

# **ARTS2785**

9i fcdYfg 5[Y cZ7 UtUgtfcd\Yž % (!% ()

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

## GHJZ7cbHJWh8YHJ]`g

## 7cbj Ybcfg

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@c\\U||cb. G\\cc``C\\Z|\\\žA\cfj\Yb'6fck\b'6i]\X]b[\z'@\j\Y``&z'&),

CdYb]b[ '<ci fg. 'A cbXUm'! : f]XUmž - Ua '! ') da

D\cbY.'Ž\*%'&'-',)'%\*,%

: UI . 'Ž \* %'&'-' , ) ', +\$)

9a U]`. '<u>\U`4 i bgk "YXi "Ui</u>

## 7ci fgY 8YHJ] g

## 7 fYX]h'Dc]bhg'\*

## Gi a a UfmcZh\Y 7ci fgY

H\Y'YUf'mik YbhJYh\'Wbhi fmk Ug'U'WUhUghfcd\]WUbX'hfUbgZcfa Uhji Y'dYf]cX']b'hk YbhJYh\!Wbhi fmi9i fcdYUb\]ghcfm''H\Y': ]fghK cf'X'K Uf'WUhU`mgYX']bhYbgY'XYa c[fUd\]Wz']XYc`c[]WU'z'UbX'YWcbca ]Whi fa c]'''Mci k]``ZcW g'cb'h\Y'fY`UhJcbg\]d'VYhk YYb'gcWjc!YWcbca ]WWf]gYg'UbX'h\Y'XYj Y`cda YbhcZfUX]WU'bYk 'dc`]hJWU'a cj Ya Ybhg'fY"["'6c`g\Yj]ga z'GHU']b]ga z'ZUgWjga 'UbX'B UhJcbU'`GcWJU']ga z'h\UhdcgYX'Ybcfa ci g'h\fYUhg'hc bUgWYbh`]VYfU'`XYa cWfUWJYg''Mci 'k]``'U'gc'YI d`cfY'gca Y'cZh\Y'fYa Uf\_UV'Y'UffUmcZW 'hi fU``UbX'gcWJU` ]bbcj UhJcbg'h\UhZck YfYX']b'h\]g'hi a i 'hi ci g'dYf]cX'fJ ]gi U``Ufhgz``]hYfUhi fYz'h\YUhfYz'WJbYa Uz'gcWJU``h\Ycfmz qYI i U`]hmUbX'[YbXYfz"

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

- %" UbU`mgY`a U'cf'dc`]hJWU`ž'gcWJU`ž'W\`h fU``UbX`YWcbca ]WXYj Y`cda Ybhg`UbX`]ggi Yg`]b`9i fcdY VYhk YYb`% %( `UbX`% ( )
- &" Yj U`i UhY h\Y`g][ b]ZWUbWY cZh\YgY XYj Y`cda Ybhg UbX`]ggi Yg`UbX`d`UWY h\Ya `]b`WcbhYl h
- '" a U\_Y`gVXc`Uf`mUf[i a Ybhg`i g]b[`]bXYdYbXYbhm`cWUhYX`UbX`WfYX]V`Y`Yj ]XYbWY"
- ("YId`U]b fY`Yj UbhUgdYWg cZ9i fcdYUb dc`]hJWgžW\`h fY'UbX#cf'gcVJYhmVYhk YYb'% %('UbX'% ()
- ) " Waa a i b] WUHY ] XYU g Ua cb[ ghd YYfg#Yb[ U[ Y ] b X] g W g g ] c b g # Y Y UHY g

k

### HYUWX]b[ GhfUhY[]Yg

H\Y``YUfb]b[`UbX`hYUW\]b[`ghfUhY[m]g`XYg][bYX`hc`XY`]j Yf`U`Wci fgY`h\UnYbWci fU[Yg`ghi XYbhYb[U[Ya Ybh k]h\Y`Z]Y`Xg`cZ9i fcdYUb`Ghi X]Yg`UbX`9i fcdYUb`<]ghcfmUbX`XYj Y`cdg`h\Y]f`Wf]h\Wb``UbX`fYgYUfW\`g\_]``g h\fci [\`a i `h]d`Y`a cXYg`cZhYUW\]b[`UbX`UggYgga Ybh'`H\YfY`]g`U`hk c!\ci f``YWhi fYž`U`cbY!\ci f``YWhi fY#gYa ]bUfž`UbX`U`cbY!\ci f`h hcf]U``dYf`k YY\_"'9UW\`k YY\_"U`gdYV]Z]WXYj Y`cda Ybhcf`]ggi Y`k ]``VY`h\Y\ZcW`q`cZh\Y``YWhi fYž'h\Y`fYUX]b[q`UbX`hi hcf]U``X]qW\qq]cb"

H\Y``YY``YW **‰** W

XYj Y`cda YbhgʻUbX`]gjyNYyyVJgggPi fcdY

fcdghc"

## 5ggYgga Ybh

8 Y hU] `Y X `] b Zcfa Uh] c b `k ] `` `V Y `Uj U] `UV `Y `c b `A c c X `Y "

### 5ggYgga YbhHUg\_g

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Hi hcf]U``F YgdcbgYg'	&\$I	Bch5dd`]WUV`Y	&ž˙( ž˙)
HU_Y' <ca td="" y'5ggygga="" ybh<=""><td>' \$ı</td><td>&amp;, #\$(#&amp;\$&amp;%`%%\$\$`5A</td><td>&amp;ž˙(</td></ca>	' \$ı	&, #\$(#&\$&%`%%\$\$`5A	&ž˙(
: ]bU`F YgYUfW.'9ggUm	) \$1	%#\$(#&\$&%`%%) - `DA	%ž'&ž'' ž'(

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

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GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\.'(|'\$\$'kcfXg

8 YW] g.

Ghi XYbhgʻgi Va ]h'Zci fʻhi hcf]U`ʻfYgdcbgYgʻXi f]b[ ˈh\YˈhYfa žYUWkʻUdd"'' \$\$`k cfXgʻd`i gʻei Ygh]cbg":H\YfYgdcbgYgʻk]``VY`VUgYX`cb`ei Ygh]cbgʻh\UhiUfY``]b\_YX`hc'h\Y`a U]bʻfYUX]b[ gʻZcfʻh\Y`k YY\_"

Gh XYbhg k ]``fYWY]j Y ZYYXVUW\_j ]U'U'fi Vf]WUbX g\cfh]bX]j ]Xi U``Wa a Ybhg cb h\Y]f ZfghfYgdcbgYž Vi hcb`m a Uf\_g cb h\Y Zc``ck ]b[ 'h\fYY fYgdcbgYg"

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

 $H\Y'k\YY\_`mih\ hcf]U``fYgdcbgYg'k\]```fYei\]fY'gh\XYbhg'hc'Yb[\ U[\ Y'Wf]h]WU``mik\]h\ `fYUX]b[\ g'UbX'hc'X]gd`Umih\Y]f ck\ b'`UbX'YbWci\ fU[\ Y'h\Y]f'WUgga\ UhYgfiUbU`mh]WU``g_]``g''`$ 

Gi Va ]gg]cb'bchYg. 'Gh XYbhg'k ]```gi Va ]hh\Y]f'k YY\_`mfYgdcbgYg'j ]U'A ccX`Y"'H\Y'XYUX`]bY']g'cb H\i fgXUmUh'&da 'fbccbŁh\Y'XUmVYZcfY'h\Y'h hcf]U`"

 $\label{thm:continuous} \begin{tabular}{ll} Hi & fb & gYH & gYY Hi & fb & gYY Hi & fb$ 

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GhUfh:XUhY. &, #\$(#&\$&%\*\$-.\$\$\*5A

@Yb[h\. Udd" %\\$\$\$!\%) \$\$ k cfXg

8YW]`q.

Gh XYbhg k ]``\Uj Yhk c'\ci fg hc Waa d'YhY Ub cb`]bY cdYb Vcc\_'Ugg][ ba Ybh]b h\Y Zcfa cZUb YggUm

ei Ygh]cb""H\Ymk]``VY"YI dYWYX"hc"k f]hY"Uddfcl ]a UhY`mVYhk YYb"%\$\$\$"UbX"%) \$\$"k cfXg"

: YYXVUW\_]b h\Y Zcfa cZg\cfnk f]hhYb Wca a Ybhg"

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

⇒glfi Wfcbg'k ]``VY'dcglYX'cb'a ccX'Y"

Gi Va ]gg]cb bch/g. %\$\$\$!%) \$\$ k cfXg VUgYX cb "YWi fYg UbX hi hcf]U`g" G\cfhZYYXVUW\_i j ]U'a ccX`Y"

5ggYgga Ybh' .: ]bU`F YgYUfWX '9ggUm

GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\. &ž\$\$\$!&ž)\$\$ k cfXg

#### 8 YW] g.

: ]bU``fYgYUfW.`YggUmf&ž\$\$\$`hc`&ž) \$\$`k cfXgŁ"`Gh XYbhg`UfY`YI dYWYX`hc`i gY`Uh`YUgh, `ei U`]hmgci fWYg" H\Ymk ]```gi Va ]hh\Y`YggUmj ]U`Hi fb]h|b"

H\Y'Ugg][ ba Ybhk ]``VY'a Uf\_YX'cb`]bY'k ]h\'ZYYXVUW\_j ]U'U'fi Vf]WUbX'Wca a Ybhg']b'Hi fb]h]b"

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

Ghi XYbhgʻk f]hYʻUbʻYggUmiflWU"`&ž\$\$\$!&ž) \$\$ʻk cfXgŁʻVUgYXʻcbʻ]bXYdYbXYbhifYgYUflW."'Ghi XYbhgʻfYWY]j Y ZYYXVUW\_j JUJbX]j JXi U``Wca a YbhgʻUbXʻfi Vf]Wk Jh\Jbʻh\fYY`k YY\_gʻUZhYfʻh\Y`XYUX`]bY"

 $\label{thm:continuous} \begin{tabular}{ll} His plant of the lighthfully a property of the ligh$ 

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

Ghi XYbhgʻUfYʻghfcb[`miYbWci fU[YX'hcʻUhhYbX'U```WUggYgʻUbX'fYj ]Yk '`YWhi fY`fYWcfX]b[g"

## 7ci fgY GWX YXi `Y

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

## H]a YtUV`Y

8 UhY	HmdY	7 cbhYbh
K YY_'%'%) : YVfi Ufm!'% : YVfi Ufm	@YWn fY	+blfcXi Wfcfm@YWh fY. H\Y'5[Y'cZ7UHUgHcd\Yž% (!%()/
		6Y``Y`¥dcei Y.'9i fcdY'6YZcfY'% %(
		K\mX]X'h\Y'ghUhYg'XYW]XY'Zcf'kUf']b'%-%(3
	Hi hcf]U`	=blfcXi Wjcb
		K cfX'K Uf'%'K \m3'9  dYWUh]cbg'UbX'fYU`]hm'
		A Ud`YI YfW]gY`f% %( ž'% % ž'% ( ) Ł
K YY_'&.'&&': YVfi Ufm!'&* : YVfi Ufm	@YWi fY	HfUbg]hcb hc h\Y BYk K cfX = DYUW UbX h\Y dcghk Uf'dYUW gYhiYa Ybh/
		K \Yb'X]X'h\Y'k Uf'YbX3
	Hi hcf]U`	K \Yb'X]X'K cf'X'K Uf'%YbX3'Hf]i a d\'cZ@]VYfU`]ga cf'fYj Yb[ Y3'
K YY_" ."%A UfWX"!") A UfWX	@YWhifY	9a VUlhiYX`8Ya cWfUWh`H\Y`6c`g\Yj ]_FYj c`i h]cb UbX`]rg`WcbgYei YbWfg`Zcf`]bh/fk Uf`9i fcdY
	Hi hcf]U`	GcWJU``7 f]g]g.`< ck 'X]X'H\Y`6c`g\Yj ]_'fYj c`i H]cb ]bZi YbWf']bHYfk Uf'9i fcdY3
K YY_'(.', 'A UfWX'!'%& A UfWX	@YWn fY	9a VUlhiYX`8Ya cWfUWni&.`7 ci bhYffYj c`i h]cbg`UWfcgg 9i fcdY"
		; i Ygh@YWn fY. 5#DfcZ8Uj ]X 6`UUnYfž'9Wcbca mUbX Dc`]h]Wg`]b`h\Y`5[Y`cZ7UhUghfcd\Y
	Hi lcf]U`	7 ci bhYffYj c'i hJcbg'UbX'h\Y'f]gY'cZX]WUhcfg.' <ck gi WWggZ `'k Ug'h\Y']bhfcXi WJcb'cZ`]VYfU` XYa cWfUWn]b'h\Y'5[Y'cZ7UhUghfcd\Y3</ck 
K_YY_") . "%) "A_UfVX "! "%-	@YWhi fY	H\Y`5[Y`cZ8]\\U\rg.`BUn]ga `UbX`G\U`]b]ga
A UfVX	Hi hcf]U`	CfX]bUfmdYcd`Y`]b`fcfU`]fUf]Ub`gcVJYfJYg
K YY_'*.'&&'A UfWX'!'&* A UfWX	@YWn fY	Bc'WUggYg'!': 'YI]'K YY_
K YY_`+.`&- `A UfWX`!`& 5df]`	@YV <b>Yi</b> fY	±bHYfUWNjjY``YWNifY.`A]bcf]hjYg`]b`h\Y`5[Y`cZ 7UHUgHfcd\Y
		; YbcWJXY. '5 'BYk 'K cfX ']b 'h\Y '5 [Y 'cZ7 UHUgHcd\Y"
	Hi hcf]U`	Bc'hihcf]U'g'!'9UghYf': f]XUm'

## FYgci fWyg

### DfYgWf]VYX F Ygci fWYg

5```\_YmfYUX]b[g'Zcf'h hcf]U'g'k]``'VY'Uj U]`UV'Y'cb'a ccX`Y'UbX'j ]U'@Y[Ubhc"

### FYWca a YbXYX FYgci fWYg

FYWca a YbXYX'VUW\_[ fci bX'fYUX]b[.'A cghcZh\Y'fYWca a YbXYX'Vcc\_g'UfY'Uj U]'UV'Y'Uhih\Y'I BGK @\VfUfmfbca Y'cb`\bYE'cf'Uhih\Y'I BGK '6cc g\cd"

=fYWca a YbX'h\Y'Zc``ck]b[ 'gi fj Ymg'cZYUfm'lk YbhJYh\!Wfbh fm'9i fcdYUb'\]ghcfm

7 cbUb': ]gWkYfž'9i fcdY'VYlk YYb'8Ya cWfUWnUbX'8]WfUlcfg\]d.'% \$\$!% () 'fC | ZcfX.'K ]'Ym'6`UW\_k Y``ž &\$%%''

F cVYfh; Yfk Uft\\ž'H\Y'J Ubei ]g\YX.'K \mt\\Y': ]fgh'K cf'X'K Uf': U]`YX'hc'9bXž'% %+!% &' f@cbXcb. DYb[i]bž'&\$%+Ł"

±Ub?? Yfg\Uk ž'Hc'< Y``'UbX'6UW\_. '9i fcdYž'% %(!% ( - 'f@cbXcb. 'DYb[i ]bž'&\$%\*Ł"

='U'gc'\][\`mfYWcaaYbX'h\Y'Zc``ck]b['gifjYmg'cb'h\Y'k\c`Y'cZh\Y'hkYbh]Yh\!WYbhifm

B]Wkc`Ug`8ci a Ub]g`ffYX\{z`H\Y`C|ZcfX`<UbXVcc\_`cZ9i fcdYUb`<]ghcfm'% %(!%()`fC|ZcfX.`C|ZcfX | b]j Yfg]hmDfYggž&\$%\*\{"

A Uf\_'A Unck Yfz'8 Uf\_'7 cbh}bYbh '9i fcdY'g'Hk Ybh}Yh\ '7 Ybh fmfBYk 'Mcf\_. 'F UbXca '< ci gYz'% - - Ł"'F cVYfh C "'DUI hcb'--'>i `]Y' < Ygg`Yfz'9i fcdY']b'h\ Y'Hk Ybh}Yh\ '7 Ybh fm": ]Zh\ '9X]h]cb'fb'cghcb. 'K UXgk cfh\ z'&\$\%\Ł"

A Ufj ]b DYffmYhU`" $\ddot{z}$ Gci fW'g'cZ9i fcdYUb'< ]ghcfmG]bW''% \$\$"'GYWcbX'9X]h]cb'fbcghcb. K UXgk cfh\ $\ddot{z}$ &\$\%\\\\\"

## 7 ci fgY 9j U`i Uh]cb UbX 8 Yj Y`cda Ybh

Ghi XYbhgʻk]```\Uj YʻUbʻcddcfhi b]hmhcʻdfcj]XYʻZYYXVUW\_ʻh\fci [\'h\Y`a m9I dYf]YbWYʻgi fj Ymgʻh\Uhk]``VY Uj U]`UV`Yʻ]bʻA ccX`Y"'H\Y``YWhi fYfʻk]```U`qcʻWc``YWh]bZcfa U``ZYYXVUW`]bʻh\Y`WUqqfcca "

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

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

Image: Ybwei bhyfu'dfcv'ya k \yb'uhhya dhjb[ 'hc'gi va ]hmci f'Ugg][ ba Ybhh\fci [ \ 'Hi fb]h]bž'd'YUgY

Hy'Yd\cby'9| hy'fbu''Gi ddcfhcb'-', ) '' ' ' %cf'Ya U]''h\Ya 'cb'Y! hy'fbu'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'''=Z'mci
UfY'i bUV'Y'hc'gi va ]hmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\ 'Hi fb]h]b'mci 'a Um'Udd'mZcf'Ub'Y! hy'bg]cbž'Vi hmci
a i ghfYhJ]b'mci f'h]W\_Yhbi a VYf'Zfca '9! hy'fbU''Gi ddcfhfU'cb[ 'k ]h\ 'Ubmch\Yf'fy'Yj UbhXcW a Ybhgt'hc
]bWi XY'Ug'Yj ]XYbW' hc'gi ddcfhmci f'Y! hy'bg]cb'Udd']WUh]cb"'=Zmci 'Ya U]''9! hy'fbU''Gi ddcfhmci 'k ]'`
Ui hca Uh]WJ'`mfYW']j Y'U'h]W\_Yhbi a VYfZ'Vi h]Zmci 'hY'Yd\cbY'mci 'k ]``bYYX'hc'gdYW]Z]WJ'`mUg\_'Zcf'cbY''
Hi fb]h]b'U'gc'dfcj ]XYg'i dXUhy'g'cb'h\Y]f'gmghYa 'ghUh' g'cb'Hk]hyf''

; YbYfU`mž'UggYgga YbhiHug\_g'a i ghVY'gi Va ]hhYX'Y`YVWfcb]\WJ``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`hYfbUh]j 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