Lab 4: The Difference Between Heat and Temperature

1. *Imagine* (don't do it yet) that you are going to mix together a sample of hot water with an equal amount of cold water.

   (a) Assuming that you know the initial temperature of both samples before they are mixed, develop a rule or equation that will allow you to predict the final temperature of the mixture.

2. Use the following procedure for mixing the samples. It is important to know the temperatures of the two water samples *immediately* before they are mixed.

   Step 1: Use the graduated cylinder to measure 25 mL of tap water into one of the styrofoam cups. Label this cup "cold".

   Step 2: Record the temperature of the cold water first - it will be near room temperature and will not change much while you prepare the hot water.

   Step 3: Measure 25 mL of hot water into the second styrofoam cup. Label this cup "hot". (Open **SPARKVue** application in the **PASCO SPARK LXi** interface. Open **PASCO** Experiment. Select **PHYS101L** . Open **Heat and Temperature** file to record temperature)

   Step 4: Record the temperature of the hot water. It should be around 60°C.

   Step 5: Leaving the thermometer in the hot water, pour the cold water into the cup with hot water. Do this as soon as you can after recording the temperature of the hot water.

   Step 6: Immediately after pouring record the temperature of the mixed water.

   Use the above mixing procedure a total of three times and record your data in the table below. (*Hint: The final temp will be the same for both the cold and hot water.*)

Cold Water			Hot Water		
Initial temp	Final temp	Temp change	Initial temp	Final temp	Temp change

   (a) How do the temperature changes of the hot and cold water samples compare?

(b) Was your "rule" for predicting the final temperature of the mixtures confirmed by your data? If not, modify your rule/equation to fit your data and write it clearly here.

3. Next you are going to be mixing hot and cold water samples of different amounts. Make measurements for the 3 different ratios described and record your data in the table below.

Cold Water				Hot Water			
Mass (gram)	Initial temp	Final temp	Temp change	Mass (gram)	Initial temp	Final temp	Temp change
25				50			
50				25			
25				75			

(a) Does your rule that you developed for *equal* amounts of hot and cold water work for *unequal* amounts of water?

(b) Is it possible to predict the which sample will change temperature more when mixing unequal samples? How?

(c) Do you think that heat and temperature are the same thing? Explain your thinking.

4. Your instructor should have shown you a procedure using boxes to show heat transferred to and from objects. On a separate sheet of paper, use this procedure to answer the following questions. Record your final answers below.

(a) A 4 gram sample of water at 40°C is mixed with a 6 gram sample at 20°C. What will be the final temperature of this mixture?

(b) A 4 gram sample of water at 12°C is mixed with a 3 gram sample at 40°C. What will be the final temperature of this mixture?

(c) How much heat must be transferred to 10 g of water to raise its temperature by 6°C?

(d) Imagine that we have 8 g of water initially at 30°C. If each gram gains 2.4 calories of heat, what is the final temperature of the whole sample? How much heat is gained by the whole sample?

(e) Imagine that we have 4 g of water initially at 40°C. If the final temperature of the sample is reduced to 25°C, how many calories are removed from each gram? How much heat is lost by the whole sample?

5. Imagine that we have 8 g of hot water and 2 g of cold water. If 16 calories of heat are transferred from the hot water to the cold water, answer each of the following questions:

(a) How much heat does each gram of hot water lose?

(b) How much heat does each gram of cold water gain?

(c) How much does the temperature of each gram of hot water change?

(d) How much does the temperature of each gram of cold water change?

(e) How much does the temperature of the entire hot water sample change?

(f) How much does the temperature of the entire cold water sample change?

6. Using the data from one of your trials of mixing equal amounts of hot and cold water and all of your trials of mixing unequal amounts, fill out the following table. Plot a graph on the graph paper provided with the mass times temperature change of the hot water on the y-axis and the mass times temperature change of the cold water on the x-axis.

Cold Water			Hot Water		
Mass (gram)	Temp change	Mass times Temp change	Mass (gram)	Temp change	Mass times Temp change
25			25		
25			50		
50			25		
25			75		

(a) What is the slope of your graph? What does this imply about the relationship between the mass times temperature change for both the hot and cold water samples?