1. (12 points)   Answer the following.

a. (4 points)   Based on the conversions between Celsius and Fahrenheit and between Celsius and Kelvin, determine absolute zero on the Fahrenheit scale.

b. (4 points)   The Rankine temperature scale is related to Fahrenheit in the same way that Kelvin is related to Celsius (i.e., $0\,\mathrm{R}$ corresponds to absolute zero and $1\,\mathrm{R} = 1\,\mathrm{F}°$ as a temperature difference). Determine the boiling point of water on the Rankine scale.

c. (4 points)   Determine kT for room temperature, where k is Boltzmann's constant (you will need to look up the value). Express the answer in electron-volts.

2. (10 points) A copper ball ($\alpha = 17 \times 10^{-6}$/K) of radius 13.010 cm is placed in a 13.000 cm radius circular hole of an aluminum plate ($\alpha = 23 \times 10^{-6}$/K). Both the ball and plate are at 20°C.

a. (4 points) To what temperature must the copper ball and aluminum plate both be raised or lowered to in order for the ball to be able to pass through the plate?

b. (4 points) Same problem, except consider a 13.010 cm *aluminum* ball on top of a 13.000 cm circular hole in a *copper* plate.

c. (2 points) What if the ball and the plate are both made of copper?

3. (10 points) 10 g of ice at 0°C is placed into a 35 g aluminum cup filled with 50 g of water, both initially at 30°C. The mixture is thermally isolated from its environment and allowed to come to equilibrium.

a. (5 points) What is the final temperature of the mixture?

b. (5 points) How much ice (at 0°C) should be added to bring the final temperature of the mixture down to 0°C?