

## KEY WORDS

**material:** substance that has been prepared for making different types of products

**iron ore:** rock containing iron

**marble:** a type of stone used for floors or other surfaces

**quarry:** the place where stone is taken from the ground near the earth's surface

**hide:** the skin of an animal processed to be used to make clothes and other goods

## 1 Raw materials

Look at the photographs below. What **materials** can we process from each one?



Wool comes from the hair of sheep.

Cotton comes from the plant of the same name.

Oil platforms are structures designed to extract petroleum from below the sea.

The wood for your desk comes from tree trunks and the steel for its legs comes from **iron ore**.

**Marble**, like other types of stone, comes from a **quarry**.

Wool, cotton, oil, wood, minerals and marble are examples of raw materials.

**Raw materials** are substances that are extracted directly from natural objects.

Raw materials can be **classified** into three main categories:

- **animal** origin: wool, silk, **hides** ...
- **vegetable** origin: cotton, wood, cork, linen ...
- **mineral** origin: marble, clay, iron ...

## 2 Materials

Raw materials are transformed by physical and chemical processes into the various types of materials that are used for manufacturing. They are prepared so that they are ready to use for making many different products.

- A **physical process** is when a substance changes its state, for example when a metal melts. The chemical composition of the material does not change.
- A **chemical process** is when a substance is transformed into a different substance with different characteristics. The composition of the material changes. For example, petrol derivatives are transformed to create some types of plastic.

Some common examples of materials used for manufacturing are: paper, **planks** of wood, plastic, metal and glass.

## 3 Manufactured goods

Your textbook, exercise book, chair, desk, watch and sweater are all examples of manufactured goods.

A **manufactured good** is any object created by humans to satisfy their needs and improve their standard of living.

The manufacturing process:

1. **We get** raw materials from nature.
2. **We process them** to make materials.
3. **We make** goods with these materials.

For example, trees are cut into logs, logs are made into **planks** of wood, and these are used to make furniture.

**KEY WORDS**  
**plank:** wood cut into flat boards of varying size and thickness



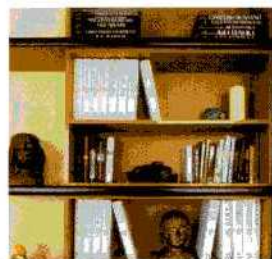
A manufactured good can be made of various pieces made from various different materials.



raw material



material



manufactured product



## KEY WORDS

**source:** origin

**fastener:** object or apparatus used to join or connect pieces together

**thread:** a very thin piece of cotton or other fibre used for sewing or weaving

**Lycra®:** an elastic synthetic textile, normally used in the manufacturing of clothes

**plaster:** a mixture of a specific powdered rock and water, used to cover walls; becomes hard when dry

**clay:** fine-grained, flexible, humid earth that becomes hard when fired

**firing:** a process of using very high temperatures in an oven to harden clay into ceramics

## Technical materials

Common materials used to make manufactured goods:

Materials	Source and characteristics	Uses
<b>Wood</b> 	Tree trunks, e.g. fir, pine and chestnut	Furniture, floors, paper manufacturing, construction materials, wall panelling, decorative objects, tool handles
<b>Metals</b> 	From minerals which are found in rocks. They are classified into: <ul style="list-style-type: none"> <li>• <b>Ferrous metals</b>, which contain iron, for example steel.</li> <li>• <b>Non-ferrous metals</b>, which don't contain iron, such as copper, bronze, tin, zinc and aluminium.</li> </ul>	Structural components, machines parts, tools, electrical components, fixtures and <b>fasteners</b>
<b>Plastics</b> 	Oil, coal, natural gas, vegetable materials (cellulose) and animal proteins, made into cellophane, PVC and rubber	Tubing, packaging, toys, containers, outer covering of electrical cables
<b>Textiles</b> 	Natural raw materials, e.g. wool, cotton and silk plastics (synthetic materials) made into nylon and <b>Lycra®</b>	<b>Thread</b> for making textiles with different uses
<b>Stone</b> 	Stone in different forms and sizes (from large rocks to fine sand) processed into marble, slate, glass and <b>plaster</b>	Construction materials (exterior and interior wall coverings) and decorative objects and sculpture
<b>Ceramics</b> 	<b>Clay</b> (transformed into ceramics by using a process called <b>firing</b> ), made into pottery, earthenware and porcelain	Construction (bricks, roofing tiles), plates and bowls, sinks and decorative objects

## Activities

4 Listen and repeat the words. Which is the odd one out? Why?

- rubber, PVC, glass, nylon
- bookshelf, chair, brick, paper
- marble, plaster, sand, thread



## 4 Properties of materials

We use different materials in different ways depending on their properties.

### 4.1. Physical properties

These properties relate to how materials react to external **stimuli**, e.g. electricity, light, heat or the applying of various forces.





#### Electrical properties

*What happens when an electric current is passed through a material?*

- **Electrical conductivity.** Some materials **conduct** electricity, e.g. metals.
- **Electrical insulation.** Some materials don't conduct electricity, e.g. plastic materials and wood.

#### Thermal properties

*What happens when a material is heated?*

Thermal properties	Characteristics	Examples
<b>Thermal conductivity</b> 	<ul style="list-style-type: none"> <li>• <b>Thermal conductors</b> are materials that conduct heat.</li> <li>• <b>Thermal insulators</b> are materials that don't conduct heat.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Thermal conductors:</b> metals</li> <li>• <b>Thermal insulators:</b> wood and plastic</li> </ul>
<b>Expansion and contraction</b> 	<ul style="list-style-type: none"> <li>• When the <b>temperature increases</b>, the material expands.</li> <li>• When the <b>temperature decreases</b>, the material contracts.</li> </ul>	Metals are especially sensitive to expansion and contraction.
<b>Fusibility</b> 	Some materials change from solid to liquid when their temperature is increased.	Metals, some plastics and glass
<b>Welding</b> 	Some materials can be used to weld two pieces of the same or different materials together.	Metals. For example, in this photo the robot is welding the metal pieces in the car production line.

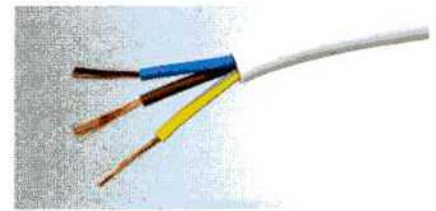
### KEY WORDS

**stimulus** (*pl.: stimuli*): something that produces a reaction or change

**conduct** (*vb.*): allow something to pass through it or transmit it

**wire**: a thin metal filament or cable

**weld** (*vb.*): join together pieces, such as metal, by using heat or chemicals



Electric cables are covered with plastic, an insulating material, and inside they contain copper **wires**, a conductive material.

### Activities

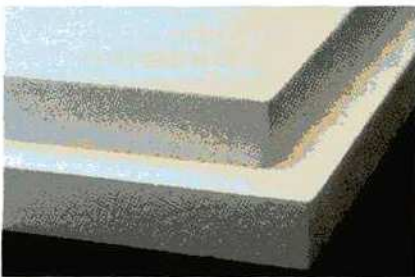
- Which of the following materials are electrical conductors and which are insulators? *Plastic, aluminium, wood, iron and copper.*
- Copy and choose the correct option.
  - To find out if a material is a thermal conductor you can touch it. If it becomes *cold / warm*, it's a thermal conductor.
  - Metal / Wood* is the material that is most sensitive to thermal expansion.
  - A characteristic of materials used for welding is *fusibility / conductivity*.

## KEY WORDS

**allow (vb.):** permit

**ferrous:** containing iron

**steel:** a very hard metal made of iron and carbon



Acoustic insulation, polyurethane.

## Acoustic properties

*Can you hear sound through a material?*

- **Acoustic conductivity.** The capacity of materials to transmit sound.
- **Acoustic insulators.** Some materials don't conduct sound well, e.g. glass, fibre, cork and plastics.

## Magnetic properties

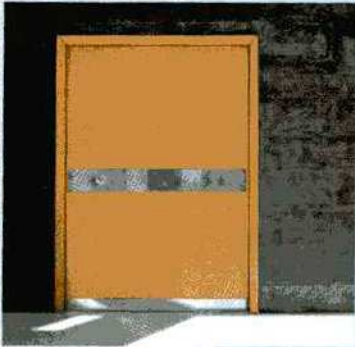


*Does a material react to a magnet?*

- **Magnetism.** Some metals attract other metallic materials; iron has this property. This **allows** it to become a permanent magnet. It attracts other **ferrous** materials, such as **steel**.



## Optical properties

*Can you see light through a material?*

Optical properties	Opaque	Translucent	Transparent
<b>Characteristics</b>	Other objects can't be seen through them. These materials don't allow light to pass through them.	These allow light to pass through them, but don't allow objects behind them to be seen clearly.	Other objects can clearly be seen through these materials.
<b>Examples</b>	Wood and metals 	Some types of glass, tissue paper and plastic 	Glass and some plastics 



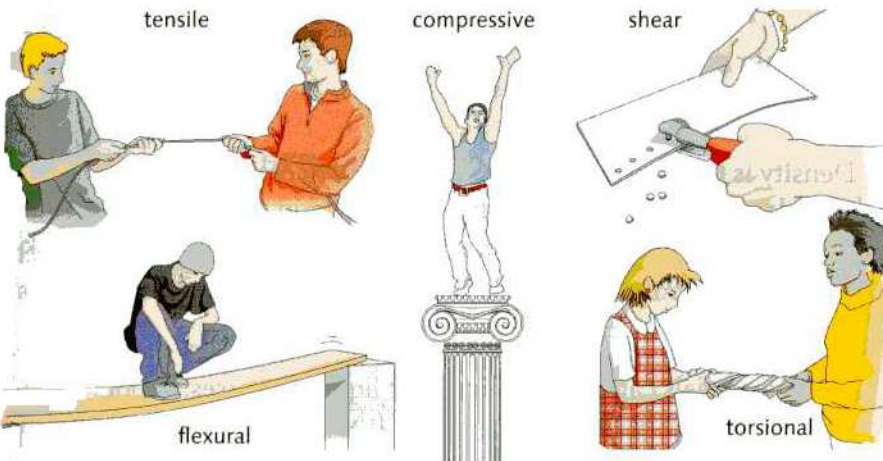
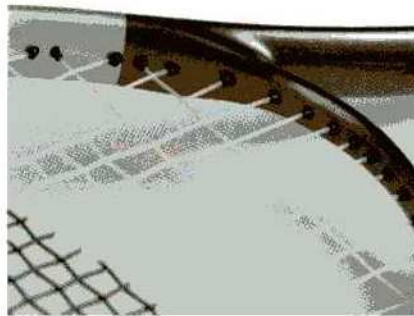
## Mechanical properties

What happens to a material when external forces are applied?

### Mechanical strength

The mechanical strength of materials depends on the type of force that acts upon them.

There are several types of strength: **tensile strength**, **compressive strength**, **flexural strength**, **torsional strength** and **shear strength**. For example, **tennis racquet strings** have to be tense so that when the racquet hits the ball the strings experience a flexural force.



## KEY WORDS

**tensile strength:** resists stretching

**compressive strength:** resists crushing or compressing

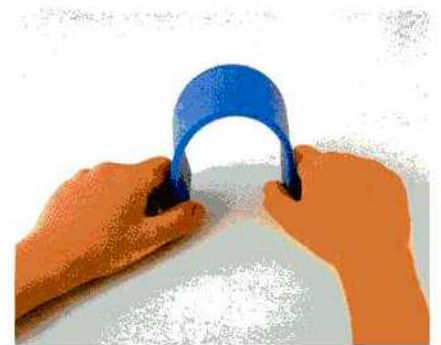
**flexural strength:** resists bending or flexing

**torsional strength:** resists twisting

**shear strength:** resists sliding forces

**spread (vb.):** cover a larger area

**filament:** very thin wire



Elastic material

### Elasticity and plasticity

- **Elasticity** allows the material to return to its original form after a force that has changed its shape is removed.
- **Plasticity** allows it to be permanently deformed.

### Malleability and ductility

- **Malleability** allows a material to be **spread** into sheets or films. Materials with this property are **malleable**.
- **Ductility** allows a material to be formed into **filaments**, or wires. Materials with this property are **ductile**.



Plastic material

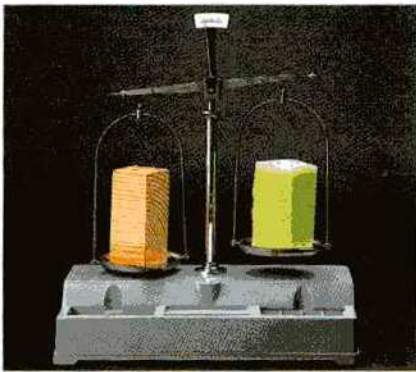
## KEY WORDS

**scratch (vb.):** make a mark on the surface of something

**hammer:** a tool with a heavy metal head used to hit other objects or surfaces

**weigh (vb.):** measure how heavy an object is, determine what its weight is

**release (vb.):** emit, expel



The piece of wood weighs more than the sponge



Volcanic rocks, like pumice stones, are porous materials.



Permeable and impermeable materials

## Hardness

A hard material is not easily **scratched** by another material.

The Mohs scale of minerals was created by the Austrian geologist **Friedrich Mohs** (1773–1839). The minerals are graded from 1 to 10 according to how hard they are. Here are some examples:

1	Talc	3	Calcite	5	Apatite	7	Quartz	9	Corundum
2	Gypsum	4	Fluorite	6	Feldspar	8	Topaz	10	Diamond

## Toughness and brittleness

■ **Toughness** is the resistance to breaking that a material shows when hit by something.

■ **Brittleness** is the opposite, when the material breaks easily.

For instance, if we hit a metal object with a **hammer**, e.g. a bell, it doesn't break. If we hit a mirror or glass object, it breaks easily.

## Other properties

### Density

Density is the relationship between the mass of an object and its volume. In the top photograph, the piece of wood **weighs** more than the sponge, but both pieces are of a similar volume. The wooden block has a higher **density** than the sponge.

### Porosity

Some materials can absorb or **release** liquids or gases. Wood, some stones and ceramic materials are porous (they contain tiny holes called pores). This property is related to density: if a material is more porous, it's less dense.

### Permeability

Some materials allow water or other liquids to filter through them. An earthenware jug containing liquid, or a wet cloth becomes wet because they're made from **permeable** materials.

### Impermeability

Some materials don't allow water or other liquids to filter through them. For instance, glass is impermeable, so liquids stored in bottles don't escape. Plastics and cork are also **impermeable**, or **waterproof**.



## 4.2. Chemical properties

We can see these properties when the chemical composition of a material changes because it interacts with other substances.

### Oxidation

This happens when a mineral reacts with oxygen in the air or water. Metals are the most sensitive materials to oxidation. The reddish-brown substance produced is called rust.



The cans have rusted and are covered with reddish dust.



To prevent rusting materials are coated with paint, varnish or enamel.

### KEY WORDS

**avoid (vb.):** prevent something from happening

**harmful:** can cause damage and can be dangerous

**poisonous:** containing a substance that is toxic and capable of causing damage or death

**damage:** the act of breaking, spoiling or hurting something



This symbol means that a material is recyclable.

## 4.3. Ecological properties

The environment is a system made up of human beings, flora, fauna, earth, air, climate and landscape which all interact. Materials are classified according to the impact they have on the environment:

	Characteristics	Examples
Recyclable materials	These can be reused. They help conserve natural resources and <b>avoid</b> the accumulation of waste products.	Glass, paper, cardboard, metal, plastics ...
Toxic materials	These are <b>harmful</b> to the environment. They can be <b>poisonous</b> for living things because they contaminate the soil, the water and the atmosphere.	Mercury, heavy metals, petroleum
Biodegradable materials	These are materials that decompose naturally and don't cause <b>damage</b> to the environment	Paper, water-soluble plastics (materials that decompose on contact with cold or hot water)



Batteries contain chemical substances that are toxic, for example, mercury. Don't forget to put used batteries in the special containers provided in your town so that they can be recycled without damaging the environment.

Some materials come from **renewable raw materials**. These raw materials can be regenerated.

- **Renewable raw materials:** wool, cotton and wood.
- **Non-renewable raw materials:** coal, oil and minerals.