Year 9 Knowledge organiser

Engineering materials and properties

Types of materials		
Ferrous Metals	Ferrous metals which contain **iron**. They may have small amounts of other metals or other elements added, to give the required properties. They will corrode if unprotected	Iron, carbon steels, high speed steels
Non Ferrous metals	Non Ferrous metals which do not contain iron. Pure metals (have no other metal or element)	Copper, brass, bronze, aluminium, zinc, tin, lead, titanium
Polymers		
Thermo plastics	**Thermo Plastics** -usually a plastic polymer, which becomes more soft when heated and hard when cooled. **Thermoplastic** materials can be cooled and heated several times without any change in their chemistry or mechanical properties	ABS, Polyethylene, HIPS, PVS, polycarbonate, polypropylene
Thermoset plastics	polymer that irreversibly becomes rigid when heated.	Polyseter resin, urea – formaldehyde, epoxy resin, phenol- fromaldehyde.
Ceramics	A ceramic is an inorganic non-metallic solid made up of either metal or non-metal compounds that have been shaped and then hardened by heating to high temperatures.	Tungsten carbide, glass, ceramic bearing material
Composites	A composite material is a material made from two or more materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the original components	Glass reinforced plastic, Carbon fibre, concrete
Smart Materials	Smart materials, are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds	Shape memory alloys, thermochromic materials, Shape memory plastics, Quantum Tunnelling Composite.
Alloys	Alloying metals involves mixing two or more metals and other elements to improve their properties.	

High Carbon Steel

The hardest of the carbon steels. Less ductile, tough and malleable.
Uses - Chisels, hammers, drills, files, lathe tools, taps and dies

Medium Carbon Steels

Stronger and harder than mild steels. Less ductile, tough and malleable.
Uses - Metal ropes, wire, garden tools, springs.

Cast Iron

Hard, brittle, strong, cheap, self-lubricating.Whitecast iron, grey cast iron, malleable cast iron.
Uses - Heavy crushing machinery. Car cylinder blocks, vices, machine tool parts, brake drums, machine handle and gear wheels, plumbing fitments.

Aluminium

Greyish-White, soft, malleable, conductive to heat and electricity, It is corrosion resistant. It can be welded but this is difficult.
Uses - Aircraft, boats, window frames, saucepans, packaging and insulation, pistons and cranks.

Copper

Red, tough, ductile, High electrical conductor, corrosion resistant, Can work hard or cold. Needs frequent annealing.
Uses - Electrical wire, cables and conductors, water and central heating pipes and cylinders. Printed circuit boards, roofs.

Aluminium alloys

Ductile, Malleable, Work Hardens.
Uses - Aircraft and vehicle parts.

Brass

Very corrosive, yellow in colour, tarnishes very easily. Harder than copper. Good electrical conductor.
Uses - Castings, ornaments, valves,forgings.

Mild Steel

Tough, high tensile strength, ductile. *Because of low carbon content it can not be hardened and tempered. It must be case hardened.*
Uses - Girders, Plates, nuts and bolts, general purpose.

High Speed Steel

Can be hardened and tempered. Can be brittle. Retains hardness at high temperatures.
Uses - Cutting tools for lathes.

High Tensile Steel

Very strong and very tough.
Uses - Gears, shafts, engine parts.

Stainless Steel

Corrosion resistant
Uses - Kitchen draining boards. Pipes, cutlery, aircraft.

Properties of materials	
malleability	The ability of a material to permanently deform in all directions without cracking.
ductility	The ability of a material to deform, usually by stretching along its length.
conductivity/resistivity	The ability of a material to conduct heat or electrical energy. Opposite for resistivity
hardness	**Resistance of a material to deformation, indentation, or penetration by means such as abrasion, drilling, impact, scratching**
machinability	**Machinability is a characteristic of a material, such as a metal, that makes it easy to drill, shape, cut, grind**
corrosion resistance	**How well a substance (especially a metal) can withstand damage caused by oxidization or other chemical reactions**
elasticity/plasticity	The ability of a material to permanently change in shape.

Materials and uses	
Ferrous and non ferrous metals and alloys	**Used for cast iron machine bases, bronze for boat propellers, Copper used in wiring and circuit boards.**
Thermoplastics	**ABS for appliance casing**
Thermoset Plastics	**Phenol-formaldehyde for heat resistant saucepan handles.**
Ceramics	**Tungsten carbide for cutting tool tips)**
Composites	**Carbon fibre for bicycle frames**
Smart materials	**Shape memory alloy in alarm systems**

Destructive testing	is undertaken in order to understand a specimen's performance or material behaviour, these procedures are carried out to the test specimen's failure.	Tensile Testing, Hardness testing
Non Destructive Testing	is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system for characteristic differences or welding defects and discontinuities without causing damage to the original part	Conductivity testing, Crack testing, Ultra Sonic Testing