Measurement, lines standard, end standard and steel rule

Objectives: At the end of this lesson you shall be able to
- **name the base unit of length measurement as per the international system of units of measurement (SI)**
- **state the multiples of a metre and their values.**

Mearsurement

It is an action of measuring something, quantifying in standard units. The standard length under International (British) system is inches/feet, yards, miles, whereas in Metric unit it is millimeter, centimeter, meter & kilometer. Length determines the distance between two points or the amount space between two points expressed in standard unit.

Line & End standard

Linerar measurement is basically a Metrological science of precise and accurate measurement. Measurements are classified as linear measurement, angular measurement and form measurements. All these are carried out as per standards established and maintained at the highest level of standardisation.

As per the System International (SI) system of measurements the standard unit for length measurement is meter. The meter (m) is defined as the length of the path travelled by light in vaccum during the time interval of 1/299 792 458 of a second, each artifact meter is calibrated against the proto type for use as National Standard.

Length measurement are grouped as Line Standard and end Standard. When the length being measured in expressed as the distance between two lines, this is known as Line Standard. Line standards are not as accurate as end standards & can't be used for close tolerance measurement.

End standard is standard of length in the form of a metal bar (cylindrical) or block (ship gauge) or feeler gauge, Limit gauges, whose end faces are the standard distance apart.

All measurements measured along a line through a graduated scale insttruments such as Vernier caliper, Micrometer etc., comes under Line standard measurements.

All measurements done with the help of gauge block set (slip gauges) or cylindrical bar, measuring wise, etc, are covered under the End standard measurements. Limit gauges line Go and No Go snap gauges, plug gauges etc also comes under End standard.

When we measure an object, we are actually comparing it with a known standard of measurement.

The base unit of length as per SI is the metre.

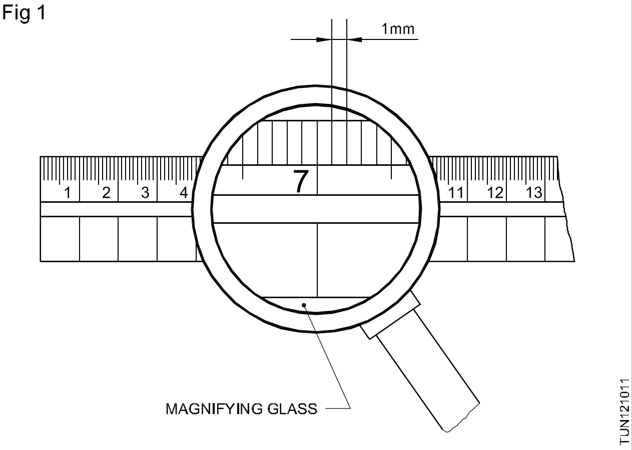
Length - SI units and multiples.

Base unit : The base unit of length as per the systems international is the metre. The table given below lists some multiples of a metre.

1 Metre (m)	= 1000 mm
1 Centimetre (cm)	= 10 mm
1 Millimetre (mm)	= 1000µm
1 Micrometre (µm)	= 0.001 mm

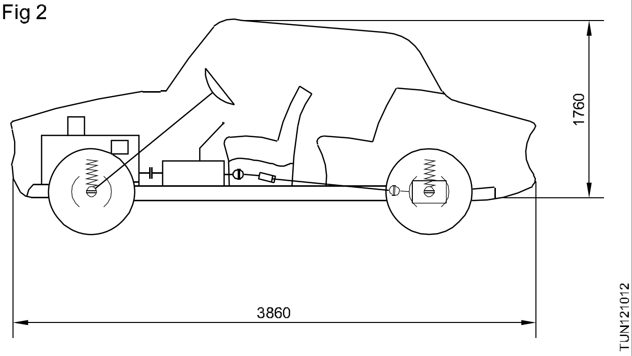
Measurement in engineering practice: Usually, in engineering practice, the preferred unit of length measurement is the millimetre. (Fig 1)

Fig 1



Both large and small dimensions are stated in millimetres. (Fig 2)

Fig 2



The british system of length measurement : An alternative system of length measurement is the british system. In this system, the base unit is the imperial standard yard. Most countries, including great britain itself, have, however, in the last few years, switched over to SI units.

12 Inch = 1 Feet

3 Feet = 1 Yard

Line standards and end standards

Line standards

In the line standard the unit of length is defined as the distance between the centres of engraved lines e.g. steel rule.

End standards

When the length being measured is expressed as the distance between two surfaces, e.g. slip gauges.

Difference between line standards and end standards

The differences between line standards and end standards are given as follows:

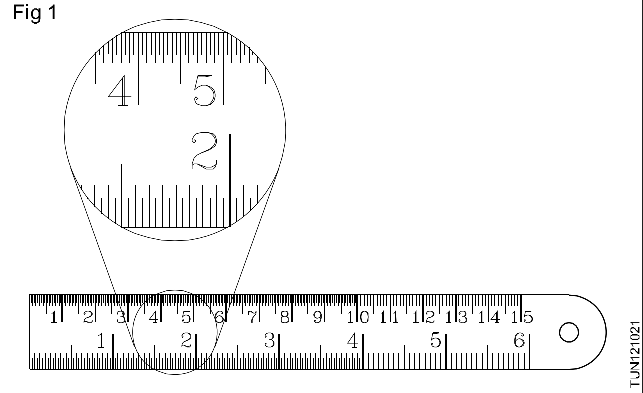
Sl. No	Line standard	End standard
1	Line standards do not provide high accuracy.	End standards more suited to accuracy requirement of high order.
2	They are quick and easy to use over a wide range.	They are time consuming in use, and prove only one dimension at a time.
3	They are not subjected to wear although significiant wear on leading and leads to under-sizing.	They are subjected to wear on their measuring faces.
4	They are subjected to the parallax effect, a source of both positive and negative reading errors.	They are not subjected to parallax effects as their use depends on 'feel'.

Steel rule - Different types

Objectives: At the end of this lesson you shall be able to
- **state the purpose of steel rule**
- **state the types of steel rule**
- **state the precautions to be followed while using a steel rule.**

Engineer's steel rule (Fig 1) are used to measure the dimensions of work pieces.

Fig 1



Steel rules are made of spring steel or stainless steel. These rules are available in length 150mm. 300mm and 600mm. the reading accuracy of steel rule is 0.5mm and 1/64 inch.

For accurate reading it is necessary to read vertically to avoid errors arising out of parallax. (Fig 2)

Steel rule in english measure, they can also be furnished with metric and english graduation in a complete range of sizes 150, 300, 500 and 1000 mm. (Fig 3)

Fig 2

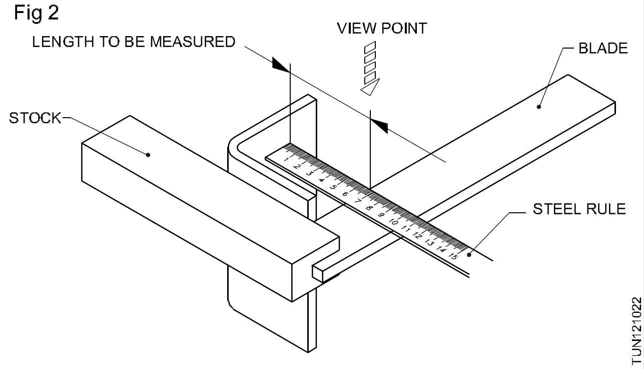
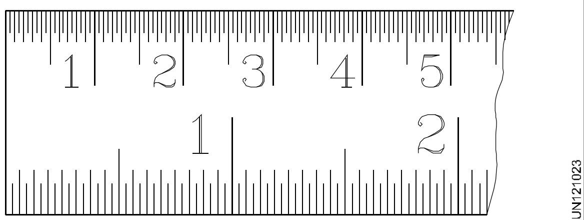


Fig 3

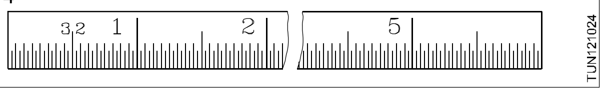


Other types of rule

- Narrow steel rules
- Short steel rules
- Full flexible steel rule with tapered end

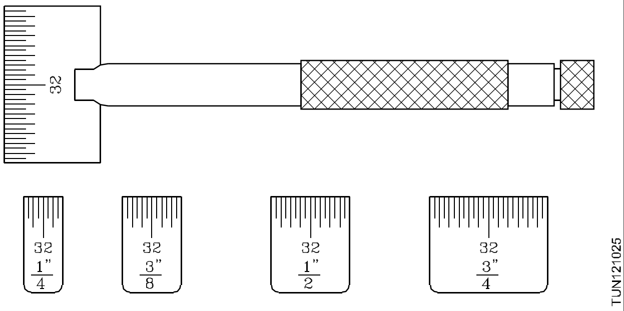
Narrow steel rule : Narrow steel rule are used to measure the depth of key-ways and depth of smaller dia, blind holes and other jobs, where the ordinary steel rule cannot reach. Width approximately 5mm thickness 2mm. (Fig 4)

Fig 4



Short steel rule (Fig 5) : This set of five small rules together with a holder is extremely useful for measurements in confined or hard to reach locations which prevent use of ordinary steel rules. It is used suitably for measuring grooves, short shoulder, recesses, key ways etc. in machining operation on shapers, millers and tool and die work.

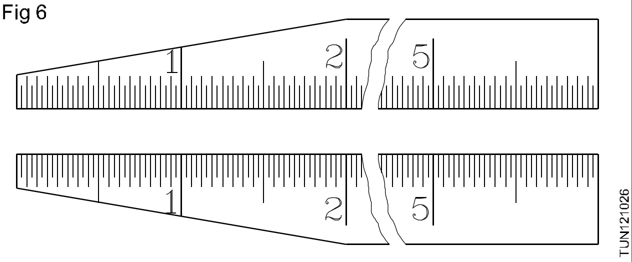
Fig 5



The rules are easily inserted in the slotted end of the holder and are rigidly clamped in place by a slight turn of the knurled nut at the end of the handle. five rule lengths are provided 1/4", 3/8", 1/2", 3/4" and 1" and each rule is graduated in 32^{nds} on one side and 64ths on the reverse side.

Steel rule with tapered end : This rule is a favorite with all mechanics since its tapered end permits measuring of inside size of small holes, narrow slots, grooves, recesses etc. This rule has a taper from 1/2 inch width at the 2 inch graduation to 1/8 inch width at the end. (Fig 6)

Fig 6



For maintaining the accuracy of a steel rule, it is important to see to it that its edges and surfaces are protected from damage and rust.

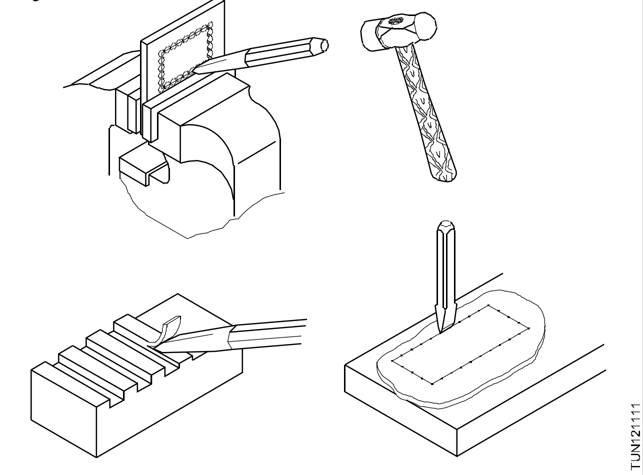
Do not place a steel rule with other cutting tools. Apply a thin layer of oil when not in use.

Hammer & Chisel - Materials, types and uses

Objectives: At the end of this lesson you shall be able to
- **list the uses of a cold chisel**
- **name the parts of a cold chisel**
- **state the different types of chisels**
- **follow the safety measures.**

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig 1)

Fig 1

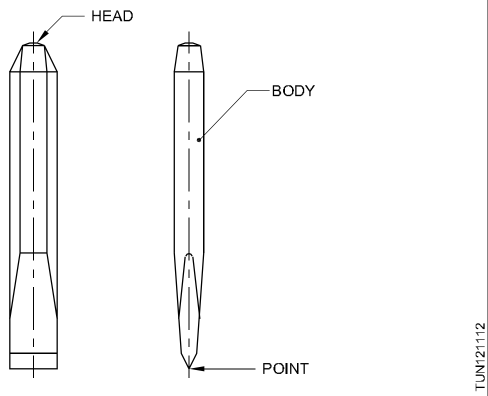


Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

Parts of a chisel (Fig 2) : A chisel has the following parts.

Head, body, point or cutting edge

Fig 2



Chisels are made from high carbon steel or chrome-vanadium steel. The cross-section of chisels is usually hexagonal or octagonal. The cutting edge is hardened and tempered.

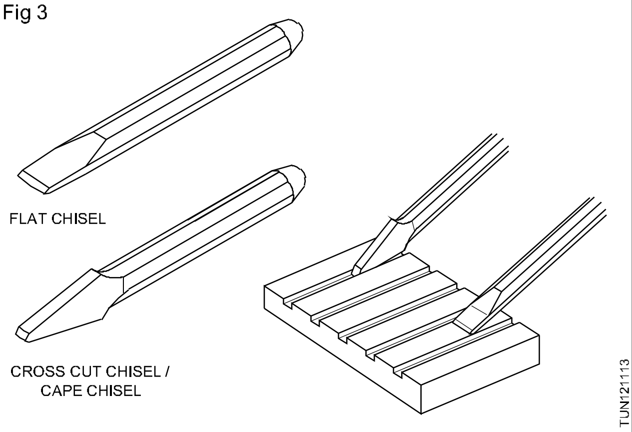
Common types of chisels : There are five common types of chisels.

- Flat chisel
- Cross-cut chisel
- Half-round nose chisel
- Diamond point chisel
- Web chisel

Flat chisels (Fig 3) : They are used to remove metal from large flat surfaces and chip-off excess metal of welded joints and castings.

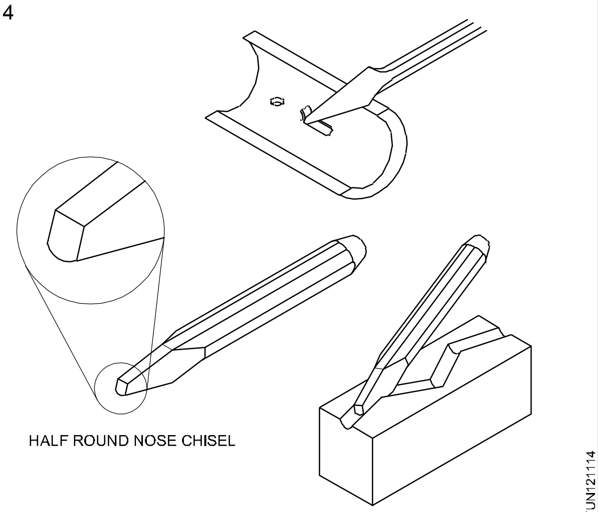
Cross-cut or cape chisels (Fig 3) : These are used for cutting keyways, grooves and slots.

Fig 3



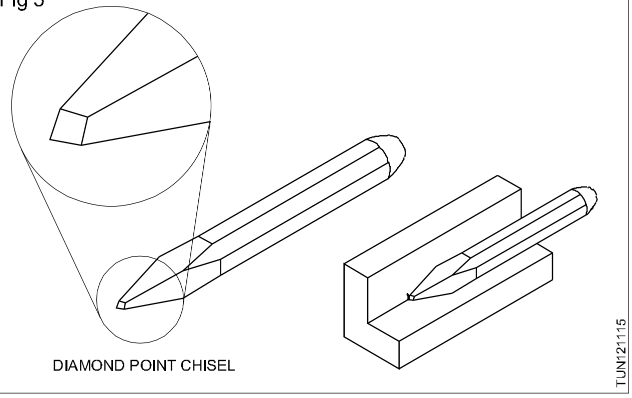
Half-round nose chisels (Fig 4) : They are used for cutting curved grooves (oil grooves).

Fig 4



Diamond point chisels (Fig 5): These are used for squaring materials at the corners, joints.

Fig 5



Web chisels/punching chisels (Fig 6) : These chisels are used for separating metals after chain drilling.

Chisels are specified according to their

– length

– width of the cutting edge

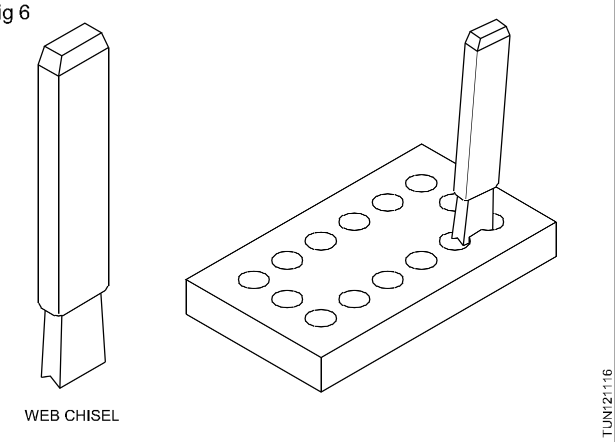
– type

– cross-section of the body

The length of chisels ranges from 100 mm to 200 mm.

The width of the cutting edge varies according to the type of chisels.

Fig 6



Hammer

Objectives: At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **name the parts of an engineer's hammer**
- **name the types of engineer's hammers**
- **specify the engineer's hammer.**

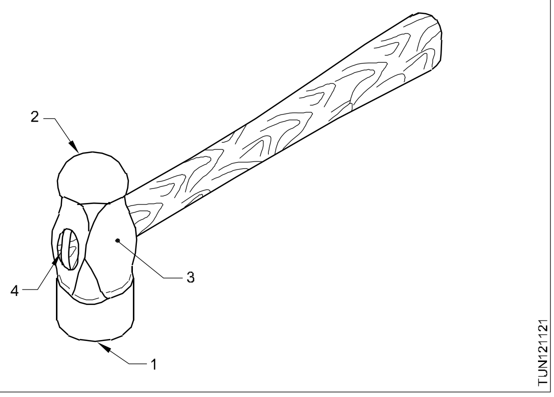
An engineer's hammer is a hand tool used for striking purposes while punching, bending, straightening, chipping, forging and riveting.

Major parts of a hammer : The major parts of a hammer are the head and the handle.

The head is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

The parts of a hammer head (Fig 1) are the face (1), pein (2), cheek (3) and the eyehole (4).

Fig 1

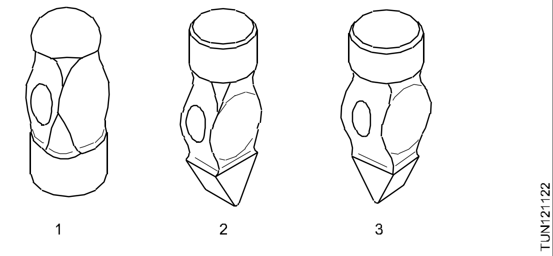


Face: The face is the striking portion. A slight convexity is given to it, to avoid digging of the edge. It is used for striking while chipping, bending, punching etc.

Pein: The pein is the other end of the head. It is used for shaping and forming work like riveting and bending. The pein is of different shapes such as :

- ball pein
- cross-pein
- straight pein (Fig 2)

Fig 2



The face and the pein are case hardened.

Cheek: The cheek is the middle portion of the hammer head. The weight of the hammer is stamped here.

This portion of the hammer-head is left soft.

Eyehole: The eyehole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eyehole. (Figs 3 and 4)

Fig 3

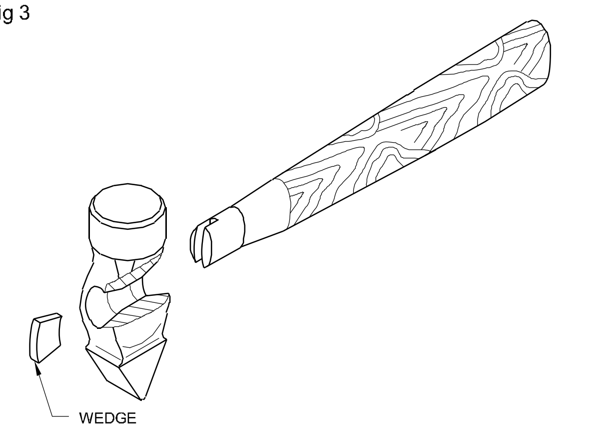
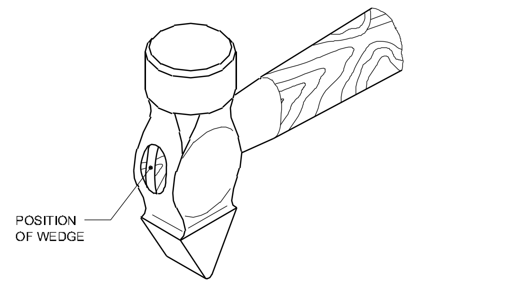
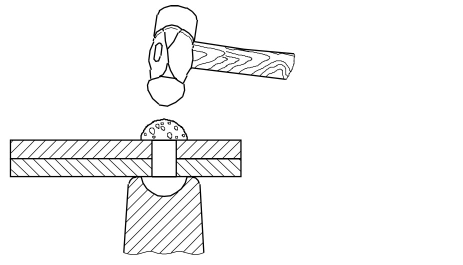


Fig 4



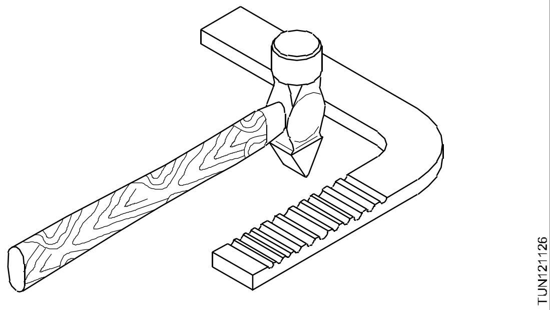
Application of hammer pein : The ball pein is used for riveting. (Fig 5)

Fig 5



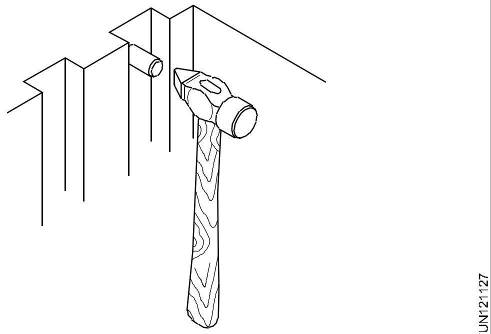
The cross-pein is used for spreading the metal in one direction. (Fig 6)

Fig 6



The straight pein is used at the corners. (Fig 7)

Fig 7



Specification: An engineer's hammers are specified by their weight and the shape of the pein. Their weight varies from 125 gms to 750gms.

The weight of an engineer's hammer used for marking purposes is 250 gms.

The ball pein hammers are used for general work in machine/ fitting shop.

Before using a hammer:

- make sure the handle is properly fitted.
- select a hammer with the correct weight suitable for the job.
- check the hammer head and handle whether any crack is there.
- ensure that the face of the hammer is free from oil or grease.

Angles of chisels

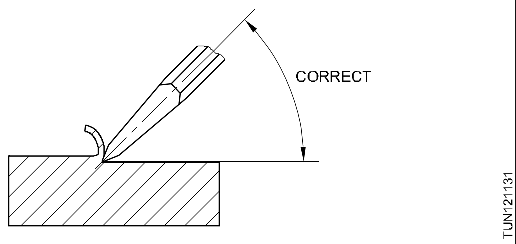
Objectives: At the end of this lesson you shall be able to
- **select the point angles of chisels for different materials**
- **state the effect of rake and clearance angles.**

Point angle and materials: The correct point/cutting angle of a chisel depends on the material to be chipped. Sharp angles are given for soft materials and wide angles for hard materials.

The correct point and angle of inclination generate the correct rake and clearance angles. (Fig 1)

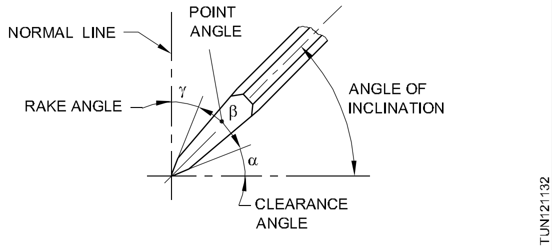
Rake angle : Rake angle is the angle between the top face of the cutting point and normal (90°) to the work surface at the cutting edge. (Fig 2)

Fig 1



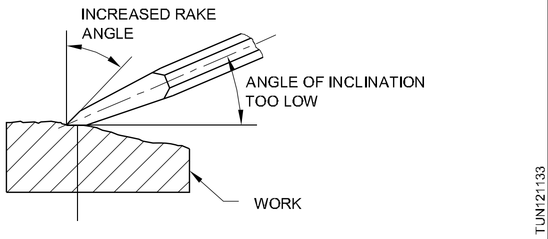
Clearance angle : Clearance angle is the angle between the bottom face of the point and the tangent to the work surface originating at the cutting edge. (Fig 2)

Fig 2



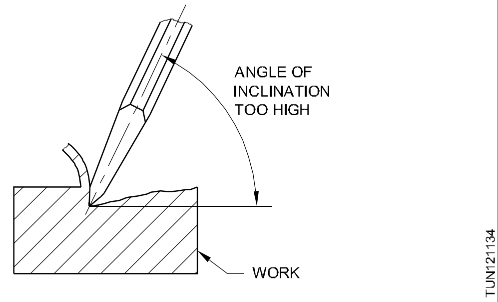
If the clearance angle is too low or zero, the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip. (Fig 3)

Fig 3



If the clearance angle is too great, the rake angle reduces. The cutting edge digs in and the cut will become deeper and deeper. (Fig 4) The correct point angle and angle of inclination for different materials for chipping is given in Table 1.

Fig 4



Crowning : A slight curvature is ground called "Crowning" to the cutting edge of the chisel, to prevent digging or corners, which leads to breakage of chisel point. "Crowning" allows the chisel to move freely along a straight line while chipping.

The point angle of cutting tool for the machining of different material is shown in table 1

Table 1

Material to be cut	Point angle	Angle of inclination
High carbon steel	65°	39.5°
Cast iron	60°	37°
Mild steel	55°	34.5°
Brass	50°	32°
Copper	45°	29.5°
Aluminium	30°	22°

Selection of metals

Objectives: At the end of this lesson you shall be able to
- **state the different methods of identifying ferrous metals and alloys**
- **state how non-ferrous metals and alloys are identified**
- **state the corrosion, scaling, rusting.**

A fitter has to handle different types of metals in his work. A knowledge about how to recognise and differentiate the commonly used metals will help him in many ways.

Ferrous metals and alloys can be identified by

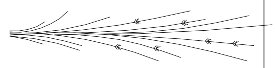
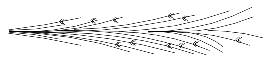
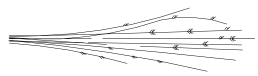
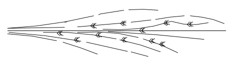
- their appearance (colour, texture etc)
- their weight (light or heavy)
- the sound
- cold hammering
- the spark test (grinding).

Note

The above characteristics of different ferrous metals and alloys are given in Table 1. Apart from the above tests, steel bars are also identified by the code colours painted on them.

Different colours are marked, based on the different composition of materials and grade. Colour charts are available to determine the different metals.

Table 1

Ferrous metals & alloys	Appearance	Density/ weight	Sound (Drop a ø 15 bar 25 cm long, on to the ground)	Cold hamme -ring	Spark test	
Low carbon steel	Smooth scale with blue/ black sheen/ silver grey	7.85 medium	Medium metallic sound	Flattens easily	Stream of yellow white sparks varying in length, slightly 'fiery'.	
Medium carbon steel	Smooth scale black sheen steel	Weight 7.85 medium	Higher note than that of low carbon	Fairly difficult to flattern	Yellow sparks shorter than those of low carbon steel, finer and more feathery.	
High carbon steel	Rougher scale black	Weight 7.85 medium	Good ringing sound	Difficult to flattern	Sparkless bright, starting near grinding wheel and more feathery with secondary branching.	
High speed steel	Roughness scale black with reddish tint	Weight 9 comparitivily to heavy	Lower ringing more like low carbon steel	Very difficult flattern tends crack easily.	Faint red streak ending in fork.	

Most non-ferrous metals and alloys can be identified by their colour. (Table 2)

Table 2

Metal/Alloy	Colour
Copper	Distinctive red colour
Aluminium	Dull white
Lead	Bluish-grey colour
Tin	Silvery white, with a slightly yellowish tinge
Brass (Alloy) (free cutting)	Distinctive yellow colour
Bronze (alloy)	Colour between copper and brass

Rusting

Rusting is the process in which iron turns into iron oxide. It happens when iron comes into contact with water and oxygen. The process is a type of corrosion that occurs easily when natural conditions.

Rusting is the conversion related to iron and iron-based alloys. Non-ferrous metals corrode but do not rust. (Fig 1)

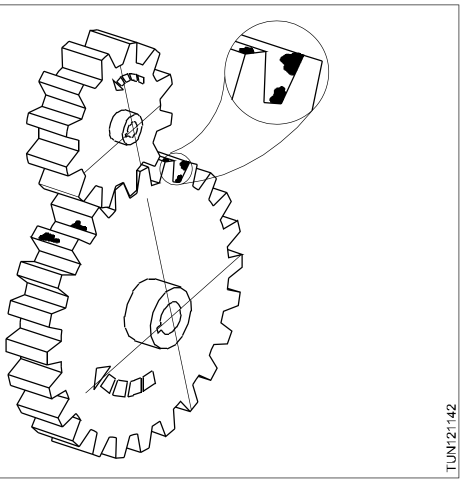
Fig 1

Corrosion

The slow and continuous eating away of metallic components by chemical or electro-chemical action is known as corrosion. Corrosion affects the service conditions and accuracy of the components. It is very essential to understand the causes for corrosion and to know the metals that resist corrosion.

Conversion is the deterioration of materials by chemical interaction with their environments. The term corrosion is some times also applied to the degradation of plastics, concrete and wood, but generally refers to metals. (Fig 2)

Fig 2



Scaling

Scale is hard mineral coatings and corrosion deposits made up of solids and sediments that collect on or it distribution system.

Scaling which is the deposition of mineral solids on the interior surfaces of water lines and containers. (Fig 3)

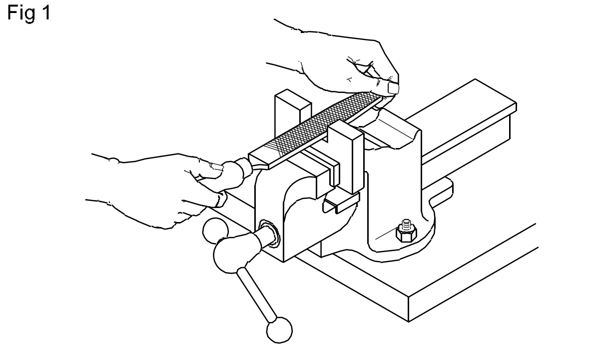
Fig 3

Files - Different type, uses, grade, shape, hacksaw cutting

Objectives: At the end of this lesson you shall be able to
- **name the parts of a file**
- **name and state the uses of each grade of file**
- **list and state the uses of different cuts of files**
- **state the specification of a file.**

Filing is a method of removing excess material from a workpiece by using a file. (Fig 1)

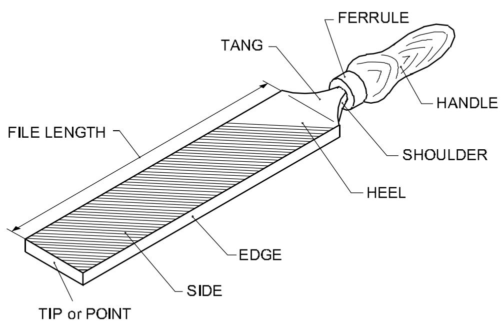
Fig 1



Files are available in many shapes and sizes. They are made of high carbon or high grade cast steel. The teeth portion of the file (body) alone is hardened and tempered.

Parts of a file (Fig 2): The illustration above will help you in learning the parts of a file.

Fig 2



Files are specified according to their (1) length (2) grade (3) cut and (4) shape.

Eg. File flat 300 mm bastard double cut.

The length of a file is the distance from the tip to the heel.

File grades are determined by the spacing of the teeth.

A rough file is used for removing rapidly a larger quantity of metal. It is mostly used for trimming the rough edges of soft metal castings (Fig 3A) and fins-burrs on forged components.

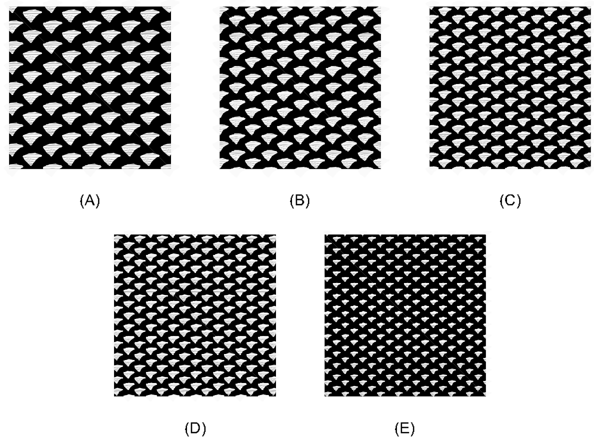
A bastard file is used in cases where a heavy reduction of material is required. (Fig 3B)

A second cut file is used to give a good finish on metals. It is excellent to file hard metals. It is useful for bringing the jobs close to the finishing size. (Fig 3C)

A smooth file is used to remove small quantities of material and to give a good finish. (Fig 3D)

A dead smooth file is used to bring the material to accurate size with a high degree of finish. (Fig 3E)

Fig 3



Flat file & hand file

Objectives: At the end of this lesson you shall be able to
- **state the features of flat and hand files**
- **state the application of flat and hand files**
- **list different cuts and their uses.**

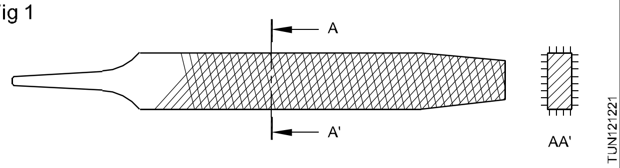
Files are made in different shapes so as to able to file and finish components to different shapes.

The shape of files is usually specified by their cross section.

The files useful for this exercise are flat files and hand files.

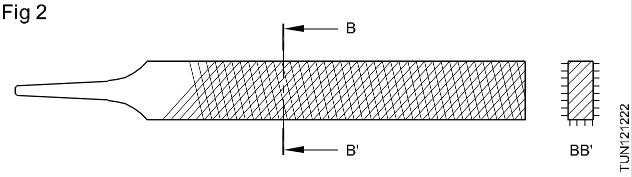
Flat files (Fig 1)**:** These files are of rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut and the edges single cut. These files are used for general purposes work. They are useful for filing and finishing external and internal surfaces.

Fig 1



Hand files (Fig 2)**:** These files are similar to the flat files in their cross-section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is a single cut whereas the other is a safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces already finished.

Fig 2



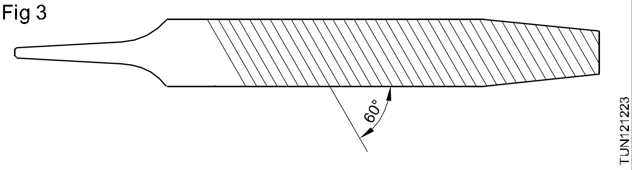
The most used grades of files are bastard, second cut, smooth and dead smooth. These are the grades recommended by the Bureau of Indian Standards. (BIS)

Different sizes of files with the same grade will have varying sizes of teeth. In longer files, the teeth will be coarser.

The uses of the different cuts of files are as follows.

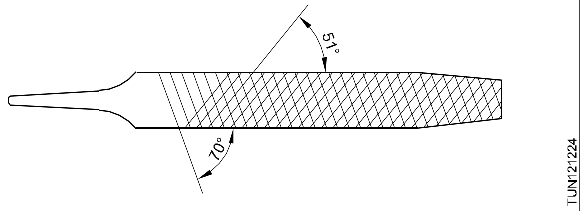
Single cut files are useful for filing soft metals like brass, aluminium, bronze and copper and also used for deburring the job on lathe. (Fig 3)

Fig 3



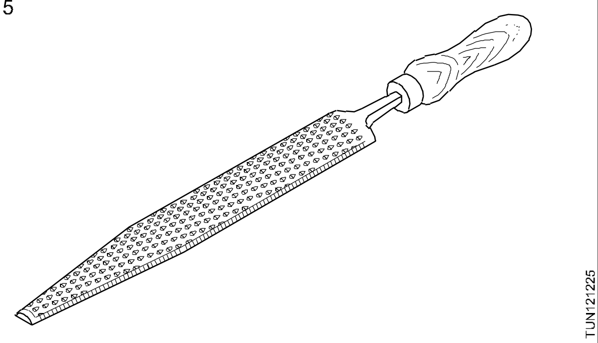
Double cut files remove material faster than the single cut files. (Fig 4)

Fig 4



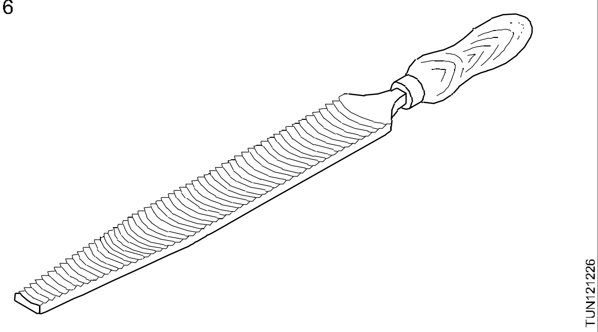
Rasp cut files are useful for filing wood, leather and other soft materials and are available only in half round shape. (Fig 5)

Fig 5



Curved cut files have deeper cutting action and are useful for filing soft materials like aluminium, tin, copper and plastic. (Fig 6)

Fig 6



Hacksaw frame

Objectives: At the end of this lesson you shall be able to
- **name the different types of hacksaw frames**
- **specify hacksaw blades.**

Hacksaw frame: A hacksaw frame is used along with a blade to cut metals of different sections and is specified by the type and maximum length of the blade that can be fixed.

Example

Adjustable hacksaw frame-tuber-250-300 or 8” - 12”

Types of hacksaw frames

Solid frame (Fig 1a) : Only a blade of a particular standard length can be fitted to this frame. e.g. 300mm or 250mm.

Adjustable frame (flat type) : Different standard lengths of blades can be fitted to this frame i.e. 250mm and 300mm.

Adjustable frame (tubular type) (Fig 1b) : This is the most commonly used type. It gives a better grip and control.

Parts of a hacksaw frame

1 Handle

2 Frame

3 Tubular frame with holes for length adjustment

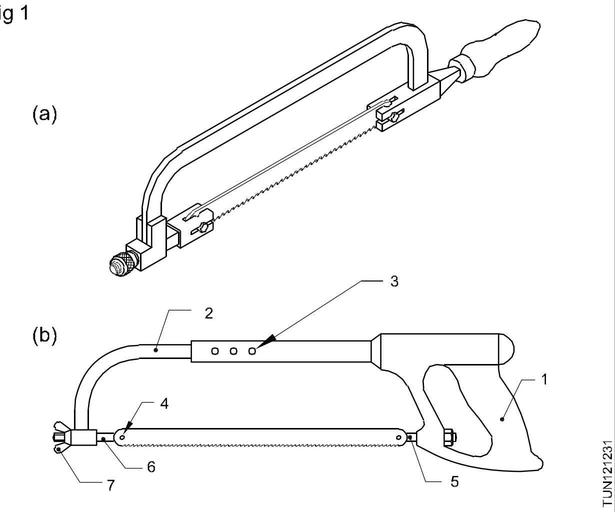
4 Retaining pins

5 Fixed blade-holder

6 Adjustable blade-holder

7 Wing - nut

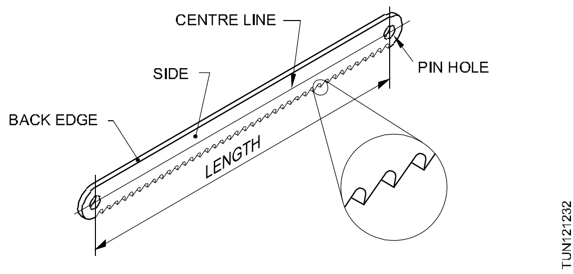
Fig 1



Hacksaw Blade

A hacksaw blade is made of either low alloy steel (LA) or high speed steel (HSS), and is available in standard lengths of 250 mm and 300 mm. (Fig 1)

Fig 2



Parts of a hacksaw blade (Fig 1)

1 Back edge

2 Side

3 Centre line

4 Pin holes

Type of hacksaw blades

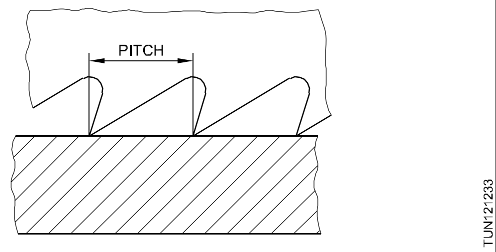
All-hard blade: The full length of the blade between the pins is hardened and it is used for harder metals such as tool steel, die steel and HCS.

Flexible blade: Only the teeth are hardened. Because of their flexibility these blades are useful for cutting along curved lines. Flexible blades should be thinner than all - hard blades.

Pitch of the blade (Fig 2)**:** The distance between adjacent teeth is known as the 'pitch' of the blade. (Fig 2)

Classification	Pitch
Coarse	1.8 mm
Medium	1.4 mm & 1.0 mm
Fine	0.8 mm

Fig 3



Specification: Hacksaw blades are specified by the length, pitch and type of material. (The width and thickness of blade is standardised)

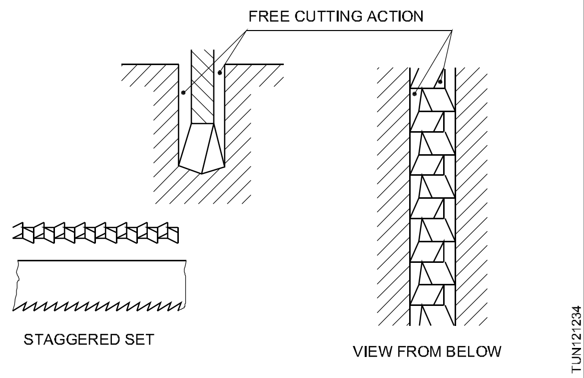
Example

300 x 1.8 mm, pitches LA all-hard blade.

To prevent the hacksaw blade binding when penetrating into the material, and to allow free movement of the blade, the cut is to be broader than the thickness of the hacksaw blade. This is achieved by the setting of the hacksaw teeth. There are two types of hacksaw teeth settings.

Staggered set (Fig 3)**:** Alternate teeth or groups of teeth are staggered. This arrangement helps for free cutting, and provides for good chip clearance.

Fig 4



Wave set (Fig 4)**:** In this, the teeth of the blade are arranged in a wave-form. The types of sets for different pictures are as follows:

Fig 5