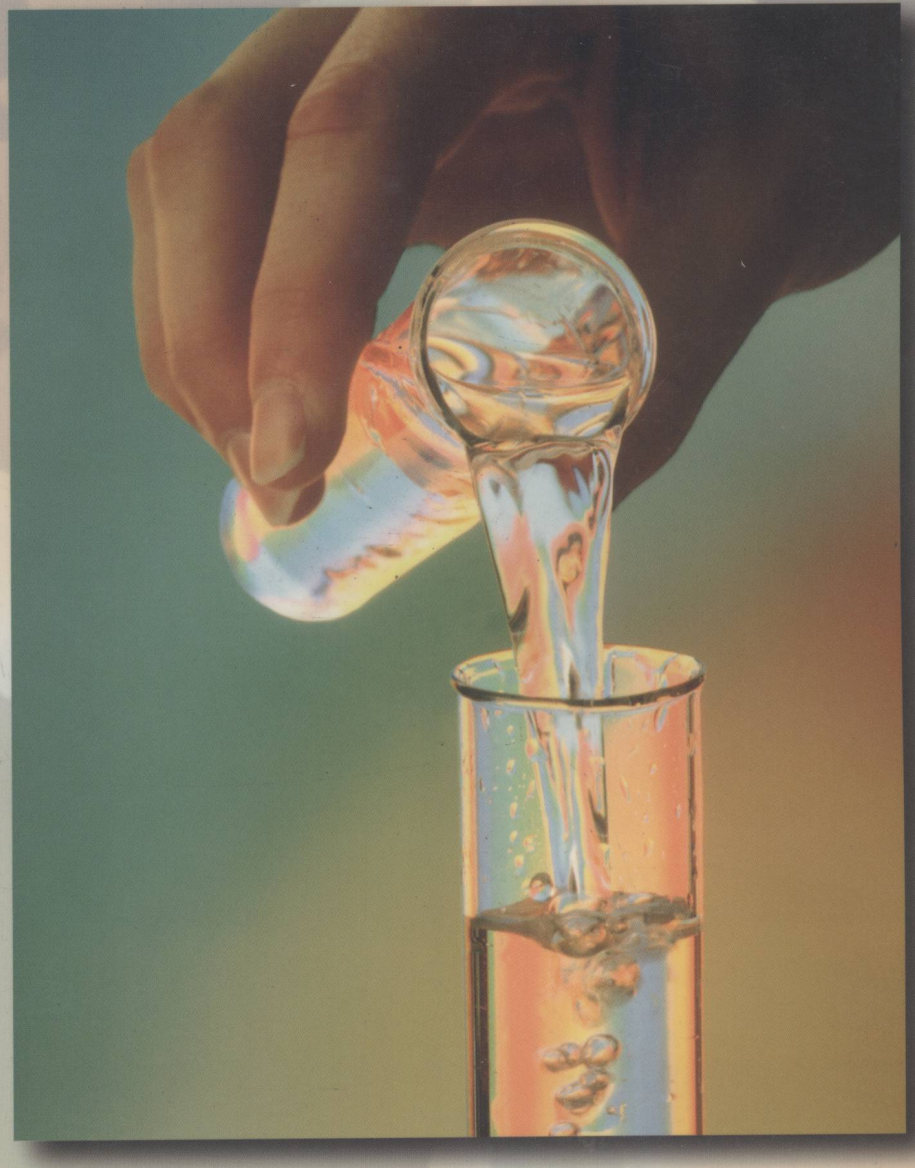
HANDS ON Chemistry



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Hands on Chemistry

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Hands on Chemistry

Hands On Chemistry
Preface: To the Student

Welcome to a new way of doing chemistry laboratory! Our focus in writing this manual has been on developing highly readable experiments that will provide you with a successful learning experience. Our method for developing laboratories begins with identifying concepts that are of particular interest or challenge to students and which we feel would benefit from clarification through laboratory work. From this, objectives are developed which are included in the beginning of each laboratory and which serve as a key focus point for all aspects of the given experiment. The pedagogical approach of the laboratory is then chosen to make the most of the topic we are trying to teach you. For example, some laboratories benefit from a discovery type approach while others are best taught following a more traditional expository approach.

Each experiment contains the sections described below.

- **Title and Author**

The title includes information about the chemistry involved as well as the context of the experiment. We include the author's name on each experiment that they write so that they are given proper credit and so that the students using the laboratory manual can make a connection with the authors. Even though the experiments are edited for overall continuity, each author has a slightly different writing style and we feel this adds to the interest of the manual.

- **Objectives**

The objectives are brief statements outlining the goals for the laboratory. The objectives should answer the questions, "What will the student know after completing the experiment?" and "What will the student be able to do after completing the experiment?" Whenever possible we stress to the students that what they are doing and what they are learning is significant and relates to or enhances material covered in lecture.

- **Introduction**

The introduction consists of a practical or interesting example that serves as a context for the laboratory experiment. This brief attention grabber is intended to make the student want to learn about the material and want to perform the experiment.

- **Background**

The background section is intended to provide the student with the pertinent chemistry required for successful completion of the experiment. The background includes complete descriptions of all relevant chemical equations, explanations of all experimental procedures and information required for analysis of results and data.

- **Overview**

The overview provides the student with the big picture of what they will actually be performing in the experiment and serves to relate the background to the upcoming procedure.

- **Procedure**

The procedure begins with a list of materials (chemicals, glassware and instruments) required for the experiment. The details of the procedure depend, to some degree, on the goals for the experiment. For certain experiments, it is appropriate for the students to develop their own procedure. Some experiments will have provided data tables though usually the students are required to make their own. Some experiments have discovery type components when it helps accomplish the objectives of the experiment. Detailed safety and waste disposal information is also provided to the student for each experiment.

- **Pre-laboratory exercises**

Our goal with the pre-laboratory assignments is to prepare students so that when they enter the laboratory they are fully aware of what they are trying to do and why. After completing the pre-laboratory questions the students should have a firm grasp of the chemistry involved in the upcoming experiment.

- **Post-laboratory work**

The post-laboratory work is our opportunity to make sure that the goals of the experiment have been achieved. Appropriate post-laboratory work involves writing up the laboratory experiment, performing calculations using data from the experiment, answering open-ended writing assignments and performing analysis of data and errors.

Hands On Chemistry
Table of Contents

What's the Matter? The Nature of the World Around Us

Jeffrey Paradis

OBJECTIVES

- Explain various daily observations in terms of the particulate nature of matter.

INTRODUCTION

The theory that matter is made up of atoms is fundamental to our current understanding of chemistry (as well as aspects of biology, physics, astronomy, engineering and geology). Until recently however, scientists had only indirect evidence for the existence of atoms. Being able to see atoms would allow scientists to, among other things, design better computer chips and drugs. You might wonder why we can't just make a microscope powerful enough to look at atoms. It turns out that the wavelength of visible light is too large to resolve the distances between individual atoms. This is analogous to trying to read Braille while wearing a baseball glove.

In the early 1980's scientists at IBM developed a method for making images of the surface atoms of certain materials. They named this method Scanning Tunneling Microscopy (STM) and were awarded the 1986 Nobel Prize for their ground-breaking work. Never before had scientists been able to enter the atomic world with such ease and clarity (Figure 1).

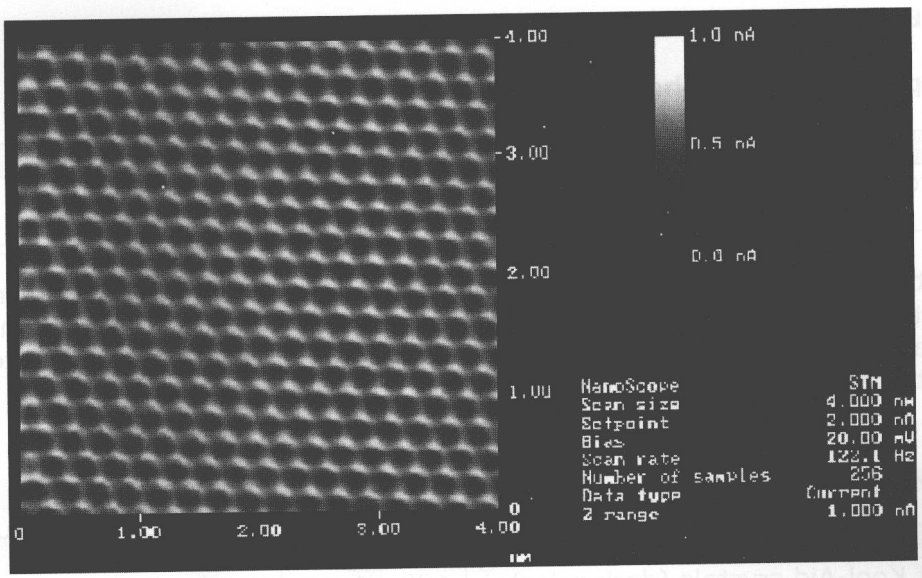

Figure 1. An STM image of the surface of graphite (carbon).

BACKGROUND

Matter is Particulate

Chemistry is often termed "the central science" because it involves the study of matter. Our study of chemistry will therefore benefit if we have a firm conceptual understanding of the nature of matter. Dalton's first postulate provides us with some insight. The postulate states that "An element is composed of extremely small indivisible particles called atoms". For our purposes we can expand on Dalton's statement and think of all matter as being made up of incredibly small particles. This postulate is in conflict with the common misconception people have that matter is continuous. In studies of elementary to university students, over half of the students held concepts suggesting a perception of matter as a continuous medium, rather than as an aggregation of particles. This misconception is so common because our day-to-day experience with matter seems to suggest that it is continuous (for example, we can't see the individual particles that make up our desk). It is the goal of this experiment that you will gain an appreciation of matter as being made up of infinitely small particles. This knowledge will serve as a foundation for all later learning in chemistry.

OVERVIEW

In this experiment, you will examine four different everyday phenomena from the point of view of matter being composed of extremely small particles (atoms, ions and molecules) that are too small to see.

PROCEDURE

Part A: Evaporation of Alcohol

Chemicals Used	Materials Used
Rubbing alcohol	Chalk board Cotton ball

Take one cotton ball and soak it with alcohol so that it is thoroughly wet but not dripping. Drag the cotton ball across the chalkboard to make a wet streak about one foot long. Describe what happens to the streak. Does it happen all at once? Approximately how long does it take to happen?

Part B. Dissolving Crystals

Chemicals Used	Materials Used
Container of Kool-Aid crystals (dark color)	100 mL graduated cylinder Spatula

Fill the graduated cylinder with fresh water. Let it sit for a minute so any air bubbles may rise and the solution is clear. Prop a piece of white paper up behind the graduated cylinder so it will be easier to make your observations. Get some Kool-Aid on the end of the spatula – no more than the size of a pea. Drop the crystals into the center of the top of the water in the graduated cylinder. Do NOT stir. In addition to a written description of what you see happening, include a sketch of what you observe a few seconds after the colored crystals are added to the water. After you have written your observations empty the graduated cylinder into the sink. Do not drink the Kool-Aid.

Part C. Mystery balloon

Materials Used
A blown up balloon with a few drops of scented oil in it

Carefully pick up the balloon and smell it. Other than the smell of the latex balloon itself, record what else you can smell.

Part D. Mixing liquids

Chemicals Used	Materials Used
Bottle of alcohol (colored yellow) Bottle of water (colored blue)	Glass stirring rod Graduated cylinders (2)

Pour approximately 20.0 mL of water into one graduated cylinder and approximately 20.0 mL of alcohol into the other graduated cylinder. Record the volumes of each liquid. In this experiment you will be watching for slight changes in volume so make your readings of volume as carefully as possible. Carefully pour the water into the alcohol so none is lost and stir carefully to mix the two liquids. Record the volume and color of the mixture. When you are done, pour the "water + alcohol" down the sink.

What's the Matter? The Nature of the World Around Us

Name:	Lab Instructor:
Date:	Lab Section:

PRE-LABORATORY EXERCISES

1. Define the underlined terms in the BACKGROUND section.

2. Give three examples of things that are samples of matter. Give three examples of things that are not samples of matter.

3. The scale on the image of the carbon atoms (INTRODUCTION, Figure 1) indicates 4.00 nm. At this point you are not expected to know what that means, but it translates to 0.000000004 meters. Knowing this, roughly what is the radius, in meters, of a single carbon atom according to the STM image? Show your work.

4. The head of a pin is as big as about 600,000,000,000,000,000,000 atoms of aluminum! If every person on the Earth counted one aluminum atom every second, how many years would it take us all to count all of the aluminum atoms on the head of the pin? Comment on what the magnitude of this number tells us about the size of an atom.

What's the Matter? The Nature of the World Around Us

Name:	**Lab Instructor:**
Date:	**Lab Section:**

RESULTS and POST-LABORATORY QUESTIONS

Part A: Evaporation of Alcohol

Describe your observations:

How does your observation support the idea that matter is made up of extremely small particles that are too small to see? How might the evaporation process look different if matter was continuous (not made up of tiny particles)?

Part B. Dissolving Crystals

Describe and draw a picture of what you observed:

How do your observations support the idea that matter is made up of extremely small particles that are too small to see? How might the process of dissolving look different if matter was continuous (not made up of tiny particles)?

As the crystals fell through the water what caused the water to change color?

OVER →

RESULTS and POST-LABORATORY QUESTIONS continued...

Part C. Mystery balloon

What other smell was present?

Propose an explanation for the fact that a chemical inside of the balloon can be detected outside of the balloon.

Part D. Mixing liquids

Volume of water (blue): Volume of alcohol (yellow):

Actual volume of "water + alcohol":

Color of the "water + alcohol":

What was the expected volume of the "water + alcohol"?

Try to come up with at least 2 possible explanations for your observation. How could you go about testing each possible hypothesis? Try to explain why the final volume and the final color was different than the sum of the two liquids that made it up.

As a model for helping us understand what occurred when mixing the water and alcohol, imagine two graduated cylinders one with approximately 20 mL of large ball-bearings and the other with approximately 20 mL of small ball-bearings. Next imagine you pour the graduated cylinder of small ball-bearings into the cylinder of large bearings. Predict what you would see happen. How does this model help you understand/revise what was happening earlier when you mixed the two liquids. Explain.

RESULTS and POST-LABORATORY QUESTIONS continued...

1. What is between the atoms in a sample of matter? Which part of this laboratory helps support your answer?

2. Using your knowledge about the particulate nature of matter, propose a description for what is happening when you use a tea bag to make a cup of tea.

3. Do you think that foods would have a smell if matter wasn't particulate? Explain.