Class copy...do not write on this sheet!

Assigned on Friday, October 17, 2025

9.2 Lab: Determination of the Specific Heat of an Unknown Metal

Due Tuesday, October 21, 2025

Objectives

1. Identify what factors affect the rate at which a substance changes temperature.
2. Use calorimetry to determine the specific heat capacity of an unknown metal.
3. Use the specific heat capacity and density of an unknown metal to determine its identity.

Procedure (Place a check mark in the box next to each step as you complete it!)

1. You will be given a metal sample. Record the letter of your unknown metal sample in Table 1 on the line corresponding to your station number. In Table 1, circle the station number that you are at.

2. Place a 400-mL beaker with about 300-mL of water on a hotplate and turn the temperature setting to the highest setting.

3. Determine the mass of your assigned piece of metal and record the mass in data Table 1.

4. Tie a piece of string around your piece of metal and the other end of the string to an iron ring. Very carefully, suspend the metal in the water making sure that it is completely submerged but not touching the bottom of the beaker.

5. Bring the water to boiling and heat the metal in the boiling water for 5 minutes. While the metal is heating, move on to the next step.

6. Measure out about 100-mL of tap water using a graduated cylinder. In Table 1, record the exact mass of the water used. (Hint: the density of water is 1.00 g/mL, so the volume of water in mL is the same as the mass of water in g.) Pour this water in the calorimeter.

7. When the metal is finished heating, measure the initial temperature of the water in the calorimeter and record this value in Table 1.

8. Measure the temperature of the water in which the metal is heating. The temperature of the water is the same as the temperature of the metal. Record the initial temperature of the metal in Table 1.

9. Lift the metal out of the water and cut the string holding the metal (be very careful that the metal does not drop and hit the bottom of the beaker!!!!) and quickly place the hot metal into the calorimeter and place the lid on top.

10. Place the thermometer into the calorimeter and gently use the stirring ring in the calorimeter to stir the water. Observe the temperature over time and record the highest temperature reached in Table 1. This temperature is when the metal and water have reached **thermoequilibrium** (the same temperature).

11. Scan the QR Code to the right and record your data in the class data table online (BE SURE TO ENTER YOUR DATA IN THE CORRECT PERIOD'S TABLE!). You will need to copy the completed class data in Table 1. All pieces of metal with the same "unknown metal number" are the same type of metal. (link to table: https://tinyurl.com/yftffwkb)

12. If you have time, begin working on the analysis questions. You will have time next week to continue working on this lab with your group.

Name: _____ Period: _____ Assigned on Friday, October 17, 2025

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Data

Table 1: Calorimetry Measurements

Metal Letter	Mass of Metal (g)	Mass of Water in Calorimeter (g)	Initial Temperature of Water in Calorimeter (^oC)	Initial Temperature of Metal (^oC)	Final Temperature of Water and Metal in Calorimeter (^oC)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Analysis

1. Notice that the final temperatures for the water and metal in the calorimeter were different for every group. What factors do you think affected this final temperature to make them different? List at least three.

_____

_____

2. Some substances can change their temperatures very quickly and some change their temperatures very slowly. What about different substances do you think causes them to have these differences?

_____

_____

3. What is **temperature**? _____

4. What is **heat**? _____

5. What is the **specific heat capacity** of a substance? _____

_____

6. What is the **formula for the specific heat capacity of a substance**? _____

7. What is the **Law of Conservation of Energy**? _____

8. In this experiment, the metal went from a high temperature to a low temperature which means it lost heat energy. But according to the Law of Conservation of Energy, energy cannot be “lost”. Where did the heat energy lost by the metal go? _____

_____

9. According to the Law of Conservation of Energy, what must be true about the heat lost by the metal and gained by the water in the calorimeter? _____

Given your answer to question #9, the following equations must be true in a calorimetry experiment:

$$q_{water} = -q_{metal}$$

$$m_{water}C_{water}\Delta T_{water} = -(m_{metal}C_{metal}\Delta T_{metal})$$

Water is a substance that has been studied extensively and you can find physical data on it very easily. The specific heat capacity of water (C_{water}) is 4.18 J/g·K or 1.00 cal/g·K. Given this value and the data collected in the experiment, the specific heat of the unknown metal can be calculated algebraically using the equation shown above.

Calculations

10. Calculate the specific heat of your unknown metal. Show your work below. Be sure that you include units on all numbers and round your answer to the correct significant figures.

11. Calculate the specific heat for all the metal samples and record your answers in Table 2. You do not need to show your work for these calculations.

Table 2: Calculated Specific Heat for Each Metal Sample

Station Number	1	2	3	4	5	6	7	8	9	10
Specific Heat (J/g·K)										

12. Which station numbers do you believe had the same metal as yours?

Analysis and Conclusion

13. Using the average value of the specific heat of your metal and the accepted values of specific heats of various metals given in Table 3, what is the identity of your unknown metal?

_____

Table 3: Specific Heat Capacity of Selected Metals

Metal	Specific Heat Capacity (J/K·g)
Li	3.561
Mg	1.024
Al	0.903
Fe	0.449
Ni	0.444
Zn	0.389
Cu	0.385
Ag	0.235
Au	0.129
Pb	0.128

14. What is the percent error of your experimental specific heat? Show your work.

15. Why is it better to use the average of multiple trials to draw conclusions in an experiment than to just use one trial?

_____

_____

_____

_____

19. Identify an experiment error that affected your experimental value of the specific heat of your metal. Be specific about how the error affected your value. (e.g., "The metal was wet when its mass was determined causing the recorded mass of the metal to be larger than its actual mass. Because the mass of the metal was in the denominator of the equation used to calculate the specific heat of the metal, the larger mass value led to a calculated specific heat that was too small.")

_____

_____

_____

20. Was the cooling of the metal an endothermic or exothermic process? _____