



SCIENCE

STUDENT BOOK

▶ **8th Grade | Unit 2**

SCIENCE 802

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Structure of Matter 1

Introduction

The Greek philosophers of the third and fourth centuries B.C. were great thinkers, and they thought about matter and about problems that are studied today by chemists and physicists. They asked questions like this: If you divide a cup of water in half, then divide it in half again, and continue dividing it in half, do you ever run out of water and end up with something else? The thinkers of ancient Greece tried to *reason* things out without doing experiments. As a result, not all of them got the same answers.

The man who came closest to our modern view of matter was Democritus, who lived about 460 B.C. He believed that all matter was composed of a large number of small objects which he called atoms (this Greek word means *indivisible*). Democritus thought these objects were all of the same material, but came in different shapes and sizes.

Aristotle believed that all matter was composed of four things: earth, fire, air, and water. He disagreed with almost all of the ideas of Democritus.

Ideas changed very little until the seven-teenth century when such scientists as Robert Boyle and Isaac Newton developed new theories about matter. These men did some experimenting along with their thinking and developed the atomic theory. This theory states that matter is made up of atoms, which act as building blocks for all matter.

Today with the aid of the electron microscope and other modern technology, molecules can be “seen”; models of particles even smaller than atoms have been set up. Throughout the centuries mankind has attempted to unravel the inner secrets of matter, of all that God has so perfectly and wonderfully created.

In this LIFEPAAC® you will study some of the information scientists have discovered about matter and thus gain an ever greater appreciation for what God did for us in creating this magnificent universe. He also has given us the intelligence to understand some of what He has done. As you begin this LIFEPAAC on the structure of matter, pray also that you will learn more about God who created it.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAAC. When you have finished this LIFEPAAC, you should be able to:

1. Explain what matter is.
2. List two general properties of matter.
3. List at least five special properties of matter.
4. Describe one chemical property of matter.
5. State the differences among solids, liquids, gases, and plasmas.
6. Calculate the volume of a solid and liquid.
7. Calculate the density of matter.
8. Explain the different parts of an atom.
9. Draw a molecular diagram linking atoms together.
10. Explain briefly the atomic theory.
11. Write a definition of an element.
12. Interpret the numbers and symbols on the Periodic Table.
13. Write a definition of a compound.
14. Write a definition of a mixture.
15. Name at least two examples each of an element, compound, and mixture.

1. PROPERTIES OF MATTER

What is matter anyway? Just for fun see how many of the following items you can identify correctly. Check with an X each one you think is matter.

- | | | | |
|------------|--------------------------|----------------|--------------------------|
| 1. sugar | <input type="checkbox"/> | 6. light | <input type="checkbox"/> |
| 2. heat | <input type="checkbox"/> | 7. milk | <input type="checkbox"/> |
| 3. wood | <input type="checkbox"/> | 8. electricity | <input type="checkbox"/> |
| 4. gravity | <input type="checkbox"/> | 9. rice | <input type="checkbox"/> |
| 5. air | <input type="checkbox"/> | 10. sound | <input type="checkbox"/> |

Scientists study the world around us to learn how materials are alike and different. Some of

the ways that kinds of matter differ are easy to see and some are not. Every kind of material has at least one property that makes it different from any other material. For example, glass is used instead of plastic in cookware; why? The materials used to make a lock have special properties. What property explains the rust that may be on a piece of metal? Can matter be changed from one kind to another? These questions and others are answered by studying the properties of matter.

In the preceding quiz, if you checked all the odd-numbered items, you did very well. If you missed several, you will soon know how to tell the difference between matter and nonmatter.

SECTION OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. Explain what matter is.
2. List two general properties of matter.
3. List at least five special properties of matter.
4. Describe one chemical property of matter.
5. State the differences among solids, liquids, gases, and plasmas.
6. Calculate the volume of a solid and liquid.
7. Calculate the density of matter.

VOCABULARY

Study these words to enhance your learning success in this section.

amorphous (u mōr' fus). Shapeless. Lacking complex organization.

atom (at' um). The smallest particle of an element that can exist alone.

balance (bal' uns). An instrument for weighing.

buoyancy (boi' un sē.) The upward force of a fluid on an object.

Celsius scale (sel' se us skal). The temperature scale with freezing at 0° and boiling at 100° for water.

centigrade (sen' tu grā d). The temperature scale with 0° at freezing and 100° at boiling. Same as Celsius.

classify (klas' u fī). To assign to a category.

crystalline (kris´ tu lin). Made of crystals.

cubic (kyü´ bik). Having the form of a cube.

cylinder (sil´ un dur). A chamber having a shape like a pipe.

density (den´ su tē). The mass of a substance per unit volume.

displace (dis plā s). To remove from the usual place.

Fahrenheit (far´ un hī t). The temperature scale with freezing 32° and boiling at 212° for water.

linear (lin´ ē ur). Like a straight line.

mass (mas). The amount of matter in an object.

meniscus (mu nis´ kus). The curved top surface of a liquid column.

mineral (min´ ur ul). A crystalline element or compound found in nature.

molecule (mol´ u kyül). Two or more atoms chemically combined.

pressure (presh´ ur). The application of force to something.

principle (prin´ su pul). A fundamental law or belief about something.

volume (vol´ yum). Space occupied, measured in cubic units.

Note: All vocabulary words in this LIFEPAAC appear in **boldface** print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.

Pronunciation Key: hat, āge, cāre, fār; let, ēqual, tērm; it, īce; hot, ōpen, ōrder; oil; out; cup, pūt, rüle; child; long; thin; /TH/ for then; /zh/ for measure; /u/ represents /a/ in about, /e/ in taken, /i/ in pencil, /o/ in lemon, and /u/ in circus.

GENERAL PHYSICAL PROPERTIES OF MATTER

How is all matter alike? If you have ever dropped something into a full pail of water, you might have noticed that some of the water flowed over the edge of the pail. Whatever was dropped into the pail took up some of the space that had been filled by the water. As a result, some of the water was pushed out of the pail. Air can also push water out of one place and into another.

Takes up space. The first general property of matter is that it takes up space. No two units of matter can take up the same space at the same time. One unit must move. The amount of space that matter takes up is called **volume** of that matter. Thus a giant boulder has more volume than a small rock. However, any unit of matter, large or small, solid, liquid, or gas, takes up some space and therefore has volume.

Has weight and mass. If you were to lift a popsicle stick and a large rock, you could tell quickly which one was heavier. This experiment would tell you about another general property of matter. All matter on earth has weight. When you weigh something, you are measuring the pull of the earth's gravity on that object. Why do some things weigh more than others? The reason is that some things have more matter in them than others. The amount of matter in an object is called the **mass** of that object. Mass is measured in grams. The more mass an object has, the greater will be the pull of the earth on it, and thus it will weigh more on the earth. Keep in mind, however, that the terms *mass* and *weight* are defined differently.

**Complete this activity.**

- 1.1 List the two general properties of matter
- a. _____
- b. _____



View 802 Volume & Density, from the Grade 8 SCIENCE EXPERIMENTS Video

Study and follow these important safety rules.

1. Follow directions carefully.
2. Do *not* mix anything without instructions.
3. Do *not* taste anything unless told to do so.
4. Place chemicals and investigation materials in a safe place.
5. Check with your teacher to see if chemist's goggles are needed for eye protection.

**Important Safety Rules****Try this investigation.****These supplies are needed:**

- metric ruler
- small block of wood

Follow these directions to find the volume. Put a check in the box when you have completed the step.

- 1. First find the volume of a small rectangular block of wood. Volume equals length times width times height ($V = l \times w \times h$). The amount of space that an object takes up is its volume.
- 2. Measure in centimeters (cm) the length, width, and height of the block of wood and record in the table.
- 3. Now multiply the length times the width and take that answer and multiply it times the height. This is the volume of the piece of wood.

Volume = $l \times w \times h =$ _____ (answer)

Since you went from **linear** measurement (cm) to **cubic** measurement (cm^3), the units change and your answer will be in cubic centimeters (cm^3).

**Volume of Uniform Object Experiment**

	Measurement
length	
width	
height	
<i>Note:</i> Be sure you included the units (cm) with each measurement.	



Try this investigation.

These supplies are needed:

- string
- small rock
- water
- graduated **cylinder**

Now find the volume of an odd-shaped object. You can find the volume of some odd-shaped objects by using the general property that matter takes up space. Put a check in the box when you have completed the step.

- 1. Pour water into a graduated cylinder until it is about half full, stopping at one of the level marks on the cylinder.
- 2. Read and record the level of the water in the table. This reading is the volume of the water. Be sure you are reading at the lowest point of the curved surface (**meniscus**). Study Figure 1 to read the correct level.
- 3. Tying the string on the rock, lower the small rock completely into the water. Let it settle at the bottom.
- 4. Record the level of the water with the rock in it on the table. This reading is the volume of the water *and* the rock.
- 5. Find the volume of the object by subtracting the reading of the water (2) from the reading of the water and the rock (4).

	Volume
2. level of water	
4. level of water and rock	

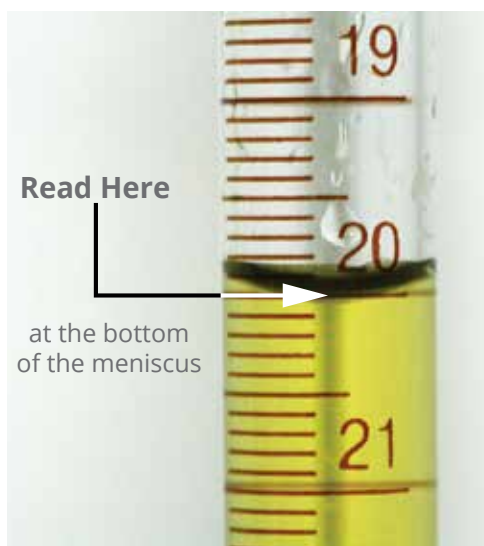


Figure 1 | The Meniscus

volume of water plus rock (4) _____
 minus volume of water (2) - _____
 answer _____

Your answer is the volume of the rock.



TEACHER CHECK

initials _____

date _____

Volume Odd-Shaped Object Experiment

SPECIAL PHYSICAL PROPERTIES OF MATTER

We know that all matter must possess mass and take up space. Yet, other properties can help us learn what makes each kind of substance different from the others.

Knowing the shape, odor, taste, color, **density**, **buoyancy**, and boiling point of a material will tell us what the substance is like. These properties are called *special properties*. These special properties tell us a great deal about the ways a substance may react or be used. For example, you may have three beakers full of different liquids; one contains plain water, one contains grape juice, and one contains white vinegar. All three liquids have mass and take up space.

How can we tell them apart? One way is to **classify** the three liquids according to their special properties. The grape juice can be distinguished from the other two by its color and taste. The water and the vinegar look the same but can be distinguished from each other by odor, taste, and boiling point.

We can also find out many of the special properties of a substance by looking at a table or chart that has this kind of information.

Knowing what is different about matter helps us classify things. Since all matter has mass and takes up space, the special properties are important for us to know.



Follow these directions.

- 1.2** Collect at least six different objects that may be found nearby (rocks, pencil, eraser, chalk, etc.). After you have collected the objects, sort them into different groups according to their properties. You may even think up some special properties of your own.

a. How did you classify the objects? _____

b. What different properties did you use in making your groups? _____

Complete this activity.

- 1.3** Write as many properties as you can which tell the difference between the following pairs.

a. chalk and snow _____

b. soda pop and water _____

c. salt and sugar _____

d. wood and plastic _____



Follow these directions.

- 1.4** Get a sample of some rock or **mineral**. Use your senses and any tools you have to find out all you can about the properties of the sample. On a piece of paper write a description of your sample. Now put your sample with several other rocks and minerals. Verbally describe your rock and have a classmate try to guess the one you described.

Density. Density is an important special property of matter that needs further explanation. Density is the mass of a substance per unit of volume. It may be expressed in grams per cubic centimeter (g/cm^3). For example, water has a density of 1 gram per cubic centimeter. If we compare a thousand grams of iron with a thousand grams of feathers, their masses are equal; but the box containing the feathers would be much larger than the one containing the piece of iron, because the iron has a greater density. Another way of looking at density is to compare steel and polished aluminum. They look alike, but their densities are different. Simply, a cubic centimeter of iron contains more mass than does a cubic centimeter of aluminum. To find the density of a substance, you must first know its mass and volume.

Formula

$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}}$$

Sample Problem

$$\text{Density} = \frac{72 \text{ (g)}}{36 \text{ (cm}^3\text{)}} = 2 \text{ g/cm}^3$$

Substance	Density g/cm^3
cork	0.22
water	1.0
sugar	1.6
aluminum	2.7
iron	7.9
gold	19.3

Figure 2 | Densities of Different Substances



Try this investigation.

These supplies are needed:

- balance
- small wooden block
- metric ruler

Follow these directions. Put a check in the box when you have completed each step.

- 1. Take a small rectangular wooden block and measure the length, width, and height in centimeters.
- 2. Calculate the volume of the block by using the formula: volume equals length times width times height ($V = l \times w \times h$). The result will be the number of cubic centimeters (cm^3).
- 3. Use the **balance** to find the mass of the block in grams. Then calculate the density using the formula. Be sure to divide the mass by the volume to get the answer.

$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}} = \frac{\text{(g)}}{\text{(cm}^3\text{)}} = \text{_____ g / cm}^3$$



TEACHER CHECK

_____ initials

_____ date

Density Experiment



Define these words.

1.5 density _____

1.6 volume _____

1.7 mass _____

**Complete these sentences.**

- 1.8 Volume is measured in cubic _____ .
- 1.9 Mass is measured in _____ .
- 1.10 Water has a density of _____ .
- 1.11 Density equals mass divided by _____ .

Buoyancy. Why do some things float? You already know that heavy objects tend to sink, and light or hollow objects tend to float. Floating is related to *density*. Paper, cork, wood, and some plastics float on water. Each of these substances has a low density. A piece of steel will sink to the bottom. Yet, a merchant ship made of steel will float. Why?

When an object is placed into a liquid, it pushes that liquid aside. The object **displaces** the liquid. In other words, it moves the liquid to another place since both substances can not occupy the same space at the same time. When

you get into a bathtub, you probably notice that the water level rises. Your body is displacing or pushing aside a certain amount of water. If the mass of the amount of liquid displaced is equal to or greater than the mass of the object that displaced it, the object will float. This law, or principle, is named for Archimedes, the Greek philosopher who discovered it. It is sometimes referred to as Archimedes' **Principle**. When a block of wood is placed in water, it sinks until an amount of water exactly equal to the mass of the block is displaced. The water underneath the wood exerts a push or force to hold it up. This upward force is called buoyancy.

**Complete these activities.**

- 1.12 Write Archimedes' Principle. _____

- 1.13 Define *buoyancy*. _____

- 1.14 When an object is placed in water, it pushes aside, or _____, the liquid.

Plasma. The fourth state or phase of matter is called plasma. Plasma is quite rare on earth. However, in the stars the plasma state is very common. For example, stars such as the sun contain matter in the plasma state. Matter in the plasma state is extremely high in energy and dangerous to living things. Plasma cannot

be kept in a container made from ordinary matter, because the container would quickly be destroyed. Instead, magnetic fields produced by powerful magnets are needed to keep the high-energy plasma from escaping. One day, producing plasmas on the earth may meet most of our energy needs.



Complete these sentences.

- 1.44 The fourth state of matter is called _____ .
- 1.45 Plasma is very common in the _____ .
- 1.46 The plasma state is extremely high in _____ .



Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Put an X next to each item that is matter (each answer, 2 points).

- 1.01 _____ rice
- 1.02 _____ light
- 1.03 _____ gravity
- 1.04 _____ sugar
- 1.05 _____ wood
- 1.06 _____ electricity
- 1.07 _____ sound
- 1.08 _____ milk
- 1.09 _____ heat
- 1.010 _____ air

Match these items (each answer, 2 points) (some have more than one acceptable answer).

- | | | | |
|-------|-------------------------------|----|--|
| 1.011 | _____ meniscus | a. | upward force of a fluid on an object |
| 1.012 | _____ mass | b. | fixed shape |
| 1.013 | _____ freezing point of water | c. | snowflake |
| 1.014 | _____ buoyancy | d. | 0° Celsius |
| 1.015 | _____ solid | e. | frozen water |
| 1.016 | _____ amorphous | f. | amount of matter in object |
| 1.017 | _____ expands | g. | no definite geometric shape |
| 1.018 | _____ gas | h. | round in shape |
| 1.019 | _____ crystalline | i. | ability to react with another substance |
| 1.020 | _____ chemical property | j. | curved top surface of a liquid column |
| 1.021 | _____ plasma | k. | without |
| | | l. | molecules far apart |
| | | m. | 32° Celsius |
| | | n. | definite geometric shape |
| | | o. | state in which matter is extremely high in energy and cannot be contained by ordinary matter |

List the two general properties of matter (each answer, 3 points).

1.022 _____

1.023 _____

List five special properties of matter (each answer, 3 points).

1.024 _____

1.025 _____

1.026 _____

1.027 _____

1.028 _____

Match the correct letters with the word (each answer, 2 points).

- | | | | | | |
|-------|-------|-------|--------|----|--------------------|
| 1.029 | _____ | _____ | solid | a. | definite shape |
| 1.030 | _____ | _____ | liquid | b. | no definite shape |
| 1.031 | _____ | _____ | gas | c. | definite volume |
| | | | | d. | no definite volume |

Calculate volume (this answer, 7 points).

- 1.032 Given a block of wood 2 cm long, 4 cm wide, and 3 cm high, determine its volume. Do all work in the space provided.

Answer

Calculate density (this answer, 10 points).

- 1.033 Given a piece of metal with a mass of 112 grams and volume of 24 cubic centimeters (cm³), what is its density? Use the correct formula to obtain your answer, and do all work in the space provided.

Answer

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> 74 92 </div>		SCORE _____	TEACHER _____ <small>initials date</small>
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