

Physical Science

Matter and Energy

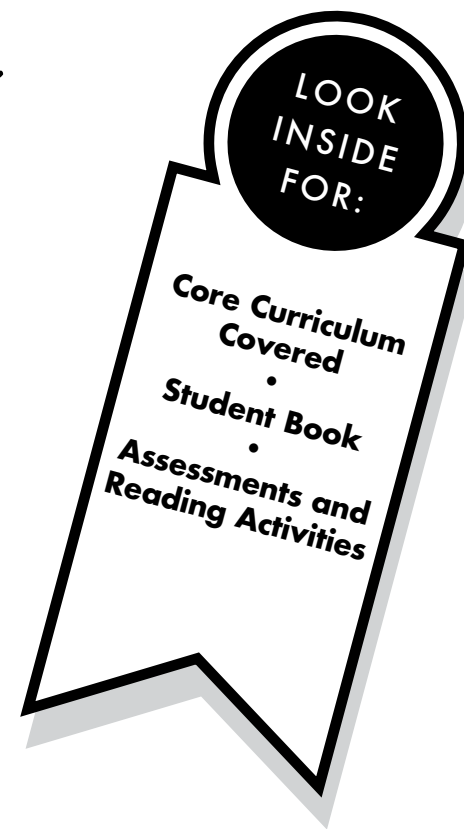
Advanced Level

# All About Matter

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# All About Matter

What are some of the properties of matter?

## CORE CURRICULUM STATEMENTS

**Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.**

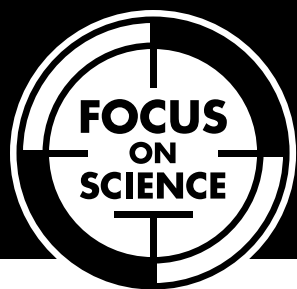
Matter takes up space and has mass. Two objects cannot occupy the same place at the same time.

Matter has properties (color, hardness, odor, sound, taste, etc.) that can be observed through the senses.

Objects have properties that can be observed, described, and/or measured: length, width, volume, size, shape, mass or weight, temperature, texture, flexibility, reflectiveness of light.

Measurements can be made with standard metric units and nonstandard units.

The material(s) an object is made up of determine some specific properties of the object (sink/float, conductivity, magnetism). Properties can be observed or measured with tools such as hand lenses, metric rulers, thermometers, balances, magnets, circuit testers, and graduated cylinders.



Advanced Level

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# Student Book

*All About Matter*

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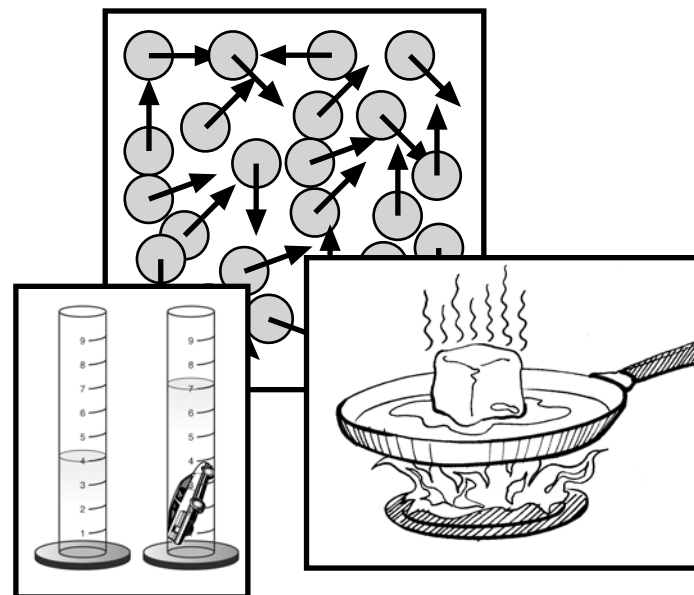


Physical Science

Matter and Energy

# All About Matter

by Laura Portalupi





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Curriculum materials for **your** content standards

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– Predict –

*What do you think you will  
learn from reading this book?*

## What Is Matter?

Imagine you are holding a balloon on a stick. The balloon and the stick are both made of matter. What about the air inside of the balloon? That is matter, too, even though you cannot see it. You can tell it is matter if you carefully put a hole in the balloon with a pin, then put your hand in front of the hole and feel the air escaping.

Everything in the universe is made of matter or energy. Matter comes in all shapes, sizes, and textures. Sometimes you can see it and sometimes you can't.

Matter is anything that takes up space and has **mass**. Mass is determined by the amount of material in an object. Think of it this way. Imagine you have an apple and a bicycle. Which one is easier to lift? The apple is easier to lift because it has less mass than the bicycle.

**mass:** the amount of material in an object

## States of Matter

Matter exists in one of three states—solid, liquid, or gas.

**Solid**—Matter that is solid has a certain shape. It does not change shape unless something forces it to change. A brick is an example of a solid. So is a flower.

**Liquid**—Matter that is liquid does not have a certain shape. It flows to take the shape of its container. Water and honey are examples of liquids.

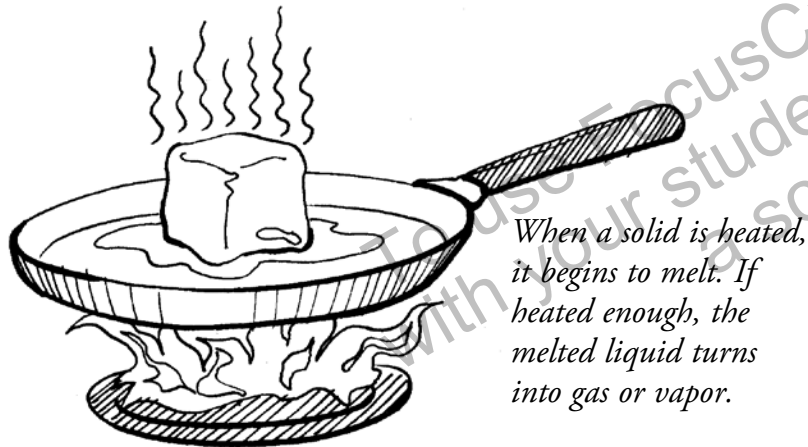
**Gas**—Matter that is gas does not have a certain shape, either. It expands to fill whatever space it is in. Oxygen and carbon dioxide found in air are a gases.

Matter can change from one state to another. Applying heat can cause a solid to become a liquid. Applying even more heat can cause a liquid to become a gas. This is how the states of matter are changed.

– Describe –  
How are liquids different from gases?

Water clearly demonstrates the three states of matter. When water is a liquid, you can drink it, wash with it, or swim in it. If you fill cups of different sizes with liquid water, you will see that it takes the shape of each cup.

When water is a solid, we call it ice. If you put ice cubes into a cup, you will see that they do not change shape. When water is a gas, it is called water vapor. If you boil water, some of the water will **evaporate**. The vapor will fill the kitchen and expand to the hallway when you open the door.

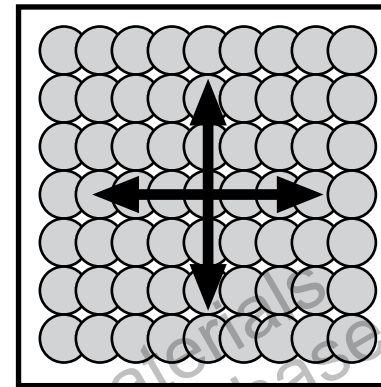


*When a solid is heated, it begins to melt. If heated enough, the melted liquid turns into gas or vapor.*

*– Hypothesize –*

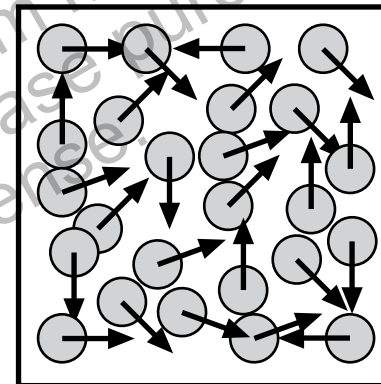
*How could you turn the vapor back into liquid water?*

**evaporate:** change from a solid or liquid into a gas, or vapor



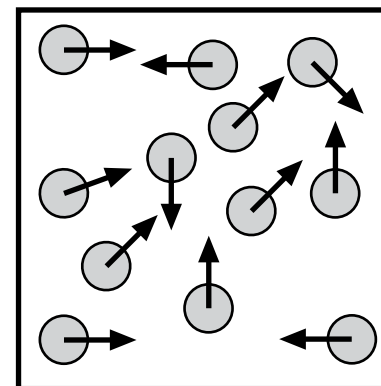
## Solids

*Solids have packed particles. They cannot move around very much.*



## Liquids

*The particles in liquids are able to move around more.*



## Gases

*In gases, particles are farthest apart. They can move in all directions.*



## Physical Properties

When water goes from one state to another, it changes size and shape, but its substance is still the same. For example, you can easily change ice back into liquid water. This is called a **physical change**, which means the object has changed, but not permanently.

In some physical changes, the properties of the object change. A **physical property** is a quality that you can detect with your five senses. When you look at an ice cube, you could describe it as solid, hard, and box-like. You could describe water as liquid, flowing, and shapeless. State, texture, and shape are all physical properties.

Physical properties also allow us to compare and contrast different substances. For example, what do a carrot and an onion have in common? They are both hard and solid. What is unique about each one? A carrot is long, orange, and sweet. An onion is round, white, and bitter.

**physical change:** a change in the properties of matter without becoming a new substance

**physical property:** a quality that you can detect with your five senses

## Shape

Physical properties of matter can be observed and measured. When you look at an object, what do you see? One thing you will notice is the shape.

Shape can tell us a lot about the purpose of the object. For example, a ball is round so that it can roll easily. A glass is cylindrical so that it can hold a drink.

Sometimes solid matter can change shape without becoming a liquid or gas. Clay is a solid form of matter. If you mold it into a ball, it is round. If you press down and flatten the clay like a pancake, it is round but flat. If you roll it into a rope, it is long and thin. The matter is still the same—it is clay. But the shape of the matter has changed.

– Recall –

*What are the five senses we use to determine the physical properties of something?*

---

## Size

Size is another way to describe matter. You can observe the object and describe how it looks.

*Gigantic, big, small, and tiny* are all words that describe size.

Sometimes we compare two objects using the size of common objects. For example, if your friend says, “That snowman is as big as a car,” you might picture a big snowman.

Measuring objects using tools can more accurately describe their size. For example, you could use a meter stick to accurately determine the snowman’s height.

## Color

Matter can be brightly colored, dull, or colorless.

We use color to describe matter every day.

Imagine two football teams are playing a game. An easy way to tell them apart is by the color of their uniforms.

All states of matter can be described by color. Some glue is white, tomato juice is red, and water is clear or colorless unless you add something to it. Have you seen exhaust from the tailpipe of a car? Exhaust is a gas, and it might look gray.

---

## Texture

Have you ever played a game where you have to guess what an object is just by feeling it? If so, you were using your sense of touch to give you clues.

Texture is the way something feels. *Rough, smooth, soft, and bumpy* are all words that describe texture.

## Mass

Everything that is matter has mass. Objects with a lot of mass are heavy, while objects with very little mass are light. Lemonade has mass and pizza has mass. A rock may have more mass than an empty plastic bottle, even though it may be smaller in size. A good way to measure the mass of an object is by weighing it on a scale.

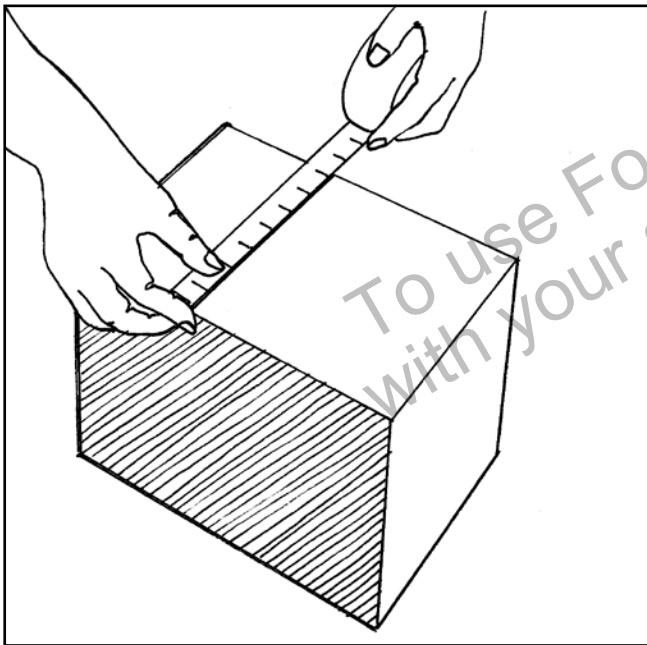
You can measure the mass of liquid matter, too. Weigh an empty glass. Then fill it with lemonade and weigh the glass again. Subtract the weight of the empty glass and you will have the weight of the lemonade.

– Extend–

*Can you think of any other physical properties used to describe matter?*

## Volume

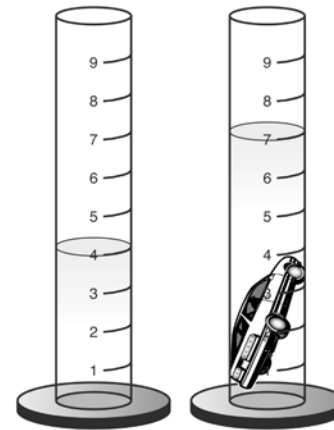
Volume is the amount of space that matter takes up. You can measure volume in a few different ways. A ruler or a tape measure will give you the volume of a solid. Perhaps you want to know how much a box can hold. Find the length, width, and height of the box. Then multiply these numbers to get the volume. For example, if the box is 2 meters long, 1 meter wide, and 1 meter high, then the volume is  $2\text{m} \times 1\text{m} \times 1\text{m} = 2$  cubic meters.



**volume:** the amount of space that matter takes up

Liquid matter is measured using fluid ounces (fl oz) or gallons (gal) in the U.S. customary system and milliliters (mL) or liters (l) in the metric system. A graduated cylinder has markings that will tell you the volume of a liquid. It can also give you the volume of a solid that has an unusual shape, such as a toy car.

Fill the graduated cylinder halfway with water. Record the height of the water. When you add the toy car to the water, the water goes up. Record this new height. Subtract the first height from the second height, and the result is the volume of the toy car.



*The volume of the toy car is  
 $7\text{ mL} - 4\text{ mL} = 3\text{ mL}$ .*

*– Apply –  
Which has a greater volume, a toy car or a real car?*

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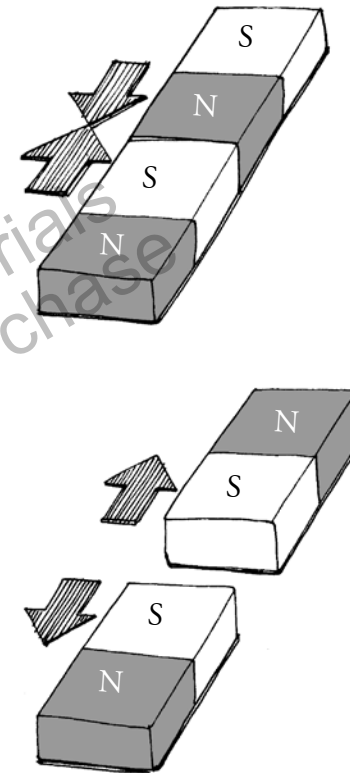
## Magnetism

Some substances have a physical property called magnetism. If a substance is magnetic, it will attract metals such as iron. People use these substances to make magnets.

To determine whether a substance is magnetic, move a magnet close to it. If you feel the magnet being pulled towards the substance, then it is magnetic. The magnet might even stick to the substance if the attraction is strong enough.

Magnets have north and south poles. Similar magnetic poles **repel** each other, while unlike poles attract. To attract magnets to each other, place opposite ends near each other. To repel magnets away from each other, place similar ends near each other.

**magnetism:** the ability of metals to attract metals such as iron  
**repel:** drive or push away



*The south poles are marked with an “S”. The north poles are marked with a “N”. What would happen if you placed the north poles near each other?*

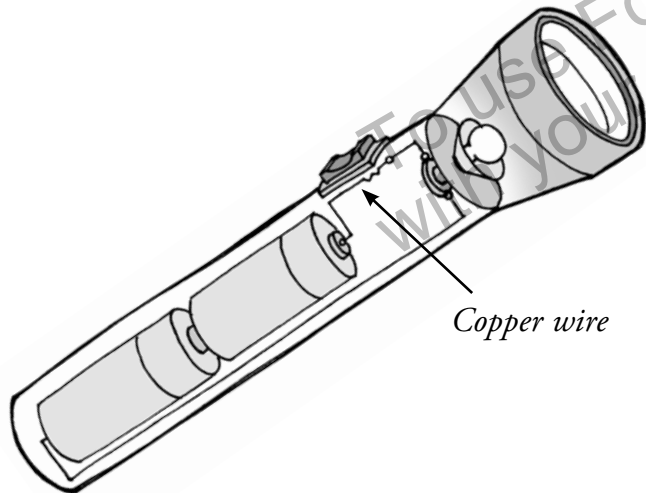
– Experiment –

*Test whether different objects around your home are attracted to a magnet. Record your findings in a chart.*

# Conductivity

**Conductivity** is the ability to transfer electricity, heat, or sound. Some materials have high conductivity while others have low conductivity.

Electrical conductivity is the ability to transfer a **current**. Most materials that have high conductivity are metals such as copper, silver, and gold. Silver is the best **conductor** of electricity, but copper is almost as good and it costs less. The wires inside electric appliances are usually made of copper.

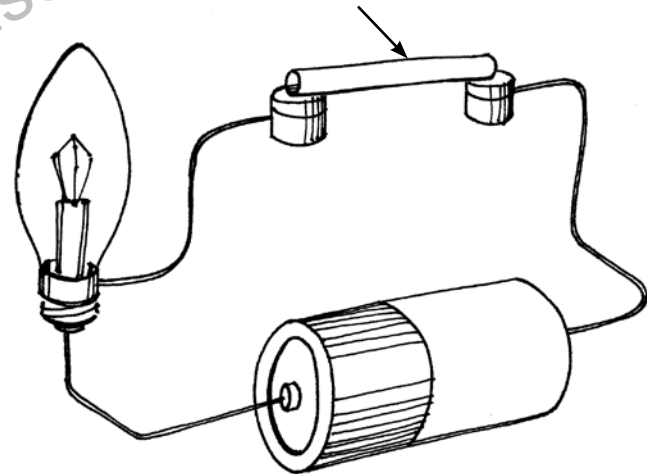


**conductivity:** the ability to transfer electricity, heat or sound  
**current:** a flow of electricity that goes in one direction  
**conductor:** a material that transfers heat or electricity

## Testing for Conductivity

Let's test the electrical conductivity of an object. Look at the diagram below. First, we connect a wire from the battery to an object, say a paper straw. Then, we connect another wire from the straw to the light bulb. We connect a third wire from the light bulb to the other end of the battery. If the bulb lights up, the straw is a conductor.

*This paper straw is being tested as a conductor.*



– Hypothesize –

*Is a paper straw a good conductor of electricity?*

---

Heat can also be conducted or transferred. Think about cooking. If you are preparing soup using a stove, you do not want to touch the pot with your bare hands. Cooking pots are often made of aluminum, copper, or iron.

A cooking pot is a conductor, which is a material that transfers heat. This is necessary in order for the soup to cook. But you can stir the soup with a wooden spoon and not get burned. This is because wood has low **thermal conductivity**, which means the heat moves slowly through the material.

**thermal conductivity:** the ability to transfer heat

---

## Insulation

A material that keeps heat from transferring is an **insulator**. It has very low thermal conductivity. Air and feathers are two examples of matter that are insulators. If you wear a feather-filled coat during winter, it will keep you warm. The feathers keep your body heat from escaping.

Material	Thermal Conductivity in Watts per Meter per Degree K (W/mK)
Air	0.024
Cork	0.043
Wood	0.17
Brick	0.69
Glass	1.05
Ice	2.18
Steel	46.0
Aluminum	250.0
Copper	401.0
Silver	429.0

The lower the thermal conductivity number, the better the insulator. Higher numbers indicate good conductors.

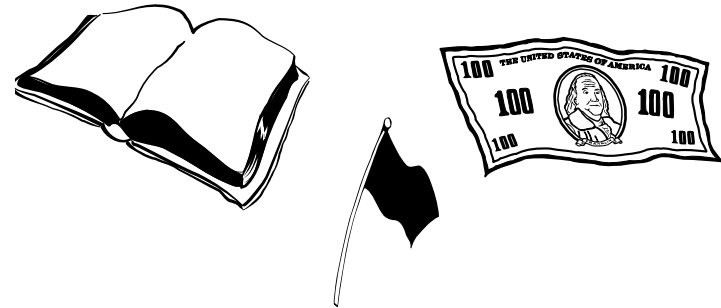
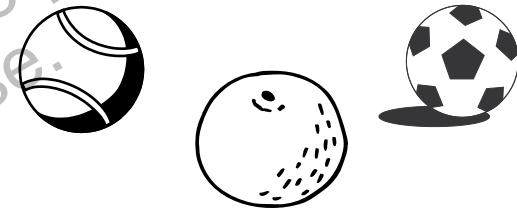
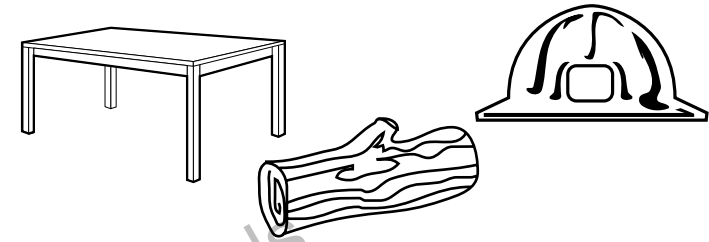
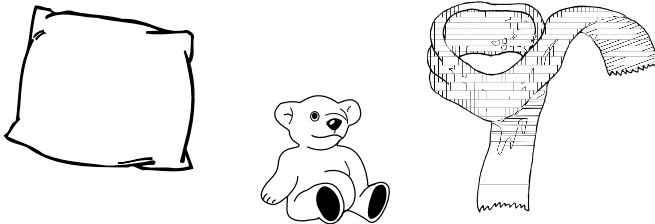
**insulator:** a material that keeps heat or electricity from transferring

# Categorize

Physical properties allow us to categorize matter. To categorize is to group items together because they share a physical property. For example, if you were to categorize by color, you could put a green shirt, a green leaf, a green frog, and a green car in the same group. Even though these things are different from each other in many ways, they are all the same color.

If you were to categorize by size, you could put a paper clip, a quarter, a stamp, and a grape in the same group. What are some other ways you might categorize matter?

*What physical property do the items in each group share?*



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## Glossary

**conductivity**—the ability to transfer electricity, heat, or sound

**current**—a flow of electricity that goes in one direction

**evaporate**—change from a solid or liquid into a gas, or vapor

**insulator**—a material that keeps heat or electricity from transferring

**magnetism**—the ability to attract metals such as iron

**mass**—the amount of material in an object

**physical change**—a change in the properties of matter without becoming a new substance

**physical property**—a quality that you can detect with your five senses

**repel**—drive or push away

**thermal conductivity**—the ability to transfer heat

**volume**—the amount of space that matter takes up

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## To Find Out More . . .

Want to learn more about matter?

### Try these books

*States of Matter* by Robert Snedden. Reed Educational and Professional Publishing, 2001.

*Solids, Liquids, and Gases* by Carol Ballard. Heinemann, 2004.

### Access these Web sites

Chem4Kids  
<http://www.chem4kids.com>

BrainPOP  
<http://www.brainpop.com/science/matter/>

### Write for more information

Odyssey Magazine: Adventures in Science  
Cobblestone Publishing Company  
30 Grove Street, Suite C  
Peterborough, NH 03458



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Published by FOCUScurriculum

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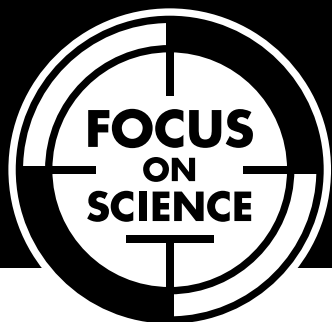
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# Assessments

*All About Matter*

Print pages 20–22 of this PDF for the assessments.

# Check Understanding

Shade the circle next to the correct answer.

- Which statement best compares liquid matter and solid matter?
  - Liquid matter has more mass than solid matter.
  - Liquid matter can become a solid by applying heat.
  - Liquid matter does not have a certain shape, while solid matter does.
  - Liquid matter and solid matter both flow to take the shape of their container.
- Your friend has a marble collection. She places the marbles on the floor near some nails containing iron. One of the marbles rolls to the nails. Which statement is a correct conclusion about this marble alone?
  - The marble is rough.
  - The marble is round.
  - The marble is an insulator.
  - The marble is magnetic.

- The data table below shows the weight of a single pumpkin growing on a pumpkin plant over a three-month period. The weight of the pumpkin is in pounds. (lbs).

**Weight of Pumpkin**

Month	Weight
June	5 lbs
July	17 lbs
August	29 lbs

If the patterns shown continues, the weight of the pumpkin in September will be

- 32 lbs
- 37 lbs
- 41 lbs
- 46 lbs

# Check Understanding

**Write your answer on the lines provided.**

To categorize is to group items together because they share a physical property. Look at the thermal conductivity chart below. One way to categorize these materials is by thermal conductivity. Air, cork, wood, brick, glass, and ice have low thermal conductivity. Steel, aluminum, copper, and silver have high thermal conductivity.

Material	Thermal Conductivity in Watts per Meter per Degree K (W/mK)
Air	0.024
Cork	0.043
Wood	0.17
Brick	0.69
Glass	1.05
Ice	2.18
Steel	46.0
Aluminum	250.0
Copper	401.0
Silver	429.0

- Identify a different physical property you could use to categorize the materials in the chart.

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Categorize these materials using the physical property you chose.

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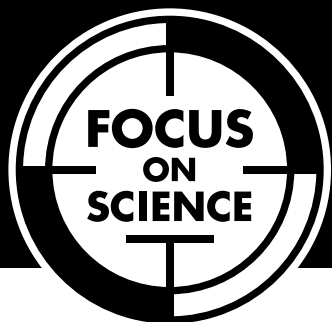


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# Assessment Scoring Guidelines

1. Answer C is correct.
2. Answer B is correct.
3. Answer C is correct.
4. Student's should categorize the items by identifying a physical property, such as state, and then grouping the materials according to this physical property.

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# English Language Arts Activities

*All About Matter*

Print pages 24–28 of this PDF for the reading activities.

# Summarize

## TRY THE SKILL

When you summarize, you tell the major points to help you remember what you read. It is like writing a very short version of the book.

**Look at the table of contents below. Use this table of contents to write a summary of *All About Matter*. Look at the title of the introduction and the title of each chapter. Then, write a few sentences to explain the major points of each chapter.**

<b>Introduction:</b>	
What Is Matter?	4
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<b>Chapter 2:</b>	
Physical Properties	8
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# Make Connections

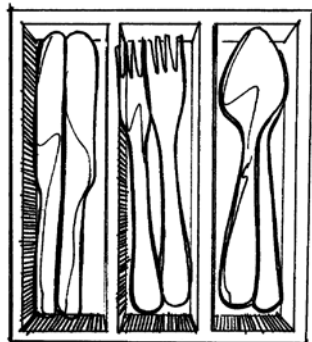
## TRY THE SKILL

Sometimes you can compare one text with another text. A text could be a piece of writing, a film, a picture, another object, or even an experience.

**Below are two texts. What connections do you see between them? Read the passage from *All About Matter* and study the picture. Then answer the questions.**

Physical properties allow us to categorize matter. To categorize is to group items together because they share a physical property. For example, if you were to categorize by color, you could put a green shirt, a green leaf, a green frog, and a green car in the same group. Even though these things are different from each other in many ways, they are all the same color.

If you were to categorize by size, you could put a paperclip, a quarter, a stamp, and a grape in the same group. What are some other ways to categorize matter?



1. How are the objects in this picture categorized?

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2. What other physical properties do these objects have in common?

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3. Write a few sentences explaining how you categorize other objects at home.

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# Fact and Opinion

## TRY THE SKILL

A statement of fact expresses only what can be proven. For example:

*Most materials that have high conductivity are metals such as copper, silver, and gold.*

A statement of opinion is based on a belief or view of something. For example:

*Silver is the most beautiful metal.*

Sometimes writers mix fact and opinion. So it is important to ask questions when you read. Ask yourself, "Is this always true or is this what someone thinks?" If the answer is yes, then it is a fact.

---

**Read the following sentences. Shade the circle next to the sentence that is an opinion.**

1.  A Matter can be brightly colored, dull, or not visible at all.  
 B Yellow is a lovely color for a raincoat.  
 C All states of matter can have color.

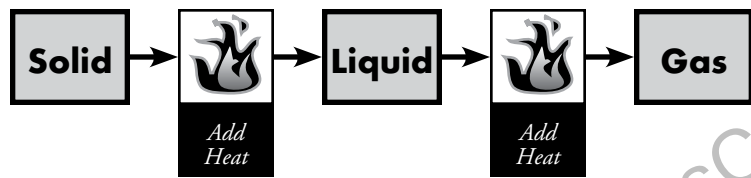
2.  A When water is a liquid, you can drink it, wash with it, or swim in it.  
 B If water is heated enough, it turns into steam.  
 C When water is cold, swimming is no fun.
3.  A If a substance is magnetic it will attract metals such as iron.  
 B Matter is more interesting if it is magnetic.  
 C Similar magnetic poles repel each other, while unlike poles attract.
4.  A It is better to have heat in winter than a fan in summer.  
 B A material that keeps heat from transferring is an insulator.  
 C Electricity can be transformed into heat.
5.  A Texture is the most important physical property.  
 B Texture is the way something feels.  
 C Rough, smooth, soft, and bumpy are all words that describe texture.

# Analyze Graphic Information

## TRY THE SKILL

Charts, graphs, and diagrams are like pictures that give information. The diagram below shows what happens when heat is added to a substance. You can see that the form of the substance changes.

Look at the chart below and the questions and answers.



1. **What happens when heat is added to a solid?**  
It becomes a liquid or a gas.
2. **What happens when heat is added to a liquid?**  
It becomes a gas.
3. **Which of these would be the hottest—solid, liquid, or gas?**  
A gas would be the hottest.
4. **What do you think would happen if you removed heat energy from a liquid?**  
It would become a solid.

Look at the chart below and then answer the questions. Use complete sentences.

### Boiling Points of Different Substances

Water	212° F
Iron	4,982° F
Oxygen	-297.4° F

1. Put the boiling points in the chart from the lowest to the highest.  
\_\_\_\_\_  
\_\_\_\_\_
2. Which substance has the highest boiling point?  
\_\_\_\_\_
3. Which substance has a boiling point that is below 0° F?  
\_\_\_\_\_
4. Which substance needs the most energy to reach its boiling point?  
\_\_\_\_\_

# Answer Key

## Summarize

Students' answers will vary. A sample answer is given below.

Matter is anything that has mass and takes up space. There are three states of matter: solid, liquid, and gas. Matter can change from one state to another. Physical properties are anything that you can detect with your five senses. Shape, size, color, texture, mass, volume, magnetism, and conductivity are physical properties. If a substance is magnetic, it attracts metals such as iron. If a substance has high conductivity, it transfers heat or electricity. It is possible to categorize matter based on physical properties.

## Make Connections

Students' answers will vary. Sample answers are given below.

1. The objects are organized by shape and/or purpose.
2. They are all the same color and made of the same material, so they have the same thermal conductivity. They are the same size. They have the same texture.
3. I categorize my clothes. My socks go in one drawer. My pants go in another drawer, and my shirts go in a third drawer.

## Fact and Opinion

1. B
2. C
3. B
4. A
5. A

## Analyze Graphic Information

1. The boiling points in order are oxygen, water, and iron.
2. Iron has the highest boiling point.
3. Oxygen's boiling point is below zero.
4. Iron needs the most heat to reach its boiling point.