

Year 10 Design & Technology Knowledge Organiser: Theory: Unit 1

Physical properties of materials

keyword	definition
absorbency	the tendency to soak in something such as liquid, heat and light
density	the mass of a material per unit of volume, how compact the material is
fusibility	the ability of a material to change from one state to another to allow it to be joined with another material
electrical conductivity	the ability to conduct electricity (pass through)
thermal conductivity	the ability of a material to conduct heat

Working properties of materials:

keyword	definition
strength	the ability of a material to resist force and stress without breaking
hardness	the ability to resist abrasive wear through impact. very hard materials are prone to being brittle
toughness	the ability to absorb shock without fracturing
malleability	the ability to deform under compression without cracking, splitting or tearing
ductility	can be drawn out into a thin strand without snapping
elasticity	the ability to return to it’s original shape after being compressed or stretched

Manufactured boards

- usually made from timber waste and **adhesive**
- often **veneered** to make them more aesthetically pleasing
 - cheap to buy

	Working and physical properties	Uses
 MDF Medium-density fibreboard	- dense - absorbent – can be damaged by moisture - smooth, even surface– takes finishes well - light brown - no grain	- flat pack furniture - shelving
 Plywood	- very strong due to multiple layers glued at right angles - easy to cut and finish - can be stained or painted	- construction - furniture - toys
 Chipboard	- not very strong - absorbent – can be damaged by moisture - rough, uneven surface so often coated with a veneer	cheap self assembly furniture



Softwoods come from **coniferous** trees. Coniferous trees have **needles** and are **evergreen**. They **grow quickly**.

Soft Cats Eat Pork, Lamb and Sausages

	working properties	physical properties	uses
pine	quite strong	yellow with brown streaks	- cheap furniture - construction work - joinery
larch	- hard - tough - durable	- yellow to reddish brown - resistant to rot	- decking - building cladding - boats and yachts
spruce	- strong - hard - not very durable	good strength to weight ratio	- crates - ship masts - aircraft frames



Hardwoods come from **deciduous** trees. Deciduous trees have **broad leaves** and **lose their leaves** in winter. They **grow slowly**.

Hard Dogs Leave Bad Bite Marks On Arms

	working properties	physical properties	uses
oak	- very strong - hard - tough durable	- open grained - light brown	- high quality furniture - indoor flooring
mahogany	- fairly strong - durable	reddish brown	high quality furniture
ash	- tough – absorbs shock well - flexible	- open-grained - light creamy brown	- tool handles and ladders - sports equipment
balsa	very soft	- off-white to tan - low density	modelling
beech	hard	pinkish-brown	- chairs - and toys

natural fibres:

- come from **plants and animals**
- are **biodegradable** and **sustainable**
- are **non-allergenic**

cotton: strong, durable, absorbent, crease easily

wool: warm, soft, absorbent, crease resistant

silk: smooth, lustrous, strong

A fibre is thin hair-like structure that can be either long or short.

- Short** fibres are called **staple** fibres.
- Long** fibres are called **filament** fibres.

synthetic fibres:

- are made from chemicals found in **fossil fuels**
- are **less sustainable** than natural fibres as fossil fuels are non-renewable
- can **cause more environmental damage** through extracting the fossil fuels and through the processes used to make the fibres
- are **not biodegradable**

elastane (Lycra): extremely elastic, strong, durable, lightweight, not absorbent, highly flammable

polyester: strong, durable, highly elastic, crease resistant, dries quickly, not absorbent, melts as burns

polyamide (Nylon): strong, durable, warm, good elasticity, crease resistant, not very absorbent, melts as burns

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- Papers and boards are usually made from wood, bamboo, hemp or cotton.
- All FSC wood can be traced from forest to store
- Papers and boards are available in three stock forms; rolls, sheets and ply
- The **weight of paper and board** is measured in **gsm – grams per square metre**. The higher the gsm, the thicker and heavier the product. Standard printer paper is around 80gsm. Above 200gsm it is not paper anymore- it is board (also known as card or cardboard).
- Paper is sold in A sizes

Papers & boards

Common papers include: bleed proof, cartridge paper, grid paper, layout paper and tracing paper.

Common boards include inkjet card, foam core board ...

corrugated card:

- a fluted core between two outer layers
- can be printed on
- strong and rigid
- from 250 gsm +

solid white board:

- high quality bleached surface
- excellent for printing
- strong
- 200-400gsm

foil lined board:

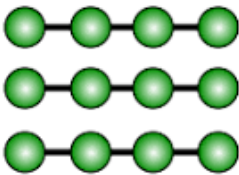
- has an added aluminium foil lining to keep flavour in, insulate or keep moisture in or out

Duplex board (carton board):

- one smooth white side
- tough
- lower cost than solid white board
- might have additives to prevent moisture transfer
- 230-420gsm

Polymers

Plastics are synthetic polymers made from polymers, obtained from finite resources such as crude oil and natural gas. Plastics are increasingly being produced using more sustainable sources such as vegetable starches



Thermoforming plastics (or thermoplastics):

- generally more flexible
- polymer chains are quite loose with very few cross links
- when they are reheated they can be reshaped

PMMA



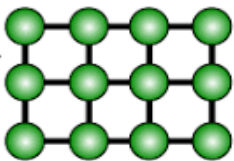
HDPE



PP



PETE



Thermosetting plastics (or thermosets)

- more rigid and once they have been formed or set they cannot be reformed
- polymer chains have many cross links which stops them from moving
- Thermosets will burn when heated rather than melt.

Epoxy resin (ER)



Urea formaldehyde (UF)



Melamine formaldehyde (MF)



Composite materials are made up of different materials which are combined to improve their properties.

- Fibre-based composites** (reinforced with fibres)

- Particle-based composites** (made with small particles of material)

Carbon reinforced plastic is used in F1 car bodies, helmets and sports equipment



Concrete- a mix of cement, sand and aggregate. Used in construction and street furniture

- Sheet-based composites**

These are manufactured boards. They are mixed together with glue either with chips of wood or thin layers

Metals & alloys

- Metal ores are mined from the earth
- Once ore is mined, any waste material must be separated, this is called smelting
- Bauxite ore is the primary source of aluminium
- Precious metals such as gold, silver and platinum are naturally occurring and rare.
- Other metals are extracted by being heated in a blast furnace - including iron and copper
- Most metals can be recycled

Ferrous metals contain iron, are magnetic and prone to corrosion

- low carbon steel
- cast iron
- high carbon/ tool steel



Non ferrous metals do not contain iron, are not magnetic and are not easily corroded.

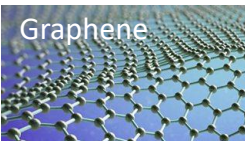
- aluminium
- copper
- tin
- zinc



Alloys include brass, stainless steel and high speed steel.

Modern materials

A modern material is a material that has been **engineered to improve it's properties**. Examples include...



Graphene



Titanium



Metal foam



LCD- Liquid crystal displays (LCDs) use the light-modulating properties of liquid crystals to display an image.

Nanomaterials are tiny particles of 1 to 100 nanometres (nm).



They are used for thin coatings such as phone screens or materials that repel water.

Smart materials

A smart material is one that **changes with a stimuli** such as **heat, light, moisture and pressure**.



Thermochromic- reacts with heat



Photochromic – reacts to light



Polymorph- is a polymer that becomes malleable when 62 degrees. When cooled it gets hard but if heated again can be remoulded



Quantum-tunnelling composite (QTC) is an insulating rubber containing tiny particles of metal. When squashed, the metal particles meet and allow the flow of electrical current.