

Name:

Period:

Seat#:

**Required Sections:** (Refer to R-5 for guidelines and requirements. Make note of any specific changes given by your teacher in class)

**Prelab:** All written in your lab notebook – Background Paragraph, Materials, Procedures, and set up Data Tables before you get to class (see requirements for data tables below).

**During Lab:** Data section - Draw a larger version of the data table shown in this handout in your lab notebook – make it big enough for good observations and data! REMEMBER TO PUT IT ON A NEW PAGE AFTER YOUR PRELAB SO IT DOESN'T GET COLLECTED BEFORE YOU CAN USE IT!

**Post-lab:** - Calculation section, Discussion Questions Section

## Background Paragraph:

Follow the guidelines given in your R-5 reference sheet. Do not forget to address the key things, which includes but is not limited to:

- Define thermochemistry
- Define specific heat
- Write the equation used to determine heat transferred.
  - o What does each variable stand for?
  - o What are their units?
- Explain what the algebraic sign represents when calculating heat transferred.
- Describe the process of calorimetry.
  - o How is it used?
  - o What key Law allows us to do the math in calorimetry?

## Concepts:

1<sup>st</sup> Law of Thermodynamics      Specific Heat      Calorimetry

## Materials

Hot plate	250 ml Beaker	Thermometer	Metal Cubes	Graduated Cylinder
Styrofoam cup with lid	Water	Balance	Tongs	

## Procedure:

- 1) Measure the mass of your metal cube.
- 2) Place the metal cube into the 250ml beaker and submerge with water. Start a hot water bath in a beaker. Crank the hot plate to 450°C. Be sure the water level will cover the metal cube when submerged
- 3) Measure 75 ml of tap water and record the mass on your data table. Pour the 75 ml of water into the Styrofoam calorimeter
- 4) Measure and record the temperature of the water in the calorimeter on your data table as  $T_{\text{initial}}$  for the water
- 5) When the water is boiling, start the time for 4 minutes. Assume the temperature of boiling water is the temperature of the metal and record as  $T_{\text{initial}}$  for the metal cube. Do NOT assume the water is boiling at 100°C exactly – it may not be pure water, and your thermometer may not be calibrated. You need to actually take the temperature to help insure good calculations!
- 6) Using tongs remove the metal cube from the boiling water and quickly transfer it to the Styrofoam calorimeter containing the 75 ml of water. Quickly place a lid on the cup and insert the thermometer.
- 7) Record the highest temperature of the water and record as  $T_{\text{final}}$  for the water and the metal
- 8) Perform a second trial on the same metal block so you can average your results.
- 9) Perform the lab again (steps 1-8) with a second metal block. If your instructor has enough calorimeters you may be able to do the second metal cube at the same time by running two calorimeters at once.

## Safety Precautions

Remember that hot and cold glass, and hot and cold metal cubes will look the same! Do not burn yourself! Assume things are hot if you do not know otherwise!

**Dougherty Valley HS Chemistry**  
**Thermochem – Identifying an Unknown Metal with Specific Heat**

**Data**

**Descriptive Title for Data Table**

	Trial One		Trial Two	
	75 ml H <sub>2</sub> O	Metal Cube #1	75 ml H <sub>2</sub> O	Metal Cube #1
Mass (g)				
T <sub>initial</sub> (Celsius)				
T <sub>final</sub> (Celsius)				
ΔT (Celsius)				
Q (energy in J)				

  

	Trial One		Trial Two	
	75 ml H <sub>2</sub> O	Metal Cube #2	75 ml H <sub>2</sub> O	Metal Cube #2
Mass (g)				
T <sub>initial</sub> (Celsius)				
T <sub>final</sub> (Celsius)				
ΔT (Celsius)				
Q (energy in J)				

**Calculations** Be sure to show all work – individually in lab notebook. *PLEASE BOX FINAL ANSWERS!*

1. Calculate (Q) for water using  $Q = (m)(C)(\Delta T)$
2. Calculate the specific heat (C) for the metal using the same equation in #1. Remember that  $q_{\text{water}} = -q_{\text{metal}}$ .
3. Using the chart below, identify the metal(s) that you tested. Support with evidence (your calculations/results).
4. Calculate your % error based on which metal(s) you believe you had.

Metal	Specific Heat (J/g°C)
Steel	0.46
Lead	0.130
Aluminum	0.903
Brass	0.376
Gold	0.129
Niobium	0.265
Krypton	0.248

$$\% \text{ error} = \frac{|\text{Accepted value} - \text{Experimental Value}|}{\text{Accepted value}} \times 100\%$$

**Discussion Questions**

1. Discuss sources of error in this experiment that might account for any deviation from the accepted specific heats. Be specific and explain how each error affects results. Remember that “human error” is not a “thing,” and “calculation errors” are not a source of experimental lab error. Also remember to only discuss sources of error that did/could have affected your specific lab group. Don’t list all sorts of crazy things! Do not forget to explain if each error would make your results too high or too low.
2. Brainstorm a way that we could redo this lab to get a better % error – how can we redesign it to remove some of the identified sources of error?
3. If a student did a similar lab but instead of unknown metal cubes, they used a small brass pipe fitting (fitting #1) and a large brass pipe fitting (fitting #2) that they found at Home Depot. Identify which variables should be the same, which will be different, which will be bigger and which will be smaller. Be sure to include the following variables: m, C, T<sub>initial</sub>, T<sub>final</sub>, Q.
4. A 50.6 g sample of iron metal is heated and put into 104 g of water at 19.7°C in a calorimeter. If the final temperature of the iron sample and the water is 24.3°C, what is the temperature of the iron sample when it was placed in the water? Show all work to receive full credit. *Put a box around your final answer.*
5. If 40.0 g of water at 70.0°C is mixed with 40.0 g of ethanol at 10.0°C, what is the final temperature of the mixture? (*Hint: the heat lost by the water equals the heat gained by the ethanol. Assume no heat loss to the surroundings.*) Show all work to receive full credit. *Put a box around your final answer.*