Ms. Randall
Regents Chemistry
Lab activity: Specific Heat of a Metal

Background: The specific heat of a substance is the amount of energy needed to change the temperature of a standard mass of the substance (usually 1 gram) by one degree Celsius. It is a characteristic physical property and may be used to identify substances. Different substances have different specific heats. The relationship between energy, mass, temperature change, and specific heat is:

$$Q=mC\,\Delta T$$

Change in heat (ΔH) is the amount of energy absorbed or lost by the substance. In this activity, ΔH will be measured in joules. A copper cylinder will be heated and cooled to find the specific heat of copper metal. Copper metal is commonly used as metal coating for pots, pans and hot water heating pipes.

Pre-lab Practice questions:

1. It was found, for an unknown substance, that 428.4 Joules of energy were required to heat 680 grams 5.00°C. What is the specific heat of the unknown substance? Give appropriate units.

2. The specific heat of water is 4.2 J/g*°C. If the temperature of 56.0g of water drops from 34.0°C to 19.0°C, how many Joules of energy were lost from the water?

Objective: To determine the specific heat of copper metal.

Materials: Copper rod, Bunsen burner, calorimeter, test tube, clamp, balance, calorimeter, tongs, 400mL beaker, ring stand, wire gauze, thermometer.

Safety: Safety Goggles, apron.
Procedure:

1. Set up a hot-water bath by filling a 400mL beaker about half way with tap water and placing on a piece of wire gauze on a metal ring attached to a ring stand. Set it so you burner can heat it.
2. Obtain a copper rod and measure its mass. Record it in the data table.
3. When your water bath has begun to boil, using tongs **gently** place the metal into the hot water and continue heating. The sample should remain in the boiling for 6-7 minutes. While waiting, continue with the steps 4 & 5.
4. Obtain a calorimeter. Determine the mass of the calorimeter, lid and thermometer carefully. Record in your data table.
5. Fill the calorimeter with distilled water until it is half full and then measure the mass of the calorimeter again plus the water.
6. While keeping the metal in the water bath, carefully record the temperature of the boiling water. Since the metal has been sitting in the water, we can assume that the temperature of the metal at this point is the same as temperature of the water.
7. Measure the temperature of the water in the calorimeter. Record in your data table.
8. With tongs, carefully remove the metal from the boiling water and immediately place the metal piece into the calorimeter. Avoid having droplets of hot water fall into the calorimeter.
9. With the thermometer or thermostat, gently stir the water in the calorimeter and record the highest temperature reached.
10. Recover the metal by carefully pouring off the water and placing the sample on paper towel.
11. Turn off your Bunsen burner and allow the water bath to cool.

Data:

Mass of copper rod	
Mass of Calorimeter	
Mass of Calorimeter plus water	
Temperature of boiling water(copper rod)	
Initial temperature of water in calorimeter	
Final temperature of water in calorimeter	

Calculations:

Mass of water in calorimeter	
Δ Temperature of water ˚C (final-initial)	
Δ H of water (Q=mCΔT)	

Assuming that all the heat gained by the water came from the metal rod and that all of the heat lost by the metal rod went into the water; calculate the specific heat for copper.

Δ H *of Metal* **Δ H *of Water***

mCΔT = mCΔT

Δ H of metal	
Mass of metal	
Δ Temperature of metal ˚C (final-initial)	
Specific heat of metal(copper)	

Analysis:

1. Did the water gain or lose energy? Explain.

2. Explain why the copper rod had a large change in temperature while the water had a small change in temperature when they were placed together. (Hint: Look at their specific heats)

3. In terms of molecular motion, what was happening to the speed of the molecules in the water when the copper rod was added? What happened to the speed of the molecules of the copper rod?

4. Calculate your percent error for the specific heat of copper. (Accepted value=0.382 J/g*˚C**)**

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Lab conclusion: Specific Heat of a Metal

1. **Write a paragraph summarizing what you have learned about the scientific concept of the lab from doing the lab. Back up your statement with details from your lab experience.**

2. **Object A at 40ºC and object *B* at 80ºC are placed in contact with each other. Which statement describes the heat flow between the objects?**

   A) Heat flows from object *A* to object *B*.
   B) Heat flows from object *B* to object *A.*
   C) Heat flows in both directions between the objects.
   D) No heat flow occurs between the objects.

3. **An iron bar at 325 K is placed in a sample of water. The iron bar gains energy from the water if the temperature of the water is**

   A) 65 K B) 45 K C) 65°C D) 45°C

4. **The average kinetic energy of water molecules is greatest in which of these samples?**

   A) 10 g of water at 35°C
   B) 10 g of water at 55°C
   C) 100 g of water at 25°C
   D) 100 g of water at 45°C

5. In an experiment using a calorimeter, the following data were obtained:

Mass of calorimeter + water	150. g
Mass of calorimeter	100. g
Final temperature of water	55°C
Initial temperature of water	25°C

What is the total number of Joules absorbed by the water?

A) 1,000 B) 1,500 C) 6,300 D) 4,500