

Module Overview

The concepts covered in *Properties of Matter* closely correspond with those in the National Science Education Standards for Grades 5–8 (see Appendix B in this volume). The focus of this module is the physical and chemical properties that characterize matter. Students examine several characteristic properties (for example, appearance, density, melting and boiling points, and chemical behavior) and investigate how these properties relate to pure substances (elements and compounds) and mixtures. They engage in a series of inquiries carefully designed to develop their understanding of the properties of matter.

Each lesson builds on skills and concepts presented in previous lessons. As students progress through the module, they take greater responsibility for their own learning, eventually planning and conducting their own procedures, devising their own data tables, and analyzing the results they obtain. Therefore, the module should be taught as a complete unit. It should not be used as a sourcebook of occasional experiments.

The module is divided into three parts: Characteristic Properties of Matter; Mixtures and Solutions; and Compounds, Elements, and Chemical Reactions. The concepts taught in this module are summarized in the Conceptual Sequence Flow Chart (page xxvii).

PART 1 CHARACTERISTIC PROPERTIES OF MATTER

In Lesson 1, students briefly explore some of the properties of matter by doing a series of short, simple inquiries. These inquiries provide them with the opportunity to discuss their ideas about some of the properties they will study in the module.

In Lessons 2, 3, and 4, students investigate

the relationship between mass, volume, and density. They determine that the density of a pure substance remains constant regardless of the quantity of the substance. They make measurements and calculate the approximate density of solids, liquids, and air (a mixture of gases). They also use density to predict the behavior of solids and liquids in a density column they make.

In Lesson 5, students construct and calibrate liquid- and air-filled thermometers. They then discuss the effect of temperature on the volume of matter and relate that to the effect of temperature on the density of matter.

In Lesson 6, students continue to explore the effect of temperature change and heat on matter by observing what happens when several substances are heated and then allowed to cool. In Lesson 7, they focus on the effect of changing temperature on water by measuring the temperature of ice as it is heated. They graph their results and use the curve they obtain together with their own observations to discuss how heat affects the temperature, phase changes, and melting and boiling points of water.

Phase change is also discussed in Lesson 8. Students predict the effects of melting and freezing on the mass of a sample of ice and water. They then discover that mass is conserved during phase change. They use their class results as the basis of a discussion on sources of experimental error.

Lesson 9 is an assessment for the first part of the module. It consists of a performance assessment and a written assessment. In the performance assessment, students measure the mass and volume of an irregular object made from a mystery substance. By comparing the object's density with a given set of data, they can identify the substance from which the object is

made. Most of the written part of this test requires students to apply their skills and knowledge to interpret data.

PART 2 MIXTURES AND SOLUTIONS

Lesson 10 is an introduction to the Anchor Activity. The Anchor Activity requires students to combine the knowledge they gain during the course of the module with information collected from the library and the Internet. Over the course of the next few weeks, they develop an exhibit and make an oral presentation, both of which relate the function and history of a simple manufactured object to the properties of the materials used to make it.

In Lesson 11, students discuss their ideas about pure substances and mixtures. Using a specified set of apparatus and their own criteria, they decide whether several samples of matter are pure substances or mixtures. Their results are discussed in terms of problems encountered in identifying some of the samples—particularly solutions—as mixtures.

The components of solutions and solubility are the focus of Lessons 12 through 18. In Lesson 12, students investigate how different substances behave when they are mixed with water, and they discuss the components and properties of a solution. In Lesson 13, they measure the solubility of two different substances and discuss solubility in water as a characteristic property of matter. They revisit mass, volume and the conservation of mass in Lesson 14, when they predict and then measure what happens to mass and volume when solvents and solutes are mixed. In Lesson 15, they compare how soluble and insoluble substances behave when filtered and then apply the technique of filtration to clean a sample of rock salt. In Lesson 16, students discuss nonaqueous solvents and design an inquiry in which they

design an inquiry to compare the effectiveness of various solvents in removing stains. In Lesson 17, students use paper chromatography to separate a solution that contains several solutes. They then apply this technique to solve a mock forgery. In Lesson 18, students add salt to ice and boiling water to investigate the effect of solutes on melting and boiling points. They then compare the time it takes to melt different alloy samples (solders) and relate the concept of solutions to solids.

Lesson 19 is an assessment. It consists of a performance assessment and a written assessment. In the performance assessment, students describe the properties of the components of an unknown mixture. This, together with the written part, assesses the knowledge, concepts, and skills developed in Parts 1 and 2 of the module.

PART 3 COMPOUNDS, ELEMENTS, AND CHEMICAL REACTIONS

In Part 3, students focus on some properties of pure substances. In Lesson 20, students use electrolysis to split a pure substance (water) into its constituent elements (hydrogen and oxygen). They compare the properties of these three substances and are introduced to the concepts of an element and a compound.

In Lesson 21, students study several elements. They collect data on these elements, both from direct observation and from Element Cards that contain information on the characteristic properties of the elements. They use these data to classify the elements into groups according to their own criteria. They then compare the groups they have devised with those in the periodic table.

Lesson 22 uses the information students collected in Lesson 21 to classify elements into metals and nonmetals. They observe a chemical reaction between a metal (iron) and a nonmetal

(oxygen) and construct a simple word equation for this synthesis reaction.

In Lessons 23 and 24, students continue to investigate reactions with metals. In Lesson 23, they compare how different metals react with dilute hydrochloric acid and construct a reactivity series based on their results. They continue to explore the concept of reactivity and its implications by designing experiments to determine the effects of air and water on different metals. In Lesson 24, students design an investigation to determine the effects of air and water on the corrosion of treated and untreated steel.

In Lesson 25, students revisit the concepts of mass and changing matter. They apply their skills to determine what happens to the mass of

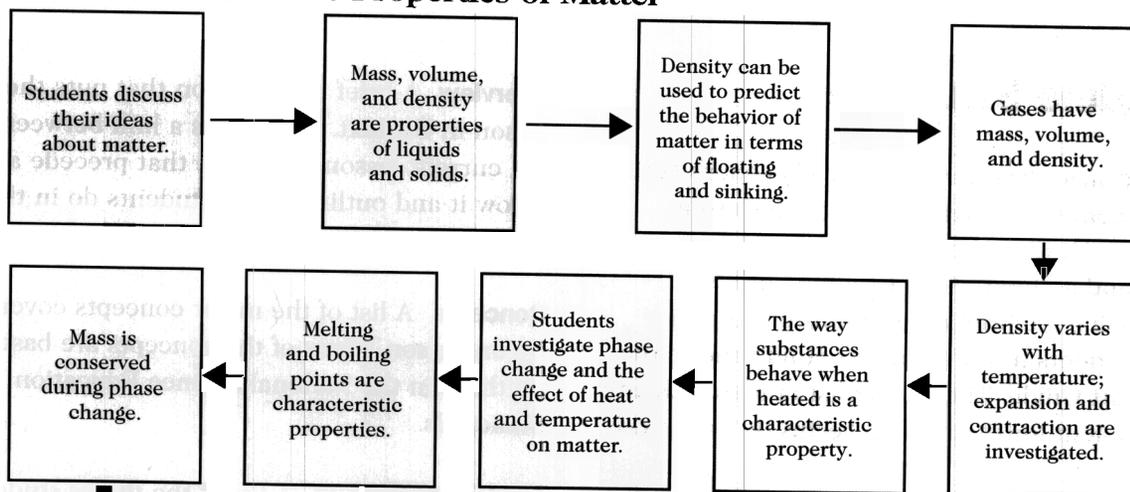
a substance during a chemical reaction.

Students react a known mass of antacid tablet and water in an open system and in a closed system. They compare mass at the beginning and end of these reactions. They then summarize the conservation of mass for changes of state, dissolving, and chemical reactions as a law of conservation of mass.

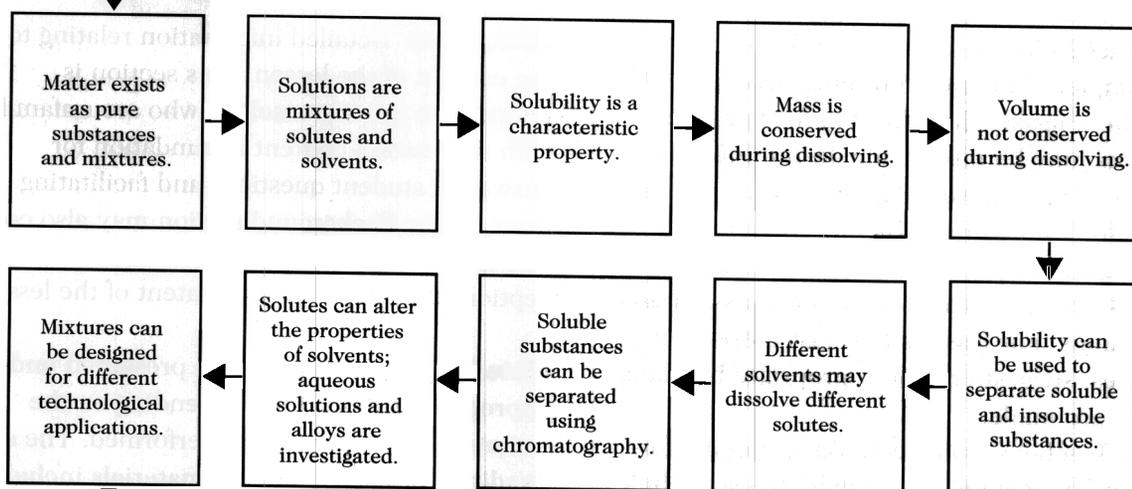
Lesson 26 is an assessment consisting of a performance component and a written component. The performance assessment requires students to apply their knowledge of solubility, chemical reactions, and conservation of mass to the production of a solution and to a precipitate reaction. The written assessment is a comprehensive test that covers the entire module.

Conceptual Sequence for *Properties of Matter*

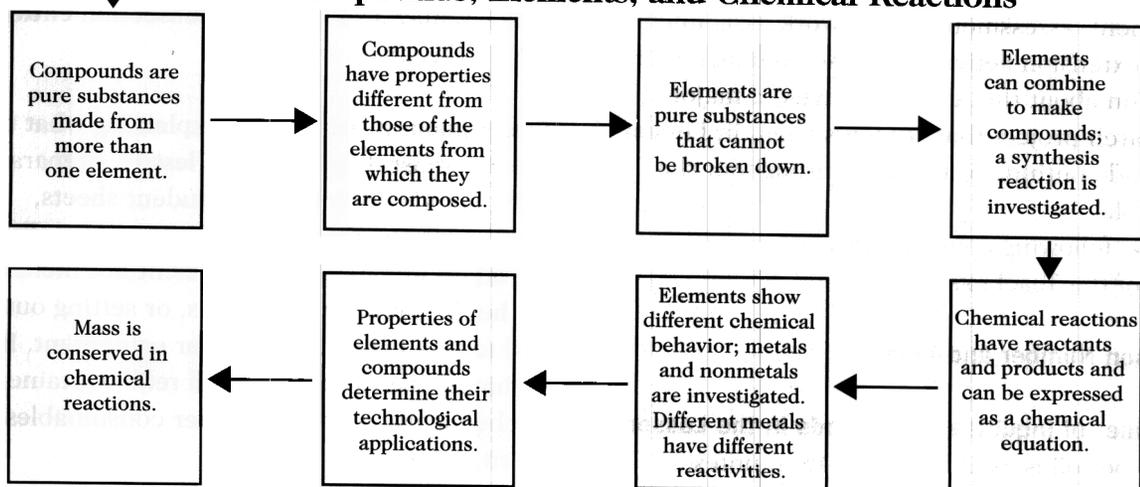
Part 1: Characteristic Properties of Matter



Part 2



Part 3: Compounds, Elements, and Chemical Reactions



Module Structure

Properties of Matter includes a Teacher's Guide, a Student Guide, Inquiry Cards (for use in Lesson 1), Element Cards (for use in Lesson 21), and a materials and equipment kit.

Following are brief descriptions of the major components in the Teacher's Guide and in the Student Guide. The master list of materials and equipment for the module begins on page xxxv.

TEACHER'S GUIDE

The Teacher's Guide for *Properties of Matter* includes 26 lessons. The shortest lesson can be completed in one 45-minute class period, and the longest takes three to four periods. Lessons may be taught in a 45-minute class period or in back-to-back periods to accommodate block scheduling. Block scheduling requires less time for materials management and allows more time for class discussion and extensions. For lessons that last more than 45 minutes, suggestions for appropriate breaking points are made.

The Teacher's Guide contains general information on teaching the module. It also includes information about the science concepts that apply to each lesson, materials and their management, assessments, homework assignments, and extension activities. It also contains information about the Anchor Activity, a major research project that students begin in Lesson 10 and continue to work on throughout the module.

The following components appear in each lesson of the Teacher's Guide:

Lesson Number and Title

Number of Inquiries and Periods in the Lesson

One period is assumed to be 45 minutes.

Overview A brief introduction that puts the lesson in context. It provides a link between the current lesson and those that precede and follow it and outlines what students do in the lesson.

Concepts A list of the major concepts covered by the lesson. Many of the concepts are based on those in the National Science Education Standards.

Student Objectives A list of the things students are expected to accomplish in the lesson.

Background Detailed information relating to the content of the lesson. This section is intended to provide teachers who are unfamiliar with the lesson's content a foundation for answering student questions and facilitating inquiry. The Background section may also contain information about common student misconceptions that relate to the content of the lesson.

Materials A list of materials, presented under appropriate subheadings depending on the nature of the inquiry to be performed. The subheadings for lists of student materials include For Each Student, For Each Pair of Students, and For Each Group of 4 Students. Each materials list may also include a subsection entitled For the Teacher.

Preparation A list of steps explaining what the teacher must do prior to the lesson. Preparation may include photocopying student sheets, preparing transparencies or newsprint, collecting additional items of equipment not included in the kit, preparing solutions, or setting out and testing balances and other equipment. It is assumed that the teacher will refill containers of chemicals and replace other consumables when necessary.

Getting Started A brief exercise or activity that introduces students to or provides the context for the lesson. In some cases, students first brainstorm what they already know about the topic. This encourages students to begin thinking about the topic of the lesson and allows the teacher to assess their pre-existing ideas.

Inquiry Number and Title Lessons may contain more than one inquiry. Each inquiry has its own number, title, and procedure.

Procedure A step-by-step guide for facilitating the inquiry. This section provides a carefully planned route through the lesson and complements the Procedure in the Student Guide.

Reflections A list of steps presenting guidance on how to provide closure for the lesson. Students may be asked to reflect on their inquiry results and discuss how the concepts encountered in the lesson can be applied to situations outside the classroom.

Homework Homework assignments that relate to either the current or the next lesson. Many of the assignments involve the reading selections that appear in the Student Guide. Additional homework can be assigned from the extensions (see below).

Extensions Activities designed to extend students' experience of the topic into other fields of science and other content areas. These activities provide the opportunity for science teachers to collaborate with colleagues from other content areas to ensure a more integrated curriculum.

Assessment A section that suggests methods for assessing students for each lesson. Teachers

may wish to assign point values in keeping with their regular grading schemes. When a lesson itself is designed as an assessment, scoring rubrics are provided.

Preparation for [a subsequent lesson] Brief mention of preparation and/or materials needed for an upcoming inquiry. It is suggested that teachers check materials requirements before each lesson is to be taught.

Student Sheets Reproducible worksheets that students use to record their ideas and interpret their data and to answer questions about the concepts covered in the inquiries. Student sheets may also be used for homework assignments, reviews, and assessments. Most lessons have at least one student sheet; some have several. Masters for these sheets appear at the end of each lesson in the Teacher's Guide. Teachers must photocopy sufficient quantities of them before each lesson. (Appendix A is a lesson-by-lesson list of student sheets, giving the number, title, and page numbers of each.)

STUDENT GUIDE

The Student Guide is intended to be used in conjunction with the Teacher's Guide. The components in the Student Guide complement those in the Teacher's Guide. For example, both guides contain lists of student objectives, but the wording may differ slightly between the two volumes, as appropriate for teachers and for students. The materials lists are less detailed in the Student Guide than in the Teacher's Guide. Some sections are unique to each guide; for example, Homework and Extensions are not included in the Student Guide, while reading selections do not appear in the Teacher's Guide. The two volumes are

designed to be complementary, and the teacher needs both guides to facilitate inquiry.

Each lesson in the Student Guide contains the following sections:

Lesson Number and Title

Introduction A brief section of text that places the concepts included in the lesson in context with those that have preceded it and with the students' own experiences. It may also provide a brief preview of the lesson. Some introductions include background information to draw students into the topic to be investigated.

Objectives for This Lesson A list that outlines what the students are expected to accomplish by the end of the lesson.

Materials A list that specifies the size of the group in which the students will be working as well as the materials they will require.

Getting Started A brief exercise or activity that introduces students to the topic of the lesson. It may include a brainstorming session on what students already know about the topic or a series of questions or experiences that form the basis for a brief group or class discussion.

Number and Title of Inquiry

Procedure Step-by-step instructions that students follow to complete an inquiry or to

explore the concepts of a lesson more fully. This section often contains questions that students discuss in their groups, answer on their student sheets or in their science notebooks, and discuss with the class.

Reflecting on What You've Done A closing section that provides students an opportunity to think about and discuss what they have learned in the lesson and to begin to apply what they have learned to new situations.

Reading Selections Readers—frequently accompanied by photographs and illustrations—that pertain to the content of the module or, more specifically, to that of a lesson. Most lessons in this module have one or more reading selections. A reading selection may provide background information that helps apply the concepts addressed in the lesson or it may introduce additional concepts from other areas of the National Science Education Standards. Most reading selections develop these concepts in the context of the world outside the laboratory. They are also intended to increase students' awareness of the history of science and technology.

Inquiry Cards and Element Cards In Lessons 1 and 21, cards are used to organize lessons in which students move through a series of inquiries or stations. These cards are provided in the materials and equipment kit.