Name:_____ Date:_____

Lab Partners: Lab Table Number:

ENERGY: ACT **Using a Constant-Pressure Calorimeter to Identify an Unknown Metal**

Purpose

The purpose of this lab is to use a constant-pressure calorimeter to determine the specific heat of an unknown metal. In addition, you will device, and carry out, a secondary test to identify the metal.

Background

The specific heat (s) of a substance is an intensive property and commonly used to identify an unknown substance. In this experiment, you will use a constant-pressure calorimeter to study the transfer of heat from the unknown metal to water. The data you need to collect are the masses, initial temperatures, and final temperatures of the water and unknown metal.

Based on the conservation of energy:

$$q_{water} = -q_{metal} \qquad \text{(Eq. 1)}$$

One can't directly measure the heat of an object. We can substitute the equation $q = m\ s\ \Delta T$ into Eq. 1 to derive a workable equation for this experiment.

$$(m_{water})(s_{water})(\Delta T_{water}) = -(m_{metal})(s_{metal})(\Delta T_{metal}) \qquad \text{(Eq. 2)}$$

The unknown metal will be heated and placed in a constant-pressure calorimeter containing a known mass and temperature. By knowing the mass, initial temperatures, and final temperatures of both substances, along with the specific heat of water, one can calculate the specific heat of the unknown metal. Looking up the specific heats of different metals will help you to determine, if not the specific metal, then narrow down the possibilities identities for the unknown metal.

Procedure

1. Determine the mass of your sample of unknown metal. Note any other observations that may help you to identify it.
2. Measure approximately 50 grams of the unknown metal. Record the mass exactly. GENTLY add the metal to a large test tube. The metal should fill the test tube about half-way. It helps to tip the test tube so that the metal pieces roll down the side of the test tube.
3. Place the test tube with the metal in a 400-600 mL beaker and fill it with water so that the water level is above the level of metal in the test tube. Place on a hot plate and bring the water to a boil.
4. While you are waiting for the water to boil (thereby heating the metal to 100°C) measure, to two decimal places, the mass of approximately 150 mL of water. Do not include the mass of the Styrofoam® cup.

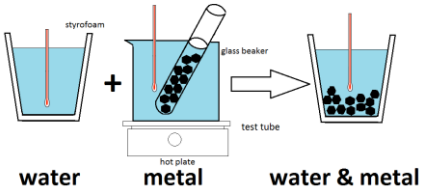

Figure 1. Sketch of the experiment using a constant-pressure calorimeter to determine the specific heat of an unknown metal.

5. Let the water boil for five minutes ensuring that the temperature of the metal inside the test tube is in equilibrium with the boiling water.
6. Although we can assume that the water will boil at 100ºC, we need account for any inaccuracy of the thermometer: we need to know the difference in temperatures, not the absolute values. With the same thermometer, measure the temperature of the water in the Styrofoam® cup just before measuring the temperature of the boiling water.
7. Using a test tube holder, CAREFULLY remove the test tube from the boiling water and GENTLY and CAREFULLY pour the metal into the Styrofoam® cup.
8. Record the temperature of the water at equilibrium.
9. Describe the secondary test and include your results in the Results, Calculations, & Conclusion section.

Data

	Water	Metal
Mass (g)		
Temperature, Initial (ºC)		
Temperature, Final (ºC)		
Other Observations Helpful for Identifying the Unknown Metal:		

Results, Calculations, & Conclusion

1. Showing all calculations, beginning with the basic equation, to determine the specific heat of the unknown metal.

(over →)

2. What are some possible metals for the unknown. Provide at least two intrinsic properties and justify your answer.

Substance	Specific Heat Capacity at 25°C in J/g°C
aluminum	0.90
brass	0.38
calcium	0.65
copper	0.385
gold	0.129
iron	0.444
lead	0.16
lithium	3.56
magnesium	1.02
nickel	0.44
potassium	0.75
sodium	1.23
sulphur	0.73
tin	0.21
zinc	0.39