1 Materials

A mechanical engineer uses different materials to build **machinery** or **tools**. A specific knowledge of materials is required, concerning qualities, properties, costs and general characteristics.

1 **What are these objects made of? Match the words in the box with the pictures, then read the text.**

steel gold wood plastic glass ceramic

1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

When a machine or a tool is made, the most suitable material must be chosen by considering its properties, which can be classified as mechanical, thermal, electrical and chemical. The main types of materials used in mechanical engineering are metals, polymer materials, ceramics and composite materials.

The most commonly used materials are metals, which can be divided into ferrous and non-ferrous. They can be used in their pure form or mixed with other elements. In this second case we have an **alloy** and it is used to **improve** some properties of the metals. The most commonly used ferrous metals are iron and alloys which use iron. Because iron is soft and pasty it is not suitable to be used as a structural material, so a small amount of **carbon** is added to it to make **steel** alloy.

Non-ferrous metals contain little or no iron. The most common non-ferrous metals used in mechanics are **copper**, **zinc**, **tin** and **aluminium**. Some common non-ferrous alloys are **brass** (formed by mixing copper and zinc), **bronze** (formed by mixing copper and tin) and other aluminium alloys which are used in the aircraft industry. Other examples of materials used in mechanical engineering are **plastic** and **rubber**.

PVC or polyvinyl chloride is a type of plastic and is used to **insulate wires** and **cables**. Rubber is a polymer and its best property is elasticity, as it returns to its original size and shape after deformation.

Ceramic materials are good insulators: hard, resistant and strong, but **brittle**. Composite materials are made up of two or more materials combined to improve their mechanical properties. **Concrete** is reinforced with steel and is used in building engineering.

2 **Read the text again and match the words with their definitions.**

1 alloy	a	☐ a type of plastic used for insulation
2 steel	b	☐ a combination of different metals
3 PVC	c	☐ an alloy formed by mixing iron and carbon
4 concrete	d	☐ an alloy formed by mixing copper and zinc
5 brass	e	☐ metals containing iron
6 ferrous materials	f	☐ a composite material used to build houses
7 ceramic	g	☐ a metal not suitable as structural material
8 iron	h	☐ a good insulator but brittle

3 **Read the text again and answer the questions.**

1 What is the basic classification of metals?
2 What are the characteristics of iron?
3 Why are alloys created?
4 Which materials are good insulators?
5 Is steel an alloy? Which metal does it contain?

4 1 Listen and complete the definitions with the words in the box.

cooking	coins	alloy	air	copper	wires	steel
carbon	gold	ferrum	expensive	ductile		

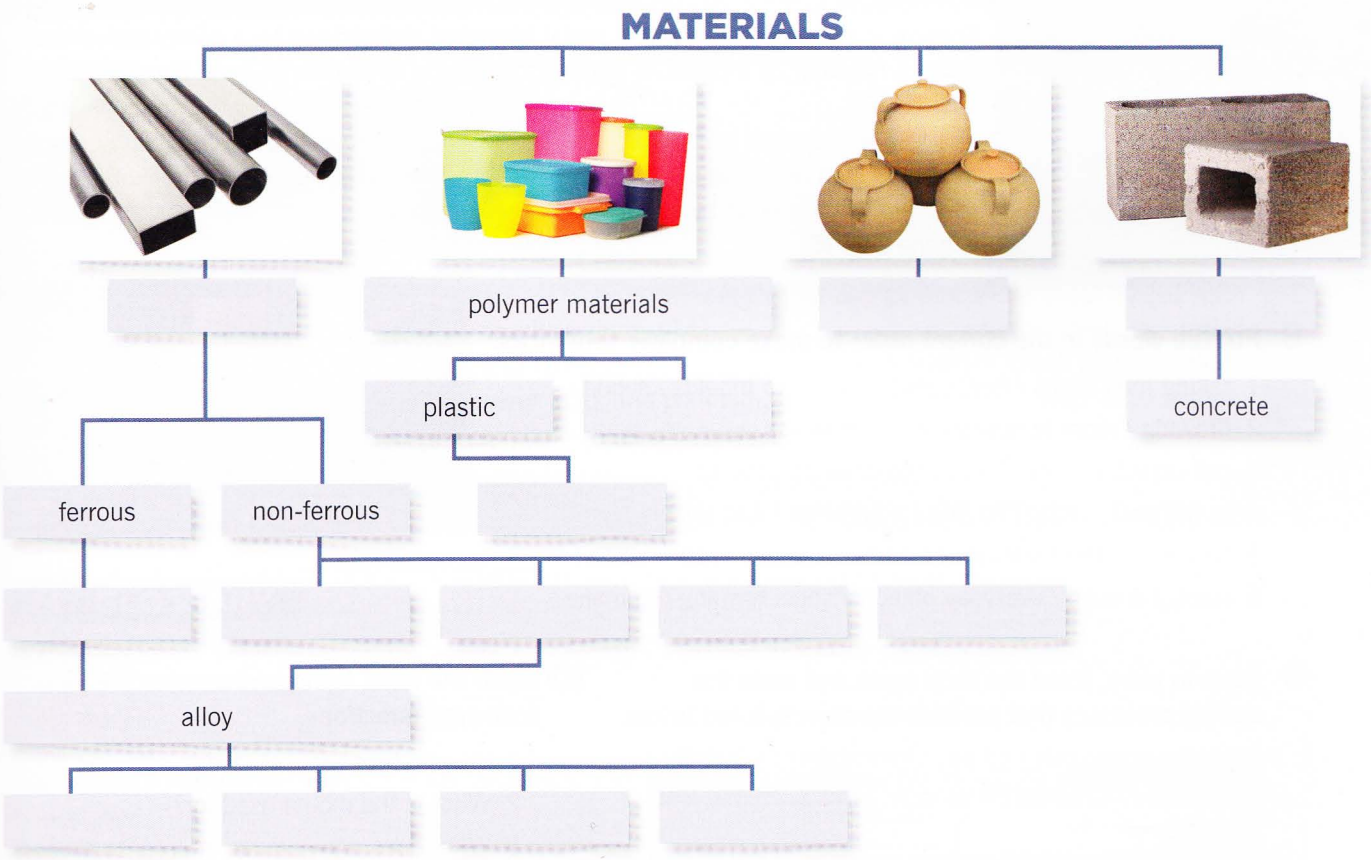
Iron: Its Latin name is (1) *ferrum*. It is magnetic and has a silvery colour. In prehistoric times it was used to make ornaments and weapons. If exposed to the (2) _____, it **oxidises**.

(3) _____: It is one of the most widely used metals by humans. In prehistoric times it was used to make cooking utensils, (4) _____ and ornamental objects. It is used in (5) _____ and cables.

(6) _____: It is the most (7) _____ metal and is used to create precious jewellery. It is the most (8) _____ metal.

(9) _____: It is an (10) _____ formed from iron and (11) _____. It can contain between 2.1% and 4% carbon. It is also used for (12) _____ utensils and pans.

5 Complete the following diagram.



6 Write a summary of the texts in exercises 1 and 4 following the flow chart.

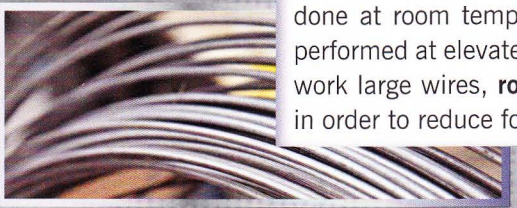
Write about the importance in engineering of having a specific knowledge of materials. → List the materials and the main groups used in mechanics. → Tell the difference between ferrous and non-ferrous metals. → Say what an alloy is and why it is used. → Write a list of non-ferrous metals and alloys.

1

Metal processes

7 2 **Listen and complete the texts about the different processes metals can go through.**

Casting is a 6,000 year old process. It is the oldest and most well-known technique based on three fundamental steps: moulding, melting and (1) _____. First the pattern is made to form the **mould**. Then an empty mould is created, and finally the empty cavity is filled with molten metal which is then left to solidify into the shape. Casting materials are usually (2) _____ but can also be plastic, resin or various cold materials for example (3) _____. Casting is usually used for making complex shapes.



Drawing is a manufacturing process for producing wires, **bars** and (4) _____ by pulling on material through a series of **dies** until it increases in length. It is divided into two types: sheet metal drawing, and wire, (5) _____, and **tube** drawing. Drawing is usually done at room temperature but it can be performed at elevated temperatures to hot work large wires, **rods** or **hollow** sections in order to reduce forces.

Forging is the process by which metal is heated and shaped by a compressive force using a **hammer** or a press. It is used to produce large quantities of identical parts, such as (6) _____ parts in the automobile industry. Cold forging is done at a low temperature using (7) _____ metals and plastic. Hot forging is done at a high temperature and makes metal easier to shape without breaking. In the past, forging was done by a **blacksmith** using a hammer. Nowadays industrial forging is done with (8) _____ powered by a machine.

8 **Put the words in the correct order to make complete sentences.**

1 taking their forms / fluid substances / into moulds / solidify _____
2 drawing / room temperature / is done at _____
3 not essential / heat / is / in the drawing process _____
4 in the past / using / forging / a hammer / was done _____
5 can be / brittle materials / extrusion / done / with _____
6 many / is used / everyday objects / sheet forming / to make _____

9 **Work in pairs. Read the texts again and write the correct processes that produce the objects listed below.**

Product	Process
1 wires	
2 pasta	
3 sheet	
4 bricks	
5 tubes	
6 rods and bars	
7 golden leaves	
8 machine parts	
9 concrete	

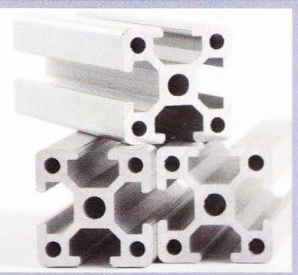
10 **Read the texts again and answer the following questions.**

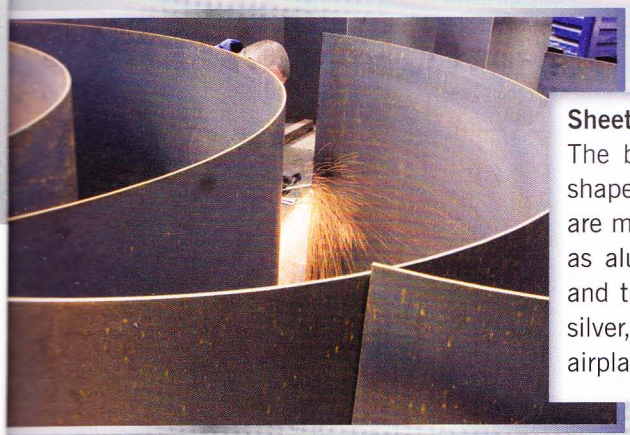
1 Which steps are included in casting?
2 What is the mould used for?
3 What does drawing use in order to process metals?
4 What types of drawing are there?
5 What kind of process is forging?
6 How was forging done in the past?
7 What does rolling consist of?
8 What materials can be used in rolling?
9 What are the advantages of extrusion?
10 What materials can be used in extrusion?
11 What kind of process is sheet metal forming?
12 What can vary in sheet metal forming?

Rolling is a metal forming (9) _____ in which a material (metal, plastic, paper or glass) is passed through a pair of rollers. According to the (10) _____ of material rolled, there is hot rolling or cold rolling.

Extrusion is a process used to produce objects with a fixed cross-sectional profile. A material is pushed or drawn through a die of the desired cross-section. The two main (11) _____ of this process are its ability to create very complex cross-sections and work materials that are brittle. The extrusion process can be done with hot or cold materials. Commonly extruded materials include metals, polymers, (12) _____, concrete and foodstuffs.

Ceramic can also be formed into shapes via extrusion. Terracotta extrusion is used to produce **pipes**. Many modern **bricks** are also manufactured using a brick extrusion process. Extrusion is also used in (13) _____ processing. Products such as certain pastas, many breakfast cereals, French fries, dry pet food and ready-to-eat snacks are mostly manufactured by extrusion.





Sheet metal forming is simply metal formed into thin and **flat** pieces. The basic forms can be cut and **bent** into a variety of different shapes. Everyday objects are constructed with this process. There are many different metals that can be made into sheet metal, such as aluminium, (14) _____, copper, steel, tin, nickel and titanium. For decorative uses, important sheet metals include silver, gold, and platinum. Sheet metal forming is used in car bodies, airplane wings and roofs for (15) _____.

MY GLOSSARY

alloy /ælɔɪ/ _____
aluminium /æljʊˈmɪniəm/ _____
bar /bɑː(r)/ _____
bent /bent/ _____
blacksmith /ˈblæksmɪθ/ _____
brass /brɑːs/ _____
brick /brɪk/ _____
brittle /ˈbrɪtl̩/ _____
bronze /brɒnz/ _____
cable /ˈkeɪbl̩/ _____
carbon /ˈkɑːbn/ _____
casting /ˈkɑːstɪŋ/ _____
concrete /ˈkɒŋkriːt/ _____
copper /ˈkɒpə(r)/ _____
die /daɪ/ _____
drawing /ˈdrɔːɪŋ/ _____
extrusion /ɪkˈstruːʒn/ _____
flat /flæt/ _____
hammer /ˈhæmə(r)/ _____
hollow /ˈhɒləʊ/ _____
to improve /tuː ɪmˈpruːv/ _____
to insulate /tuː ˈɪnsjʊleɪt/ _____
machinery /məˈʃiːnəri/ _____
mould /məʊld/ _____
to oxidise /tuː ˈɒksɪdaɪz/ _____
pipe /paɪp/ _____
plastic /ˈplæstɪk/ _____
rod /rɒd/ _____
rolling /ˈrəʊlɪŋ/ _____
rubber /ˈrʌbə(r)/ _____
shape /ʃeɪp/ _____
sheet /ʃiːt/ _____
steel /stiːl/ _____
tin /tɪn/ _____
tool /tuːl/ _____
tube /tjuːb/ _____
wire /ˈwaɪə(r)/ _____
zinc /zɪŋk/ _____