



# MECH9325

: i bXUa YbHJ`g`cZ5Wt i gh]Wg/ `B c]gY

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

GWcc`cZA YWUbjWU`UbX`A Ubi ZUWf]b[ `9b[ ]bYYf]b[ `..##`I BGK `9b[ ]bYYf]b[ ]

7ci fgY`Cj Yfj ]Yk

GHJZZ'7cbHJW`8YHU]`g

7cbj Ybcfg

B Ua Y	9a U]	5j U]'UV]'m	@cWU]cb	D\cbY
B ]W`Y`?Ygg]ggc[ `ci	b"_Ygg]ggc[ `ci 4 i bgk "YXi "Ui	HYUa g	F cca `(\$, ; ž @Yj Y` (ž 5]bgk cfl Vi ]X]b[ `>%+	

8Ya cbghfU]c fg

B Ua Y	9a U]	5j U]'UV]'m	@cWU]cb	D\cbY
7 ]U]'@]b	W]_U]" ]b4 i bgk "YXi "Ui			
F ca Ub`? ]g`Yf	f"_]g`Yf4 i bgk "YXi "Ui			
; m]b]G\Ub_Uf G\Ufa U	[ m]b]g\Ub_Uf" g\Ufa U4 i bgk "YX i "Ui			
>YZFYmDYb[	YZFYm'dYb[ 4 i bgk "YXi "Ui			

GWXcc`7cbHJW`bZcfa U]h]cb

@cWU]cb

I BGK `A YWUb]WU`UbX`A Ubi ZJW` f]b[ `9b[ ]bYYf]b[

5]bgk cfl `Vi ]X]b[ `>%+ž@Y] Y`%

5Vcj Y`7cZY`cb`7Ua di g

<ci fg

-.\$\$-).\$\$da žA cbXUm±: f]XUm†

†7`cgYX`cb`di V`]W\c`]XUmžGWXcc`gWYXi `YX`Yj Ybfg`UbX`I b]j Yfg]mG\i hXck b

K YV

GWX [Cc`Za`YX`Ub\]WU`UbX`A Ubi ZJW` f\]b\[ `9b\[ \]bYYf\]b\[](#)

[9b\[ \]bYYf\]b\[ `Gh XYbhGi ddcfhGYfj \]Wg](#)

[9b\[ \]bYYf\]b\[ `bXi gflU`HfU\]b\]b\[](#)

[I BGK `Gh Xm5VfcUX`UbX`9I WU\]b\]Y](#)

fZ \*%&L-' , ) ; ) \$\$-Bi WYi g'Gh XYbh<i V

fZ \*%&L-' , ) '+\*\*%-9b[ ]bYYf]b[ 'Xh ghf]U'HfU]b]b[

fZ \*%&L-' , ) " %+ -'I BGK 'Gh Xm5VfcUX'UbX'I BGK '9I WUb[ Y'fZcf']bVci bX'gh XYbhgk

fZ \*%&L-' , ) '( \$- +'-GVWcc`C ZWYf



H\]g'Wci fgY'k ]''dfcj ]XY'Uk UfYbYgg'cZbc]gY'UbX']hg' [ YbYfUHcb" H\]g'Wci fgY' ]g'U'gc ]bhYbXYX'hc' [ ]j Y'mci  
hY'g\_]`g'hc'a YYh'hY'bYYXg'cZhcY'Ya VUf\_]b[ 'cb'U'WUfYf' ]b'UWci gh]Wg" H\Y'`YWfi fY'a UHf]U'zh hc f]U'  
YI YfW]gYg'UbX'U'j Uf]YhmcZUggYgga YbhUW]j ]hYg'k ]''VY' [ ]j Yb" :bj ]hYX' ]bXi gHfmUWci gh]WWcbgi 'hUbg'k ]`  
[ ]j Y' [ i Ygh`YWfi fYg'hc'XYa cbghUfY' hY'fY'Yj UbW'cZUWci gh]Wg'UbX'bc]gY' ]b'U'fUb[ Y'cZUdd']W]hcbg"


GhUfhXUHy. Bch5dd`WUVY

@Yb[ h. F YZf'hc'hY\UbXci hZcfYUWX`UV"

8YhU]`g.

fUe@UV`%k j`Wca dUFY`X]ZYfYbhXYgW]drcfg`Zcf`ja Y`j Ufm]b[ `bc]gY"@UV`&k j`WU`W`UH`hY`gci bX`dck Yf`Yj`Y`g`cZU`gci bX`gci fW`Zca`gci bX`dfYggi fY`Yj`Y`a YUgi fYa Ybhtg"

fV`E`H\YfY`UfY`tk`c`UVg"

fW`E`H\Y`UVg`UfY`hc`VY`WcbXi`WYX`]bX]j`]Xi`U`m`

fX`E`5`a`Uf\_]b[ `fi`Vf]Wk`j`VY`dfcj`]XYX`Zcf`YUWX`UV"

fY`E`H\Y`XYUX`]bY`Zcf`UVgc`i`hY`Z]`j`g`cbY`k`YY`\_`UZf`hY`Xi`Y`XUH`Zcf`YUWX`UV"

fZ`E`A`Uf\_g`Zcf`YUWX`UV`k`j`VY`fYh`fbYX`k`]h`b`&k`YY`\_g`cZ`hY`Xi`Y`XUH`"

Hk`c`UVg`k`j`VY`[`j`Yb`]b`h`g`Wci`fgY`"9UWX`UV`]g`k`cfh`%\$i`"@UV`%]g`Xi`Y`Hi`YgXUm&-`>i`bY`)`da`"@UV`&]g`Xi`Y`Hi`YgXUm&\$`>i`m)`da`"

Gi Va ]gg]cb`bchYg. j`]U`A`ccXY

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`bchgY`Y`Hi`fb`]h`b`g]a`]Uf]mifYdcfhtg"

5ggYgga`Ybh`.5gg][`ba`Ybh

GhUfhXUHy. Bch5dd`WUVY

8YhU]`g.

fU`E`H\Y`Ugg][`ba`Ybh]g`hY`bi`a`Yf]WU`XYg][`b`cZU`gcb]WVfmg]U`bc]gY`VUff]Yf`"

fV`E`H\Y`UggYgga`Ybh`Ug`tk`c`dUfhtg`5`dfY`ja`]bUfmdcghYf`k`cfh`)`i`]g`Xi`Y`]b`k`YY`\_`+`"H\Y`Z]bU`dcghYf`k`cfh`%)`i`]g`Xi`Y`k`YY`\_%\$"

fW`E`H\Y`Ugg][`ba`Ybh]g`Ub`]bX]j`]Xi`U`UggYgga`Ybh`

fX`E`5`a`Uf\_]b[ `fi`Vf]Wk`j`VY`dfcj`]XYX`Zcf`hY`Ugg][`ba`Ybh`

fY`E`H\Y`XYUX`]bY`Zcf`UVgc`i`hY`Z]`j`g`cbY`k`YY`\_`UZf`hY`Xi`Y`XUH`Zcf`YUWX`dUfhcZ`hY`Ugg][`ba`Ybh`

fZ`E`A`Uf\_g`Zcf`hY`Ugg][`ba`Ybhk`j`VY`fYh`fbYX`k`]h`b`%k`YY`\_cZ`hY`Xi`Y`XUH`"

Gi Va ]gg]cb`bchYg. j`]U`A`ccXY

Hi`fb`]h`b`gYh]b[`.H\]g`]g`bchU`Hi`fb`]h`b`Ugg][`ba`Ybh

5ggYgga Ybh(. : ]bU`9I Ua ]bUḥcb

@Yb[ ḥ.





# F Ygci fWg

## F YWta a YbXYX`F Ygci fWg

F YWta a YbXYX`hI hg`Zcf`h`jg`Wci fgYzk` \jW`UfY`Uj Uj`UV`Y`]b`h`Y`I` BGK` `Vcc\_g\cd`Ug`k`Y``Ug`h`Y`I` BGK`  
`]VfUfmz`UfY``]ghYX`VY`ck`.

Ga`]h`z`6`">"z`DYH`fgz`F`">"`UbX`C`k`Yb`z`G`"5`Wci`gh`Wg`UbX`bc]gY`Wc`bfc`z`&bX`YX]h`cbz`5XX]gcb`K`Yg`Ym`  
@cb[ a`Ub`z`%`-`\*`"

Bcfrcb`z`A`"D`"UbX`?`UfW`i`V`z`8`":`i`bX`Ua`Yb`fU`g`c`Zbc]gY`UbX`j`]VfU]h`cb`Ub`U`mg]g`Zcf`Yb[ ]b`YY`fgz`&bX`9X]h`cbz`  
7`Ua`Vf]X[ Y`I` b]j`Yfg]m`D`f`Y`ggz`7`Ua`Vf]X[ Y`z`&`\$`\$`"`"

6]Yg`z`8`"5`"UbX`<`Ub`g`Yb`7`"(">"9b[ ]b`YY`f]b[ `]B`c]gY`7`cb`f`c`:`H`Y`c`f`m`UbX`D`f`U`W`]W`z`'`f`X`9X]h`cbz`9/`:`B`G`d`c`b`z`  
&`\$`\$`"`"

I`g`Y`Z` ``]b`\_`g`.

I`BGK` `@]VfUfmk`YVg]hY`.[`\]h`d`g`.#`k`k`k`"``\]VfUfm`i`b`gk`"Y`X`i`"U`i`#`](#)

A`cc`X`Y`.[`\]h`d`g`.#`a`cc`X`Y`"h`Y`h`i`b`gk`"Y`X`i`"U`i`#`c\[ \]b`#`b`X`Y`I`"d`d`](#)

H`Y`U`a`g`:

[`\]h`d`g`.#`Y`U`a`g`"a`\]W`c`g`c`z`h`W`c`a`#`#`Y`U`a`#`%`i`'`U`\\$`+`%`&`Z`U`\\$`\\$`W`X`\('`Y`+`,`\\$`\)`Z`\\*`Z`W`Y`%`\\$`-`Z`/`Z`\(``\\$`h`f`Y`U`X`"h`U`W`&`#`W`c`b`j`Y`f`g`U`h`  
\]c`b`g`3\[`f`c`i`d`-`X`1`\(``,`+`Y`\(``Z`%`d`Y`+`\\$`Y`!`\(``,`-`!`-`-`V`%`\(``\\$`V`%`+`V`\(``Z`V`/`h`Y`b`U`b`h`X`1`'`Z`\\*`W`U`\(``I`Y`+`%`\)!`\(``,`X`V`I`  
V`,`Y`%`\\$`,`\\*`+`V`-`Z`Z`U`'](#)

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

:`Y`Y`X`V`U`W`\_`c`b`h`Y`W`c`i`f`g`Y`]g`[`U`h`Y`f`Y`X`d`Y`f]c`X]W`U`mi`g]b[ ]j`U`f]c`i`g`a`Y`U`b`g`z`]b`W`i`X]b[ `h`Y`I`BGK`  
a`m`9]d`Y`f]Y`b`W`d`f`c`W`g`g`z`]b`z`c`f`a`U`X]g`W`g`g]c`b`]b`W`U`g`g`z`U`b`X`U`h`h`Y`G`W`c`c`gh`X`Y`b`h`g`h`U`Z`a`Y`Y`h`b[ g`"M`c`i`f`  
Z`Y`X`V`U`W`\_`]g`h`U`\_`Y`b`g`Y`f]c`i`g`m`7`c`b`h]b`i`U`]a`d`f`c]Y`a`Y`b`h`g`U`f`Y`a`U`X`Y`h`c`h`Y`W`c`i`f`g`Y`V`U`g`Y`X`z`]b`d`U`f`h`z`c`b`m`c`i`f`  
Z`Y`X`V`U`W`\_`"

Gi Va ]gg]cb'cZ5ggYgga YbhiHUg\_g

5ggYgga Ybhigi Va ]gg]cb'UbX'a Uf\_]b[ 'Wf]hYf]U

G\ci 'X'h\Y'Wci fgY'\Uj Y'Ubmbcb!Y'YVWfcb]WUggYgga Ybhigi Va ]gg]cbž'h\YgY'g\ci 'X'\Uj Y'U'ghUbxUfX  
GWkcc'Wcj Yf'g\YYH'

5`gi Va ]gg]cbg'UfY'YI dYWYX'hc'VY'bYUhiUbX'WYUfmgYhici H'Mci f'fYgi 'hg'UfY'h\Y'd]bbUWY'cZU`mci f'\UfX  
k cf\_'UbX'g\ci 'X'VY'hYUhiX'k ]h'Xi Y'fYgdYWf'DfYgYbh]b[ 'fYgi 'hg'WYUfmi[ ]j Yg'h\Y'a Uf\_Yf'h\Y'VYghWUbxWY  
cZi bXYfgtUbx]b[ 'mci f'a Yh\cX/Yj Yb']Zh\Y'bi a Yf]WU'fYgi 'hg'UfY']bVc'ffYWf'

A Uf\_]b[ '[ i ]XY']bYg'Zcf'Ugg][ ba Ybhigi Va ]gg]cbg'k ]`VY'dfcj ]XYX'Uhih\Y'gUa Y'h]a Y'Ug'Ugg][ ba YbhXYH]g  
hc'Ugg]ghk ]h'a YH]b[ 'UggYggUV'Y'fYei ]fYa Ybhg" Gi Va ]gg]cbg'k ]`VY'a Uf\_YX'UWVc'fX]b[ 'hc'h\Y'a Uf\_]b[  
[ i ]XY']bYg'dfcj ]XYX"

@UHY'dc`]Wm

K cf\_gi Va ]hYX'`UHY'k ]h\ci hUb'Uddfcj YX'YI hYbg]cb'Vmih\Y'Wci fgY'Wc'fX]bUhc'f'cf'XY'Y[ UHYX'Ui h\cf]hm]g  
gi VYWihc'U'`UHY'dYbU'micZ&\$'dYfW'bhf&\$i 'E'cZ'h\Y'a U] ]a i a 'a Uf\_'dcgg]V'Y'Zcf'hUhiUggYgga Ybh]hYa ž  
dYf'WU'YbXUf'XUm'

H\Y'`UHY'dYbU'mi]g'Udd'YX'dYf'WU'YbXUf'XUmif]bWi X]b[ 'k YY\_YbXg'UbX'di V]W\c'XUmgE'hUhih\Y  
UggYgga Ybh]g'c] YfXi Y'"H\YfY'g]bc'dfc!fUfU'cZ'h\Y'`UHY'dYbU'miZcf'gi Va ]gg]cbg'a UXY'dUfhk Umih\ci [ '\U  
XUm'

K cf\_gi Va ]hYX'UZfY'h\Y'XYUX']bY'Zcf'UVgc'i hY'ZU]' ]g'bchUWVW'dhYX'UbX'U'a Uf\_'cZnYfc'k ]`VY'Uk UfXYX  
Zcf'hUhiUggYgga Ybh]hYa "

: cf'gca Y'UggYgga Ybh]hYa gžU'`UHY'dYbU'mia UmibchVY'Uddfcdf]UHY'"H\YgY'UfY'WYUfmi]bX]WUhiX'']b'h\Y  
Wci fgY'ci h]bYž'UbX'gi W'UggYgga Ybhg'fYW'j Y'U'a Uf\_'cZnYfc']ZbchWca d'YhX'Vmih\Y'gdYW]ZYX'XUHY"  
9I Ua d'Yg']bWi XY.

% K YY\_'micb']bY'hYghg'cf'UVcfUhc'fmik cf\_'k cffh'U'ga U`dfc'dcf]cb'cZ'h\Y'gi VYW'ia Uf\_ž'cf  
&" C b']bY'ei ]nnYg'k \YfY'Ubgk Yfg'UfY'fY'YUgYX'hc'gfi XYbhg'cb'Wca d'Yh]cbž'cf  
' " DfcZYgg]cbU'UggYgga YbhHUg\_gžk \YfY'h\Y']bhYbh]cb ]g'hc'WYUHY'Ub'Ui h\Ybh]WUggYgga Ybh'hU  
\Ug'Ub'UVgc'i hY'gi Va ]gg]cb'XUHYž'cf  
(" DUgg# U]'UggYgga YbhHUg\_g"

9I Ua ]bUH]cbg

UggYgga YbhdYfZcfa UbWžmci 'UfY'Y'[ ]V'Y'hc'Udd'mZcf'GdYWU'7 cbg]XYfUhc'b'df]cf'hc'gi Va ]h]b[ 'Ub  
UggYgga Ybhcf'g]h]b[ 'Ub'YI Ua "

I BGK 'bck '\Ug'U': [\]h\]c'G\]h#Gi Va \]hfi\\_Yžk \\]](#)W'a YUbg'hUh]Zmci 'UfY'a dhUb'YI Ua 'cf'gi Va ]hU'd]YW'cZ  
UggYgga Ybhž'mci 'UfY'XYWUf]b[ 'mci fgY'Z]hYbci [ \ 'hc'Xc'gc'UbX'WUbbch'UfY'Udd'mZcf'GdYWU'  
7 cbg]XYfUhc'b"

: cf'XYfU]g'cZUdd'm]b[ 'Zcf'GdYWU'7 cbg]XYfUhc'b'UbX'WcbX]h]cbg'Zcf'hY'Uk UfX'cZgi dd'Ya YbhUfm  
UggYgga Ybhž'd'YUg'gY'Y'hY'jbZcfa Uhc]b'cb'I BGK 'g'[GdYWU'7 cbg\]XYfUhc'b'dU\]Y"](#)

D'YUgY'bc'hY'hUhghi XYbhg'k ]'bchVY'fYei ]fYX'hc'dfcj ]XY'UbmXcW a YbhUfmYj ]XYbW'hc  
gi ddcfhUVgYbW'g'Zca 'UbmWUggYg'a ]ggYX'VYWU]i gY'cZ7CJ -8!%- 'di V']W\YU'h'a YUgi fYg'gi W'Ug  
]gc'Uh]cb" I BGK 'k ]'bchVY' ]bg]gh]b[ 'cb'a YX]W'Wf]h]WUhg'Zca 'UbmcbY'XYa YX'hc'VY'U'dcg]h]Y'WUgYž  
cf'k \Yb'hYm\Uj Y'fYVčj YfYX" 'Gi W'Wf]h]WUhg'UfY'X]Z]W'h'hc'cVh]b'UbX'di hUb'i bbYW'ggUfmgfU]b'cb  
gh XYbhg'UbX'a YX]W'ghUZZ'

5dd']W]h]cbg'Zcf'gdYWU'Wcbg]XYfUhc'b'k ]'VY'fYei ]fYX'Zcf'UggYgga YbhUbX'dUfh]W]dUhc'b'UVgYbW'g'—  
Vi hbc'XcW a YbhUfmYj ]XYbW'Zcf'7CJ -8 %- ]'bYgg'cf']gc'Uh]cb'k ]'VY'fYei ]fYX"

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

I BGK `Ug`Ub`cb[ c]b[ `Wca a ]ha Ybhlc`ZcghYf]b[ `U`W`hi fY`cZ`YUfb]b[ `]bZcfa YX`VmiUWUXYa ]W]bhY[ f]mi`5`  
I BGK `gh`XYbthg`Uj`Y`U`fYgdcbg]V`]hmlc`UX`YfY`hc`h`g`df]bW]d`Y`cZUWUXYa ]W]bhY[ f]mi`D`U[ ]Uf]ga  
i bXYfa ]bYg`UWUXYa ]W]bhY[ f]miUbX`]g`bchlc`YfUHX`Uhl`BGK`"B`SY[Sde\_`SfG@E|`[e VWX` VW`Se ge[`Y`  
fZWi`ad/e`ad[VWSe`aXafZWde`S`V`bSee[`Y`fZW\_`aXSe`kagdai``ž

D`U[ ]Uf]ga` ]g`U`hmdY`cZ]bhY`YWfi`U`h`YZh`#`hW]b`hU`\_Y`a`UbmiZcfa`gž`Zca`XY`]VYfUHX`WX`YU]b[ `hc`UWUXYbH`m`  
Wc`dm]b[ `Zca`U`gci`fW`k`]h`ci`hUW`bck`YX[`Ya`Ybh`I`BGK` `Ug`dfcXi`WX`U`k`YVg]h`k`]h`U`k`YU`h`cZ`  
fYgci`fW`g`hc`gi`ddcfhgh`XYbthg`hc`i`bXYfgHbX`UbX`Uj`c]X`d`U[ ]Uf]ga`ž` ]g]h`[gh`XYbth`i`bgk`"YXi`"Ui`#`d`U\[ \]Uf\]ga`"](#)  
H`Y`@YUfb]b[ `7`YbhY`Ugg]gh`gh`XYbthg`k`]h`i`bXYfgHbX]b[ `UWUXYa ]W]bhY[ f]miUbX`ck`bchlc`d`U[ ]Uf]gY`  
H`Y`miU`gc`lc`X`k`cf`g`cdg`UbX`W]b`Y`d`gh`XYbthg`cbY!cb!cbY"

Mci`U`fY`U`gc`fYa`]bXYX`h`UhWfYZ`h`ja`Y`a`UbU[`Ya`Ybh]g`Ub`ja`dcfHbhdUfhcZgh`XmiUbX`cbY`cZ`h`Y`  
]XYbh]Z`YX`W]i`gYg`cZ`d`U[ ]Uf]ga` ]g`d`ccf`h`ja`Y`a`UbU[`Ya`Ybh`G`h`XYbthg`g`lci`X`U`ck`gi`Z`W]Ybh]h`ja`Y`Z`c`f`  
fYgYUfW`ž`X`fU`Z]b[ `UbX`h`Y`dfcdYf`fY`Z`fY`bW]b[ `cZ`gci`fW`g`]b`dfY`dUf]b[ `U`UggYgga`Ybh]Ug`g"

ž`d`U[ ]Uf]ga` ]g`Zci`bX`]b`mci`f`k`cf`\_`k`Y`b`mci`U`fY`]b`Z`fghmY`Ufž`mci`f`Y`Wfi`fY`f`k`]`c`Z`Y`f`mci`Ugg]ghU`bW`hc`  
]a`dfcj`Y`mci`f`UWUXYa ]Wg\_]`g`"H`Y`mia`UmUg`\_`mci`hc`cc`\_`Uhgca`Y`cb`]bY`fYgci`fW`gž`U`h`Y`bX`h`Y`@YUfb]b[`  
7`YbhY`ž`cf`gca`Y`h`ja`Yg`fYgi`Va`]h`mci`f`k`cf`\_`k`]h`h`Y`dfcV`Ya`Z]`YX`"<ck`Yj`Yf`a`cfY`gYf]ci`g`]bgHbW`g`]b`Z`fgh`  
mY`Ufž`gi`W`Ug`gh`U`]b[ `Ubch`Y`f`gh`XYbthg`k`cf`\_`cf`dUm]b[ `gca`YcbY`hc`Xc`mci`f`k`cf`\_`ž`a`UmVY`]bj`Ygh[`U`h`X`hUg`g"

5 WUXYa ]W=Zcfa Uh]cb

7 fYX]hdc]bhg

7 ci fgY`WYX]hg`W`W`UH`X`]b`I` b]hg!C Z 7 fYX]hfl C 7 E`H`Y`bcfa U`k cf`cUX`YI dYWUh]cb`Zf`cbY`I C 7

- [AccXY](#)
- [@UV5WYgg](#)
- [7ca di hb\[ : UW\]hYg](#)
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