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

PTRL5019

: i bXUa YbHJ`g`cZF YgYfj c]f`9b[]bYYf]b[[·]5

7ci fgY[·]Cj Yfj]Yk

GHJZZ7cbHJWh78YHJ]`g

7 cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]m	@cWUhjcb	D∖cbY
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Π

7ci fgY[·]8YHJ]`g

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Gi a a UfmcZh\Y'7 ci fgY

: i bXUa YbłUʻgʻcZFYgYfj c]fʻ9b[]bYYf]b["'FYgYfj c]fʻ8YgWf]dh]cb"'<mXfcgHUh]WdfYggi fYʻUbX`[Ych\Yfa U` [fUX]Ybhg" Dcfcg]hmidYfa YUV]`]hmfY`Uh]cbg\]dgʻUbX`fcW_'a]WfcgHfi Wfi fYg"'J c`i a Yhf]WUbX`]b]h]U` \mXfcWUfVcb'j c`i a Y"': `i]X`GHUh]Wg": `i]X`Zck gž`Ua]bUf`UbX`h fVi `YbhZck g"`6ci bXUfm`UmYfg":: `ck `]b d]dYgž'Zf]Wf]cb']b'd]dYž'9i `Yf`UbX`6Yfbci ``]fg`Yei Uh]cb" 5b[i `Uf`a ca Ybhi a `Yei Uh]cb"`GhYUXmZck `YbYf[m Yei Uh]cb"A]bcf``cggYg":: `ck `cj Yf`gi fZJVWg"`GhYUXmgfUhY`]bW]bYX`Zck `UbX`dfYggi fY`dchYbh]U`"GhYUXm ghUhY`fUX]U``Zck ":: `ck `]b`gYf]Yg`UbX`]b'dUfU`Y`"'J Yfh]WU`k Y``a cXY``UbX`g_]b`YZYWf

7 ci fgY 5]a g

H\Y'U]a 'cZh\]g'Wci fgY']g'hc'[]j Y'gh XYbhUb']bg][\h]b'hc'dYhfc`Yi a 'fYgYfj c]fg/hc']bhfcXi WY'gh XYbhhc]a dcfhUbhfcW_'UbX'Zi]X'W\UfUWfYf]gh]Wg/UbX'hc'Ugg]ghgh XYbhhc'Ubgk Yf'_Ymei Ygh]cbg'hc'fYgYfj c]f Yb[]bYYfg"'H\Y'Wci fgY'U`gc'U]a g'hc'XYj Y`cd'Z bXUa YbhU``fYgYUfW\'g_]``g'Zcf'dcgh[fUXi UhY'Wci fgYk cf_ gh XYbhg']b'DYhfc`Yi a '9b[]bYYf]b["

7cifgY`@YUfb]b[`CiHWcaYg

- %" 5dd`miZ bXUa YbHJ``H\Ycf]Yg`UbX`WcbWYdhg`hc`gc`j Y`a UbmifYgYfj c]f`Yb[]bYYf]b[`dfcV`Ya gžY"["]b]h]U``\mXfcWUfVcb`]b`d`UVY`ž`VUg]WfcW_`UbX`Zi]X`dfcdYfh]Ygž`\mXfcgHJh]WdfYggi fY`X]gHf]Vi h]cbž k UhYf`]bZi I `UbX`g]b[`Y`d\UgY`Zi]X`Zck "`
- &" 7 f]h]WU``mUbU`mgY`h\Y`i bXYf`m]b[`h\Ycf]YgžWcbWYdhgžUggi a dh]cbg`UbX`Uf[i a Ybhg`WcbWYfb]b[`Zi]X Zck `i bXYf`X]ZYfYbhfYgYfj c]f`WcbX]h]cbg"
- ' " 8 Yj Y`cd`fYgYUfW\`UbX`Wcaaib]WUh]cb`g_]``g`UbX`glfUhY[]Yg`h\Uhk ci`X`giddcfhih\Y`F YgYUfW\ Dfc^YWiWcadcbYbhcZh\Y`dfc[fUa"

HYUWX]b[GhfUhY[]Yg

H\Y'HYUWX]b[''UddfcUWX'hc'YYYa d`cmYX'k]```]bj c`j Y``YWi fYg'UbX'hi hcf]U`g'''@YWi fY'dfYgYbHJHjcbg'Wcj Yf h\YcfYHJWD``UbX'dfUWfJWU``UgdYWfgž'k \]W\'UfY'U`gc'XYgWf]VYX']b'h\Y'gi ddcfh]b[''UWUXYa]WHYI hg'UbX HYUWX]b[''fYgci fWfg''5'gYf]Yg'cZ]b!WUgg'YI YfWjgYg'k]```VY'Ya d`cmYX'hc'fY]bZcfWf'UbX'Vi]`X'i dcb'h\Y WcbWfdhg']bhfcXi WfX'Xi f]b[''h\Y''YWi fYg'''Nci 'UfY'YbWci fU['YX'hc'Ug_'ei Ygh]cbg'UbX'YI dfYgg'ZYYXVUW_ Xi f]b[''WUggYg'''Nci 'UfY'YI dYWfX'hc'fYUX'dfYgWf]VYX'a UhYf]U`g']b'UXj UbWf'cZWUggYg'hc'YbUV'Y'UWf] Y

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8YHJ]`g.

5 fYgYUfW\'dfcYWficb'gYjYfU`'hcd]Wg'gi [[YghYX'hc'ghiXYbhg'Zc``ckYX'VmcfU``dfYgYbhUh]cb"'H\Y'g`]XYg bYYX'hc'VY'Ya U]`YX'hc'dYmaUb4 i bgk "YXi "Ui 'Vmh\Y'XiY'XUhY''

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GhufhiXuhy.Bchi5dd`]WUV`Y

8YHJ]`g.5gg][ba Ybhg

FYgci fWg

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GiddcfhaUhYf]U`Zcf'h\]g`WcifgY`]bWiX]b[Zk\YbYjYf`UjU]`UV`YžWcd]Yg`cZ`YWifY`bchYgžfYWcaaYbXYX fYUX]b[gžYhW`WUb`VY`ZcibX`cb'AccX`Y"

H\Y`YWMifY`bchY`aUmVY`j]YkYX`UbX`Xckb`cUXYX`Zfca`h\Y`IBGK!AccX`Y` \hnd.##accX`Y`hY`h'ibgk"YXi"Ui#

FYWca a YbXYX⁻FYgci fWYg

: c``ck]b[g'UfY 'h\Y 'fYWVca YbXYX 'Vcc_g'Zcf'h\]g'Wci fgY"

• 8g`VS_WfS'e aXDWeWcha[d7`Y[`WWd[`Yž'8U_Y'f%+, Ł"

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

H\Y'GW\cc``\Ug'XYjY`cdYX'U'[i]XY`]bY'hc'\Y`d'mci'k\Yb'giVa]hhjb['U'WcifgY'Ugg][baYbh'

K Y`YbWcifU[Y`mci`hc`fYHU]b`U`WcdmcZYjYfmUgg][baYbhgiVa]HYX`Zcf`UggYggaYbhZcf`mcif`ckb`fYWcfX Y]h\Yf`]b`\UfXWcdmcf`Y`YWffcb]WZcfa"

5```UggYgga Ybhg`a i gh\Uj Y`Ub`UggYgga YbhWcj Yf`g\YYhUhUV&YX"

7cifgY'Wcad`Yh]cb

7 ci fgY Wea d`Yh]cb`fYei]fYg`gi Va]gg]cb`cZU```UggYgga Ybh`]hYa g"`: U]`i fY`hc`gi Va]hU```UggYgga Ybh`]hYa g a UmfYgi `h`]b`h\Y`Uk UfX`cZUb`I bgUh]gZUWcfm: U]`i fY`fI : Ł`[fUXY`Zcf`h\Y`7 ci fgY`i b`Ygg`gdYW]U` Webg]XYfUh]cb`\Ug`VYYb`gi Va]hhYX`UbX`Uddfcj YX"`D`YUgY`bchYž`U`Wea dYhYbWm\i fX`Y`cZ) \$i ``]g`Udd`]YX`hc h\Y`Z]bU``UggYgga Ybh'

@UhY Gi Va]gg]cb cZUb 5gg][ba Ybh

: i ```a Uf_g`Zcf`Ub`Ugg][ba YbhUfY`cb`mdcgg]V`Y`k \Yb`Ub`Ugg][ba Ybh`]g`fYWY]j YX`Vmh\Y`Xi Y`XUhY''`

K Y'i bXYfgHUbX'h\Uh'Uh'h]a Yg'mci 'a Umbch'VY'UV'Y'hc'gi Va]h'Ub'Ugg][ba Ybh'cb'h]a Yž'UbX'h\Y'GV\\cc``k]`` UVW&a a cXUhY'UbmZU]f'UbX'fYUgcbUV'Y'YI hYbg]cb"'K Y'k ci `X'fYV&a a YbX'mci 'fYj]Yk 'h\Y'I BGK 'GdYVJU` 7 cbg]XYfUh]cb'[i]XY`]bYg'-'gYY'gYWf]cb'VY'ck "

@UhY`gi Va]gg]cb`k]```bchVY`UVWYdhYX`UbX`k]```VY`Wcbg]XYfYX`Ug`bc`gi Va]gg]cb"

GdYWJU``7cbg]XYfUh]cb

- DfYj Ybhimci Zfca 'Wca d'Yhjb['U'Wci fgY'fYei]fYa Ybh
- ? YYd mci 'Zfca 'UHYbX]b['Ub'UggYggUV'Y'UWf]j]m
- Ghcdimci igi Va]hh]b[iUggYggUVYkcf_ZcfUWci fgY
- G][b]ZWUbhmUZYWhinci f`dYfZcfa UbW']b`UggYggUV`Y`k cf_žVY`]hU`Zcfa U``YbX!cZgYa YghYf YI Ua]bUh]cbž'U`WUgg`hYghž'U``UVcfUhcfmhYghž'U`gYa]bUf`dfYgYbhUh]cb`cf`Ubmch\Yf`Zcfa `cZ UggYgga Ybh

K Y`Ug_`h\Uhimci `d`YUgY`WcbhUWih\Y`7 ci fgY`7 cbj Ybcf`]a a YX]UhY`mcbWY`mci `\Uj Y`Wca d`YhYX`h\Y`gdYW]U` Wcbg]XYfUh]cb`Udd`]WUh]cbžbc``UhYf`h\Ub`cbY`k YY_`Zca `gi Va]gg]cb"

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- | BGK `@YUfb]b[`7YblfY`!`<u>k k k "`\\ii bgk "YXi "Ui</u>
- 7 ci bgY``]b['gi ddcfh! '<u>k k k "Wci bgY``]b["i bgk "YXi "Ui</u>

9ei]HUV`Y`@YUfb]b[`GYfj]VW`g`U]a g`hc`dfcj]XY`U```gh`XYbhg`k]h\`U`ZYY`UbX`WcbZ]XYbh]U``gYfj]VW`h\Uh dfcj]XYg`dfUWh]WU``gi ddcfhhc`Ybgi fY`h\Uhmci f`\YU`h\`WcbX]h]cb`XcYgbfhiUXjYfgY`mUZZYWhmci f`gh`X]Yg''` \hhdg.##gh`XYbh'i bgk "YXi "Ui #Y`g

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

Mci f``YWi fYf`UbX'h\Y'I b]j Yfg]mik]``YI dYWinci f`gi Va]hYX'Ugg][ba Ybhg`UfY'hfi `minci f`ck b`k cf_''I BGK \Ug`j YfmWYUf`[i]XY`]bYg`cb`k \Uhd`U[]Uf]ga `]g`UbX`\ck `hc`Uj c]X`]h'`D`U[]Uf]ga `]g`i g]b[`h\Y'k cfXg`cf]XYUg`cZch\Yfg`UbX'dfYgYbh]b[`h\Ya `Ug`nci f`ck b''D`U[]Uf]ga `]g`U`mdY`cZ]bhY``YWi U``h\YZh'' #iWUb`hU_Y a UbmZcfa gž'Zīca `XY`]VYfUhY`W\YUh]b[`hc`UVW]XYbhU``mWcdm]b[`Zīca `U`gci fWY`k]h\ci hUW_bck `YX[Ya Ybh' H\Y'I b]j Yfg]mi\Ug`UXcdhYX`Ub`YXi WUh]j Y`UddfcUV\'hc`d`U[]Uf]ga `UbX`\Ug`XYj Y`cdYX`U`fUb[Y`cZ fYgci fWYg`hc`gi ddcfhigh XYbhg''5```h\Y`XYhU]`g`cb`d`U[]Uf]ga ž`]bWi X]b[`gca Y`i gYZ ``fYgci fWYgž'WUb`VY Zci bX`Uhi<u>k k k "gh XYbh'i bgk "YXi "Ui #d`U[]Uf]ga</u>."

5```A]b]b[''9b[]bYYf]b['gh XYbhg'UfY'fYei]fYX'hc'Wcad`YhY'U'gh XYbhXYWUfUh]cb'Zcf'UWUXYa]W]bhY[f]hm k \]WX']g'ci h]bYX']b'h\Y'Ugg][baYbhWcjYf'g\YYhg'''6mg][b]b['h\]g'XYWUfUh]cbz'mci 'U[fYY'h\Uhmcif'k cf_']g mcif'ckb'cf][]bU'`k cf_"

-Zmci 'bYYX'gca Y'UXX]h]cbU``gi ddcfrik]h 'mci f`k f]h]b['g_]``gž'd`YUgY'WcbhUWrih Y`@YUfb]b['7 YbffY`cf'j]Yk gca Y'cZh Y'fYgci fW'g'cb'h Y]f`k YVg]hY. <u>k k k "`Wi bgk "YXi "Ui</u>"''H\Y'@YUfb]b['7 YbffY`]g'XYg][bYX'hc`\Y`d mci ']a dfcj Y'mci f'UWUXYa]Wk f]h]b['UbX'Wca a i b]WUh]cb'g_]``g"'Gca Y'gh XYbg'i gY'h Y'7 YbffY`gYfj]WYg VYWUi gY'h Ym'UfY`Z]bX]b['h,Y]f'Ugg][ba Ybhg'U'W,U``Yb[Yž'ch Yfg'VYWUi gY'h Ymk Ubhhc`]a dfcj Y'Ub'U'fYUXm gi WWYggZ ``UWUXYa]WdYfZcfa UbWY''

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7 ci fgY FYgi `hg

: cf^{*}XYHJ]`gʻcbʻI BGK ^{*}UggYgga Ybhdc`]Whž'd`YUgY`j]g]h<u>'k k k "gh XYbh'i bgk "YXi "Ui #UggYgga Ybh</u>

=ðigca Yi]bgHJbWYgimci fiZ]bU``Wci fgYifYgi `ha UmVYik]H\\Y`X`UbX`bchfY`YUgYX`cbiH\Y`I_BGK_id`UbbYX`XUHY" H\]gi]gi]bX]WJHYX`VmU`Wci fgYi[_fUXYifYgi `hicZY]H\Yf.

- @9'-']bX]WUhYg'mci '\Uj Y'bchWca d'YhYX'cbY'cf'a cfY']hYa g'cZUggYgga Ybh/cf
- K 8 --]bX]WUhYg'h\YfY']g'Ub']ggi Y'k]h\ cbY cf'a cfY Ugg][ba Ybh/cf
- K 7 '--'k \]WX ']bX]WUHYg mci '\Uj Y 'Udd`]YX 'Zcf'GdYW]U` '7 cbg]XYfUH]cb'Xi Y 'hc']` bYgg'cf'a]gUXj YbH fY UbX 'h\Y Wci fgY'fYgi 'hg'\Uj Y 'bchVYYb 'Z]bU`]gYX"

⊕ Y]h Yf Yj Ybh]hk ci X'VY mci f fYgdcbg]V]]mhc WebhUWhAY 7 ci fgY 7 cbj YbYf Ug gccb Ug dfUWŋWUYY Vi h bc ``UhYf h Ub Zj Y f) EXUmg UZhYf fY YUgY cZh Y Wei fgY fYgi `h' Zmci `Xcb'h WebhUWhAY Webj YbYf cb h]a Yž mci `a UmVY fYei]fYX hc fY!gi Va]hUb Ugg][ba Ybhcf fY!g]hh Y ZjbU`YI Ua `UbX`a UmfYgi `h`]b mci `ZJ]`]b[`h Y Wei fgY" Mci `k ci `X`U`gc`\Uj Y`U`B 7 fWei fgY bchWea d`YhYXE'a Uf_cb mci f`hfUbgWf]dhUbX`k ci `X`bYYX hc fY! Ybfc```]b h Y Wei fgY"

Ghi Xm]b['U'Wci fgY']b'h\Y'GW\cc``cZA]bYfU`g'UbX'9bYf[mFYgci fWfg 9b[]bYYf]b['Uh'I BGK

FYdcfhkf]h]b[[i]XY

H\Y`GW&cc``\Ug`U`<u>FYdcfhK_f]hb[`; i]XY`fFK; Ł</u>`Uj U]`UV`Y"`5`WcdmcZh\]g`]g`Uj U]`UV`Y`cb`h\Y`Wci fgY A ccX`Y`g]hY"

7ca di hjb[FYgci fWrg UbX + bhrfbYh5WWrgg FYei]fYa Ybhg

I BGK 'A]bYfU`gʻUbX`9bYf[mF Ygci fWYgʻ9b[]bYYf]b['dfcj]XYgʻV`YbXYX``YUfb]b['i g]b['h\Y`cb!`]bY`A ccX`Y @A G`f@YUfb]b['A UbU[Ya YbhGmghYa Ł"`5`gc`gYY`! 'HfUbg]h]cb]b['hc`Cb`]bY @YUfb]b[...<u>'k k k "Wcj]X%-ghi Xmcb`]bY"i bgk "YXi "Ui</u>

+i]g'YggYbh]U``h\Uhmci `\Uj Y`UVWYgg'hc`U`D7`cf`bchYVcc_`Wa di hYf"A cV]`Y`XYj]WYg'gi W`Ug'ga Ufhid\cbYg UbX`HUV`Yhg'a UmWca d`]a Ybh`YUfb]b[ž`Vi hUVWYgg'hc`U`D7`cf`bchYVcc_`Wca di hYf"]g'U`gc`fYei]fYX"`BchY h\Uhigca Y`gdYW]U`]ghYb[]bYYf]b[`gcZhk UfY`]g`bchUj U]`UV`Y`Zcf`A UWWca di hYfg"

- A]b]b['9b[]bYYf]b['Ghi XYbhg. 'CA 6'; (,
- DYhfc`Yi a '9b[]bYYf]b['Ghi XYbhg. H9H6'@, '('/'@, '')

⊨fi]gʻfYWca a YbXYXʻh\Uhimci `\Uj YʻfY[i `Uf`]bhYfbYhUWWYggʻhcʻdUfh]W]dUhY`]bʻZcfi a `X]gW gg]cbʻUbXʻ[fci d k cf_"`Hc`fi bʻA ccX`Y`a cghYZZYWfj Y`mžmci `g\ci `X`\Uj Y.

5W_bck `YX[Ya YbhcZ7ci bhfm

 $\label{eq:constraint} \begin{array}{l} K_{1}^{*}(UW_{bck}^{*})X_{1}^{*}(V,V) = K_{1}^{*}(V,V) = K_{1}$