Temperature of a Flame

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Topic: Specific Heat and Thermal Equilibrium

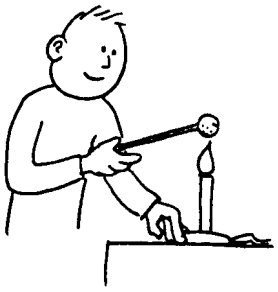
Purpose

To indirectly measure the temperature of a flame.

Equipment and Supplies

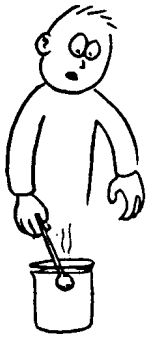
brass ball and ring apparatus (the ball needs to be removable)
Fisher (preferred) or bunsen burner
400 mL beaker
100 mL graduated cylinder
balance
thermometer

Discussion



How hot is a typical flame? Certainly hot enough to shatter any thermometer placed in it, so don't! Instead, you can measure the temperature of a flame indirectly. If a brass ball is held in a flame and becomes red-hot, at some point the ball and flame are in thermal equilibrium. If we determine the temperature of the hot ball, then we'll know the temperature of the flame.

Procedure



Step 1: Unscrew the brass ball of a ball and ring apparatus and measure its mass using a balance. Record the mass of the ball. Re-attach the brass ball to the handle.

Step 2: Use a graduated cylinder to measure 250 mL of water into a 400 mL beaker. Warm the water until it's about 60°C. Measure and record the temperature of the water. Record the mass of the water below.

Step 3:. Heat the brass ball until it's red-hot. **Caution: Do not touch anything or anybody with the ball!** While still red-hot, *carefully* thrust the ball into the beaker of water. Try to hold it steady in the middle of the beaker. For best effect, you might try either turning down the room lights or turning them off completely. What do you observe? After the ball has completely cooled down, record the final temperature of the water.

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initial temperature of the water, T_i = _____

final temperature of the water, T_f = _____

change in temperature of the water, ΔT_w = _____

mass of water, m_w = _____

mass of ball, m_b = _____

Analysis

1. The quantity of heat in calories lost by the ball equals the quantity of heat gained by the water. Calculate this quantity of heat gained by the water. Remember, the specific heat of water is 1 cal/g °C.

$$Q_{lost} = Q_{gained}$$

$$c_b m_b \Delta T_b = c_w m_w \Delta T_w$$

$$c_w m_w \Delta T_w =$$

2. Since the heat gained by the water equals the heat lost by the ball and the specific heat of brass is 0.09 cal/g °C, calculate the change in temperature of the brass ball after it was cooled down by the water.

$$Q_{lost} = c_b m_b \Delta T_b$$

$$\Delta T_b = \frac{Q_{lost}}{c_b m_b} = \frac{Q_{gained}}{c_b m_b} = \frac{c_w m_w \Delta T_w}{c_b m_b}$$

$$=$$

3. What is temperature of the flame? Remember, the final temperature of the water and the ball is higher than room temperature.

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4. What would have been your calculated flame temperature if the change in water temperature were 1°C greater than what you actually measured? Show your calculations.

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5. What are sources of error for this experiment? Considering your sources of error, does your calculation for the temperature of the flame more likely represent a minimum or maximum value?

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