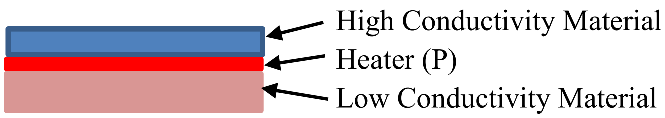
Workshop 6 Introduction to Heat Sinks and Energy Balances

Name ________________________ **Review Energy Balances**

Workshop 6 is similar to Workshop 5 except the heater is used now. This allows the heat to go in two directions (instead of one direction in Workshop 5) because there are now two heat sinks. These are necessarily on either side of the heater. This adds complexity to the problem and requires the use of thermal resistances and the energy balance together to analyze the system. Specifically, how much of the thermal energy from the heater goes to each heat sink? This is an important problem in many thermal systems.

To make the problem simpler, each heat flux will be assumed to be one-dimensional. On one side of the heater will be a low conductivity material and on the other will be a high conductivity material, both starting at the same temperature. When the heater is turned on, heat flux will go to both of the materials. The heat flux sensor can be used to measure how much goes to each material.



The energy balance can be used to show that the total power from the heater P has to go to the combination of the two materials. Draw the overall energy balance on the figure and write the algebraic energy balance here in terms of the heat transfer to the high conductivity material q_{hc} and to the low conductivity material q_{lc}.

The relative size of the thermal resistances will dictate the relative size of q_{hc} and q_{lc} (how much energy goes to each material). Because there is only one heat flux sensor, you will need to use it twice. First to measure what goes to the high conductivity material and then to low conductivity material.

Workshop 6 Results

Name ______________________________

Place the heater on a low thermal conductivity material (such as carpet or a mattress) and place the metal piece (a high conductivity material) from the kit over top. Slide the heat flux sensor between the metal and the heater. Sketch the system with a control volume for each case and clearly label the four main components: low conductivity material (LCM), heater, sensor, and metal. Label the direction of the heat fluxes. Start the data acquisition to establish the steady-state condition then turn on the heater. Allow the heater to run for about one minute to clearly see the response of the temperature and heat flux. Next move the heat flux sensor between the heater and the carpet. Repeat the sketch and data acquisition for this case.

a) Sensor between heater and metal

b) Sensor between heater and LCM

Plot the heat flux and temperature responses for both cases. Add these plots to this workshop sheet and note the heat flux and temperature change (ΔT) values at the end of the measurement time in the table.

	q" (W/m^2)	ΔT (°C)
Heater to Metal		
Heater to LCM		

1. Why are the heat flux values so different?

2. Which material provides the better heat sink?

3. Why is one heat flux likely positive and one heat flux negative with the same sensor? Which direction was the sensor placed?

4. What is the total power flux provided by the heater? P/A =

5. What is the fraction of the power that goes to the metal, q''_m / (P/A) =

6. Why is the temperature response for the two cases so different?