Heat And Temperature Worksheet

Make sure the brass cylinder has been placed in the pot of boiling water.

I.   Mixing the same materials

Material: 2 Styrofoam cups, 2 thermometers, sources of water at two different temperatures (hot and cold), digital balance, bucket to dump excess water.

1.   We will be mixing water at various temperatures and determining experimentally the final temperatures of the water. You can use hot and cold tap water.

Prediction 1-1: discuss with your group and write down below what you think the final temperatures of the following combinations of water will be:
   a) equal amounts at temperatures T_1 and T_2.

   b) unequal amounts by a factor of two at temperatures T_1 and T_2. Cup 1 has mass 2m at temperature T_1 and cup 2 has mass m at temperature T_2.

2.   Now let's discuss the experiment. **Do not begin until instructed to do so here!** Use two Styrofoam cups and the digital balance to mass your cups. Then obtain the water from your instructor and fill the cups no more than 1/3 full. Mass your cups until you obtain the amount of water you want. Measure the water temperature of each cup with a thermometer. In a minute you will pour the cold water into the cup of hot water and will need to read the temperatures of both thermometers until they come to equilibrium. When you are ready, you may **begin**. You will need to do both experiments described in 1a and 1b. Describe in your journal what happens. Do your experimental results agree with your predictions?

1a Equal Amounts at Temperatures T_1 and T_2	
Mass Cup:	Mass Cup:
Mass Cup + Hot Water:	Mass Cup + Cold Water:
Mass Hot Water:	Mass Cold Water:
T_1:	T_2:
T_{1+2}:	

Question 1-1: What happened? Do your results agree with your prediction?

1b Unequal Amounts by a Factor of 2 at Temperatures T_1 and T_2	
Mass Cup:	Mass Cup:
Mass Cup + Hot Water:	Mass Cup + Cold Water:
Mass Hot Water:	Mass Cold Water:
T_1:	T_2:
T_{1+2}:	

Question 1-2: What happened? Do your results agree with your prediction?

Question 1-3: Use your results to formulate an equation to predict the final temperature T of mass m_1 of water at temperature T_1 mixed with mass m_2 of water at temperature T_2.

II.   Mixing different materials

Material: tongs, digital balance, Styrofoam cup, hot metal object, room temperature water, thermometer.

Prediction 2-1: Predict what would happen if you placed a piece of hot metal into a cup of room temperature water of the same mass. How will the temperatures of each material change? Discuss this with your group and write your prediction in your journal.

1. Follow the directions of your instructor, which may be different than given here. You should have already placed the 88.6 g brass cylinder in the boiling water so that it has reached thermal equilibrium. Mass out an equal amount of room temperature water in a large Styrofoam cup. Remember to take account of the mass of the cup.

2. Place the thermometer in the cup and measure the temperature. You will be placing the hot metal object into the cup of water and measuring the temperature. You do not want to lose heat to the outside surroundings. Is there anything you can do to prevent this heat loss? Carefully using the tongs, grab the hot piece of brass from the boiling water, shake off the water on the brass, briefly wipe the excess water off with a paper towel, and place the brass cylinder carefully into the cup of water. Stir and measure the temperature of the water often. Record the temperature when it is constant; it will take a few minutes.

2 Equal Amounts of Different Materials at Temperatures T_1 and T_2	
Mass Cup:	Mass Brass Object:
Mass Cup + Water:	
Mass Water:	
T_w:	T_b:
T_{w+b}:	

Question 2-1: What do you think the temperature of the metal object was during the experiment? Was the final temperature of the water consistent with your prediction? Explain why or why not.

Question 2-2: Does the formulation you made in question 1-3 apply in this case? Why or why not? If not, formulate another relation that predicts the final temperature for the present experiment.

Question 2-3: Now let's determine the specific heat of the brass cylinder. Assume the initial temperatures of the water and brass are T_w and T_b, respectively, and the final temperature of the water is T. The heat lost by the brass is $m_b c_b \Delta T_b$ where ΔT_b is the temperature lost by the brass, T_b - T. The heat gained by the water is $m_w c_w \Delta T_w$ where ΔT_w is the temperature gain by the water, T - T_w. Now it should be easy to determine the specific heat of brass c_b. Compare your experimental value with the accepted value of 0.88 cal/(g ^{0}C).