

Lesson 3: Properties of Matter I

☐ Getting Started

Matter, because it has certain characteristics, can be classified into groups based on visible features or functions. In this lesson you will be learning about patterns that are used for organizing the elements into groups. **Patterns** are observed arrangements of forms and events that are used for organization and classification. Patterns are the result of relationships and the factors that influence them and depend on careful observation of similarities and differences.

For matter, similarities and differences are the result of multiple characteristics. They include, but are not limited to **conductivity** — the ability of an object or substance to transmit heat, electricity, or sound; properties such as melting temperature, density, and hardness; and the type of matter that the element is in normal conditions. Most elements are classified in one of the following two ways:

- **metals** -- chemical elements that are **malleable** (can be shaped or bent without breaking) and **ductile** (able to be drawn out into wire or hammered into very thin sheets), are usually solid, have **luster** (bright or shiny condition or tone), and are good conductors of heat and electricity
- **nonmetals** — elements that do not have the character of metals; they can be gases such as carbon or nitrogen

Stuff You Need

- *Eyewitness Chemistry* by Ann Newmark
- aluminum foil (kit)
- copper wire (kit)
- play dough (kit)
- quarter, dime, or nickel
- rock
- ruler
- small pan
- thermometers (kit)

Ideas to Think About

- What makes one piece of matter different from another?
- Is all matter beneficial and useful? (Why does some matter exist?)
- What are the properties of matter?

Things to Know

- **conductivity**: the ability of an object or substance to transmit heat, electricity, or sound
- **ductile**: able to be drawn out into wire or hammered into very thin sheets
- **electrical**: involving the conduction of electric current

- **luster:** a bright and shiny condition or tone
- **malleable:** describes a substance that can be shaped or bent without breaking
- **metal:** a chemical element that is malleable and ductile, usually solid, has luster, and is a good conductor of heat and electricity
- **nonmetal:** elements that do not have the character of metals; they can be gases such as carbon or nitrogen
- **patterns:** observed arrangements of forms and events that are used for organization and classification
- **periodic table:** display of the chemical elements organized on the basis of their atomic numbers, electron configurations, and recurring chemical properties
- **thermal:** relating to, affected by, or producing heat

☐ Reading and Questions

Read pp. 22-26 in *Eyewitness Chemistry*. (Optionally also read p. 27.) Then answer the following questions.

1. Who created the periodic table, based on his Periodic Law? Why did he leave gaps in the table?

2. What are the characteristics of most metals?

3. What does a metal's order of reactivity indicate?

4. Are most elements metals or nonmetals? What are the characteristics of most nonmetals?

Activities

☐ Activity 1: Element Characteristics

The **periodic table** is a display of the chemical elements organized on the basis of their atomic numbers, electron configurations, and recurring chemical properties. In the activities in this lesson, you will learn a little bit more about some specific properties. In this activity, you will look at the properties of malleability, ductility, and luster. You will use substances such as play dough, aluminum foil, and copper wire to test each characteristic, and you will record your findings on the "Element Characteristics" activity page. Be sure to read the procedures carefully as well as the instructions for each section of the activity sheet.

Malleability

Malleability means that a material can be hammered or flattened into thin sheets without breaking.

Examples: silver, gold, iron, lead

Ductility

Ductility is the ability of an element to be stretched or drawn out into a wire.

Examples: gold, steel



Malleability and Ductility

www.beyondthepage.com/link/8208/

This video demonstrates the difference between the properties of malleability and ductility.

Follow these steps:

1. Take the play dough and work it in your hands. Try to flatten it into a thin sheet. How large of a sheet can you make before the play dough begins to fall apart?
2. Now roll and stretch the play dough into a long tube/wire. See how long of a tube you can make before it breaks apart.
3. On the "Malleability" and "Ductility" tables of the activity sheet, record whether or not you think the play dough is malleable and ductile.
4. Based on your examination of the aluminum foil and copper wire (and the information in the video) determine if those materials are malleable or not malleable and ductile or not ductile. Also record any similarities and differences you note.

Luster

Luster means a bright and shiny condition or tone.

Examples: silver, gold

Follow these steps:

1. Compare and contrast the following: a quarter, dime, or nickel (choose one) with a rock.
2. Look for the presence or absence of luster in each item.
3. Next, observe the play dough, aluminum foil, and copper wire and decide if each item does or does not have luster.
4. On the "Luster" table, record your observations as well as any similarities or differences in luster you observe among the objects.

Conductivity

Conductivity is the ability of an object or substance to transmit heat, electricity, or sound.

Examples: silver, gold, iron, steel, brass, bronze, mercury, graphite, dirty water, concrete

Follow these steps:

1. Roll the play dough into a cylinder about 6 inches long; do the same for the aluminum foil. (The copper wire should already be in the desired shape.)
2. Fill a small pan with cold water and add ice to it.
3. Read the paragraph above the "Conductivity" table on the activity page and then predict whether you think each item will conduct heat or not. Record your predictions for each section.
4. Place one end of the play dough cylinder in the ice water. Place a thermometer at the opposite end of the cylinder and record the temperature in the "Before" column of the table.
5. After five minutes, again measure the temperature of the play dough cylinder and record your findings in the "After" column.
6. Repeat Steps 4-5 for the aluminum foil and then for the copper wire.
7. Make note of differences between the play dough, the aluminum foil, and the copper wire.

When making observations about conductivity, consider the following. Did you expect a change in temperature of the material? What did you observe? If no change occurred, write "no change." If a change did occur, write what type of change (for

example, the material cooled down or the material warmed up). Use brief statements.

Wrapping Up

In this lesson, you have been introduced to different traits associated with matter. You have learned about malleability and ductility, two properties that influence ways that matter can be shaped. You have been introduced to conductivity, a property related to the ability of matter to conduct heat, and also to luster, a property that deals with appearances. As you ponder what you have learned, keep these traits in mind. For your final project, you will be asked to build something and pick what materials you will use based on traits covered in this lesson. Also keep in mind the key concepts of structure and function as we continue to progress through the unit.

ELEMENT CHARACTERISTICS

Directions: If an object is malleable, write a check mark. If it is not, write an X.

MALLEABILITY				
PLAY DOUGH	ALUMINUM FOIL	COPPER WIRE	SIMILARITIES	DIFFERENCES

Directions: If an object is ductile, write a check mark. If it is not, write an X.

DUCTILITY				
PLAY DOUGH	ALUMINUM FOIL	COPPER WIRE	SIMILARITIES	DIFFERENCES

Directions: If an object has luster, write a check mark. If it does not, write an X.

LUSTER				
PLAY DOUGH	ALUMINUM FOIL	COPPER WIRE	COIN	ROCK

Directions: In this activity, you are looking for a change in temperature. It may be subtle, but you should see differences in temperature in the aluminum and copper; the play dough temperature should remain unchanged. Keep in mind that conductivity is not just about electricity. Make a prediction before you start: do you think each material will conduct heat or not? Write your predictions in the prediction section before you write the temperature.

CONDUCTIVITY								
PLAY DOUGH			ALUMINUM FOIL			COPPER WIRE		
PREDICTION	BEFORE	AFTER	PREDICTION	BEFORE	AFTER	PREDICTION	BEFORE	AFTER

Lesson 3: Properties of Matter I

Getting Started

? Ideas to Think About

- What makes one piece of matter different from another?
- Is all matter beneficial and useful? (Why does some matter exist?)
- What are the properties of matter?



Things to Know

- **conductivity**: the ability of an object or substance to transmit heat, electricity, or sound
- **ductile**: able to be drawn out into wire or hammered into very thin sheets
- **electrical**: involving the conduction of electric current
- **luster**: a bright and shiny condition or tone
- **malleable**: describes a substance that can be shaped or bent without breaking
- **metal**: a chemical element that is malleable and ductile, usually solid, has luster, and is a good conductor of heat and electricity
- **nonmetal**: elements that do not have the character of metals; they can be gases such as carbon or nitrogen
- **patterns**: observed arrangements of forms and events that are used for organization and classification
- **periodic table**: display of the chemical elements organized on the basis of their atomic numbers, electron configurations, and recurring chemical properties
- **thermal**: relating to, affected by, or producing heat

⦿ Skills

- Know how to use the periodic table to identify elements. (S)
- Understand the organization of the periodic table based on the properties of the elements: identify regions corresponding to metals, nonmetals, and inert gases. (S)
- Classify elements by their properties, including their melting temperature, density, hardness, and thermal and electrical conductivity. (S)
- Identify the properties of an atom including mass and electrical charge. (S)
- Know each element has a specific number of protons in the nucleus (the atomic number), and each isotope of the element has a different but specific number of neutrons in the nucleus. (S)

Introducing the Lesson

The periodic table is organized based on visible patterns associated with the properties of the elements. These properties lead to the specific organization of the elements in the table. In the activities in this lesson and those that follow, your child will learn a little bit more about some specific properties. The activities in this lesson will look at the following properties: malleability, ductility, conductivity, and luster.

Reading and Questions

1. Who created the periodic table, based on his Periodic Law? Why did he leave gaps in the table?

Dmitri Mendeleev. He put all known elements in the table but predicted that new elements would be discovered that would have the properties of the elements belonging in those spaces.

2. What are the characteristics of most metals?

Can conduct heat and electricity, are malleable and ductile.

3. What does a metal's order of reactivity indicate?

How the metal reacts with water and with air. The order can indicate how easy or difficult it is to isolate or extract the metal.

4. Are most elements metals or nonmetals? What are the characteristics of most nonmetals?

Most elements are metals. Most nonmetals are not malleable and are not ductile. They are not good conductors of electricity or heat.

Activities

Activity 1: Element Characteristics

In this activity, your child will examine play dough, aluminum foil, and copper wire to determine whether the materials do or do not have certain properties. A video helps explain the difference between the properties of malleability and ductility and demonstrates whether aluminum and copper are malleable and ductile.

Answer Key:

- **Malleability:** aluminum and copper are malleable; answers may vary for play dough (it can be pounded into a thick sheet but may break apart as the sheet gets thinner)
- **Ductility:** aluminum and copper are ductile; answers may vary for play dough (it can be rolled into a thick tube but may break as the tube gets thinner)
- **Luster:** the coin, aluminum foil, and copper wire all have luster; the rock and play dough do not
- **Conductivity:** predictions will vary; play dough has poor conductivity; aluminum and copper have good conductivity

Wrapping Up

Questions to Discuss

- Which of the traits do you think are important regarding the structure and function of types of matter? (Malleability and ductility: the shapes of matter influence its functions. For example, since wire is used to conduct electricity and aluminum is used to wrap up objects such as food, it is important that both can be easily shaped. Conductivity: matter can be used to conduct heat or electricity. Since many household appliances and industries utilize energy in the form of heat or electricity, conductivity is an important characteristic.)
- Which of the traits do you think are not important regarding the structure and function of types of matter? (Luster is not as important. It deals primarily with how things look and has limited benefit with regards to important functions.)

- *Challenging Question:* Why do you think play dough is less malleable, less ductile, and less conductive than copper and aluminum? (The properties of matter are influenced by atomic structure and atomic bonds. Aluminum and copper are made up of only one type of atom — copper or aluminum — so the types of bonds among atoms of these elements are different than the types of bonds among the types of atoms that make up play dough.)

Things to Review

- Matter has distinct properties that determine its function.
- Some properties are associated with how easily matter is shaped (malleability, ductility); others deal with specific functions (conductivity) or with appearance (luster).
- The properties of matter are influenced by the structure of matter at its most fundamental level, the atom.