CONCEPT 1

Matter can be described by its physical properties.

Activity

Observing Properties

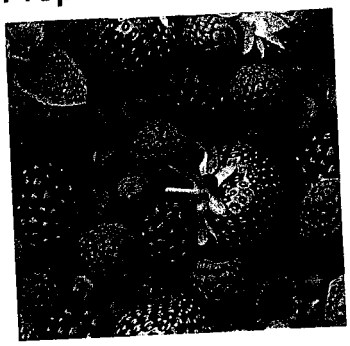
Choose an object in the classroom. Write down as many of its properties as you can. Then trade your description with a partner and see if you can identify the object. Afterwards, reflect on which properties helped to make the object more or less difficult to identify.

All matter has different characteristics that can be used to describe it. A **physical property** of matter is a characteristic that can be observed or measured without changing its chemical identity (the type of matter that it is).

physical property
characteristic of matter that can be observed or measured without changing its chemical identity

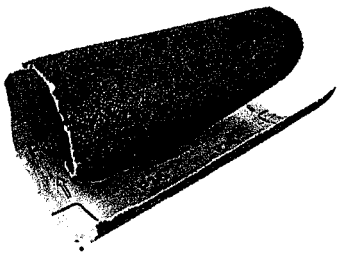
Physical Properties

Qualitative Physical Properties

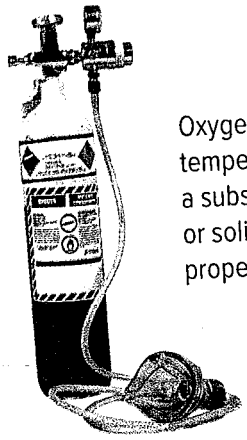


These berries, all B.C. crops, each have distinct colours, flavours, and odours due to a variety of substances in each fruit.

Texture is a physical property that describes how the surface of a substance feels. This sandpaper has a rough texture.



This gold ring was made by Haisla artist Barry Wilson. Gold is popular for jewellery because it is lustrous (shiny) and malleable (easy to shape). Diamond is prized for its sparkle and hardness.



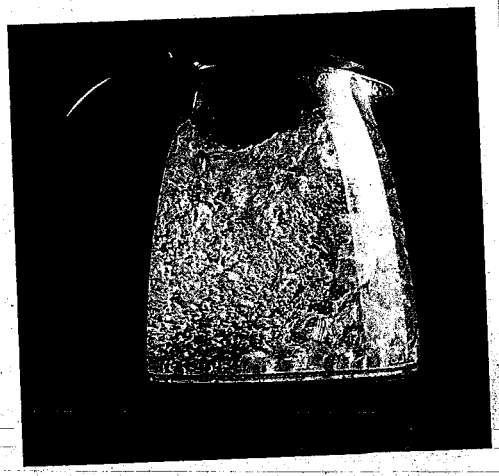
Oxygen is a gas at room temperature. The state of a substance—gas, liquid, or solid—is a physical property.

Figure 2.5 shows examples of physical properties of matter. *Qualitative physical properties* can be described and compared using words, such as "red," "sweet-smelling," or "shiny." You do not need to use an instrument to make measurements when observing qualitative physical properties. However, many physical properties have numerical values associated with them. Those properties that can be measured and assigned a value are called *quantitative physical properties*.

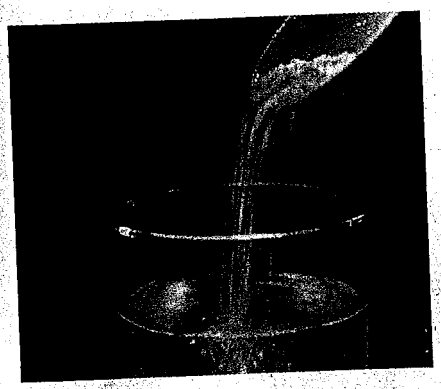
Figure 2.5 Matter can have a variety of physical properties.

Quantitative Physical Properties

The temperature at which a substance melts is called the melting point. The melting point of most chocolates is between 30°C and 32°C, which is less than normal human body temperature.



The boiling point is the temperature at which a liquid becomes a gas. The boiling point of water is 100°C.



Solubility is the amount of matter that dissolves in another kind of matter. The solubility of table salt in water is 0.4 g of salt in 1 mL of water.

Tlingit Haida master carver Nathan Jackson uses the difference in hardness between wood and steel in his work. Various hardness scales are used to associate a number with the hardness of a material.

Viscosity describes the rate at which a material flows. Molasses has a high viscosity, which means it flows very slowly. Depending on the type, molasses is 5000 to 10 000 times as viscous as water.

Mass and Volume

mass quantity of matter in an object or sample

All matter has two things in common: mass and volume. **Mass** is the quantity of matter in a sample that is being measured. A balance is used to measure mass, and there are a variety of different types. **Figure 2.6** shows two electronic digital balances in use. Some common units for measuring mass are the kilogram (kg), gram (g), and milligram (mg).

volume amount of space a substance takes up

Volume is the amount of space that a material takes up. Most often, the volume of a solid is measured in cubic units, such as cubic metres (m^3) or cubic centimetres (cm^3). The volume of a gas or liquid is measured in litres (L). Small volumes are often recorded as millilitres (mL). The unit used to measure the volume of a solid is related to the unit of volume used to measure liquids and gases. One cubic centimetre is the same volume as one millilitre ($1\ cm^3 = 1\ mL$).

Density—A Physical Property Related to Mass and Volume

Suppose you have two identical shopping bags. One is filled with loaves of bread and hotdog buns, and the other is filled with containers of juice and milk. Which would be easier to lift? Even though both bags are the same size, the second bag would be much heavier because it contains more mass in the same volume. This example describes a quantitative physical property called density.

density quantity of mass in a certain volume of material

Density is the mass of a material that occupies a certain volume. Common units of density are grams per cubic centimetre (g/cm^3) for solids and grams per millilitre (g/mL) for liquids and gases. **Figure 2.6** compares two items with different densities.

Figure 2.6 The grape and foam have the same mass but different volumes. Which substance has the greater density? Explain why.

Determining Density

You do not usually measure density directly. Instead, you measure the mass and volume of a sample and then calculate density using this equation:

Density Equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

For example, jet fuel is tested to ensure it meets certain standards. One standard is density. If a sample of jet fuel has a mass of 8.30 g and a volume of 10.3 mL, what is its density?

$\text{mass} = 8.30\ \text{g}$

$\text{volume} = 10.3\ \text{mL}$

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{8.30\ \text{g}}{10.3\ \text{mL}}$$

$$= 0.806\ \text{g/mL}$$

The density of water is about 1 g/mL. Therefore, the density of the jet fuel is less than the density of water. Jet fuel and water do not mix, so when jet fuel is added to water, it forms a layer that floats on top of the water. **Figure 2.7** shows how liquids with different densities can form layers in a container.

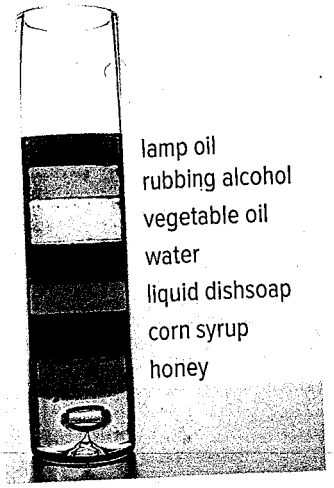


Figure 2.7 These liquids have different densities. (Dyes were added to the liquids to help you see the layers.) **List the liquids in the order of most dense to least dense.**

Activity

Finding Density

Your teacher will provide you and a partner with a set of cubes of different materials.

- Using a ruler, measure the volume of each cube. What units will you use?
- Measure the mass of each cube. What units will you use?
- Determine the density of each cube. Make sure to report it in the correct units.

Which material was the densest? Which material was the least dense?

Before you leave this page . . .

1. What is a physical property? Give three examples as part of your answer.
2. What is the difference between a qualitative property and a quantitative property?