

7.1 States of Matter

According to the kinetic molecular theory, all matter is made up of very small particles that are constantly moving. The more energy the particles have, the faster they can move and the farther apart they can get. Matter expands when its temperature is raised and contracts when its temperature is lowered. If enough energy is added to or removed from matter, the matter changes from one state to another.

Key Terms

condensation
evaporation
expansion
mass
melting
solidification
sublimation
volume

Oxygen, glass, and water are all examples of matter. Matter is anything that has mass and volume. Mass is the quantity of matter that a substance or object contains; the more matter, the greater the mass. For example, a bowling ball has more mass than a basketball (Figure 7.1). Mass is usually measured in grams (g) or kilograms (kg).

Volume is the amount of space taken up by a substance or object. For example, a basketball has a greater volume than a bowling ball. The volume of a liquid is usually measured in millilitres (mL), litres (L), or cubic centimetres (cm³).



Figure 7.1 A bowling ball has more mass but less volume than a basketball.

Did You Know?

In the past, there has been some question as to the physical state of glass. It has been argued that glass is a very stiff liquid. Glass is now known to be a type of solid called an amorphous solid.

Recall from earlier studies that there are three familiar states (phases) of matter:

- Solid is the state of matter that has a definite shape and volume (for example, a bowling ball).
- Liquid is the state of matter that has a definite volume, but its shape is determined by its surroundings (for example, water in a beaker).
- Gas is the state of matter that has its volume and shape determined by its surroundings (for example, helium in a balloon).

All solids, liquids, and gases are made of very small particles that have spaces in between them. In this activity, you will model evidence of the spaces.

Safety



- Ethanol is poisonous.
- Be careful to wipe up any spills.

Materials

- funnel
- water
- two 100 mL graduated cylinders
- 250 mL graduated cylinder
- 50 mL ethanol
- marbles
- 50 mL sand
- stirring rod

Science Skills

Go to Science Skill 8 for help in using models in science.

What to Do

1. Copy the following data table.

Trial	Volumes	Predicted Total Volume (mL)	Actual Total Volume (mL)
1	50 mL water 50 mL water		
2	50 mL water 50 mL ethanol		
3	50 mL marbles 50 mL sand		
4	Trial 3 plus 50 mL water		

Trial 1 Water and Water

2. Use a funnel to carefully measure 50 mL of water into each of the two 100 mL graduated cylinders.

3. Predict the total volume you will have when you combine these two volumes.
4. Add one of the volumes of water to the other. Stir with the stirring rod. Record the total volume.

Trial 2 Water and Ethanol

5. Carefully measure 50 mL of water into one 100 mL graduated cylinder and 50 mL of ethanol in the other cylinder.
6. Predict the total volume you will have when you combine these two volumes.
7. Add one of the volumes to the other. Stir with the stirring rod. Record the total volume.

Trial 3 Marbles and Sand

8. Add marbles to the 250 mL graduated cylinder until they reach the 50 mL mark.
9. Predict what the new volume will be when you add 50 mL of sand to the marbles.
10. Add 50 mL of sand. Record the new volume. Save the mixture for Trial 4.

Trial 4 Marbles, Sand, and Water

11. Predict what the new volume will be when you add 50 mL of water to the marbles and sand.
12. Add 50 mL of water. Record the new volume.
13. Clean up and put away the equipment you have used.

What Did You Find Out?

1. If the 50 mL of water and 50 mL of water did not add up to 100 mL, explain why.
2. If the 50 mL of water and 50 mL of ethanol did not add up to 100 mL, explain why.
3. If the 50 mL of marbles and 50 mL of sand did not add up to 100 mL, explain why.
4. If the 50 mL of marbles, 50 mL of sand, and 50 mL of water did not add up to 150 mL, explain why.
5. If you had added the substances in Trial 3 to the cylinder in reverse order, would the total volume be greater or less? Explain.