

CHEM 1110 Experiment #2. Determining the Density of Solids

Part 1: Determining the Density of a Regular-Shaped Object

Purpose:

- Record observations of physical properties of matter.
- Record measurements, using the correct number of significant figures and units.
- Perform conversions and other calculations.
- Use density to identify an unknown.
- Apply the definitions of accuracy and precision

Materials:

- ruler
- unknown sample
- 50 or 100 mL graduated cylinder

Care of the Balance:

- Never weigh a chemical directly on the balance pan. It may corrode the balance, contaminate the chemical, and makes it difficult to transfer the chemical. Always weigh a chemical in a container, such as a small beaker, or on weighing paper to protect the balance.
- Never drop an object on the balance. Place it gently in the center of the pan.
- Never weigh hot objects. Allow them to cool first to get an accurate reading.
- Clean up any spills immediately. Depending on the nature of the spill call the instructor over first.

Procedure: Record all data and observations in the Data section of the report sheet.

- Take 3 pieces of the same shape from the tube containing the unknown and perform the following steps:
 - 1) Record the unknown # in your notebook.
 - 2) Describe the unknown. Enter the observations in the notebook/data sheet.
- Mass:
 - 1) Using the balance, tare off the mass of a sheet of weighing paper.
 - 2) Place one of the unknown pieces on the weighing paper.
 - 3) Record the mass to the nearest 0.0001 g in the data table.
- Distance:
 - 1) Using a ruler, measure the dimensions of the same unknown piece used above to the nearest 0.01 cm. Record the values in the data table.
- Volume:
 - 1) Fill a graduated cylinder about $\frac{1}{2}$ way with water and record the volume to the nearest 0.1 mL (V_i) in the data table.

- 2) Carefully transfer the same unknown piece used above into the graduated cylinder, making sure the entire unknown is submerged in the water. Tap the side of the cylinder to remove any air bubbles. Record this volume to the nearest 0.1 mL (V_f) in the data table.
 - 3) Recover the unknown sample and dry it.
- Repeat the procedure for the other 2 pieces.
 - When done, return the dry unknown pieces to the tube and hand in to instructor.

Part 2: What is the Density of an Egg?

Objective of the Lab: Assessing the density and the variation of density of eggs.

Introduction

Back in the days before there were digital balances, people had to get creative to devise ways for (to obtain) relatively accurate measurements, for example for density. In the process of soap making, in addition to using animal fat, wood ash was boiled to extract lye (which was mostly K_2CO_3 and KOH). The concentration of the lye solution was tested by gauging its density with... an egg! If the egg sank, the solution was too dilute, if it floated on the surface, it was too concentrated, and if it freely floated in the solution, it had the right concentration (see Figure 1). In fact, the buoyancy of the egg was a measure of density, which in turn was a measure of the concentration. Later, more sophisticated instruments, such as hydrometers (see Figure 2) were used based on the same principle to measure density more accurately. Even today, hydrometers are used, for example to gauge the density (and the concentration) of battery acid in car batteries.

There is one caveat to the floating egg problem. The eggshell (mostly $CaCO_3$) is porous and it allows water to leave slowly. Also, when the egg starts to go bad, the organic molecules inside start to decompose and form gases, most of which also leave, otherwise the egg would blow up (and if you had the pleasure to experience a cracked bad egg, you must have smelled the gases that formed). Therefore, the mass of the egg can change over time, however its volume doesn't change since it has a hard shell.

Figure 1

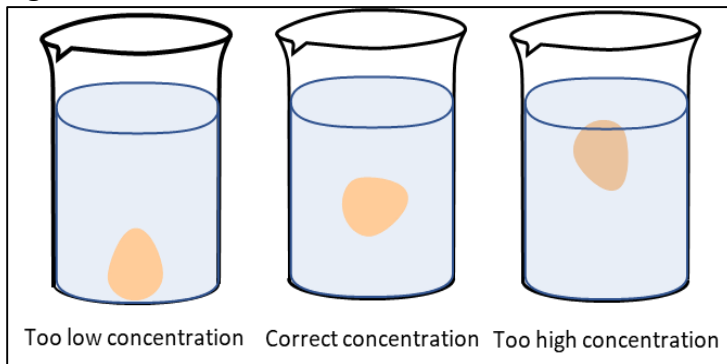
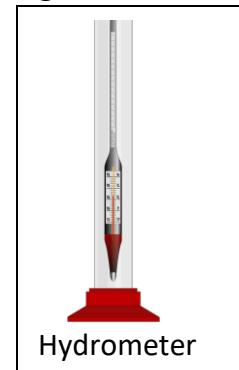


Figure 2



Materials

- 400-mL beaker
- 150 mL beaker (3)
- Spatula
- About 50 g table salt
- Plastic weighing dish
- A fresh and an older egg
- Balance

Procedure/Observations

| Step | Description | Observations/Notes |
|------|---|-----------------------------|
| 1. | Pour about 300 mL water into a 400-mL beaker. | |
| 2. | Obtain a fresh and an older egg, and record their numbers and expiration dates on the data sheet. | |
| 3. | Fill a plastic weighing dish 2/3 rd with table salt. No need to weigh the dish or the salt. | |
| 4. | Using a spatula carefully lower the fresh egg into the water. Record your observation. | |
| 5. | Add a pea-size volume of salt to the water and carefully stir it with a glass rod, so as not to crack the egg, yet to dissolve the salt. Observe the position of the egg. | |
| 6. | Keep adding about the same amount of salt each time, followed by stirring, to dissolve the salt until the egg starts to float and remains floating in the solution. Note: <ul style="list-style-type: none">• You can remove the egg carefully before adding more salt to allow more effective stirring.• Make sure there are no crystals left undissolved before adding more salt.• When you think the egg is floating, allow the egg to position itself. You can also move it to the surface, to see if it moves down a bit, and push it to the bottom to see if it rises. Each time allow a few seconds for the egg to position itself.• If you added too much salt and the egg rises to the surface, add a few mL water and mix until the egg floats in the middle. | |
| 7. | When the egg is floating, weigh three 150-mL beakers and record their masses. | Record masses in the table. |

| | | |
|-----|--|-----------------------------|
| 8. | <p>Transfer 10.00 mL of the solution, using a 10-mL pipet, into each weighed 150-mL beaker, weigh them again, and record their masses.</p> <p>Note:</p> <ul style="list-style-type: none"> • Mark the beakers to avoid mixing them up. • Transfer the solutions back into the beaker when done weighing. | Record masses in the table. |
| 9. | Replace the fresh egg with the older one. Record your observation. | |
| 10. | Add a few mL water to the solution and mix it well with the glass rod and observe if the egg floats. | |
| 11. | Keep adding a few mL of water at a time, followed by mixing, until the egg floats. | |
| 12. | Weigh three 150-mL beakers and record their masses. | Record masses in the table. |
| 13. | Transfer 10.00 mL of the solution into each weighed beaker, weigh them again, and record their masses. | Record masses in the table. |
| 14. | Dispose of the solution and clean the used glassware as instructed. | |

Name:

Date:

Report Sheet

Part 1 Data:

unknown # _____

Description:

Part 1: Data Table

| Measurement | Piece 1 | Piece 2 | Piece 3 |
|--------------------|---------|---------|---------|
| Diameter () | | | |
| Height () | | | |
| Mass () | | | |
| Initial volume () | | | |
| Final volume () | | | |

Part 2: Data Table

| Trial | Fresh egg | | | | Older egg | | | |
|-------|------------|---------------------|--------------|------------|------------|---------------------|--------------|------------|
| | Number: | Exp. Date: | Number: | Exp. Date: | Number: | Exp. Date: | Number: | Exp. Date: |
| | Beaker () | Beaker+solution () | Solution () | Volume () | Beaker () | Beaker+solution () | Solution () | Volume () |
| 1. | | | | | | | | |
| 2. | | | | | | | | |
| 3. | | | | | | | | |
| | | Average: | | | | Average: | | |
| | | Density: | | | | Density: | | |

Note: It is assumed that the volume is 10.00 mL for each measurement. Mark the appropriate units in the table.

Note: Incorporate appropriately your observations and the data table in your report.

Calculations: Show all your work.

1. Using unit analysis, convert the value of the height of one of the pieces of the unknown to:

a. mm

b. m

2. Using unit analysis, convert the initial volume reading from one of the pieces to:

a. dL

b. μL

3. Calculate the volume of the unknown for each trial:

a. From the distance measurements: $V_{cylinder} = \pi r^2 h$, $r = \frac{d}{2}$

• Piece 1:

• Piece 2:

• Piece 3:

b. From the graduated cylinder measurements:

- Piece 1:

- Piece 2:

- Piece 3:

4. Calculate the density of the unknown for each trial.

a. Using the volume from the distance measurements:

- Piece 1:

- Piece 2:

- Piece 3:

- Calculate the average density:

b. Using the volume from the graduated cylinder measurements:

- Piece 1:

- Piece 2:

- Piece 3:

- Calculate the average density:

Part 2: Show your calculations of density for the fresh egg and older egg. Use appropriate units.