY']a]hg'cZhY'Zcfa "'5F HG' \$) ('fUW'g'hY
Yj c'i h'c'b'cZ'h]g[]YbFY'Zca]hg'cf][]bg']b'hY'V']Xi b[gfca Ubz'cf'"bcj Y'cZYXi WU]cb"z'hc]hg'a cghfYW'bh
dYfa i hU]cbg']b'W'fYbhZ]W]cb'UbX'Z'a "'C i f'gY'YW]cb'cZYI Ua d'Yg'k]'fU'Ub[Y'k]XY'mUW'cgg'a YX]Uz'h'a Y
dYf]cXg'UbX'[Yc[fUd\]W]'cWU]cbg'z'dU]f]b['hY'WUgg]W]'k]h' hY'WcbhYa dcfUfmUbX'hY'WUbc'b]W]'k]h
hY'gi Vj Yfgj] Y"'5g'k Y''Ug'Ug_]b['k \mi'hY'fUbg]h'cb'Zca 'mci h'hc'a Uhi f]mVYW]a Y'gi W'Ub']a dcfU'bh
WcbW'fb']b'a cXYfb']hYfUhi fY'z'k Y'k]'W'cbg]XYf'\ck 'h]g'bUffU]h] Y'hYa d'U'h'\Ug'VYYb'h'ghYX'VmW'Ub[]b[
\]g'rcf]W]'W'cbX]h'cbg'UbX'\ck 'gi W'Ub'UffU]h] Yg'WU'b'\Y'd'i g'hc'i bXYfgh'UbX'ci f'ck b'Yi dYf]YbW'g'cZ[fck]b[
i d']b'U'fUd]X'mW'Ub[]b['k cfX"

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

% H\]b_]UbX'k f]h'W]h]WU'mUVci h'hY'fc'Y'cZW'hi fU'fYdfYgYbH]cbg']b'g\Ud]b['Uggi a dh]cbg'UVci h
mci h'z'UXi 'h'ccX'z'YXi WU]cb'UbX'chYf'fY'U'hYX'W'cbW'dhg"
&" G]h' U'h'U'j Uf]Ym'cZ'W'ci fgY'a U'hYf]U'g']b'fY'U'h'cb'hc'Ub'c]j YfU'fW]b['W'hi fU'h'Ya Y"
' " 7cbg'f]i W'Ub']bXYdYbXYbhUf[i a Ybh'
(" F Y'U'h'a U'hYf]U'g'UbX'W'cbW'dhg'gh'X]YX'hc'W'cbhYa dcfUfm'iei Ygh]cbg'cZ'mci h'z'YXi WU]cbz'
UXi 'h'ccX'UbX'W'ca]b['cZU[Y"

HYUW]b['GhfU'hY[]Yg'

8Y'j] Yfm]b'h]g'W'ci fgY]g'U'W'ca V]bU]cb'cZ'YW'fi fYg'fUf[Y' [fci d'U'UbX'gYa]bUfg'f]ga U'' [fci d'U']@YW'fi fYg
k]''b]f'cXi W']Ym'W'cbW'dhg'UbX'h'Yc'fYh]WU'a U'hYf]U'g'UbX'g]h' U'hY'hYi hg'UbX'Z'a g']b'fY'U'h'cb'hc'hY]f
\]g'rcf]W]'W'cbhYi hg'"GYa]bUfg'k]''VY'X]gW'gg]cb!VUgYX'z'UbX'k]''VY'Z'c'W'gYX'cb'YbW'ci fU[]b['gh'XYbh]hc'
XYj Y'cd'hY]f'ck b'Uf[i a Ybh]UbX'cd]b]cbg'UVci h'hY'a U'hYf]U'g'gh'X]YX'UbX'z'YgdYW]U''n'z'UVci h'hY
W'cbW'dhg'i bXYf]m]b['h'YgY'a U'hYf]U'g'"Gca Y'gYa]bUf'h]a Y'k]''VY'XY] c'hY'hc'k cf_g\cdd]b['UggYgga Ybh
hUg_g"

...

5ggYgga Ybh

Mci 'a i ghUHYa dhU''UggYgga Ybhg]b'cfXYf'hc'VY'Y'[]V'Y'hc'dUgg'hY'Wci fgY''

5ggYgga YbhHUg_g

5ggYgga YbhHUg_	K Y][\h	8i Y'8UH'	Ghi XYbh@YUfb]b[Ci hWta Yg'5ggYggYX
5bbcfUH]cb'UW]j]lm	(\$	7\YW_A ccX'Y'Zcf'XYHU]`g	%ž'&ž(
C b`]bY'e]nnYg'	%)\$	7\YW_A ccX'Y'Zcf'XYHU]`g	&ž(
9ggUm) \$	7\YW_A ccX'Y'Zcf'XYHU]`g	%ž'&ž' ž(

5ggYgga Ybh'8YHU]`g

5ggYgga Ybh% '5bbcfUH]cb'UW]j]lm

8YHU]`g.

H\]g'hUg_]bj c`j Yg'i g]b['U'gcW]U''UbbcfUH]cb'dfc[fUa 'hc'a U_Y'UbbcfUH]cbg'cb'fU'gYh'hYI hf]g'`

%) \$!k cfXg'cf'Yei]j U'Ybh

: YYXVUW_j]U'@A G

5ggYgga Ybh&. 'C b`]bY'e]nnYg'

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Hk c'cb`]bY'ei]nnYg'hYghighi XYbhgf_bck `YX[Y'cZd]f]a Ufm'hYI hg'UbX'W'cbW'dtg'ghi X]YX'UW'cgg'hY'hYfa "

: YYXVUW_j]U'@A G

5ggYgga Ybh' . '9ggUm

GHUfhXUH'. Bch5dd]WVY

8YHU]`g.

5'a U'cf'YggUmU'ck g'gh XYbhg'hc'i gY'hY]f'_bck `YX[Y'cZdf]a Ufm'hYI hg'Ug'k Y''Ug'hYc'fmiUbX'W]h]W]ga 'Ug
hY'VUg]g'Zcf'Ub'cf][]bU'Uf[i a Ybh'

: YYXVUW_j]U'@A G

Hi fb]h]b'gYh]b[. H\]g'Ugg][ba Ybh]g'gi Va]hYX'h'fci [\ 'Hi fb]h]b'UbX'ghi XYbhg'Xc'bchgYY'Hi fb]h]b
g]a]Uf]mfYdcf]g'

F Ygci fWg

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Bcj Y`g`fUj U]UV`Y`Uhl BGK `Vcc_g\cdŁ

5bmYX]h]cb`]g`Z]bY` `hYl hg`k]h`Ub`f`VY`ck`UFY`ci`hcZW`dnf][`h`zgc`Uj U]UV`Y`ZFY`cb`]bYzVi`h`h`Y`c`h`Yfg`mci`k`j``bYXX`hc`di`fWX`UgY`cf`Vcfffck

<Ybfmi>Ua YgžFZWBađđS[f aXS >SVk

>Ua Yg`>cmWž3`BadđS[f aXfZW3d]ef`Se`S`Kag`Y`?`S`

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Gmj]U`D`U`h`ž`F`Z`W`4`W`^<Sd

NUX]Y`Ga`]h`ž`E`i` [`Y`F`_`W`

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FZWG`hS`cg[eZWW`M`b`S`d`S`[fa`Q`X]f``G`U`m`U`]h`F`U`m`f`]Z`m`c`i` `U`j`Y`U`W`U`b`W`ž`d`Y`U`g`Y`h`f`m`h`c`U`g`c`k`U`h`W`h`h`Y`Z`f`g`h`U`b`X`h`h`f`X`Z`a`g`]b`h`h`Y`5`d`i`h`f`]c`[`m`ž`B`S`f`Z`W`d`B`S`U`Z`S`[U`b`X`3`b`g`d`E`S`e`S`d`ž`Vi`h`F`Z`W`G`h`S`cg[eZWW!3bSdS[fa

Gi Va]gg]cb`cZ5ggYgga YbhiHUg_g

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Ʒmci`YbWci bHYf`U`dfcV`Ya`k` \Yb`UH`Ya` dh]b[`hc`gi`Va`]hmc`i`f`Ugg][`ba`Ybhi`h`fci`[`\`Hi`fb]h]b`z`d`Y`UgY`
HY`Yd`\\cbY`9I`HYfbU`Gi`ddcfhcb`-`,`,)`````%cf`Ya`Uj`h`Ya`icb`YI`HYfbU`HY`hgi`ddcfh4`i`bgk`"YXi`"Ui`""`Gi`ddcfh`
\\ci`fg`UfY`,`.\$\$Ua`-`-%\$.\$\$da`icb`k`YY`XUmg`UbX`-`.\$\$Ua`-`,`).\$\$da`icb`k`YY`YbXg`f1`*)`XUmg`U`mY`Uf2`"Ʒmci`
UfY`i`bUV`Y`hc`gi`Va`]hmc`i`f`Ugg][`ba`Ybhi`Xi`Y`hc`U`Zi`h`k`]h`Hi`fb]h]b`mci`a`UmUdd`m`Zc`f`Ub`YI`HYbg]cb`z`Vi`hmc`i`
a`i`ghfY`hU]b`mci`f`h]W`Yhbi`a`VYf`Z`ca`9I`HYfbU`Gi`ddcfh`f`U`cb[`k`]h`Ubmc`h`Y`f`fY`Yj`Ubh`Xc`W`a`Yb`hg`L`hc`
]b`Wi`XY`Ug`Yj`]XYb`V`hc`gi`ddcfh`mci`f`YI`HYbg]cb`Udd`]W`h]cb`"Ʒmci`Ya`Uj`9I`HYfbU`Gi`ddcfh`mci`k`j`
Ui`hc`a`U`h]W`m`f`Y`W`j`Y`U`h]W`Y`hbi`a`VYf`z`Vi`h]Z`mci`HY`Yd`\\cbY`mci`k`j`b`YYX`hc`gd`Y`W`Z`W`m`Ug`_`Zc`f`cbY`"
Hi`fb]h]b`U`gc`d`fcj`]XYg`i`d`XU`h`g`cb`h`Y]f`gm`gh`Ya`g`hU`h`g`cb`Hk`]h`Y`f`"

;`YbYfU`m`z`UggYgga`YbhiHUg_g`a`i`gh`VY`gi`Va`]h`Y`X`Y`Y`W`f`cb]W`m`j`]U`Y`]h`Y`f`Hi`fb]h]b`cf`U`A`cc`X`Y`
Ugg][`ba`Yb`h`h`b]bg`h`Ub`W`g`k`\\Y`f`h`g`]g`b`ch`d`c`g`g]V`Y`z`]h`k`j`VY`g`h`U`h`X`cb`mci`f`W`ci`fg`Y`g`A`cc`X`Y`g`]h`k`]h`
U`h`Y`fb`U`h]`Y`gi`Va`]gg]cb`X`Y`hU]`g`"

:`cf`]b`Z`fa`U`h]cb`cb`\\ck`hc`gi`Va`]h`Ugg][`ba`Yb`hg`cb`]b`Y`j`]U`A`cc`X`Y`.`\\`h`d`g`#`gh`XYb`h`i`bgk`"YXi`"Ui`#`ck`!
gi`Va`]h`Ugg][`ba`Yb`h`a`cc`X`Y`"

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

D`U[]Uf]ga `]g`i`g]b[`h`Y`k`c`f`X`g`c`f`]X`Y`U`g`c`Z`c`h`Y`f`g`i`U`b`X`d`f`Y`g`Y`b`h]b[`h`Y`a` `U`g`m`c`i`f`c`k`b`" `#`W`U`b`h`U`_`Y`a` `U`b`m`
Z`c`f`a`g`Z`Z`c`a` `X`Y`]V`Y`f`U`h`Y` `W`X`Y`U`h]b[`h`c` `U`W`W`Y`X`Y`b`h`U` `m`i`W`c`d`m]b[`Z`c`a` `U`g`c`i`f`W` `k`]h`c`i`h`U`W`_`b`c`k` `Y`X[`Y`a` `Y`b`h`

I`B`G`K` `[`f`c`i`d`g`d`U[]Uf]ga `]b`h`c` `h`Y` `Z`c` `c`k`]b[`W`U`h`Y`[`c`f`]Y`g.

- i bXYfgHUbX'mci f'f][\hg'UbX'fYgdcbg]V']hYg'Ug'U'gh XYbhUhl BGK
-

5 WUXYa]WbZcfa Uh]cb

: cfYggYbh]U`gh XYbh]bZcfa Uh]cb fY`Uh]b[`rc.

- fYei Yghg`Zcf`YI H`bg]cb/
- `UhY`gi Va]gg]cbg`[i]XY`]bYg/
- fYj]Yk `cZa Uf_g/
- I BGK `<YU`h`UbX`GUZY`mdc`]WYg/
- YI Ua]bUh]cb`dfcW`Xi fYg/
- gdYW]U`W`bg]XYfUh]cb`]b`hY`Yj YbhicZ]`bYgg`cf`a]gUXj Ybh fY/
- gh XYbhYei]mUbX`X]gUV`]m/
- UbX`c`hYf`YggYbh]U`UWUXYa]W]bZcfa Uh]cbz`gYY

[\ftdg.#k k k "Uftg"i bgk "YXi "Ui #W ffYbhgh XYbh\]UWUXYa \]W\]bZcfa Uh\]cb#dfchW`g!\[i \]XY`\]bYg#](#)

⇒ U[Y`7 fYX]h

7 UgdUf`8 Uj]X: f]YXf]W`zGi bf]gY

7 F ⇒ C G

7 F ⇒ C G `Dfcj]XYf`7 cXY. \$\$\$- , ;

5 W_bck `YX[Ya YbhicZ7 ci bhfm

K Y`UW_bck `YX[Y`hY`6YXY[U`dYcd`Y`k `c`UfY`hY`fUX]h]cbU`W`ghcX]Ubg`cZ`hY`UbXg`cb`k `]W`I BGK
? Ybg]b[`rcb`W]a di g`]g`cW]hYX"