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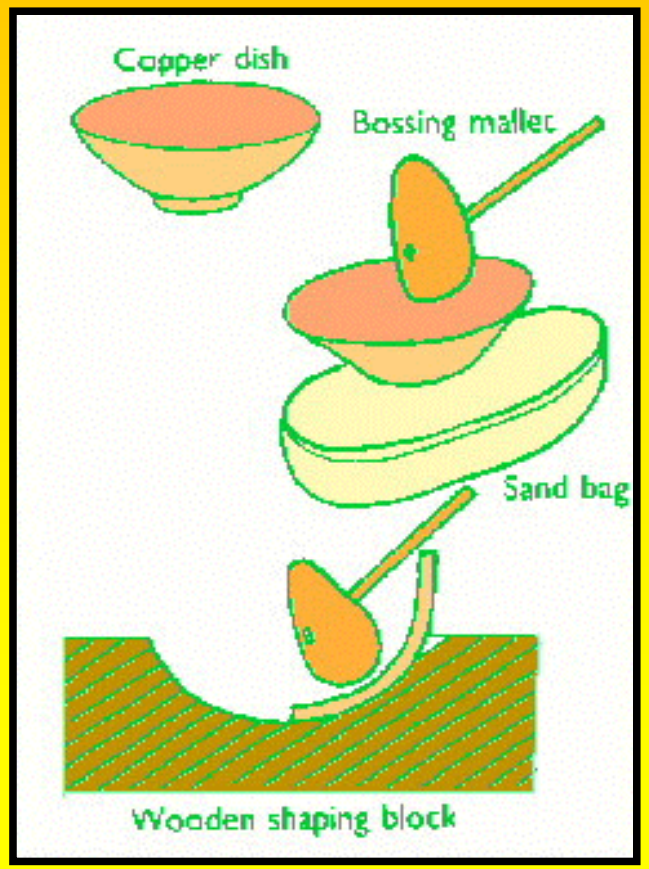
MATERIALS` PROPERTIES

MALLEABILITY - if a material can be deformed in all directions by such as hammering and pressing without it cracking or splitting it is said to be malleable. These materials need not be strong but they need to be 'plastic'. That is they need to be able to be bent often without breaking. Lead is a good example of a metal which is malleable.



TOUGHNESS

The ability to withstand sudden shocks or blows without it fracturing. It can also be applied to the ability of a material to withstand cracking if it is subjected to bending forces or shear forces.

BRITTLENESS

This is the opposite of toughness. Materials that are brittle cannot withstand any strain before they crack or break. Two good examples of this type of material would be acrylic and glass.

STABILITY

Materials which are stable resist changes in size and shape, which can often be caused by weather, particularly wet or dry conditions. Wood tends to warp and twist if it gets too wet or dry. Plastic tends to bend and stay bent if it is subject to constant force. This stretching due to force is called 'creep'. It is most important that certain objects such as turbine blades resist 'creep' because they are subjected to a lot of rotational force and high temperatures which are known to cause 'creep'.

DUCTILITY - usually means the ability of a material to be stretched twisted or bent without breaking. All ductile materials are malleable but all malleable materials are not necessarily ductile. For example clay can be easily shaped but when you try to stretch it, it breaks.

ELASTICITY - the ability to flex and bend when forces are applied and then return to normal when the forces are removed (eg. an elastic band).

HARDNESS

Any material which can resist wear and tear, denting and twisting and bending is said to have the quality of hardness. Drills, files emery cloth and glasspaper have these qualities.

SOLID TIMBER

Woods are classified into two main groups, softwoods and hardwoods. You should try to understand the main differences between softwood and hardwood and be able to give a couple of examples of each.

Click to see some examples . . .

SOFTWOODS

HARDWOODS

It would also be useful for you to know about seasoning of timber and to know about some of the defects which commonly occur in trees.

Click to find out . . .

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SOFTWOOD

- Usually evergreen trees (Don't lose their leaves)
- Grow fast therefore cheaper.
- Often used as construction material as trees grow tall and straight giving long planks

European redwood		Quite strong, Lots of knots, durable when preserved. cheap		General woodwork, cupboards, shelves, roofs.
Stika Spruce		Tough, easily worked, straight grain. cheap		Indoor work only, low cost furniture
Parana pine		Tough with fine grain, prone to twisting		General woodwork, fitted furniture
Douglas fir		Strong, needs protection outdoors		Furniture, plywood, doors, windows. (Xmas trees)
Red cedar		Soft and weak.Very durable against weather, insects and rot		Weather boarding

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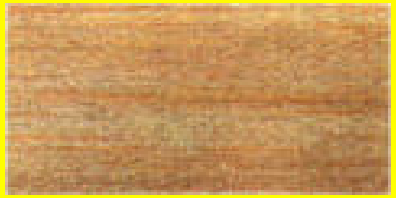
HARDWOOD

- Hardwoods are usually have broad leaves and are deciduous (lose their leaves)
- Distinguished from softwoods by the structure of the grain
- They are generally more expensive than softwoods as they take longer to grow

Oak		Very strong,tough, durable.		Furniture, veneers, doors, fences
Beech		Close grain works and finishes well, Hard and strong but not durable outdoors		Wood floor in your house Functional furniture, tools, toys
Mahogany		Hard and Strong but not easy to finish. Expensive Indoor work only		Expensive furniture, veneers
Teak		Very durable, Fire resistant, but quickly blunts tools		Fine furniture, chairs, tables, shop fronts
Balsa		Very light and very soft, but strong for its weight		Model making, life belts, rafts

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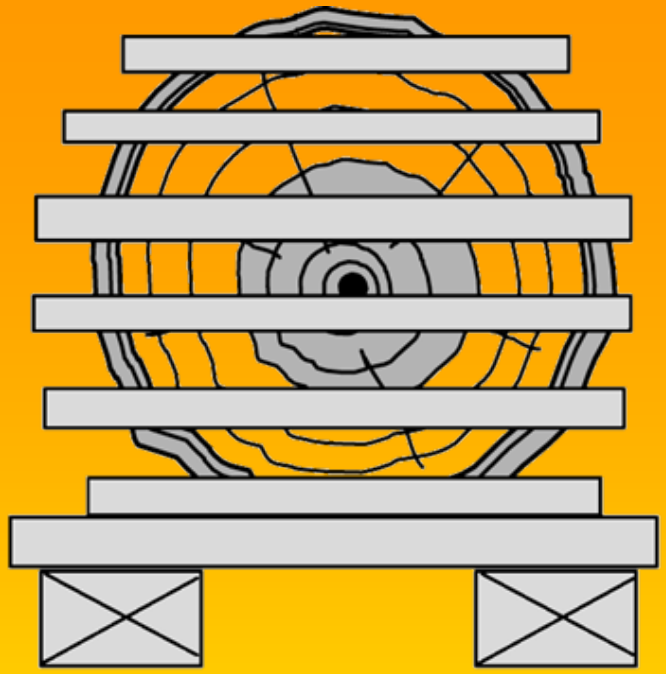
SOLID TIMBER

SEASONING



Seasoning is the controlled process of reducing the moisture content of the timber so that it is suitable for the environment and intended use. We need to reduce the moisture content of timber for the following reasons:

- Every time the moisture content reduces the timber shrinks.
- Consequently it will show fewer tendencies to warp, split or shake.
- Seasoned timber although lighter will be stronger and more reliable.
- The sap in timber is a food for fungi and wood parasites. Remove the sap and the wood will be less attractive to these dangers.
- Dry well seasoned timber is stronger.
- Dry well seasoned timber is easier to work with and consequently safer especially machine working.
- Timber with higher moisture content is difficult to finish i.e. paint, varnish, etc.

There are two main ways of seasoning timber, Natural (Air) and Artificial (Oven) drying. Both methods require the timber be stacked and separated to allow the full circulation flow of air, etc. around the stack.

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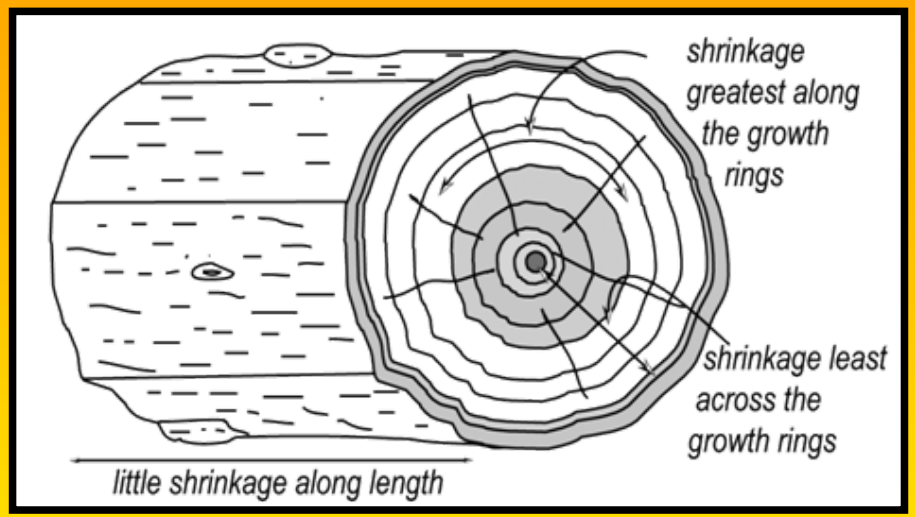
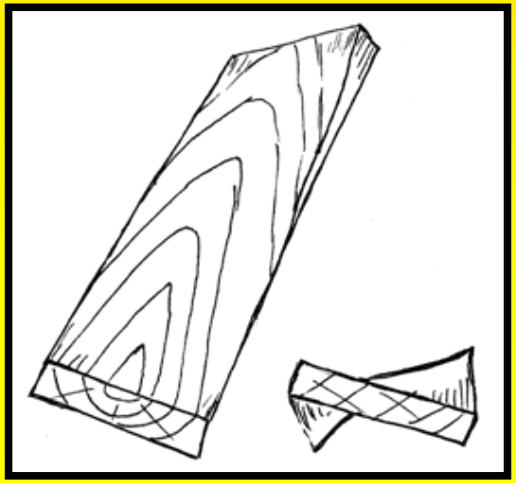
DEFECTS

Because wood is a natural material, we have to put up with the fact that it will not be perfect and will come with some flaws (defects). Here are some of the most common defects found in timber.



SHRINKAGE

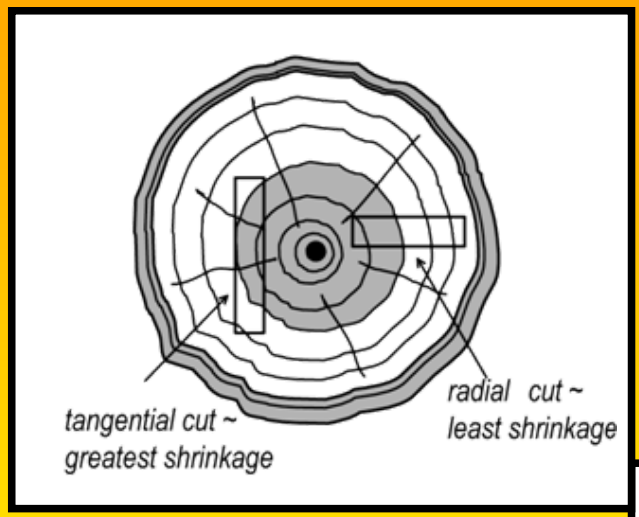
When timber is seasoning and it's moisture content (MC) is reduced below the Fibre Saturated Point (FSP) continued drying will cause dramatic change such as increase in strength but also distortion and shrinkage.



TWISTING

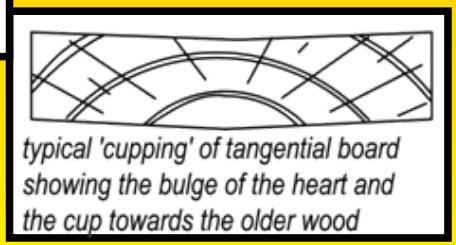
This happens due to the board being cut close to the centre of the tree which has spiral grain.

The board is not of much use but small cuttings may be obtained from it with careful selection.



CUPPING

Depending on which way a board is cut out of a tree, more or less 'cupping' will result. Some rings are much longer than the others close to the heart therefore there will be more shrinkage at these parts than the others ~ cupping is the result.



typical 'cupping' of tangential board showing the bulge of the heart and the cup towards the older wood

BOW

Bow is a seasoning and/or storage defect caused by the failure to support the board with stickers at sufficient intervals. The boards own weight and probably those above it bears down and the resultant bow is inevitable.

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MANUFACTURED BOARDS

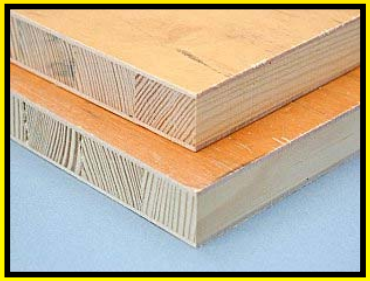
Where wood is required to cover a large surface, solid timber is usually not the solution. The widest solid planks are restricted by the maximum width of a tree. Where wide wooden objects are required (table tops, doors etc.), manufactured boards are often the solution. There are many types of board to consider.

PLYWOOD

Plywood is probably the most widely available manufactured board material. It is made by bonding together a number of thin veneers of softwood or hardwood - or a combination of each. There is always an odd number of veneers and the direction of the grain runs alternately to give the material strength; the more veneers used, the stronger the plywood. Both the type of glue and veneers determine the suitability of a sheet for a particular application. The finish quality of plywood varies enormously, some have attractive grains while others can have a large number of knots.

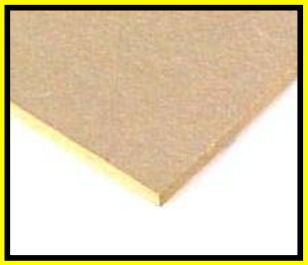
CHIPBOARD

Chipboard is made by bonding together wood particles with an adhesive under heat and pressure to form a rigid board with a relatively smooth surface. Chipboard is available in a number of densities; normal, medium and high-density. Normal density is fairly soft and 'flaky', high-density is very solid and hard (often used for worktops and fire doors) - medium density is somewhere in between.



BLOCKBOARD

Blockboard is composed of a core of softwood strips (up to about 25mm wide) placed edge to edge and sandwiched between veneers of hardwood, the 'sandwich' is then bonded under high pressure.



MDF – medium density fibreboard

MDF is made from wood fibres glued under heat and pressure. MDF has many qualities that make it an ideal alternative to plywood or chipboard. It is dense, flat, stiff, has no knots and is easily machined. Its fine particles provide a material without a recognisable "grain". Unlike plywood and blockboard, MDF contains no internal voids (small holes), and will produce better edges providing it is correctly machined.

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FERROUS & NON-FERROUS METALS

While preparing for the Standard Grade exam, you must get yourself familiar with the range of common metals to be found in a workshop. They fit in two categories, 'ferrous' and 'non-ferrous' metals. These metals can be used to build/manufacture a wide range of items. Study the properties of the materials below.

FERROUS METALS - Metals that contain iron.

NAME	ALLOY OF	PROPERTIES	USES
Mild Steel	Carbon 0.1 - 0.3% Iron 99.9 - 99.7%	Tough. High tensile strength. Can be case hardened. Rusts very easily.	Most common metal used in school workshops. Used in widely in engineering.
Carbon Steel	Carbon 0.6 - 1.4% Iron 99.4 - 98.6%	Tough. Can be hardened and tempered.	Cutting tools such as drills.
Stainless steel	Iron, nickel and chromium.	Tough, resistant to rust and stains.	Cutlery, medical instruments.
Cast iron	Carbon 2 - 6% Iron 98 - 94%	Strong but brittle. Compressive strength very high.	Castings, manhole covers, engines.
Wrought iron	Almost 100% iron	Fibrous, tough, ductile, resistant to rusting.	Ornamental gates and railings.

NON-FERROUS METALS - Do not contain iron

NAME	COLOUR	ALLOY OF;	PROPERTIES	USES
Aluminium	Light grey	Aluminium 95% Copper 4% Manganese 1%	Ductile, soft, malleable, machines well. Very light.	Window frames, aircraft, kitchen ware.
Copper	Reddish brown	Not an alloy	Ductile, can be beaten into shape. Conducts electricity and heat.	Electrical wiring, tubing, kettles, bowls, pipes.
Brass	Yellow	Mixture of copper and zinc 65% - 35% most common ratio.	Hard. Casts and machines well. Surface tarnishes. Conducts electricity.	Parts for electrical fittings, ornaments.
Silver	Whitish grey	Mainly silver but alloyed with copper to give sterling silver.	Ductile, Malleable, solders, resists corrosion.	Jewellery, solder, ornaments.
Lead	Bluish grey	Not an alloy.	Soft, heavy, ductile, loses its shape under pressure.	Solders, pipes, batteries, roofing

METALS

FERROUS & NON-FERROUS

WHERE DOES METAL COME FROM

WHAT ARE ALLOYS

PROPERTIES OF METALS

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THERMO PLASTICS & THERMOSETTING PLASTICS

Plastics are to be seen all around us and there are two main groups:

THERMOSETTING PLASTICS → Once 'set' these plastics cannot be reheated to soften, shape and mould.

THERMOPLASTICS → These plastics can be re-heated and therefore shaped in various ways.

EXAMPLES - THERMOPLASTICS

These plastics possess a common property, they soften when heated and are often used in schools to vacuum form shapes. Usually, when heated and formed into a shape - if reheated they return to their original shape.

Acrylic. (Known also as PERSPEX) This is the most common plastic in a school workshop. It is purchased usually in the form of sheets and comes in a range of colours. It can be translucent (e.g. smoked), transparent or opaque. It is resistant to most acids and weather conditions.

Polythene. Can be moulded into almost any form due to its excellent moulding qualities. Used for the production of bottles, bowls, toys, tube etc... It is available in large sheets. There are two types: High density which is rigid and hard, and low density which is tough and flexible. Machine parts are generally made from high density polystyrene whilst bottles are made from the low density polystyrene.

Polyvinyl Chloride. Better known as PVC. It is a tough material which can be purchased as a hard material or alternatively a flexible form. It can be welded or bonded with an adhesive. It has a range of uses including water pipes, raincoats, long play records, coating on electrical wires and many more.

EXAMPLES - THERMOSETTING PLASTICS

Many **adhesives (glues)** are thermosetting plastics. A good example is 'Araldite' which is an epoxy resin that hardens when a second chemical is added (a catalyst). It will bond most materials including woods and metals as well as some plastics.

Polyurethane. This forms the basis of many paints and varnishes because it is very tough and has water resistant qualities.

Melamine Formaldehyde. Used in the production of plastic laminates because of its smooth surface and hygienic qualities. It is also used in electrical plugs and sockets because it can be cast and it is an excellent insulator.

Polyester resins. If resins are combined with a material such as fibre glass the result is a very tough material that can resist impact. This type of material is known as a *glass reinforced plastic* (GRP) and is used in car body repairs, sailing boats, corrugated sheet because of its lightness, toughness and resistance to water.

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PLASTICS

INJECTION MOULDING

THERMO & THERMOSETTING

BLOW MOULDING