4. What is meant by the symbol Δt?

   It represents the change in temperature of the object, $t_f - t_i$.

5. If 30.0 mL of water at 45.0°C is added to an unknown amount of water at 10.0°C, and the final temperature of the mixture is 30.0°C, what is the mass of water that was at 10.0°C?

   $$(30.0\ g)\left(4.18\ \frac{J}{g\cdot{}^\circ C}\right)(15.0^\circ C) = (x)\left(4.18\ \frac{J}{g\cdot{}^\circ C}\right)(20.0^\circ C) \therefore x = 22.5\ g$$

Materials

Some 8 oz foam cups are tapered enough at the bottom so that they can fit most of the way into a 250 mL beaker, making the 400 mL beaker unnecessary.

The zinc and/or copper metal shot from Lab 3B may be used here, as well as any of a number of other metals.

balance
beaker, 250 mL
beaker, 400 mL
Bunsen burner
cardboard lid, 4″ × 4″
goggles
graduated cylinder, 100 mL
iron ring
matches
metal shot, 50-70 g
plastic wrap, approx. 1″ square
polystyrene cups, 6-8 oz, two
ring stand
rubber stopper, 1-hole, #4, split
test tube holder
test tube, large
thermometer
wire gauze

Procedure

1. Fill your 250 mL beaker halfway with water and place it on a wire gauze supported by an iron ring attached to your ring stand. Light the Bunsen burner and begin heating the water. While the water is heating, weigh your dry, large test tube and square of plastic wrap on the balance. (Record: 1.) Add enough dry metal shot to fill half of the test tube; weigh it again with the opening covered with the plastic wrap. (Record: 2.)
2. Place the covered test tube containing the metal shot into the beaker of water and bring the water to a boil. It is important to keep the plastic wrap over the end of the tube while it is heating in order to prevent water from getting inside the test tube. Allow the water to boil for several minutes before obtaining its temperature. Be sure the thermometer is not touching the sides or bottom of the beaker when you measure the temperature of the boiling water to 0.1°C. Allow the test tube to remain in the boiling water for at least ten minutes. By that time, you can safely assume that the temperature of the metal shot is the same as that of the boiling water. This is the initial temperature of the metal. (Record: 3.)
3. While the metal sample is heating, weigh your two nested foam cups. (Record: 4.) Using your 100 mL graduated cylinder, measure about 50 mL of distilled water into the inner cup and weigh again. (Record: 5.) Place the nested cups into the 400 mL beaker to give them more stability. Insert the thermometer into the split rubber stopper, using a drop or two of liquid soap to lubricate it. Adjust the position of the stopper on the thermometer so that the bulb of the thermometer does not touch the bottom of the inner cup when it is inserted through the hole in the cardboard lid. (See Figure 10B-1 for the assembled setup.) Measure the initial temperature of the water in your foam cup calorimeter to 0.1°C. (Record: 6.)
4. Using your test tube holder, remove the test tube from the boiling water, take off the plastic wrap, and quickly pour the metal into the calorimeter. *Be careful not to get any drops of hot water into the calorimeter or to splash water from the calorimeter when you pour in the metal shot!* Cover it with the cardboard lid and stir the mixture carefully with your thermometer. Note the temperature of the water about every 30 seconds and record the highest temperature reached. (Record: 7.) This is the final temperature of both the metal and the water.