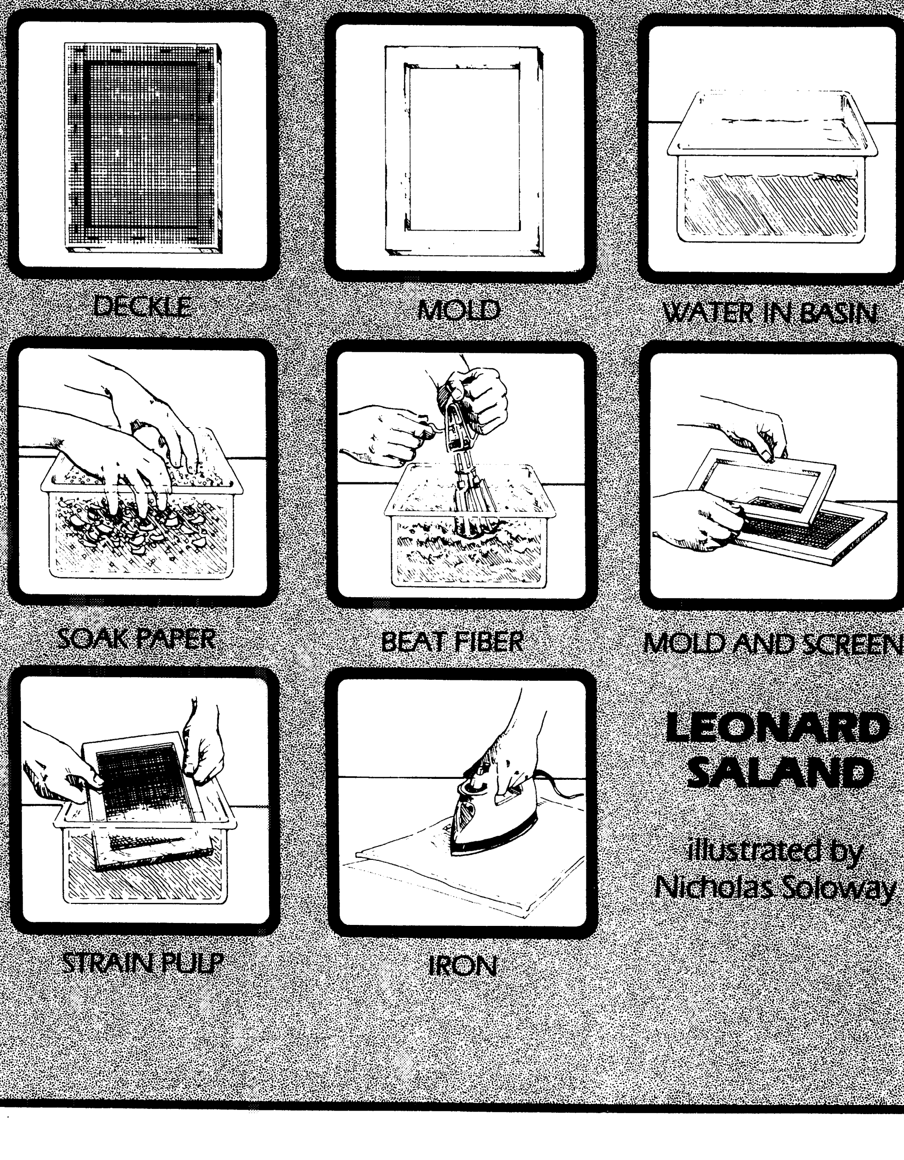
PRACTICAL CHEMISTRY LABS

A RESOURCE MANUAL

THE PAPERMAKING PROCESS



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Contents

To the Teacher

This lab resource manual is intended to make chemistry more meaningful to your students. There are 60 different exercises, all in convenient reproducible form, ready to be photocopied. You have complete flexibility to select labs most suited to your program.

The labs are designed to be simple and pertinent. They require the use of common pieces of apparatus and materials. The experiences are planned to minimize the hazards inherent in lab exercises while maximizing the outcomes. In order to ensure a smoothly running lab program the following procedures are recommended:

1. The labs should correlate with current classroom topics. They should reinforce the theory being taught.
2. Classes should be familiarized with the lab problem, the apparatus to be used, and the procedures to be followed. Show the class the apparatus, and how it should be used, but do not prejudice the students by performing the lab as a demonstration. Allow the students to make their own discoveries.

   Warn the class of safety hazards and precautions that should be taken for each lab at hand.
3. Lab exercises should be followed up with a review of procedures, observations, and conclusions. All questions and the defined problem on the lab sheet should be answered. The quizzes accompanying each lab are designed to be administered *after* the lab is performed.
4. Students should write their lab reports using a well-defined and structured format. A suggested format is provided in this manual. It is further suggested that each student keep a notebook for all reports.

Lab Features

The labs reinforce the steps of the scientific method. Each lab expresses its aim in problem form. This directs students and their teachers to the main idea of each lab without the necessity of reading through the lab sheet. The definition of the problem is recognized as the first step in the scientific method.

Information is gathered from observations. The Procedure section leads the student step by step to the pertinent observations.

Lab sheet questions are designed to make students trained observers. They must reason and draw conclusions based on observations.

To challenge advanced students, rigor may be introduced into reasoning skills by requiring a statement of reasons, based on observations, for each conclusion. The last conclusion should be the answer to the lab problem.

Each lab is followed by Teacher Notes that provide the answers to questions on the lab sheet and pertinent notes.

The five-question post-lab quizzes measure student understanding of the lab content. The quizzes also serve to establish a serious academic atmosphere for each lab session.

Overall, this manual has been designed to ensure successful laboratory experiments for you and your students. We would like to hear your questions and comments about these labs. Address them to Science Editor, J. Weston Walch, Publisher, Box 658, Portland, Maine 04104. User response will help us evaluate our success in supplying a useful, practical lab resource.

Safety Rules for the Chemistry Lab

1. Do not enter the lab without your teacher present.
2. You **MUST** wear **safety goggles** at all times when in the lab.
3. Always work at your assigned place.
4. Wear a lab apron and tie back long hair when working in the lab.
5. Lab tables should be clear of student belongings. The only things that should be on your lab table are your lab instructions, your pen, the required equipment, and the chemical materials provided by your teacher.
6. Never perform an experiment without your teacher's permission.
7. Do not use matches without your teacher's permission.
8. Avoid playful, distracting, or boisterous behavior.
9. Never eat or drink anything in the lab.
10. Do not taste any chemicals.
11. If any chemical comes into contact with your skin, you should first wash it off under cool running water. Then you should report the accident to your teacher. Keep chemicals away from your face.
12. Rinse your hands after your experiment is completed, especially before lunch. You may have chemicals on your hands or under your fingernails.
13. Check all glassware for cracks. All glassware must be heat resistant if it is to be heated.
14. When heating a test tube, use your test tube holder. Be sure that the open end is not pointing toward anyone.
15. Do not visit friends at another work station.
16. Do not pour reagents (chemicals) back into their bottles. Pour liquids down the drain or into the appropriate storage bottles as directed by your teacher.
17. Do not throw solid wastes into the sinks.
18. Clean up spills and accidents immediately.
19. Never leave a heating container unsupervised.
20. If you experience a problem with your experiment, stop and ask your teacher for help. Do not ask friends for help.
21. Report all accidents to your teacher.

I have read and understand all of these rules. ________________________________

Student

Lab #30
The Electrochemical Cell

Name: ____________________

Date: ____________________

PROBLEM: How can electricity be generated from a chemical solution?

Materials

- steel wool
- strips of copper, iron, zinc, aluminum, tin, and lead
- carbon graphite electrode
- voltmeter (full-scale deflection no more than 5 volts, preferably lower scales should be available)
- 2 wires
- 250-mL beaker
- dilute sulfuric acid
- salt (NaCl)

CAUTION: Sulfuric acid is dangerous. Sulfuric acid spills should be cleaned up with a sodium bicarbonate solution. Do not allow sulfuric acid to remain on your clothing. If any acid touches your skin or eyes you should rinse the area with large amounts of cool water. Remember to wear your eye goggles, apron, and gloves.

Note: In this experiment we measure the tendency for metals to push their electrons onto a graphite electrode. Graphite is a form of carbon that conducts electricity. The voltage, shown on the voltmeter, indicates the activity of the metal. More active metals lose their electrons more easily. They will produce a greater voltage against the graphite electrode. Metals less active than carbon, like copper, draw electrons from the carbon to reverse the direction of the flow of electrons.

Procedure

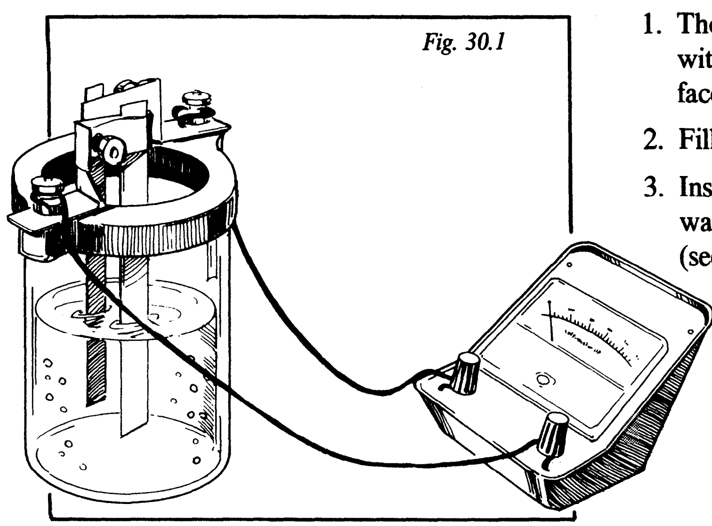

Fig. 30.1

1. Thoroughly clean the surfaces of your metal strips with your steel wool. Do not touch the clean surface. Why?
2. Fill your beaker about 2/3 full with water.
3. Insert your carbon (graphite) electrode into the water, and connect it with wire to the voltmeter (see Figure 30.1).

Name: ______________________________

Date: ______________________________

4. Connect the copper strip with wire to your voltmeter, and then insert it into the water. Do not allow the metal strip to touch the carbon electrode. Why? Repeat this step for each of your other metal strips. Record your results in the table below.
5. Repeat step 4 for each of the other metals.
6. Repeat steps 1–5 using dilute sulfuric acid in place of water.
7. Repeat steps 1–5 using salt water.

Record the voltages for each metal versus graphite in the table below.

Data Table

	Copper	*Iron*	*Zinc*	*Aluminum*	*Lead*	*Tin*
Water						
Acid						
Salt Water						

Optional Exercise

8. Predict which two different metals would produce the greatest voltage when immersed in dilute acid. Devise an experiment using the materials in this lab to support your conclusions.

Optional Exercise

9. Insert a strip of copper and a strip of zinc into a lemon. Do not allow the metals to touch. Connect the strips with wire to the voltmeter. Record your observations. Repeat this procedure with other fruits and vegetables.

CAUTION: Do not eat foods into which metals were inserted. Dissolved metals, taken into your body, can cause heavy metal poisoning.

Conclusions

1. List the metals in their order of activity.
2. Why do different metals generate different voltages?
3. Which medium is best to use for an electric battery?
4. How would you design an electrochemical cell to produce maximum voltage?
5. How can we derive electrical energy from two different metals?

Quiz #30
The Electrochemical Cell

Name: ______________________________

Date: ______________________________

Directions: Circle the letter in front of the answer that best completes the statement.

1. The fundamental idea developed in this experiment is that
   a. electrical energy can be stored as chemical energy.
   b. chemicals can produce electrical energy.
   c. metals differ in their activity.
   d. all of the above are true.

2. Electrical energy is generated in all cases except when
   a. the same metals are in the same solution.
   b. the same metals are in different solutions.
   c. the same metals are at different temperatures.
   d. two metals with different activities are in the same solution.

3. The voltage of the electrochemical cell depends on
   a. the activity differences of the metals used.
   b. the media in which the metals are bathed.
   c. the temperature of the media.
   d. all of the above.

4. In this experiment, the metal vs. carbon pair that produces the greatest voltage is
   a. Zn vs. C.
   b. Cu vs. C.
   c. Sn vs. C.
   d. Fe vs. C.

5. In this experiment, the metal vs. carbon pair that produces the smallest voltage is
   a. Zn vs. C.
   b. Cu vs. C.
   c. Sn vs. C.
   d. Fe vs. C.

Lab #30: The Electrochemical Cell

Teacher Notes

ANSWER TO PROBLEM

Electrical energy is generated from an electrochemical cell when metals of different activities are allowed to transfer their electrons on a wire.

Procedure

1. The metal surfaces should not be touched because the salts and oils on your skin will contaminate the fresh metal.
4. The electrodes cannot be allowed to touch, because the electrons from the more active metal will not flow on the wire. It will be easier for them to flow directly to the other electrode through the short circuit where they touch.
8. The greatest voltage would result with a combination of the most active metal against the least active metal. In this experiment the best results would be obtained with copper against zinc. While aluminum is more active than zinc, we are really working with aluminum oxide. The metal oxidizes rapidly on exposure to air.
9. Different metals in an acidic medium, regardless of the source of the medium, will generate a voltage.

Conclusions

1. The order of activities of the metals used is as follows: aluminum, zinc, iron, tin, lead, and copper. N.B., Aluminum oxide actually replaces aluminum. See step 8 above.
2. Metals produce different voltages because of their different activities. Their voltages will also vary by the medium in which they exist.
3. In this experiment an acid medium is best to use for an electrical cell.
4. To obtain a maximum voltage we would seek to couple the most active metal with the least active metal (or most active nonmetal).
5. Electrical energy can be derived from two different metals by making use of their differences in activity.

LAB QUIZ ANSWERS

1. d
2. a
3. d
4. a
5. c

Lab #46
Testing for Vitamin C

Name: ______________________________

Date: ______________________________

PROBLEM: How can we test for vitamin C?

Materials

- 125-mL Ehrlenmeyer flask
- buret clamped in a ring stand
- 1% starch solution, aqueous iodine solution
- vitamin C solution (dissolve a vitamin C pill in water)
- apple juice
- orange juice
- tomato juice
- sodium bicarbonate
- white paper
- Bunsen burner

<u>*Note:*</u> In this experiment we will add a measured amount of iodine to a vitamin C solution to which starch has been added. The vitamin C will be quickly oxidized by the iodine.

$$I_2 + C_6H_8O_6 \longrightarrow C_6H_6O_6 + 2H^+ + 2I^-$$

iodine + ascorbic acid ⟶ dehydroascorbic acid + hydrogen ion + iodide ion
(vitamin C)

The point at which the oxidation of the vitamin C is complete will be revealed by the dark blue-black color produced by the iodine and starch. The amount of vitamin C in each food can be determined by comparing the amount of iodine solution needed to oxidize the known concentration of vitamin C.

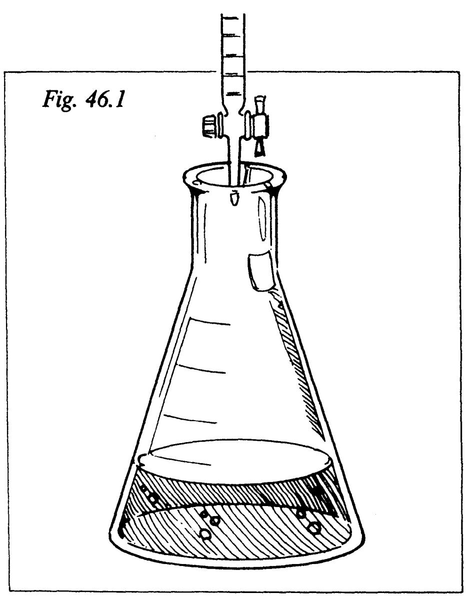

Fig. 46.1

Procedure

Standardizing Your Vitamin C Solution

1. Fill your buret to the 50-mL mark with your iodine solution.
2. Dissolve a 50 mg vitamin C pill in 100 mL of water. Carefully measure 25 mL of prepared vitamin C solution into a clean Ehrlenmeyer flask. Add ten drops of a 1% starch solution to the vitamin solution.
3. Place your flask on the white paper under the buret (see Figure 46.1). Slowly add the iodine solution to the vitamin C until one drop of iodine causes the vitamin C solution to turn blue-black. This is the **end point** of the solution. Record the volume of iodine used in the data table provided.

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Date: ______________________

4. Gently boil 25 mL of orange juice for one minute. Repeat step 3 with the boiled juice.
5. Add 1 gram of sodium bicarbonate to 25 mL of fresh orange juice. Repeat step 3.
6. Repeat step 3 with 25 mL of fresh tomato juice.
7. Repeat step 3 with 25 mL of fresh apple juice.

Data Table		
Food	*mL of Iodine*	*mg of Vitamin C*
25 mL Prepared Vitamin C Solution		
25 mL Orange Juice (fresh)		
25 mL Orange Juice and Sodium Bicarbonate		
25 mL Orange Juice (boiled)		
25 mL Tomato Juice		
25 mL Apple Juice		

Conclusions

1. How does the amount of iodine solution used indicate the vitamin C content?
2. Which juice has the most vitamin C?
3. How can we test for vitamin C?
4. How does heat affect vitamin C content of foods?
5. How does sodium bicarbonate affect the vitamin C content of foods?

Quiz #46
Testing for Vitamin C

Name: ______________________

Date: ______________________

Directions: Circle the letter in front of the word or words that best complete the statement.

1. In one test for its presence, vitamin C in starch solution
   a. stains yellow with nitric acid.
   b. turns blue-black with iodine.
   c. turns Benedict's solution red on heating.
   d. changes iodine into iodide ions.

2. The food with the greatest amount of vitamin C is
   a. sugar.
   b. orange juice.
   c. apple juice.
   d. tomato juice.

3. Vitamin C is destroyed by all of the following except
   a. heat.
   b. sodium bicarbonate.
   c. iodine.
   d. refrigeration.

4. If more drops of fruit juice are needed to change iodine this shows
   a. lower vitamin C content.
   b. higher vitamin C content.
   c. a dilute solution.
   d. a concentrated solution.

5. All of the following foods provide vitamin C except
   a. oranges.
   b. tomatoes.
   c. bread.
   d. lemons.

Lab #46: Testing for Vitamin C

Teacher Notes

ANSWER TO PROBLEM

Vitamin C is detected by its ease of oxidation. In this experiment the vitamin C is oxidized by iodine. In the air, vitamin C is oxidized by oxygen. When the vitamin C is completely oxidized, the free iodine shows itself by turning a starch solution blue-black.

Solution Preparation

The aqueous iodine solution is prepared as follows. Dissolve 10 grams of potassium iodide (KI) in 100 mL of water. Dissolve 1 gram of iodine crystals, stirring constantly.

Conclusions

1. The amount of iodine used is directly proportional to the vitamin C content.
2. Fresh orange juice has the most vitamin C of those used in this lab exercise.
3. See Answer to Problem above.
4. Heat destroys vitamin C. Note that vitamin C is destroyed in cooking.
5. Sodium bicarbonate destroys vitamin C. This vitamin is most stable in an acidic environment.

LAB QUIZ ANSWERS

1. b
2. b
3. d
4. b
5. c