Classifying Matter

Reflect

What do ice cream, root beer, and carbon dioxide gas have in common? Not only do these ingredients combine to make a good treat on a hot, summer day, but they are also made of matter.

Matter can be found in many different shapes, sizes, and forms. For example, the ice cream, the root beer, and the gas that makes the root beer fizz are all types of matter. Even your body is made of matter. What other things in your life contain matter?

substance: matter that is made up of the same particles throughout

What is matter?

Simply put, *matter* is the stuff that every physical thing is made of. Matter can be described and classified by its properties. A *property* is a characteristic or feature of a **substance** or an object. Matter has physical properties and chemical properties. You will learn about chemical properties later in your study of science. For now, we will focus on the physical properties of matter.

What Do You Think?

Take a look at the following things. Describe the properties of each. What does the thing look like? How do you think it would feel in your hands? What do you think would happen if you put it in a container of water?

What Do You Think?

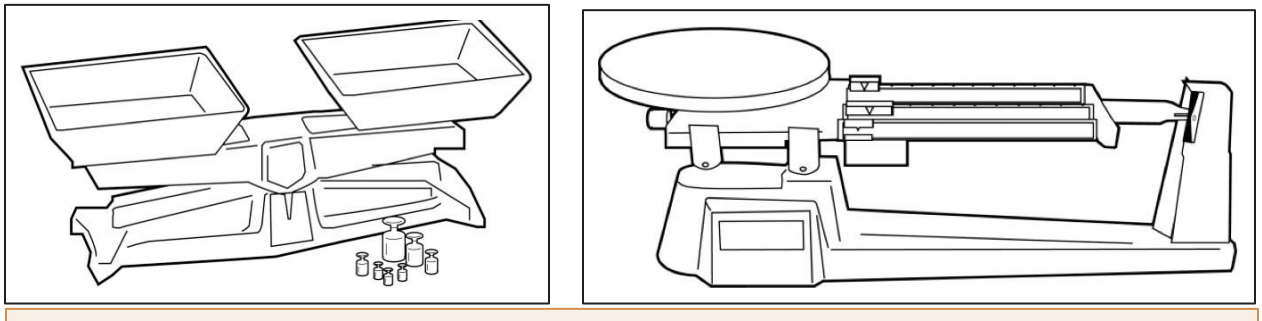
How is matter classified? What tools or tests can you use to measure or observe matter?

Physical properties can be observed and measured. Some physical properties of matter—such as size, color, and shape—can be observed using your senses. Measurements made using science tools can be used to describe other physical properties of matter. Let's take a closer look at some of the most commonly observed properties of matter.

Physical State: Remember the root beer float discussed at the beginning of this passage? It is an example of all three physical states of matter: solid, liquid, and gas. The ice cream is the solid, and the root beer is the liquid. The substance that makes the root beer fizz is a gas called carbon dioxide.

A solid has its own shape, so it takes up a set amount of space. A book, a table, and a pencil are all examples of solids. A liquid also takes up a set amount of space, but it does not have its own shape. It will take the shape of whatever container it is in. At room temperature, milk, orange juice, and water are all liquids. A gas has no definite shape. It will fill up any available space. Air and helium are examples of gases.

Mass: Mass is a measure of how much matter an object or a substance is made of. In a science lab, mass is measured in milligrams (mg), grams (g), or kilograms (kg). The mass of an object can be measured using a pan balance or a triple-beam balance.



A pan balance (left) compares the masses of different objects. The pan holding the more massive object sinks, while the pan holding the less massive object rises. A triple-beam balance (right) is used to measure the mass of an object. It typically provides more precise measurements than a pan balance.

Look Out!

Do not confuse mass and weight. Mass is the amount of matter in an object. It is usually measured in grams and kilograms. Weight is the measurement of the force of **gravity** pulling on an object. Scientists measure weight in units called newtons. In everyday life, people sometimes measure weight in pounds and ounces.

gravity: the force that pulls objects toward the center of Earth

How does matter behave when placed in water? What if it is stirred into water? How does matter react to a magnet?

Other properties of matter describe how substances behave in the presence of other substances. For example, what happens when objects are exposed to water or magnets? What happens when objects are exposed to energy?

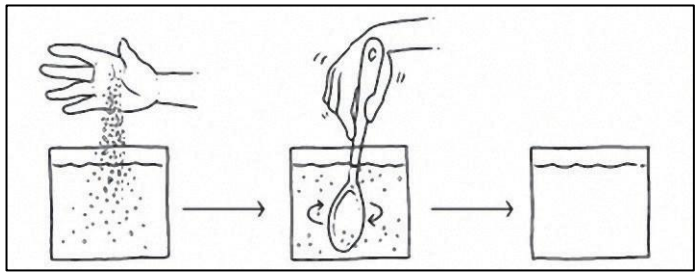
Magnetism: Magnetism is a physical property of some metals, such as iron. A magnet may attract, or pull, objects made of those metals toward it and may even pick up some of them. Not all metals are magnetic. Aluminum, copper, tin, and gold are not attracted to magnets. Nonmetals—such as plastic, wood, and paper—are also not attracted to magnets.

Relative Density: Whether something sinks or floats compared to something else is called relative density. Water is often used as a reference point. In the picture to the left, the plastic duck has less density than the iron nail. That is why the duck is floating and the nail has sunk to the bottom. What else is more dense than the duck?

The Ability to Conduct or Insulate Thermal Energy or Electric Energy: Materials that allow energy to pass through them easily are called conductors. Many metals—including copper, iron, and aluminum—are good conductors of both thermal and electrical energy. Pots and pans are usually made of metal because they conduct thermal energy well. Wires used in circuits are generally made of copper because it is a good conductor of electric energy. Insulators are materials that slow or stop the flow of energy. Wood, plastic, and fabric are good insulators of both thermal and electric energy.

Look Out!

Solubility in Water: Solubility is the ability of a solid to dissolve in a liquid. To dissolve means to spread out evenly in the liquid. Because sugar and salt both dissolve in water, they are classified as water soluble. Many solids, such as sand and iron filings, are not water soluble.



Try Now

Take a few minutes to examine the physical properties of everyday objects.

1. To complete this activity, you will need the following materials:
   - A triple-beam balance
   - A bar magnet
   - A beaker filled halfway with water
   - Several small objects such as an iron nail, a marble, a wooden block, and a piece of aluminum foil. (Each object should fit completely in the beaker.)
2. Record the physical state of each object.
3. Predict which object has the greatest mass and which object has the least mass. Then, use the triple-beam balance to measure the mass of each object. (If one of your objects is round, you may need to place it in an empty beaker so that it will stay on the balance. To determine the mass of the round object, subtract the mass of the empty beaker from the combined mass of the beaker and the round object.)
4. Predict whether each object is magnetic. Then, place the magnet next to each object, and record what happens.
5. Predict whether each object is more dense than the water in the beaker. Then, place each object in the water, and record what happens.

What Do You Think?

Career Corner: What Is Materials Engineering?
A materials engineer works with metals, ceramics, plastics, and other substances to create new materials and new ways to use them based on their physical properties. Here are some new and exciting products developed by materials engineers: clothing that repels mosquitoes; plastics that help repair shattered bones; and stretchable clothing material that returns to its original shape. Materials engineers must have a degree in materials science, engineering, or a related field.

Scientists in the Spotlight: Electronic Skin
John Rogers, a materials scientist at the University of Illinois at Urbana-Champaign, mixed his knowledge of electronics and of the human body to create a small sticker that can track a person's vital signs: heart rate, breathing rate, and temperature. Rogers and his colleagues have built an electronic device that sticks to a person's skin like a temporary tattoo. When placed on a person's forehead or wrist, the sticker (which is smaller than a postage stamp) can track vital signs. It can also record brain waves, blood flow, and muscle movement.

What Do You Think?

What do you know?

Matter has many physical properties that can be observed and used for classification. Look at the table below. Match each property with its definition. Then, write an example of each property in the third column. Write your answers in complete sentences.

Physical Properties of Matter		
• conductor of energy	• magnetism	• mass
• physical state	• relative density	• solubility

Property	What It Means	Example
	the amount of matter in a substance or an object	
	a force that pulls magnetic objects	
	a form that matter can take: solid, liquid, or gas	
	whether something sinks or floats in a liquid, such as water	
	ability of a solid to dissolve in a liquid, such as water	
	allows electricity or heat to flow through it	

Connecting With Your Child

Reviewing Physical Properties at Home

By fifth grade, children will have learned about many physical properties of matter: size, mass, shape, color, texture, flexibility, physical state, magnetism, relative density, volume, temperature, solubility, and conductivity. They should be able to define and give examples of each of these terms. They should also be able to explain how to observe and measure each property. Given the appropriate tools—for example, a balance to measure mass, a ruler to measure length, a graduated cylinder to measure volume, and a thermometer to measure temperature—they should be able to measure each property.

Take your child on a tour of a specific location such as a park or a playground. You may also explore a room of your home. As students explore, he or she should identify each object he or she sees and describe that object using as many physical properties as he or she can. If possible, bring a magnet, a balance, and other tools so that your child can include specific measurements as part of the descriptions. Monitor him or her closely to make sure he or she explores safely and does not touch anything that might cause injury. If your child is unable to measure a property directly, he or she should predict the value of that measurement. Try to confirm each prediction later.

Encourage your child to create flash cards of each object and property measured. He or she can use these flash cards as study aids.

Here are some questions to discuss with your child:

- Which of these objects has more mass? Which of these objects has less mass?
- Which properties of matter can you observe using only your senses? Which properties do you need tools to measure?
- Do you think this object is a conductor or an insulator? How could you test this?
- What is this object's relative density compared to water? Why do you think this?