## !"#\$%&'(#!%")TO),!-.)/#'&!0/) #\$%&!"'(()''"! 0+1-+2/!3/\$4+21\$-5!('(67('(8! \*,2++/\$/91:!;15/,<2./.=1!>++?%5!1,2++/\$/91) %\$/?1!@.1-+A!./!B 0 C)!

#### (%' \$/0)&0/(\$!1#!%'')

$$\begin{split} & B4+2!\$^{-1!\%} . /9!E/A!, . \&@\%+\_!<\$^{-25`!}, \$/+\&E!<E1!.R-+/!J++/!4\$+>+A!E1!\&+2+!\\ & a+/-+2-E\$/\&+/-lb!\#\%\&!4\$+>\$/9!, E/!J+!+/1+`!+\_, \$-\$/9`!E/A!+4+/!+22\$R5\$/9`!J=-!=\%-\$\&E-+\%5`!\\ & \$^{-1!1=@@.1+A!-.!J+!E/!+/P.5EJ\%+!\%+\$1=2+!E, -\$4\$-5L!D<=1`!.=-1\$A+!.R!, +2-E\$/!, \$2, \%+1!\\ & FE, EA+&\$E`!, \$/+@<\%\&E`!RE/!, . & \&=/\$-\$+1\Gamma`!>+!1+\%A. & !1++?!-.!E/E\%5N+!\&.4\$+1!-<+!>E5!-<E-!\\ & >+!\&\$9<-!+\_E\&\$/+!E!>.2?!.R!E2-!.2!\%\$+2E=2+L!; /A!5+-`!E\%./9!>\$-<!E!4E2\$+-5!.R!.-<+2!\\ & , . /-+\&@.2E25!4\$1=E\%!\&+A\$E`!.=2!R\%\&!+\_@+2\$+/,+1!.R-+/!A\$2+,-\%5!F.2!\$/A\$2+,-\%5!I!<E@+!.=2!\\ & 4E\%=+1`!J+\$\$+R1`!E/A!.@$/$./1!EJ.=-!.=21+\%4+1`!EJ.=-!\%8R+`!E/A!EJ.=-!.=2!1., \$+-5L! \end{split}$$

 $\begin{array}{l} : !5+E27\%./9!\$/-2.A=,-\$./!-.!R\$\%\&!!-=A\$+1`!-<\$!!, .=21+!>\$\%\%!+\_@\%.2+!-<!!, ./,+@-1!.R!R\$\%\&!\\ R.2\&`!R\$\%\&!E+1-<+-\$,1`!E/A!R\$\%\&!!-5\%+`!><\$\%+!2+&E\$/\$/9!E-+/-\$4+!-.!-<+!4E2\$.=1!>E51!$/!\\ ><\$,<!,\$/+&E!E\%>E51!E\%1.!$/4.\$4+1!E/!$/-+2E,-\$./!>$-<!J.-<!1@+,$R\$,!E=A\$+/,+1!E/A!\$E29+2!\\ 1.,$E\$!1-2=,-=2+1L!D<2.=9<.=-!-<+!, .=21+`!>+!>$\$\$\,\$1.+\$5!+_E&\$/+!-<+!, ./1-2=,-$./!.R!E!\\ 4E2\$+-5!.R!R\$\%\&!R.2&1!E/A!1-5\%+1) $/, \%=A\$/9!-<+!, \%E11\$, E\%!S. .\$5>..A!1-5\%+`!A.,=&+/-E25!\\ $/+&E`!+_@+2$&+/-E\$!R$\$&1`!E/A!, ./-+&@.2E25!$/A+@+/A+/-!E/A!9\%.JE\$!, $/+&E1L!K=2$/9!\\ -<+!RE\$!+_@+2$&+/-E\$!R$\$&1`!E/A!, ./+&E2!E-+/-$./!-.!-<+!, ./1-2=,-$./!.R!R$\$&!$&E9+1`!151-+&1!\\ R!R$\%\&!+A\$-$/9`!R$\$&!1.=/A`!E/A!-<+!4E2$+A!&.A+1!.R!.29E/$N$/9!-<+1+!,.2+!+\$+&+/-1L!D<+!\\ 1+,./A!-+2&!.R!-<+!,.=21+!>$\$\$\$!$/*2.A=,+!?+5!-<+.2+-$,E\$!@+21@+,-$4+1!$/!,$/+&E11=A$+1!E1!\\ >+\$\$!E1!+_E&$/+!9+/2+`!E=-<.21<$@`!/./7/E22E-$4+!,$/+&E1`!-2E/1/E-$./E\$!R$\$&E2$/9`!E/A!\\ .$ 

$$\begin{split} & E^{+2}/E^{4} + d^{-1}, \\ & A^{+0} + A^{-1}, \\ & A^{+0} + A^{+1}, \\ & A^{+0} + A^{-1}, \\ & A^{+0} + A^{-1},$$

(+@ABC) (+>\*C>\*5)G .=21+!; 11\$9/&+/-1`!C+, =2+!1\$A+1`!B O C!2+EA\$/91`!D=-.2\$E\$!G\$%@1`!E/A!\*-2+E&\$/9!C\$/?1!>\$\$%!J+!@.1-+A!./!-<+!B O C!1\$-+!R.2!-<+!, =21+:!<--@:dd.>%L=>.L,E!G\$%,?!./!-<+!\$CB+@ADCB!J=-./!-.!R\$/A!-<+!E@@2.@2\$E-+!,./-+/-L!; \$%%!, =21+!E11\$9/&+/-1!&=1-!J+!1=J&\$--A!-.!B O C!15!-<+!A=+!AE-+1!\$%1+A!./!-<+!15%%EJ=1L!\*-=A+/-1!E2+!2+1@./1\$J\$%+!R.2!,<+,?\$/9!-<+!, =21+!B O C!1\$-+!./!E!2+9=%E2!JE1\$1!R.2!/+>1!E/A!=@AE-+1L!!D<\$1!\$1!-<+!@2\$&E25!&+-<.A!J5!><\$,<!\$/R.2&E-\$./!>\$%%!J+!A\$11+&\$/E-+A!-.!E%%!1-=A+/-1!\$/!-<+!.%E11L!

1,2++/\$/9!\$/-2.A=,-\$./1!E/A!9=\$A\$/9!n=+1-\$./1!@.1-+A!+E,<!>++?!\$/!-<+!B O C!#.2=&! 1+,-\$./L!

 $\begin{array}{l} \label{eq:sphere:spher$ 

 $\begin{aligned} & \text{CD}+A?F>GB5)ZE2-\$, \$@E/-1!\$/!-<\$1!, .=21+!E2+! )@+2&\$-+A!-.!2+, .2A!-<+!1+11\$./1`!+_, +@-! \\ &><+2+!2+, .2A\$/9!\$1!E/!E@@2.4+A!E, ..&\&.AE-\$./`!.2!-<+!@E2-\$, \$@E/-!<E1!-<+!@2\$.2!>2\$-+/! \\ &@+2&\$11\$./!.R!-<+!\$/1-2=, -.2L!h.=!1<.=\$A!E\$1.!2+&+&J+2!-<E-!-<+!, .=21+!\$+, -=2+1!E2+! $/! \\ &-<+!@=J\,\$\$, !A.\&E\$/!J=-!E2+!+E, <!\$/1-2=, -.2c1!\$/-+\$\%+, -=E\$!@2.@+2-5L!D<+5!1<.=\$A!/.-!J+! \\ &1<E2+A!.2!A\$1-2\$J=-+A!.=-1\$A+!-<+!, .=21+!\$/!E/5!&E//+2L!! \end{aligned}$ 

 $\begin{array}{l} \textbf{-CD*@AC)} & @*IF>CB5)C+, -=2+!1\%\$A+1!>\$\%\%!J+!@.1-+A!+E, <!>++?!./!B 0 CL!D<+1+!1\%\$A+1!>\$\%\%!\\ @2.4\$A+!E!J2\$+R!.4+24\$+>!.R!\%+, -=2+!-.@\$, 1!R.2!-<E-!>++?`!J=-!-<+5!>\$\%\%!/.-!, ./-E\$/!E\\!-<+! 2+\\+4E/-!&E-+2\$E\\!R2.&!\\+, -=2+!E/A!!<.=\\A!/.-!J+!1++/!E1!E!!=J1-\$-=-+!R.2!>++?\\5!\\+, -=2+1L! [+!1=2+!-.!A.>/\%.EA!-<+1+!\\+, -=2+!.4+24\$+>1!J+R.2+!, \\E11!-.!<+\\@!5.=!-E?+!/.-+1!A=2\$/9! \\+, -=2+!@+2\$.A1L!! \end{array}$ 

 $\begin{aligned} \mathbf{OP} = \mathbf{E} \mathbf{B} : |\mathbf{D} < +2+! > \$ \$ \$ |\mathbf{J} + ! . . . +! (7 < . = 2! + \_\mathbf{E} &! $ / ! + \mathbf{E} < ! - +2 &! \mathbf{E} / A! . . . . +! 67 < . = 2! , & @2+<+ / 1 \$ 4 +! \mathsf{R} $ / \mathsf{E} \$ ! \\ & \mathsf{E} - ! < +! + / A! . \mathsf{R}! < +! , & = 21 + L! \mathbf{D} < +! \$ / 7 , & \mathsf{E} 11! + \_ \mathsf{E} & \$ 1! > \$ \$ \$ ! \$ / , & \texttt{N} = A + ! & \texttt{E} = \$ - \$ @ \$ + ! , < . \$ , + `! 1 < . 2 - ! @ \mathsf{E} 2\mathsf{E} 92\mathsf{E} @ < ! \\ & \mathsf{E} / 1 > + 2! n = + 1 - \$ . . / 1` ! \mathsf{E} / A! , & \$ @ d \$ & \mathsf{E} 9 + ! \mathsf{E} / \mathsf{E} \$ 5 1 + 1 L! \mathbf{D} < +! \mathsf{R} \$ / \mathsf{E} \$ ! 67 < . = 2! + \_ \mathsf{E} & \$ ! > \$ \$ \$ ! J + ! . . & @2 + < + . / 1 \$ 4 + ! \$ \\ & J = -! \$ - ! > \$ \$ \$ ! J + ! 1 . & \texttt{H} > < \mathsf{E} - ! > \$ \$ 9 < - + A! - . > \mathsf{E} 2A1! & \mathsf{E} - + 2 \$ \mathsf{E} \$ ! \mathsf{R} 2 . & \$! - < ! ! 0 \$ / - + 2! - + 2 & \mathsf{L}! \mathsf{D} < +! \mathsf{R} \$ / \mathsf{E} \$ ! + \_ \mathsf{E} & ! \\ & \mathsf{R} . 2! - < ! . . = 21 + ! > \$ \$ \$ ! J + ! 1 . < + > < \mathsf{E} - ! > + $ 4! A = 2 \$ / 9! - < +! 0 \$ / - + 2! - + 2 & \mathsf{E} & ! \mathsf{B} < \mathsf{A} = + \mathsf{A} ! \mathsf{A} = 2 \$ / 9! - < +! 0 \$ / - + 2! + \_ \mathsf{E} & ! @ + 2 \$ . A! \mathsf{F} - \$ & + \mathsf{A} = + \mathsf{A} ! \mathsf{A} = 2 \$ / 9! - < +! 0 \$ / - + 2! + \_ \mathsf{E} & ! @ + 2 \$ . A! \mathsf{F} - \$ & + \mathsf{A} = + ! \mathsf{D} [ ; \mathsf{IL} ! \\ & \mathsf{D} < + 2! > \$ \$ \$ ! J + ! / . ! + \mathsf{E} & ! 1 . < + A = \$ + \mathsf{A} ! \mathsf{R} . 2! - < +! \mathsf{K} + . + & \mathsf{J} + 2! + $ \mathsf{E} & ! @ + 2 \$ . A! !! \end{aligned}$ 

 $\begin{aligned} 1 = JCA & 0 \ 6 \ BBFG > E \ C > *B: \ !D < +2+! > \$ \% !J + !-> . !1 < .2-! > 2\$ -+/!E11\$9/\& +/-1!R . 2!-<+! , .=21+`!E! \&\$1+7 \\ +/71, k/+!E/E\%51\$1!E/A!E!1+n=+/, +!E/E\%51\$1d1 < .-!J2+E?A .>/L!D <+!E11\$9/\& +/-1!E2+!\& +E/-!-.! \\ <+\%@!5 .=!A+4+\% . @!5 .=2!1?\$ \% 1! . R!, \% . 1+!R\$ \& !E/E\%51\$1!E/A!, 2\$-\$, E\%!-<\$/2\% /9L!q * @+, \$R\$, ! \\ E11\$9/\& +/-!2+n=\$2+& +/-1!>\$ \% \$!J+!@ . 1-+A!\$/!-<+! ; 11\$9/& +/-1!R . \%A+2! . /!B 0 C! . /!-<+!AE-+1! \\ \%1-+A!J+\% . >L!! \end{aligned}$ 

 $\label{eq:started_st$ 

 $\begin{array}{c} 0 \quad .2?\$/9!\$/!92 \\ .=@1`!1-=A+/-1!>\$\%!@2+@E2+!E!\\ 1<.-!J2+E?A \\ .>/!.R!E!9\$4+/!1+n=+/, +!R2 \\ .\&!./+! \\ .R!-<+!R\$\&1!R2 \\ .\&!-<+!, \\ .=21+L!h \\ .=!>\$\%!-<+/!\\ @2.4\$A+!E/!+11E5! \\ .R!-<\$1!1+n=+/, +d1<.-!J2+E?A \\ .>/!E1!@E2-! \\ .R!-<+!R\$/E\%!+\_E\&!R \\ .2!\\ -<+!, \\ .=21+L!K+-E\$\%+A!\$/1-2=, \\ ./1!>\$\%!J+!@ \\ .1-+A!./!B \\ OCL!! \end{array}$ 

 $\begin{array}{l} q ; \$ \$ ! @ 2. @ + 2\$ 5! 1 = J \& \$ -+ A! @ E @ + 21! > \$ \$ \$ ! J +! , E 2 + R = \$ \$ 5! \& E 2? + A!E, , . 2A\$ / 9! - . ! -< +! i 2EA\$ / 9 \\ i = \$ A + \$ \$ / + 1! \$ / , \$ = A + A! -< +! + / A! . R! -< +! 15 \$ \$ E J = 1L! o + 4\$ +> ! -< +1 +! 9 = \$ A + \$\$ / +1! , E 2 + R = \$ \$ 5! J + R . 2 + > 2\$ - \$ / 9! 5 . = 2! @ E @ + 21! \\ E R - + 2! - + + 4\$ / 9! 5 . = 2! E 11\$ 9 / & + / -! \& E 2? ! E / A! , . \& \& + / -1 L \end{array}$ 

$$\begin{split} &K.!5.=&2!J+1-!-.!1-E5!>\$-<\$/!-<+!E11\$9/+A!>.2A!\$\$\&\$-!R.2!+E,<!E11\$9/\&+/-L!O.2?!./!+A\$-\$/9!\\ &F.2!+\_@E/A\$/9I!5.=&2!@E@+2!1.!-<E-!5.=!E2+!>\$-<\$/!'' j!.R!-<+!>.2A!\$\&\&\$-L!O_,+11\$4+\$5!1<.2-!\\ &F.2!\$./9I!+11E51!>\$\$\$!\$.1+!\&E2?1!=@!-.!./+!R=\$\$!\$+--+2!92EA+L!;11\$9/\&+/-1!T' j!.2!\&.2+!\\ &.4+2!-<+!>.2A!\$\&\&\$-!\&E5!J+!2+=&2/+A!-.!1-=A+/-1!R.2!EAA\$-\$./E\$!+A\$-\$/9L!;11\$9/\&+/-1!-<E-!\\ &E2+!T' j!=/A+2!-<+!>.2A!\$\&\&\$-!>\$\%\$!2+,+\$4+!E!RE\$\%\$/9!92EA+L!! \end{split}$$

 $\begin{array}{l} ; 11\$9/\&+/-1!\&=1-!J+!!=J\&\$-+A!-.!B \ O \ C!./!-<+!A=+!AE-+!\$\$1-+AL!G\$\$, ?!./!-<+!\\ \textbf{6BBFG>EC>*B!\$\$/?!\$/!-<+!, .=21+!@E9+!E/A!R. \$\$.>!-<+!\$/1-2=,-\$./1!-.!=@\$.EA!5.=2!\\ E11\$9/\&+/-L!VE?+!1=2+!5.=!2+,+\$4+!E!, ./R\$2\&E-\$./!-<E-!-<+!E11\$9/\&+/-!<E1!J++/!\\ =@\$.EA+AL!; /5!E11\$9/&+/-1! >$-<.=-!@+2&\$11\$./!>\$\%! J+!E, ,+@-+A`!E/A!\%E-+!\\ @+/E\sh-\$+1!>\$\%!E@@\sh5!=/-\$\sh'-<+!E11\$9/&+/-!\$1!=J\&\$--+A!\$/!B \ O \ CL!; 11\$9/\&+/-1!<E/A+A!\$/!\\ \%E-+!>\$-<.=-!@2$.2!@+2&\$11\$./!.2!E, ,&&.AE-\$./!>\$\%!J+!2+=2/+A!>$-<!E!92EA+!./\%5`!/.!\\ ,\&\&+/-1`!E/A!6j!@+2!AE5!\%E-+!F\$/,\%=A\$/9!>++?+/A1I!A+A=,-+A!R2.&!-<+!92EA+!E11\$9/+A!\\ -.!5.=2!@E@+2L!ZE@+21!1=J\&\$-+A!ER-+2!-<+!E11\$9/\&+/-!<E1!J++/!2+=2/+A!-.!-<+!+2+1-!.R!-<+!\\ \%E11!>\$\%!/.2\&E\\%5!/.-!J+!E, ,+@-+AL!! \end{array}$ 

\*-=A+/-1!&=1-!&E?+!1=,<!2+n=+1-1!>+\\!\$/!EA4E/,+!.R!-<+!A=+!AE-+!E/A!<E4+!E! 9..A!2+E1./!R.2!-<+!+\_-+/1\./L!O\_-+/1\./1!,E/!./\\5!J+!92E/-+A! !>+!<E4+!2+,+\4+A! ,./R\2&E-\./!.R!E,,.&&.AE-\./!R2.&!5.=2!;,EA+&\,!G.=/1+\\.2L!!

0+!>\$\\!A.!.=2!4+25!J+1-!-.!2+=2/!E11\$9/&+/-1! ;11\$9/&+/-1!>\$\\!J+!2+=2/+A!-<2.=9<!B 0 CL!\R!5.=!>\$1<!-.!A\$1,=11!-<+!,.&&+/-1!.2! 92EA+!5.=!<E4+!2+,+\$4+A!./!E/!E11\$9/&+/-!.2!-+1-!>\$-<!5.=2!\$/1-2=,-.2`! )/.!+\_,+@-\$./1L!!

 $\begin{array}{l} J+!, \ &\& @\${+-+A:!RE\$} = 2+!-.!A.!1.! > \$\$\%! \\ &+EA!-.!E/!E=-.\&E-\$, !\#!R.2!-<+!, \ .=21+L!h.=2!R\$/E\$! \\ 922 \left[ \ L+1, \&@\${+-+A:!} \\ \end{array}$ 

/CD\*F+>)!!!5) (% . 2!''!''7)! . 670/)

### ; CCL)RY S ''+OT)RVURZ S (+>\*F>@F\*H)0?F\*F>G)

/DACC>F>G5) !F\*@\$+%J+29`!3\*`!"]^T`!"(8!&LI!

\$C=?F>G5)\\#;X:!G<E@-+2!H!F@91L!("H7(T(I!

#### ; CCL)RR S ''+OT)WYUWW S &FBD+>\*F>@F\*H)0?F\*F>G)

/DACC>F>G5)  $F : 2 <= 2!Z + / / ! 3 * : ! " ] H^{1} ! " " ! \& / LI!$ 

 $C=?F>G5) # ; X: !G<E@-+2!H!F@91L!(T(7(H(I!U!G<E@-+2!""!F@91L!8('78(8I! !!!U!G<E@-+2!"(!F@91L!8^(78^He!8m"78m8I! U!WB 0 CX:!G..?`!a; /.-<+2!*-.25:!V5-<!E/A!S$1-.25!$/!$ 

b!

/CD\*F+>)!45),!-..)/%'''&)

; CCL)RW S ''+OT)W[UWb S OICEC>\*B)+M), FIE)/+@>?)

/DACC>F>G5) FB21./!0+\\+1`!3\*`!"]8"`!""]!&\/LI!

\$C=?F>G5)\#; X:!G<E@-+2!6!F@91L!"''7""'I!U!G<E@-+2!^!F@91L!(H67(m"I! U!G<E@-+2!m!F@91L!6"676((I!U!G<E@-+2!"(!F@91L!8^H78^]I!

; CCL)RV S &CDT)\Uc S /+@>?)&CBFG>)=>?)\*`C)6D\*)+M) - FB\*C>F>G)

/DACC>F>G5) F#2E/,+1!#.2A!G.@@.\E`!"]^8`!""6!&\$/LI!

\$C=?F>G5)\\#; X:!G<E@-+2!^!F@91L!(m"76'(I!U!G<E@-+2!"(!F@91L!8m878]'I!

)

/CD\*F+>)45 f 0 g) (%'' (01#/)F>), !- .)#Q0%\$ g)=>?) (\$!#!(!/.)

### ; CCL)R\ S 3 = 1XURY S , FIE)/\*HIC5)\$C=IFBE)

\$C=?F>G5)W#; X:!G<E@-+2!m!F@91L!6'6'676"6I!U!G<E@-+2!"(!F@91L!8^]78m"I! U!WB 0 CX:!VE11..A`!a; /!; +1-<+-\$, !; @@2.@2\$E-+!-.!G./A\$-\$./1b! ; CCL)RZ S 3 = 1, RZUR[S, FIE)/\*HIC5)7 CAE =>)0PJACBBF+>FBE)=>?), FIE)''+FA)

/DACC>F>G5)	F#L 0 L! V =2/E=`! i +2&E/5`!"]((`!]8!&\$/LI!
U!	F#2\$-N!CE/9`!3 *`!" ]T6`!] ' !&\$/LI!

\$C=?F>G5)\\#; X:!G<E@-+2!" (!F@91L!8HT78HmI! U!\B O CX:!\*, <2EA+2`!ag.-+1!./!#\$\&!g.\$2b!

; CCL)Rc S 3=>1)WV S . !&#0 \$ . )0 8 6 .  $)dW)^{1}>U$  (I=BBa)

ee''%)/(\$00''!''7)+A)#'#%\$!6-/)\*`FB)KCCL)

; CCL)R[ S 3=>T)WbUVR S 1BHD`+=>=IH\*FD)=>?), CEF>FB\*), FIE)#`C+AH)

/DACC>F>G5 F; R2+A!S, <, ., ?'!3\*'!"]Tm'!" (m!&\$/LI!

\$C=?F>G5)WB 0 CX: !V=%4+5`!a s \$1=E%!Z%+E1=2+!E/A! g E22E-\$4+!G\$/+&Eb! U!V.A%+1?\$`!a#+&\$/\$/\$-5!J5!K+1\$9/:! b!

; CCL)RX S , CNT)ZU[ S  $\#^{C}$  () 6 @\*C@A) $\#^{C}$  (+AH)=>?), CE =IC) 6 @\*^ +AB^ FJ)

/DACC>F>G5) FK.2.-<5!; 2N/+2`!3\*`!"]8'`!]'!&\$/LI! U FME/+!GE&@\$./`!g+>!u+E%E/A`!"]6`!"'^!&\$/LI!

\$C=?F>G5)WB 0 CX:!VE5/+`!a#+&E%+!;=-<.21<\$@!o+,./1\$A+2+Ab! U!f %\$/9+2`!aG./-+1-+A!O/A\$/91b!!

; CCL)Rb S , CNT)RWUR  $\langle S 7 C > AC \rangle / @?FCB \rangle$ 

/DACC>F>G5) FM. </!GE2@+/-+2`!3\*`!"]^m`!]"!&\$/LI!

\$C=?F>G5)W#; X:!G<E@-+2!]!F@91L!6(^766]e!68"7688I! U!WB 0 CX:!G%.4+2'!aS+2![.A5`!S\$&1+\\kb!

; CCL)WY S , CNT)RbUWR S ) \$ 0 6 & ! " 7 ) ; 00 f )

1

/CD\*F+>)4!5)''%'', !(#!%'')=>?)''%''U''6\$\$6#!40)(!''0.6)

; CCL)WR S , CNT)WcUWX S #`C)h#A@\*`i)+M)&+D@EC>\*=AH)

/DACC>F>G5)

- Fo.J+2-!K2+>`!3\*`!"]H6`!T(!&\$/LI!
- U! F f + /-! i E22 + -- [3 \*] H]'! T! & /LI!
- U! F\*E2E<!Z. \\\+5`!GE/EAE`!( ' " (`!" ' ] !&\/LI!!!!

**\$C=?F>G5**)\\#; X:!G<E@-+2!'' !F@91L!6T(76^"I!U!G<E@-+2!'''!F@91L!8687886I!

## ; CCL)WW S . =AD`)\UC S OPJCAFEC>\*=I) (F>CE=)

/DACC>F>G5)

	!F#+2/E/A!Ct9+2d!K=A%+5!V=2@<5`!#2E/,+`!"](8`!""!&\$/LI!
!	!F [ =v=+%`!#2E/ ,+`!" ] ( ]`!"H!&\$/LI!
!	

## 

## 6DD+EE+?=\*F+>)M+A)/\*@?C>\*B)KF\*`)&FB=NFIF\*FCB:!

\*-=A+/-1!>\$-<!A\$1EJ\$%\$-\$+1!>.2?!>\$-<!;,,+11\$J%+!OA=,E-\$./!FR.2&+2%5!\*\*KI!><\$,<! @2.4\$A+1!2+,.&&+/AE-\$./1!R.2!E,,.&&.AE-\$./!JE1+A!./!&+A\$,E%!A.,=&+/-E-\$./!.2! @15,<.%.9\$,E%!E/A!,.9/\$-\$4+!-+1-\$/9L!D<+!E,,.&&.AE-\$./!@.%\$,5!,E/!J+!R.=/A!<+2+:! ;,EA+&\$,!;,..&&.AE-\$./!R.2!\*-=A+/-1!>\$-<!K\$1EJ\$%\$-\$+1L!

### 6 DD + E E + ?=\*F +>)M + A) / \*@?C>\*B) +>) . C?FD=I) 7 A + @>?B:!

\*-=A+/-1!1++?\$/9!E,EA+&\$,!E,,.&&.AE-\$./!./!&+A\$,E%!92.=/A1!R.2!E/5!&\$11+A!-+1-1`! +\_E&1`!@E2-\$,\$@E-\$./!,.&@./+/-1!E/Ad.2!E11\$9/&+/-1!>.2-<!F+\$-<+2!E%./+!.2!\$/! ,.&J\$/E-\$./I!"'j!.2!&.2+!.R!-<+\$2!R\$/E%!92EA+!&=1-!E@@%5!-.!-<+!;,EA+&\$,!G.=/1+%%\$/9! .RR\$,+!.R!-<+\$2!<.&+!#E,=%-5!E/A!@2.4\$A+!A.,=&+/-E-\$./L!

$$\begin{split} \mathbf{K}_{\cdot, = \& + / - E - \$, /!1 < E \$ \$ ! \mathbf{J} + !1 = \mathbf{J} \& \$ - + A^{!} ! E 1 ! 1 \dots /! E 1 ! @ . 11 \$ \mathbf{J} \$ + `! - . ! - < + ! \mathbf{B} R R \$, +! . R! - < + ! \mathbf{K} + E / ! . R! - < + ! \\ 1 - = A + / - c 1! \# E, = \$ - 5! . R! 2 + 9 \$ 1 - 2E - \$ . / `! - . 9 + - < + 2! > \$ - <! E! 2 + n = + 1 - ! R . 2! 2 + \$ \$ + R! 1 @ + . \$ R 5 \$ / 9! - < + ! / E - = 2 + ! . R! \\ - < + ! E, , . \& \& . A E - \$ . / ! \mathbf{J} + \$ / 9! 2 + n = + 1 - + A L! D < + ! * - = A + / - ! \mathbf{V} + A \$, E \$ ! G + 2 - \$ R \$, E - +! F * \mathbf{V} G I!, E / ! \mathbf{J} + ! \\ R . = / A! E - ! \end{split}$$

1

<--@1:dd>>>L=>.L,Ed=/\$41+,d@ARdE,EA+&\$,z@.%\$,\$+1dE@@+E%1d&+A\$,E%R.2&L@ARL!
D<+!R=%%!@.%\$,5!\$1!1+-!.=-!<+2+:!
<--@1:dd>>>L=>.L,Ed=/\$41+,d@ARdE,EA+&\$,z@.%\$,\$+1dE@@+E%1dE,...&&.AE-\$./z&+A\$,E%L@AR!

### **\$** CIFGF+@B) **6** DD+**E E**+?=\*F+>:!

 $\begin{aligned} &*-=A+/-1!1<.=&A!, ./1=&-!-<+!3/$4+21$-5p1!&1-!.R!2+, .9/$N+A!2+&9$.=1!<.&AE51`!E/A!1<.=&A! \\ &9$4+!2+E1./EJ&+!/.-$, +!$/!>2$-$/9`!@2$.2!-.!-<+!<.&AE5`!-.!-<+!\/1-2=, -.2!E/A!E/!; ,EA+&$,! \\ &G.=/1+&2!$R!-<+$2!, .=21+!2+n=$2+&+/-1!>$&!J+!ERR+, -+A!J5!E!2+&9$.=1!.J1+24E/, +L! \\ &; AA$-$./E&!$R.2&E-$./!$1!9$4+/!$/!-<+!!O+1-+2/!V=&-$,=&-2E&!GE&+/AE2L! \end{aligned}$ 

### /\*=\*CEC>\*)+>)7C>?CAU2=BC?)=>?)/CP@=I)4F+IC>DC:!

 $\begin{array}{l} 0 + 1 + 2/!\$1!, & \&\$-+A!-.!2+A=,\$/9!\$/, \$A+/-1!.R!9+/A+27JE1+A!E/A!1+\_=E\$!4\$.\$+/, +!E/A!\\ @2.4\$A\$/9!, & \&E11\$./E-+!1=@@.2-!-.!E/5./+!><.!<E1!9./+!-<2.=9<!-<+1+!-2E=&E-\$, !+4+/-1L!\\ \label{eq:asymptotic} \label{eq:$ 

## /UPPORT SERVICES!

$$\begin{split} & o+9\$1-2E2\$E\$!*+24\$,+1!\underline{<--@:dd}>> L2+9\$1-2E2L=>.L,E! \\ & *-=A+/-!*=@@.2-!*+24\$,+1!\underline{<--@:dd}=A+/-L=>.L,Ed@1@d<+@2A>+Jd{,&A | \$.9\$/! \\ & *+24\$,+1!@2.4\$A+A!J5!-<+!3*G!\underline{<--@:dd}>+1-+2/=1,L,Ed1+24\$,+1d! \\ & ;,EA+&\$,!*=@@.2-!U!O/9E9+&+/-!\underline{<--@:dd}>>L1A,L=>.L,Ed! \end{split}$$

 $\begin{array}{l} C > = I) QC = I^{*} 5!^{*} - = A + / -1! > < . !E2 + !\$ / !+\& . -\$ . / E \& d\& + / -E \& !A\$1 - 2 + 11! !< . = \& A! 2 + R + 2! - . ! V + / -E \& ! S + E \& - < Q \ 0 \ + 1 + + 2 / !R \ . 2! E! \ , \ . \& @ \& + - + ! \& \$1 - ! \ . R! \ . @ - \$ . / 1! EJ \ . = -! < . > ! - . ! \ . J - E \$ / ! < + \& @ L! \\ \leq -- @ : dd > > L = > \ . \ . \& d\& + / - E \& < + E \& - < d! \end{array}$ 

## 6 CADEMIC OFFENCES)

\*,<.\%E1-\\$,!.RR+/,+1!E2+!-E?+/!1+2\$.=1\%5!E/A!1-=A+/-1!E2+!A\\$2+,-+A!-.!2+EA!-<+!E@@2.@2\\$E-+! @.\\$,5`!1@+,\$R\$,E\\%5`!-<+!A+R\$/\$-\$./!.R!><E-!,./1-\\$-=-+1!E!\*,<.\%E1-\\$,!BRR+/,+`!E-! <--@:dd>>>L=>.L,Ed=/\\$41+,d@ARdE,EA+&\\$,z@.\\$,\\$+1dE@@+E\\$1d1,<.\%E1-\\$,zA\\$1,\\$@\\$/+z=/A+292 (+EJI=F>\*B5!\R!1-=A+/-1!<E4+!E!,.&@%E\$/-!,./,+2/\$/9!E!,.=21+!\$/!><\$,<!-<+5!E2+!+/2.%%+A`! -<+5!&=1-!R\$21-!A\$1,=11!-<+!&E--+2!>\$-<!-<+!\$/1-2=,-2!.R!-<+!,.=21+L!\R!1-=A+/-1!E2+!1-\$%%!/.-! 1E-\$1R\$+A`!-<+5!1<.=%A!-<+/!-E?+!-<+!,.&@%E\$/-!-.!-<+!O/9%\$1<!K+@E2-&+/-!,<E\$2L!D<+1+! 2+9=%E-\$./1!E2+!\$/!@%E,+!J+,E=1+!E!RE\$%=2+!-.!R.%%.>!-<+1+!@2.,+A=2+1!,2+E-+1!-<+!@.-+/-\$E%!

## <u>2)^[Y)\*+)[ba:</u>!

 $\begin{array}{l} 6 \ AG@ \ EC>*5! G \\ HE2! \\ A+4+ \\ & @ \\ & +/-! \\ & R!E! \\ & 1@+, \\ & R \\ & , !-<+1 \\ & 1' \\ & > \\ & -<! \\ & @ \\ & 2-2! \\ & @ \\ & E2E92E \\ & @ \\ & -1! \\ & & ; \\ & A+n=E-+ \\ & 5! \\ & A+-E \\ & & +A! \\ & +A! \\ & +R+2+ \\ & , +!-. \\ & +--1 \\ & & ! \\ & & \\ & & \\ & & \\ & & \\ & & & & \\ & & & & \\ & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & &$ 

# $\underline{Y}))^{\$} CJ + A^{\ast})^{\ast} + ) \& CJ = A^{\ast} EC > ^{\ast}a!$

Z%E9\$E2\$1&!>\$-<!\$/-+/-!-.!A+,+\$4+L!