

Hands-On Experiment

Density and Measurement

GOALS:

1. To measure liquid volume as accurately as possible with graduated cylinders.
2. To measure the volume of irregular shaped solid objects by liquid volume displacement.
3. To measure liquid volumes by pipetting into containers.
4. To weigh objects as accurately as possible on a Top Loader Balance.
5. To weigh objects to six significant figures on an analytical balances.
6. To calculate the density of known and unknown solids and liquids by measuring the mass and the volume of the objects with lab instruments.
7. To observe experimental deviations through error of instruments or students.
8. To introduce the terms accuracy, precision, reliability, sensitivity as related to an analytical procedure.

EQUIPMENT:

10 ml Graduated cylinder
100 ml Graduated cylinder
10 and 25 ml Volumetric pipette
25 to 50 ml Erlenmeyer Flask with solid rubber stopper
110°C Thermometer

CHEMICALS OR UNKNOWN:

One solid rubber stopper (either a #2, #1, or #0 as long as it freely fits into the 100 ml graduated cylinder)

Unknown solid: Metal slugs in box at the front desk or box of pennies

Distilled water

Unknown liquid: Acetone, Alcohol, other organic Liquid

INSTRUMENT:

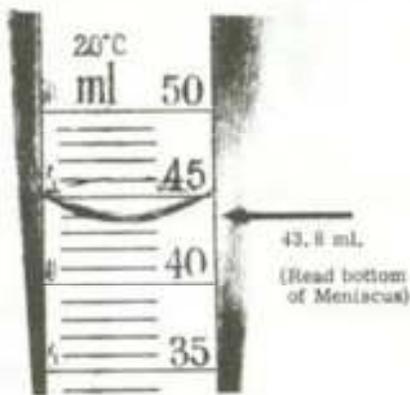
Top Loading Balance (0.01g)
Top Loading Balance (0.001g)

PROCEDURES:

- (1) The student should read the experiment before attending lab.
- (2) The student should copy the sample data page into her/his lab notebook.
- (3) Turn in your Measurement experiment's Post Lab Report and Data Page copies from your lab notebook

PART A: DENSITY OF A KNOWN SOLID

- (1) The students will calculate the density of rubber by measuring the mass and the volume of the rubber stopper. The rubber stopper must be small enough so that it will not jam in the graduated cylinder. The students should use a 100 ml graduated cylinder.
- (2) The 100 ml graduated cylinder should have division marking for each milliliter so that the student may measure the volume estimated to the nearest $\frac{3}{10}$ or $\frac{2}{10}$ of a milliliter.



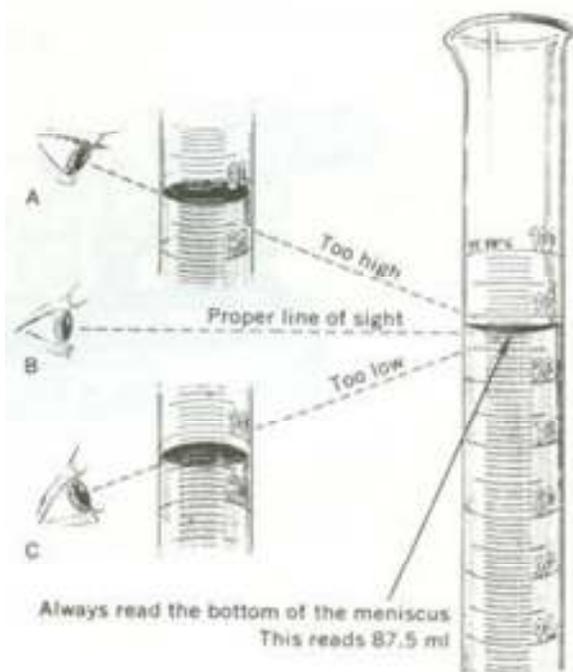
Remember to always read a graduated cylinder with your line of sight directly perpendicular to the **BOTTOM** of the meniscus.

On a white piece of paper, make a heavy dark line at least $\frac{1}{4}$ in thick. Place the paper, behind the graduate. Slide the paper up until the top of the dark line is about one division below the meniscus.

This technique will make the meniscus more prominent and easier to read, allowing you to estimate between the lines for one more significant figure.

- (3) Your graduated cylinder must be clean. Clean glassware will be free of water droplets clinging above the meniscus. (water film is okay) Place 15 ml or more water in the graduate. Read the volume accurately and record in your lab notebook. Your reading should **estimate** one decimal place.

- (4) The student will next weigh the rubber stopper directly on the Top Loading Balance on your lab island. The mass should be recorded to the nearest 0.01 gram. Record the mass in your lab notebook.



- (5) Then the student will carefully slide the stopper into a graduate by tipping the graduate to a 45° angle. The student should not splash one drop. Tap the graduate to free any trapped air bubbles. If any water droplets are clinging above the meniscus, you will have to wash the graduate with soap and water and begin again.
- (6) The student will record the new volume in the lab notebook. **Calculate the volume of the stopper**, by subtracting the reading #3 from the reading #6. This is known as a **volume of a solid by liquid replacement**.

- (7) Using a calculator, divide the mass of the stopper by its volume to determine the density. **DENSITY is MASS PER UNIT VOLUME**. Therefore by dividing the mass of the rubber stopper by its volume, the density may be calculated.

Since the mass should be at least two figures accurate and the volume at least two figure accurate the density should be calculated to three significant figures, the rounded off to two significant figures answer.

The correct answer is 1.24g/ ml for the black stoppers and 1.44 g/ ml for the green stoppers. **Rounded off, that would be 1.2** and 1.4

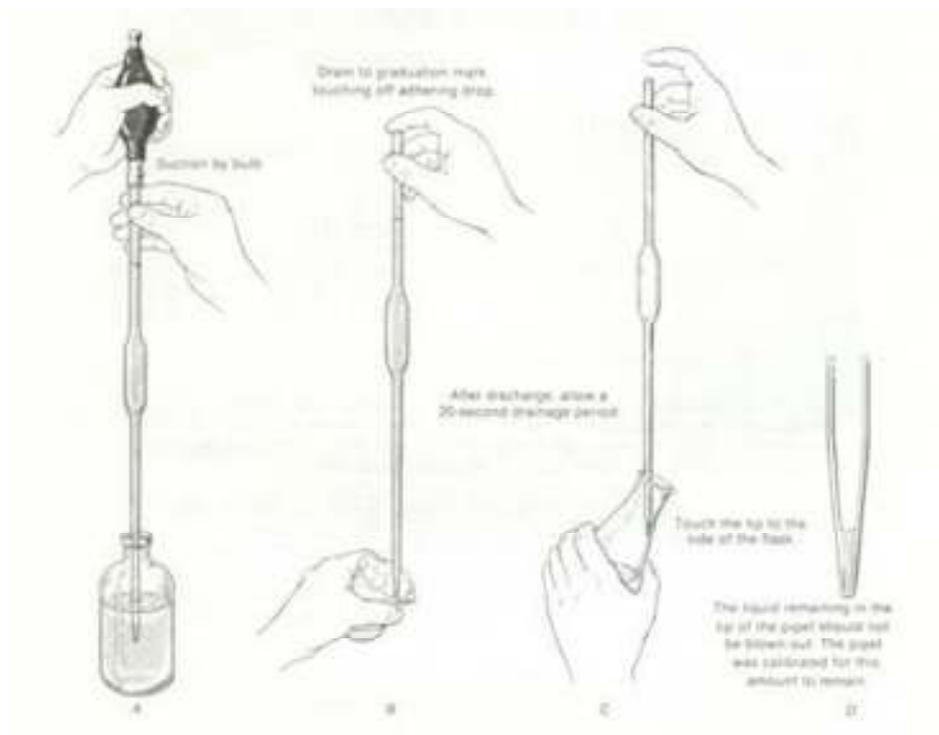
PART B: DENSITY OF AN UNKNOWN SOLID

- (1) Calculate the density of an unknown solid assigned to you by your instructor. Use the procedures similar to **PART A**, with the following modifications: (metal slugs in the box on the front desk or 25 Post 1982 pennies, or pellets)
- (2) Use a 10 ml/ 25 ml/ or 50 ml graduate that has division marking at least 2/10 of a ml or preferably 1/10 of a ml(10 mL graduate), that the object(s) will fit inside.
- (3) Weigh the metal slugs or pennies. Record in your lab notebook.

- (4) Measure approximately 5 ml of water in the 10 ml graduate or 10 ml in 25 ml graduate and read the volume level to the nearest $\frac{2}{10}$ or $\frac{2}{10}$ of a ml. Some of our graduates will come close to the nearest $\frac{3}{10}$ ml.
- (5) Tilt the graduate and carefully slide the unknown into graduated cylinder, so as not to splash out any water. Make sure the unknown is completely submerged and the water below the 10 ml line/or top line. Record the volume.
- (6) Calculate the volume of the solid.
- (7) Calculate the density of the solid to the nearest $\frac{1}{10}$ of a gram by rounding off the answer.
- (8) Using a paper towel from the wash sink, drain off the water from the graduate, pour the unknown on the towel (careful not to spill). Fold the towel and blot until dry. Put the dried unknown back on the cart or front desk.

PART C: DENSITY OF A KNOWN LIQUID

- (1) With a pipette, small flask, and a Top Load Balance (0.001g) student will calculate the density of water to three significant figures.
- (2) Weigh you 50 ml stoppered dried flask.
- (3) Using your 100 ml graduate, obtain about 40 or 50 ml of deionized water. (squeeze bottle or from carboy at wash-up sink)
- (4) After you have made your first weighing, pipette 25 ml of deionized water in your weighed flask. **At the fill mark on the pipet (line above the bubble) exactly 25.0 ml water can be measured with a SENSITIVITY of + $\frac{2}{100}$ of an ml.**



- (5) 25.00 ml has been listed in your lab notebook.
- (6) Weigh the flask and contents on the same Top Loading Balance you used before. Refer to your procedures or
- (7) Calculate the mass of the water. (subtract empty flask from the flask plus water)
- (8) Calculate the density of water to three decimal places.
- (9) Record the temperature of the water by using a 110°C Thermometer. Use the table on the next page for the correct density.

TABLE FOR DENSITY OF WATER

TEMPERATURE °C	DENSITY g/ml	TEMPERATURE °C	DENSITY g/ml
15°	0.9979	26°	0.9959
16°	0.9978	27°	0.9957
17°	0.9977	28°	0.9955
18°	0.9975	29°	0.9952
19°	0.9973	30°	0.9949
20°	0.9972	31°	0.9946
21°	0.9970	32°	0.9944
22°	0.9968	33°	0.9941
23°	0.9966	34°	0.9938
24°	0.9964	35°	0.9935

25°

0.9962

36°

0.9932

PART D: DENSITY OF UNKNOWN LIQUID

- (1) Using the Top Load Balance, (0.001 g) and a 10 ml pipet, dry flask, calculate the density of an unknown liquid. Use the same procedures as you followed in PART C, but add these modifications.
- (2) Using a clean dried 25 ml stoppered flask, weigh on the Top Loading Balance (0.001 g).
- (3) Obtain an unknown from the front desk (Acetone, Ethyl alcohol (ethanol), or methyl alcohol (methanol) in a small beaker. Pipette, using a 10.00 ml volumetric pipette, 10.00 ml into the weighed flask stopper.
- (4) Weigh the stoppered flask on the Top Loader Balance (0.001 g).
- (5) Calculate the density of the unknown. Have your data page in your lab notebook initialed by the instructor before leaving the lab.