*Chem 1314 Sections 14 – 21 and 23*
Laboratory, Week of October 4, 2004
Fall 2004

Name_____
TA Name _____
Lab Section #_____

ALL work must be shown to receive full credit. **Due by noon, Friday, October 8th in an envelope outside Dr. G's office (PS201).**

Pre-Laboratory Questions:

1. In this experiment you will be immersing a piece of metal that has been heated to a known temperature into a sample of water of known temperature (room temperature). Initially the temperature of the metal is higher than the temperature of the water.

   a) When a piece of hot metal is added to the water (initially at a temperature around room temperature) does the metal gain or lose heat? Explain.

   b) When a piece of hot metal is added to the water (initially at a temperature around room temperature) does the water gain or lose heat? Explain.

   c) What is the relationship between the heat gained/lost by the metal and the heat gained/lost by the water?

   d) After adding the piece of metal to the water, how are the final temperature of the metal and water related?

The goal of this experiment is to investigate what happens when a piece of hot metal is added to a sample of water at or near room temperature. NOTE: I expect each student to collect their own, unique set of data for the experiments in this activity.

Activity 1. Comparison of the heat exchanged by metals

Start the simulation (http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/thermochem/heat_metal.html). In the upper left corner of the simulation is a list of six metals, four with names and two unknown metals.

For the experiment select two metals to work with according to the table below;

| OSU Student Number (last digit) | Metal #1 | Metal #2 |
|---|---|---|
| 0 or 1 | Silver | Copper |
| 2 or 3 | Gold | Iron |
| 4 or 5 | Silver | Iron |
| 6 or 7 | Copper | Gold |
| 8 or 9 | Iron | Copper |

ACTIVITY #1:

Make a prediction of which of the two metals assigned to you will raise the temperature of water the highest.

> You need to make a fair comparison. For example if you use 10 g of metal #1 at 80°C, and 50 mL of water at 25°C, you should use 10 g of metal #2 at 80°C and 50 mL of water at 25°C. The initial temperature of the metal ($T_i$) should be greater than the initial temperature of the water ($T_i'$).
>
> Complete the following:

1a. Identify your Metal #1: _____ Identify your Metal #2: _____

1b. Prediction (which metal will raise the temperature of the water the highest?): ____

1c. Explain how you arrived at your answer.

2. Use the computer simulation to do your experiment. Record your data below. The specific heat of water is 4.18 $\frac{J}{g \cdot {}^{\circ}C}$. The density of water is 1.00 g/mL.

DATA: (Enter the name of one of your metals, and record the initial mass and temperature for both the metal and for water. Click on the Start button and observe what happens. Record the final temperature for the metal and for water. Repeat this in the second table for the other metal assigned to you.)

| Experiment #1 | | | |
|---|---|---|---|
| | Mass | Initial Temperature | Final Temperature |
| Metal _____ (#1) | | | |
| Water | | | |

| Experiment #2 | | | |
|---|---|---|---|
| | Mass | Initial Temperature | Final Temperature |
| Metal _____ (#2) | | | |
| Water | | | |

Did your prediction(1c) match your experimental results? Explain.

In the two experiments above, heat was transferred from

_____ to _____

CALCULATIONS:

3a. For each experiment (in Part 2) calculate the heat that was exchanged (absorbed or released) by the water. You may use the formula $q = mc\Delta T$. Show all steps and be sure to include units in all steps and in your answer. Be sure to indicate the "sign" (i.e. positive or negative).

Experiment #1

Experiment #2

3b. For each experiment (in Part 2) calculate the heat that was exchanged (absorbed or released) by the metal. Show all steps and be sure to include units in all steps and in your answer. Be sure to indicate the "sign" (i.e. positive or negative).

Experiment #1

Experiment #2

3c. Compare the values of the heat exchanged by the water and the metal. Within experimental error, was the Law of Conservation of Energy obeyed?

Experiment #1

Experiment #2

ACTIVITY #2:

4a. If you double the mass of Metal #1 in Part 2, keeping everything else the same, predict what will happen to the $\Delta T$ of the water ?

4b. If you double the mass of water in Part 2, keeping everything else the same, predict what will happen to the $\Delta T$ of the water?

Do these two experiments using the computer simulation.

DATA:

| Experiment #1 | | | |
|---|---|---|---|
| | Mass | Initial Temperature | Final Temperature |
| Metal _____ (#1) | | | |
| Water | | | |

| Experiment #2 | | | |
|---|---|---|---|
| | Mass | Initial Temperature | Final Temperature |
| Metal _____ (#2) | | | |
| Water | | | |

Did your predictions (in Part 4) match the results of the computer simulation? Explain.

ACTIVITY #3: Determination of the specific heat of an unknown metal.

5. Select one of the unknown metals (Metal X or Metal Y) to work with according to the table below;

| OSU Student Number (last digit) | Unknown Metal |
|---|---|
| 0 - 4 | X |
| 5 - 9 | Y |

Your Metal is, _____

Design and carry out an experiment that will help you determine the specific heat of this metal.

Write the experimental procedure you used to determine the specific heat of the unknown metal:

What observations did you collect?: (You may or may not need all of the cells below.)

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Using your observations indicate the Evidence you have to support the Claim you will make below.

Claim: The specific heat of metal _____ is _____.

POST-LAB Questions:

1a. A piece of metal at a high temperature was added to 110.0 g of water initially at 23.60 ˚C. When the temperature of the water with the piece of metal was measured again the final temperature was 33.35 ˚C. Calculate the amount of heat absorbed by the water.

b. How much heat did the metal give off in this experiment?

c. If the mass of the metal was 70.0 g and the initial temperature of the hot metal was 160.0 ˚C, calculate the specific heat of the metal.

2. A piece of silver weighing 70.00 grams is heated to 150.0 ˚C and added to 130.0 g of water initially at 24.20 ˚C. Calculate the final temperature of the mixture.

3. A sample of metal weighing 95.0 g is heated to 180.0 ˚C and added to 115 g of water initially at 24.80˚C. The final temperature of the mixture is 35.78 ˚C. Identify the metal as silver, gold, copper, or iron.