

AS LEVEL Section A

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Metal Part 1



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design



### Learning Outcomes

#### Students should be able to:

- Demonstrate knowledge of the available form of supply of metals;
- Understand the difference between ferrous and non ferrous metals and alloying;
- Demonstrate knowledge and understanding of the properties, working characteristics and uses of the following metals – aluminium, aluminium alloys, copper, brass, zinc, steel (mild, medium and high) and stainless steel;



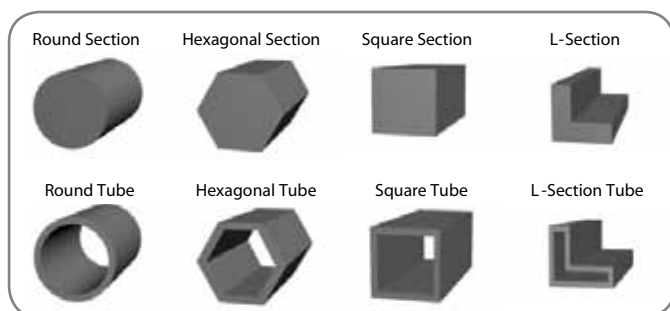
### Course Content

#### Available form and supply of metals

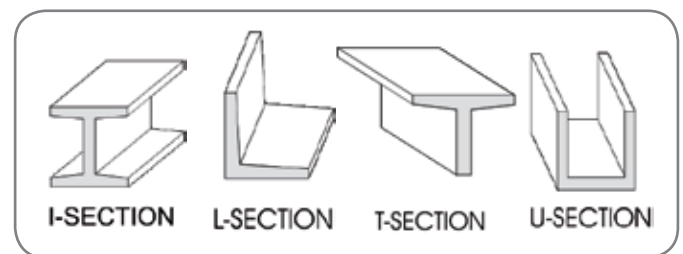
Metals make up a major portion of all the naturally occurring elements and form about quarter of the Earth's crust.

#### Forms and availability:

The diagrams below show examples of solid lengths and also tubes. When you order metals you need to describe the section you want. As well as being supplied in sheet form, the sections shown below are the most common.



Beams are used to 'span' distances, such as the distance between two walls. How well the beam works depends the material it is made from and its shape. In some buildings you can easily see the steel girders that hold the roof up. These are made from different 'sections' or shapes and some are named below.



#### Ferrous metals

Ferrous metals contain **Iron** and other elements. Almost all ferrous metals, including mild steel, cast iron and tool steel, are magnetic.

Iron is the basis for more sophisticated metals; however, in Britain, production depends on the importing of high-grade **magnetite ore**. The conversion of ore into a usable material involves a number of processes:

- Washing
- Grading
- crushing

In the production of iron, ore is refined in a blast furnace to provide pig-iron.

Ferrous metals and alloys include:

- Steel (mild, medium and high)
- Stainless steel
- Iron
- Cast iron

## Non-ferrous metals

This group of metals contain no iron. The following metals are included in this group:

- Aluminium
- Aluminium alloys
- Copper
- Brass
- Zinc

Aluminium is the most plentiful metal in the Earth's crust. Increasing demand for lightness combined with strength also makes it the largest, in terms of production output, with the non-ferrous category. Aluminium comes from its hydrated form, Bauxite.

## Alloys

**Alloys are a mixture of two or more metals** formed together with other elements to create new metals with improved properties and characteristics. There are two groups:

- Ferrous alloys
  - Stainless steel (steel and chromium)
  - High speed steel (steel and tungsten)
- Non-ferrous alloys
  - Brass (copper and Zinc)
  - Duralumin (aluminium and copper)

Properties of alloy steel, such as hardness, are increased by the addition of other metals such as chromium, tungsten, nickel and vanadium. **Carbon steels** can lose their hardness at high temperatures; however, high-speed steels maintain their hardness even at red heat. **High-speed steels** are used to manufacture cutting tools and drill bits.

**Stainless steel** contains 12% chromium and some nickel and offer qualities such as resistance to corrosion.

Material	Category	Melting point	Composition	Properties and working characteristics	Uses
Cast Iron	Ferrous	1200°C	Iron +3.5% carbon, wide range of alloys, white, grey and malleable forms.	Hard skin, brittle soft core, strong under compression, self lubrication, cannot be bent or forged.	Heavy crushing machinery, car brake drums or discs, vices or machine parts.
Stainless steel	Alloy (ferrous)		Alloys 18% chromium, 8% nickel, 8% magnesium.	Hard and tough, resists wear, corrosion-resistant, different forms affect malleability, difficult to cut or file.	Sinks, cutlery, dishes, teapots.
Mild Steel	Alloy (ferrous)		Alloys of iron and carbon 0.15-0.35% carbon.	Tough, ductile and malleable, high tensile strength, easily joined, welded, poor resistance and corrosion, cannot be hardened and tempered, general purpose material.	Nails, screws, nuts, bolts, Girders, car bodies.
High-speed steel	Alloy (ferrous)		Medium carbon steel + tungsten + chromium + vanadium.	Very hard, resistant to frictional heat even at red heat, it can only be ground.	Lathe cutting tools, drill bits, milling cutters.
Aluminium	Non-ferrous	660°C	Pure metal	High strength/weight ratio, light, soft, and ductile, annealing necessary, difficult to join, non-toxic, good conductor of heat and electricity, corrosion resistant, corrosion resistant, polishes well	Kitchen cooking utensils, packaging, cans, foils, window frames.
Copper	Non-ferrous	1083°C	Pure metal	Malleable, ductile, tough, suitable for hot and cold working, good conductor for heat and electricity, corrosion-resistant, easily joined, solders and brazes well, polishes well, rather expensive.	Hot water storage cylinders, central heating pipes/tubing, wire electrical, copper clad board (PCB).
Brass	Alloy (non-ferrous)	900-1000°C	65% copper, 35% zinc	Corrosion-resistant, increased hardness, casts well, work hardens, easily joined, good conductor of heat and electricity, polishes well.	Casting, boat fittings, ornaments.
Zinc	Non-ferrous	232°C	Pure metal	Very weak, poor strength/weight ratio, extremely resistant to atmospheric corrosion, low melting point, ductile but difficult to work, expensive.	Galvanised steel, dustbins, corrugated iron sheet roof, die casting alloys and rust proof paints.



## Revision questions

1. Electrical cables use copper for the wire and polythene for the outer cover. State **two** specific properties that would have influenced the selection of copper.
2. Metals are supplied and used in a range of forms.
  - State **four** different forms in which metal is available.
  - Drill bits can be manufactured from high carbon steel. Give **two** reasons why high carbon steel is used.
3. When selecting a metal for external gates, railing and stairs, the designer needs to consider the following:
  - Functional requirements
  - Manufacturing demands
  - Environment
  - Availability

From each of the **four** points above, briefly outline the information the designer would gain from each.

