FLINN SCIENTIFIC

Name_____

Pre-Lab Homework Assignment

1. A student prepares for the AP Chemistry exam by studying thermodynamics in lab. Before performing calorimetry experiments, she determines the specific gravity of four metal cylinders (see Figure 2). Review the procedures in *a* and *b*, and answer the questions/statements *in italics*.

   a. Density by Measurement Procedure:

   - Record the mass of each cylinder to the nearest 0.1 g.
   - Carefully measure the dimensions (diameter and length) of the metal cylinder to the nearest millimeter (0.1 cm).
   - *How will the student calculate the volume of the cylinder?*
   - *Determine how to calculate density of each cylinder.*

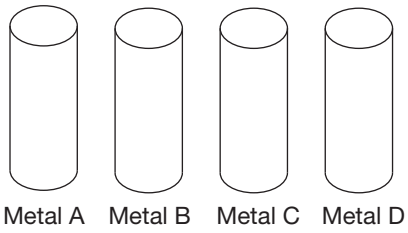


Figure 2.

   b. Density by Displacement Procedure:

   - Record the mass of each cylinder to the nearest 0.1 g.
   - Fill a 50- or 100-mL plastic graduated cylinder about half way with water. Record the volume of water in milliliters.
   - Carefully place the metal cylinder into the graduated cylinder. It works best to tip the graduated cylinder and slide the metal cylinder in along the side.
   - Record the new volume of water in the cylinder.
   - *Determine how the student calculates the volume of the metal sample.*
   - *Determine how to calculate the density of each cylinder.*

2. The student determined that if the density of a metal is known, its atomic radius can be mathematically determined. Review the following calculations, and answer the questions/statements *in italics*.

   Determination of Aluminum Metal Radii:

   - Density of aluminum from Question 1 = 2.70 g/cm^3.
   - *Calculate the mass of one aluminum atom.*
   - Aluminum has a face-centered unit cell, shown in Figure 3. Refer to your AP Chemistry textbook for more information on metallic unit cells.

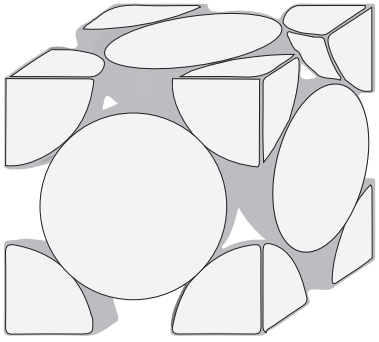


Figure 3.

   - Face-centered unit cells have 4 atoms in the unit cell. *Use the mass of the aluminum atom to calculate the mass of the unit cell.*
   - Determine the size of the unit cell by (mass of the unit cell/density of aluminum), with units of cm^3.
   - *The unit cell is a cube, determine the length of the cell in cm.*
   - Use the Pythagorean Theorem ($A^2 + B^2 = C^2$) to determine the length of the hypotenuse.

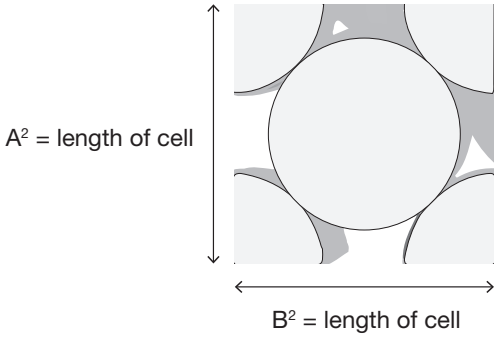
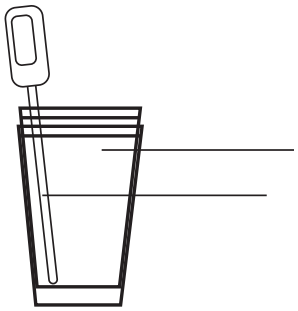


Figure 4.

- *Look at Figure 4. How many radii are there along the hypotenuse? Calculate the radius of each aluminum atom. Convert the value from cm to pm.*

3. Specific gravity is a comparison (or ratio) of the mass of a substance to the mass of an equal volume of water. What is the relationship between specific gravity and density?
4. Look at the student's calorimetry setup below. Label the experiment equipment.



5. The student wrote her own procedure to confirm the specific heat values of the metal samples in the following table. Answer questions in parts *a–c* in italics.

Metals	Specific Heat		Mass of Sample Provided (g)
	(in cal/g·°C)	(in J/g·°C)	
Aluminum, Al	0.215	0.899	57.99
Copper, Cu	0.092	0.385	58.00
Steel	0.110	0.460	58.03
Tin, Sn			58.00
Zinc, Zn	0.092	0.385	57.99

a. Calorimetry Procedure:

- Weigh a specific heat metal sample on a balance to the nearest 0.1 g.
- Place the metal sample in a boiling water bath for approximately 5–10 minutes. *Why is this step necessary?*
- Fill a coffee cup calorimeter with a measured quantity of room temperature or slightly chilled water. Measure and record the temperature of the water in the calorimeter in °C.
- Using tongs, lift up the heated metal sample from the boiling water bath and carefully place it into the water in the calorimeter.
- Stir the water in the calorimeter with a stirring rod, slowly and constantly. Use a thermometer to measure and record the highest temperature that the water reaches. *Does the heat gained by the water equal the heat lost by the sample?*

b. Calculate the heat gained by the water in the tin calorimetry experiment from the table. The metal was heated to 100 °C in a calorimeter containing 60 g of water at 18 °C, and the temperature of the water increased to 22 °C.

c. Calculate the heat lost by the same metal sample.

6. Work with your partner to determine the identity of your metal sample—there are 6 unknown metal samples to choose from and 5 known metal samples to observe. Write a procedure prior to arriving to lab to be approved by the instructor. As a class, reason through the data and determine the identity of the metal samples. Data tables with known density and specific heat values will be provided. Following are some helpful tips:

   a. Think safety first. Make sure you have the proper personal protective equipment (PPE) available to perform this lab (i.e., goggles, apron and gloves).

   b. Make a list of the equipment and glassware needed for this lab.

   c. Number the steps in your procedure; remember to be as detailed as possible, from set-up to clean-up.

   d. Draw necessary data tables in your notebook for data collection during the lab.

Metal Samples	Specfic Heat (J/g·°C)	Density (g/cm^3)
	0.899	2.7
	0.380	8.5
	0.385	8.9
	0.460	7.8
	melts in the range 92—95°C	9.6
	0.460	7.8