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Laboratory experiments for basic chemistry

LABORATORY EXPERIMENTS FOR BASIC CHEMISTRY

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Figure 11-1, page 103, is used by permission of Bausch & Lomb. Table 1, page 195, is used by permission of the Chemical Rubber Company.

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PREFACE

We wrote Laboratory Experiments for Basic Chemistry for use in one-term or two-quarter introductory chemistry courses for students with practically no background in science and mathematics. The experiments provide support for key principles covered in lectures. They also give the student chances to learn skills that will be useful in the further study of college chemistry. The manual is organized so that it follows our textbook, Basic Concepts in Chemistry, but we have included enough extra experiments--some on subjects not covered in our text--that an instructor can use it as a lab manual to accompany other textbooks for courses in preparatory chemistry and chemistry for liberal arts majors.

This manual covers a range of objectives, clearly stated with each experiment. Our first few experiments deal with basic lab skills, such as classification, weighing, measuring, and separating various materials. Later experiments deal with basic concepts of chemistry--for example, the differences between elements, compounds, and mixtures, and the chemistry of elements within a group.

We wanted our manual to be flexible; therefore we have included several additional experiments for the instructor to choose from because we realize that an instructor could not cover all the experiments we offer in a one-semester course. In effect, we are offering a smorgasbord of experiments to fit a variety of needs.

Key features of our manual are:

1. A list of "things you will learn by doing this experiment" preceding each experiment.

2. A complete list of materials the student needs to perform each experiment, which appears at the beginning of each experiment. We include chemicals that are relatively inexpensive and equipment that is in common use. An alphabetical list of materials needed in experiments is also given at the end of this book.

3. Discussions of the basic principles underlying each experiment. In some cases we give actual laboratory data, gathered as the manuscript was class-tested, so that the student can see exactly what's involved in performing the experiment.

4. Step-by-step procedures in outline form. We warn against possible hazards and list precise safety rules. We also point out possible complications that could develop in some experiments.

5. Clear diagrams showing the design and setup for each experiment.

6. Exclusive use of metric notation. We give English-metric conversions considerable coverage in our textbook.

7. Thought-provoking questions (take a look at them and you'll see what we mean) for class discussion and individual study.

8. Report pages, which are geared to help students record the data and understand the calculations involved in each experiment.

In addition, an instructor's guide is available, with suggestions and short cuts for managing these experiments efficiently and safely. The guide discusses each experiment in detail and gives directions for preparing the materials needed for it.

We have based this laboratory manual on our experience in teaching basic chemistry at Middlesex County College in Edison, New Jersey, since 1969. The manual constitutes a complete program of experiments and exercises; it does not omit basic skills or concepts just to simplify the presentation.

We recommend doing Experiments 1, 2, 3, and 4, in that order, so that the students can learn basic lab techniques first. After that, we invite users to help themselves to what remains, to skip around at will, and to try whichever experiments best suit the particular course.

Students who can profit most from using this laboratory manual are those who have taken few courses in science and mathematics. Often we have found that students who benefit most from our course had little or no success in their high school work in science and mathematics.

Adults who are returning to school can also benefit from this manual. Some may have taken high school chemistry long ago but at this point don't recall much of what they learned. Some may be wary of taking a science course. If some students' skills in mathematics and science are rusty, they should find that the material offered here is a refresher. The simple, basic approach we use enables students to overcome their timidity and regain skills and confidence. This particular group of older students has shown strong motivation and remarkable achievement when using this laboratory manual.

We would like to thank several reviewers without whose help the present form of our manual would be neither as useful nor as complete. Larry K. Krannich of the University of Alabama at Birmingham deserves special thanks for suggesting many helpful points. So too do Arnold Loebel of Merrit College in California, Stanley M. Cherim of Delaware County Community College in Pennsylvania, David G. Williamson of California Polytechnic State University at San Luis Obispo, and Wilma Meckstroth of the Ohio State University Newark Campus.

We hope that you enjoy doing these experiments and invite you to send us any suggestions for improvements.

Alan Sherman
Sharon Sherman
Leonard Russikoff

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SAFETY REGULATIONS FOR CHEMISTRY LABORATORIES

Read these safety regulations carefully, and be sure you understand them. Before each laboratory session, your instructor will discuss any safety hazards that might be associated with that day's experiment.

1. Report all accidents to your instructor.

2. Wear safety goggles and a laboratory apron in the laboratory at all times. Always wear eye covering that will protect your eyes against both impact and splashes. (If you should get a chemical in your eye, wash the eye with flowing water from the sink or fountain for 15 to 20 minutes.)

3. Do not perform any unauthorized experiments.

4. In case of fire or accident, call the instructor at once. Note the location of fire extinguisher, safety shower, fire blanket, eyewash, and phone, so you can use them quickly in an emergency.

5. If you cut or burn yourself or accidentally inhale fumes, notify your instructor at once. The instructor will arrange immediate treatment according to the regulations of your college.

6. Do not taste anything in the laboratory. (This applies to food as well as chemicals. Do not use the laboratory as an eating place; never eat or drink from laboratory glassware.)

7. Exercise great care in noting the odor of fumes and avoid breathing fumes of any kind.

8. Do not use mouth suction to fill pipettes with chemical reagents. (Use a suction bulb to fill pipettes.)

9. Do not force glass tubing into rubber stoppers. Lubricate the tubing and introduce it gradually and gently. Protect your hands with a towel when you are inserting lubricated tubing into stoppers.

10. Confine long hair whenever you are in the laboratory.

11. Place all hot glassware on your asbestos mat to cool; this will also signify to all laboratory personnel that the glassware is hot. Do not hand hot glassware to another person, because a person's natural instinct is to reach for it.

12. Corrosive acids and bases are very soluble in water. If either a corrosive acid or base comes in contact with your skin, you can wash it off your skin before much damage is done. Haste in washing the affected area is essential. Summon the laboratory instructor if you spill a corrosive acid or base on your skin.

13. Carry out experiments in which noxious fumes are produced, or in which there is danger of explosion, under a fume hood with the safety shield pulled down for protection.

14. Do not wear open-toed shoes or shorts in the laboratory, since they do not offer enough protection to the body.

15. Never point a test tube containing a reacting mixture (especially when you are heating it) toward another person or toward yourself.

16. If you are preparing a dilute acid solution, never pour water into concentrated acid. Always pour the acid into the water while stirring the water constantly.

17. Be extremely cautious when you are lighting a Bunsen burner.

18. Never engage in horseplay in the laboratory.

19. Read the label carefully before removing a chemical from its container.

20. Never work in the laboratory alone.

Please sign the form below and give it to your instructor.

I, the undersigned, have read the Safety Regulations for Chemistry Laboratories, and I understand them.

(Signature)_____

(Date)_____

EXPERIMENT 1

CLASSIFICATION

Time About 2 hours

Materials A selection of buttons (enough so that each group of students may have about 50), bar magnet, a selection of various chemical substances (labeled only by a letter code) in sealed test tubes or vials

Introduction

Putting objects into groups because they share some similar characteristic is called classification. Nearly all branches of science use systems of classification. Systems of classification are necessary to help the scientist handle the huge amounts of data and facts that have accumulated over the years. When individual objects are placed into groups based on properties they have in common, the study of a large number of objects is made much easier.

SOME THINGS YOU WILL LEARN BY DOING THIS EXPERIMENT

1. You will learn many ways to classify a group of objects. Each time you classify something according to a different aspect of it, you learn more about it.

2. You will learn how classification of a large number of objects into a few categories makes it easier to study the objects, because all the objects in a specific group have something in common.

Discussion

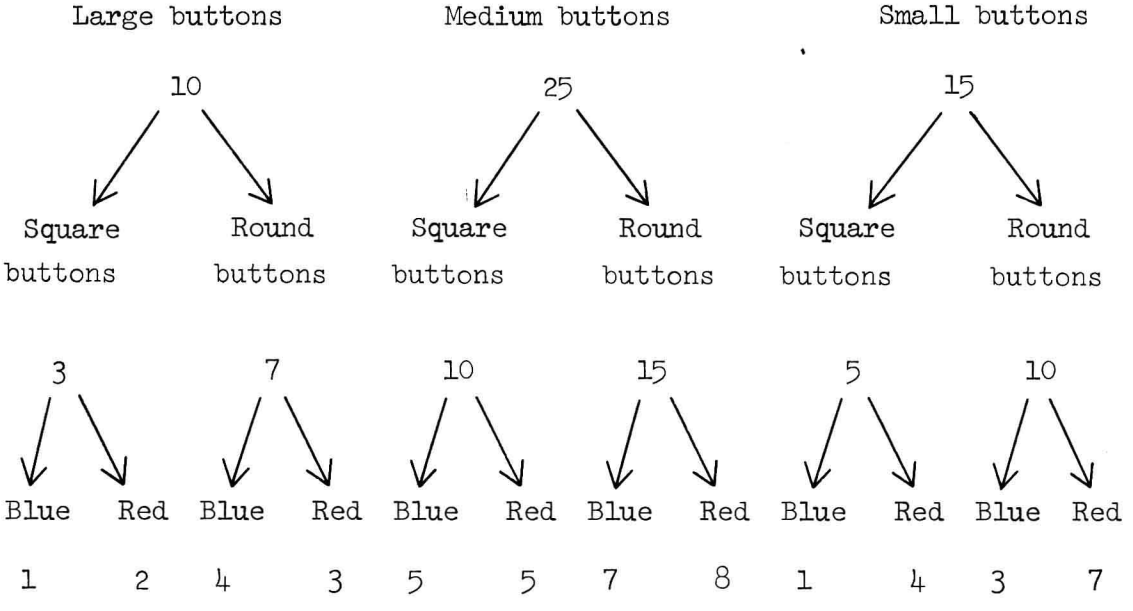
In this exercise you will have a chance to devise your own classification system. You will make your own rules for setting up categories and subcategories. To be a successful classifier, you will have to make use of all your powers of observation, especially your sense of sight. In other experiments, you'll make use of your other senses as well. Good luck!

PART 1: THE CLASSIFICATION OF BUTTONS

You will be given a handful of buttons. Buttons, of course, are common objects that you see every day. But have you ever stopped to think that buttons could be put into groups because they share certain similar characteristics? Examine the buttons and decide how you want to classify them. Some people form groups based on the sizes, shapes, colors, and other characteristics of the buttons. When you have decided how to group the buttons, you should then form subgroups and further subdivide, if possible. For example, if you choose to group the buttons by size, you can have large buttons, large round buttons, and large white round buttons. After you have classified them, make a chart showing how your classification scheme works. Also list the number of buttons in each group and subgroup (see the example below). If time permits, repeat the experiment using different criteria for the groups. Compare your classification system with those of other people in the class.

Sample Chart

Classification by Size



PART 2: THE CLASSIFICATION OF SOME CHEMICAL SUBSTANCES

Note: Be sure that you have your safety glasses on for this part of the experiment.

In this part of the experiment you will try to classify some chemical substances. First get your set of substances from the instructor. Notice that the test tubes and vials are sealed. In this experiment you will not remove the contents of the test tubes and vials. Again, make your own rules for setting up groups and subgroups.

You may want to use criteria such as the appearance (texture, color, and so forth) of each substance, or the physical state (solid, liquid, gas) of each substance. The instructor will place a bar magnet at your disposal if you wish to use it as an aid in deciding on a classification scheme. In a later experiment we'll look at some of these substances again and see how most chemists classify them.

Prepare a chart similar to the one you prepared in Part 1, to show the results of your classification scheme. If time permits, try a second classification. Compare your system with those of other people in the class.

Caution: Be extremely careful with the vials containing the mercury, bromine, and chlorine. These materials are very hazardous, and problems can arise if the vials are broken.

Some Questions to Ponder and Answer

1. List some of the advantages of your classification system for buttons.

2. List some of the advantages of your classification system for the chemical substances.

REPORT ON EXPERIMENT 1

Name_____

Section_____ Date_____

Instructor_____

Part 1: The Classification of Buttons

Use this report page to show your classification system.

Name_____

Part 2: The Classification of Some Chemical Substances

Use this report page to show your classification system.

Name_____

Section_____ Date_____

Instructor_____

Responses to "Some Questions to Ponder and Answer"

1.

2.

EXPERIMENT 2

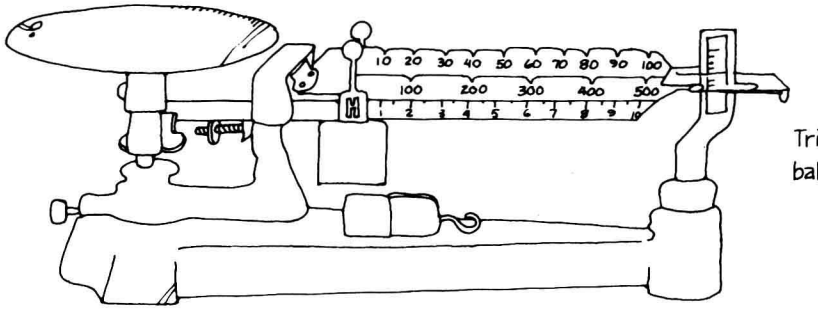
USE OF THE BALANCE: DETERMINING THE DENSITIES OF SOME COMMON OBJECTS

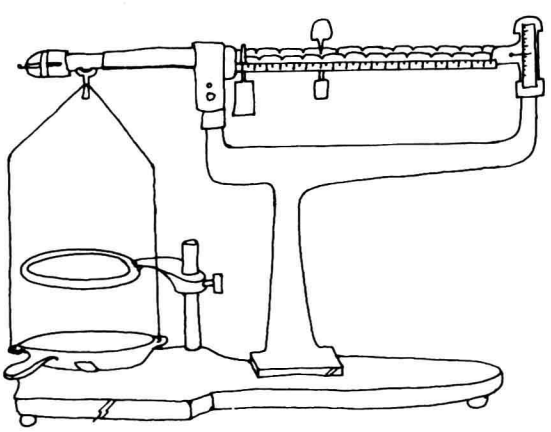
Time About 2 hours

Materials Triple-beam balance, aluminum weighing pans, beakers (50 ml, 100 ml), graduated cylinders (10 ml, 25 ml, 50 ml), metric rulers, objects of varying density (distilled water, a small block of wood, an iron cylinder, a glass marble, ethyl alcohol)

Introduction

One of the most important instruments in the laboratory is the balance. With a balance, the chemist is able to weigh materials with great accuracy and precision. There are many different types of balances available to the chemist today; Figure 2-1 shows some of them.





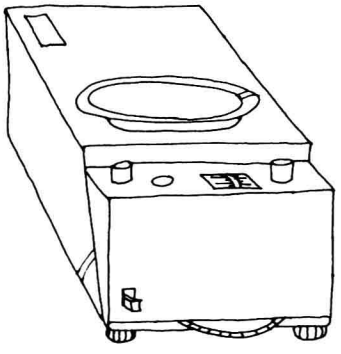


Figure 2-1 Various types of balances used in a chemical laboratory