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 $\$\%\&'!(\%)'\&^*'!+,-./01,20!(34\&^*)!.25!67\&5,4\&2,!8.27.4\&'!\&20,25,5!03!-/39\&5,!.!/,:,/,2^*,!3:!\\ +,-./01,20!-34\&^*\&,'!.25!-/3^*,57/,'!:3/!\&2:3/1.0\&32!3:!.44!'0.;,%345,/'<!!=0!\&'!/,*3>2\&?,5!0\%.0!\\ '-,*\&.4!*\&/*71'0.2^*,'@!230!5\&/,*04)!.55/,'',5!A)!0\%,!8.27.4@!./,!4\&;,4)!03!./&',!:/31!0&1,!03!\\ 0\&1,<!\$\%,!8.27.4@!'!230!1,.20!03!*32'0/.&2!0\%,!+,-./01,20B'!.A&4&0)!03!/,.*0!&2!0%3',!\\ *\&/*71'0.2^*,'!.25!&0!\&'!725,/'0335!0\%.0!5,9\&.0&32'!:/31!-34&^*&,'!3/!>7&5,4&2,'@!1.5,!&2!>335!\\ :.&0\%!A)!0\%,!C\%.&/!3/!A)!:.*740)!3:!0\%,!+,-./01,20@!1.)!A,!2,*,''./)!32!3**.'&32<!$

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%&'()*+!",)-'-$.!&/0!1(-0$)-/$.!
"23456!789! 1 :49;348;<!=2>!&??248@A;8@B!#;7??248@A;8@!789!#78C!2=!&9D:85@B!#;<;7>5EB!
789!F;=;><28!) 7G!%75:366!!
E,9&'&32!+.0,F!G,A/7./)!#0!"HIJK!L*03A,/!M0!"HIMK!"HII!
N = -/39.5!A) F!G. *740)!
<u>-H!-8@>29:5@428!</u>
\$\%, !5, -./01, 20! -/, ', 204)!\%. '!0\%/, .!*.0, >3/\&, '!3:!:.*740)!0\%. 0!./, !230!32!:74400\&1, 0!0, 27/, 5!3/!
0,27/,00/.*;!-3'&0&32'!P2320/,>74./!:.*740)!1,1A,/'0F!
N0!N5R72*0!G.*740)!
S0!E,',./*%!G.*740)!
C0!T,::,/'32!U.A!G.*740)!
C.0,>3/)!N0!\&!!:7/0%,/!!7A5\&9\&5,5!\&203!!
N.0!N5R72*0!G.*740)!0!(/&1./)!N::&4&.0&32F!$,.*%&2>!
NAQ!N5R72*0!G.*740)!0!(/&1./)!N::&4&.0&32F!E,',./*%!
. '!4&'0,5!32!0%,!5,-./01,20.4!V,A'&0,<!!
/.2; @!/,2,V.4\*320\&27.0\&32!3:!.:\&4\&.0\&32\@.25!-/3130\&32\\&2!\.2;!:3/!.44!:37/!0)-,'!3:!:.\*740)<!!
--H! 1 :8;>73! 1 :49;348;<!!
10!N44!\&2\&0\&.4!. - 3\&201.20!!3:!:.*740)!\&2!32.!3:!0%.!D!0) - .'!5.'*/\&A.5!.A39.!/,X7&/,!.!930.!3:!
0%,!:744!/,>74./!:.*740)@103!A,!*3257*0,5!A)!0%,!+,-./01,20!C%.&/<!=0!&'!,Y-,*0,5!0%.0!0%,!C%.&/<!
V&44!0.;,!0%,!/,'740!3:!0%&'!930,!.25!.2)!*311,20'!&203!*32'&5,/.0&320!A70!0%,!740&1.0,!5,*&'&32!
&'!%&'!3/!%, /'!P&2!*32'740.0&32!V&0%!T,::,/'32!U.A!V%,/,!.--/3-/&.0,0<!
"0!=:!0%, !&2&0&.4!/.2;!3:!.2!.--3&201, 20!&'!230!.0!0%, !4,9,4!3:!PN5R72*0WE,',./*%WT,::,/'32!U.A0!
N''^{1}(0.20!(/3:..''3/0!0\%,!/,4,9.20!+,-./01,20!(/3130\&32!.25!\$,27/,!C311\&00,..!V\&4!/,9\&,V!
0\%, !*, 25&5, 0, 8'!*/, 5, 20&. 4'!, 25!-/3-3', !0\%, !, --/3-/&. 0, !/, 2; !03!0%, !+, -, -/01, 20!C%, &/<!\$%&'!
5,0,/1&2.0&32!'%3745!A,!1.5,!.**3/5&2>!03!0%.!/74.'!3704&2.5!A.43V<!
#0!N44!2320/.>74./!:.*740)!1.1A./'!4&'0.5!&2!=<!'%3745!A.!/.9&,V.5!P.0!4..'00!32*.!.9./)!#!
),../'!.25!0%,&/!.-3&201,20!,&0%,/!*320&27,5!3/!0,/1&2.0,5<!$%,!-/&1./)!/,'-32'&A&4&0)!:3/!0%&'!
/,9&,V!,25!0%,!:&2,4!5,*&'&32!4&.'!V&0%!0%,!+,-,01,20!C%,&/!P&2!*32'740.0&32!V&0%!T,::,/'32!
U.A!\&2!0\%, !*.', !3:!T, ..., '32!U.A!G.*740) 0 != 0!\&'!, Y-,*0,5!0\%.0!0\%, !C\%.\&'!V\&44!'34&*&0!0\%, !
*3 1 1 , 20'! . 25!930, '!P. '!. - -/3 -/& . 0, 0!3:! . 44!/, >74 . /!: . *740)! 1 , 1 A , / '! . '!&2 - 70!A , :3/,! 1 . ; &2>!
%&'!3/!%,/!5,*&'&32<!!
DQ!N2)!-/3130\&32!\&2!/.2;@!,\&0\%,/!.'!-./0!3:!0\%,!#0),./!/,9\&,V!P',,!#0!3/!&2&0&.0,5!32!/,X7,'0!A)!
0%,!:.*740)!1,1A,/!&2!X7,'0&320!V&4!%.9,!03!A,!*32'&5,/,5!A)!0%,!/,4,9.20!-/3130&32!.25!
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0,27/,!*311&00,,'!.25!:3443V!0%,!/74,'!3704&2,5!A,43V<!

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/, '-, *0\&9, 4) @103! @A/, + $(1-22-*$/&(B+\frac{4}{8}-=-*+\frac{4}{8}) + 8##/? @11-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-*$/&(3+47!.25!1-22-**)/&(3+47!.25!1-22-**)/
3+4(56$$#$%+&%7(6$$/8#+%-9(:*/2-$$/*@!&2!.**3/5!V&0%!0%,!IbbJ! 8 L a<!c30,!.4'3!0%.0!0%,/,!&'!23!
432>,/!.2)!7--,/!4&1&0!32!0%,!271A,/!3:!T,::,/'32!U.A!PN''&'0.20@!N''3*&.0,0!(/3:,''3/'!0%.0!
*.2!A,!.-3\&20,5<!
8 35,4!:3/!T,::,/'32!U.A!(/3:,''3/'%&-F!
I<!
            $%&'! -3'&0&32! &'! .! R3&20! .--3&201,20! 03! 0%,!:.*740)! 3:! 0%,! L45! +31&2&32!
            a2 49, (10)! + . - ./01, 20!3:!(%) **'!3:!.!-, (32!V%3!&'!.!/, >74./!1, 1A, (!3:!0%.!1)
            `a ENWT,::,/'32! U.A! '*&,20&:&*! '0.::<!!=0! 1.)! A,! 1.5,!.0!.2)! 3:! 0%,! 0%/,,!
            -/3:, ''3/\&.4!/.2; '0!.25!0\%, !-, /'32!. -3\&20, 5!V\&44!A, !5, '\&>2.0, 5!. '!T, ::, /'32!U.A!
            PN''&'0.200!N''3*&.0,Q!(/3:,''3/<!
"<!
            $%,! '.4./)! .25! :/\(\ell2\),! A,2,:\(\ell0'\)! 3:! 0%,! \(\ell2\)*7 1 A,20! \(\nabla\)44! A,! -.\(\ell5\)! ,20\(\ell/\,4\)! A)!
            a ENWT, :: , /'32!U.A<!
#<
            N!T,::,/'32!U.A!PN''&'0.20@!N''3*&.0,0!(/3:,''3/!&'!230!,4&>&A4,!:3/!0,27/,!.0!L45!
            +31 \&2 \&32! a2 \&9 , /' \&0 ) <!
            $%,!&2&0&.4!0,/1!3:!0%&'!R3&20!.--3&201,20!&'!:3/!0%/,,!),./'<!!$%,!.--3&201,20!&'!
D <
            /,2,V.A4,!'7AR,*0!03!0\%,!C320\&2>,2*\&,'!'0.0,5!.A39,!.25!*320\&27,5!'.0\&':..*03/)!
            -, /: 3/1.2*, !A)!0\%, !\&2*71A, 20<!
Z \langle
            $%,\&2*71A,20!\%.44!,2R3)\:744!\&>\%0\!.25!-\&9\&4,>,\!3:!.\:.*740)\!1,1A,\!3:\L45\
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\label{eq:control_co
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 \$\%, !-3/0:34\&3! '\%3745! *320.\&2!0\%, !:3443V\&2>! 1.0, /\&.4' !.25!A, !:3/1.00, 5!. '!\&25\&*.0, 5!A, 43V<! c 30, !0\%.00! \ '075, 20!3-&2&32! '7/9, ) '!./,!*32'&5,/,5!&2!0\%,!.227.4!/,9&,V!.25!./,!230!.!-./0!3:! 0%,!0,.*%&2>!-3/0:34&3!/,9&,V<]!
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IQ S/\&,:!~711./)!
N!'711./)!&'0!3:!.44!*37/','!0.7>%0!57/&2>!0%,!-,/:3/1.2*,!-,/&35<!G3/!,.*%!*37/',!&2*475,!
0%,!:3443V&2>!&2:3F!
       c.1,!.25!271A,/!3:!0%,!*37/',!
         , 1, '0,/!.25!$&1,!V%,2!0%,!*37/',!V.'!0.7>%0!
       C/.5\\delta!\%37/'!!
       c71A,/!3:!'075,20'!!
       $%,!39,/.44!=2'0/7*03/!_::,*0\psi9,2,''!\*3/,!Pf7,'0\psi32!IHQ!:/31!0\psi,!\075,20!L-\psi2\psi32!
        `7/9,)'!!
       =:!V,A'&0,!&'!7',5!03!-3'0!&2:3/1.0&32!g!&2*475,!0%,!V,A!.55/,''!
C320, 20!3:!0%,!$,.*%\d2>!(3/0:34\d3!
G3/!.44!*37/','!-/39&5,!0%,!:3443V&2>F!
    0 C37/',!=2:3/1.0\(\)32!\(\)2*475\(\)2>!\)44.A7'!!!
       E, -/, ', 20.009, !, Y. 1 - 4, !3: !U, *07/, !c 30, 'h!
       [31, V3/;!N''\&>21,20'!.25!'3470\&32'h!
       C3-)!3:!, .*%! Y. 1!&2*475&2>!G&2.4!.25!30%, /!0, '0&2>!1.0, /&.4&!&:!. --4&*.A4, h!
       G&2.4!>/.5,!5&'0/&A70&32!:3/!,.*%!*37/',!0.7>%0!
       !P3-0&32.40!N2)!.55&0&32.4!/,4,9.20!&2:30!&2!-./0&*74./!3/&>&2.4!*7//&*7471!5,9,43-1,20<!!
    h=:!0%,!'.1,!*37/',!V.'!0.7>%0!13/,!0%.2!32*,!57/\(\delta\)2>!0%,!-,/:3/1.2*,!-,/\(\delta\)35\(\text{!324}\)!32,!
    ',0!3:!0%,',!53*71,20'!2,,5'!03!A,98-939(1Tf[($)9.920.2(2>!000.24)0.2(*50354.900.24125n)0.2(0.24
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1:49;348;<!28!@E;!'>40;>47!=2>!\$J73:70428!2=!.5E237>36!&504J406!789!#;<;7>5E! E,9&'&32!+.0,F!T.27./)!Ib0!"HIZ! ! "'>;7AG3;!!

 $\begin{aligned} &N2)!: \&/!.25! \ 1 \ , 2\&2>:74! \ , 9.47.0\&32!3:!0\% ,!'*\%34./4)!.25! \ ,' \ , /*\%!.**31-4\&'\%1 \ , 20'!3:!.! \\ &: *740)! \ 1 \ , 1 \ A \ , /! \ , X7\& \ ,'!. !X7.4\&0.0&9 \ ,!R75>1 \ , 20!A. \ ,' \ ,5!32! \ ,Y- \ , /0\&' \ ,!.25! \ ,V \ ,/ \ ,2 \ ,''!3:!0\% \ ,! \\ &* \&/*71'0.2* \ ,'!72\&X7 \ ,!03! \ , .*\%!'7A:\& \ ,45<! \ i \ , &&4 \ ,!X7.20&0.0&9 \ ,!5.0.!P'7*\%! \ .'!271 \ A \ ,/!3:! \\ &- 7A4\&^*.0&32'0!*&0.0&32'!3/!030.4!>/.20!132 \ ,)!/\ ,* \ ,&9 \ ,50!1 \ .)!-/39&5 \ ,!7' \ ,:74!&2-70!:3/!'7*\%! \ .! \\ &R75>1 \ ,200!-7/\ ,4)!271 \ , /&^*.4!'*3/ \ ,'!* .2230!.5 \ ,X7.0 \ ,4)!/\ ,:4 \ ,* 0!0\% \ ,!X7.4&0)0!A/ \ ,.50\%!.25!5 \ ,- 0\%!3:! \\ &: .*740)!1 \ ,1 \ A \ ,/B'!/\ ,' \ ,/*\%!.25!'*%34./4)!.* 0&9&0& \ ,'<!=2!0%&'!53*71 \ ,200!V \ ,!4&'0!'31 \ ,!3:!0\% \ ,! \\ &1 \ 3/ \ ,!*31 \ 1 \ 32!&25&* \ .03/'!:3/!!'7** \ ,'':74!/\ ,' \ ,/*\%!* \ /, \ ,/0!-700&2>!- \ ,/0&*74./! \ ,1-\% \ ,'&'!32!5.0.! \\ 0\% \ .0!/\ ,-/\ ,' \ ,20!0\% \ ,! \ ,Y-4&*&0!3/!&1-4&*&0!/\ ,*3>2&0&32!3:!0\% \ ,!: \ ,*740)!1 \ ,1 \ A \ ,/B'!/\ ,' \ ,/*\%! \ ,Y* \ ,44,2* \ ,! \\ A) \ ,!0\% \ ,!2.0&32.4! \ .25!&20,/2.0&32.4!*31 \ 1 \ ,72&0)!3:!*320, \ ,Y0!.25! \ ,//&9,!.0!.!-/3- \ ,/!V \ ,&>\%2>!3:!.44!0\% \ ,! \\ ,9&5,2* \ ,!-70!:3/0\%!03! \ ,//&9,!.0!.!*31-/\ ,% \ ,2'&9,!.--/.&' .4!3:!0\% \ ,!: .*740)!1 \ ,1 \ A \ ,/B'!'*& \ ,20&:&*! \\ '*%34./'%&-<!!$

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- Z< [323/'0!.V./5'0!:,443V'%&-'0!.25!2.1,5!-/&?,'!.'!V,44!.'!30%,/!/,*3>2&0&32!!A)! -/3:,''&32.4!.25!'*%34./4)!3/>.2&?.0&32'<!!!
- J< (,,/!/,9&,V,/!3:!>/.20!-/3-3'.4'!.25!-7A4&*.0&32!'7A1&''&32'@!3/!1,1A,/'%&-!32!,5&03/&.4!A3./5'!:3/!4,.5&2>!'*&,20&:&*!R37/2.4'<!!!
- $d < ^{,4,*0\&32!.'!*32:,/,2*,!3/>.2\&?,/@!*329,2,/!3/!-/3*,,5\&2>'!,5\&03/<!!!}$
- b< \ ,4,*0\(\delta\)2!:3/!-.2,4'!.59\(\delta\)2>!0\(\delta\),!:,5,/.4!3/!'0.0,!>39,/21,20!32!'*\(\delta\),20\(\delta\)2!\(\delta\)'7,'\(\delta\)!3/!
 2.0\(\delta\)32.4!4.A'!.25!0\(\delta\),\(\delta\)/2\(\delta\)2!A3./5'<!!!
- IH< \$.2>&A4,!/,'740'!4&;,!-.0,20'@!5,9&*,'@!-/3*,57/,'@!'3:0V./,@!1.27.4'@!!0,Y0A33;'!.'!

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"23456!=2>!O;8@2>48K!789!$J73:7@428!2=!);5@:>;><!
E,9&'&32!+.0,F!G.44!"H"#!
=2!*32'&5./&2>!0%.!1.203/&2>!.25!.9.47.0&32!3:!4.*07/./'@\&0\&\!&1-3/0.20!03!A../!&2!.1 &25!0%.!
9.47.A4,!*320/\&A70\&32!0\%,)!1.;,!03!0\%,!0,.*\%\&2>!\&2!0\%,!+,-./01,20\&!G7/0\%,/0!0\%,!0)-\&*.4!
4,*07/,/!*.//\&,'!..!9,/)!\%,..9)!0,..*\%\&2>!43..5!..25!3:0,...2!0,...*\%,'!0\%,!\&20/357*03/)!*4..'','!V\&0\%!
1.2)!:/, '% 1,2@!V%3!53!230!.4V.)'!%.9,!/,.'32.A4,!,Y-,*0.0\k32'!3:!0\%,\k/!\k2'0/7*03/\!=0!'\%3745!
A. !0% .!+ . - ./01 .20! - 34&*) !230!324) !03! 1 32&03/!0% .!4 .*07/ ./!A70! .4'3!03! .*0&9 .4)! .2> .> .!&2!
,2*37/.>\&2>!0%,!4,*07/,/B'!*./,,/!5,9,43-1,20\\!=5,.4\)\@!,.*\\\!4,\\@7/,/!'\\\3745!A,!.''\\\>2,5!.!
:.*740)!1,203/!03!%,4-!V&0%!%&'!-/,-./.0&32!:3/!-/3130&32<!
 .07897>9<!=2>!''>2A20428!02!.;842>!);50:>;>!2>!O7<0;>!);50:>;>!
U, *07/, /!: *740)!-, /:3/1.2*, |&!!, 9.47.0, 5!.*/3''!0%/, .!531.&2'F!0..*%&2>0!', /9&*, 0!.25!
-/3:, ' \cdot \& 32.4!5, 9, 43 - 1, 20 \& ! _ 9 \& 5, 2 *, !3: !, Y *, 44, 2 *, !*. 2!A, !5, 132 \cdot 0 /. 0, 5!\& 2!. !9. /\&, 0) |3: !V. ) \cdot \& !
0%,/,:3/,0!0%,!,9&5,2*,!'7--3/0&2>!*.','!:3/!-/3 1 30&32!&'!,Y-,*0,5!03!9./)!*.',!A)!*.'.<!
_9&5,2*,!3:!%&>%0X7.4&0)!0,.*%&2>!&2*475,'!*32'&'0,204)!:.93/.A4,!'075,20!.25!-../!
6/, 0/!V, 8/%0!&'!-4.*, 5!32!-, 1/9.47.0&32'!A,*.7', 1/9%, 1/182*475, 1/2.4) '1/8'!3:!*37/', 1/9320, 1/90.
 1.0, \frac{1}{2}.0, \frac{1}
.25!, 2>.>&2>!.*0&9&0&, '0!5,9,43-1,20!3:!3/&>&2.4!&2'0/7*0&32.4!1.0./&.4'0!0..*%&2>!-/.*0&*.'!
&2:3/1,5!A)!5.0.0!*344.A3/.0&9,!0,.*%&2>0!.25!.--/3-/&.0,!/&>3/!&2!.''&>21,20'0<!N--4&*.20'!
'%3745!5, 132'0/.0,!>/3V0%!.25!5,9,43-1,20!!&2*475&2>!-,5.>3>&*.4!&1-/39,1,20!!.25!
\&2239.0\&32'!P, < @1.2!.AA/, 9\&.0, 5!0, .*%\&2>!-%&43'3-%)!4\&2;, 5!03!*%.2>, '!&2!.'', ''1, 20@1.
,2>.>,1,200!,0*<0<!!!
 9&5,2*,!3:!%&>%0X7.4&0)!-/3:,''&32.4!',/9&*,!&2*475,'!1,,0&2>!,Y-,*0.0&32'!:3/!,'',20&.4!
5, -./01, 20!570&, '!P'7*%!. '!.59&'&2>0!.25!.*0&9, !-./0&*&-.0&32!&2!..*740)!>39, /2.2*, !P, ><!!
:.*740)!1,,0k2>'0!*320/&A70k2>!03!',./*%,'0!,0*40<!!N55&0k32.4!'7A'0.20k9,!',/9k*,!.0!0%,!
+, -./01, 200!C344, >, 0!a249, /'00)0!3/!-/3:, ''032.4!4, 9, 4!0'!.4'3!, 2*37/.>, 5<!$%0'!1.)102*475, !
',/9&*,!32!*3 1 1 &00,,'0!:3/1 .4!*320/&A70&32'!03!/,*/7&0 1 ,20!.25!/,0,20&32!3:!'075,20'0!:7/0%,/!
-./0k*&-.0k32!&2!:.*740)!>39,/2.2*,@!-./0k*&-.0k32!&2!',/9k*,!.*0k9k0k,'!3:!-/3:,''&32.4!
 .''3*&.0k32'0!.55k0k32.4!.59&'&2>!.*0k9k0&,'0!.25!*7//&*7471!.25!-/3>/.1!5,9,43-1,20k!
U, *07/, /!!./, !230!7'7.44)!, Y-, *0.5!03!1, 203/!725, />/.57.0, !3/!>/.57.0, !'075, 20'!\(\delta !./.\), '.../*\(\delta !./.\)
-/3R,*0'@!A70!0%&'!'%3745!A,!',,2!.'!.!9.47,5!:3/1!3:!',/9&*,<!=2!-./0&*74./!'7**,'':744)!
1,203/&2>!'075,20'!:3/!-%)'&*'!',2&3/!0%,'&'!-/3R,*0'!'%3745!*,/0.&24)!A,!/.>./5,5!.'!.2!
&1-3/0.20!*320/&A70&32!03!0%,!0,.*%&2>!-3/0:34&3!3:!0%,!4,*07/,/<!
=2!3/5,/!03!A,!,::,*0\kg,!\k2!0\%,',',!/34,'!.25!*32'\k5,\k2>!0\%,!\%,.9)!0,.*\k2>!43.5'\langle\k0!\k'!'7>>,'0,5!
0\%.0!0\%, !271A, /!3:!*311\&00, .!. '`&>21,20'!'\%3745!230!, Y*, .5!0\%, .!. 25!0\%.0!\&: !0\%, !4,*07/, /!\%.'!
.!1 .. R3/! . 59& &2>!-3 &&32!0% . 0!0% ,!4,*07/,/! %3745!A ,!*32 &5,/,5!:3/! .!*37/' ,!/,4, . ' ,<!
 _9&5,2*,!3:!%&>%0X7.4&0)!-/3:,''&32.4!5,9,43-1,20!*.2!&2*475,!.!9./&,0)!3:!.*0&9&0&,'0!'7*%!.'!
1, 1A, /\% -\% 2!/, 4, 9.20! -/3: .\% 32.4! \3 \% , 0 \% , 0 \% . 0 \% 25 \% 2 >! 32: ./, 2 \% , '!P, < 0!/, '.../ \% \% ! 0... \% \% 2 > 0!
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3/!.59\&'\&2>!:3*7',50@!.00,25\&2>!0,.*\%\&2>0:3*7',5!V3/;'\%3-'!3/!V,A\&2./'@!,2>.>\&2>!\&2!/,',./*\%!
P03!5,,-,2WA/3.5,2!;23V4,5>,!3:!5&'*&-4&2,0'-,*&:&*!*320,20&((/3:,''&32.4!5,9,43-1,20!
:3*7',5!32!5\&'*\&-4\&2./)!*320,20!;23V4,5>,@!-,5.>3>)@!5\&9,/'&0)!\&''7,'@!.25!
.59&'&2>\| 1,203\&2>!./,!.44!9.47,5<!!=0!&'!&1-3/0.20!03!-/39&5,!*31-,4&2>!,9&5,2*,!3:!
-3''\&A4,!;\&25'!3:!,9\&5,2*,!4\&'0,5!\%,/,!./,!-/,',2\&!(/3130\&32!-3/0:34\&3'!'\%3745!1.;,!*4,./!
%3V!0\%, !: *740)!1, 1A, /!\% \cdot '!7', 5!-/3:, ''&32.4!5, 9, 43-1, 20!03!'0/, 2>0\%, 2!0\%, &/!-/3:, ''&32.4!
-/.*0&*,<!
9\&5,2*,!:3/!-/3:0\&32!03!, 2\&3/!U,*07/,/!/,X7\&/,'!-/3:\&*\&,2*)!.25!*3:1-,0,2*,!\&2!.44!
531.&2'!3:!0,.*%&2>0!',/9&*,0!.25!-/3:,''&32.4!5,9,43-1,200!.'!V,44!.'!03!,Y*,,5!,Y-,*0.0&32'!
&2!.0!4,.'0!32,!3:!0%,',!531.&2'<!\,\/9&*,!*320/&A70&32'!V&0%&2!0%,!5,-./01,20!./,!'7::&*&,20!:3/!
-/3 1 30&32!03!\, 2&3/!U, *07/, /<!!!
(/3 1 30&32!03! 8 . '0,/!U,*07/,/!/,X7&/,'!*320&27,5!-/3:&*&,2*)!.25!*3 1 - ,0,2*,!&2!.44!53 1 . &2'!
3:!0, .*\%\&2>0!', /9\&*, 0!.25!-/3:, ''\&32.4!5, 9, 43-1, 20&!N!*/\&0\&*.4!, Y-, *0.0&32!:3/!-/3130&32!03!
8.'0,/!U,*07/,/!&'!.''71-0&32!3:!4,.5,/'%&-!/34,'<!!$%&'!1.)!&2*475,!*%.&/&2>!*311&00,,'@!
0.; $2>!32!.51 $2$'0/.0$9,!:72*0$32'0!.25!-/39$5$2>!1,203/'%$-0!.'!V,44!.'!30%,/!4,.5,/'%$-!
/34, '<!! 8 . '0, /!U, *07/, / '!* . 2!5, 1 32 '0/.0, !1, 203/'%&-!0%/37>%!0%, &/!V3/; !V&0%!R72&3/!: . *740) @!
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1 #&0 (&*$!"#, 1 #&O!",)-'-$.!&/0!1 (-0$)-/$.!
!
"'23456!28!@E;!1>79:70;!.0:9;80!."$&P!*;<0!
!
E,9&'&32!+.0,F!N-/&4!"I0!"H"H!
!
c320_2>4&'%!'-,.;&2>!>/.57.0,!'075,20'!17'0!-.''!0%,!`(_Nj!$,'0!V&0%&2!32,!),./!3:!0%,&/!
'0./0!3:!>/.57.0,!'*%334!.0!L+a<!G.&4&2>!03!53!'3!*3745!,20.&4!:3/:,&0&2>!5,-./01,20.4!:&2.2*&.4!
''7--3/0<!E,X7,'0'!:3/!.2!,Y0,2'&32!A,)325!0%,!32,0),./!4&1&0!17'0!A,!1.5,!&2!V/&0&2>!03!0%,!
+,-./01,20!C%.&/!:3/!*32'&5,/.0&32!.25!V&44!A,!.--/39,5!324)!&:!0%,!/,X7,'0!&'!5,,1,5!03!A,!
R7'0&:&,5<!
!
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"'23456!28!' 2:8048K!78!(."&.!*&!02M7>9!0E;!0;?7>0A;8073!1>79:70;!*;75E48K!
#;Q:4>;A;80!
!
E,9&'&32!+.0,F!L*03A,/!"I0!"HIZ!
N--/39,5F!6/.57.0,!(/3>/.1!C311&00,,!
!
N!'075,20!V%3!',/9,'!.'!.!0,.*%&2>!.''&'0.20!P$NQ!:3/!a`(N`!V&44!%.9,!0%.0!.''&>21,20!*3720!
.'!:74:&44&2>!32,0%.4:!PIW"Q!3:!0%,!+,-./01,20.4!>/.57.0,!'075,20!0,.*%&2>!/,X7&/,1,20!P"!
\-3&20']Q\!
!
N!'075,20!V%3!',/9,'!.'!.!$N!.0!0V3!<;?7>70;!a`(N`!'*%334'!V&44!,./2!D!-3&20'!.25!V&44!
%.9,!:744)!'.0&':&,5!0%,!+,-./01,20!0,.*%&2>!/,X7&/,1,20\!
!
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1:49;348;<!28!%:3=43348K!@E;!*;75E48K!#;Q:4>;A;8@!=2>!.@:9;8@<!$8@;>48K!28!78!#&!!

E,9&'&32!+.0,F!`,-0,1A,/!"D@!"HIZ!
!

$%,!+,-./01,20!%.'!.!0,.*%&2>!/,X7&/,1,20!:3/!.44!(%+!'075,20'<!83'0!'075,20'!V&44!'.0&':)!

0%&'!/,X7&/,1,20!&2!0%,&/!:&/'0!),./!.'!.!6$N<!`31,!'075,20'@!%3V,9,/@!V&44!'0./0!.'!.!6EN!

7-32!.//&9.4!.0!L+a<!!G3/!'7*%!'075,20'@!0%,!0,.*%&2>!/,X7&/,1,20!'%3745!23/1.44)!A,!

:74:&44,5!23!4.0,/!0%.2!0%,!:37/0%!),./!&2!0%,!>/.57.0,!-/3>/.1<!
!

$%,!6(+@!&2!*33/5&2.0&32!V&0%!0%,!L-,/.0&32'!8.2.>,/@!V&4!-,/&35&*.44)!/,1&25!'075,20'!!

V%3!'0&44!2,,5!03!:74:&44!0%,&/!0,.*%&2>!/,X7&/,1,20<!$%,!'075,20B'!.59&'3/!V&44!.4'3!A,!230&:&,5<!
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!
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Ib

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"'23456!28!STT!); J;3!$3;5%4J;! '2:><;<!*7C;8!,:%<49;!%E;!"E6<45<!0;?7>%A;8%!!
E,9&'&32!+.0,F!`,-0,1A,/!b%!"HID!
N--/39.4!A)F!6/.57.0,!(/3>/.1!C311&00,,!
!

I< MHH04,9,4!*37/','!0.;,2!A)!-%)'&*'!>/.57.0,!'075,20'!&2!5,-./01,20'!30%,/!0%.2!0%,!
(%)'&*'!+,-./01,20!P:3/!,Y.1-4,%&2!0%,!C%,1&'0/)!+,-./01,20@!*.2!X7.4&:)!.'!.2!
,4,*0&9,<!!!!
!
"< N!>/.57.0,!'075,20!17'0!'7A1&0!.!/,X7,'0!&2!V/&0&2>!03!0%,!6(C!03!0.;,!.!MHH!4,9,4!
*37/',!370'&5,!3:!0%,!(%)'&*'!+,-./01,20!.25!03!%.9,!&0!*3720!03V./5!0%,!,4,*0&9,!
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!
1:49;348;<!28!&9A484<@>7@428!2=!@E;!R>4@;8! '78949756!$I7A487@428
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"D

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''23456!28!@E;!04<<;>@7@428!789!04<<;>@7@428!0;=;8<;!!

"J

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"23456!28!$J73:70428!2=!1>79:70;!*;75E48K!&<<4<0780<!
E.9\&\&32!+.0.F!
$%,!C344,>.!3:!`*&,2*,!/,X7&/,'!0%.0!$N!.9.47.0\(\delta 2'!\)\(3745!A.\)!*31-4.0.5!V\(\delta 0\)\(\delta 2\)!.\(\delta 1'\).\(\delta 1'\).\(\delta 2''\)!*3745!A.\(\delta 1''\).
V, , ; "!.25!:\&"/0!", 1, "0, /!, 9.47.0\&32"!./, !57, !\&2!0%, !N" "3*\&.0, !+, .2B"!3::\&*, !A)!0%, !, \&>%0%!
*4.'','!:3/!:&/'0!),./!$N'<!!
G&/'0!),./!$N'!V&44!A,!,9.47.0,5!0V&*,!.!),./!P32*,!,9,/)!',1,'0,/Q@!',*325!),./!$N'!V&44!A,!
 ,9.47.0,5!32*,!.!),./!P57/&2>!0%,&/!:37/0%!0,.*%&2>!',1,'0,/Q<!$%&/5!P.25!.A39,Q!),./!$N'!./,!
324)!,9.47.0,5\&:\!0\%,)\!./,\!,\&0\%,\!!.\!*.25\&5.0,\!03\!A,\!231\&2.0,5\!:3\!32,\!3:\!$N\!.V.\/5\!3\!0\%,\&\!
$V3!,9.47.0\(\delta\)2'!./,!2,,5,5!:3/!231\(\delta\)2.0\(\delta\)2'!.\(\shi\)1.70'0.25\(\delta\)2'!.\(\shi\)1.70'0.25\(\delta\)2'!.\(\shi\)1.70'0.25\(\delta\)2'!.\(\shi\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)1.70'0.25\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)3'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'!.\(\delta\)2'
NV./5!PL + a \%! \%, !5, .54 \%2, !:3/!'7*\%!231 \&2.0 \&32' \&'!7'7.44)!, 25!3: |T.27./) <!!=2!3/5, /!03! \%.9,!
 7: \& \& \& 20!, 9.47.0\& 32' : 3/!.V./5! 231 \& 2.0\& 32' @ 10\%, !+, -./01, 20! V \& 44!', 4, *0!', 9, /.4!*.25 \& 5.0, '!
:3/!.V./5!23 1 &2.0&32!.:0,/!0%,!/,>74./!,9.47.0&32'!PA)!0%,!:&:0%!V,,;!3:!*4.'','0<!`31,0&1,!
57/&2>!0%, 14. '0!:, V!V,,; '!3:!*4.'', '!.!', *325!P, Y0, 25, 50!, 9.47. 0&32!:3/!0%, ',!$N'!V&44!A,!
*3257*0,5<!!!
                                                                                                      !
                                                                                 1
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"23456!28!1>79:70;!.0:9;80!.:??2>0!
!
E,9&'&32!+.0,F!L*03A,/!Z0!"HHD!
N--/39,5!A)F!(%)'&*'!+,-./01,20!G.*740)!!
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 $\$\%,!+,-./01,20!3:!(\%)'\&^*'!\&^!*311\&00,5!03!.''\&^10\&2>!,.*\%!>/.57.0,!'075,20!.*\%\&,9,!%\&^1\%,/!,57*.0\&32.4!3AR,*0\&9,'<!=20,>/.4!.'-,*0'!3:!'7**,'':74!-/3>/,''!03V./5!0\%,!(%<+<!./,!0\%,!*%3&*,!3!32,B'!53*03/.4!/,',./*\%!03-&*!.25!0\%,!1.&20,2.2*,!3:!'0,.5)!:725&2>!:3/!07&0&32!.25!-,/'32.4!'0&-,25<!$\%,!:3443V&2>!-34&*)!*4./&:&,'!0\%,!*311&01,20!0\%,!+,-./01,20!3:!(%)'&*'!%.'!P'7AR,*0!03!.9.&4.A4,!:725&2>0!03!,2'7/,!.5,X7.0,!:725&2>!720&4!0%,!'075,20!*31-4,0,'!0%,!'(%<+<!.25!&0!*4./&:&,'!0%,!/,'-32'&A&4&0&,'!3:!0%,!'075,20*!!$

*E:!%4><@!*M2!+:7><!!

"b

 $*31-4,0,!..!(\% \leftarrow (1 \text{ a } 25,/!23/1 .4!*\&/*71 '0.2*,'!..!'075,20!V\%3!\%.'!1 .\&20.\&2,5!..!6 (N!3:!>/,.0,/!0\%.2!\# \leftarrow (1.5!-.'',5!0\%,!X7.4\&:)\&2>!,Y.1!.0!0\%,!%\&>\%,/!4,9,4@!.25!V\%3',!.59&'3/!\%.'!.5,X7.0,!/,',./*\%!:725&2>@!V&44!*320&27,!03!/,*,&9,!:725&2>:!$

&=0;>!0E;!%4><0!%2:>!&579;A45!.;A;<0;><!!

a 25,/!.44!A70!, Y0/.3/5&2./)!'&07.0&32'@!32*,!.!'075,20!A,>&2'!%&'\\%,/!',*325!'711,/@!\%,\\'\%,!

#H

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(23456!=2>!0E;!788:73!"EHOH!<0:9;80!0>7J;3!7M7>9<!!!
!
E,9&'&32!+.0,F!G.44!"H"#!
N--/39,5!A)F!6/.57.0,!(/3>/.1!C311&00,,!!
!
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 $\$\%, !L + a! + , - ./01, 20!3:!(\%) '\&*'@!0\%/37>\%!0\%, !>, 2,/37'!'7--3/0!A) !0\%, !C344,>, !3:!^*\&,2*,'@! ,'0.A4\&'\%, '!0V3!', 1 \&0.227.4!0/.9, 4!.V./5'!&2!0\%, !. 1 3720!3:!nZHH!03!-./04) !5,:/.) !0\%, !,Y-,2','! :3/!(\%<+!'075,20'!&2!>335!'0.25&2>!&2!0\%,!5,-./01,20!03!.00,25!2.0&32.4!3/!&20,/2.0&32.4! *32:,/,2*,'<!$\&'!-34\&')!'-,*&:&,'!0\&,!-/3*,57/,!.25!*/\&0,/&.!A) !V\&*\&*\&0\&,!V&22,/'!:3/!0\&'! .V./5!V&4!A,!',4,*0,5<!$

- I< N22372*, 1, 20'!:3/!, .*%!0/.9,4!.V./5!V&44!A,!1.5,!.0!0%,!A,>&22&2>!3:!0%,!G.44!.25! 0%,!\[^-/\&2>!', 1, '0,/'<!
- "< \$%,!.V./5!*.2!324)!A,!>&9,2!03!.!'075,20!V%3!V&4!-/,',20!3/&>&2.4!/,'740'!3:!0%,&/! (%<+!/,',./*%!.0!.!'*&,20&:&*!*32:,/,2*,<!!
- #\langle \cdot, 4, *0\k32!*/\k0, \langle \cdot.!./, !A.', 5!32!..!/, *3 1 1, 25.0\k32!4, 00, \langle !:/3 1 !0\kgaps, !'075, 20!.59\k'3\langle !25! 0\kgaps, !.*.5, 1 \&*!.25!\langle ', ../*\%!-, \langle :3/1.2*, !3:!0\kgaps, !'075, 20\k!!
- \mathbb{D} \$\%,\/,\!\!\!.\!4\!\1\!\!0\!3:\!32,\!\!\.9,\4\!\\\\\.\\5\!-\,\!\),\.\!\!\3\!\,*\\!\\\075,2\!\
- Z< \$%,!(%<+!.59&'3/!3:!0%,!'075,20!17'0!-/39&5,!0%,!2,*,''./)!1.0*%&2>!:725'!*39,/&2>! .4!,Y-,2','!/,X7&/,5!:3/!.!'075,20!03!>&9,!.!-/,',20.0&32!.0!.!*32:,/,2*,<!

#I

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''23456!28!1>79:70;!'2:><;!*>78<=;><B! R 74J;><B!789!'>;940!G6!$ I7A4870428!
E,9\&'\&32!+.0,F!"HHM!
                  I< `075,20'!./,!23/1 .44)!.443V,5!03!0/.2':./!7-!03!I"!%37/'!3:!>/.57.0,!*37/','!&:!
                                    . --/39,5!A) 10\%, 16/.57.0, 10\%, 16/.57.0, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%, 10\%
                                  03!0\%3', !3::, /, 5!.0!L45! + 31 \&2\&32! a 2\&9, /'&0)!\&'!23/1.44)!5, 0, /1 &2, 5!A)!0\%, !6/.57.0,!
                                    (/3 > /.1!C311\&00, <!!E, X7, '0'!03!5, 0, /1\&2, !*37/', !0/.2':, /!, X7\&9.4, 2*)!17'0!A,!
                                    '7--3/0\(\delta\geq\!1.0,\\delta\.4'\left\!1\(\sigma\), \(\delta\), \(\delta\)
                                  03!0\%, 16/.57.0, 1/3 > /.1! + 4/, *03/<!
                  "< $%,!6/.57.0,!(/3>/.1!+&/,*03/!1.)!V.&9,!.!/,X7&/,5!>/.57.0,!*37/',@!23/1.44)!7-32!
                                  0%,!/,*311,25.0&32!3:!0%,!6/.57.0,!(/3>/.1!C311&00,,<!!$%,!6/.57.0,!(/3>/.1!
                                  C3 1 1 &00, ,!/, *3 1 1 ,25'!'7*%!.!V.&9, /!&:@!&2!0%,!*3 1 1 &00, ,B'!R75>1 ,20@!0%,!'075,20!
                                  \%.'!-/,9\&37'!,Y-,/\&,2*,!,X7\&9.4,20!03!0\%.0!03!A,!>.\&2,5!:/31!0\%,!*37/',!.25!\&:!0\%,!
                                    '075,20B'!&20,/,'0'!./,!:7/0%,/,5!A)!%&'\\%,/!230!0.;&2>!0\%,!/,X7&/,5!*37/',<!!N!V/&00,2!
                                  /,X7,'0!:3/!'7*%!.!V.&9,/!.25!'7--3/0&2>!,9&5,2*,!17'0!A,!-/,',20,5!03!0%,!C%.&/!3:!
                                  0%,!6/.57.0,!(/3>/.1!C311&00,,<!!$%,!6/.57.0,!(/3>/.1!C311&00,,!:3/V./5'!&0'!
                                  5,0,1 &2.0&32'!03!0%, 16/.57.0, 1.4/.89/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.4/.1 +&/, 3.
                                  /,'-32'&A4,!:3/!-4.*&2>!.!V/&00,2!/,*3/5!3:!.44!V.&9,5!*37/','!&2!0%,!'075,20B'!
                                   -,/1.2,20!/,*3/5'!\&2!0\%,!+,-./01,20!3:!(\%)'\&*'<!
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#< \$\\.2\!\.\!\!3\!\V\.\!9\\.\!3\!\\\,X7\!\\,5\!>\\.57\.0\,!*37\\\,\'!\!53\,\'!\!230!\,Y\,1\-0!\.\!\'075\,20!\.\/3\!\

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E,9&'&32!+.0,F!L*03A,/!I"@!"HHM!

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N0!0%,!T.27./)!"HHZ!G.*740)!8 ,,0&2>!&0!V.'!5,*&5,5!0%.0!725,/!*,/0.&2!*&/*71'0.2*,'@!
'075,20'!'%3745!A,!.443V,5!03!A,!,Y,1-0!:/31!0.;&2>!0%,!&20/357*03/)!4.A3/.03/)<!$%,!a 6C!
:&2.4&?,5!1&23/!/,9&'&32'!03!0%,!-34&*)!32!IHWI"WHM<!!

N!'075,20!*.2!A,!,Y,1-0!:/31!&20/357*03/)!4.A'!324)!725,/!0%,',!*325&0&32'F!!

I< N!'075,20!%.'!/,*,&9,5!.!C!3/!A,00,/!&2!0%,!,X7&9.4,20!4.A!*37/',!.0!.230%,/!72&9,/'&0)<!
$%,!4.A!*37/',!&'!4&'0,5!.'!.!',-./.0,!4&2,!&0,1!32!0%,!'075,20B'!0/.2'*/&-0<!!!
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$\langle N!'075, 20!\%.'!0.; , 2!0\%, |4.A!.4/, .5\rangle!.0!L + a!.'!-./0!3:!.2!\&20/357*03/)!-\%\rangle'\&*'!*37/',!$

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1:49;348;<!28!.;842>!*E;<4<!
!
E,9&'&32!+.0,F!"d!T.27./)!"HIZ!PC33;0!
N--/39,5!A)F!a25,/>/.57.0,!C311&00,,0!"b!T.27./)!"HIZ<!
N--/39,5!A)F!(%)'&*'!G.*740)@!H#!G,A/7./)!"HIZ<!
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7&)\$+40/)\%+&C!

 $\$\%,/,!./,!0V3!3-0\&32'!:3/!*31-4,0\&2>!0\%,!^{2&3/!}\%, '\&'<!\$\%,!:\&''0!\&'!03!*31-4,0,!(\%)'\&*'! Dbb i @!V\%\&*\!\&'!.\#!*/,5\&0!*37/', !0.; ,2\&2!32,!', 1,'0,/@!PG.44@!^-/&2>!3/!^711,/0\&!!\$\%,!',*325!&'!..\@V30', 1,'0,/!3-0&32!&2!V\&\&*\!0\%,!'075,20!0.; ,'!0\%,!32,!*/,5\&0!(\%)'\&*'!Ddb i !\&2!0\%,!:\&''0!', 1,'0,/!.25!0\%,!\@V30*/,5\&0!(\%)'\&*'!DbH i !\@,!:3443V\&2>!', 1,'0,/<!^{2\&3/!}\$\%,'\&'!*.2!.4'3!A,!'*\%,574,5!57/\&2>!0\%,!'711,/!',''\&32'<!^7**,'':74!*31-4,0\&32!3:!A30\%!(\%)'\&*'!Ddb i !.25!DbH i !\&'!,X7\&9.4,20!03!(\%)'\&*'!Dbb i !.25!'.0\&':\&,'!A30\%!0\%,!V\&0\&2>!.25!3/.4!*31172\&*.0\&32!7--,/!4,9,4!>,2,/.4!,57*.0\&32!/,X7\&/,1,20'!:3/!-\%)'\&*'!1.\R3/'<!$

\$%,!030.4!0&1,!*311&01,20!/,X7&/,5!A)!0%,!'075,20!'%3745!A,!*311,2'7/.0,!V&0%!.!',2&3/!4,9,4\pm,0*/,5&0!-%)'&*'!*37/',<!G3/!*31-4,0&32!3:!(%)'&*'!Dbb i !3/!(%)'&*'!DbH i @0%,!'075,20!17'0!-/,-./,!.!V/&00,2!:&2.4!/,-3/0!P\$%,'&'0!V%&*%!&'!/,9&,V,5!.25!*/&0&X7,5!A)!0%,&/!\$%,'&'!C311&00,,@!.25!1.;,!.!-7A4&*!3/.4!-/,',20.0&32!32!0%,&/!-/3R,*0!03!0%,!5,-./01,20!32!`,2&3/!\$%,'&'!(/,',20.0&32!+.)<!!

\$%,/,!./,!0%/,,!3AR,*0\(\delta\)9,'!:3/!0%,!\,2\(\delta\)3/!\$%,'\(\delta\)'!E,',./*\(\delta\)!*37/','F!

- (/39&5,!.2!&25,-,25,20!/,',./*%!,Y-,/&,2*,!:3/!0%,!'075,20<!
- E, \(\delta 2:3/\delta, \delta 1.0, \delta 4\delta \delta 1.1, \delta 4\delta, \delta 3.1, \delta \delta, \delta 3.1, \delta \delta, \delta 3.1, \delta \delta \delta \delta \delta \delta 2\delta 2\delta \delta \delta 2\delta \delta 2\delta \delta 2\delta \delta 2\delta 3.1, \delta \delta \delta \delta \delta \delta 2\delta 2\delta

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_.*%!'075,20!V&4!%.9,!.!0%,'&'!*3 1 1&00,,!*32'&'0&2>!3:!.0!4,.'0!0%/,,! 1, 1 A,/'0!&2*475&2>!
0%,!E,',./*%!N59&'3/!.'!*%.&/<!\$%,!'075,20!.25!0%,&/!.59&'3/!'%3745!*%33',!0%,!30%,/! 1, 1 A,/'!
3:!0%,!*3 1 1&00,,0!;,,-&2>!&2!1&25!0%.0!.0!4,.'0!32,!3:!0%,! 1, 1 A,/'!17'0!A,!:/3 1!.!'7A:&,45!3:!
-%)'&*'!5&::,/,20!:/3 1 !0%.0!3:!0%,!`,2&3/!\$%,'&'!/,',./*%<!\$%/,,!*3 1 1&00,,! 1, 1 A,/'!17'0!A,!
-%)'&*'!:.*740)!P/,>74./!3/!.5R72*00<!N55&0&32.4! 1, 1 A,/'!:/3 1!370'&5,!0%,!5,-./0 1,200!V%3',!
,Y-,/0&',!*3&2*&5,'!V&0%!0%,!/,',./*%!03-&*0!./,!.443V,5<!!\$%,!'075,20! 17'0!.';!0%,!30%,/!
*3 1 1&00,,! 1, 1 A,/'!&:!0%,)!./,!V&44&2>!03!',/9,!32!0%,&/!`,2&3/!\$%,'&'!C3 1 1&00,,<!%2>!<@:9;80<!
@7C48K!@E;!@M2U<;A;<@;>!<;Q:;85;!@E;6!A:<@!528=4>A!@E70!;75E!52AA4@;;!A;AG;>!4<!
7J7437G3;!=2>!@E;!@M2!<;A;<@;><!>>;O:4>;9!@2!52A?3;@;!@E;!52:><;<

#M

'32<;!@2! O49U.; A;<@;>!P0)-&*.44)!A,:3/,!G.44!3/!`-/&2>!S/,.;@!.44!`,2&3/!\$%,'&'!'
'075,20'!17'0!.//.2>,!03!1,,0!V&0%!0%,&/!E,',./*%!N59&'3/!03!5&'*7''!0%,&/!-/3>/,''!&2!
0%,!-/3R,*0:!\$%,!N59&'3/!1.)!/,X7,'0!.!V/&00,2!-/3>/,''!/,-3/0!.25\\\3/!.!1,,0\\\2>!V\\\0%,!30\\%,/!C311\\\00,,!8,1A,/'<!

[H! \$ / 0!, %!. \$ O \$. * \$ #!#\$", # * . N!

 $\begin{array}{l} N0!0\%,!,25!3:!0\%,!',1,'0,/\ell!.44!(\%)'\&^*!Ddb\ i\ !'075,20'!17'0!*31-4,0,!.!A/\&,:!(/3>/,''!E,-3/0!.25!'7A1\&0!\&0!03!0\%,\&/!E,',./*\%!N59\&'3/!A,:3/,!.!>/.5,!*.2!A,!/,*3/5,5!:3/!0\%,!I!*/,5&0!%37/!*37/',<!`075,20'!&2!(\%)'&^*!DbH\ i\ !.25!(\%)'&^*!Dbb\ i\ !V&44!*31-4,0,!.25!'7A1&0!0%,&/!V/&00,2!`,2&3/!$\%,'&'!.'!,Y-4.&2,5!&2!`,*0&32'!Z!.25!M!A,43V<!!$

\H!!!! .\$ /-, #!*W\$.-.!"#\$.\$ / *&*-, /!0&+N!

#J

 $0\%,)!V\&44! '\&>2!0\%,!`\&>2.07/,!(.>,!3:!0\%,!V/\&00,2!0\%,'\&'<!\$\%,!*31-4,0,5!:\&2.4!`,2\&3/!\$\%,'\&'!V\&44!A,!'7A1\&00,5!03!0\%,!\$\%,'\&'!N59\&'3/\&2!SL\$[!\%./5!*3-)!.25!5\&>\&0.4!:3/1.0\!\$\%,!5\&>&0.4!:3/1.0!17'0!A,!*31-4,0,!.25!&2*475,!.!*3-)!3/!'*.2!3:!0\%,!3/\&>&2.4!`&>2.07/,!(.>,<!$

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                V3/:<!
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                ^44_ f 7.4&0)!3:!0%,! i /&0&2>!P"Z t 0!
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                          A< \$\%, !0\%, '&'!&'!V, 44!3/> .2&?, 5<!
                          *< $\%,! ',20,2*,! '0/7*07/,! .25! 93*.A74./)! ./,! .--/3-\&.0,! :3/! .2!
                725,/>/.57.0,!!*&,2*,!1.R3/<!
                ^444_ (/,',20.0&32!.25!G3/1.00&2>!P"Z t Q!
                          < G3/1.00\&2>!\&'!-/3:, ''\&32.4!.25!*32'\&'0,20!0\%/37>%370!0\%, !53*71, 20\&1
                          A E_{1}, E_{2}, E_{3}, 
                R37/2.4<!
                          *< G&>7/, '!. 25!0.A4, '!./,!-/, ', 20,5!*4, ./4)@!V&0%!.--/3-/&.0,!*.-0&32'<!
H: '10')%+&!+(!F$'1!I#&%+$!=''#-%-!>$#-#&)')%+&!!
$%,!3/.4!-/,',20.0\k32!V\k4!A,!,9.47.0,5!.**3/5\k2>!03!0\k,!:3443V\k2>!*/\k0,/\k.F!
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                            L/>.2&?.0&32!.25!*4./&0)!3:!0%,!'4&5,'!P"Z t 0!
                           .< $,Y00!5&.>/.1'!.25!:&>7/,'!./,!/,.5.A4,!A)!.2!.75&,2*,!&2!LCc(`!H"HH
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#b

\$%,!E,',./*%!N59&'3/!V&4!'7A 1 &0!0%,!3/&>&2.4!9,/'&32!3:!0%,!`,2&3/!\$%,'&'!V&0%!0%,!
2>4K4873!.4K870:>;!''7K;!02!0E;!.;842>!*E;<4<!'22>948702>!G;=2>;!0E;!970;!2=!0E;!
(84J;><406!'2AA;85;A;80!';>;A284;<!N!5&>&0.4!*3-)!17'0!.4'3!A,!:3/V./5!03!0%,!
`,2&3/!\$%,'&'!C33/5&2.03/<!C320.*0!0%,!C33/5&2.03/!&:!%,4-!&'!2,,5,5!-/&20&2>!0%,!%&>%!
X7.4&0)!3/&>&2.4!9,/'&32<!\$%,!-.-,/!*3-)!&'!/,X7&/,5!.'!&0!*320.&2'!3/&>&2.4!'&>2.07/,'!
.25! 1.)!*320.&2!*343/!&1.>,'<!\$%&'!*3-)!V&44!A,!A3725!.25!53*71,20,5!A)!0%,!
5,-./01,20<!N!*31-4,0,!,4,*0/32&*!*3-)!P-5:!:3/1.00!3:!0%,!:&2.4!53*71,20!&'!.4'3!
/,X7&/,5!:3/!5,-./01,20.4!/,*3/5'<!N55&0&32.4!A3725!*3-&,'!./,!3:0,2!/,X7,'0,5!A)!0%,!

DH

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DI

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E,9&'&32!+.0,F!G,A/7./)!"0!"HIJ!

`0.07'F!(7A4&*!!!

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$%,!*/&0,/&.!:3/!231&2.0&32!03!`&>1.!(&!&'F!!!
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- N! 1 &2& 171!6 (N!&2!-%)'&*'!3:!#<HH<!
- N0!4, . '0!#!', 1, '0, /'!3:!:74400&1,!*344,>,!V3/;!*31-4,0,5!P#M!*/,5&0!%37/'Q<!
- N0!4, . '0!0V3!DHH04,9,4!-%) '&*'!*37/', '!*31-4,0,5!.0!L+a!V&0%!.!S!3/!A,00,/<!
- E.2; &2>!&2!7--,/!32,00%&/5!3:!0%,!C34,>,!3:!`*&,2*,'!

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"23456!28! (89;>K>79:70;!);J;3! 'E733;8K;!$I7A<!48!0E;!"E6<45<!0;?7>0A;80!
E,9\&\&32!+.0,F!a2;23V2!
N!'075, 20!.0!L45!+31 \&2 \&32!a2 \&9./' \&0.!1.)!/, X7.'0!03!0.:.!*%.44,2>.!,Y.1!03!/,*&9.!
*344,>,!*/,5\\dots!A.',5\\dots2\!-\\dots3/!;23V4,5>,\left\!N4!\*\\dots.44,2>,!,Y. 1!/,X7, '0'!17'0!A,!'7A1\\dots00,5\\dots03!
0\%, !F22#8-(/2(:*#/*(3-+*&#&'(6$$-$$, -&<math>\%!V\%&*%!0%, 2!:3/V./5'!/,X7, '0'!03!0%, !.--/3-/&.0,!
5, -./01, 20!:3/!. --/39.4!.25!.51 \&2\&'0/.0\&32 <!=:!0%, !/, X7, '0&'!. --/39, 5@!0%, !'075, 20!V&44!A, !
/, X7\&/, 5!03! - .)!07\&0\&32!.0!.!/.0,!',0!A)!0\%,!a2\&9,/'&0)<!
(,/1 \&'' \& 32!03!0.;,!.!*\%.44,2>,!,Y.1!\& 2!-\%)' \&''!\&'!230!.7031.0 \&*!.25!V \& 44!A,!5,0,/1 \& 2,5!32!.!
*.',0A)0*.',!A.'&'!A)!0%,!C+N<!!
=0! c 3/1.44)0!.!*\%.44,2>,!,Y.1!V&44!324)!A,!.443V,5!&:F!
        IQ $%,!'075,20!%.'!0.;,2!.25!-.'',5!.!*344,>,!4,9,4!P230!%&>%!'*%3340!*37/',!.0!
             .230\%, /!\&2'0\&070\&32!V\&0\%!. !>/.5, !V\%\&*\%!V3745!. 443V!: 3/!0/.2': ./!03!L + a! A70!V\%\&*\%!
             53, '!230!0/.2':,/!:3/!-"\\\*+/*G\\\\&+\*?!/,..'32'!\\P:3/!,\Y.1-4,\F!.!:3/,\&>2!\*344,>,!:3/!
             V\% %*%!, X7 &9.4,2*)!%.'!230!A,,2!5,0,/1 &2,50<!
         "0 N!'075, 20!*. 2!5, 1.32'0/.0,!, Y-, /\&, 2*, 10%, 0!&'!, X7&9.4, 20!03!%, 9&2>!0.;, 2!.!*344, >,!
             4,9,4!-%) '&*'!*4.''!P:3/!,Y.1-4,0!:/31!0%,!1&4&0./)!3/!V3/;!,Y-,/&,2*,!&2!&257'0/)&!
==0!
```

! D#

```
"23456!28! '>;940!=2>!0E;!&9J785;9!"375;A;80!$I7A!
E.9\&\&32!+.0.F!G.A/7./)!"@!"HIJ!
N=-/39,5!A)F!^0,-\%,2!S7,401.22!.25!C\%./4,'![)5,!
                              '*3/,!#!uuv!( [ r `!IHI c!
(%)'&*'!I!!
                              '*3/,!#!uuv!( [ r `!IH" c!
(%)'&*'!"'!!
              !
                      !
                              '*3/,!#!uuv!([r`!IHIc!w!([r`!IH"c!!
(%)'&*'!S!!
                                     P0%&'!&'!.!4,>.*)@!(%)'&*'!S!&'!23!432>,/!3::,/,50!
(%)'&*'!I!!
                              '*3/,!D!@Z!uuv!([r`!IIIc!!!
(%)'&*'!"!!
                      ١
                              '*3/,!D!@Z!uuv!( [ r `!II" c!!!
(%)'&*'!S!!
                              '*3/,!D@!Z!uuv!([r`!IIIc!w!II"c!
                              '*3/,!#!!!uuv!([r`!IIIc!P2,V!.55&0&320!
(%)'&*'!C!P8,*%.2&*'0!!
                              '*3/,!#!!!uuv!([r`!II"c!P2,V!.55&0&32Q!
(%)'&*'!C!P_q 8 Q!!
(%)'&*'!C!P8,*%.2&*'Q!!
                              '*3/,!D@!Z!uuv!( [ r `!"#I c!
                              '*3/,!D0!Z!uuv!( [ r \\" c!
(%)'&*'!C!P_q 8 0!!!
E,9\&'\&32!+.0,F!T74)!J@!"HIZ!
N - -/39.5!A)F!C + N!
`0.07'F!(7A4&*!
$%,!(%)'&*'!+,-./01,20!V&44!.V./5!N(!*/,5&0!.'!:3443V'F!!
N(!(\%)'\&*'!I!'*3/,!3:!D!3/!ZF!!L+a!([r`!IIIc@!D!*/,5\&0'!
N(!(\%)'\%*'!"!*3/,!3:!D!3/!ZF!!L+a!([r]!II"c@!D!*/,5\&0'!
N(!(\%)'\%'!C@!8, *\%.2\%'!'*3/,!3:!D!3/!ZF!L+a!([r`!"#Ic@!D!*/,5\@'!]
N(!(\%)'\&*'!C@!_4,*0/\&*\&0)!.25!8.>2,0\&'1!'*3/,!3:!D!3/!ZF!L+a!([r`!"#"c@!D!*/,5\&0'!])
E.9\&\&32!+.0.F!+.*.1A./!IH@!"HIH!
N = -/39,5!A)F!(\%)'\&*'!+,-./01,20!G.*740)!
`0.07'F!(7A4&*!
$\%,!(\%)'\&\*'!+,-.\01,20!V\&\4!.V.\/5!0\%,!:3\\43V\&2>!\*\,5\\\0!:3\!N(!\_Y.1'\F!
    I< (%)'&*'!S!_Y.1!C/,5&0!:3/!(%)'&*'!IIIc0II"c!Pd!*/,5&0'0!V&44!A,!.V./5,5!:3/!.!*3/,!
       3:!D!3/!Z<!!
    "< (%)'&*'!C!_Y.1!P8,*%.2&*'Q!C/,5&0!:3/!(%)'&*'!"#Ic!PD!*/,5&0'Q!V&44!A,!.V./5,5!:3/!
       .!'*3/,!3:!D!3/!Z<!!
   \#(\%)'\&^*'!C!_Y.1!P_4, *0/\&^*\&0)!.25!8.>2,0\&'10!C/,5\&0!:3/!(\%)'\&^*'!"\#"c!PD!*/,5\&0'0!V\&44!
       A,!.V./5,5!:3/!.!'*3/,!3:!D!3/!Z<!!
                                           !
```

DD

```
1:49;348;<!28!@E;!'$#*-%-'&*$!,%!'&#$$#!$d''$#-$/'$N!''E6<45<!!
E.9\&\&32!+.0.F!!
N'!.!-./0!3:!0\%, !C./, ./!N59.20.>,!(/3>/.10!.25!&2!.2!,::3/0!03!,2*37/.>,!'075,20'!03!-7/'7,!
 -/3:, ''&32.4!, Y-, /&, 2*, !3-3/072&0&, '!V%&4, !.0!L45!+31 &2&32! a 2&9, /'&0) @!0%, !C./,, /!
18.2.>, 1.20!C.20./!-/3-3'.'!0\%, 15.9.43-1.20!3:!.!C./0\&:&*.0.!3:!(/3:.''&32.4! Y-./&.2*.<!
$\%,!*,\\langle \langle \tau.0,\langle \tau'.\tau.3!.\!:\langle 9,x*\\,5\langle 0!-\/3:,\'\langle 32.4!,Y-,\langle \langle 2*,\!*3\\,\langle 2*475\langle 2>!=20,\/2'\langle -!
3/!C33-,/.0\&9,!_57*.0\&32!.25!*37/','!3::,/,5!A)!0\%,!C./,,/!8.2.>,1,20!C,20,/0!.25!*./,,/x
:3*7',5!*37/','!.4/,.5)!&2!,.*%!1.R3/!*7//&*7471@!V&0%!.!1&2&171!3:!0V,49,!*/,5&0'!/,X7&/,5!
:3/!0%,!C,/0&:&*.0,!3:!(/3:,''&32.4! Y-,/&,2*,<!N59.20.>,'!3:!0%,!*,/0&:&*.0,!&2*475,F!!
 . < N2!.55 \&0 \&32.4!*/,5,20 \&.4!03!1.;,!'* \&,2*,!0,* \&2343>)!>/.57.0,'!13/,!1./;,0.A4,!!!
A < +3*71,20.0\&32!3:!*33-,/.0\&9,!,57*.0\&32!3/!\&20,/2'%\&-!!!
*< N!-30, 20&.4!&2*/,..',!&2!*33-,/.0&9,!,57*.0&32!/,>&'0/.0&32!V&0%370!&2*/,..'&2>!0%,!030.4!
                            271A, \frac{1}{1}, \frac{1}, \frac{1}{1}, \frac{1}{1}, \frac{1}{1}, \frac{1}{1}, \frac{1}{1}, \frac{1}
                            /,>&'0,/!&:!0%,!*/,5&0!!*.2230!A,!.**31 135.0,5!&2!0%,!*7//&*747 1!!!
5<(./0&*&-.0&32!&2!*./,,/!,Y-43/.0&32!.25!R3A!',./*%!0,*%2&X7,'!*37/','!03!:7/0%,/!,X7&-!!
                            >/.57.0\(\delta\)>!\(\delta\)\(\delta\)\(\delta\)!\(\delta\)\(\delta\)\(\delta\)!\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\delta\)\(\de
                              8.2.>. 1.20!C.20./!U&&'32!03!3704&2.!0%.!-/3>/. 1!3:!'075)!'-.*&:&*!03!0%.!1.R3/<!
                            G3443V&2>!*31-4,0&32!3:!0%,!*37/',V3/;@!0%,!C8C!U&.&'32!V3745!*,/0&:)!'.0&':.*0&32!
                            3:10\%, 1/\sqrt{X7}\%, 1,2(32!3:10)0.2(\%,)-0.2(\&)02(\$0.2(0)-0.2(!0)0.2(3!:)!0)(\&)0.2(*)0.2(::)0.2:10,13:!!
```

! DZ

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",)-'-$.!,/!&R&#0.!&/0!.'W,)&#.W-".!
!
"23456!28!.;3;5@48K!#;54?4;8@<!=2>!@E;!04;9;>45E!.5E237><E4?!
!
E,9&'&32!+.0,F!T.27./)!"I0!"H"H!
!
$%,!:744!2.1,!3:!0%,!'*%34./'%&-!&'F!\$%,!S/&.2!+32.45!+&,5,/&*%!.25!G4.9&.!N4,Y.25/.!
```

DM

```
"'23456!28!.;3;5@48K!#;54?4;8@<!=2>!@E;!02A48428!.5E237><E4?!

E,9&'&32!+.0,F!T.27./)!"I@!"H"H!
!

^,4,*0&32!3:!>/.57.0,!'075,20'!03!/,*,&9,!0%,!.227.4!+31&2&32!^*%34./'%&-!V&44!A,!1.5,!A)!
0%,!+,-./01,20!C%.&/@!&2!*32'740.0&32!V&0%!0%,!6(+<!
```

DJ

Db

```
&""$ / 0-dN!, (*0&*$0!",)-'-$.!
"23456!=2>! '>;7@48K! '2:><;!/:AG;><!=2>!&"! '>;94@!!
E,9\&\&32!+.0,F!!L*03A,/!I"@!"HHM!
`075,20'!V%3!0.;,!0%,!N(!,Y.1!&2!-%)'&*'!*.2!,./2!*/,5&0!:3/!0%,!4,*07/,!-3/0&32!3:!37/!
&20/357*03/)!*37/', '0!A70!230!0%, !4.A!-3/0&32<!=2!3/5, /!03!/,*, &9.!, X7&9.4,2*)!:3/!(%)'&*'!III0!
II"0!"#I0!3/!c`C("E f0!'075,20'!17'0!.4'3!*31-4,0,!37/!I!*/,5&0!4.A!*37/',!P(%)'&*'!II#!3/!
IID0<!!
=2!3/5, /!03!'0/, .14\&2, !0\%, !.V./5\&2>!3:!*/, 5\&0!.25!:3/!, .')!\&1-4, 1, 20.0&32!3:!0\%, !2, V!5, >/, ,!
.75\&0!'3:0V./,0!\&0!V3745!A,!3:!>/,.0!A,2,:&0!03!\%.9,!.!*37/',!271A,/!.''3*&.0,5!V&0%!0%,!
4,*07/,!-3/0\(\delta\)2!3:\!0\(\sigma\),\!*4.\'\,\'\!\$\\(\delta\)\!\!37/\,\!\\\3745\!2,9,\!\/72\!.25\!\075,20\!\\\3745\!230\!A,\!.443\V,5\!
03!'&>2!7-!:3/!&0<!$%.!5.'*/&-0&32!V3745!230!.Y-4&*&04)!/.:./!03!0%.!\4.*07/.0-3/0&32<1!$%&'!&'!
-./0&*74./4)  !&1-3/0.20!A,*.7',  !&:!..!4,*07/,  !324)  !-3/0&32!3:!37/!&20/357*03/)  !*37/',  '!  V.'!
.9.\&4.A4,@!*, /0.\&2!5, -./01, 20'!1\&>\%0!3-0!03!';\&-!0\%, !4.A<!!
G37/!2,V!\*37/',']!V&44!A,!4&'0,5<!$%,\*37/',!5,'*/&-0&32!V&44!/,.5!'31,0%&2>!4&;,!0%&'F!!
(%) '&*'!IZI0IZ"!PM!*/, 5&0'0F!`075, 20'!V%3!/, *, &9,!.!#@!D@!3/!Z!32!0%, !N(!(%) '&*'!S!, Y. 1!
.51&2&'0,/,5!A)! $`!V&4!A,!.V./5,5!#!*/,5&0'!:3/!(%)'&*'!IZI!.25!#!*/,5&0'!:3/!(%)'&*'!IZ"<!!
(%) '&*'!"ZIF!`075,20'!V%3!/,*,&9,!.!D!3/!Z!32!0%,!N(!,Y.1!(%) '&*'!C!,Y.1!P8,*%.2&*'Q!
.51&2&'0,/,5!A)! $`!V&4!A,!.V./5,5!#!*/,5&0'!:3/!(%)'&*'!"ZI<!!
(%) '&*'!"Z"F!` 075,20'!V%3!/,*,&9,!.!D!3/!Z!32!0%,!N(!,Y.1!(%) '&*'!C!,Y.1!P 4,*0/&*&0)!.25!
8.>2,0\&'10!.51\&2\&'0,/,5!A)! $\`!V&44!A,!.V./5,5!\(\frac{1}{2}!\),5\(\lambda'\)!:3/!(\(\lambda'\)\(\lambda''\)!"Z"\(\lambda'!\)
PN*07.4!*37/',!271A,/'!.25!5,'*/\&-0&32'!03!A,!5,0,/1&2,5!&2!*32'740.0&32!V&0%!T75)!
S3V1.20<!!
$%, 20!, X7&9.4,2*)!*/,5&0!*.2!A,!>&9,2!.'!:3443V'F!!
IZIwII#!u!III!IZ"wIID!u!II"!"ZIwII#!u!"#I!"Z"wIID!u!c`C("E_f!!
=2!.55&0&320!.2)!32,!3:!0%,!\*37/',']!PIZ"0!IZ"0!IZ"0!"ZI0!3/!"Z"0!u!c`C(#E_f!!
c 30,!0%.0!*/,5&0!:3/!(%)'&*'!"#"!V&44!230!A,!.V./5,5!A,*.7',!0%,!(%)'&*'!C!N(! Y. 1 !P 8 0!
53,'!230!*39,/!3-0&*'<!!
                                !
١
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ZH

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/2A4873!.5E;9:3;!2=!1>79:70;!$3;504J;!'2:><;<!
E,9\&\&32!+.0, F!+,*,1A,/!"HIMK!"HIZ!
N = -/39, 5!A F! (%) '&*'!+, -./01, 20!G. *740)!
=2!3/5,/!03!-/39&5,!>/.57.0,!'075,20'!V&0%!.!:744!/.2>,!3:!*37/','!2,,5,5!:3/!.!135,/2!
>/.57.0,!,57*.0\(\)32\(\)!+,-.\(\)01,20!\(\)\(\)44!.00,1-0!03!3::,\(\)!,4,*\(\)\(\)9,!*37\(\)','!A.',5!32!0\(\),!
:3443V&2>!'*%,574,F!
r NE!I!
G.44!, 1, '0,/F!
   • ([r\!dD"!N59.2*,5!f8!
   • ([r]!JZDWdZD!N**,4,/.03/!(%)'\&*'!
`-/&2>!`, 1,'0,/F!
   • ([r\!JYY\\dYY!N031&*\\834,*74./!(%)'&*'!h0!
   • ([r] dJI! f7.2071!G4,45!\%,3/)!
   • ([r \cdot dZb!C4.''\&*.4!8, *\%.2\&*'!.25!_4, *0/31.>2,0\&'1!\&2!N**,4,/.03/!(%)'&*'!
<u>r_NE!"!</u>
G.44!, 1, '0,/F!
   • ([r\!J""\d""!c7*4,./!.25!(./0\%*4,!(%)'\&*'!=!
   • ([r\!dZJ!(4.'1.!(%)'\%*'!
`-/&2>!`,1,'0,/F!
   • ([r]!JY)WdY)!C325,2',5!8.00,/!hh0!
```

ZI