basic concepts of chemistry in the laboratory

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BASIC CONCEPTS OF CHEMISTRY IN THE LABORATORY

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CONTENTS

INTRODUCTION

There are two important reasons for a general chemistry laboratory assignment: First, to help the student understand the lecture material; second, to give him experience in the methods used by scientists to obtain and utilize data. Although you will be repeating the work of many other experimenters, always try to maintain a strictly scientific attitude in this work: regard each experiment as a potential scientific discovery; treat each observation as if it is of great importance; understand what you are doing and why you are doing it. Otherwise you are like a cook blindly following directions to bake a cake—and then throwing the cake away!

Writing the laboratory notebook. To do scientific work one must learn to keep a proper record of experimental results in a permanent notebook. The notebook should be self-explanatory. Anyone who reads it should be able to understand the purpose and nature of the experiments. Data and observations should be carefully organized and calculations should be easy to trace.

The notebook is written in ink. Never erase or tear out a page. If you believe an observation to be erroneous, cross it out neatly but leave it legible. A laboratory notebook is a record of *all* the results obtained by a worker.

A suggested format for the laboratory notebook is as follows:

1. Title page (first right-hand page of experiment): Title of experiment, date, and purpose are written at top of page. Make an entry in the Table of Contents for the experiment at this time.

2. The right-hand pages are used to record experimental data in data tables, calculated results (but not details of calculations), observations, conclusions, and answers to questions (see illustration).

Left page	*Right page*
diagrams	title, date
graphs	data tables
setups for calculation	observations
	conclusions
equations	answers

Writing the laboratory notebook.

3. The left-hand pages are used for supplementary material such as diagrams, graphs, details of calculations, and chemical equations.

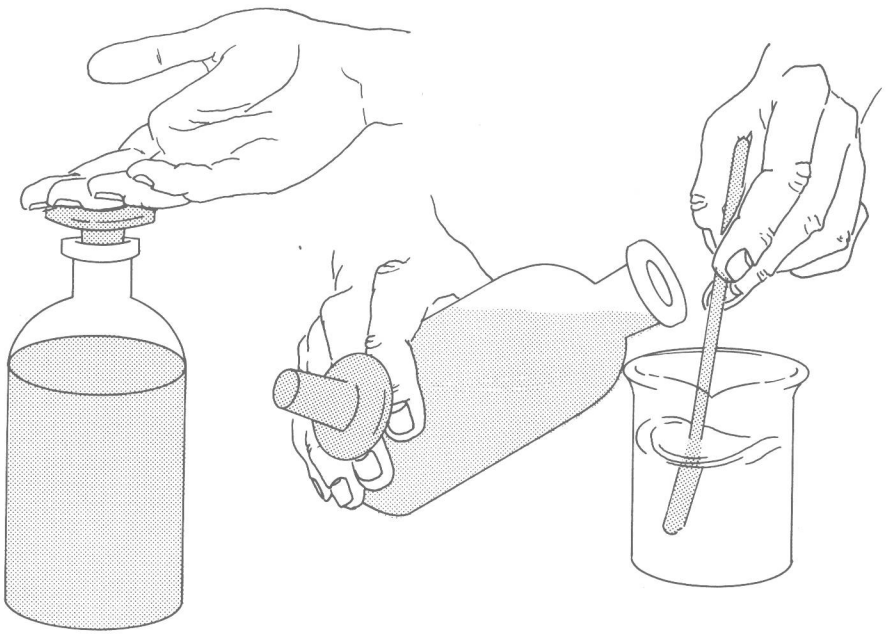
Questions need not be copied, but should be answered in complete sentences which contain statements of the questions, for example:

Question: What color is the Bunsen burner flame when it is properly adjusted?
Answer: The Bunsen burner flame is blue when properly adjusted.

Observations and data are recorded *directly* in the notebook as each step of the procedure is completed. After completion of each experiment, you should submit the notebook to the instructor for checking.

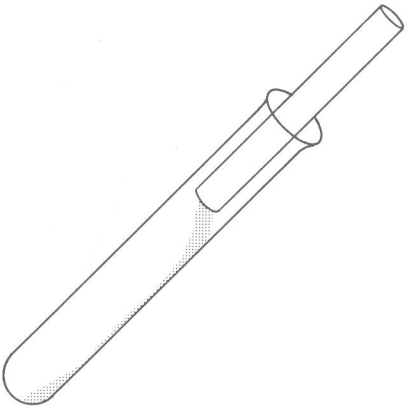
Handling reagents. The following suggestions will avoid waste or contamination of reagents:

Liquid reagents may be poured from the bottle directly into a test tube, or may be stored in a beaker. Hold the bottle stopper between your fingers while pouring; never set it down on a desk top where it may be contaminated (see illustration). Try to estimate your needs so that you do not take large excesses of reagent, but if you find you have an excess, discard it. *Never* pour reagents back into reagent bottles. *Never* insert stirring rods, glass tubes, or pipets into a reagent bottle.



Hold the stopper between your fingers while pouring reagents out of a bottle.

Solid reagents should never be poured directly from a bottle into a test tube. Pour solid out of the bottle onto a clean smooth piece of paper, roll the paper into a cylinder with the solid inside, and transfer to the test tube as shown (see illustration). Certain solids, such as sodium peroxide, potassium chlorate, and potassium permanganate react with paper and they should be transferred with a clean spatula from bottle to test tube.



The rolled-paper technique for transferring solids to a test tube.

Keeping work areas clean. The student is responsible for keeping his area of the laboratory in neat, orderly, and usable condition. At the end of a laboratory period, he is to clean up the desk and trough area where he has been working, regardless of the condition in which he found it. The desk should be wiped clean with a damp sponge. Paper and match sticks should be removed and placed in waste receptacles. Equipment borrowed from the stockroom should be returned.

Safety and first aid. The best guide to safety in the laboratory is to know the dangers and to avoid them. The principal cause of accidents is carelessness. The most common injuries are burns from hot objects and cuts on glass.

Your instructor will explain the first-aid procedures which are used in your laboratories. In the space following, note where he says to go (1) in case of minor cuts or burns, and (2) in case of serious injury. In any case, if you suffer an injury, notify your instructor immediately!

FIRST AID

FIRST AID

A fire extinguisher is located nearby. Note its location.

The best first aid for chemicals spilled on the skin or clothes is immediate washing with copious amounts of water. If the spill was in your eyes, wash with water immediately and notify the instructor, who has eyewash available.

Do not taste chemicals unless specifically directed to do so, and sniff them with great caution (see illustration for a safe method of sniffing).

ALWAYS smell a substance by wafting its odor gently toward your face.

Perform experiments in the fume hood if noxious gases are likely to be released. **MOST IMPORTANT.** ***NEVER*** perform unauthorized experiments!

Please sign the following statement:

I have read the preceding laboratory rules_____

(signed)

Preliminaries to be completed before the first laboratory period:

Read the preceding material on laboratory notebook and safety, and sign the statement.

Place your name on the outside of the laboratory notebook and on the bottom edge of the pages of the notebook.

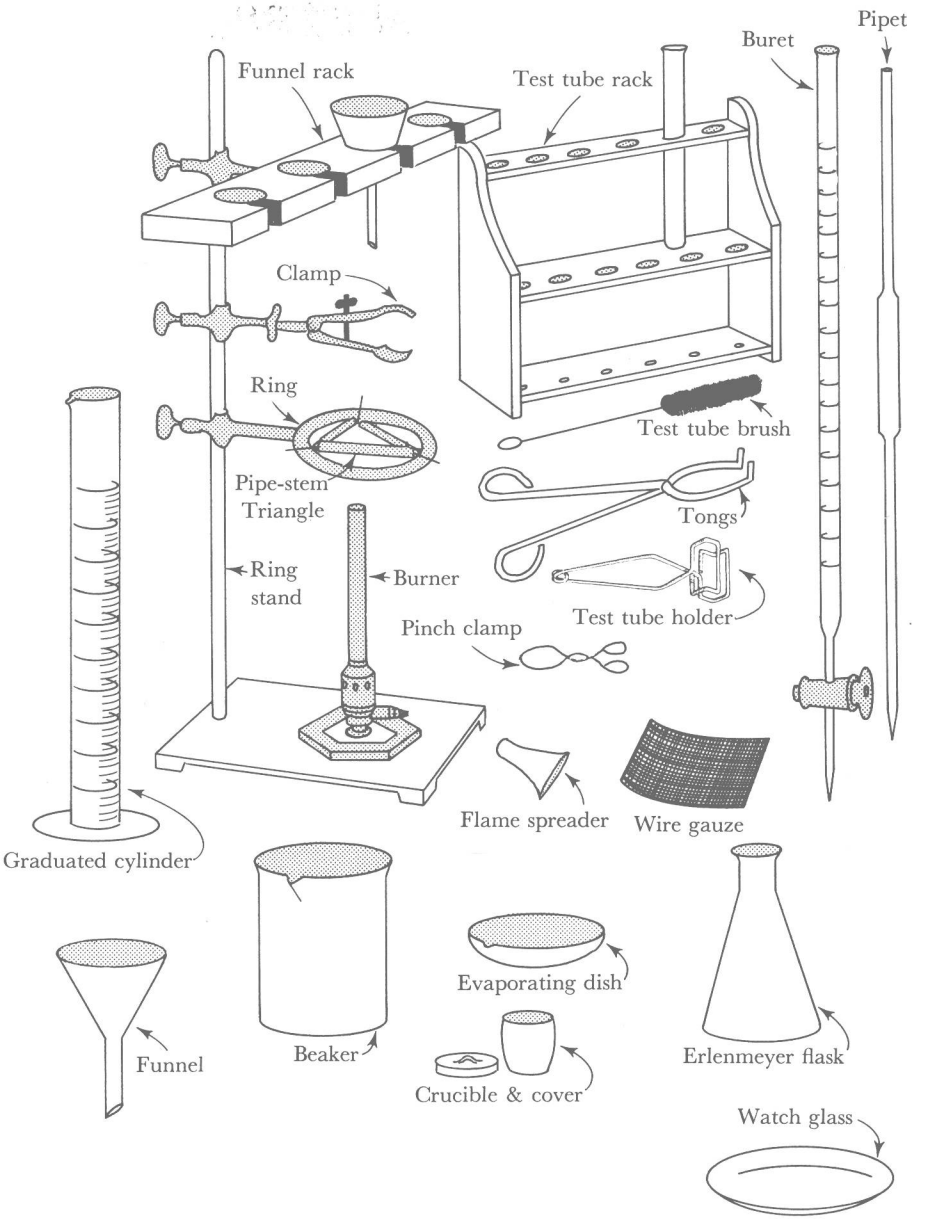
Number the pages consecutively in the upper right-hand corner; right-hand pages are odd-numbered, left-hand pages are even-numbered.

Reserve pages 1 and 3 of your notebook for the Table of Contents.

The form of the Table of Contents is shown below:

TABLE OF CONTENTS

Experiment No.	Title	Notebook Page No.	Instructor's Approval



Desk equipment needed for experiments in this manual.

Experiment 1

Burner and Glassworking

Equipment: **glass cutter, burner, wood splints, glass tubing, wire gauze**

Object: **to become familiar with the operation of a laboratory burner and to learn some of the simple manipulations required in working glass tubing**

Discussion:

The burner is an essential tool in many chemical operations. An efficiently operating burner has a blue flame about 5 cm (2 inches) high and makes only a slight noise. Flame height can be adjusted by regulating the gas flow. Flame color and noise depend on the gas-air ratio.

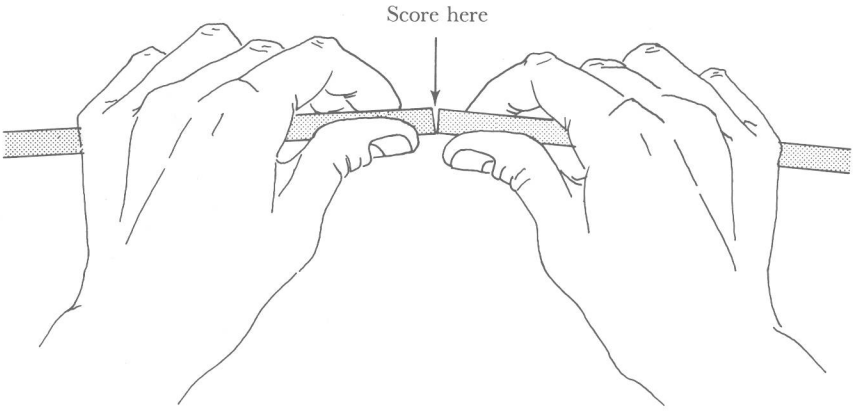
One of the first things each of us learn when working glass is that hot glass tubing looks exactly like cold glass tubing! See the instructor if you burn yourself. It is often wise to start several projects at the same time so that the first can be cooling while work is conducted on other items. Your instructor will demonstrate the various operations of glassworking.

Procedure: **A. The burner**

Completely close the air and gas inlets on your burner. Now open the gas inlet slightly and light the burner. Note the color of the flame, vary the height of the flame with the gas regulator, and gradually open the air regulator. Note the effect on flame color and noise. After the burner is properly adjusted (see "Discussion"), probe the various regions of the flame with a wood splint to determine which portions are hottest and which are relatively cool. Make a drawing of the flame and indicate hottest and coldest regions.

B. Glassworking

1. **Cutting.** Small-diameter glass tubing can be conveniently cut to length by scoring at the desired length and snapping with thumb pressure on the backside of the score mark (see illustration). If more than modest pressure is required, the tubing should be scored again in the same place. The score can be made with either a triangular file or glass cutter. Obtain a short length of scrap tubing and cut it into still shorter lengths. It is advisable to wrap the tubing with a towel while breaking it.



Breaking a section of glass tubing. It is advisable to wrap the tubing in a towel (not shown).

2. Fire-polishing. Freshly cut glass surfaces are very sharp. The sharp edges of tubing are generally rounded by strong heating (*i.e.*, fire-polishing), but excessive heating will completely seal the end of small diameter glass tubing. Always fire-polish both ends of your tubing before bending it to the desired shape. Hot glass tubing should be placed on a flat wire gauze or other heat-resistant surface; never on the desk top. Fire-polish the ends of some scrap tubing and attempt to seal the end of one piece by continued heating. The yellow color imparted to the flame is due to sodium compounds in the glass.

3. Bending. A small Bunsen or Tirrill burner is often used for bending glass; many instructors recommend the use of a wingtip, an attachment for spreading the Bunsen flame. A somewhat more rapid method involves use of the larger Meker burner. In order to obtain a smooth unstrained bend, two to three centimeters of tubing must be heated to softness.

Obtain a piece of glass tubing at least 20 cm long, heat it with constant rotation until it softens, remove it from the flame, and bend it to a 90° angle. Quickly place the still-soft tubing on a flat wire gauze and hold it in position for about ten or fifteen seconds, then allow it to cool.

A good bend and a poor bend.

Ask your instructor to examine the bend, and make a few more bends at different angles. Make at least one bend using a Meker burner if one is available.

4. **Drawing.** At times it is desirable to draw a fine tip on a piece of glass tubing. This is accomplished in much the same manner as bending except that the tubing must be heated more strongly. Obtain a 20 cm length of glass tubing and rotate it in the flame as before, but this time continue heating until the glass sags under its own weight. Quickly withdraw the tubing from the flame and stretch it as far as you can. Hold the tubing firmly in this position for at least five to ten seconds. Failure to hold the tubing at this point will result in a misshapen tip. The tubing can now be bent until the fine capillary portion breaks. After the tubing has cooled, cut off the finest portion of the tip and carefully fire-polish the small end. Submit your collection of glass-workings to the instructor for his approval and comments.

Experiment 2

The Metric System; Density

Equipment: **assorted glassware, centimeter ruler, laboratory balance, platform scale, buret**

Object: **to become more familiar with the relative size of the common metric units of measure, and to apply the significant-digit analysis to the measurement of some common quantities**

Discussion:

This is the first experiment which requires compilation of measured data. Refer to the Introduction for the correct method. Record all data *in the notebook* as you obtain it. *Scratch-paper notes will be confiscated by the instructor!*

The laboratory balance and the buret are precision instruments for measuring mass and volume. This is your first opportunity to use them in this laboratory, but there will be several other experiments in which their use will help you to obtain precise measurements. Take this opportunity to practice with them. Listen carefully to your instructor's directions.

Procedure:

1. Measure the length of one of your test tubes in centimeters. Record your result in a data table as "Length of a test tube . . . _____ cm."

2. Determine the inside dimensions of your lab desk drawer in cm. Calculate its volume in liters. Record measurements and calculated volume in the data table.

3. Measure the volume (to the brim) of a 100 ml beaker using a 50 ml graduated cylinder. Record your data. What can be said about using a beaker for accurate volume measurements? Compare your result with those of your neighbors.

4. Obtain a 100 ml sample of an *unknown liquid* from your instructor.

(a) Density of a liquid (rough). Carefully clean your 10 ml graduated cylinder and rinse it twice with small portions of the unknown liquid. Discard the washings. Then fill the graduate to the 10.0 ml mark (see illustration showing how to read to the bottom of the meniscus).