



Trees contain different substances like resins, oils, sugars and colouring.

Resin is a dark or yellow sticky substance that plants release. It forms a layer on the surface that protects it from wounds, cuts and possible attacks from other organisms.

Understand

1. Find out how resin is collected from pine trees and what the resin is used for.

¹**trunk**: the main part of a tree

²**log**: a big piece of wood

³**sawmill**: a factory that turns logs into planks

⁴**plank**: a long, thin, flat piece of wood used for building or floors



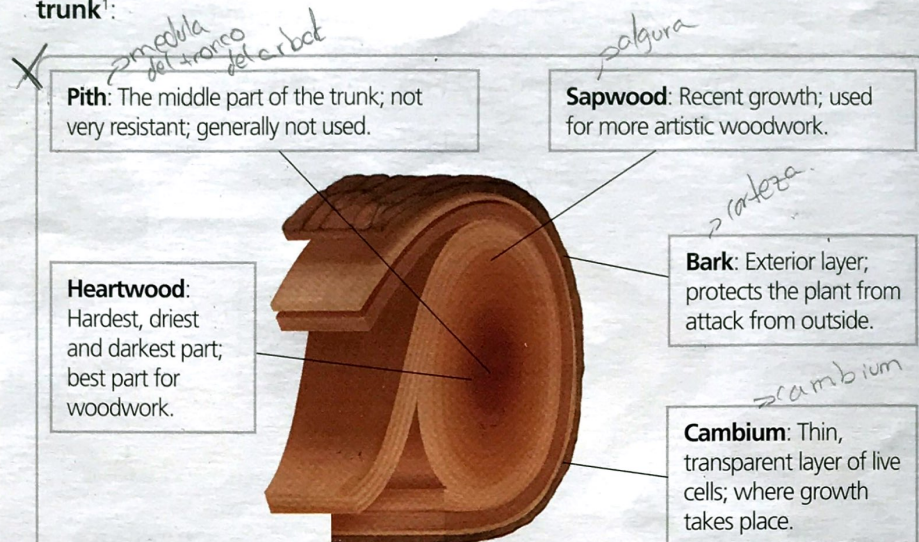
Key concepts

- Wood is basically made up of cellulose and lignin.
- The heartwood is the most suited part for woodwork.
- The stages in getting wood are: logging and pruning, transporting, stripping the bark, cutting, drying and planing.

1. WOOD

Wood is a **raw material** of plant origin. It is composed of **cellulose** fibres, which is like the skeleton of all plants, and **lignin**, which makes it hard and rigid.

Wood is under the bark of trees and bushes. Look at the different parts of a tree trunk¹:



Understand

2. What are the rings in a tree trunk? Write a definition.

Apply

3. Which part of the trunk would be most suited for your puzzle?

When you cut down a tree you can see the rings in the form of concentric circles. If a tree grows quickly, the rings are easier to see.

1.1. Getting wood

Logging and pruning: Trees are cut at the base of the trunk. Once the tree is down, the branches are cut off.

Transport: Huge machines are used to lift the **logs**² and pile them on the trucks that take them to areas for easier access. They are then taken to a **sawmill**³ by road, rail or by sea and rivers.

Stripping the bark: The bark stripping machine has rollers with teeth that remove the bark from the logs as they turn.

Cutting: Logs are cut to the length that is needed and then these pieces are cut into **planks**⁴.

Drying: Before working with wood it must be dried so that it doesn't change shape with changes in temperature. Dry wood is lighter and lasts longer.

Planing: Planer machines eliminate any rough surfaces and make accurate-sized sheets of wood.

Understand

4. What do you think controlled logging is?
5. What factors affect the process of drying wood?

2. CLASSIFYING WOOD

There are lots of different types of wood but for technical purposes we classify them into two types: **hardwoods** and **softwoods**.

Hardwoods <i>duas</i> <i>Arboreas</i>		Softwoods <i>blandas</i>	
Hardwoods usually come from deciduous trees. They grow slowly and have thick, compact trunks. They contain little resin and can be many different colours.		Softwoods are usually from conifer trees, with needle-shaped leaves. They grow quickly, contain a lot of resin and are pale-coloured. They are light and easy to work with.	
Tree type	Uses <i>mabiliano</i>	Tree type	Uses
	Used in furniture and floors because it bends and is easily shaped. Also used to make toys, kitchen utensils, tool handles, etc.		Used in furniture, electrical posts, boats, floors, etc.
Beech <i>haya</i>		Pine	
	Used in furniture, doors, windows, parquet floors, boats, barrels, etc.		Used in building, boats, simple furniture, carpentry, boxes, paper, etc.
Oak <i>corcho</i>		Silver fir <i>Arbol plateado</i>	
	Used in joinery, luxury furniture, handmade objects, musical instruments (pianos, clarinets and violins), etc.		Used in furniture frames, plywood, paper, etc.
Mahogany <i>caoba</i>		White poplar <i>Alamo</i>	

Understand

- What are the grain and knots in wood? Look up information about different types of wood.
 - Why are there fewer knots in hardwoods?
 - What is the grain like in hardwoods?
- What's the relationship between a tree's growth and the resistance of the wood? What about its growth and its density?

Apply

- What type of wood will you use for your puzzle: hardwood or softwood? Which type of tree? Why?



Key concepts

- Wood is classed as hardwood or softwood.
- It is used mainly in building, making furniture and paper.



Amazon forest, Peru

Analyse

9. Look up information about the world's largest forests. How we can help save them?

⁵warp: bend out of shape

⁶shavings: very thin strips cut from wood

⁷grind: make into a powder by crushing

Understand

10. What are the advantages and disadvantages of using natural wood instead of engineered wood?
11. What kind of wood would you use to make the following?
- a wooden handle
 - a boat
 - a guitar
 - a window frame
 - a decorative object
 - parquet floor
12. Find out possible uses of plywood, chipboard and fibreboard.

Apply

13. What kind of engineered wood will you use for your puzzle? Explain why.

⁸bleach: whiten with chemicals



Key concepts

- Engineered wood is made from shavings, chips and sheets.
- Paper is mostly made of cellulose.

3. DERIVATIVES OF WOOD

Derivatives of wood are not taken directly from cutting logs but from sheets, fibres or chips of wood which are compressed and glued together. Derivatives include **engineered wood** and **cellulose materials**.

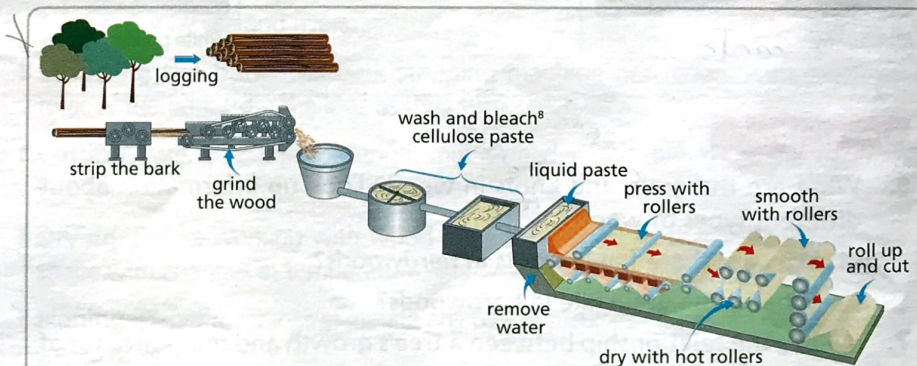
3.1. Engineered wood

Type	Source	Characteristics
 Plywood <i>contrachapado</i>	Formed by gluing together thin sheets with synthetic resins. The fibres on each sheet are at a 90° angle to each other. Very resistant.	Can warp ⁵ due to changes in humidity.
 Chipboard <i>aglomerado</i>	Made with wood shavings ⁶ and chips which are glued together by compression.	Fragile but not easily deformed. Rough surface. Seriously affected by humidity.
 Fibreboard <i>tablero de fibras</i>	Fibres come from grinding ⁷ chips. This produces tiny wood threads which are glued together using synthetic resins to make planks.	Polished surface, fine texture. Very resistant to humidity.

3.2. Cellulose materials

These are made from the cellulose of wood. They include paper, cardboard, silk *sedal* paper and card. *pastas de madera*

Wood is pulped and mixed with water and chemicals to make a cellulose paste. This paste is compressed and made into layers with a machine so that it turns into sheets.



The process of making paper from wood

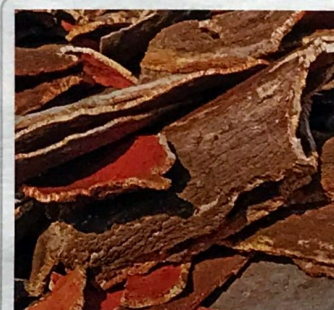
Understand

14. Find out about the process of recycling paper. Which parts of the process of making paper from wood are not included in recycling paper?

4. PROPERTIES OF WOOD

The uses of wood are related to their properties.

Properties		Soft	Hard	Engineered
Density	Heavy			
	Average	X	X	X
	Light			
Resistance and toughness	Very resistant		X	
	Needs protection	X	X	X
Waterproof	Waterproof			
	Not waterproof	X	X	X
Colours	Great variety		X	X
	Little variety	X		
Electrical conductivity	Conductor			
	Insulator	X	X	X
Thermal conductivity	Conductor			
	Insulator	X	X	X
Acoustic conductivity	Conductor	X	X	X
	Insulator			
Easy to work with	Requires ability		X	
	Needs some care	X	X	X
	Easy to work with	X		X
Recyclable	Yes	X	X	X
	No			
Biodegradable	Yes	X	X	X
	No			
Reusable	Yes	X	X	X
	No			



Cork is taken from cork oaks. It is soft, porous, very light, waterproof, elastic and an insulator.

Understand

15. Make a list of its uses.

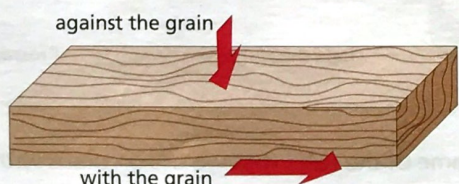


Understand

16. Do you know why wood floats? What is the lightest wood?

Understand

17. Listen to the five sentences and decide if they are true or false. Correct the false ones.
18. Why does wood offer more resistance when you cut it against the grain rather than with the grain?



Apply

19. Say which properties of wood are most relevant for the design of the final task.



Key concepts

- Wood is a good electrical and thermal insulator but it is an acoustic conductor.
- It is not waterproof and needs protection.
- It is resistant, tough and biodegradable.

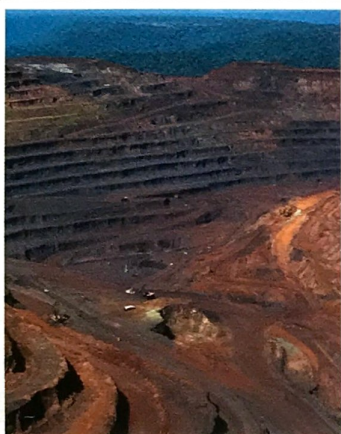
1. METALS

Metals are substances from minerals which contain one or more metallic elements, and sometimes non-metallic substances such as carbon.

They have many uses and are a key element in transport, telecommunications, agriculture, construction and manufacturing, among other sectors.

1.1. How metals are obtained

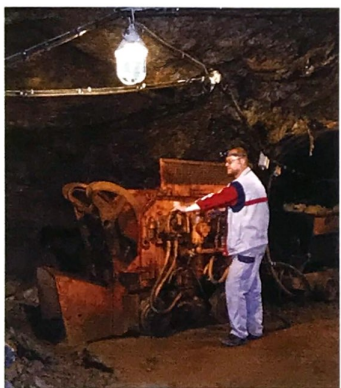
We are going to look at the process from the mining of minerals (raw material) to using metal to make different objects.



Surface mining

Understand

1. What is the environmental impact of surface mining? How are its effects reduced?

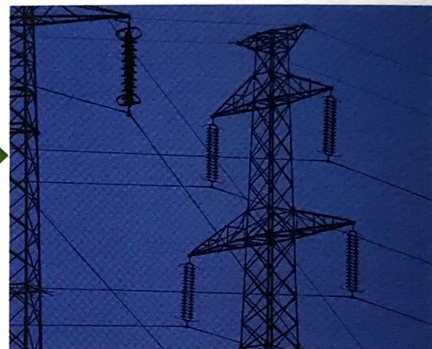


Understand

2. What machinery is used to dig mines and extract minerals?



Bauxite



High-voltage power lines

Metals come from minerals which are part of rocks. Aluminium, for example, is taken from minerals such as bauxite.

Mining is carried out in **surface mines** if the minerals are close to the surface, or in **underground mines** if they are deeper under the surface.

In mines, the useful minerals, or **ore**, and the useless minerals, or **gangue** are together and must be separated using different physical processes. When the ore is separated from the gangue, the next step is to make metal from the ore. The ore is taken to an **ironworks** and undergoes complex physical and chemical processes.



Metallurgy is the group of industries involved in mining and transforming metallic minerals.

1.2. Classifying metals

Depending where they are from, metals can be classified as ferrous or non-ferrous:

- **Ferrous metals:** Their main component is iron. They include **pure iron, steel** and **cast iron**.
- **Non-ferrous metals:** Their main component is not iron - or they contain very little of it. This group includes **copper, bronze, aluminium** and **zinc**.

1.3. Properties of metals

As you will probably have seen, metals are hard, non-adhesive, cold and very smooth if they have been polished or treated.

Some characteristics are:

- They are good **electrical, thermal** and **acoustic conductors**.
- They are **ductile** and **malleable**.
- They are **tough**.
- They **melt** at high temperatures so they can also be used for **welding**.
- They **expand** when the temperature rises and **contract** when it cools.
- Some are **magnetic** and are attracted to magnets.
- Most of them **rust** when they come into contact with air and oxygen.
- They can be **recycled** and **reused**.
- Some of them, such as lead or mercury, are **toxic** for the environment.

Understand

4. What are the ductile and malleable properties of metal useful for? Do you know any other material that has these properties?

Apply

5. Of the different properties of metal, which ones are needed:
 - a) to make a drinks can?
 - b) for our flower project?

Understand

6. Recycling aluminium cans is a simple process. How is it done? How does it save energy compared to making cans from the mineral bauxite?
7. Say which property is the most important in making the following things: an electrical cable, a ship, an anvil, water pipes for a building, a metal bridge.

Analyse

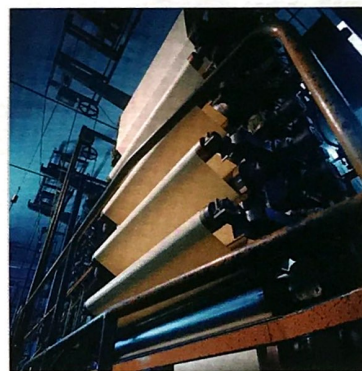
8. Why should we put batteries in special containers?



Iron and some other metals can be transformed into permanent magnets by a mechanism called **ferromagnetism**. We can make very powerful magnets this way.

Understand

3. Find out about magnets and find four things magnets are used for.



Metals are ductile and malleable



Key concepts

- Metals are materials that come from minerals which can be used in many sectors.
- Metals are taken from mines. In mines there are two types of materials, ore, which can be used, and gangue, which cannot.
- Depending where they are from, metals are ferrous or non-ferrous.
- Metals are good electrical, thermal and acoustic conductors. They are also resistant, ductile, malleable and tough; they can melt and they can be recycled.



Many minerals from the Earth's surface contain iron. The most important ones are magnetite (in the picture), haematite, limonite, siderite and pyrite.

¹**alloy**: a metal made by combining two or more metals

²**melt**: change from solid to liquid

³**machine**: make or operate with a machine

⁴**casing**: a cover or shell

⁵**chassis**: the base frame of a car



Among the different types of iron, there's **wrought iron**, composed of pure iron, silicate and very small quantities of carbon. It's special because it's very malleable and can be easily welded and shaped.

2. FERROUS METALS

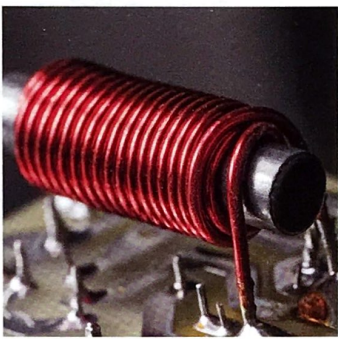
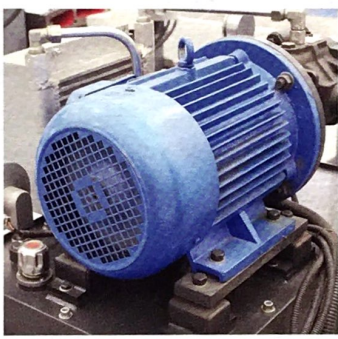
Iron minerals from the Earth's surface undergo different processes to obtain **pure iron** and its **alloys**¹: steel and **cast iron**.

Depending on the percentage of carbon, ferrous metals are classified as:

■ **Pure iron**: the concentration of carbon is between 0.008% and 0.03%.

■ **Steel**: between 0.03% and 1.76%.

■ **Cast iron**: between 1.76% and 6.67%.

Ferrous metals	Properties	Uses
Pure iron 	Greyish white colour. Good magnetic properties. Disadvantages: only melts ² at high temperatures; difficult to machine ³ ; fragile and brittle.	Rarely used. Used in electronics and electrical components.
Cast iron 	Very hard and resistant.	Machine parts, casing ⁴ for engines, stands for machines, pistons, street lamps, drain covers ...
Steel 	Very hard and resistant. Very resistant to traction. Easy to weld. Alloys with chrome and nickel to make stainless steel.	Structures in construction, car chassis ⁵ , boats, trains, machinery, tools, screws, domestic appliances, kitchen utensils, taps ...

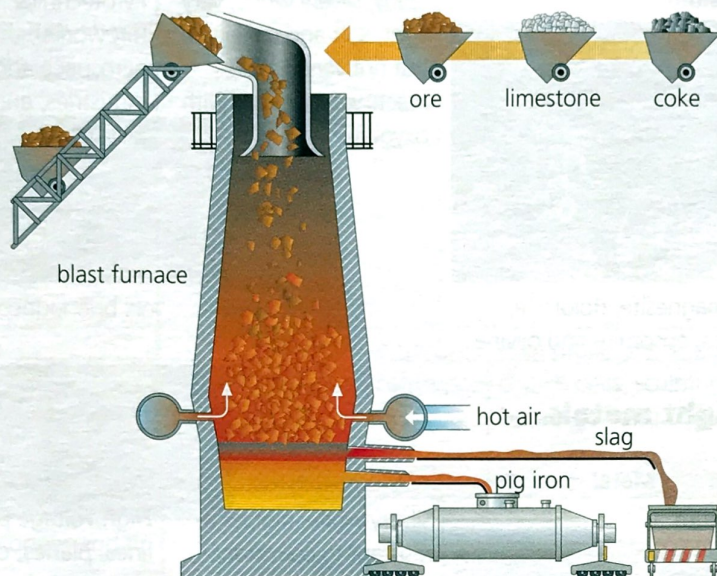
Understand

9. Look for information about wrought iron and how it's made. Then, find three examples of what it's used for.

The steel-making process

The steel-making process includes the following stages:

- Iron mineral is washed to eliminate any impurities.
- It is crushed and **sieved**⁶ to separate the gangue from the ore.
- The ore is mixed with coke and limestone, and then put into a **blast furnace** with temperatures of over 1 500°C.



The Tinto River in Huelva gets its name from the colour of its waters due to the iron which is dissolved into them.

Understand

10. Apart from iron, the river water contains other metals. Find out which ones.

- **Slag** is obtained. This is a **by-product**⁷ made up of carbon and other impurities.

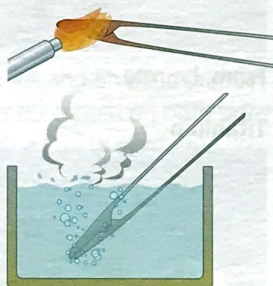
The **pig iron** is taken to a **converter** to:

1. reduce the percentage of carbon.
2. eliminate impurities.
3. adjust the composition of the steel by adding other elements such as nickel or chrome.

To improve the mechanical properties of steel, it undergoes different thermal processes.

- **Quenching**, which is cooling the metal very quickly when it is red hot.

- **Tempering**, where the hot metal is cooled very slowly.



Understand

11. Find out about the different minerals in iron. Write about its composition in your notebook.
12. Find out where there are steelworks in Spain. Give some reasons for their location.

Analyse

13. The tools we use to cut metal are usually made of steel, which includes some chrome in its composition. Why is that?
14. Find out when the first furnaces in history were made. How were they constructed?

⁶sieve: pass through a net with very small holes

⁷by-product: a secondary product made during the production of something else



Key concepts

- Pure iron is used in electronics and electrical components. It has good magnetic properties, a high melting point and is fragile and brittle.
- Cast iron is used for machinery, mainly because it is very hard and resistant.
- Steel is the most widely-used metal in industry and construction, and in machinery and transport because it is very hard, tough and resistant to traction.

Stainless steel is made by adding chrome and nickel to steel.

Metals	
Ultra-light	Density (g/cm ³)
a)	1.74
Light	Density (g/cm ³)
Titanium	b)
c)	2.7
Heavy	Density (g/cm ³)
d)	19.26
e)	13.55
Lead	11.34
Nickel	9
f)	8.92
g)	7.88
Tin	h)
Chrome	7.19
Zinc	7.13

Understand

15.  Listen and complete the table.

⁸roofing: material for making the roof of a building

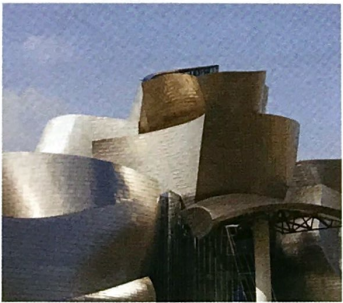
3. NON-FERROUS METALS

Non-ferrous metals are classified into the following categories, according to their density: **ultra-light**, **light** or **heavy**.

3.1. Ultra-light metals

Metal	Properties	Uses
Magnesium 	Shiny, silvery white; very light, soft and malleable, but not very ductile; reacts very strongly with oxygen.	Pyrotechnics (fireworks), the aerospace and car industries, and bicycles.
From: magnesite, dolomite, carnallite, epsomite and olivine		

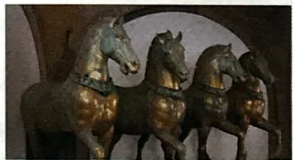
3.2. Light metals

Metal	Properties	Uses
Aluminium 	Silvery white; highly resistant to corrosion; very soft; low density; high malleability and ductility; good at conducting electricity and heat.	High voltage power lines, planes, cars, bicycles, light metalwork, roofing ⁸ , decoration, kitchen tools and drinks cans.
From: bauxite		
Titanium 	Silvery white, shiny; light; very hard and strong.	The aerospace industry, building structures and medical prostheses (artificial limbs).
From: rutile and ilmenite		

Understand

16. What metals would you use to make: windows, bicycles, bone grafting and rooftops?
17. What are the main uses of aluminium? Look for other uses and write a list in your notebook.

3.3. Heavy metals

Metal	Properties	Uses
Copper  From: cuprite, chalcopyrite and malachite	Reddish, very shiny; soft; good electrical and thermal conductor; very malleable and ductile; rusts easily.	Electrical wiring, telephone lines, pipes, radiators, decoration, architecture, jewellery and handcraft.
Brass  From: copper and zinc	Very resistant to corrosion.	Handcraft, jewellery, plumbing, capacitors ⁹ and turbines.
Bronze  From: copper and tin	Resistant to general wear and corrosion.	Boat propellers, filters, church bells, sculptures, nuts, bearings ¹⁰ and cogs ¹¹ .
Zinc  From: sphalerite and hemimorphite	Bluish grey; fragile; not very hard.	Roofing, plumbing ¹² and in the car industry. A layer of zinc is used on other materials to stop corrosion.
Tin  From: cassiterite	Shiny white; very soft and malleable; does not oxidise at room temperature.	Tin foil and tin plate (a sheet of steel coated on both sides with a thin layer of tin). Alloyed with lead, it is used for soft soldering.
Lead  From: galena	Silvery grey; soft and malleable; lead fumes are toxic when inhaled.	Batteries, protective measures against nuclear radiation. An additive in glass to increase its hardness and add weight.

Analyse

18. Drinks cans are usually made of aluminium but another metal is often used in its place. What is it? Why is a layer of tin added? What is the easiest way to identify each type of can?

⁹**capacitor**: a device used for storing electricity

¹⁰**bearings**: the support and guide of a rotating wheel within a machine

¹¹**cog**: a wheel with parts cut out of its edge for transferring motion

¹²**plumbing**: system of pipes in a building or house

Key structures

Adjectives in English usually go before the noun.

a shiny metal

We use the suffix *-ish* with numbers, colours or times to mean 'approximately'.

reddish blue



Key concepts

Non-ferrous metals are:

- **Ultra-light**: magnesium. Used in the aerospace and car industries because of its ductile and malleable properties.
- **Light**: aluminium and titanium. Have many uses thanks to their varied properties: structures, electrical lines, metalwork.
- **Heavy**: copper, zinc, tin, lead. Have many uses in architecture, decoration, machinery and welding.



Metal is sold in sheets, plates, bars (triangular, square, cylindrical, hexagonal), or as pipes, wire...

Analyse

19. Why do metal pieces sold for construction have so many different shapes (round, square, I-shaped, H-shaped)? Why do you think one is chosen over another?

¹³**railings**: a fence made from rails or straight pieces of metal

¹⁴**rivet**: a short pin for holding two pieces of metal together



Apollo in the Forge of Vulcan.
Diego Velázquez, 1630

Analyse

20. Look for information about the era when this picture was painted. What metal are they forging? What tools did they have back then?

4. SHAPING TECHNIQUES

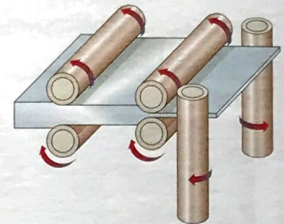
To make pieces for **sale** or for **industry**, the metal goes through a series of shaping processes, depending on the type of metal and what we want to make.

4.1. Shaping

These are techniques used to change the shape of the piece of metal by **applying** an **external force**. It can be done when the metal is hot or at room temperature.

Rolling

The unprocessed metal is passed through a series of **rollers** that compress it, reduce its thickness and increase its length. It's usually done when the metal is hot.

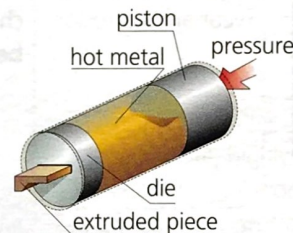


Uses: Sheets, plates, bars ...

Extrusion

The heated metal is pushed through a hole by a piston, using compression.

Uses: Bars, tubes and other shapes.

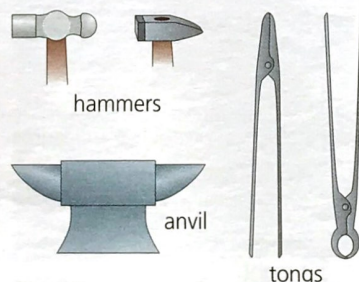


Forging

The metal piece is shaped by repeated and continuous compression forces using **hammers, tongs** and **anvils**.

Manual forging has been replaced by industrial or mechanical forging. The piece is placed on a platform that acts as an anvil. Using a pneumatic or hydraulic machine, the hammer rises and falls onto the piece again and again. Forging is usually carried out when the piece is hot.

Uses: **Railings**¹³, bed headboards, horseshoes, keys, tools, nails, screws, **rivets**¹⁴, engine pieces ...

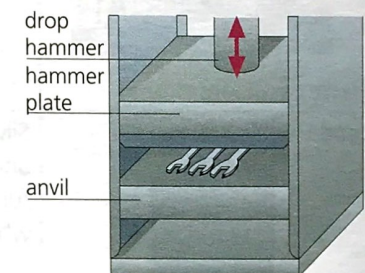


Manual forging

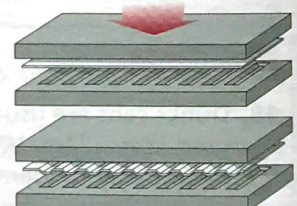
Press forging

The heated metal is placed between two dies, one fixed and the other mobile. The dies are the shape of the object we want to make. They are pressed together so that the piece takes the shape of the die.

Uses: Car body parts, radiators ...



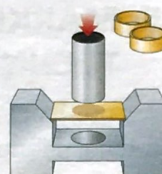
Industrial forging



Punching

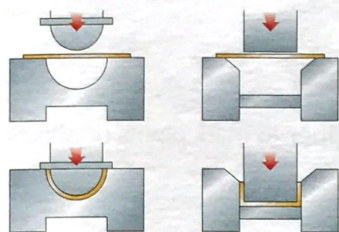
This is a cold forging process: a sheet of metal is hit with a punch to make the required shape in a mould.

Uses: **Hollow**¹⁵ pieces, such as bearings, from flat pieces.



¹⁵**hollow:** having a hole or space in the middle

¹⁶**engine block:** the solid piece of an engine that doesn't move



Bending

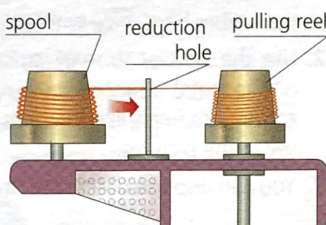
A metal sheet is subjected to force to make a curved shape with a specific curve radius.

Uses: Curved pieces or with angles.

Wire drawing

A wire is pulled through a hole that has the required dimensions. A rotating drum is used to pull it through the hole to increase its length while reducing its diameter.

Uses: Metal strings and wires.

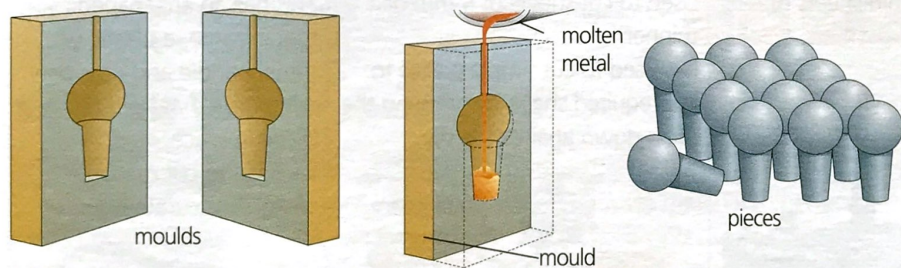


4.2. Casting

Molten metal is poured into a container with a hollow space inside, which is the shape of the object we want to make. The **mould** can be made from sand, steel or cast iron.

1. The metal is heated in a furnace.
2. The liquid metal is poured into the mould.
3. It is left to cool down.
4. The piece is removed from the mould.

Uses: **Engine blocks**¹⁶, fire hydrants, small parts and alloys with low melting points, ornaments, jewellery, sculptures and dental implants.



Understand

21. Of all the shaping techniques you have read about, which one do you think is used to make drinks cans?
22. Which shaping techniques are used to make these objects?



Key concepts

Shaping processes produce pieces for sale and for industry.

■ **Shaping:** The piece of metal is modified by applying an external force. There are different techniques according to the shape that needs to be made.

■ **Moulding:** Consists of pouring molten metal into a mould, whose inside cavity is the same shape as the shape we want to make.