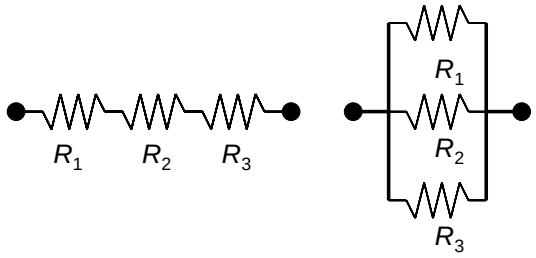
PROBLEM 3.25

KNOWN: Values of three individual thermal conduction resistances.

FIND: Which conduction resistance should be reduced by half in order to most effectively reduce the total conduction resistance.

SCHEMATIC:



Case A Case B

ASSUMPTIONS: (1) Steady-state, one-dimensional conduction, (2) Constant properties.

ANALYSIS: We begin with the series resistance network, Case A. The total thermal resistances associated with the nominal values of the individual thermal resistances, as well as for situations where the nominal resistance values are reduced by 50%, are presented in the table below.

Case A	R_1 (K/W)	R_2 (K/W)	R_3 (K/W)	R_{tot} (K/W)	
Nominal	2	4	8	14	
	1	4	8	13	
	2	2	8	12	
	2	4	4	10	<

The reduction in the total thermal resistance is greatest if the value of R_3 is reduced from 8 to 4 K/W.

Case B	R_1 (K/W)	R_2 (K/W)	R_3 (K/W)	R_{tot} (K/W)	
Nominal	2	4	8	1.143	
	1	4	8	0.7273	<
	2	2	8	0.8888	
	2	4	4	1.00	

For the resistances in parallel, the reduction in the total thermal resistance is greatest if the value of R_1 is reduced from 2 to 1 K/W.

Hence, it is not possible to make a recommendation to the chief engineer as to which resistance should be targeted for reduction without first knowing how the resistances are placed within the resistance network.

COMMENTS: A common and serious mistake is to assume that the largest thermal resistance dominates the thermal resistance network. Although this is sometimes the case, careful analysis will often reveal quicker, and less expensive alternatives to either reduce or increase the total thermal resistance.