WJEC AS D&T Product Design In-depth Knowledge & Understanding 2.3.5 (a) Characteristics and properties of materials

Natural timbers

Timbers are split into two categories:

- Softwoods – comes from coniferous trees, which usually remain evergreen. These grow faster than hardwoods and usually have needles and pines instead of traditional leaves.
- Hardwoods – come from deciduous trees that shed leaves in autumn. These grow slower than softwoods and are less plentiful and more expensive as a result.

Oak, Beech, Mahogany, Ash and Balsa are all hardwoods. Generally, hardwoods are tough and durable, with close grain, with the exception of Balsa, which is very lightweight and soft, used for model making. Hardwoods are traditionally used for higher end furniture and furnishings.

Pine, Cedar, Larch and Spruce are all common softwoods. Softwoods tend to be paler in colour, with darker grain, and are generally more lightweight than hardwoods. Softwoods like pine are very popular for household construction and fencing.

Natural timbers require seasoning to lower moisture content prior to use.

Manufactured boards

Papers, cards, MDF, plywood, chipboard, hardboard and blockboard are all man-made materials, known also as regenerated materials. Often using recycling, these materials offer a greener, more 'eco' approach to sourcing materials and provide a 'cradle to cradle' cycle rather than disposal after use.

Polymers

Polymers can be synthetically engineered as well as obtained from natural sources, and fall into two categories:

- **thermosetting or thermosets**
- **thermoforming or thermoplastics**

Thermosetting plastics are heated, formed and cooled once. They cannot be reshaped or recycled. Common thermosetting polymers include epoxy resins (ER), melamine formaldehyde (MF), polyester resin (PR) and urea formaldehyde (UF).

Thermoforming plastics can be heated, shaped and cooled more than once and are much easier to recycle. These include polystyrene, polypropylene, PVC and acrylic.

Stock forms of materials

- Metals are generally sold as sheets, bars, rods, tubes and angles. Some are available on rolls, and some as wire.
- Polymers can come as powders, granules, films, foams, pellets, sheets, rods, tubes, and in some cases reels (PLA for 3D printing).
- Natural timbers are available as planks, boards and mouldings such as skirting boards.
- Manufactured boards tend to be available in sheets.
- Many stock forms come in standard sizes; papers start at largest A0 and tend to half in size down to A6.
- Cards and boards are available as sheets and rolls, with gsm and microns are also used to measure these.

Metals and alloys

Metals are also split into two categories:

- ferrous metals that contain iron, are magnetic and corrode
- non-ferrous metals do not contain iron, are not magnetic and corrosion resistant.

Ferrous metals include mild steel, carbon steel, cast iron and wrought iron. These will all require a protective finish applied.

Non-ferrous metals include aluminium, copper, lead, zinc, tin and precious metals like gold and silver. These metals tend to polish well but can oxidise.

Metals tend to be good conductors of heat and electricity, and have varying levels of ductility, malleability, flexibility, strength, durability and hardness.

Alloys are mixtures of metals with an element to improve its properties or aesthetics. Common alloys include brass, pewter, bronze and stainless steel. Alloys can be ferrous and non-ferrous and may require protective finishing.

Modern and SMART materials are more recently developed and can be considered performance materials. Carbon fibre is a modern composite which provides high strength-weight ratio and can achieve complex shapes and forms. Glass reinforced plastic is another composite used to replace more traditional materials. Kevlar is a popular woven modern material.

SMART materials are reactive and change when external stimuli is applied. Shape memory alloys (SMA), QTC and thermochromic and photochromic inks, sheets or pigments are all smart materials.