

# **ARTS2040**

K cfX'@|hYfUhi fY. FYUX]b[ 'h\Y'; `cVU``DfYgYbh

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

### 7ci fgY'Cj Yfj ]Yk

### Ghuzz 7 cbhuWh8 Yhu]`g

'7cbj Ybcfg'

B Ua Y	9a U]`	5j U]`UV]`]m	@cWJhjcb	D\cbY
: ]cbU'A cff]gcb	Z'a cff]gcb4 i bgk "YXi "Ui		FcVYfh KYVghYf'Fa &\$-	- ' , ) ) &+)

#### GWkcc~7cbhJWh~abZcfa Uh]cb

Fcca " &ž`Yj Y`" FcVYfhK YVghYf`6i ]`X]b[

D\cbY.'f\$&E'-',)'(,)\*

9a U]` gUa 4 i bgk "YXi "Ui

K YVg]hY. \hdg.#gUa "Ufhg"i bgk "YXi "Ui

 $\label{eq:hamiltonian} $$HY'GWKcc``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck`YX[Y'h\Y'HfUX]tjcbU``7i gtcX]Ubg\cong h\Y'6YXY[U'`fPYbg]b[tcb'WJa di g\cong tz'; UX][U'`fP]tmUbX'5fth/ '8Yg][b'7Ua di gYg\cong tubX't\Y'B[i bbUk U` dYcd'Y'fbi gtfU']Ub'8YZYbW': cf\w'5\\WXYa m']b'7UbVYffU\cozh\Y'`UbXg'k\YfY'YUW\cozh\Y'YUW\cozh\Y''UbXg'k\YfY'YUW\cozh\Y'' \cozh\Y''\UbXg'k\YfY'YUW\cozh\Y'' \cozh\Y''\UbXg'k\YfY'YUW\cozh\Y'' \cozh\Y''' \cozh\Y'''' \cozh\Y''' \cozh\Y'''' \cozh\Y''' \cozh\Y'' \cozh\X''' \cozh\Y''' \cozh\Y''' \cozh\Y'' \cozh\Y''' \cozh\Y'' \cozh\Y'' \cozh\Y'' \cozh\Y'' \cozh\Y''' \cozh\Y'' \cozh\Y''' \cozh\Y''' \cozh\Y''' \cozh\Y''' \cozh\Y'' \cozh\Y''' \cozh\Y''' \cozh\Y''' \cozh\Y'' \cozh$ 

## 7ci fgY 8YHJ) g

7 fYX]hDc]bhg\*\*

Gi a a UfmcZh\Y 7ci fgY

Gi VYWh5fYU. 7`Y/eZ

"H\Y'Wci fgY']g'cf[Ub]gYX']bhc'kk c'a cXi 'Yg.''K UhYf'UbX''@UbX'"·H\]g'[Yc[fUd\]WD'ZcW g'k]''gi ddcfhih Y gWcdY'cZmci f'fYUX]b['UbX'ZcghYf'X]gW gg]cb'k]h\]b'UbX'UWfcgg'WYffU]b'Zcfa i 'Uh]cbg'cZh\Y''k cf'X''']hYfUfm WUbcb"''Mci 'k]''h\]b\_'UVci hei Ygh]cbg'cZ[ 'cVU''a cj Ya Ybh'UbX'g]hi UhYX'VY'cb[]b[ ž'Ug'k Y'''Ug'W ffYbh ']hYfUfmYb[U[Ya Ybhg'k]h\'UfYUg'cZi f[Ybh'WcbWYfb.'j i 'bYfUV'Y'VcX]YgžhYff]hcf]U''WcbZ]WfžYWc'c[mžh\Y'W]hm UbX'h\Y'Ub]a Uh]b['ei Ygh]cb'cZ[ 'cVU''WYbhfYg'UbX'dYf]d\Yf]Yg"'K cbXYfž\_bck 'YX[Yž'Yh\]Wg'UbX YI d`cfUh]cb'UfY'\_Ymh\Ya Yg'h\Uh'hfUbgYWhVch\'a cXi 'Yg"''''

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

%" I bXYfgHJbX`U`bi a VYf`cZh\YcfYh]WJ``]ggi Yg`]b`[`cVU``UbX`hfUbgbUh]cbU``k f]h]b[`UbX`UbU`mgY``]hYfUfm

## 5ggYgga Ybh

 $8 \ Y \ L^3 \ L^$ 

### 5ggYgga Ybh'HUg\_g'

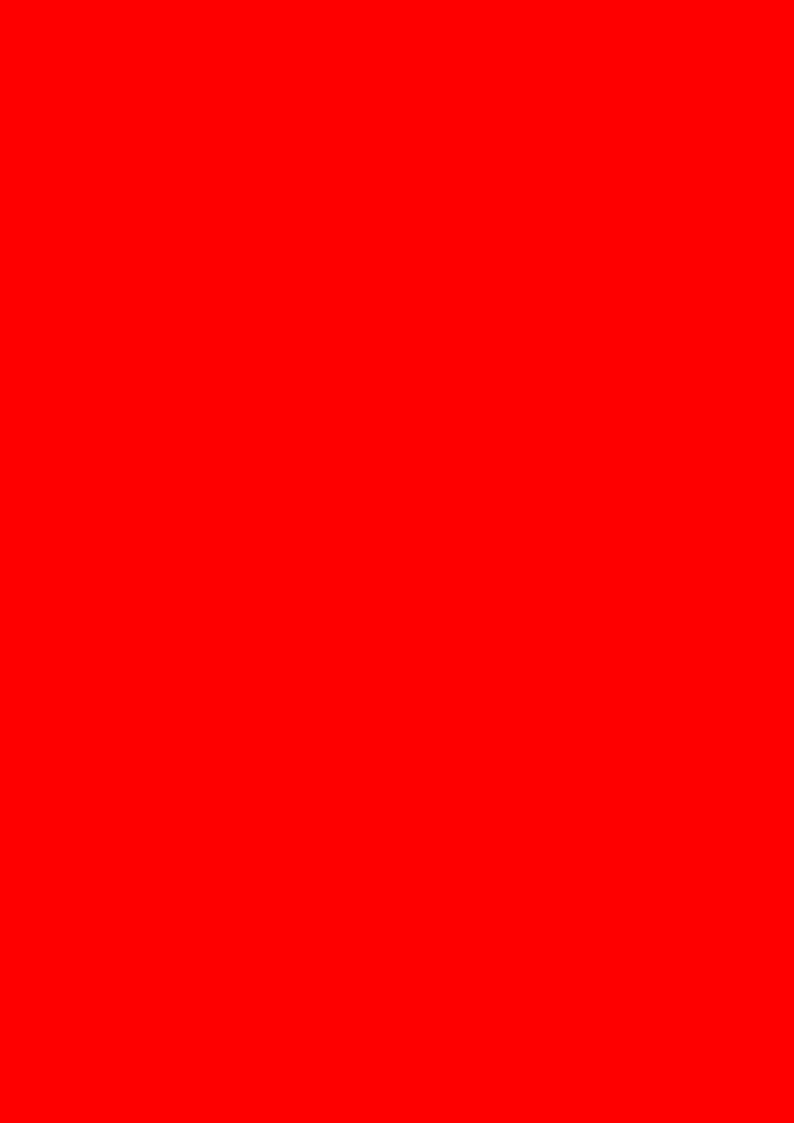
5ggYgga Ybh'hUg_	K Y][ \h	8i Y'8UHY	Gh XYbh@YUfb]b[ Ci hWca Yg 5ggYggYX
FYUX]b[ 'UbX'FYgYUfWX'@c[ '	(\$1	&) #\$' #&\$% `\$(.\$\$`DA	%Ž Ž(
A U⁄cfʻ9ggUmi	*\$1	&*#\$(#&\$% `\$(.\$\$`DA	&Ž Ž(

### 5ggYgga Ybh'8YHJ]`g

5ggYgga Ybh'% 'F YUX]b[ 'UbX 'F YgYUfW\ '@c[

GhUfhXUhY. Bch5dd`]WUV`Y

\$



Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

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

\_Zmci YbWci bhYf'U'dfcV`Ya 'k \Yb'UhYa dhJb[ 'hc'gi Va ]hmci f'Ugg][ ba Ybhh\fci [ \ 'Hi fb]hJbž'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'' =Zmci
UfY'i bUV`Y'hc'gi Va ]hmci f'Ugg][ ba YbhXi Y'hc'U'ZUi 'hk ]h\'Hi fb]hJb'mci 'a Um'Udd'mZcf'Ub'Y! hYbg]cbžVi hmci
a i ghfYhU]b'mci f'hJW\_Yhbi a VYf'Zfca '9! hYfbU``Gi ddcfhfU'cb[ 'k ]h\'Ubmch\Yf'fY`Yj UbhXcW a Ybhgt'hc
]bWi XY'Ug'Yj ]XYbW'hc'gi ddcfhmci f'Y! hYbg]cb'Udd`]WUhJcb'' =Zmci 'Ya U]`'9! hYfbU``Gi ddcfhmci 'k ]``

### 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"'=hWUb`hU\_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b[ 'hc`UWW]XYbhU``mWcdm]b[ 'Zfca `U`gci fW'k ]h\ci hUW\_bck `YX[ Ya Ybh'

 $I BGK `[fci dg'd`U[]Uf]ga `]bhc'h\Y'Zc``ck]b[`WUhY[cf]Yg.$ 

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$ 

- i bXYfglUbX`mci f`f][\hg`UbX`fYgdcbg]V]`]h]Yg`Ug`U`gh XYbh'Uhi BGK
- VY'Uk UfY'cZd`U[]Uf]ga ž'Wcdmf][\hzil BGK 'Gh XYbh7cXY'cZ7cbXi WhUbX'5WWdhUV`Y'I gY'cZ I BGK '= H'F Ygci fWfg'Dc`]Wh
- VY 'Uk UfY 'cZh\Y 'ghUbXUfXg 'cZVY\Uj ]ci f'Yl dYWhYX 'cZYj YfmcbY ']b 'h\Y 'l BGK 'Wcaaib]hm
- `cWUHY 'gYfj ]WYg'UbX `]bZcfa UH]cb'UVci hI BGK 'UbX'I BGK '@]VfUfm

#### 5 WUXYa ]W = b Zcfa Uh cb.

: cf`YggYbhJU``gh XYbh`]bZcfa UhJcb`fY`UhJb[ hc.

- fYei Yghg Zcf Yl hYbg]cb/
- `UhY`gi Va ]gg]cbg`[i ]XY`]bYg/
- fYj ]Yk 'cZa Uf\_g/
- I BGK '< YU`h\ 'UbX'GUZYhm'dc`]W[Yg/
- YI Ua ]bUhcb dfcWXi fYg/
- gdYWJU``Wcbg]XYfUHjcb`]b`H\Y`Yj YbhcZ]``bYgg`cf`a ]gUXj Ybhi fY/
- gh XYbhYei ]mUbX X]gUV]`]m/
- UbX'ch\Yf'YggYbhJU`'UWUXYa ]W]bZcfa UhJcbž'gYY

\hdg.#k k k "Uffg"i bgk "YXi "Ui #W ffYbhgh XYbhg#UWJXYa ]W]bZcfa Uf]cb#dfchcWc`g![i]XY`]bYg#

.

#### a U[Y'7fYX]h

di `YS&\$%\* Sa U`Yi USc]`!YbUa Y`!]b\_!dc`mi fYh\UbY!cb!WUbj UgS%) &) !1 %) &) a a

#### 7F = 7CG

7F = 7CG Dfcj ]XYf 7cXY. \$\$\$-,;