! ! ! ! ! # " \$ % " &! ' (!) * ' + , - % * , ./! ! * 0\$ + 0) &, ./!) * ' 1 ' + ' & ./! " \$ - !) ' & 0 + 0, .!

"!# "\$% "&!'(!)* '+, -%*, ./!

)*0\$+0)&, ./!)*'1'+'&./!"\$-!)'&0+0, .!

!"#\$%& '& ' ()\$*)\$+")

) 23 - 3!45! 1 267879 : !

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 $\label{eq:F3} F3!!!126! - 7GH7@IH6!7J!) 24&7<7K2: !45!1267&79: !4<!9@I5H6=!?: !E7<H75!+7&8696!LK75!H26! \\ @6G7>>65=IH475!7J!4H<!1267&79: !-6KI@H>65H3! \\ \end{tabular}$

$$\begin{split} &126! > 6 > ?60 < !7J! H26! - 6KI0H > 65H! M27! G75 < H4HLH6! H26! - 7GH70I8! (IGL8H : !I06!06 < K75 < 4?86/! \\ &H207L92! H26! < H0LGHL06 < !I5 = !K07G6 = L06 < !<6H!7LH!45! H24 < ! # I5LI8/!J70!7JJ60459! H26! = 7GH70I8! \\ &<HL = 46 < !H2IH!I06! = 6 < G04?6 = !2606N!J70! I = > 4HH459! IKK84GI5H < !H7! H26!) 23 - 3!) 0790I > !45! H26! \\ &"06I < !7J! < K6G4I840IH475! < 6H!7LH!?687MN!J70! < 6HH459! H26!06PL406 > 65H < !H7!?6! > 6H!? : ! \\ &<HL = 65H < !7; 60 < 66459! H2640! K07906 < < !I5 = !0L = 9459! H2640! < LGG6 < <JL8!G7 > K86H475!7J! \\ &= 7GH70I8! M70RN!I5 = !J70! = 4 < G2I09459! I88! H26 < 6!06 < K75 < 4?484H46 < !45! R66K459! M4H2! H26!97I8 < /! \\ &G75; 4GH475 < /!I5 = !0CI0IGH604 < H4G < ! <HH6 = !26063! \end{split}$$

126!K784G46<!I5=!K@7G6=L@6<!7J!E7<!!75!+788696S<!#7@04<<6:!+788696!T@I=LIH6!.G2778!7J!"@H<!I5=!.G465G6<!I8<7!97;605!7L@!K@79@I>!I5=!I@6!57H!=LK84GIH6=!26@63!)&6I<6!G75<L8H!H264@!M6?<4H6!IHU!

 $\label{eq:2HHK-UVVMMM3} 2G_{36} = LVG75H65HV?GWM6?V<G2778<V>GI<V9@I=LIH6VGL@@65HW9@I=LIH6W<HL=65H<VK784G46<WI5=WK@7G6=L@6<32H>8!!!$

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) * 0 \$ + 0) & , . ! " \$ - ! ' * 0 , \$ 1 " 1 0 ' \$. !

O *%/-)**l*)2+343)-\$56&"-)

 $\label{eq:a3} A3!!!126!JL5=I>65HI8!97I8!7J!9@I=LIH6!6=LGIH475!45!1267879: !L5=6@!H24<!K@79@I>!4<!H7!7JJ6@!45H6886GHLI8!86I=6@<24K!H7!H26!IGI=6>:/!H26!G2L@G2/!I5=!<7G46H:3!$

$$\begin{split} D3!!!126!) & 23 - 3!45!1267879: !4<!45H65=6=!H7!6PL4K!>65!I5=!M7>65!?7H2!J70!IGI=6>4G!\\ ;7GIH475<!I5=!J70!7H260!>454<H046<!<LG2!I<!G2L0G2!I5=!L54; 60<4H: !I=>454<H0IH475/!H2678794GI8!0656MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!056MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!056MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!056MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!056MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!056MI8/!26I8H2!GI0616H24G</!I5=!7H260!GI0660<!J70!M24G2!H2678794GI8!0666!H7MI0=<!H24<!E69066!IGG70=4598:!I4>!IH!57L04<2459!I!G7>>L54H:!7J!J14H2/!</H26278I08:!G75; 60<IH475/!06<6I0G2/!I5=!H6IG2459!H2IH!4<!G65H606=!75!H26!IKK07K04IH475!7J!+204<H4I5!84J6!I5=!H27L92H/!KI<HI5=!K06<65H/!45!MI:<!H2IH!G75H04?LH6!H7!H24<!97I83!$$

$$\begin{split} &Y3!!!126! - 7GH70I8!(IGL8H:!65=6I;70<!H7!K07;4=6!4H<!)23 - 3!< HL=65H<!M4H2!I5!6=LGIH475!\\ &M24G2!4<!45H690IH4;6!0IH260!H2I5!5I007M8:!<K6G4I84O6=N!M24G2!4<!<6H!M4H245!H26!G75H6XH!\\ &7J!H26!+204<H4I5!G2L0G26<!45!I88!H26!04G256<<!7J!H2640!6GL>654GI8!I5=!G75J6<<475H8!\\ &=4;60<4H:!I5=!45!H2640!068IH475!H7!G75H6>K70I0:!GL8HL06N!M24G2!4<!4H<68J!ZG75J6<<475I8!\\ &45!5IHL06N!I5=!J70!M24G2!H267879:!4<!=756!I<!ZJI4H2!<66R459!L5=60<HI5=4593S!\\ &$6;60H2686<<!H26!G75J6<<475I8!?IGR907L5=!70!<HI5G6!7J!IKK84GI5H<!M26H260!+204<H4I5!\\ &70!57H/!M488!57H!7J!H<68J!45J8L65G6!I5:!=6G4<475!I<!H7!H2640!I=>4<<4753! \end{split}$$

75'6%8"'\$%/)9*':&9\$&*'-)

 $\begin{array}{l} [3!!!1267879:!I<!I!M2786!4<!2606!L5=60<!H77=!I<!I5!65H60K04<6!H2IH!45;4H6<!H26!\\ 45H690IH475!7J!+204<!H4I5!G7>>4H>65H!I5=!KI0H4G4KIH475!45!G7>>L54H46<!7J!JI4H2/!M4H2!\\ KL0<L4H!7J!H26!24926<!H!<!HI5=I0=<!7J!IGI=6>4G!45PL40:3! \ 7M!H24<!45;4HIH475!>492H!\\ 45J70>!H27<6!<!HL=46<!M24G2!I06!45;78;6=!45!<LG2!I5!65H60K04<6!4<!I!PL6<!H475!H2IH!4<!I!=684?60IH6!G7>K7565H!7J!H26!45PL40:14H<68J3! \end{array}$

]3!!!#6>?6@<!7J!H26!1267879:!-6KI@H>65H!JIGL8H:!I@6!G7>>4HH6=!?7H2!H7!H26!M4<6! IKK@7K@4IH475!7J!H264@!H2678794GI8!I5=!=7GH@45I8!H@I=4H475/!I5=!H7!G@4H4GI8!I5=! G75<H@LGH4;6!=4I879L6!M4H2!7H26@!H2678794GI8!K7<4H475<!I5=!M4H2!G75H6>K7@I@:!GL8HL@63!

4 "-&#"6); "%#'&'()<5\$9*8"-))

 $\begin{array}{l} B3! . \ \texttt{HL}=\texttt{65H}<!\texttt{I@6!}\texttt{6XK}\texttt{6GH}\texttt{6}=!\texttt{H7}!\texttt{I}\texttt{GPL}\texttt{4@6}!\texttt{I!}\texttt{@497}\texttt{@7L}<!>\texttt{I}<\texttt{H6}\texttt{@}: !\texttt{7J}!\texttt{H2}\texttt{6}!\texttt{aL}=\texttt{67}\texttt{W}+\texttt{2}\texttt{@4}<\texttt{H4}\texttt{I5}!\\ \texttt{H0}\texttt{I}=\texttt{4}\texttt{H4}\texttt{75}/!\texttt{65}\texttt{I}:\texttt{8}\texttt{459}!\texttt{H2}\texttt{6}>!\texttt{H7}!\texttt{G}\texttt{@4}\texttt{H4}\texttt{G}\texttt{I8}: !\texttt{K}\texttt{@7}:\texttt{6}!\texttt{H2}\texttt{6}!\texttt{J7L}\texttt{5}=\texttt{I}\texttt{H4}\texttt{75}<!\texttt{7J}!; \texttt{I}\texttt{@4}\texttt{7L}<!\texttt{H2}\texttt{6}\texttt{7}\texttt{8}\texttt{7}\texttt{9}\texttt{4}\texttt{G}\texttt{I8}!\\ \texttt{K7}<\texttt{4}\texttt{H4}\texttt{75}<\texttt{3}!\\ \end{array}$

 $\label{eq:source} FF3!.\ hL=65H<!I@6!6XK6GH6=!H7!IGPL4@6!H26!<R488<!I5=!G7>K6H65G46<!56G6<<I@: !H7!K@6<65H!\\ H264@!<G278I@<24K!H7!H26!<G278I@: !G7>>L54H: 3!!126<6!45G8L=6U!Ic!H26!K@7K6@!\\ K@7J6<<475I8!6H4PL6HH6!I<<7G4IH6=!M4H2!G75J6@65G6!KI@H4G4KIH475N!?c!M@4H459/!6=4H459!I5=!\\ K@6<65H459!KIK6@<!H7!J4H!G75J6@65G6!6XK6GHIH475<N!Gc!=684; 6@459!G75J6@65G6!KIK6@<N!=c!\\ @6WM7@R459!G75J6@65G6!KIK6@<!J7@!6; 65HL18!KL?84GIH475N!6c!<L?>4HH459!<G278I@<24K!J7@!\\ KL?84GIH475!45!K66@W@6; 46M6=!Q7L@5I8</!6=4H6=!; 78L>6<!I5=!>7579@IK2<3!\\ \end{tabular}$

 $\label{eq:FA3!!.HL=65H<!I@6!6XK6GH6=!H7!IGPL4@6!H26!<R488<!I5=!G7>K6H65G46<!56G6<<I@:!H7!<LGG66=!57H!758:!I<!IGH4;6!<G278I@<!?LH!I<!6JJ6GH4;6!H6IG26@<3!!!$

(" + % & 1 d !) * ' + , - % * , . !

2#"/&8&'%#=)'*\$"!

 $\label{eq:FD3!!!124<!<6GH475!<H1H6<!H26!<H0LGHL@6<!I5=!K@7G6=L@6<!H2IH!K6@HI45!H7!>6>?6@<!7J!H26! - 7GH7@I8!(IGL8H:/!=6J456=!?687M/!?7H2!I<!45=4;4=LI8<!I5=!45!H27<6!GIKIG4H46<!H7!M24G2! + H26:!>I:!?6!686GH6=!7@!IKK745H6=!J7@!H26!<6@;4G6!7J!H24<!)23 - 3!K@79@I>3!! + 26:!>I:!?6!686GH6=!7@!IKK745H6=!J7@!H26!$

+21596<!45!H26!<H0LGHL06<!I5=!K07G6=L06<!2606!<HIH6=!06PL406!I!HM7WH240=<!>IQ704H:!;7H6!7J!H27<6!>6>?60<!7J!H26!-7GH70I8!(IGL8H:!M27!I06!K06<65H!I5=!;7H459!IH!I!=L8:!G75;656=!>66H459!7J!H26!1267879:!-6KI0H>65H3!

>*8"'9/%\$5#")

 $\label{eq:FY3!!!12@7L927LH!H24<! \# I5LI8/!H26!J7887M459!H6@><!I@6!L<6=!I5=!I@6!H7!?6!L5=6@<H77=!M4H2!H26!>6I5459<!<HIH6=3!$

4 *9\$*#%/)7%95/\$=!@6J6@<!H7!>6>?6@<!7J!H26!JIGL8H:!7J!H26!1267879:!-6KI@H>65H!I<! =6J456=!45!eF[!?687M3!

 $\label{eq:stars} \begin{array}{l} *5\#-")*l)-\$56=!@6J6@<!K@45G4KI88: !H7!I!KI@H4GL8I@!8I56!7J!H26!2492MI: !H2IH!86I=<!H7!H26!\\)23-3!45!1267879: 3!126!H6@>!<HI5=<!H7!!#*(#%8!I<!K6G46<!<HI5=<!H7!965L<3! ` 4H245!H26!\\)23-3!)@79@I>!I!5L>?6@!7J!G7L@<6<!7J!<HL=: !I@6!I; I48I?863! \\ \end{array}$

 $\label{eq:starter} \begin{array}{l} ?\#''\%)@*1)A! '''9\&\%\&\&& 'C!4<!H26!G7>>75!=6<495IH475!7J!H27<6!<L?W=4<G4K&456<!M4H245!\\ H267879:!45!M24G2!<HL=65H<!>I:!6I@5!H26!)23-3!=69@66/!5I>6&:U!E4?&4GI8!.HL=46</!\\ +7>KI@IH4;6!1267879:/!12678794GI8!,H24G</! \4<H7@4GI8!1267879:V \4<H7@:!7J!\\ +2@4<H4I54H:/!I5=!.:<H6>IH4G!1267879:3! \end{array}$

 $\label{eq:interm} \begin{array}{l} ?\#''\%! 4<! I 8<7! L<6=! H7!@6J6@!H7!H27<6!>6>?6@<!7J!H26! - 7GH7@I8! (IGL8H: !M27/!J7@! I=>454<H0IH4; 6!I5=!7H26@!KL@K7<6</!I@6!4=65H4J46=!M4H2!756!7J!H26!<L?W=4<G4K8456<! >65H4756=!I?7; 63! \end{array}$

$$\begin{split} 1\,26!G7L@<6!7J!<&HL=: !H2@7L92!M24G2!I!<&HL=65H!G7>K86H6<!@6PL4@6>65H<!J7@!H26!)23-3!\\ 566=!57H/!I8H27L92!4H!>I:!6")1%9$*D!G7@6<K75=!M4H2!758:!756!7J!H26!"@6I<!45!M24G2!\\ -7GH7@I8!(IGL8H:!>6>?6@<!I@6!9@7LK6=3!! \end{split}$$

H6IG2459!IKK@7K@4IH6!G7L@<6</!45G8L=459!<LG2!G7887PL4I!I<!>I:!?6!K@6<G@4?6=!?:!H264@! @6<K6GH4;6!"@6I<3!

?#''%-)*1)A! ''9&%/&B%\$&*')

4 &: &-&*')*l)?#"%-)

$$\begin{split} F_3!!!126!(IGL8H: !M24G2! < 60; 6 < !H26! = 7GH70I8!K0790I > !45!1267879: !4 < !907LK6 = !45!H26 < 6! \\ "06I < U!E4?84GI8! . HL = 46 < /! + 7 > KI0IH4; 6!1267879: /!12678794GI8! , H24G < /! \ 4 < H704GI8! \\ 1267879: V \ 4 < H70: !7J! + 204 < H4I54H: /!I5 = ! . : < H6 > IH4G!1267879: 3! \end{split}$$

$$\begin{split} 1\,26!\,(\,IGL\&H:\,!>6>?6@<!I<<7G4IH6=!M4H2!6IG2!7J!H26<6!\,"\,@6I<!7JJ6@!I!G7L@<6!7@!G7L@<6<!7J!\\ <HL=:\,!&6I=459!H7!H26!\,)\,23-3! \end{split}$$

. +% ' (''-)& ') ?#''%)-\$#59\$5#'')

 $\label{eq:FB3!!!} \texttt{FB3!!!} \texttt{``5:!} \texttt{@} \texttt{GG75J49L} \texttt{@} \texttt{IH475!7J!H26<6!} \texttt{``@} \texttt{GI</!I5=!H26!6<HI?\texttt{84<2}>\texttt{65H!7J!I5:!56M!} \texttt{``@} \texttt{GI/!4<!} < \texttt{L?} \texttt{@} \texttt{GGH!H7!H26!IKK} \texttt{@} \texttt{``I8!7J!H26!M27\texttt{86!} - 7\texttt{GH7} \texttt{@} \texttt{I8!} \texttt{(IGL\$H:3!} \texttt{``} \texttt{IGL\$H:3!} \texttt{``GFT} \texttt{``GFT}$

$$\begin{split} &\text{AC3}!!! ~~5:!56M!G7L@<6!7J!<\texttt{HL}=:\texttt{!H2IH}!GI557\texttt{H}!?6!IGG7>>7=\texttt{IH6}=\texttt{!M4H245}\texttt{!H26}!<\texttt{H@LGHL@6}<\texttt{!I5}=\texttt{!}\\ &\text{K@7G6}=\texttt{L@6}<\texttt{!7J}\texttt{!H24}<\texttt{!} ~~\texttt{I5LI8}\texttt{!}>\texttt{L}<\texttt{H}!?6\texttt{!IKK@7}; 6=\texttt{!57H}!75\texttt{!}:\texttt{!H26}\texttt{!E7}<\texttt{H75}\texttt{!}+7\texttt{88696}\texttt{!}\\ &1267\texttt{879}:\texttt{!}-6\texttt{KI@H}>\texttt{65H}/\texttt{!?LH}\texttt{!R}<\texttt{7!?}:\texttt{!H26}\texttt{!}-\texttt{6I5}\texttt{!7J}\texttt{!H26}\texttt{!} ~~\texttt{H76}\texttt{!}+\texttt{788696}\texttt{!7J}\texttt{!} ~~\texttt{@H}<\texttt{!I5}=\texttt{!}\\ &.\texttt{G465G6}<\texttt{!H26}\texttt{!T@I}=\texttt{LIH6}!-\texttt{6I5}\texttt{!7J}\texttt{!H26}\texttt{!} ~~\texttt{H76}\texttt{!}+\texttt{788696}\texttt{!7J}\texttt{!} ~~\texttt{@H}<\texttt{!I5}=\texttt{!}\\ &.\texttt{G465G6}<\texttt{!H26}\texttt{!} ~~\texttt{O}\texttt{I}=\texttt{LIH6}!-\texttt{6I5}\texttt{!7J}\texttt{!H26}\texttt{!} ~~\texttt{H76}\texttt{!}+\texttt{788696}\texttt{!7J}\texttt{!} ~~\texttt{@H}<\texttt{!I5}=\texttt{!}\\ &.\texttt{G465G6}<\texttt{!H26}\texttt{!} ~~\texttt{O}\texttt{!}=\texttt{C}\texttt{:} ~~\texttt{C}\texttt{:} +\texttt{788696}\texttt{!}\texttt{!}\texttt{!} ~~\texttt{:} ~~\texttt{I}=\texttt{C}\texttt{:} ~~\texttt{C}\texttt{:} +\texttt{C}\texttt{:} +$$

G'' - ! *' - &F&/&& "-)*l)? #''%-)

?#"%). *':"'"#-)

$$\begin{split} & \text{AA3}!!! " @61!G75; 656@<!I@6!G27<65!?: !H26!I@6I!JIGL8H: !45!G75<L8HIH475!M4H2!H26! \\ &= 6KI@H>65H!G2I4@3!126!G75; 656@!<6@; 6<!64H26@!I!HM7!7@!H2@66W: 6I@!@656MI?86!H6@>/! \\ &= 6K65=459!75!H26!I@6I3! ' @= 45I@48: /!G75; 656@<!M488!?6!G27<65!J@7>!I>759!H26!H65L@6=! \\ &JIGL8H: !45!H26!I@6I3!126!G75; 656@S<!@6<K75<4?484H46<!9656@I88: !45G8L=6U!Fc! \\ &> K86>65HIH475!7J!K784G46<!7LH8456=!45!H26!I@6IS<!>I5LI8!4J!4H!2I<!756/!Ac!G75; 65459! \\ &K6@47=4G!I@6I!JIGL8H: !>66H459</!Dc!H26!G77@=45IH475!7J!H26!I=>4<<475<!K@7G6<<!M4H245! \\ \end{split}$$

|||||)

]

 $\begin{array}{l} - 4@6GH7@!7J!T@I=LIH6!.HL=46<3!126!-)*+S<!G7>>65H<!<27L8=!?6!=4<\!GL<\!<\!6=!?:!H26!<HL=65H!M4H2!H26!-4<\!<\!6@HIH475!-4@6GH7@!I5=!*6I=6@<3! \end{array}$

. *'-\$&\$5\$&*')

A^3!!!126!G7>>4##66!G75<4<#<!7J!

!!!!!

. #d\$''#d%)*1)%68d--d*')%'6)15'6d'()

 $\label{eq:245} YC3!!05!@6IG2459!4H<!=6G4<475</!I<!@69I@=<!?7H2!I=>4<<475!I5=!JL5=459/!H26!+7>>4HH66!\\ M488!?6!9L4=6=/!45!H26!J4@<H!45<HI5G6/!?:!G@4H604I!7J!6=LGIH475I8!K@6KI@IH475/!\\ =6>75<H@IH6=!IGI=6>4G!IG246;6>65H/!I5=!K@7>4<6!7J!6XG68865G6!45!H2678794GI8!\\ <G278I@<24K3!"<!<HIH6=!I?7;6/!H26!G75J6<<475I8!?IGR907L5=!70!<HI5G6!7J!IKK84GI5H</!\\ M26H26@!+2@4<H4I5!70!57H/!M488!57H!7J!4H<68J!45J8L65G6!H26!+7>>4HH66S<!=6G4<475!I<!H7!H264@!I=>4<<4753!\\$

 $\label{eq:YF3} YF3!!!126!+7>>4 \mbox{H}66! M488! I@@4; 6! \mbox{H}4\mbox{H}4\mbox{H}4\mbox{H}2\mbox{H}2\mbox{H}2\mbox{H}1\mbox{H}2\mbox{H}1\mbox{$

 $\label{eq:starter} $$: !7JJ60!7J!J45I5G4I8!I4=!7H260!H2I5!H26!\%54; 60<4H: !(6887M<24K!>L<H/!J70!KL0K7<6<!7J! J45I5G4I8!7; 60<492H/!?6!IKK07; 6=!?7H2!?: !H26!+2I40!7J!H26!I267879: !-6KI0H>65H/!I5=! ?: !H26!T0I=LIH6!-6I5!7J! "0H<!I5=!.G465G6<3!.LG2!I5!7JJ60!>I: !?6!IGG6KH6=!758: !?: !I5!IKK84GI5H!M27> !H26!+7>>4HH66!2I<!=66>6=!M70H2: !7J!I=>4<<475/!75!H26!?I<4<!7J! H26!G04H604I!<HIH6=!I?7; 6/!I5=!758: !4J!H26!IKK07; I8!2606!<H4KL8IH6=!2I<!?665!6XK84G4H8: !94; 653! $$$

 $\label{eq:2.2} YD3!!!0H!4<!L5=60<H77=!H2IH!H26!J70697459!G04H604I!IKK8:!6PLI88:!H7!H27<6!IKK84GI5H<!\\ M27>!H26!+7>>4HH66!06G7>>65=<!J70!I=>4<<475!I5=!H7!H27<6!4J!I5:/!M27>!4H!=6<495IH6<!I<!L4HI?86!J70!I=>4<<475!45!GI<6!I5:!7J!H27<6!H7!M27>!I=>4<<475!2I<!?665!?JJ606=!<27L8=!=6G8456!H7!IGG6KH!4H3!\\ \label{eq:2.2}$

4 &#''9\$*#)*1)0#%65%\$'')A\$56&''-)

75'9\$&*')&')("'"#%/)

 $\begin{array}{l} YY3!!!126! - 4@6GH7@!7J!T@I=LIH6!. HL=46<!K@7; 4=6<!I=>454<H@IH4; 6!7; 6@<492H!7J!)23 - 3! \\ < HL=46</!45G8L=459!H26!4>K86>65HIH475!7J!=6G4<475<!>I=6!?: !H26!HM7!. HI5=459! \\ +7>>4HH66<!i"=>4<<475<!I5=!-4<<6@HIH475!)@7K7<I8!*6; 46Mc3! \\ \end{array}$

75'9\$&*'-)&')!%#\$&95/%#)

Y[3!!!126!-4@6GH7@!7J!T@I=LIH6!.HL=46<!I=>454<H6@<!H26!K@7G6=L@6<!7J!H24<!#I5LI8/! 6XG6KH!M26@6!7H26@M4<6!K@7;4=6=N!6<HI?84<26<!<G26=L86<!I5=!65<L@6<!H2IH!H26:!I@6!>6HN!

!!!!!

!!!!!

)

> L < H!?6!7?HI456 = !J@7 > !H26! - 4@6GH7@1=LIH6! . HL = 46 < !45!G75 < L8HIH475!M4H2!H26! < HL = 65HS < !I = ;4 < 7@<3!!

?6:&-*#-)

A''/''9\$&*')*1)%6:&-*#-)

 $\begin{array}{l} [F3!!!126! - 4@6GH7@!7J!T@I=LIH6! . HL=46<!45!G75<L8HIH475!M4H2!H26! "@6I!+75;656@!M488!\\ I<<495!H7!6IG2!J4@<HW: 6I@!<HL=65H!I! # IQ7@! "=;4<7@!45!H26! "@6I!H7!M24G2!IKK84GIH475!MI<!\\ >I=63! "H!I5: !H4>6!IJH6@!H26!J4@<H!<6>6<H6@!7J!@6<4=65G6/!I!<HL=65H!>I: !@6PL6<H!H2IH!I! \end{array}$

- Gc '56!7J!H26!HM7!H6XH<!M488!?6!IH!I!86;68!7J!8I59LI96!M04HH65!J70!I5!45H6884965H! 575W<K6G4I84<H/!4=6I88:!K602IK<!I5!65G:G87K6=4I!I0H4G863!126!7H260!7J!H26! HM7!H6XH<!M488!7JJ60!I!H6G254GI8!I5=!<G278I08:!86;68!7J!=4<G7L0<63!
- =c 126!<HL=65H!M488!?6!I887M6=!I!=4GH475I0::!?LH!57!7H260!06<7L0G6<3!

. *8 !#"+"'-&:")"H%8 & '%\$&*'-)

O '' ' ''#%/)!#*:&-&*'-)

]_3!!! " 88!<HL=65H<!KL@<L459!H26!)23 - 3!45!1267879:!>L<H!KI<<!I!<6H!7J!M@4HH65! 6XI>45IH475<!i57@>I88:!HM68;6!27L@<c/!J7887M6=!?:!I!HM7W27L@!7@I8!7@!:&:%):*9''! 6XI>45IH4753!

]B3!!!

!

 $\label{eq:holestimate} $$ ^D3! 126! > 4570! M488! 570 > I88: !?6!06K06 < 65H6=!?: !I!H2066W27L0!6XI > !M4H245!H26! < HL=65HS <! HM68; 6!27L0 <!7J!G7 > K06265 <4; 6!6XI > <3! 126! < K6G4J4G!8659H2!7J!H24 <! > 4570!6XI > !>I: !?6! I=0L < H6=!H7!IGG7 > 7=IH6!H26! < H0LGHL06!7J!H26! < HL=65HS <! > I070!G7 > K06265 <4; 6! 6XI > 45IH475 <!! $$$

- , $\label{eq:H24G} \begin{array}{l} \texttt{H24G} < ! > I \end{tabular} 2 \end{tabular} \end{tabular} \\ \texttt{H0LGHL06N}! \\ \texttt{H0LGHL06N}! \\ \texttt{H0LGHL06N}! \\ \end{array}$
- +7>KI@IH4;6!1267879:!>IQ7@<!84R68:!M488!@6PL4@6!I!J7L@W27L@!>457@!6XI>!?6GIL<6! 7J!H26!@786!7J!H26!>457@!45!H26!<HL=65HS<!G7>KI@IH4;6!M7@RN!
- E4?86!>IQ7@<!HIR6!I5!45H6@5I88:!I=>454<H6@6=!>457@!6XI>!45!H26!f7H26@g!H6<HI>65H3!

 $\label{eq:stars} $$ ^Y3! 126!G2I40!7J!H26!G7 > K@6265<4; 6!6XI > !?7I@=!=6H6@>456<!M24G2!JIGL8H: !I@6! \\ @6<K75<4?86!J7@!G@IJH459!M24G2!KI@H!7J!H26!6XI > <3! 126!JIGL8H: !>6> ?6@!J@7> !H26! \\ <HL=65HS<!>457@!I@6I!M488!M@4H6!H26!@686; I5H!6XI > !PL6<H475i<c3!! \\ ! \\$

, *%#6)*l)"H%8&'"#-)

^_3!!!126!<HL=65HS<!#IQ70!"=;4<70!70=45I048:!G2I40<!H26!?7I0=!7J!6XI>4560</!<7!8759!I<! H26!#IQ70!"=;4<70!4<!I!>6>?60!7J!H26!1267879:!-6KI0H>65H!i.66!eF[!069I0=459! KI0H4G4KIH475!7J!H65L06=!I5=!H65L06WH0IGR!JIGL8H:!7J!H26!.1#c3!!

$$\begin{split} 126!?7I@=!>I:!57H!45G8L=6!>7@6!H2I5!HM7!6XI>456@<!J@7>!7LH<4=6!7J!H26!-7GH7@I8!\\ (IGL8H:3!"5:!6XI>456@<!7H26@!H2I5!-7GH7@I8!(IGL8H:!>6>?6@<!>L<H?6!H65L@6=!70!\\ H65L@6W68494?86!JIGL8H:!>6>?6@<!7J!"&$+"#!I!E7<H75!+788696!=6KI@H>65H!?6<4=6<!\\ 1267879:/!*#! \end{split}$$

!

4 &--''#\$%\$&*')

, %-&9)#"K5&#"8"'\$)

 $\label{eq:constraint} $$ $ [3!!! "JH6@!G7 > K86H459!@6<4=65G6/!=6 > 75<H@IH459!K@7J4G465G: !45!H26!IKK@7K@4IH6! 8159LI96</!I5=!KI<459!G7 > K@6265<4; 6!6XI > 45IH475</!6IG2!<HL=65H!M488!M@4H6!I! = 7GH7@I8!=4<<6@HIH4753! $$$

4 &--"#\$%\$&*')9*8 8 &\$\$"")

_]3!!!.LGG6<<JL8!G7>K86H475!7J!H26!=4<<6@HIH475!M488!?6!QL=96=!?:!I!=4<<6@HIH475! G7>>4HH66!7J!H2@66!>6>?6@</!756!7J!M27>!<6@;6<!I<!H26!-4<<6@HIH475!-4@6GH7@3!!

 $\begin{aligned} & \texttt{OH} = \texttt{OH} =$

4 &--''#\$%\$&*')!#*!*-%/L)!5#!*-'')%'6)l*#8)

 $\label{eq:2.1} $$ -^3!!! 1796H260!M4H2!24<!70!260!=4<<60H1H475!G7>>4HH66/!H26!<HL=65H!M488!M04H6!I!K07K7<I8!\\J70!H26!=4<<60H1H4753!126!=4<<60H1H475!K07K7<I8!<27L8=!?6!<LGG45GH157H!>706!H2I5!J4;6!H27L<I5=!M70=<!i45G8L=459!J77H57H6<!?LH!6XG8L=459!H26!?4?84790IK2:c3!0H!<27L8=!?6!G0IJH6=!<7!I<!H7!?6!G86I0!I5=!G7965H!H7!K60<75<!M27!I06!H0I456=!45!H26!IGI=6>4G!<HL=:!7J!H267879:!M4H27LH!56G6<<I048:!?6459!6XK60H<!45!H26!<K6G4I8406=!<L?06GH!>IHH60!7J!H26!=4<<60H1H4753!$

__3!126!K@7K7<I8!<2I88!45G8L=6!IH!86I<H!H26<6!686>65H<U!

n!I!=68456IH475!7J!H26!-9*! "!7J!H26!K@7Q6GH/!H796H26@!M4H2!I!G86I@!I5=!G75G4<6!\$+"-&-) -\$%\$"8" '\$N!

n!I!K@684>45I@:!45=4GIH475!7J!27M!H26!7;6@I88!I@9L>65H!M488!L5J78=N!

- n!I5!IGG7L5H!7J!H26!=4<<6@HIH475S<!@68IH475!H7!6X4<H459!M7@R!45!H26!J468=/!I5=!27M!4H! M488!G75H@4?LH6!H7!H26!GL@@65H!<HIH6!7J!<G278I@<24KN!
- n!I5!6XK8I5IH475!7J!H26!IKK@7IG2!I5=!>6H27=<!H2IH!M488!?6!L<6=N!
- n!I!G75G@6H6!I<<6<<>65H!7J!H26!K@7Q6GHS<!J6I<4?484H: !45!@68IH475!H7!84?@I@::I5=!7H26@!@6<7L@G6<!I;I48I?86!H7!H26!<HL=65HN!
- $\label{eq:rescaled} n!6;4\!=\!65\text{G}6!7J!\text{H}26!\!<\!\!\text{HL}\!=\!65\text{HS}\!<\!\!!\text{G}7\!>\!K6\text{H}65\text{G}6!45!\text{H}26!\text{@}686;15\text{H}!\text{/\%}'(5\%("-!7J!\!<\!\!\text{G}2781\text{@}\!<\!\!24\text{KN}!15\!=\!!$
- $\label{eq:rescaled_$

; & 8 & \$\\$\\$ & * ' -)\%-)\$*)\$& 8 '')

$$\begin{split} &\text{BD3}!!! \cdot \text{HL} = 65\text{H} < !M27!21; 6!G7 > \text{K86H6} = !188!@6PL4@6 > 65\text{H} < !J7@!\text{H26}!) 23 - 3!6XG6KH!\text{H26}! \\ &= 4 < < 6@\text{H1H475}! > L < \text{H}! < \text{H488}!G75J7@ > !H7!\text{H26}!@69L81H475 < !G75G6@5459!@694 < H@1H475! < 6H!?: !H26! \\ &T@1 = L1H6! \cdot G2778!7J!\text{H26}! # 7@@4 < 6: ! + 788696!7J! " @H < !15 = ! . G465G6 < !1H!E7 < H75! + 7886963! \\ &126!T@1 = L1H6! \cdot G2778!18 < 7!@6PL4@6 < !H21H! = 4 < 6@\text{H1H475} < !6! < L? > 4\text{HH6} = !J7@! = 6J65 < 6!M4H245! \\ &6492\text{H}! : 61@ < !7J!\text{H26}! < \text{HL} = 65\text{HS} < !65\text{H0}15G6!45\text{H7}!\text{H26}!\text{K}@79@1 > !i < \text{HL} = 65\text{H} < !M27!\text{M6}@6!6507886 = !45! \\ &H26! < \text{K}@459!7J!\text{ACAC}!21; 6!?665!9@15\text{H6} = !756!1 = = 4\text{H475}18! : 610!\text{H7}!@6 = @6 < < !H26!6JJ6G\text{H}?J!\text{H26}! \\ &G7; 4 = !\text{K15} = 6 > 4G!75!\text{H2}64@! < \text{HL} = 46 < c3!, XH65 < 475 < ! > 1 : !?6!9@15\text{H6} = !758: !J70!\text{H2}6! > 7 < \text{H}! \\ &6XG6K\text{H475}18!7J!\text{G}4@\text{GL} > < \text{H15}G6 < !15 = !H265!758 : !M4H2!\text{H2}6!\text{K}&07; 18!7J!\text{Ic}!\text{H2}6! > 7 < \text{H}! \\ &6XG6K\text{H475}18!7J!\text{G}4@\text{GL} > < \text{H15}G6 < !15 = !H265!758 : !M4H2!\text{H2}6!\text{K}&07; 18!7J!\text{Ic}!\text{H2}6! - 4@6G\text{H7}0!7J! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !?c!\text{H2}6! - 4 < < 60\text{H1}\text{H475}! - 4@6G\text{H7}0!\text{G7}5\text{H4}5965\text{H}!\text{L}K75!6; 4 = 65G6!\text{H2}1\text{H}!\text{H2}6! \\ &< \text{HL} = 65\text{H}!21 < !\text{K}@7 = LG6 = !\text{K}@684 > 451@ : !6; 4 = 65G6!7J! < G2781@ < 24\text{K}!45!\text{H2}64@! = 4 < < 60\text{H}1\text{H475}! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !P26! - 4 < < 60\text{H}1\text{H475}! - 406\text{G}75J4 = 65\text{H}!15 = !\text{H2}6! - 4 < < 60\text{H}1\text{H475}! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !H26! - 4 < < 60\text{H}1\text{H475}! - 406\text{G}75J4 = 65\text{H}!15 = !H26! - 4 < < 60\text{H}1\text{H475}! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !H26! - 4 < < 60\text{H}1\text{H475}! - 406\text{G}75J4 = 65\text{H}!1421\text{H}!26! = 4 < < 60\text{H}1\text{H475}! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !H26! - 4 < < 60\text{H}1\text{H475}! - 406\text{G}75J4 = 65\text{H}!21\text{H}!26! = 4 < < 60\text{H}1\text{H475}! \\ &T@1 = L1\text{H6}! \cdot \text{HL} = 46 < !15 = !H26! - 4 < < 60\text{H}1\text{H475}! - 406\text{G}75J4 = 65\text{H}!21\text{H}!26! = 4 < < 60\text{H}1\text{H475}! \\ &T$12 \times 100$$

A5F8(--(*')*l)6(--''#%)(*)

BY3!!! ` 265!H26!=4<<6@HIH475!4<!G7>K86H6/!4H!4<!H7!?6!<L?>4HH6=!H7!H26! - 7GH7@I8!(IGL&H:! H2@7L92!H26! - 4@6GH7@!7J!T@I=LIH6!.HL=46</!H796H26@!M4H2!I!756WKI96!I?<H@IGH!7J!4H<! G75H65H<3!126! - 4@6GH7@!7J!T@I=LIH6!.HL=46<\$!7JJ4G6!M4&8!I@@I596!J7@!G7K46<!7J!H26! =4<<6@HIH475!I5=!H26!I?<H@IGH!H7!?6!I;I48I?&6!J7@!H26!45<K6GH475!7J!(IGL&H:!>6>?6@<3!"H!

J:%/5%\$&*')*l)-\$56'''\$-)

0 **6)-\$% '6& '()6"l& '"6)

B_3!!!

))

N'\$"##5!\$&*')*1)1&'%'9&%/)-5!!*#\$)

 $\label{eq:FCD3!!!-L@459!H26!K@7?IH475I@::!<6>6<H60/!H26!<HL=65H!75!K@7?IH475!4<!84I?86!H7! 45H6@0LKH475!7J!24<!70!260!J45I5G4I8!I4=/!4J!I5:3!126!=6G4<475!H7!M4H2278=!<H4K65=<!@6<H<!M4H2!H26!-4@6GH70!7J!T@I=LIH6!.HL=46<3!126!-4@6GH70!7J!T@I=LIH6!.HL=46<!>I:!<H4KL8IH6! H2IH!@6<L>KH475!70!G75H45LIH475!7J!I!<H4K65=!4<!G75H45965H!LK75!H26!<HL=65HS<!@6>7;459!<K6G4J4G!=6J4G465G46<!M4H245!I!<K6G4J46=!H4>63! \\ \end{tabular}$

2*--&F&/&\$=)*1)"H\$"'-&*')

$$\label{eq:constraint} \begin{split} FCY3!!!126!K@7?IH475I@:!K6@47=!>I:!?6!6XH65=6=!?6:75=!I!<6>6<H6@/!4J!45!H26!\\ @L=9>65H!7J!H26!-4@6GH7@!7J!T@I=LIH6!.HL=46</!<L?<HI5H4I8!K@79@6<<!H7MI@=<!@6>6=:459!\\ =6J4G465G46<!4<!?6459!>I=6/!7@!4J!6XH@I7@=45I@:!G4@GL><HI5G6<!MI@EI5H!I5!6XH65<4753! \end{split}$$

4&-8&--%/)1#*8)2+343)-\$56&"-)

 $\label{eq:FC} FC] \texttt{3!!!126!} - \texttt{4@6GH7@!7J!T@I=LIH6!.HL=\texttt{46<!M488!57H4J:\texttt{H26!<\texttt{HL}=\texttt{65H!}\texttt{45!M@4H459/!<\texttt{HIH459!}\texttt{H26!}} \\ \texttt{9@7L5=<!J7@!=\texttt{4}<>\texttt{4}<<\texttt{I83!}+\texttt{7K46<!7J!}\texttt{H24}<!\texttt{57H4J4GIH475!}\texttt{M488!?\texttt{6!J486=!}\texttt{M4H2!}\texttt{H26!}-\texttt{6I5!}\texttt{7J!}\texttt{H26!} \\ \texttt{F7<\texttt{H75!}+\texttt{788696!T@I=LIH6!.G2778!}\texttt{7J!}" \texttt{CH}<!\texttt{15=!.G465G6}<!\texttt{16}:\texttt{16$

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