

7ci fgY'Cj Yfj]Yk

Ghuzz 7 cbhuWh8 Yhu]`g

'7cbj Ybcfg'

B Ua Y	9a U]`	5j U]`UV]`]lm	@cWUh]cb	D\cbY
GcbmU^@]ZgWk]lm		6mYa U]` Uddc]bha Ybh	KYVghYf*%\$(-',)(,+'

GWkcc~7cbhJWh~abZcfa Uh]cb

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

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

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

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

 $\label{eq:hamiltonian} $$HY'GWCC``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck`YX[Y'thY'HfUX]tjcbU``7i gtcX]Ubgž thY'6YXY[U'`fPYbg]b[tcb'WJadi gtž; UX][U'`fP]tmUbX'5fth' '8Yg][b'7Uadi gYgt'UbX'thY'B[i bbUkU' dYcd'Y'fbi gtfU']Ub'8YZYbW': cfW'5WJXYam']b'7UbVYffUt'cZthY'`UbXg'k\YfY'YUWX'WJadi g'cZl BGK ']g`cWJtYX''$

5 htyb X Ub WY F Yei] fYa Yb hg

5 gh XYbh]gYl dYWYX hc UhrbX X'U``WUgg'WcbhUWr\ci fg'

: cf ⁻ YggYbhJU`-ghi XYbh']bZcfa l	ปทู่cb"fY`Uhjb["hc."fYe	i YghgʻZcfʻYl hYbg]cb/f	Yj]Yk cZa Uf_g/cW	∛dUħjcbU``\YU`h\

7ci fgY 8YW] g

7 fYX]hDc]bhg * Gi a a UfmcZh\Y 7 ci f@\Y\Y\\15fYU.? ge[U

 $\{C \mid I = \}H \mid BDJGH$ NDJ L>AA = DC: NDJG 8G>I >86A 6C9 8DAA67DG6I >K: H@>AAH >C BJH>8 B6@>C < L>I = I =: HJEEDGI D; 6 HE: 8>6A>H: 9 >C9>K>9J6A KD86A >CHI GJB: : MADG: C: L > CCDK61 > K: BD9: AH I = 61 A: 69 > C < HI 8: CI JGN 8DAA: 81 >K: H =6K: :BEADN 9 | D EG: H: C| BJH>8 D; E6H| 6C9 EG: H: C| (@>AAH L>AA 7: =DC: B6HI: G8A6HH: H EDE JE 8DC8: GI H 6C9 8DBBJC>I N L>9: : K: CI H ;D8J LDG@H=DEH L>AA E6GI >8>E6I: >C 6C 6EEGDK: 9 *#(, : CH: B7A: 6C9 JC9: G I =: <J>96C8: D L>AA | 6@: 6 B: C| DGH=>E GDA: >C : CH: B7A: EG: E6G6| >DC | =6| B6N >C8AJ9: A 9 > G: 8 | > C < DC: D; | =: LDG@H JC9: G H J9 NDG D | =: G 6 E E G D K: 9 6 8 | > K > I >: H 6 H >C8AJ9: A:69>C<6GIH 6C9 BJH>8 EG68I >I >DC:GH LDG@>C< >C "JHI G6A>6 I D96N 6GI >HI >8 >9: CI >I N 6C9 86G: : G A: 6GC >C < I D 7J >A 9 > C < 6GI H DG <6C >H6I >DC L >I 8DCI: BEDG6GN 8G: 61 >K: EG681 >8:

5 hh Y WcbWi g]cb cZh]g Wci fgY h Y gh XYbhk] ` VY UV Y hc

%" 8 Ya cbglfUllY 'UXj UbWYX'a i g]WWc``UVcfUlrjcb'g_]``g
&" & 8 Ya cbglfUllY 'YUXYfg\]d 'UbX'a Ybhcfg\]d'g_]``g']b' I BGK 'YbgYa V'Y'dUfrjW]dUlrjcb
' " ' " '8 Ya cbglfUllY 'UXj UbWYX'llYW\b]WU``g_]``g'UbX'a i g]WU``^ X[Ya Ybh']b'dYfZcfa UbWY
(" 8 Ya cbglfUllY 'h\Y'WJdUW]mmhc'XYj]gY'U'Wc``UVcfUlrj Y'a i g]Wdfc^YWiUbX'XcW a Ybhifk]h\ 'h\Y'gi ddcfh
cZgW\c`Uf`mgci fWYgŁ'h\Y'dfYdUfUlrjcb'dfcWYgg'Zfca 'WcbWYdlicb'hc'fYU`]gUlrjcb"

HYUWX]b[GhfUhY[]Yg

K]th th Y gi ddcffic ZU gdYWJU]ghj cWU ži]bghfi a YbhU cf Wca dcg]hjcbU thYUW.Yfž WUgg k cf_g\cdg UbX ghi X]cg fl%\$ Ž , '\ci fgŁghi XYbhg k]``Z fh\Yf fYZ]bY dYfZcfa UbW cf Wca dcg]hjcb g_]``g UbX dfYdUfY gc c UbX Wc ``UVcfUhj Y dYfZcfa UbW g" '' 9 bgYa V Y UbX a i g]WU ``YUXYfg\]d g_]``g fYei]fYX VmU XYj Y cd]b['dYfZcfa Yf k]``VY \cbYX h\fci [\dufh]WJdUhjcb]b U' i b]j Yfg]lmYbgYa V Y f&\$ \ci fgŁUbX h\Y cddcfhi b]mhc hU_Y U YUXYfg\]d cf a Ybhcf fc Y ''fVmhU_]b['U'fc Y]b cbY cZh\Y i b]j Yfg]lm[fci dg i bXYf h\Y [i]XUbWY cZh\Y YbgYa V Y X]fYWcf cf Vma Ybhcf]b['U'Wc ``UVcfUhj Y dfc YWh]b dfc[fYgg]b h\Y A I G7 (+\$% WUgg k \]WX \Ug Wca a cb gYa]bUfg k]h\ A I G7 (+\$' Ł" H\YgY UWhj]h]Yg k]` Wcbhf]Vi hY hc h\Y XYj Y cda YbhcZ]bhY` YWh U UbX 'UYgh\Yh]W]bXYdYbXYbW fYei]fYX 'Zcf dfc ZYgg]cbU `Yb[U[Ya Ybhik]h\ dYfZcfa UbW 'cf Wca dcg]h]cb hi]h|cb"

5ggYgga Ybh

Mci 'a i ghfY[]ghYf'mci 'df]j UhY`]bghfi a YbhU`žj cWU`cf`Wca dcg]hJcb'h hcf'k]h\'h\Y`G5A 'cZ]WY`VmK YY_`%"' D`YUgY'bchY'h\UhU``UggYgga YbhHUg_g'k]``VY`X]gW ggYX`]b`XYhU]``]b`h\Y`ZJfgh`YWfi fY"': cf'U```Ugg][ba Ybhgž h\Y`<Ufj UfX`fYZYfYbWJb[`gmghYa `fbUa YžXUhYŁ'g\ci `X`VY`i gYX"'`D`YUgY`fYZYf`hc'l BGK `fYZYfYbWJb[`[i]XYcb`]bY`Zcf`XYhU]`g"

5ggYgga Ybh'HUg_g'

5ggYgga Ybh'tUg_	K Y][\h	8iY'8UhY	Gh XYbh@YUfb]b[CihWca Ygʻ5ggYggYX
Gc`c'dYfZcfa UbWY']b'WcbWYfh	' \$1	Bch5dd`]WUV`Y	(
DYfZcfa UbWY dfc YWYzdfcdcgU`UbX fYZYWJcb) \$1	% #\$) #&\$% `\$) .\$\$ DA	%Z Ž(
9bgYa V`Y	&\$I	Bch5dd`]WUV`Y	%ž&Ž

5ggYgga Ybh'8YHJ]`g

5ggYgga Ybh% 'Gc`c'dYfZcfa UbWY']b WcbWYfh

GHUffhixwhy.

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

 $7 \text{ c}^{\text{u}}\text{U}\text{cfuh}^{\text{u}}\text{j}^{\text{u}}\text{d}\text{f}\text{Z}\text{cfa}$ UbWY dfc YWg k] $^{\text{u}}\text{V}\text{J}^{\text{u}}\text{g}$ WYX ZcfA Um%) $2^{\text{u}}\text{J}^{\text{u}}$ 2. $2^{\text{u}}\text{J}^{\text{u}}$ 3. $2^{\text{u}}\text{J}^{\text{u}}$ 3. $2^{\text{u}}\text{J}^{\text{u}}$ 3. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 3. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 4. $2^{\text{u}}\text{J}^{\text{u}}$ 5. $2^{\text{u}}\text{J}^{\text{u}}$ 6. $2^{\text{u}}\text{J}^{\text{u}}$ 6. $2^{\text{u}}\text{J}^{\text{u}}$ 6. $2^{\text{u}}\text{J}^{\text{u}}$ 6. $2^{\text{u}}\text{J}^{\text{u}}$ 7. $2^{\text{u}}\text{J}^{\text{u}}$ 7. $2^{\text{u}}\text{J}^{\text{u}}$ 8. $2^{\text{u}}\text{J}^{\text{u}}$ 9. $2^{\text{u}}\text{J}^{\text{u}}$

null Gi Va]gg]cb bchYg.bi ``

Hi fb]hjb'gYhjb[.'H\]g'Ugg][ba Ybh']g'gi Va]hhYX'h\fci [\'Hi fb]hjb'UbX'gh XYbhg'Xc'bch'gYY'Hi fb]hjb g]a]`Uf]hmfYdcfhg"

5ggYgga Ybh' 9bgYa V`Y

GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\.'bi ``

8YHJ]`g. `DYfZcfa UbW'`UbX`dUffjWjdUfjcb`]b`Ub`Uddfcj YX`I BGK `YbgYa V`Y`UbX`HJ_]b['U``YUXYfg\]d`cfa Ybhcf]b['fc`Y`Ug`Uddfcdf]UhY`hc`YbgYa V`Y`UWfj]hJYg`i bXYf`h\Y`[i]XUbW'`cZh\Y`YbgYa V`Y X]fYWhcf"C b[c]b['UggYgga Ybh'UbX`fYdcfh'Zca 'YbgYa V`Y`X]fYWhcf"``8]fYWhcf"``8]fYWhcf"```ck]b['hYgh'

5 **X**X][h]cbU' XYHJ] g.

5```ghi XYbhg`]b`A | G7(+\$'`UfY`fYei]fYX`hc`dUfh]W]dUhY`]b`cbY`| BGK YbgYa V`Y''``=bZcfa Uh]cb`UVci h

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

Gh XYbhg UfY Yl dYWYX hc di hh\Y]f bUa Yg UbX gh XYbhbi a VYfg cb Yj YfmdU[Y cZh\Y]f Ugg][ba Ybhg"

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

☐ Included the following of the fol

ł `G][b]Z]\WbhmUZZY\Wimci f`dYfZcfa Ub\Wr`]b`UggYggUV`Y`k cf_ž`VY`]h'U`Zcfa U``YbX!cZgYa YghYf`Yl Ua]bUh]cbž`U \WUgg`hYghž`U``UVcfUhcfmhYghž`U`gYa]bUf`dfYgYbhUh]cb`cf`Ubmch\Yf`Zcfa 'cZUggYgga Ybh'

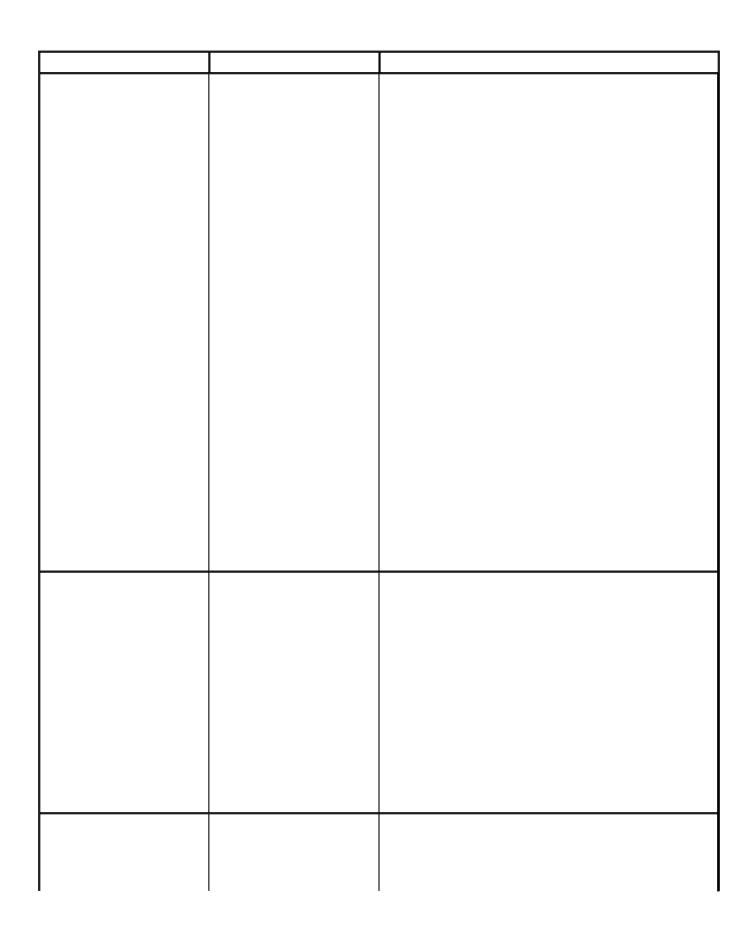
5 WUXYa]W<cbYghmUbX D`U[]Uf]ga

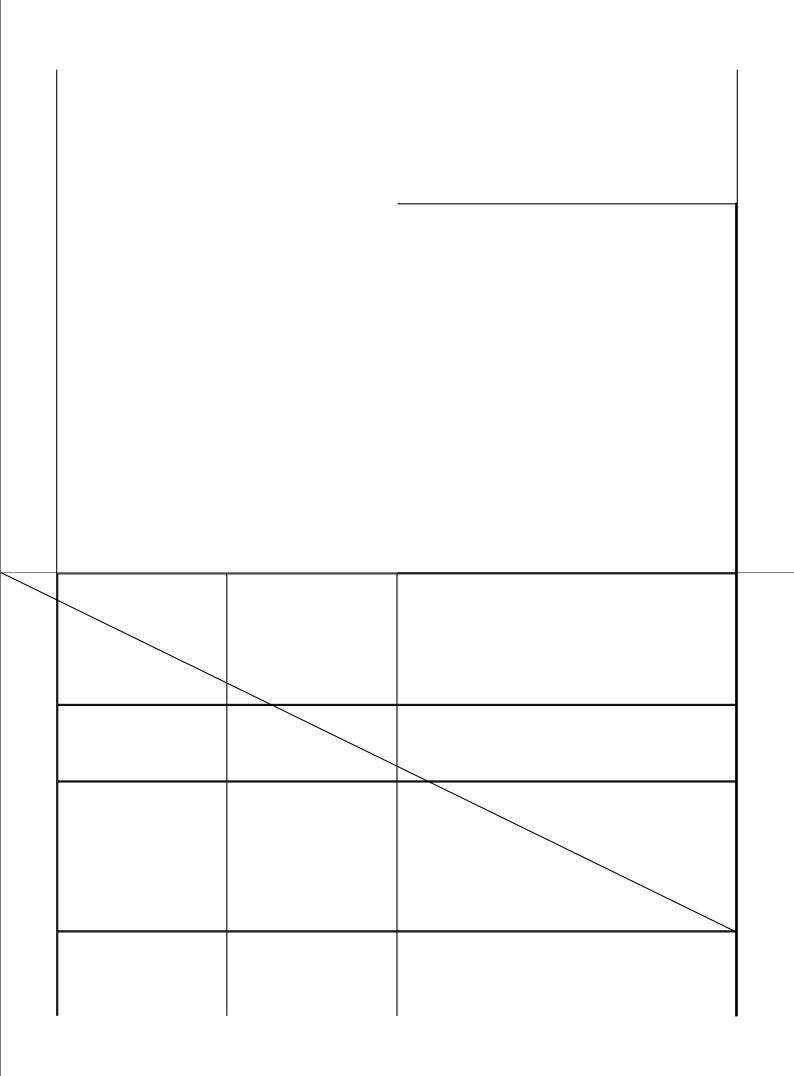
D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i\in\WbihU_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiW\YUh]b[ihciUVW]XYbhU`mWcdm]b[iZfca iUigci fWlik]h\ci hiUW_bck iYX[Ya Ybh'i

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

7 cdm]b[.'i g]b['h\Y'gUa Y'cf'j Yfmg]a]`Uf'k cfXg'hc'h\Y'cf][]bU`h\I hcf']XYU'k]h\ci hUW_bck `YX[]b['h\Y gci fW'cf'i g]b['ei chUh]cb'a Uf_g"'H\]g'U'gc'Udd`]Yg'hc']a U[Ygž'Ufh'UbX'XYg][b'dfcYWhgž'Ug'k Y``'Ug dfYgYbhUh]cbg'k \YfY'gca YcbY'dfYgYbhg'Ubch\Yf'g']XYUg'cf'k cfXg'k]h\ci h'WfYX]hY[cf]Yg.

- VYMYfa UbU[Ymcifh]a Y
- i bXYfgHUbX'mci f'f][\hg'UbX'fYgdcbg]V]`]h]Yg'Ug'U'ghi XYbh'Uhi BGK
 VY'Uk UfY'cZd`U[]Uf]ga ž'Wcdmf][\hž'I BGK 'Ghi XYbh'7cXY'cZ7cbXi Wh'UbX'5WW'dhUV'Y'I gY'cZ I BGK '= H'F Ygci fWfg'Dc`]Wh





GYMjb['bYk'[cU'g
F Yj]Yk '5 fh]ghA Ub]ZYghcg
9bgYa V`Y`dUffIWXYW_]b[`fYghfh\]g`k YY_`!`gWXYXi `YX UWWcfX]b[`fc`YbqYa V`Y