

2.1.2: Product design (f) sources, origins, physical and working properties of materials, components, systems

Metals

- Ferrous metals contain iron.
- Non-ferrous metals do not contain iron.
- Alloys are combinations of a base metal with other metals or non-metals.
- Metals are sourced from ores, which are a natural resource and will run out.

Metals can be conditioned and finished using heat treatments. These include:

Annealing – heating then slowly cooling the metal to remove stress, make softer and refine structure.

Normalising – heating and then cooling the metal at room temperature, reducing hardness and increasing ductility.

Case hardening – This hardens an alloy's surface by adding carbon, heating and quenching.

Tempering – applied to steel and cast iron, increasing toughness and reducing hardness and brittleness. Tempering involves heating to a high temperature and air-cooling.

Hardening – heating and then cooling the metal rapidly by submerging into a liquid or oil.

Ferrous metal	Melting point
Mild steel	1300°C
Cast iron	1200°C
Non-ferrous metal	Melting point
Aluminium	660°C
Brass	900°C
Copper	1100°C

Natural and manufactured timber

- Natural timber is grown on trees!
- Manufactured timbers are man-made.
- Timbers are categorised into hardwoods and softwoods.

Hardwoods come from trees that shed their leaves in colder months. These trees take longer to grow, and these woods are more expensive. Common hardwoods are oak, beech, balsa and jelutong.

Softwoods come from coniferous trees that are green all year round and often have pinecones and needles. They are faster-growing than hardwoods and more easily available, which makes them less expensive. Scots pine, western red cedar and Parana pine are all common softwoods.

Manufactured boards are normally made from recycled wooded waste, mixed with additives including adhesive. Popular man-made boards are MDF (Medium Density Fibreboard), chipboard, hardboard and plywood.

Hardwoods and softwoods must be **seasoned** before use. This could be by kiln drying or air drying, to ensure all moisture is removed to **prevent shrinkage**.

Hardwoods tend to have close grain and are normally polished to enhance their natural aesthetic. Beech has a pink tint, and oak light-mid brown. Balsa is pale with widely spaced grain as it is a fast-growing hardwood (even though it is soft and lightweight).

Softwoods tend to be yellow/pale with contrasting grain, and sometimes knots.

Polymers

- Polymers that can be heated and shaped repeatedly are called thermoplastics/ thermoforming.
- Thermosetting polymers (or thermosets) can only be heated and shaped once.
- Some polymers are natural, some are synthetic.

Common thermoplastics include acrylic, polythene, polypropylene, Styrofoam, polystyrene and nylon.

Common thermosets include melamine, urea formaldehyde and epoxy resins.

Papers and boards

- Paper is made from wood pulp.
- Paper is fully recyclable, reducing the need for wood fibres from trees.

Paper is used for sketching, printing, and newspapers. It is measured in **gsm** (grams per square metre).

Card is thicker and is measured in **microns**. Card can be reinforced by adding a 'wavy' layer between two flat layers, to make **corrugated card**. It is brilliant for packaging. Paper and card need to be scored before bending.

Papers and boards can be textured, embossed, and have specialist coatings and finishes applied for specific purposes. Most papers and boards are printed on, some are laminated to ensure they retain a liquid and are not absorbent.