

# 2 THEORY workshop safety

## Workshop Safety

Safety is of major importance in any craft room, it is imperative that safe working practices are observed at all times. Failure to observe safety rules will result in that individual losing the privilege to work in the craft room.

### Some general safety precautions

1. Work benches and machines must always be swept clean after use. Think of the person who has to use them NEXT.
2. ALWAYS walk when in the workshop, running causes accidents.
3. If sharp tools must be carried in the work shop they must be carried facing downwards.
4. ALWAYS work with sharp tools, blunt tools cause accidents.
5. Before any work commences all jackets should be removed and hung up. All bags placed under the workbench. Any loose cloth or hair should be tucked in or tied back.
6. Pupils should be familiar with the position and operation of the emergency stop buttons in workshops. ONLY press if an EMERGENCY arises.
7. Eye protection must be worn if operating any machinery.
8. Report any damaged tools, equipment, etc. to the teacher.
9. ALWAYS store tools in the well of the bench when not in use.
10. ALWAYS keep both hands behind the cutting edge when working with a chisel.
11. NEVER strike two hammer faces together. Flying metal chips could cause serious injury.
12. ALWAYS use a file fitted with a handle, tangs are sharp and very dangerous if used without a handle. If you are unsure what a tang is, ask your teacher, after all that is why they are there.
13. ALWAYS check machines to ensure that any rotating parts are properly guarded and free to rotate without obstruction, e.g. ensure before switching on that the chuck key is removed from the Jacob's Chuck. Never use a machine without permission from the teacher.

The Workshop is a Safety Zone

# THEORY Woods

## Softwood

These come from coniferous trees (trees that have needle like leaves and last throughout the year). Unlike hardwoods these grow quickly and can be replaced quickly after being cut down. Softwoods are cheap.

## Hardwood

These come from deciduous trees (trees that lose their Leaves every winter). they grow slowly and sometimes have twisted trunks. They are often not replaced when cut down and take a long time to grow. Their wood is expensive and used for high quality products

Name	Properties	Uses	Cost
Red Pine	Straight grained, but knotty, quite strong and easy to work. Red/ orange in colour	Building construction. Needs good protection when used outside.	Low
Parana Pine	Straight grained with few knots. Quite strong and durable but warps easily.	High quality interior construction and furniture.	High
Spruce (whitewood)	Quite strong with few knots. Resistant to splitting but not durable.	Fitted furniture e.g. Kitchen cabinets.	Low
Cedar	Straight grained and knot free. Very light and durable. Quite soft	Shed construction and good quality fencing.	High

Name	Properties	Uses	Cost
Ash	Light in colour, flexible, tough bends well and varnishes well.	Tool handles, cricket/baseball bats, snooker cues, ladders and veneers.	Med
Beech	Mid-brown colour, hard, strong, tough, tends to warp but bends well.	High quality furniture, toys, tool handles and veneers.	Med
Oak	Light brown, hard, tough, heavy and durable outside. Gets harder with age.	high quality furniture, garden furniture, boats and veneers.	High
Mahogany	Red in colour, medium weight, quite strong, durable but warps easily.	high quality furniture, shop furniture, boat fittings and veneers.	High

Timber is usually supplied in the following sections.

Planks - Vary from 38mm to 100mm in thickness and over 100mm in width

Boards - Less than 38mm in thickness and over 100mm in width.

Strips - Less than 38mm in thickness and less than 100mm width.

Squares - Square Section - thickness same as width.

Dowel Rods - Dowel Rods, or cylindrical wooden pegs, are variable in sizes

# 2 THEORY manmade boards

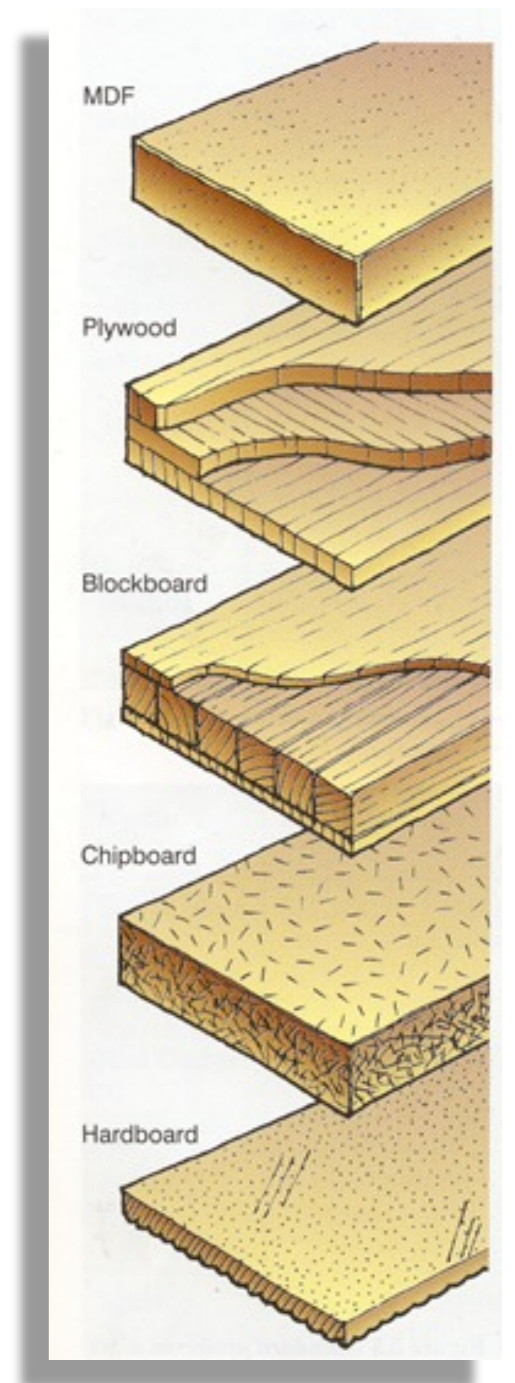
## Manmade Boards

These are made from waste wood left over from machining or working. All excess such as thin sheets (plywood), small strips/blocks (blockboard), wood chips (chipboard) and saw dust (MDF) are used to make boards.

Name	Properties	Uses	Cost
Plywood	Strong, stable, warps easily. Made by gluing layers of thin sheet wood together. It is important that the grain of each layer goes in a different direction to ensure maximum strength.	Bases of drawers or boxes. Backs of cabinets and wardrobes etc.	Med
MDF	Very strong and doesn't warp. Made from gluing and tightly compressing excess sawdust together.	Furniture and toys.	Med
Blockboard	Very strong and rigid and doesn't warp. Very heavy. Made from gluing strips/blocks of wood together.	Quality furniture, stage flooring and fire doors.	High
Chipboard	Heavy, warps easily and needs a good finish. Made by gluing and tightly compressing wood chips together.	Kitchen cabinets and worktops, roofing boards.	Low
Hardboard	Not very strong, warps easily and needs a good finish. Made similar to plywood.	Door panels, drawer bottoms and cabinet backs	Low

Manufactured boards have a number of advantages over wide wooden boards or planks:

- There is a limit to the number of wide boards that can be cut from a tree and this makes it expensive.
- Manufactured board is available in sizes up to 1525mm wide whereas hardwood is typically 300mm and softwood is 200mm maximum.
- Manufactured board is stable and of uniform thickness and consistent quality.



# THEORY metal

## Metals

All metals in use today are either PURE METALS or ALLOYS. Copper, iron, tin, lead, gold and silver are all examples of PURE METALS which have been mined from the Earth and extracted from the ore using a process called SMELTING.

An ALLOY is a mixture of pure metals or a metal with a substance such as carbon added; examples of alloys are:- Steel (Iron & Carbon), Duralumin (Aluminium & Copper), Brass (Copper & Zinc) & Bronze (Copper & Tin).

### Ferrous Metals

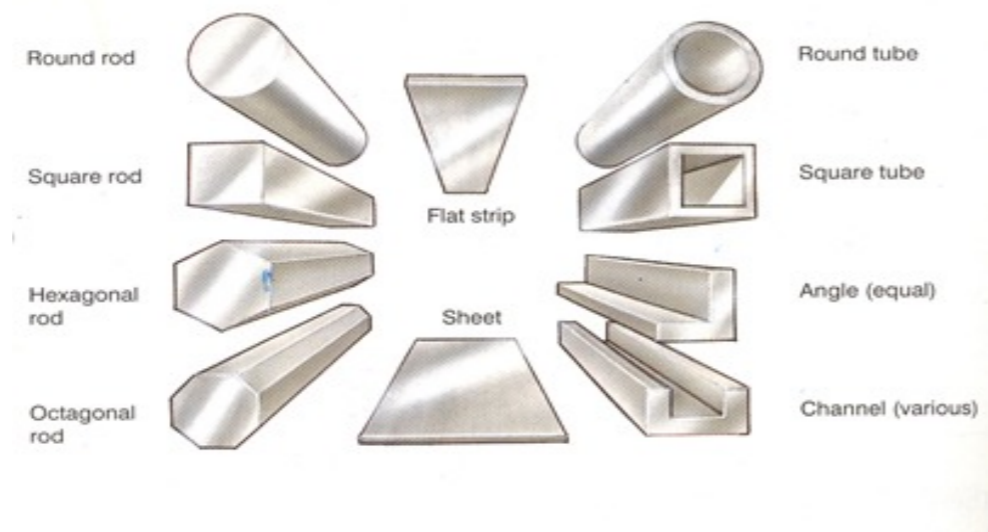
This category of metals contain iron and are usually magnetic; examples of such are Cast Iron, Mild Steel, High Carbon Steel, etc.

Name	Composition	Properties	Uses
Cast Iron	Iron + 3.5% Carbon	Smooth, soft core, strong when compressed, cant be bent or forged.	Vices, lathe beds, garden bench ends and car brake drums.
Mild Steel	Iron + 0.15 - 0.35% Carbon	Ductile, malleable, tough, high tensile strength, corrodes easily. Easily welded.	Car bodies, machine bodies, nuts and bolts, screws, nails and girders.
High Carbon Steel (tool steel).	Iron + 0.8 - 1.5% Carbon	Very hard, rather brittle, difficult to cut, poor resistance to corrosion.	Tool blades e.g. Saws, chisels, screwdrivers, centre punches and so on.
High Speed Steel	Iron + Tungsten, chromium vanadium.	Very hard, heat resistant, re-mains hard when red.	Drills, lathe cutting tools, milling cutters, power hacksaw blades and so on.
Stainless steel	Iron + chromium, nickel, magnesium.	Tough, hard, corrosion resistant, wears well, difficult to cut, bend and file.	Cutlery, sinks, teapots, kitchen ware, saucepans and so on.

### Non-Ferrous Metals

As the name implies (NON), this category of metal does not contain iron and is usually non-magnetic; examples are, Aluminium, Copper, Brass, Duralumin, Lead, Gold, Silver, etc.

### Forms of supply



Name	Composition	Properties	Uses
Aluminium	Pure Metal	Strong, light, malleable, ductile, difficult to weld, non-toxic, resists corrosion, conducts electricity and heat well and polishes well.	Kitchen foil, drinks cans and saucepans.
Duralumin	Alloy = Aluminium + Manganese, magnesium.	Stronger than pure aluminium and nearly as strong as mild steel but only one third the weight.	Greenhouses, window frames and aircraft bodies.
Copper	Pure Metal	Tough, ductile, malleable, conducts heat and electricity well, corrosion resistant, solder and polishes well.	Electrical wire, central heating pipes, circuit boards, saucepan bases.

# 2 THEORY plastic

## Plastics

The basic raw materials used in the manufacture of plastics are oil, natural gas and coal, but contrary to popular belief, plastics are not a new "space age" material. Natural plastics such as shellac, wax horn, pitch and bitumen have been known for thousands of years. Just as timber is classified as either a softwood or a hardwood and metal as either a ferrous or non-ferrous, so plastics are classified into two main groups; Thermoplastics and Thermosetting plastics.

### Thermoplastics

Thermoplastics soften when heated, can then be shaped, and then harden as they cool. With this type of plastic the softening and hardening can be repeated many times over. When a thermoplastic has been re-heated it will return to its original shape unless it has been permanently damaged by excessive heat or deformation. This characteristic of thermoplastics of re-heating is known as Plastic Memory (i.e. it remembers what its original shape was).

#### Used in schools

Plastic	Properties	Uses
Acrylic	Rigid, hard, can be clear, fluorescent, opaque, very durable outside and polishes to a high shine.	Illuminated signs, windows/glass, baths.
Nylon	Tough, self lubricating, resists wear, good chemical resistance	Gears, bearings, tights, clothing.
Polystyrene	Lightweight, hard, rigid, can be clear, good water resistance.	CD cases, packaging, model kits.
PVC	Rigid, quite hard, good chemical resistance, tough.	

#### Used in industry

Plastic	Properties	Uses
PET	Tough, clear and lightweight.	Bottles.
ABS	Very tough, scratch resistant, good chemical resistance.	Casings for electronic products, kettles, vacuum cleaners.

### Thermosetting Plastics

As the name implies thermosetting plastics (or thermosets) set or solidify, when heated and cannot be returned to their original state by further heating.

Plastics are ideal for mass production of quality products, and can duplicate or better the properties of most other materials, including aluminium, glass, rubber and steel.

#### Properties

General properties of plastics include:  
 Light weight, Resistance to corrosion, Electrical resistant, Easily formed, recyclable

#### Used in schools

Plastic	Properties	Uses
Polyester Resin	Hard, rigid, brittle, tough when mixed with glass or carbon fibre.	Boats, car bodies.
Epoxy/Resin	Strong, good, chemical and heat resistant, sticks to other materials as well.	Adhesive glue, covering electronic components such as microchips

#### Used in industry

Plastic	Properties	Uses
Melamine Formaldehyde	Rigid, scratch resistant, water and stain resistant.	Tableware laminates, top coatings on products.
Urea Formaldehyde	Rigid, hard, strong, heat resistant, does not bend when heated, good electrical insulator.	Electrical plugs, sockets, door knobs.

# THEORY plastic

## Acrylic

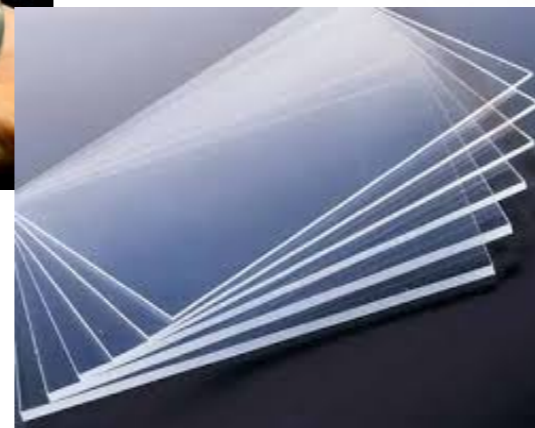
Acrylic materials are among the most commonly used thermoplastics in the school workshop and the material in which will most likely be used to manufacture any artefacts which are made. Often better known by its trade name "Perspex", acrylic is available in clear or coloured sheets, rods and tubes. Acrylic is easily scratched and therefore sheets are usually covered on both sides by protective paper or thin polythene. As has been explained acrylic can come to the workshop in many various forms.

As has been stated acrylic sheet is supplied covered with paper or polythene film to prevent scratching of the finished surface. Whilst the paper covered sheets can be marked with a pencil the polythene covered sheets, and unprotected sheets are best marked with a felt-tipped pen.

## Forms of supply

Plastics can be supplied in various forms:

- Profiled sheets, rods, tubes and bars
- Moulded compounds
- Thin layers of film and sheets
- Foam
- Casting compounds such as ingots
- Paint, varnish and lacquer for finishing
- Filaments and fibres
- Composites which contain reinforcing material

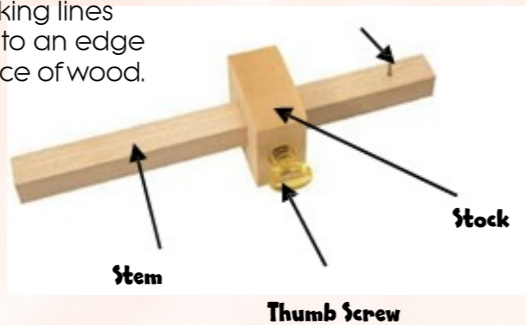


# 2 THEORY Woodwork tools

## Marking out Tools

For marking lines parallel to an edge of a piece of wood.

Marking Gauge



Try Square

For marking lines at right angles to an edge of a piece of wood.

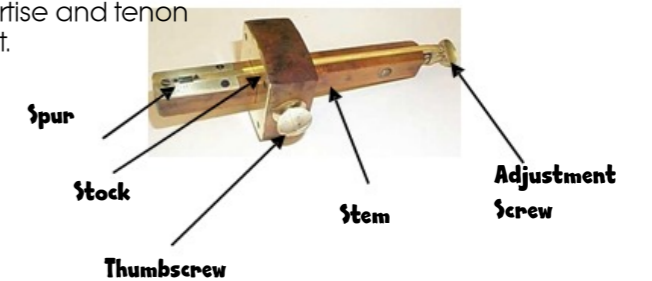
Steel Rule

For measuring sizes on wood, metal and plastic.



For marking out the width of a mortise and tenon joint.

Mortice Gauge



## Cutting and Shaping Tools Saws and Sawing

It is important to note that there are two categories of Saw: Rip Saws and Cross-cut Saws. Rip Saws are used for cutting along the grain and Cross-cut saws are used for cutting across the grain.

The term Ker refers to width of the cut that a saw blade makes.

Bench Hook/Sawing



Makes it easier to secure and saw small pieces of wood

Tenon Saw



Mainly used for cutting out joints in wood. cause the blade is very rid (stiff) due to brass back at the top of the saw. (Cross-Cut Saw)

Coping Saw



A thin saw used for making curved cuts. The blade can be set to almost any angle and is very flexible.

Panel Saw



Mainly used for making straight cuts in large pieces of timber. (Rip Saw)

## Chisels

Chisels are used for chopping away waste wood when cutting a joint. Chisels The handle on a chisel is normally made from Ash which is a very strong hardwood or polycarbonate plastic so that it will offer resistance from splitting when being used. Chisels will always have some type of ferrule that helps stop the wood from splitting.

Bevel-Edged Chisel - The blade is sloped at the edges. This chisel is normally used for pairing wood or cleaning/tidying up joints.

Mortise Chisels - Used for cutting the mortise (hole) in a mortise tenon joint. Note: that mortise chisels normally have a leather washer that helps to absorb the shock from hammering when driving the chisel through wood.



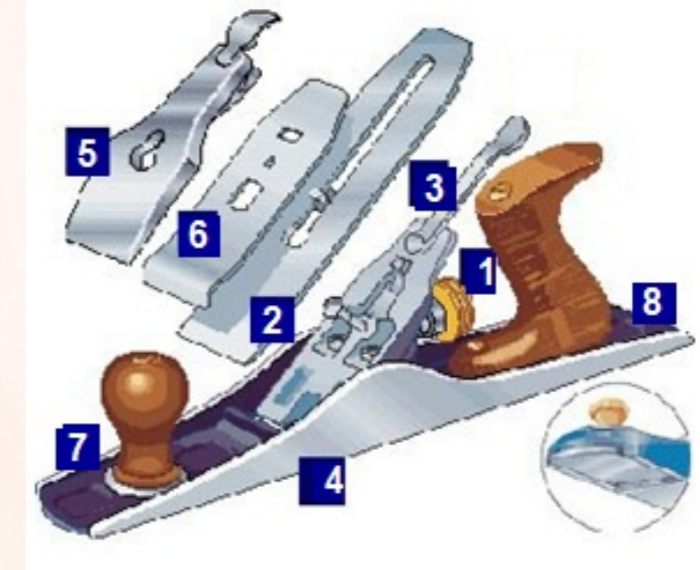
Beech/Wooden Mallet  
Used for driving a chisel through wood.



# THEORY Woodwork tools

## Smoothing and Jack planes

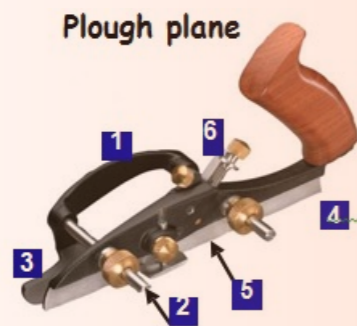
Although both Jack and smoothing planes look similar they are used for different jobs: Jack planes are used to make long edges straight and square and are longer than smoothing planes. Smoothing Planes are used to make surfaces smooth.



Plane Parts

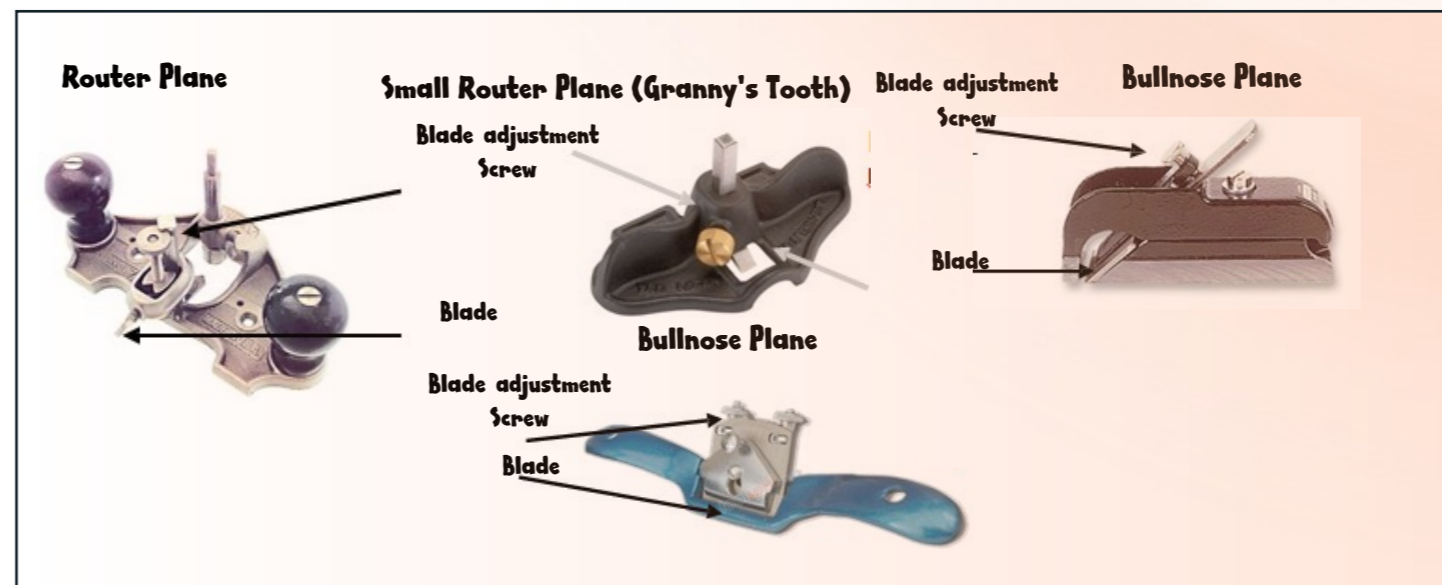
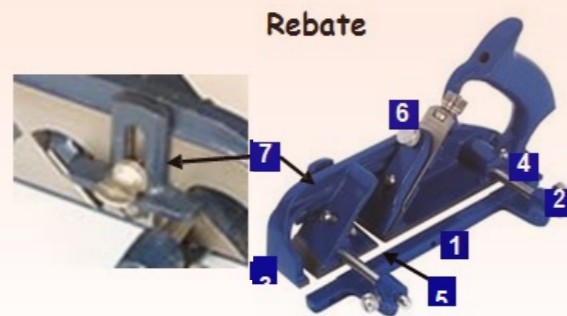
- 1. Blade Depth adjustment Screw.
- 2. Blade
- 3. Blades lateral adjustment lever.
- 4. Sole
- 5. Lever Cap
- 6. Cap iron
- 7. Toe
- 8. Heel

- 1. Fence (For measuring how far in you want to cut).
- 2. Fence adjustment screw
- 3. Toe
- 4. Heel
- 5. Blade
- 6. Blade adjustment screw
- 7. Depth gauge



Used for cutting grooves on the inside of a face on a piece of wood.

Used for cutting grooves on an edge of a piece of wood.



Plane Safety

- Always ensure that the blade is set correctly to ensure that there no risk of accident or damage to your wood/plane.
- Always place your plane side up on the work bench too



# 2 THEORY metalwork tools

## Marking out Tools

Scriber



For marking metal.

Centre Punch



For accurately punching holes before drilling.

Odd Leg Callipers



For marking straight lines parallel to the edge of a piece of metal.

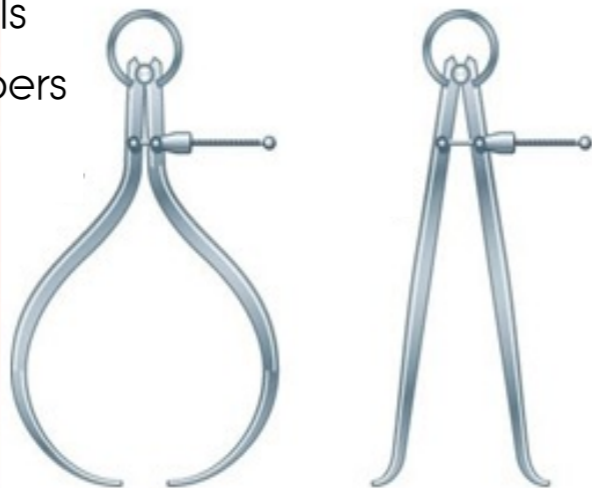
Spring Dividers



For marking circles on a piece of metal.

## Measuring Tools

Callipers



Outside:

For measuring outside widths and diameters on metal.

Inside:

For measuring inside widths and diameters on metal  
Can also be used with wood and plastic

Micrometer



For very accurate measurement of outside diameters on metal or plastic

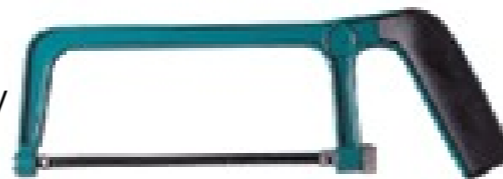
## Cutting

Hacksaw



Used for cutting thick and large

Junior Hacksaw



Used for cutting small pieces of metal such as sheet metal and wire

Power Hacksaw

Band saw type machine used for heavy cutting of large pieces of metal such as round bar or square bar.



# THEORY metalwork tools

## Vernier Callipers

The vernier callipers are also used for measuring very accurate sizes except the vernier calliper can measure internal sizes, depths and external sizes



## Folding Bars

The folding bar is used when folding sheet metal in order to obtain a straight, neat bend. They are usually held in a vice for small scale work.



## Hand Vice

This is used for holding small and especially irregular shaped parts while drilling, riveting etc.



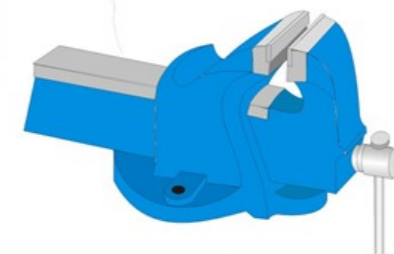
## Machine Vice

This type of vice is used to hold heavier pieces of metal while drilling. The main body of the vice has been CAST in a mould. The handle of the vice has been KNURLED.



## Engineer's Vice

The vice is bolted to the bench top so as to ensure the vice does not move while working on it. The vice is used primarily to hold metal while cutting, sawing, filing, etc. are carried out. As with the machine vice the body has also been CAST in two separate pieces.



## Toolmaker's Clamp

These are used to hold parts together while marking out, shaping and drilling.



## Hammers/Mallet

**Raw Hide Mallet** This mallet is used when it is important not to make any marks on the metal. **Ball Pein Hammer** This is a general use hammer although the ball pein end of the hammer is used specifically to round the heads of the snap head rivet.



# 2 THEORY metalwork tools

## Filing

Files are used to shape metal. They are available in a number of different shapes and degrees of roughness.

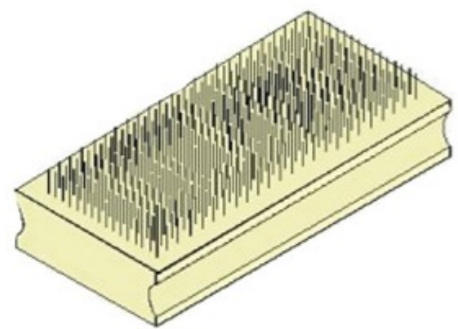
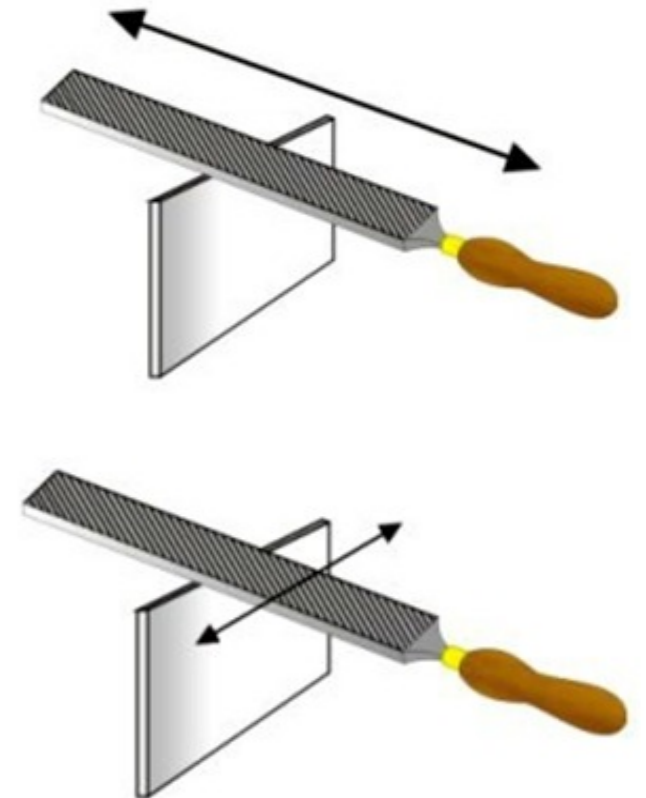
Files must not be used without a handle.

## Cross filing

In this type of filing the file is moved across the work piece using the full length of the blade. This method of filing is used for removal of a lot of material with every stroke applied.

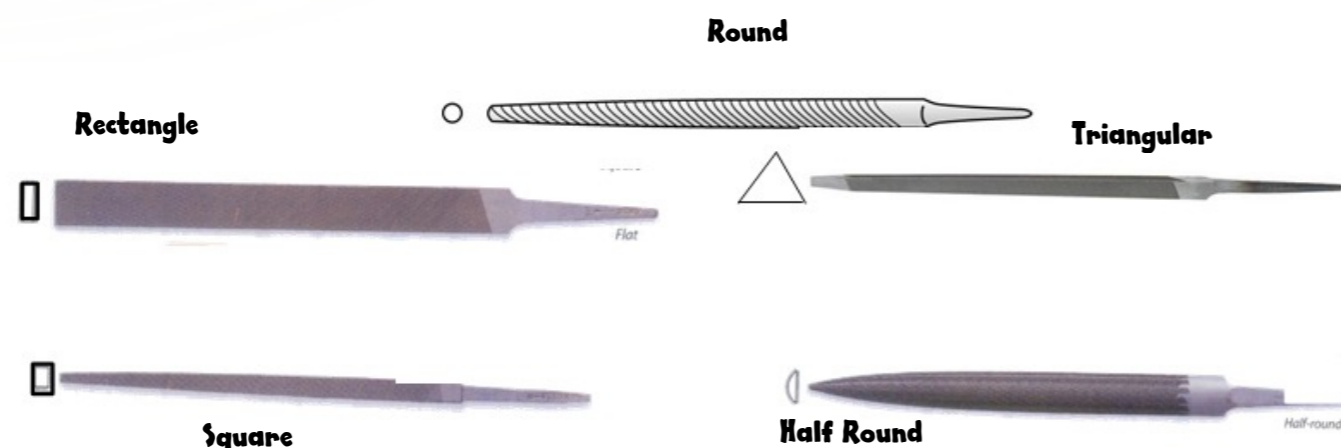
## Draw filing

In this method of filing, the file is moved sideways along the work piece and is used to obtain a smooth finish after cross filing. This method does not remove much material.



## Cleaning the file

Small pieces of aluminium or plastic can be trapped in between the teeth of the file. This is called PINNING. A FILE CARD can be used to clear the file of the excess material. The file card looks very similar to a wire brush except the teeth are very short.



## Files

There are many different files that are used for filing metal to shape and filing rough edges smooth. Files also come in a range of sizes for different jobs.

## THEORY plastics tools

### Plastics Tools

In the school workshop the most common method of cutting acrylic is by sawing. Fine toothed saws like the coping saw, hacksaw and junior hacksaw are the most suitable. Sawing must be done carefully and steadily to avoid chipping and splintering the material. The band saw can also be used but is only to be used by the teacher.

#### Hacksaw

The hacksaw is used for general cutting of metal bar, tubes, etc. The blade is easily removed by slackening or tightening of the front wing nut.

#### Junior Hacksaw

This type of saw is also used for cutting metal but is used for light work or where a hacksaw is too clumsy.

#### Coping Saw

The coping saw is used to cut curves and other awkward cuts in plastic or wood. It is also unique as it is one of only a few saws which has its teeth facing backwards. In normal sawing the cut is made in the forward stroke but with the coping saw the cut is made on the backward stroke.

Files are used to shape metal or plastic.

They are available in a number of different shapes and degrees of roughness. Files must not be used without a handle. See page 74

