Experiment 1

Basic Laboratory Operations

INTRODUCTION

This is the first "experiment" that most students perform in the laboratory. Oftentimes, the "stone is cast" in this first laboratory session. Your presentation will determine, in large part, student expectations and goals. If you emphasize the significance of the laboratory experience—the importance of laboratory safety, the application of proper laboratory techniques, and a thought process that includes the application of basic chemical principles—you will have a well-run lab.

In our laboratories, we stress the importance of practicing good laboratory technique. At the conclusion of the Laboratory Techniques section in the laboratory manual, there is a Laboratory Technique Assignment (pages 35-36). Assign this as an in-lab or take-home assignment for students to become familiar with this section of the manual.

Work Arrangement: Individuals. Divide the students into two groups:
Group I: Begin Part A
Group II: Begin Part B.

Time Requirement: 2.5 hours

LECTURE OUTLINE

1. Follow the Instruction Routine outlined in "To the Laboratory Instructor".
2. Note for students that circled superscripts in the Experimental Procedure are stopping points at which students are to make an entry on the Report Sheet.
3. **Part A.** Cite the various parts of a Bunsen burner and the zones of a properly adjusted (nonluminous) Bunsen flame.
   Demonstrate, with an explanation, the lighting of a Bunsen burner (Experimental Procedure, Part A.1). This very important technique is *not* in the Laboratory Techniques section of the laboratory manual.
4. **Part B.** Discuss the proper use and care of balances (Technique 6). Balances are used extensively in this course and students must learn to handle them with respect.
5. **Part B.2.** Repetitious mass and volume measurements show the random errors in making measurements in the laboratory and the importance of recording data with the correct number of significant figures…according to the precision of the instrument (balance and graduated cylinder). Refer to the Laboratory Data section of the laboratory manual for significant figures and how they are to be recorded.
6. **Part C.** Define density. Density is an intensive and physical property of matter. Describe the procedure for the density measurement of a water-insoluble solid and a liquid.
7. **Part C.2.** Class or group data are requested for completing the density data for water on the Report Sheet. Inform students how these data are to be collected. You may choose to have students calculate the standard deviation for the group data (see **Data Analysis** section of the laboratory manual).

The Next Step. Have students devise a procedure for measuring the density of a water-insoluble solid that is less dense than water or the density of a water-soluble solid. Extra credit?

Cautions & Disposal

- **Part A.** Where there is fire, there is danger**.**
- **Part A.** Use tongs or forceps for holding the wire gauze in the flame.
- **Part C.1.** Return the unknown solids for use in other laboratories.
- **Part C.2.** Do *not* pipet by mouth.
- **Part C.2.** Caution the students of handling potentially flammable liquids near a Bunsen flame. Dispose of the liquid unknowns in the "Waste Liquids" container.

Teaching Hints

1. **Part A.** All Bunsen burners are not the same; for example, some do not have a gas control valve. Advise students to adjust the Experimental Procedure accordingly.

   Assist students in the lighting and adjusting of the Bunsen burner. Make sure the tubing is attached to the gas outlet, *not* the water outlet! Remove combustible substances from the area near the Bunsen burner. Extinguish the Bunsen flame when it is not in use.
2. **Part B.** Over-emphasize, if necessary, the care and operation of balances. Students seem not to appreciate the delicacy (and the sensitivity) of a balance (for some reason). Oversee its operation *at all times*. Keep the balance area clean of all chemicals and glassware. Have students review Technique 6.
3. **Part C.1a.** Do students know the meaning of "tare the mass of a piece of weighing paper?" It can only be done with a balance having that feature.
4. **Part C.1c.** Roll the metal in the water to remove air bubbles. Watch that students properly read and record a meniscus (see Technique 16A).
5. **Part C.2.** Supervise the use of the pipet and the proper pipetting technique (Technique 16B)—students are *not* to pipet with their mouths. (**Caution**: *keep liquid unknowns away from the Bunsen flame*.)

Suggested Unknowns

Issue a solid sample for Part C.1 and a liquid sample for Part C.3. Provide labeled containers for the return of the solid samples and a "Waste Liquids" container for the liquid samples.

Part C.1 Solid[a]	Density (*g/cm³*)	Part C.3 Liquid[a]	Density (*g/mL*)
aluminum	2.70	methanol	0.791
copper	8.95	ethanol	0.789
iron (nails, *not* galvanized)	7.86	water	1.00
lead	11.34	1-propanol	0.804
nickel	8.90	toluene	0.867
silicon	2.42		
tin	7.28		
zinc	7.14		

[a]Volumes of 3–5 cm^3 of metal and 10 mL of liquid are needed.

Special Equipment

Bunsen burner	1	balance, ±0.01 g	1
match or striker	1	balance, ±0.001 g	1

wire gauze
crucible tongs
graduated cylinder, 10 mL 1
"Waste Liquids" container
5-mL pipet and bulb 1
weighing paper

PRELABORATORY ASSIGNMENT

1. Methane, commonly known as natural gas, is the common fuel and the oxygen is the required air component for producing an efficient, nonluminous Bunsen flame.
2. a. *Blue.* A nonluminous flame is a blue flame that indicates the fuel is undergoing *complete* combustion.
   b. *Less.* A luminous flame contains carbon particles that have not undergone combustion and therefore burns less efficiently, producing a lower temperature flame.
3. See Figures T.16a and T.16b, page 35.
4. [Depends upon the laboratory, most likely ±0.01 g or ±0.001 g]
5. Flames from a wood-burning fireplace are typically yellow in appearance because of an insufficient amount of oxygen near the burning wood producing a luminous flame. The yellow appearance of the luminous glow is due to the presence of the unburned carbon particles.
6. a. …touching the tip to the wall of the receiving vessel
   b. …forefinger or index finger (not the thumb!)
   c. The last bit of liquid remaining in the pipet after delivery should remain in the pipet.
   d. TD means "to deliver"…the pipet is calibrated to deliver the volume for the calibrated pipet, allowing the liquid to flow from the pipet with only the aid of gravity.
7. The cylinder containing the *diamond.* Platinum is more dense than diamond; therefore an equal mass of diamond would displace a larger volume of water.

   For example, 21.43 g of diamond displaces a volume of ($21.43\ \text{g} \times \frac{\text{cm}^3}{3.51\ \text{g}} =$)

   6.11 cm^3, while 21.43 g of platinum displaces only 1 cm^3 of water.
8. mass of "conc" hydrochloric acid = (11.229 – 5.333) g = 5.896 g

   $\text{density} = \frac{5.896\ \text{g}}{5.00\ \text{mL}} = 1.18\ \text{g/mL}$

LABORATORY QUESTIONS

1. When the gas control valve is slightly closed on a nonluminous flame, less fuel is available for the combustion of the fuel, reducing the "size" of the flame but still producing a nonluminous flame.
2. When the air control valve is slightly closed on a nonluminous flame, less air is available for the combustion of the fuel, producing a luminous flame.
3. The fuel for the burning candle is the candle wax. The flame is luminous because the oxygen supply at the base of the wick is insufficient to combust all of the burning candle wax.
4. *Higher density.* If the solid is not submerged, less water is displaced resulting in a smaller measured volume of the solid. A smaller volume with a given mass results in a greater reported density.

5. *Lower density.* Less mass (volume) of water will be delivered from the 5.00 mL pipet but the presumed volume of the water will remain unchanged. As a result the density measurement for water will be low since the delivered mass will be too low.
6. *Too low.* The measured mass of the delivered liquid will be measured low, but its measured volume will remain unchanged. Therefore, its density will be recorded too low.

Laboratory Quiz

1. A properly adjusted Bunsen burner flame has (one, two, three) distinct cones.
[**Answer:** three]
2. What is the criterion for clean glassware?
[**Answer:** Technique 2. "no water droplets cling to the wall"]
3. What is the fuel used for the flame in a Bunsen burner?
[**Answer:** generally, methane or natural gas]
4. A properly adjusted flame of a Bunsen burner is (nonluminous, luminous). Explain. [**Answer:** nonluminous]
5. Suppose that after delivery several drops of a liquid cling to the inner wall of a 5 mL pipet. Is the actual volume of the liquid delivered greater or less than the 5 mL recorded by the pipet? Explain.
[**Answer:** *Less than 5 mL.* The liquid on the inner wall is a part of the calibrated 5-mL pipet.]
6. A 25.0-mL volume of a liquid was dispensed from a pipet. The mass of the liquid was determined to be 21.6 g. What is the density of the liquid?
[**Answer:** 0.864 g/mL]
7. The density of lead metal is 11.35 g/cm^3. If 16.44 g of lead is added to a 10-mL graduated cylinder that contains 4.2 mL of water, what will be the final volume reading of the water in the cylinder? [**Answer:** 5.6 mL]
8. A 8.462-g metal bar changes the water level in a 50-mL graduated cylinder from 23.7 mL to 25.9 mL. Calculate the density of the metal. [**Answer:** 3.8 g/cm^3]
9. The density of lead metal is 11.35 g/cm^3. If 12.49 g of lead metal is added to a 10.0 mL graduated cylinder containing 5.72 mL of water, what will be the final volume reading of the water in the cylinder? [**Answer:** 6.82 mL]
10. The mass of a beaker is 5.944 g. After 5.00 mL of an alcohol is pipetted into the beaker, the combined mass is 9.891 g. From the data, determine the density of the alcohol. [**Answer:** 0.789 g/mL]
11. The density of Solid A is 2.70 g/cm^3 and that of Solid B is 1.79 g/cm^3. A 6.86 g sample of Solid A is transferred to a graduated cylinder containing 5.00 mL of water and a 7.11 g sample of Solid B is transferred to a graduated cylinder also containing 5.00 mL of water. Which solid sample displaces the larger volume of water? By how many milliliters? [**Answer:** Solid B, 3.97 cm^3 or 3.97 mL]
12. The density of lead is 11.3 g/cm^2 and the density of diamond is 3.51 g/cm^3. If equal masses of diamond and lead are transferred to equal volumes of water in separate graduated cylinders, which graduated cylinder would show the greater volume change? [**Answer:** diamond]

13. An air bubble adheres to the surface of a solid when it is submerged in the water of a graduated cylinder. Will the reported density of the solid be reported too high or too low? Explain.

[**Answer:** *Too low.* A larger presumed volume results in a lower reported density]