*Physics 110*
Spring 2006
Heat

NOTE: YOU WILL NEED TO LOOK UP THERMAL AND VOLUME EXPANSION
COEFFICIENTS FOR VARIOUS MATERIALS!

1. A copper telephone wire has essentially no sag between poles 35m apart onPP a
   winter day when the temperature is -20°C. How much longer is the wire when the
   temperature is 35°C on a sunny summer day?

2. A square hole measuring 8cm along each side is cut in a sheet of copper. What is
   the change in area of the hole if the temperature of the sheet is increased by 50K?
   Is this an increase or decrease in area of the hole?

3. A circular steel ring has a gap cut into it. If the ring is heated does the gap
   increase or decrease? If the gap has a width of 1.600cm when the temperature is
   30°C, what is the width of the gap when the temperature is 190°C?
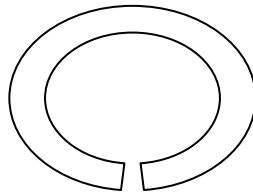
4. A mercury thermometer is constructed as shown below. The capillary tube has a
   diameter of 0.0040 cm and the bulb has a diameter of 0.250cm. Neglecting the
   expansion of the glass, what is the change in height of the mercury column that
   occurs with a temperature change of 30°C?
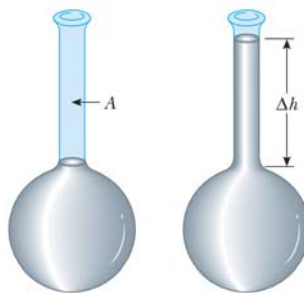
5. A thermal window with an area of 3.0m² and a thickness of 0.600cm. If the
   temperature difference between the surfaces is 25°C, what is the rate of thermal
   energy transfer by conduction through the window?

6. Calculate the "R"-values for windows made of flat glass 1/8" thick and a thermal window made of two single panes each 1/8" thick separated by a ¼" airspace. By what factor is the thermal conduction reduced if the thermal window replaces the single pane window?

7. The tungsten filament of a certain 100.0W light bulb radiates 2.0W of light. (The other 98.0W is carried away by conduction and convection.) The filament has a surface area of $0.250mm^2$ and an emissivity of 0.95. What is the temperature of the filament? (The melting point of tungsten is 3683K.)

8. The average thermal conductivity of the walls (including windows and doors) and the roof of a typical house is 0.480 W/m²°C and the average thickness is 21.0cm. The house is heated with natural gas having a heat of combustion (the energy produced per cubic meter of gas burned) of 9300 kcal/m³, where 1cal = 4.186J. How many cubic meters of gas must be burned each day to maintain an inside temperature of 25°C if the outside temperature is 0°C? (Neglect heat loss through the ground and the fact that the house absorbs and emits radiation.)