

Lesson 1: Invisible Matter

☐ Getting Started

Philosophers, not scientists, first thought of the idea of the atom. Prior to the discoveries of modern science, these philosophers and academics believed that matter was made up of invisible components that were uncuttable, or **indivisible** — they could not be divided further. In fact, the word "atom" comes from the Greek *atomos*, meaning "indivisible." One of the first to investigate this concept was Democritus, often considered the father of modern science. He is given credit for the idea of the atom.

Elements are substances that cannot be broken down into simpler substances. For example, if you have a block of pure gold, and you cut it into smaller and smaller pieces, it will always remain gold. The smallest bit that an element can be broken into is called an **atom**.

Atoms are important because of their structure. A **structure** is an organization made up of related parts functioning as a whole. Structures can be part of a **system**, a combination of related parts. The way that an object or living thing is shaped determines many of its **properties** — its characteristic qualities or distinctive features — and its **functions** — the actions or uses for which it is designed. The functioning of any object, natural or made by hand, depends on the shapes and relationships of certain key parts as well as the materials from which it is made.

In the case of **matter** — a substance or material of a particular kind that has mass, occupies space, and is convertible to energy — its various functions are based on its structure. Depending on the type of matter that is present, different functions are possible. To understand matter, we must explore one of the most basic units of matter, the atom. Matter exists in different forms and, in some of its simplest states, is not easy to see. Although some matter may be invisible to the naked eye, its behavior can often be observed.

Today, you'll look at how matter behaves in one situation, which will help you understand how it works in different situations, too.

Stuff You Need

- *Eyewitness Chemistry* by Ann Newmark
- 250-ml beaker (kit)
- dynamometer (kit)
- funnel (kit)* (Activity 1 - optional)
- pan
- plastic milk jug
- pot holder or oven mitt
- safety goggles (kit)
- scissors

- watch or timer

Ideas to Think About

- How do we know that all matter is made of smaller, "invisible" parts?

Things to Know

- **indivisible:** not capable of being separated into parts
- **atom:** the smallest portion into which an element can be divided and still retain its properties
- **element:** a substance that cannot be broken down into a simpler one
- **structure:** a system or organization made up of related parts functioning as a whole
- **function:** an action or use for which something is designed
- **property:** a characteristic, quality, or distinctive feature of something
- **system:** a combination of related parts organized into a whole
- **matter:** a substance or material of a particular kind that has mass, occupies space, and is convertible to energy

☐ Reading and Questions

Read pages 16 and 18 of *Eyewitness Chemistry* by Ann Newmark. (Optionally, also read p. 19.) Answer the following questions.

1. What was John Dalton's atomic theory?

2. What was the problem with Dalton's atomic model?

3. What is an element?

4. What two elements are most commonly found in the Earth's crust?

Activities

☐ Activity 1: Discovering that Matter Exists at an Invisible Level

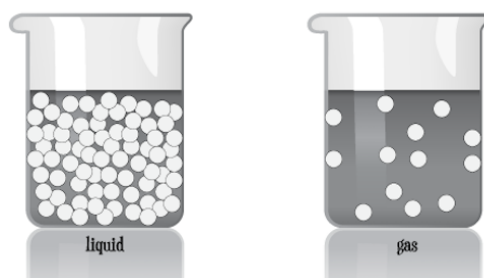
In this activity, you will boil water, pour it into an empty milk jug, seal the cap, and observe what happens. CAUTION: This activity requires handling boiling water. Be sure to wear safety goggles and handle the pot or beaker with a pot holder or oven mitt. Ask for a parent's assistance as needed.

First assemble your materials. You will need a pan, an empty milk jug with a lid, a 250-ml beaker (kit), a dynamometer (kit), a pot holder or oven mitt, safety goggles (kit), and a watch or timer. You may also need a funnel to make it easier to pour the boiling water into the container.

Procedure:

1. In a pan, heat approximately 200 ml (about 1 cup) of water until it boils. Be sure to observe what is happening with the water and think about the questions found at the top of the activity page.
2. On the activity page, sketch the empty milk jug.
3. After the water reaches the boiling point, use a pot holder or oven mitt to carefully pour the water into the empty milk jug.
4. Tightly cap the top of the container and then weigh the container and its contents. Record the mass on the activity page.
5. Set a timer for 5 minutes. When the timer goes off, observe what happens to the container and sketch what you see on the activity sheet.
6. Repeat Step 5 three more times (at 10, 15, and 20 minutes).
7. Record the mass of the container and its contents after 20 minutes. (HINT: Keep in mind that the water has transitioned from a liquid to a gas. How might that influence the weight you observe?)
8. Answer the questions at the bottom of the activity page and discuss your results with a parent. (The "Liquid and Gas Particles" image may help you answer.)

Liquid and Gas Particles



☐ Activity 2: Vocabulary

In this activity you will review some of the vocabulary that will be important for this unit. On the first "Vocabulary" page, create an illustration for each vocabulary term. You should use ideas from Activity 1 to create your illustrations. For example, "matter" covers a lot of possibilities, but you can draw an image that represents water, the container that held the water, or even the heat source. Make sure that you understand what the term represents in as many contexts as possible. Cut out the cards, separating each word from its illustration, and set the cards aside.

Next, read over the words and definitions on the second "Vocabulary" page. Cut out the cards from this page, separating each word from its definition. Use the two sets of cards to help you study the vocabulary words. You can do a Memory-type game or just try to match the definitions or illustrations to the words they describe. (Refer to the "Things to Know" section at the beginning of the lesson if you need to confirm definitions.) Your goal is to be able to recite the correct definition for each vocabulary word.

Wrapping Up

Go back and consider the questions that you answered on your activity sheet. Keep in mind the essential question from the beginning of the lesson, "How do we know that all matter is made of smaller, 'invisible' parts?" What is it about the activity that gives you evidence that water, and other types of matter, are made up of particles that cannot be seen with the naked eye? Keep this answer in mind as we progress through the remainder of this unit. What evidence were you able to collect that supports that matter is not lost when it changes from a liquid to a gas? (HINT: Consider the mass of the water before and after it was heated.)

VOCABULARY

ATOM

ELEMENT

STRUCTURE

FUNCTION

PROPERTY

SYSTEM

MATTER

VOCABULARY

ELEMENT

a substance that cannot be broken down into a simpler one

ATOM

the smallest portion into which an element can be divided and still retain its properties

STRUCTURE

a system or organization made up of related parts functioning as a whole

FUNCTION

an action or use for which something is designed

PROPERTY

a characteristic quality or distinctive feature of something

SYSTEM

a combination of related parts organized into a whole

MATTER

a substance or material of a particular kind that has mass, occupies space, and is convertible to energy

Lesson 1: Invisible Matter

Getting Started

✿ Ideas to Think About

- How do we know that all matter is made of smaller, "invisible" parts?

Things to Know

- **indivisible:** not capable of being separated into parts
- **atom:** the smallest portion into which an element can be divided and still retain its properties
- **element:** a substance that cannot be broken down into a simpler one
- **structure:** a system or organization made up of related parts functioning as a whole
- **function:** an action or use for which something is designed
- **property:** a characteristic, quality, or distinctive feature of something
- **system:** a combination of related parts organized into a whole
- **matter:** a substance or material of a particular kind that has mass, occupies space, and is convertible to energy

⦿ Skills

- Recognize that all matter is made up of atoms. (S)
- Know that atoms of the same element are all alike but are different from the atoms of other elements. (S)

Introducing the Lesson

In this lesson, your child will be introduced to the concept of invisible matter. This lesson will help your child understand how different types of matter influence the structure and function of different things. He will complete a hands-on activity that will lead to some challenging generalizations. The important part of the activity is having him build a point of reference for future reading and activities within this unit. This lesson is challenging in some regards, yet as the unit unfolds, your child will continue to better develop his understanding of the topic. Conceptually, he will be challenged to understand that various differences influence how matter behaves. By developing a basic understanding of matter your child will begin to understand why different types of matter function in different ways.

NOTE: The book used for this unit, *Eyewitness Chemistry* by Ann Newmark, will also be used in the next science unit this semester, "Chemical Reactions." This unit will use only a small portion of the book. Some readings will contain one or more pages of optional reading. Encourage your child to do the extra reading if he has time — the optional pages often go into more depth or cover a related topic. The optional pages are not covered in the questions.

Reading and Questions

1. What was John Dalton's atomic theory?

An element's atoms were all identical but were different from the atoms of other elements.

2. What was the problem with Dalton's atomic model?

He thought that atoms were completely solid, so he represented atoms using wooden balls.

3. What is an element?

A substance that has only one kind of atom.

4. What two elements are most commonly found in the Earth's crust?

Oxygen and silicon.

Activities

Activity 1: Discovering that Matter Exists at an Invisible Level

In this activity, your child will pour boiling water into an empty milk jug, seal it, and observe and sketch what happens. CAUTION: This activity requires that your child handle boiling water. Encourage him to wear safety goggles and handle the pan with a pot holder or oven mitt. Provide assistance as needed.

Your child did not need to formally answer the questions at the top of the activity page — they were more questions to think about as he observed the water boiling — but you may want to discuss the answers with him at the end of the lesson:

As the water heats, what is happening to the water particles?

Answer: Though this is a concept that will be addressed later, it gives the students a good point of reference for future lessons within the unit. As heat (energy) is added to the water, the particles of water become energized. This increased amount of energy causes the water molecules to become excited and move more.

What is happening between the particles?

Answer: Bonds between molecules of water start breaking, releasing the water molecules as water vapor (a gas). These bonds will break as long as the energy level in the container is high enough. The energy from the water is also transferred to the air in the container, exciting the air molecules.

Note: The container will expand at first because of the increased particle movement of the water vapor. Your child should find little or no difference between the mass of the container at minute 0 and minute 20.

Be sure to check your student's answers to the questions found at the bottom of the activity sheet:

- What is happening to the milk jug and why? (The milk jug with the hot liquid should initially expand. After a while, the liquid and the gases in the milk jug will cool down and the container will contract. It will either return to its original shape or it will contract to a size even smaller than the original.)
- What is making the container do this? (The jug is expanding because particles of water [water vapor] are highly energized. Because they are energized by the heat, they are moving around quickly. More and more water vapor is being created, meaning that the volume of the particles is increasing. Also, the energy in the water vapor energizes the air in the container. As the water cools, the milk jug will contract.)
- What is the difference between the water at this time versus the water when you initially poured it into the container? (As the water cools down, its volume changes.)
- What change is happening to the water to make this event occur? (The amount of energy present. More energy produces more water vapor. As the energy dissipates, the water vapor returns to a liquid state.)

Activity 2: Vocabulary

Your child should be able to cite the definition provided with a reasonable degree of comprehension and produce a drawing that reflects the same degree of understanding of the vocabulary term. Ideally some of the illustrations should refer to ideas from Activity 1. Comprehension should not be limited to the context of the activity or a specific item. Your child should be able to transfer this knowledge into a variety of contexts. You can help your child review using some of the follow-up questions at the end of the lesson.

Wrapping Up**Parent Note**

Activity 1 in this lesson had the goal of indirectly introducing one of the laws of matter to your child. The law of conservation of mass states that the total mass in a chemical reaction remains constant (that is, the reactants have the same mass as the products). The activity also gave your child a chance to think abstractly about matter. Matter is made up of smaller particles (as exhibited by the change in the shape of the container), and this matter can go through changes when energy is added.

Questions to Discuss

- Assuming that none of the steam escapes, does heating the water change the amount of water? (No. Heating water does not change the amount of water; heating the water changes the amount of energy.)
- How does changing the amount of energy influence matter? (Matter is made up of particles. When energy is added to matter, the particles that make up the matter become more active.)
- How does heating the water to boiling reveal that matter is made up of particles? (In the liquid state, the water was always the shape of the container. Once the water was heated, it started to gain energy. The more energy added, the more active the particles of water. The more active particles began to change the shape of the container.)

Things to Review

- All matter is made up of particles.
- The amount of energy in matter changes how matter acts.
- An increase in energy increases the activity of particles of matter; a decrease in energy decreases the activity of particles.