Problem 1.2-4 (1-4 in text): Resistance Network

Figure P1.2-4 illustrates a plane wall that is composed of two materials, A and B. The interface between the materials is characterized by a contact resistance. The left surface of material A is held at T_H and the right surface of material *B* radiates to surroundings at T_C and is also exposed to convection to a fluid at T_C.

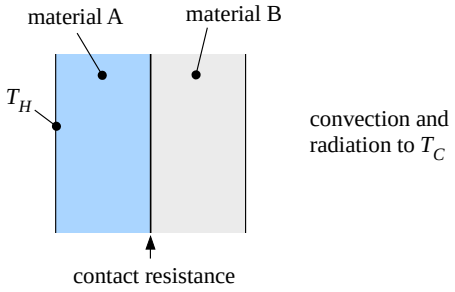

Figure P1.2-4: Composite wall with contact resistance, convection and radiation

The resistance network that represents the situation in Figure P1.2-4 should include five thermal resistors; their values are provided below:

$R_{cond,A}$ = 0.05 K/W, resistance to conduction through material A
$R_{contact}$ = 0.01 K/W, contact resistance
$R_{cond,B}$ = 0.05 K/W, resistance to conduction through material B
R_{conv} = 1.0 K/W, resistance to convection
R_{rad} = 10.0 K/W, resistance to radiation

a.) Draw a resistance network that represents the situation in Figure P1.2-4. Each resistance in the network should be labeled according to $R_{cond,A}$, $R_{contact}$, $R_{cond,B}$, R_{conv}, and R_{rad}. Show where the temperatures T_H and T_C appear on your network.

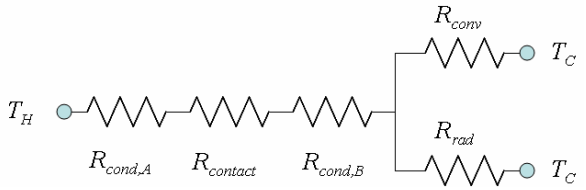

Figure 2: Resistance network that represents Figure P1.2-4.

b.) What is the most important resistor in the network? That is, the heat transfer from T_H to T_C is most sensitive to which of the five resistances?

The most important resistor in a series combination is the largest. The largest resistance is the parallel combination of R_{conv} and R_{rad}. The most important resistance in a parallel combination is the smallest; the smallest of R_{conv} and R_{rad} is R_{conv}. Thus, R_{conv} is the most important resistance.

c.) What is the least important resistor in the network?

The least important resistance is the contact resistance; it is the smallest in a series of resistors that are themselves unimportant relative to convection and radiation.