Instructor's Manual

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Laboratory Manual

General, Organic, and Biological Chemistry An Integrated Approach

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John Wiley & Sons, Inc.
New York • Chichester • Brisbane • Toronto • Singapore

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ISBN 0-471-12082-0
Printed in the United States of America
10 9 8 7 6 5 4 3 2 1
Printed and bound by Malloy Lithographing, Inc.

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Introduction

This Instructor's Manual accompanies *Laboratory Manual General, Organic and Biological Chemistry, An Integrated Approach*. The Instructor's Manual is designed to assist the laboratory instructor and stockroom personnel.

ROLE OF THE LABORATORY IN CHEMISTRY

Education in chemistry is more than learning a collection of facts; it is a continuing process of inquiry. Chemistry is, of course, an experimental science. Therefore, the laboratory experience is an essential segment of each course. In the laboratory, students move beyond received knowledge toward active understanding of the natural world. We have learned that students most easily comprehend the principles illustrated in laboratory experiments when these concepts relate to the real world. Our experiments are designed to correlate to the student's personal experience and use many common household products. We frequently use baking soda, sugar, antacids, fruit juices and other products from the grocery store in their original containers.

The fundamental objectives of our laboratory program are:

- to facilitate the understanding of abstract chemical principles with concrete examples
- to reinforce newly acquired concepts and skills learned in the chemistry lecture
- to improve observation and critical thinking skills
- to develop good laboratory techniques and ability to handle chemicals safely

DAILY LABORATORY ROUTINE

We recommend that the laboratory instructor collect the Prelab Questions at the beginning of the laboratory period. Generally, we do not allow a student to perform an experiment until this assignment is completed; we also do not allow a student to perform the experiment if the student has arrived late and has missed important procedural and safety instructions.

We spend about 20 minutes at the beginning of the laboratory period to return to and discuss the previous experiment and to review objectives, procedures, techniques, and safety precautions for the current experiment. We also discuss disposal procedures for the experiment and assign Related Questions that are to be completed.

CAUTIONS

Some of this time should be devoted to an actual demonstration of any new techniques in the procedure such as filtering, the appropriate method to heat a test tube, etc. It may also be good to review these techniques if a significant amount of time has passed since the students last used them.

Safety goggles should be worn by the students and the instructor at all times in the laboratory.

ORGANIZATION OF THE INSTRUCTOR'S MANUAL

Each of the 21 experiments is individually discussed using the following organization:

TIME

The approximate time recommended for the experiment does not allow for pre-laboratory and post-laboratory discussions.

HINTS

The procedures and techniques of the experiment are briefly discussed. Common questions and problems are identified and answered.

CAUTIONS

The Laboratory Manual includes caution statements. Sometimes those cautions are amplified in the Instructor's Manual.

We recommend following the guidelines in *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, National Academies Press, 1995, available at www.nap.edu. A good brief discussion of safety guidelines is found in Safety in the *Academic Chemistry Laboratories*, 7th edition, *Volume 1 Accident Prevention for College and University Students, and in Safety in the Academic Chemistry Laboratories*, 7th edition, *Volume 2 Accident Prevention for Faculty and Administration*. Both are available at www.acs.org for a minimal cost and appropriate copies should be given to both students and laboratory instructors.

Other similar publications are available: *Working Safely With Chemicals in the Laboratory* in addition to a number of pocket guides available at www.genium.com, *CRC Handbook of Laboratory Safety,* 5th edition available at www.crcpress.com. Some chemical companies such as Flinn Scientific, Inc. include reference information as part of their catalog available at www.flinnsci.com.

We use National Fire Protection Association (NFPA) hazard ratings. The complete reference *Fire Protection Guide to Hazardous Materials*, 2001 edition, is available at www.nfpa.org (Item HAZ01). Lab Safety Supplies provides the NFPA guide, NFPA labels, pocket guides and wall charts at www.labsafety.com.

Material Safety Data Sheets (MSDSs) must be available for use by instructors and students. These sheets are supplied by the chemical vendor at time of purchase. MSDSs are also available on the websites of many of the chemical vendors, at public websites such as http://msds.ehs.cornell.edu/, www.msdssearch.com, and at subscription websites such as www.msdsonline.com. Internet searches using keywords like "chemical MSDS" or similar will produce additional websites. One of the best sources for MSDSs, however, may be the chemical vendors.

DISPOSAL

Federal, state, and local regulations for disposal of waste should be followed. Generally we assume the institution collects appropriate waste and contracts with an outside licensed waste hauler for lawful disposal.

Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Academies Press, 1995, is an excellent reference as are the MSDSs for specific chemicals.

We recommend segregating waste as it is collected. For example, halogenated solvents should be kept separate from nonhalogenated organic solvents.

CHEMICALS

This section lists the chemicals needed for the experiment. We generally allow students to work in pairs in the laboratory. **The quantities of each chemical are those needed for 24 students working in pairs (12 pairs of students).** Allowance has been made for wasted reagents.

We recommend that all chemicals be Reagent Grade quality, unless otherwise noted.

EQUIPMENT AND SUPPLIES

Materials on this list are not in our student lockers; they are supplied on a "loan" basis for the duration of the experiment.

PRELAB QUESTIONS

Answers to Prelab Questions in the Lab Manual are provided in this manual.

REPORT

Answers to questions and expected results are listed in this manual.

RELATED QUESTIONS

Answers to questions are furnished in this manual.

APPENDIX A: SOLUTION PREPARATION

Directions are provided for preparing all solutions.

APPENDIX B: CHEMICAL PURCHASE LIST

A listing of chemical reagents available from chemical supply companies.

APPENDIX C: HOUSEHOLD AND COMMERCIAL PRODUCT PURCHASE LIST

A listing of common household items not generally available from chemical supply companies. These items may be purchased at local retail grocery, pharmacy, and hardware stores.

APPENDIX D: SUPPLIES AND EQUIPMENT LIST

Expendable supplies and equipment are listed here. In some cases specific suppliers and catalog numbers are recommended.

Experiment 1
Laboratory Techniques

TIME

2 hours

HINTS

If this is the first experiment, the location of the various safety features (safety eyewash, shower, fire extinguishers, etc.) of the laboratory should be pointed out to the students and any necessary explanation for their use provided.

Demonstrate lighting of the burner. A good source of cardboard (used in Part I) is the thick backing from pads of paper. Cut each 8 1/2 × 11 inch backing into four pieces. The cardboard must rest **on** the barrel of the burner. It should not be kept in the flame too long.

Bare copper wire or nickel-chromium wire may be used in place of iron wire. Copper wire will melt in the hottest area of the flame.

Demonstrate the filtration technique and the technique to be used for evaporation of a liquid.

It is recommended that Part I, steps 13-17 be done as a demonstration due to the potential fire hazard.

Demonstrate how to pour liquids. Demonstrate clean-up of spilled liquids and solids.

In this edition, strontium chloride replaces barium chloride in Part II. Strontium chloride is much less toxic and the strontium sulfate precipitate can be filtered without heating (digesting) the precipitate. Normal-retention filter paper (such as Whatman No. 1) can be used with this precipitate. The use of a hotplate to evaporate the water in Part III involves less risk of overheating and subsequent spattering of the contents of the evaporating dish.

CAUTIONS

Caution students about handling hot objects, such as the iron wire hotplate surfaces, and the evaporating dish.

DISPOSAL

“Waste Salts” container

CHEMICALS (Quantities are for 12 pairs of students)

sodium chloride	2 g
0.2 M sodium sulfate	140 mL
0.2 M strontium chloride	140 mL
strontium sulfate (see Appendix B)	2 g

EQUIPMENT AND SUPPLIES (Quantities are for 12 pairs of students)

bobby pin or straight pin	12 (1, if done as demonstration)
cardboard, 4 x 6 inch	12 (1, if done as demonstration)
iron wire, 5-cm length (may be reused)	12
filter paper, 12.5-cm, Whatman No. 1	
matches	

PRELAB QUESTIONS

1. Answer d
2. Answer c
3. Answer a
4. Answer b
5. Answer a
6. Answer b
7. Answer a
8. Answer b
9. The reactants are stronium chloride and sodium sulfate. The products are stronium sulfate and sodium chloride.
10. The filtrate is the liquid that passes through the filter paper.
11. The precipitate is the solid formed in the reaction that is trapped on the filter paper.

REPORT

I. 1. a. Air inlet open: blue flame with two cones

b. Air inlet closed: yellow-orange flame

2. a. Air inlet open: underside of dish remains unchanged

b. Air inlet closed: underside of dish covered with black residue

3. With air inlet closed, natural gas did not burn completely. Soot is unburned carbon.

4. Region c is hottest; region b is also very hot

5. Region d is coolest

6. Charred area is an inverted "V" with no burning inside the "V."

7. The match does not light.

8. Yes. Whenever an object was placed inside the inner core, it was not intensely heated. The match did not light; the iron wire did not glow; the cardboard did not char in this region.

9. The match head was inside the inner blue cone, a region where no burning takes place. The natural gas/oxygen mixture does not ignite until it reaches the edges of the inner cone.

10. The tip of the flame's inner cone should just touch the bottom of the beaker.

II. 1. a. Sodium chloride is soluble in water.

b. Stronium sulfate is insoluble in water.

2. The filtrate contained sodium chloride.

3. The precipitate was stronium sulfate.

4. On the basis of the solubility tests.

III. 1. A white powder.

RELATED QUESTIONS

1. Barium chloride is more toxic.

2. Sodium sulfate reacts with barium chloride to produce barium sulfate and sodium chloride. Barium sulfate is insoluble in water and is therefore less toxic than barium chloride.