WJEC AS D&T Product Design In-depth Knowledge & Understanding 2.3.5 (d)
The performance characteristics of woods, metals, polymers

Performance characteristics of materials

These are qualities, traits or individual characteristics that are required of a material for it to perform effectively. These can often include **physical** properties like density or melting points and also **mechanical** properties like hardness and strength. There are also **electrical** properties to consider, along with **chemical, thermal** and **magnetic**. Some materials are selected based on **acoustic** and **optical** properties.

Definitions of properties

- **Thermal conductivity** – this is a material's ability to pass on heat, as a conductor or insulator.
- **Electrical conductivity** – a material's ability to allow electricity to flow through it as a conductor or insulator.
- **Hardness** – a material's ability to resist permanent indentation; the harder the material, the better it resists wear or deformation.
- **Density** – a measure of how heavy an object is for a given size e.g. mass per unit. Temperature changes can affect density of materials as there is some expansion, but this change will be very small.
- **Toughness** – a material's ability to absorb energy and deform without fracturing, rupturing or failing.
- **Ductility** – the ability to sustain a large permanent deformation under tension to the point of fracture, or be stretched plastically at room temperature with failing.

Definitions of properties

- **Elasticity** – this is a material's ability to return to its original shape once the forces deforming it are removed.
- **Durability** – a material's ability to withstand wear or damage.
- **Tensile strength** – the ability to withstand a pulling force without stretching.
- **Compressive strength** – the capacity to withstand compressive stress without fracturing.
- **Malleability** – ability to be formed or shaped without breaking.

Properties of timbers

Natural timbers tend to be good based on the following properties: durability, strength, hardness, toughness, and elasticity. Natural timbers are not good conductors of heat and electricity, and are therefore good insulators.

Manufactured boards, on the other hand, are good insulators of heat and electricity, and do not warp as much as natural timbers. Manufactured boards are also strong; blockboard is more durable than others, especially MDF, which is prone to bending.

Properties of papers and boards

Papers and boards vary in thickness and this has an impact on strength. Durability can be low, especially when wet, if painted or printed on. Corrugated card is stronger and more rigid. Carton board provides increased compressive strength and moisture resistance. Papers and boards are good insulators.

Properties of metals

Metals tend to be very good conductors of heat and electricity. Most metals have high density and are malleable and ductile. All metals are hard, and this can be increased when a heat treatment finishing process is applied to some metals.

Steel requires 99% iron and 1% carbon in order to be strong, light and more workable than pure iron.

Alloys are developed to have specific properties like hardness, toughness, corrosion resistance and ductility depending on their composition. As a mixture of two or more elements, alloys like brass, pewter and bronze have properties which vary from those of its component elements.

Alloying metals offers enhanced properties, which may not be apparent as a physical material, but only when used in an engineering situation.

Unlike pure metals, alloys do not have a specific melting points, but instead a melting range depending on the alloy's exact structure.

Interrelationships between materials, form and manufacturing processes.

There is a close connection between the material, the shape or form required and the manufacturing process selected for that material to achieve that particular form.

It is sometimes debatable as to which of the three areas leads the way, but due to their individual importance, they are all critical.