

ARTS3125

91 dYf]a Ybhgʻ]bʻDYfZcfa UbWYʻUbXʻA YX]U

HYfa 'C bY''##'&\$&%

7ci fgY[·]Cj Yfj]Yk

GhJZZ 7 cbhJWh 8 YhJ] `g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`] m	@cWUh]cb	D\cb\$ ‰

7ci fgY 8YHJ] g

7 fYX]hDc]bhg *

Gi a a UfmcZh\Y'7ci fgY

: fca `XUbVJb[`fcVchg`hc`ga Ufhd\cbY`h\YUhfYgž'h\]g`Wci fgY`YI Ua]bYg'h\Yg\]Zh]b[`fY`UhJcbg\]d`VYkk YYb hYWkbc`c[mUbX`dYfZcfa UbW'`W`hi fYg"'±iWcbg]XYfg`h\Y`YI dUbX]b[`ZJY`X`cZX][]hU`W`hi fY`UbX`\ck `]hg Udd`]WUhJcbg`\Uj Y`hfUbgZcfa YX`h\Y`dUfUa YhYfg`cZdYfZcfa UbW'`UbX`fYdfYgYbhUhJcb"`Mci `k]```cVgYfj Y`U fUb[Y`cZdYfZcfa UbW'`cVYWgž`UWJj]hJYgžYj Ybhg`UbX`VY\Uj]ci fg`dfcXi WYX`]b`h\Y`YI WkUb[Y`VYkk YYb`h\Y VcXmUbX`bYk `a YX]U"`Mci `k]```XfUk `cb``YUX]b[`YI Ua d`Yg`hc`XYj Y`cd`mci f`ck b``]j Y`YI dYf]a Ybhg`UWfcgg d`UhZcfa g`h\Uhi gY`Hk]hhYfža cV]`Y`a YX]Užgi fj Y]``UbW`UbX`Mci Hi VY"`Mci `k]```YI d`cfY`h\Y`Wcbj Yf[YbW'`cZ dYfZcfa UbW'`[YbfYgž'h\Y`fYa YX]UhJcb`cZUfhk cf_gž'h\YcfYhJWD``WcbW'dhg`gi Wk`Ug`dcgh\i a Ub]ga `UbX WhYfbYhJWgžUbX`\ck ``]j Y`dYfZcfa UbW'`Yb[U[Yg`k]h\ WcbhYa dcfUfmWi`hi fU``WkUb[Y"

7 ci fqY @YUfb]b[Ci hMca Yq

- %" ⇒ YbhjZmUbX`X]gW' gg`_YmXYj Y`cda Ybhg`]b`WcbhYa dcfUfmidYfZcfa UbWY`]bgd]fYX`VmXYj Y`cda Ybhg`]b`hYW\bc`c[m
- &" 9 j U`i UhY h\Y'Yj c`j]b['fY`Uh|cbg\]d 'VYhk YYb hYW\bc`c[mUbX'UYgh\Yh]Wq
- ' " 5 ggYgg'h\Y'fc`Y'cZhYW\bc`c[mi]b'dYfZcfa UbW'\]ghcfm'UbX']b'fYW'bhih\YcfYh]WU`XYVUhYg']b'h\Y \i a Ub]h]Yg
- ("8YacbglfUlY:Ub:UXj UbWX:_bck `YX[Y:cZX]ZZYfYbhacXYg:cZdYfZcfaUbW:UbX:Ub:UddfYW]Ul]cb:cZh\Y]f'W``hifU``UbX`\]qhcf]WU``qdYW[Z]W]hm
-) " 6YHYfi bXYftu_Y`Wf]h]WU`XYVUHY`cb`WcbHYa dcfUfm'W`hi fU`]ggi Yq
- *" Di fai Y`]bX]i]Xi U`[i]XYX`fYaYUfW
- +" 7 cbg/fi Whgi g/U]bYX:Wf]hWU:Uf[i a Ybh]b:h\Y:Zcfa cZfYj]Yk g:cf:YggUmg
- , "8YacbghfUhY'U'h\cfci[\'_bck'YX[Y'cZgY`YWYX'h\YcfYh]WU`dYfgdYWhj Yg'UbX'fYgYUfW\aYh\cXg

HYUWX]b[GhfUhY[]Yg

F Uh]cbU`Y

H\]g`Wci fgY`]g`XYg][bYX`hc`ZJW]`]hUhY`ghi XYbhg'``YUfb]b['VmYghUV`]g\]b['U`a i `h]a cXU``hYUW\]b['ghfi Wi fY`]b k\]W\ ghi XYbhg`X]gW ggžfYgYUfW\ždfYgYbhž'dUff]W]dUhY`UbX``]ghYb"`H\Y`cj YfU```U]a `cZh\Y`Wci fgY`]g`hc YbUV`Y`ghi XYbhg`hc`a U]bhU]b`U`XYYdYf`i bXYfghUbX]b['cZa YX]Uh]gYX`dYfZcfa UbWY`h\fci [\`ZJW]`]hUh]b[WcbbYWf]cbg`h\Yma U_Y`VYhk YYb`fYUX]b[gž`WUgY`ghi X]Ygž'dfYgYbhUh]cbg`UbX`gWfYYb]b[g"`5ggYgga Ybhg fYZYWhih\Y`YI dYWfUh]cbg`Zcf`YI WY``YbWY`]b`fYgYUfW\`UbX`]bj Ybhjj YbYgg`h\Uhh\]g`Wci fgY`gYY_g`hc`YgHUV`]g\" H\Y`hcd]Wg`h\Y`Wci fgY`Wcj Yfg`fYZYWhUb`cb[c]b[`Wca a]ha Ybhhc`hYUW\]b[`]bbcj Uhjj YžfY`Yj UbhUbX g][b]Z]WUbha UhYf]U`g`Zcf`h\Y`X]gW]d`]bY`cZh\YUhfY#dYfZcfa UbWY`ghi X]Yg

HYUWX]b[glfUhY[]Yg

 $\label{thm:continuous} $$H\g'']g'gffi\ Wi fYX'Ug'U'Wea V]bUf]cb'cZ'YWi fYžk cf_g\cd'UbX'gfi XYbh'YX''YUfb]b['dfcW'ggYg'''H\Y Wei fgY']bWi XYg'U'gYf]Yg'cZWUggYg']b''YWi fY'#k cf_g\cd'#X]gW gg]cb'Zcfa Ufz'Zc'`ck YX'Vm'U'fYgYUfW.'UbX dfYgYbfUf]cb'UddfcUW\Z'f\fci [\`k\]W\'gfi XYbfg'UfY'YI dYWYX'fc']bfY[fUhYZ'Udd`mUbX'YI fYbX'Wei fgY a UfYf]U'g'k]h\'UbX'Zcf'f\Yf]f'dYYfg''Ghi XYbfg'UfY'YbWei fU[YX'fc'UWf]j Y`mdUff]W]dUhY']b'f\Yf\]b_]b[!f\fci [\cZ_Ymf\YcfYf]WU''UbX'dYXU[c[]\W''ei Ygf]cbg'gdY\W]Z]Wfc'f\]g'Wei fgYZ'UbX'fc'dfcUWf]j Y`mXYYdYb'f\Yf'fa g cZh\Y'Wei fgY'f\fci [\'gY'Z\'YX'fYgYUfW\''$

G9A #B5F: CFA5H. H\Y'gYa]bUf'k]``VY``ccgY`mglfi Wi fYX'Ug.``YWi fY`Z'j]gi U``gWfYYb]b[gžZc``ck YX`Vmghi XYbhX]gW gg]cb'UbX'fYUX]b[g'fU'h\ci [\'h\]g'a UmW\Ub[Y'Zfca'k YY_hc'k YY_Ł"'H\Y'U]a 'cZh\]g'WUgg Zcfa Uh]g'hc']bhY[fUhY'U'bi a VYf'cZghi XYbh`YUfb]b[a cXU`]hJYg"'H\Y'`YWi fY']bZcfa Uh]cb'dfcj]XYg'U d`UhZcfa 'Zcf'ghi XYbhg'hc'h\Yb'Yb[U[Y']b'ghi XYbh'YX``YUfb]b['dfcWYggYg'h\fci [\'h\Y'U``cWUh]cb'cZZcW gei Ygh]cbg'UbX'#cf'gYhX]gW gg]cb'hUg_g"'Ghi XYbhg'UfY'UV'Y'hc'fYZYWhj Y`mdfcWYgg'ch\Yf'ghi XYbhg' Wcbhf]Vi hJcbg']b'fY`UhJcb'hc'h\Y]f'ck bz'UbX'hc'gY`ZXYhYfa]bY'U'Wf]nJWU``UbX'UbU`mhJWfYgYUfW\'dfUWhJWY''

5ggYgga Ybh

5ggYgga YbhHUg_g

5ggYgga Ybh'tUg_	K Y][\h	8iY'8UhY	Gh XYbh@YUfb]b[Ci hWca Ygʻ5ggYggYX
9ggUm			

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9aal Imi

%\$\$!\%) \$'k cfXg

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H\]g`]g`h\Y`ZbU``UggYgga Ybh

.

 $\label{thm:condition} \mbox{Hi fb]h]b"gYh]b" Low Ybh"]g"gi Va]hhYX"h\fci [\h]b" Low X"ghi XYbhg"Xc"bchigYY" Hi fb]h]b g]a]"Uf]hmfYdcfhg" \mbox{Hi fb]h]b" Low Ybh"]g"gi Va]hhYX"h\fci [\h]b" Low X"ghi XYbhg"Xc"bchigYY" Hi fb]h]b Low Ybh"]g"gi Va]hhYX"h\fci [\h]b" Low Ybh"]g"g [\h]b" Low Ybh"]g"g [\h]b" Low Ybh"]g"g [\h]b" Low Ybh"]g"g [\h]b" Low$

FYgci fW/g

DfYgWf]VYX F Ygci fWYg

FYei]fYX`UbX`Gi [[YghYX`FYUX]b[g`UfY``}jghY}\$\$b`AccX`Y"`FYUX]b[g`a Um`W\dub[Ybbicf`bYk`gi [[YghYXfYUX]b[g`UXXYXžgc`aU_Y`gi fY`hc`fY[i`Uf`mW\YW_AccX`Y`Zcf`h\Y`acghi d!hc!XUhY`]bZcfaUh]cb"

FYWca a YbXYX FYgci fW/g

: i ft\Yf'fYgci fWYg'WUb'VY'Zci bX'cb'A ccX`Y"

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

K Y`k Y`Wca Y`Wcbghfi Whj Y`ZYYXVUW_`-YgdYWjU``mik f]hhyb`ZYYXVUW_`flya U]`gž'bchyg`YhW'Lcb'h\Y`Wci fgY Wcbhybhzghfi Whi fy`UbX`UggYgga Ybha Yh\cXg`-'bchcb`mUhih\Y`WcbWi g]cb`cZh\Y`Wci fgYžVi h'U`gc`Ug`k Y`[c U`cb["'5hh\Y`YbX`cZh\Y`Wci fgY`k Y`k]```]bj]hy`mci 'hc`dfcj]XY`ZYYXVUW_`i g]b['I BGK fig`Wci fgY`Yl dYf]YbW' gi fj Ym'

A Ubm'UgdYWg`cZh\]g`Wci fgY`UfY`h\Y`fYgi `hcZ]bbcj Uf]j Y`ghi XYbhZYXVUW_`Zfca `dfYj]ci g`mYUfg": cf Yl Ua d`Yž'h\Y`bi a VYf`UbX`[YbfY`cZWJgY`ghi X]Yg`]b`h\]g`Wci fgY`\Ug`VYYb`W\Ub[YX`]b`fYgdcbgY`hc`ghi XYbh ZYXVUW_"`K]h\`h\Y`a cj Y`hc`U`%\$!k YY_`hYUW\]b[`H\fa `]b`&\$%-žk Y`fYUffUb[YX`gca Y`WcbH\bhz`W\Ub[YX gca Y`UggYgga Ybhgž'UbX`]bhfcXi WYX`(!\ci f`gYa]bUfg"`@Ughm\Ufzk Y`fYXi WYX`h\Y`bi a VYf`cZUggYgga Ybh HUg_g`Zfca `Zci f`hc`h\fYY"

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

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

Image: Ybwci bhYf'U'dfcV'Ya k \Yb'UhYa dhjb['hc'gi Va]hmci f'Ugg][ba Ybhh\fci [\'Hi fb]h]bz'd'YUgY

HY'Yd\cbY'9| hYfbU''Gi ddcfhcb'-',) "''' %cf'Ya U]''h\Ya 'cb'Y! hYfbU'hY'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'mYUft'''=\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ub'Y! hYbg]cb\mathred{Image: Wa Jhmci h\Yf'f'Y'j UbhXcW a Ybhg\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k]'`

JbWi XY'Ug'Yj]XYbW' hc'gi ddcfhmci f'Y! hYbg]cb'Udd']\wUh]cb"'\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k]'`

Ui hca Uh]\wU'`mfYW']j Y'U'h]\w_Yhbi a VYf\mathred{Image: hY'Yd\cbY'mci 'k]\tag{Y}\wu''mug_'\mathred{Image: Wa'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY'Yd\cbY''mci 'k]\tag{Y}\wu''mug_'\mathred{Image: hY'\mathred{Image: hY'\mathred{I

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

cfi]bZcfa Uhjcbicbi\ckihcigi Va]hUgg][ba Ybhgicbi]bYij]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va]hUgg][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=hWJbihU_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiWXYUh]b[ihciUWW]XYbhU`mWcdm]b[iZfca iUigci fWYik]h\ci hiUW_bck iYX[Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga]bhc'h\Y'Zc``ck]b['WUhY[cf]Yg.

• i bXYfgHJbX'mci f'f][\hg'UbX'fYgdcbg]V]`]h]Yg'Ug'U'gh XYbh'Uhil BGK

5 WUXYa]W±bZcfa Uhjcb