



!"#\$%&' ( ) &\* ' % + &\* , \$\* - + . ' % + &\$# ! / # % - % ( # 0 \$ # 1 % & % & 2 \$ , % 2 1 ' \$ + &\$ ' 1 ( \$ - \* ) 3 \$  
1 % # ' + ) 4 \$ + 5 \$ ' 1 ( \$ / \* / 4 \$ 6 / , \* 7 3 \$ 8 \* ) 3 ( ' 9 \$

!  
\$%&! ' ( ) \* ( + , ! \$ - . / + - 0 !  
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1 \* . , + ! . / 2 + - / ( 2.3 / ( , ! ( 4352.3 / ! . 6 ! ( ! 7 + ( 82.98 , ! ) 3 / ) + 52 ! . / ! 2 \* + 3 - % : ! . 2 ! 392 + / ! , + ( 46 ! 23 ! 4 ( - ; ! ) 3 / 6 + < 8 + / ) + 6 = !  
> - 3 ? ! . 26 ! . / ) + 52.3 / : ! \* 8 ? ( / ! 2 - ( 99 . ) ; . / @ ! \* ( 6 ! + / ( 7 , + 4 ! . / 2 + - / ( 2.3 / ( , ! ( 4352.3 / 6 = ! 1 \* . , + ! 2 \* + ! A / . 2 + 4 ! B 2 ( 2 + 6 !  
( , 3 / + ! ) ( / / 32 ! 4.6 ? ( / 2 , + ! 2 \* + ! + / 2 . - + ! 7 ( 7 % ! C 7 , ( ) ; ! ? ( - ; + 2 D ! ( / 4 ! 2 \* + ! , . ; + , % ! 7 , ( ) ; ! ? ( - ; + 2 ! 93 - ! ) \* . , 4 - + / E 6 !  
3 - @ ( / 6 ! . / 2 + - 2 F . / + 4 ! F . 2 \* ! . 2 : ! 2 \* + ! A = B = ! ) ( / ! - + ? 3 G + ! . 26 ! , ( - @ + ! ) 3 / 2 - . 782.3 / = ! ! \$ % ! , . ? . 2 / @ ! 2 \* + ! 9 + 4 + - ( , !  
( 4352.3 / ! 6876.4 % ! 23 ! 3 / , % ! 43 ? + 62 . ) ! ( 4352.3 / 6 : ! 2 \* + ! A / . 2 + 4 ! B 2 ( 2 + 6 ! ) ( / ! + / 68 - + ! . 2 ! 3 / , % ! ( . 46 ! 6 % 62 + ? 6 !  
F . 2 \* . / ! . 26 ! ) 3 / 2 - 3 , ! ( / 4 ! ( 44 + 66 ! 2 \* + ! / + + 46 ! 39 ! . 26 ! 3 F / ! ) \* . , 4 - + / ! F . 2 \* 382 ! \* 3 ? + 6 ! ? 3 - + ! + 99 + ) 2 . G + , % = ! ! H ( / % !  
32 \* + - ! ( 82 \* 3 - 6 ! \* ( G + ! ( , 63 ! / 32 + 4 ! G ( - . 386 ! \* 8 ? ( / ! 2 - ( 99 . ) ; . / @ ! ( / 4 ! 532 + / 2 . ( , ! 3 - @ ( / ! 2 - ( 99 . ) ; . / @ ! ) 3 / ) + - / 6 : !

./!5+G+/2./@!2\*+!4.,82.3/!39!2\*+.-!-+638-)+6-

A/.3/=!! 1 3-,4! 1 (-!U!,. ;+,%!. /65.-+4!2\*.6!4+),(-2.3/:(6! ? (/%!%38/@!(48,26!+05+-./)+4!9.-62\*(/4!  
2\*+!\*3--3-6!39!\*3F!)\*.,4-+ /!F+-+!2-(2+4=!'!! ' (2\*+-!2\*(/!(!,.62!65+).9%./@!(!)\*.,4E6!-.@\*26!:!2!93)86+4!



39!)\*,.4-+/-D<sup>01</sup>!!Q\*+!S3/G+/2.3/!3/!2\*+! '.@\*26!39!2\*+!S\*.,4!F(6!(4352+4!7%!2\*+!V+/-+-(,!I 66+ ? 7,%!  
./!#]b]-<sup>02</sup>!! f /+!39!2\*+! ? 362!6F.92,%!(4352+4!-(2.9.)(2.3/6:!2\*.6!4+),(-2.3/!(,2+-+4!2\*+!F(%!) \*.,4-+/  
(-+!G.+F+4!,+@(!,%ZZ)\*.,4-+!/!F+-+!9./(!,%!@.G+!/(!8/.<8+!6+2!39!-.@\*26-<sup>03</sup>!!Q\*.6!4+),(-2.3/!(,63!,(.4!  
2\*+!938/4(2.3/!39!2\*+!A/.2+4!T(2.3/6!S\*.,4-+!/!6!>8/4!hATUSX>i;!F\*.)\*)!,(2+-!7+)( ? +!(!5+- ? (/+/2!  
? + ? 7+-!39!2\*+!A/.2+4!T(2.3/6-<sup>06</sup>!!Q\*.6!3-@(/.L(2.3/!\* (6!(,63!( )3 ? 5.,6\*+4!(!@-+(2!( ? 38/2!6./)+!  
2\*+!/ ) 1 .92c mB(\*+)0.2(!)-!3/!@-+!

(G(.,(7,+<sup>-13</sup>!!>3-!./62(/)+:! I 4352.3/!B+-G.)+!e-3G.4+-6!h I Be6i! ? 862!7+!(.)-+4.2+4!23!+/68-+!2\*+6+!  
(@+/.).+6!C ? ++2!)3 ? 5-+\*+/6.G+!9+4+-(,!62(/4(-46!4+6.@/+4!23!+/68-+!2\*(2!2\*+%!35+-(2+!86./@!638/4!  
5-39+66.3/(,!(/4!+2\*.)(!,(4352.3/!5-(.)+6=D<sup>16</sup>!

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5=k3 -#\$"#+, -#k>4- ?+, -#k@\*-( "22k

U/!2\*+! A/.2+4!B2(2+6:(4352./@!9-3 ?!(! S3/G+/2.3/!62(2+!. /),84+6!6.0!4.62./)2!62+56=<sup>17</sup>!!>.-62:!2\*+!  
(4352.G+!9( ? .,%! ? 862!)\*336+!( /!(55-3G+4! (4352.3/!6+-G.)+! 5-3G.4+-( /4!2\*+!/ ! ? 862! 7+!938/4!  
68.2(7,+!23!(4352!(!)\*.,4=<sup>18</sup>!!

/8?7+-!39!9+?(,+!3-5\*(/6=-26!!1\*.,+!2\*+!3/+P)\*.,4!53,.)%!F(6!(7(/43/+4!./!"N#^:!2\*+)38/2-%!62.,,!  
9(+6!2\*+!(92+-? (2\*!F.2\*!.26!3G+-9,3F./@!3-5\*(/(@+6=-27!

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5=&A\*?/%##%I"2&,#&3/,##%&

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XG+!/2\*38@\*!2\*+!+02-+?+!/+4!93-!3-5\*(/(@+6!-36+!(92+-!2\*+!5(66./@!39!2\*+!3/+P)\*.,4!53,.)%:  
3-5\*(/(@+6!\* (G+!+0.62+4!./!S\*./(!+G+-!6./)+!X?5+-3-!18E6!938/4./@!39!2\*+!@3G+-/?+/2P-8/  
9(.,-2%!./!d"#!I=K=-28!!Q\*.6!3-5\*(/(@+!/32!3/,%)(-+4!93-!)\*.4-+!/782!(,63!93-!+,4+-,%!(48,26!F.2\*382!  
)\*.4-+/=39!!Q\*.6!(,2-8.62.)!938/4./@!633!/128-/+4!7-82(,=!U2!\* (6!7++!/4.6)3G+-+4!2\*(2!B\*(/@\*(!  
3-5\*(/(@+6!\* (G+!\*3--.9)(,,%!(786+4!2\*+.-!)\*.4-+!/!. /),84./@!C4+,.7+-(-2+!62(-G(2.3/!23-28-+!(/4!  
6+08(,(66(8,2:!)3/2./8+4!3G+-!(!5+-34!39!? (%!%+(-6!(/4!,+4!23!2\*+!8// (28-(,!4+(2\*6!39!F+,,!3G+-!  
#:NNN!)\*.,4-+!/7+2F++/!#]b^!(/4!#] ]"!(,3/+D<sup>3</sup>!!Q\*+!587,.)!633/!@-+F!)3/)+-/+4!(7382!2\*+6+!  
)\*.4-+!/!(/4!2\*+!@3G+-/?+/2!9(+4!5-+668-+!23!9.0!2\*+!6%62+?.)! (786+!39!2\*+!)\*.4-+/=3/!!  
T+G+-2\*+,+66:!? (%!@3G+-/?+/2!399.)+-6!C;/3F./@,%!6855-+66+4!+G.4+/)+!39!)\*.,4!(786+!(2!2\*+!  
3-5\*(/(@+!15+-6.62+/2,%!.@/3-+4!2\*+!. /62.282+E6!\*.\*?!?3/2\*,%4+(2\*!9.@8-+6:(/4!./!#] ]":!<8(6\*+4!  
(/!. /G+62.@(2.3/!./23!3-5\*(/(@+!5-()2.)+6-D<sup>30</sup>!!U2!F(6!(+6%!93-!2\*+?!23!)3G+-!2\*+.-!2-();6!(6!2\*+!  
\$8-+(8!39!I99(-6!)38,4!+(6.,%!4.6536+!39!2\*+!\*3--.9%./@!+-02(62(+0.2(/))0.2(+0.2(!)-24.8601.92c mBT502/3(2)0



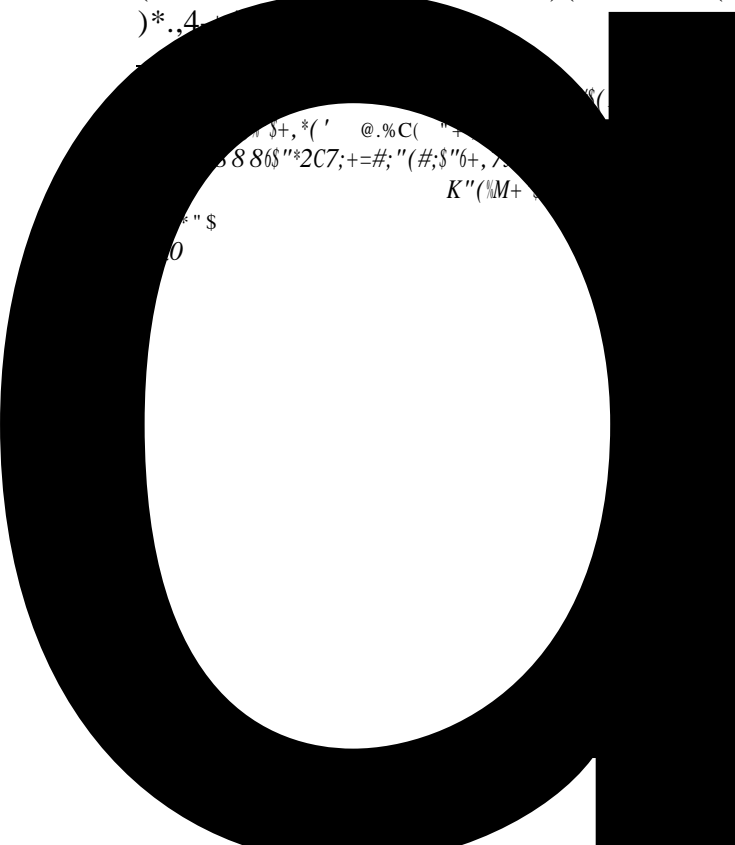
./!2\*+!#] ]N6<sup>-37</sup>!!B3 ? +!)\*.4-+/-+6.4+!./!(!9362+-!)(-+!)3 ? ? 8/.2%!6%62+ ?!(/4!(-+!4.G.4+4!( ? 3/@62!  
\*386+6!./!( ? 3-+!-8-(,)3 ? ? 8/.2%<sup>-38</sup>!!>3-!+0( ? 5,+:(!9362+-!)(-+!)3 ? ? 8/.2%!./!B\*+/%(/@:!S\*./(!  
5,(+6!2F3!)\*.4-+/-!F.2\*./!+(\*)!\*3 ? +=<sup>69</sup>!! f /+!39!2\*+6+)\*.4-+/-!.6+(6.,% ! ? 37.,+;!782!2\*+!32\*+-.!6!  
392+!/4.6(7,+4!(/4!/++46!(66.62(/)+!23! ? 3G+=<sup>6</sup>!!K.6(7,+4!)\*.4-+/-!68--+/4+-+4!23!2\*+!@3G+-/ ? +/2!

9362+!)(-+!6%62+ ? :! ? (/ %!@3G+- / ? +/2!399.).(,6!(/4!3-5\*( / (@+6!)3/2./8+!23!-+986+!23!2( ; +!) -+4.2!93-!  
2\*+.-!( )2.3/6=7/!

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U/4.(E6!9362+!)(-+!6%62+ ? !.6! ? 3-+!4+)+/2-(.,L+4!)3 ? 5(-+4!23!32\*+!/ (2.3/6:!(6!.2!.6!6+2!85!(-38/4!  
4.99+ +/2!G3,8/2(-%!( /4!587,.)!. /62.282.3/6=70!! I ,3/@!F.2\*!3-5\*( / (@+6!( /4!)\*. ,4-+ /E6!\*3 ? +6:!2\*+--+!  
(-+! (,63! /3/P)3/G+/2.3/(, ! . /62.282.3/6=71! ! Q\*+! ? 362! 5358,(-! /3/P)3/G+/2.3/(, ! (,2+- / (2.G+! .6!  
B(. j -.5(! [ 3 ? +6=72!!U/62+(4!39!(!2-(4.2.3/(, !9( ? ,.%! ? 34+; !2\*+6+!\*3 ? +6!+ /)38-(@+!2\*+!3,4+-!9362+!  
%382\*!23!2( ; +!) (-+!39!2\*+!%38/@+-%382\*=-! 1 \*.,+!2\*+!73%6!( /4!@.-,6!(-+!6+5(- (2+4! !2\*+%! (-+!2(8@\*2!23!  
5-32+)2!+ ) \*!32\*+--!!

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I ,3/@! F.2\*!4.99+ +/2! . /62.282.3/6: !U/4.( ! (,63!\* (6!. ? 5,+ ? +/2+4! ? (/ %!, (F6!23!)3 ? 7(2!)\*. ,4! (786+!  
( /4! /+@,+)2=73!!Q\*+!V8(-4.( /6!( /4! 1 (-46! I )2!39!#b]N!9.-62!6+2!2\*+!7(6.)!482.+6!39!@8(-4.( /6!39!( !  
5+-63/=76!!U2( ,63! + / )2+4! 2\*+! 5-3)+66!93-!7+)3 ? . /@! @8(-4.( /! 39! (!)\*. ,4! 32\*+ -F.6+! ; /3F/! (6!  
(4352.3/!3-!68--+/4+- . /@!(!)\*. ,4!2\* (2!3/ +!\* (6! /32!5-35+-,%!2( ; +/!) (-+!39=77!! I , ? 362!3/ +!\*8/4+4!  
%+(-6!, (2+-!Q\*+! [ . /48! I 4352.3/6!( /4!H (. /2+ / ( /) +! I )2!39!#]d^!, (4!382!2\*+!938/4(2.3/!93-!F\*(2!( !  
G(.4! (4352.3/!+ /)3 ? 5(66+6: !F\*3!\* (6!2\*+! (7.,2%!23! (4352!( !)\*. ,4! ( /4!2\*+!37.,@ (2.3/6!2\* (2!93,,3F!  
(4352.3/=78!!Y+2!2\*+!5-3G.6.3/6!93)86!3/! [ . /486!43 ? .),+4! . /!U/4.( :!3/,%! (.,3F./@! [ . /48! ? (,+6!  
( /4!9+ ? (,+6!23! (4352=89!!U/!2( /4+ ? :!Q\*+! 1 3 ? + /@6! ( /4!S\*. ,4-+ /@6!U/62.282.3/6!hJ.) + /6. /@i! I )2!39!  
#]d^!F(6!(,63!+ / ( )2+4=8! !! 1 \*.,+ /32!93)86+4!3/! (4352.3/6: !2\* .6! ( )2! ( . ? +4!93-!2\*+!7+22+- ? +/2!39!  
F3 ? + /! ( /4!)\*. ,4-+ /E6!F+,9(-+!:-+<8.- /@!( !,+ /@2\*%!5-3)+66!93-! . /62.282.3/6!)(- . /@!93-!2\*+ ? !23!@+2!  
,.) + /6+4=8!! J (62,%: ! 2\*+! \_8G+ / .,+! \_862.)+! I )2! 39! #]b^! (,63! 4.4/E2! (44-+66! (4352.3/! 4.-+)2,%=-80!!  
U/62+(4: ! .2! 93)86+4! 3/! 2\*+! -+\* (7.,2(2.3/! 39! /+@,+)2+4! )\*. ,4-+ /! F\*3! + /4! 85! 5(-2.)5(2./@! . /!  
4+., /<8+ /2! ( )2.G.2.+6=81!!Q\*.6!.6!a862!(6!G.2(,!39!( /!+ / ( )2 ? + /2! (6!2\*+!3 /+6!4.-+)2,%!68--38/4. /@!9362+!  
) (-+! 7+)(86+! ? (/ %! 9362+!) \*.,4-+ /! 43! /32! \* (G+! 2\*+! 68553-2! 2\*+%! /++4! 23! / (G.@(2+! ,.9+ =!  
' +\* (7.,2(2.3/! 6!. ? 5+- (2.G+!93-!2\*+6+!)\*. ,4-+ /! (6!2\*+%! \* (G+!,. ; ,%! /+G+! \* (4!-3,+! ? 34+ ,6!23!@8.4+!  
2\*+ ? !2\*-38@\*!- .@\*2!( /4!F-3 /@=!! f G+-!2\*+!5(62!2F3!\*8/4-+4!%+(-6:!.2!6!),+(-!2\*+!,+@.6, (28-+! \* (6!7+ + /!  
(22+ ? 52./@!23!-+93- ? !2\*+!9362+!)(-+!6%62+ ? ! ( /4!2\*+!4.-+!382)3 ? +6!2\*+!5-3@-( ? !)( /! \* (G+!3/!2\*+!  
) \*.,4



)+\$\$ (2%L+\*J( '4%: "":0, (2%8 "+%8(, (%.,#EOE;(2\$;-#0+I\$(0%  
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8 86\$"\*2C7;+=#;"(#;\$"6+, / ,7+\$\$ (29D+\*J('   
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XG+!/F.2\*!G(-.386!5-3@-(?6!23!2-%!23!+/)38-(@+!(4352.3/;!?(a3-!5-37,+?6!62.,!+0.6!F.2\*./!2\*+!  
6%62+?=!I!62(@@+./@!3/+P938-2\*!39!K+,\*E6!\*3?+,+66!(-+!)\*,4-+/:!(/4!3/+!382!39!+G+-%!\*8/4-+4!  
5-362.282+6!.6!(!)\*.,4!8/4+-!2\*+!(@+!39!9.92++/=83!I44.2.3/(,%,?!?(/%!(7(/43/+4!7(7.+6!(-+!,+92!382!  
3/!2\*+!62-++2!23!+.2\*+-!62(-G+!3-!4.+!9-3?!G(-.386!(/.?(,E!(22());6-86!!XG+!/F\*+!/)\*.,4-+!/(-+!  
C(4352+4D!7%!\*3?+6:!(/%!39!2\*+6+!(4352.3/6!28-!/382!23!7+!5(-2!39!(!7,());!?(;-+2!6)\*+?+:!6+,,./@!  
2\*+!7(7.+6!(6!)\*.,4-+!/3-!3-@(/6-87!

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K=

C ? ( ; +!68-+!2\*(2)!\* .,4-+/.!/) (-+!234(%!43!/32!7+)3 ? +!2\*+!G.)2. ? 6!39!23 ? 3--3F=D!<sup>197</sup>!!S3/6+<8+/2,%:!  
./2+-)38/2-%!(4352.3/!39!)\*.,4-+/.!./!2\*+!T+2\*+,-(/46!.6!/3F!8/(G(.,(7,+=<sup>198</sup>!

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X= ' !

' 866.(E6!9362+-!)(-+!6%62+ ? !.6!7(6+4!(-38/4!3-5\*( / (@+6:!. /!F\*.)!\*!9362+-!9( ? .,+6!)(/!7+)3 ? +!( /!  
./2+@-(,! 5(-2! 39! ? (./2(././@! 2\*+!) \*.,4-+/( /4! 2\*+! 68553-2! -+<8.-+4! 23! -( .6+! 2\*+ ? =! ! ' 866.( /!  
3-5\*( / (@+6!(-+! ; /3F /!(6!C\$(7%! [ 386+6:D!93-!)\*.,4-+!/9-3 ? !2\*-++!23!9.G+:( /4!CK+26;%!K3 ? E6:D!  
93-!)\*.,4-+/(@+6!6G+ /!23!6.02++ / =!<sup>199</sup>!! 1 .2\*!3G+-! \NN:NNN!3-5\*( /6!)8--+/2,%!.G./@!. /! ' 866.( :!2\*+!  
/8 ? 7+-!)3/2./8+6!23!./)-+(6+!7%!###` :NNN!+G+-!%+(-=<sup>200</sup>!!Q\*.6/8 ? 7+-!./),84+6!(7382!]d n !39!63).(,!  
3-5\*( /6: ! ? +(/./@! (!, .G./@! 5(-+ /2! 68--+/4+-+4! 2\*+ ? !23!2\*+! 62(2+!! XG+ /! .9!)\*.,4-+ /! (-+!./!2\*+.-!  
5(-+ /2E6!)(-+!63 ? +2. ? +6!2\*+!@3G+- / ? + /2!(66.@ /6!2\*+ ? !23!3-5\*( / (@+6!.9!2\*+!5(-+ /26!\* (G+!-+986+4!  
23!+ /-3,,!2\*+ ? !./!( /!+48)(2.3 / (,!. /62.282.3 / =!<sup>201</sup>!!Y+2:163 ? +!39!2\*+6+!3-5\*( / (@+6!3 /,%!5-3G.4+!) \*.,4-+ /!  
F.2\*! +48)(2.3 /! 85! 23! 2\*+! 6.02\*! @-(4+! F\*.) \*! + /46! 85! ,. ? .2./@! 3-5\*( /6! 23! ,3FP+48)(2.3 /!  
3553-28 / .2.+6!3 /)+!2\*+%( @+!382!39!2\*+!6%62+ ? =!<sup>202</sup>!!

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5=< > < CD2+ " < < - . < > E ; 2 " <

>8-2\*+- ? 3-+! ? (/ %!39!2\*+! ' 866.( /!3-5\*( / (@+6!(-+! ; /3F /!23!7+!C56%)\*363).( ,,%!4+5-.G./@! ' 866.( /!  
./62.282.3/6! 2\*(2! 5-3G.4+4! (4+<8(2+! 5\*%6.)(,! -+638-)+6! 782! /32! )3/6.62+/2: ! -+653/6.G+!  
(-+@.G./@=D!<sup>203</sup>!!

k\*+-1!(/4!4-(@!k\*+-1!7%!2\*+!\*(-=!7!!Q\*+%!(G+!k\*+-1!5.,6!23!)(,?!\*+-!43F/εD!8!!I/32\*+-!%38/@!  
?(/!/32+4!2\*+!62(99!C)3/62(/2,%!@(G+k)\*.,4-+/!./a+)2.3/6:!(/4!2\*+/!2\*+%!6+/2!k2\*+?1!23!2\*+!7+4-33?!  
63!2\*(2!k2\*+%1!F38,4!6,++5=D!9!!  
!

CT(2.3/(, I)2.3/!B2-(2+@%!./!2\*+!U/2+-+626!39!S\*.,4-+!/93-!"N#"P"N#\D!F(6!-+)+/2,%!. ? 5,+ ? +/2+4!  
./!(/+993-2!23!-+28-/)!.4-+!/F.2\*!4.6(7.,2.+6!23!2\*+.-!7.-2\*!9( ? ..+6!(/4!5-3G.4+! ? 3-+!./),86.G+!  
)3 ? ? 8/.2.+6!23!5--+G+/2!)!.4!(7(/43/ ? +/2=!U/!(44.2.3/!2\*+!@3G+-/ ? +/2!6!(,63!62(-2./@!23!5,())+!  
? 3-+!+ ? 5\*(6.6!3/!9362+-!9( ? ..+6=1/8!! f G+-(:,!2\*+!@3G+-/ ? +/2!7+,.+G+6!2\*.6! F.,!\*,5!(G3.4!2\*+!  
(786+!2(;./@!5,())+!F.2\*./!2\*+!3-5\*(/(@+6=!!

!  
1 \*+!/./!9362+-!)(-+!)!.4-+!/F.,!7+!/65+)2+4!7%!(!e6%)\*3,3@3PH+4.)(,Pe+4(@3@.)(,!S3 ? ? .66.3/!  
heHeSi=<sup>109</sup>!!Q\*.6!)3 ? ? .66.3/! F.,!C ? +4.)(,,%!(/4!56%)\*3,3@.)(,,%!+0( ? ./+!)!.4-+!/!.4+/2.9%!  
4+G+,35 ? +/2(,! 4+,(%6:!(/4! 93- ? 8,(2+! (! 62-8)28-+4! 5,(/! 93-! (! )\*.4E6! 98-2\*+-! +48)(2.3/!(/4!  
857-./@./@=D!0!!

j 3-+(16+/2!|=!!|=!!|= j 3-+(!F(6!2\*+!/8 ? 7+-P3+/+16+/4./@!)38/2-%!39!)\*.,4-+!/23!2\*+!A/.2+4!B2(2+6!8/2.,!  
#]j]d=D!06! ! Q\*+6+! \*.623-.)(! ? 3 ? +/26! F++! 98/4( ? +/2(! 23! ./2+-/(2.3/(,! (4352.3/E6! ./)-+(6./@!  
5358,(-.2%=!!!!

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Y+2!:2\*+! 1 3-,4! 1 (-6!F++!+/32!2\*+!3/,%!./9,8+!)+6!3/!./2+-/(2.3/(,(4352.3/6:!(6!2\*+--+!F++! ? (/!  
)+,+7-.2.+6!2\*(2!\*+.\*2+!/4!2\*+!4+ ? (/4!93-!./2+-/(2.3/(,!)\*.,4-+/=!!B3 ? +!39!2\*+!9.-62!)+,+7-.2.+6!23!  
(4352! ./2+-/(2.3/(,,%! F++! H/"& C- ;#4& -.& I ;2,(E6! \_8,+,! I /4-+F6! (/4! H/"& J,#I& %#4& GE6! Y8,!  
\$-+!/+-=107!! Q\*+6+! 9-./46! 732\*! (4352+4! (!5(-! 39!)\*.,4-+!/9-3 ? ! c .+2/( ? !./! 2\*+! #] \N6:!(/4!  
)+,+7-.2.+6!H.(!>(-3F!(/4! I /4-+F!e+,G./!(4352+4!)\*.,4-+!/9-3 ? ! j 3-+(-108!! [ 3,,%F334!(4352.3/6!  
)(-.+4! ./23! 2\*+! 2F+/2%P9.-62!)+/28-%:!(6!6++! ! F.2\*! I /@+,./(!\_3,+,! (/4! \$-(4! e.22-! ! Q\*.6!)385,+!  
(4352+4!)\*.,4-+!/9-3 ? !S( ? 734.(!X2\*.35.(!H(,(F.:!(/4! c .+2/( ? =119!! 1 \*.,+!)+,+7-.2%! (4352.3/6!  
43!/32! ? ( ;+!85!2\*+! ? (66!5+-)/2(@+!39!(4352.3/6:!2\*+%!35+/+4!2\*+!+%+6!39!2\*+! I ? +-.)(/!587,.)!23-!  
2\*+!5366.7.,.2%!(/4!(-@8(7,%!)-+(2+4!(!C2-+/4D!93-!(4352./@!./2+-/(2.3/(,!)\*.,4-+/=11!!

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>8-2\*+--!+.,.@.3/!\*(6!7++!(/!/./9,8+!)+13/!./2+-/(2.3/(,(4352.3/!6++!/(6!(!F(!%23!65-+(4!9(.2\*!(/4!  
,3G+!23!)38/2-.+6!2\*(2!(-+!5(-2.)8,(-,%!6899+-./@=11!>3-!)+2(./!-+.,@.386!6+!)23-6!:2!.6!/32!(!2-+/4:!  
782! (!482%=-10! ' +@(-4,+66: ! ? (/%! -+.,@.3/6! (/4!)\*8-)\*+6!9./4! 7+(82%! ./!(,!,93- ? 6! 39! (4352.3/!  
G.+F./@!.2!(6!(!F(!%23!5-3G.4+!2\*+!8/)/3/4.2.3/(,!,3G+!3/,%!(15(-+/2!)(/!@.G+!23!(!)\*.,4=!!/2+-/(2.3/(,!  
(4352.3/!9)+6!6+G+-(,!668+6: !+G+!/2\*38@\*! ? (/%! 39!2\*+ ? ! ? (%! 7+! 8./2+/4+4=!! B8)\*!5-37,+ ? 6!  
9(./@!./2+-/(2.3/(,(4352.3/!./),84+!8 ? (/!2-(99.);./@!(6!F+,,!(6!532+/2.(!,3-@(/!2-(99.);./@!(/4!  
\*(-G+62./@=!!>8-2\*+ ? 3-+!2\*+!./)-+(6+4!93)86!3/!)\*.,4-+!/3G+-6+(6!4.-+)2,%!.@/3-+6!2\*+!)\*.,4-+!/./!  
38-!3F/!43 ? +62.)!9362+!)-(+!6%62+ ? 6=!!!

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I,2\*38@\*! \*8 ? (/! 2-(99.);./@! \*(6! \*.623-.)(!,,%! 7++! (! 5-+G(+/2! ./4862-%:!.2! \*(6! 7+)3 ? +! (!  
)3/)+-././@,%!,(-@+! 5(-2! 39! ./2+-/(2.3/(,! (4352.3/6! 48+! 23! ? 34+-/P4(%! 2+)\*/3,3@%!(/4!+(6+! 39!  
2-(G+,,! I 6!2\*+!5358,(-.2%!39!./2+-/(2.3/(,(4352.3/6!./)-+(6+4!./!2\*+!,(2+!#]NN6:!2\*+!4+ ? (/4!93-!  
(4352(7,+!)\*.,4-+!/!-36+!(6!F+,,=11!!

+0)++4+4!2\*+!(G(.,(7,+!)\*.4-+!/93-!(4352.3/!/!2\*+6+)38/2-.+6<sup>-112</sup>!! I 6!)3/2-()+52.G+6!7+)( ? +! ? 3-+!  
-+(4.,%!(G(.,(7,+!(/4!2\*+!62.@ ? (!68--38/4./@!8/F+4! ? 32\*+-6!4+)-+(6+4:!2\*+-+! F+-+!+G+!/9+F+-!  
)\*.4-+!/!(G(.,(7,+!23!(4352!F3-,4F.4+<sup>-113</sup>!!T3F:!(6!)38/2-.+6!5-3@-+66.G+,%!4+)-. ? ./(.L+!(73-2.3/!  
2\*+-+!,. ; +,%!F.,!7+!+G+!/9+F+-!)\*.4-+!/!(G(.,(7,+<sup>-116</sup>!

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\$=Q B I > [ X !

U/.2(.,%:(4352.3/!F(6!C4-.G+!/7%!(!\*8 ? (/2(-./!-+653/6+:D!782!5-365+)2.G+!5(-+/26! F\*3! F+-+!  
4+65+-(-2+!23!\*(G+!)\*.4-+!/62(-2+4!5(%./@!68762(/2.(,!( ? 38/26!39! ? 3/+%!23!(<8.-+!)\*.4-+!/=!!Q\*.6!



U/! 3/+! 623-%! 8/)3G+-+4! 7%! S\*(-, +! S862+-.! /! Q I :!(! 9( ? .,%! (4352+4! (!)\*.,4! 9-3 ?!  
S\*./ (= !23!! Q\*+! (4352.G+! 5(-+/26! 62(-2+4! ./G+62.@(2./@! 2\*+! 3-.@./6! 39! 2\*+.-! (4352+4! 4(8@\*2+-! (92+-!  
/32.)./@! 63 ? +!.--+@8, (-.2.+6! ./! 2\*+! (4352.3/! 5-3)+66= !26!! 1 \*+ /! 2\*+! 5(-+/26! F+-+! 9./ (, %! (7,+! 23! @+2!  
./! 238)\*! F.2\*! 2\*+! ? (/! F\*3! C938/4D! 2\*+!, .22,+! @.-,:! \*+! (4 ? .22+4! 2\*+!)\*.,4! F(6! 58-)\* (6+4=!! B28//+4:!  
2\*+! 5(-+/26! 2\*+ /! \*+(-4! (7382! 2\*+! 4.-+)23-! 39! 2\*+! 3-5\* (/ (@+! F\*3! 6++ ? +4! 23!)3/9.- ? !2\*+! (4352.3/!  
(@+ /)%! 738@\*2! 2\*+! 7(7%= !27!! U/! (/3! 2\*+-.! ./2+-G.+F! 587,.6\*+4! 7%! Q V :! 2F3! (4352.G+!

5+35,+!C9./4+-6!9++6:D!(!5(% ? +/2!93-!)\*.4-+!/7-38@\*2!23!2\*+.-!(@+/@)%=-!32!!Q-(99.);+-6!392+/-+)-8.2!  
>./4+-6!F.2\*!(!5-3 ? .6+4!5(% ? +/2:!. /)-+(6+4!62(286:!3-!,+66!(786+=!33!

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XG+!/2\*+!@3G+- / ? +/2!.6!/32!6(9+!9-3 ?!)3--852.3/:(6! ? (/!@3G+- / ? +/2!399.).(,6!\* (G+!2( ; +/!5(-2!./!  
2\*+!6)\*+ ? +=!36!!>3-!./62(/)+!3/+!39!2\*+!C,(-@+62!-./@6!k./!V8(2+ ? (,(!..6!(,+,@+4,%!\*+(4+4!7%!(!235!  
@3G+- / ? +/2! 399.).(,=D!37! ! Q\*+! -./@! ./),84+4! 2\*+! 3-5\*(/(@+! .26+,9:!(6! .2! Cm7+,3/@+4! 23! 2\*+!  
@3G+- / ? +/2:!(/4! ? (/!%!k)\*.,4-+!/1! F\*3! F+/2!2\*-38@\*!2\*.6!./62.282.3!/F+-+!6+/2!23!S(/(4(!3-!2\*+!  
A/.2+4!B2(2+6:!..,+@ (,%,!7+)(86+!2\*+--+! F(6!(/!(@-++ ? +/2!7+2F++/!2\*+!V8(2+ ? (,(/!@3G+- / ? +/2!  
(/4!2\*+! 3-5\*(/(@+=D!38!!

@-(2,%!8/4+--+53-2+4=D<sup>166</sup>!!



62-++26=^9!!Q\*+!/(2.3/!633/(4G(/)+4:!(6!./!#^ ^!(!6+G+/P%+(-P3,4!7+)(?+!2\*+!9.-62!-)3@/.L+4!  
9362+-!)\*,4=^9/!!

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B2.,:!(4352.3/!-+@8,(2.3/6!F+--+! /32!. ? 5,+ ? +/2+4!8/2.,!2\*+! ? .4P#bNN6!F\*+!/H(66()\*86+226!5(66+4!  
(!62(282+193)86./@!3/!)\*,4!F+,9(-+!./!2\*+!(4352.3/!5-3)+66=^90!!>3,,3F./@!6\*3-2,%:!S\*(-,+6!J3-./@!  
\$-())+:!2\*+!4.-+)23-!39!2\*+!T+F!Y3-;!S\*,4-+/E6!I.4!B3).+2%:!7+@(/!2\*+!9362+-!)(-+!6%62+?!  
?3G+?+/2!./!#bd`=^91!!K8+!23!2\*.6!3-@(/.L(2.3/E6!5,(+) + ? +/26:! ? (/!62(2+6!(/4!63).(!(@+/.).+6!  
7+@(/!23!@+2!./G3,G+4!./!2\*+! ? (22+-ZZ98-2\*+-. /@!2\*+!,+@(!5-32+)2.3/6!39!2\*+6+!)\*,4-+/=^92!!Q\*-++!  
62(2+6!,+4!2\*+! ? 3G+ ? +/2k!H(66()\*86+226!e+//6%,G(/.(:!(/4!B382\*!K(;32(=^93!!H(66()\*86+226!7+@(/!  
6876.4.L./@!9( ? ., +6!F\*3!233;!./!(!9362+-!)\*,4:!(/4!B382\*!K(;32(!7+@(/!6876.4.L./@!2\*+!S\*,4-+/E6!  
[3?+!B3).+2%=^96!!e+//6%,G(/.(!5(66+4!(!9362+-!,.)+6./@!,(F:! ? (;./@!.! ? (/4(23-%!23!372(./!(!  
.,)+/6+!7+93-+!9362+-./@! ? 3-+!2\*(/!3+/!)\*,4=^97!!U2!F(6/E2!8/2.,!2\*+!#]NN6!2\*(2!@3G+-/ ? +/2!(@+/.).+6!  
7+@(/!23! ; +5!-)3-46!3/!9362+-!)\*,4-+/:!5+-93- ? !\*3 ? +!./G+62.@(2.3/6!(/4!4+2- ? ./+!2\*+!7+62!  
./2+-+62!39!2\*+!)\*,4=^98!!

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XG+/(92+-!%+(-6!39!. ? 5,+ ? +/2(2.3/!2\*+!9362+-!)(-+!62.,!9()+6! ? (a3-!.668+6-! 1 .2\*(7382!MM` :NN!  
9362+-!)(-+!)\*,4-+/:./!2\*+!A/.2+4!B2(2+6!2\*+!/8 ? 7+-6!\*(G+)3/2./8+4!23!-.6+!3G+-!2\*+!,(62!2+/  
%+(-6=^9!!

23!6899+!9-3 ? !4-8@!(786+:!2\*-++!2. ? +6! ? 3-+!,. ;+,%!23!7+!5-+6)-.7+4!56%)\*32-35.)! ? +4.) (2.3/6:!(/4!  
2F.)+!(6!,. ;+,%!23!6899+!9-3 ? !5362P







(6! ? (/%! (4352.G+!9( ? ..+6!\* (G+!23!,+(-/!(,3/@!2\*+!F(%=/10!!e-3G.4./@!859-3/2!,+@(!-+<8.-+ ? +/26!  
)38,4!\*+,5!9( ? ..+6! (/4!)\*.,4-+!/!7+!)3//+)2+4! ? 3-+!<8.);,%:!(/4!\*+,5!2\*+!9( ? ..%!5,(/!93-!2\*+!  
9./(/).(!-+<8.-+ ? +/26=>8-2\*+:-! ? (/%!9362+-!9( ? ..+6! (-+!8/(F(-+!39!2\*+!2-(8 ? (!9362+-!)\*. ,4-+!/!  
\*(G+! 9()+4! (/4! \*3F! .2! )38,4! (99+)2! 2\*+ ? =/11! ! e-3G.4./@! ? 3-+! )3 ? 5-+\*+/6.G+! 2-(././@! (/4!  
+48)(2.3/(,!-+638-)+6!23!2\*+!532+/2.(,! (4352.G+!9( ? ..+6!F38,4!./93- ? !2\*+ ? !3!/F\*(2!23!+05+)2!3/)+!  
2\*+%!\* (G+!(!)\*.,4!./!2\*+.-!\*3 ? +=/12!

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1 \*.,+!\* (6!7++/!(!2-+ /4!23!(4352!./2+-/(2.3/(,%,!+G+-!6./)+!2\*+! 1 3-,4! 1 (-6:!2\*+--+!(-+! ? (/%!F(%6!  
23!@.G+!2\*+!587,.)! ? 3-+!/6.@\*2!23!F\*(2!)\*.,4-+!/!43F /!2\*+.-!62-++26!(-+!9()./@=!! I 4G+-2.6./@:!F\*.,+!

9( ? ,%!) \* (-) 2+- .62.) 6: ! (/4! 32\*+-! 9() 23-6! 2\* (2! 5, (%! . /23! (4352.3 / =! ! H (/ %! (-2.9.) . (! . /2+ , , @+ /) +!  
2+) \* /3, 3@. +6! \* (G+! 7++ /! 86+4! 23! 4+G+, 35! ? (2) \* . / @! 6.2+6! 93-!) \* . , 4-+ / ! (/4! 9( ? .., +6: ! 6. ? .., (-! 23! 4(2. / @!  
6.2+! 6+-G.) +6 = / 2! !! U / G+62. / @! . / ! 2\*+6+! 2%5+6! 39! 5-3@- ( ? 6!) 38, 4! , + (4! 23! ? 3-+!) \* . , 4-+ / ! 7+ . / @! 5, ( ) +4!  
F. 2\*! 9( ? .., +6! 633 / + = !

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I / 32\*+-! F (%! 23! ? ( ; +! 2\*+! 5-3) +66! ? 3-+! +99.) . + / 2! F 38, 4! 7+! 23! 4+G32+! -+638- ) +6! 23! ) -+ (2. / @! ( ! ? 3-+!  
) 3 ? ? 8 / . 2% P7 (6+4! 9362+-! ) (-+! 6% 62+ ? =! ! S -+ (2. / @! 5 (-2 / + -6\* . 56! 7+2F++ / ! 2\*+! 62(2+! 9362+-! ) (-+! 3-!  
(4352.3 / ! (@+ /) . +6! (/4! 5-.G(2+!) 3 ? ? 8 / . 2% ! 3-@ (/ . L(2.3 / 6! , + (46! 23! G(-.386! 7+ / +9.26! 93-! 2\*+! 9362+-!  
) \* . , 4-+ / ! (/4! 9( ? .., +6 = / 2! !! T 32! 3 / , %! 43+6! . 2! \* 3, 4! 2\*+! 62(2+6! ( ) ) 38 / 2(7, +! F \*+ / ! + / @ ( @ . / @! F. 2\*! 2\*+!  
) 3 ? ? 8 / . 2. +6! (/4! 5-.G(2+! 3-@ (/ . L(2.3 / 6: ! 782! . 2! ( , 63! @ . G+6! 2\*+! 62(2+! ( ) ) +66! 23! , 3) ( , L+4! 4(2( =! ! Q\* . 6!  
\*+ , 56! (@+ /) . +6! . ? 5-3G+! ? (/ (@+ ? + / 2: ! . 4+ / 2. 9%!) \* . , 4-+ / ! (2! - . 6; ! 39! + / 2+- . / @! 2\*+! 6% 62+ ? : ! (/4! +G( , 8(2+!  
2\*+! +99+) 2.G+ / +66! 39! 2\*+ . -! 5-3@- +66 = / 20!!

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U / ! " N # \ : ! Q + 0 ( 6! F ( 6! 2\*+! 9. -62! 23! 399.) . ( , , %! 7+ @ . / ! 2\* . 6! -+93- ? ( 2.3 / ! F \*+ / ! . 26! , + @ . 6, ( 28-+! 5 ( 66+4! B+ / ( 2+!  
\$ .., ! ## = / 21! ! Q\* . 6! 7 .., ! 5-3G. 4+4! 93-! 2\*+! 2- (/ 6.2.3 / ! 39! 2\*+! S \* . , 4! e-32+) 2.G+! B+-G.) +6! hSeBi: ! 2\*+!

Q\*+!A/.2+4!B2(2+6!43+6!/32!\*(G+!2\*+!53F+-!23!)3/2-3,!32\*+!)38/2-.+6E!(4352.3/!6%62+?6:!782!.2!43+6!  
\*(G+!2\*+!53F+-!23!)3/2-3,!26!3F/=!!' +@(-4,+66!39!2\*+!A/.2+4!B2(2+6!+)3/3?%E6!7+!+9.26!9-3?!  
./2+-/(2.3/(,! (4352.3/6:!2\*+!587,.)!./2+-+62!(/4!)3/)+-!/93-!)\*.4-+/E6!6(9+2%!6\*38,4!+0)++4!(/%!  
./2+-+62!./!5-39.26=(/27!!>8-2\*+-?3-+!48+!23!