

# 7

# Matter and Materials



**What**

**you will learn**

**What's the matter**

**States of matter**

**Materials**

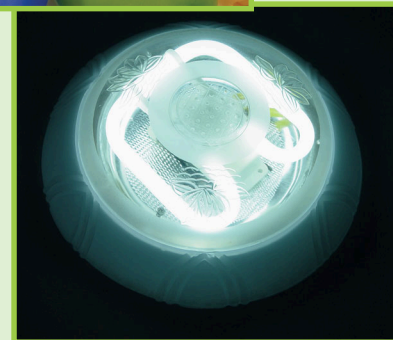
**Useful metals**

**Tiny matters**

# What's the matter?

Matter is anything which has mass and occupies space. Do you think it is possible for anything to have mass and yet not occupy space or vice versa?

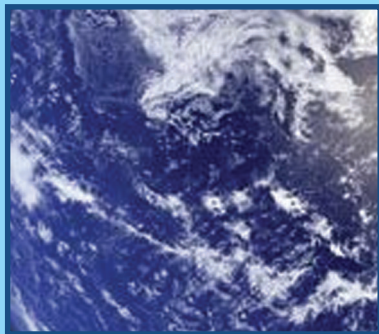
- Can you identify anything that is not matter in each of the photographs?



## Physical properties of matter

Objects or materials are recognised according to their properties.

Can you name these objects? What properties or property did you use to recognise these objects?



Its colour, shape, design and pattern are some of the ways that we recognise objects. These are called properties. Colour, shape and size are some common physical properties of matter which are clearly visible. Other physical properties include elasticity, strength, hardness, solubility, heat conductivity, electrical conductivity.

### Do you know?

*The biggest thunder clouds tower 16 kilometres into the air. That's nearly twice the height of Mount Everest.*

## Elasticity

The elasticity of a material is its ability to return to its original shape and size after being bent, stretched or compressed.

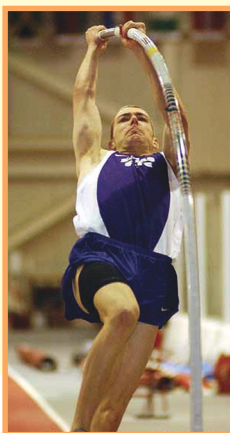
## Strength

The strength of a material is its ability to support a heavy load without breaking or tearing.



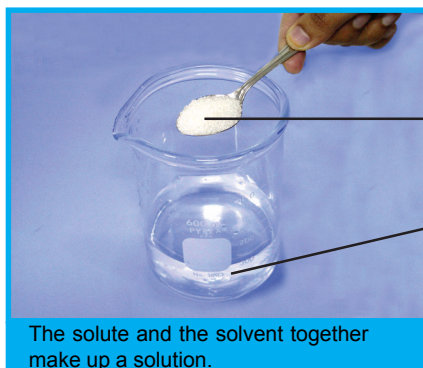
## Hardness

The hardness of a material is its ability to withstand scratches and wear. Diamond is extremely hard and can only be cut by other diamonds.



## Solubility

The solubility of a substance in a solvent (liquid) is the maximum quantity of that substances which can dissolve in a given quantity of the solvent.



The substance that dissolves is called the **solute**.

The substance that does the dissolving is called the **solvent**.



## Ideas

↪ Matter is anything that has mass and occupies space.

↪ Objects are recognised according to their properties.

↪ Colour, shape, size, elasticity, strength, hardness, solubility etc. are examples of properties.

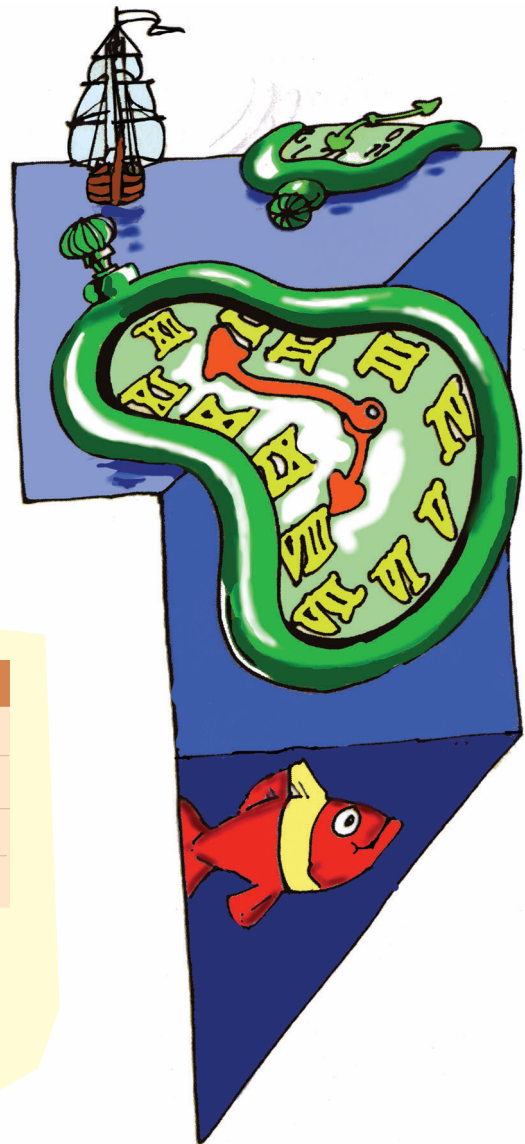
?

- 1 List some physical properties of objects around you.
- 2 What physical properties should you look for in materials used to make the following products?
  - a. furniture
  - b. airplane body

# States of matter

Matter can exist in three physical states: solid, liquid or gas. All substances can exist in the three states depending on the temperature and pressure.

Think about this picture. Why does it look so odd and dreamlike?



## Looking at solids

- 1 Collect some solid objects to look at.
- 2 Draw up a table like this. Make a column for each object.

Name of solid	1	2	3
What colour is it?			
Is it rough or smooth?			
Can you change its shape easily?			
Is it heavy or light?			

- 3 Look at your objects and fill in the table.
- 4 Some of your answers will be different for each object, others will be the same. Write down two things that all solid objects have in common.

## What do all solids have in comon?

One thing about solid objects is their sizes do not change. Another way of saying this is that a solid object always takes up the same amount of space.

This space is called its **volume**.

Another important thing about all solids is that you cannot change their shapes easily.

These two things are the same for all solids, and are called the **properties** of solids.

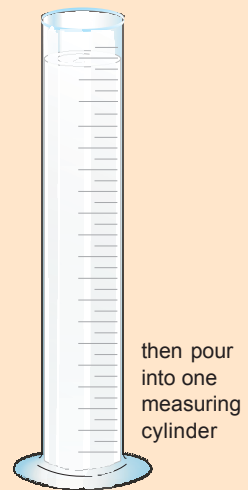
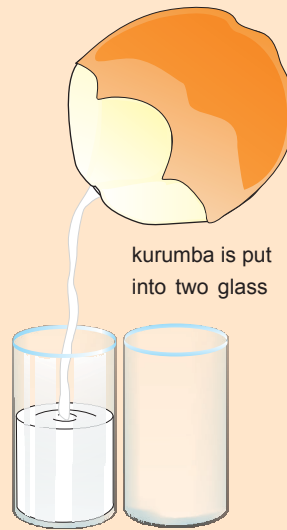
**Do** you Know?

More than 99.99% of the volume taken up by a gas is empty space.

## How do liquids behave?

Liquids are soft and runny and change shape easily. This is useful when you pour a kurumba out of its container and into a glass.

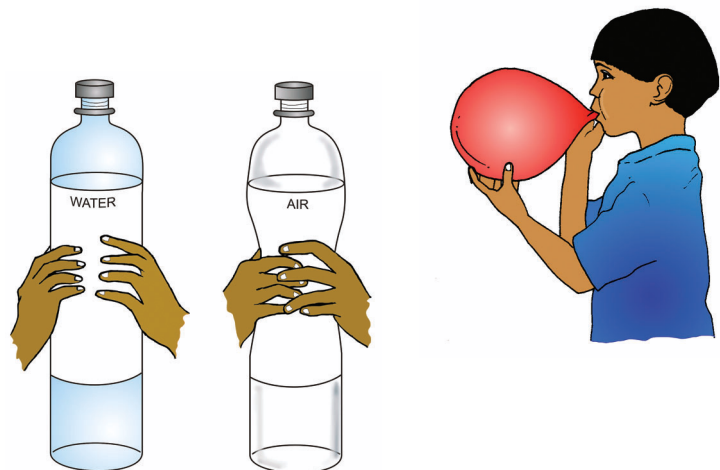
Liquids change their shape easily, but their volume always stays the same. Your half litre of kurumba will go into all sorts of different containers, but you will never get more or less than half litre of liquid.



## Gases change shape and volume

Gases change shape too. When you breathe in, your lungs get filled with air and take up the shape of lungs. When you breathe out, this 'lung-shaped' air is pushed out again. Sometimes it becomes balloon-shaped.

If you fill a plastic bottle full of air, you can squash it easily. but you cannot squash a bottle full of water. This is because the volume of a gas does not stay the same. It changes with the volume of the container the gas is in.



- 1 Fill in the blanks using the following words.

gas   solid   liquid   shape   fixed

Your bones are ----- . They are hard and have a ----- shape which supports your body. Your blood is a ----- . It changes its ----- as it flows through your veins. The air you breathe is a ----- .

- 2 A bottle of coke has solid, liquid and gas parts. Write sentences like the ones above to describe the three parts and their properties.



### Ideas

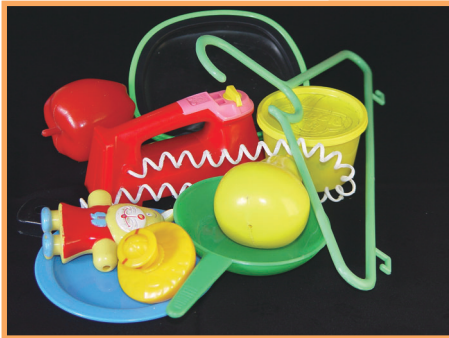
↳ Liquids have a fixed volume but no fixed shape

↳ Gases have no fixed shape and no fixed volume.

↳ These are called properties of solids, liquids and gases.

# Materials

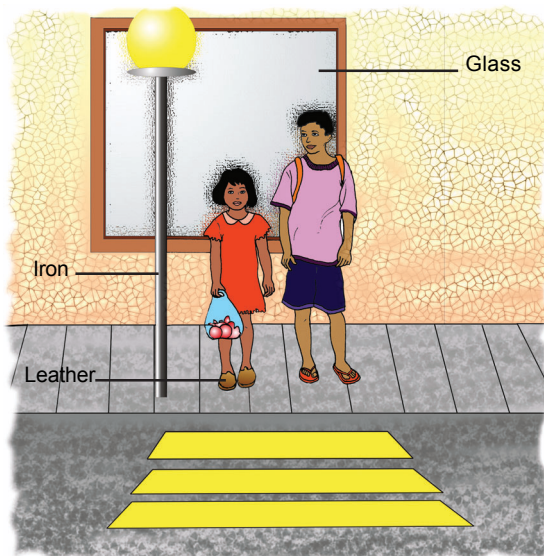
A material is a substance that is used for making objects. Some materials such as metals occur naturally while others such as plastics are human-made.



## ► Different materials for different jobs

Different objects are made from different sorts of materials. The properties of the material must be suitable for the object it is being used to make.

Look at the picture and say why you think these materials have been used for these objects.



### Do you Know?

The Egyptians were one of the first people to write with ink. They made it by mixing black soot with sticky tree sap.

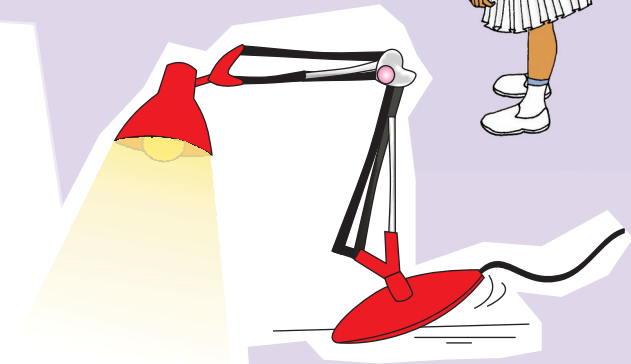
## Light or heavy?

You need to know about 'heaviness' when choosing the right material for the job. The frame of a school bag needs to be made of a **light** material. The less you have to carry, the better. The base of a reading lamp needs to be made of something **heavy** such as iron, to stop it toppling over.



## Weak or strong

Straw made of plastic is a weak material. It will break if you pull or push them. So it is not very suitable for building a house. Bricks, however, are strong enough and they won't break easily. Steel and concrete are strong materials used for building purposes.



## Hard or soft

A hard material will not scratch or dent easily. Diamond is extremely hard. It will scratch glass or metal easily. The 'lead' in your pencil is a soft material. It wears away as you write.



A tiny diamond at the tip is used to scratch the glass.



- 1 Fill in the blanks.  
Bricks and concrete are used for building because they are .....solids. Aluminium window frames are used these days because they are ..... Pencils use a solid called graphite which is so ----- that it rubs off on paper.
- 2 Which of the materials in brackets would you use to make the following , and why?
  - a. A ten story building (expanded polystyrene, brick, lead)
  - b. A ladder (lead, aluminium, rubber)
  - c. An anchor (steel, wood, glass)



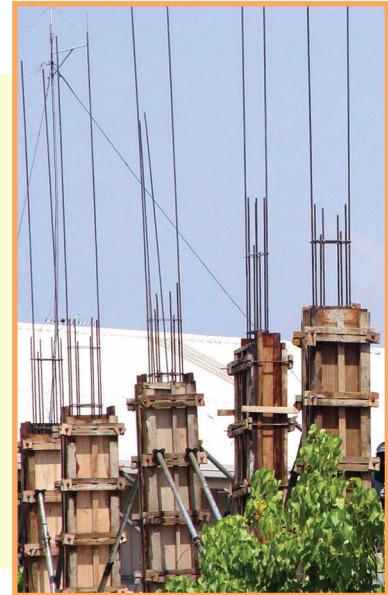
## Ideas

- Materials can have many different properties. They may be heavy or light, weak or strong, hard or soft.
- To choose a right material you have to match these properties against those needed for the job.

# Useful metals

Metals are used for variety of purposes. Metals are used for their strength. Iron and steel are used to support large buildings.

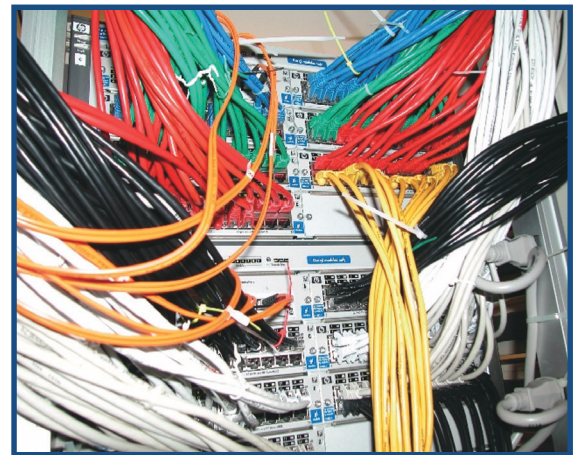
Sometimes metals are used for their hardness. Saw blades are made of steel. It will cut through wood.



## Metals conduct electricity

Metals allow electric current to flow through them. They **conduct electricity**. Copper is a good **conductor of electricity**.

You are also a conductor of electricity. If you touched a wire that had an electric current flowing through it, you would get a shock. To stop this happening, wires are coated with plastic. Plastic do not conduct electricity. They are insulators.

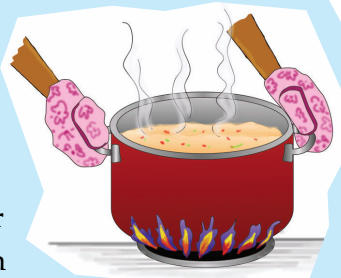


## Metals conduct heat

Metals also allow heat to flow through them. They conduct heat.

When you boil water in a kettle, the heat is conducted to the water from the flame through the metal. The metal is a **heat**

**conductor**. You need to hold the kettle using an insulator like cloth or you may burn your fingers. Most non metals are good **heat insulators**.



### Do you know?

One of the buildings at Disney World in Florida, USA looks like a giant golf ball. Its walls are made up of hundreds of metal triangles.

## Metals can be shaped

Metals are so useful that they are easy to mould into different shapes.



## Metals can corrode

When a metal is new the surface is shiny. However, most metals become dull after some time. Only a few metals like gold keep their shine and so are used for jewellery.



- 1 Fill in the blanks.  
In an electric plug, the pins are made of brass because this metal is a good ----- of electricity. The case is made of ----- as this is an ----- and so stops you getting an electric shock.
- 2 Graphite is a soft, easily broken, dull, black solid that conducts electricity. Look back at your list of properties. Is it a metal or non-metal? Why is graphite unusual?



## Ideas

⇒ Metals are good conductors of heat and electricity.

⇒ Metals are useful because they are hard and strong and can be shaped in many ways.

⇒ Non-metals are insulators of both heat and electricity.

# Tiny matters

You have seen that materials can have lots of different properties. Why is this?

All materials are made up of billions of tiny particles that we cannot see, even with a microscope. You need to understand how these particles behave. But if you cannot see these particles behave how can you tell what is happening?

The answer is to use a model. A model acts like a real thing?



## • A simple model for materials

Here is a model that helps to explain the differences between solids, liquids and gases.

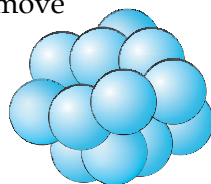
Stones and bricks are used for building. If you take a brick or a stone and break it into pieces, you would end up with individual grains of sand.

Assume the grains of sand in the brick as billions of tiny particles that we cannot see. It would help you to understand how the materials behave.

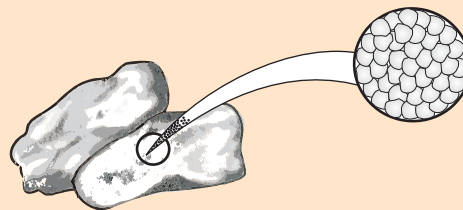


## • Properties of solids

The brick keep its shape because all the sand grains are stuck together, so they can't move about easily. You can't squash a brick because all the sand grains are packed as close as possible.



The tiny particles in solids behave similarly. The particles must be closely packed, because solids cannot be squashed easily. The particles must also be stuck together, because solids keep their shape.



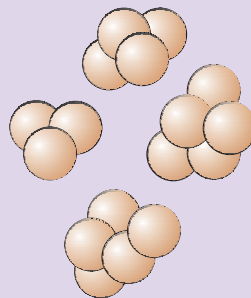
### Do you Know?

More than 1 000 000 000 atoms are needed for the ink to make this dot.

## • Properties of liquids

Dry sand behaves in a similar way to a liquid. You can pour it from one bucket to another. Sand is made from closely packed sand grains. But unlike bricks, these grains are not stuck together. They are free to move against one another.

The particles in a liquid must behave in a similar way. They must be closely packed, because liquids cannot be squashed. But they cannot all be stuck together, as they must be free to move about, like the grains of sand.



## • Properties of gases

Sometimes in very windy days when you try to walk against the wind you get sand in your eyes. What happens is that the wind whips up sand on the road. Individual sand grains separate out from one another and are kept far apart.

In a gas the particles are also separated out. When you squash a gas, for example air in a plastic bottle, you are pushing the particles close together again.



- 1 Draw diagrams of the particles in a solid, a liquid and a gas.
- 2 Explain the following
  - a. Why can you squash a gas, but not a liquid?
  - b. Why do solids keep their shape?
  - c. Why are some solids harder than others?



### Ideas

⇨ In solids, the particles are closely packed, and are stuck together.

⇨ In liquids, the particles are closely packed but are free to move.

⇨ In gases, the particles are far apart.

# ALFRED NOBEL

1833 - 1896 A.D.



Alfred Nobel was born in Sweden in 1833. He was a scientist and a businessman. In 1866 he invented dynamite and later on he discovered other explosives that were even more powerful. He then set up factories to make explosives and became very rich indeed.

Alfred Nobel was worried that his inventions might be misused. He wanted to encourage people to work for the good of humanity. He decided to set up a fund to award prizes for the very best work in science, medicine, literature and peace. Nobel died in 1896 and the first Nobel Prizes were awarded in 1901.

Today most research scientists dream of the honour of receiving a Nobel Prize. Perhaps one of you will produce work that Alfred Nobel would have wanted to reward!

*(J. Boyd & W.WhiteLaw 1989 John Murray)*