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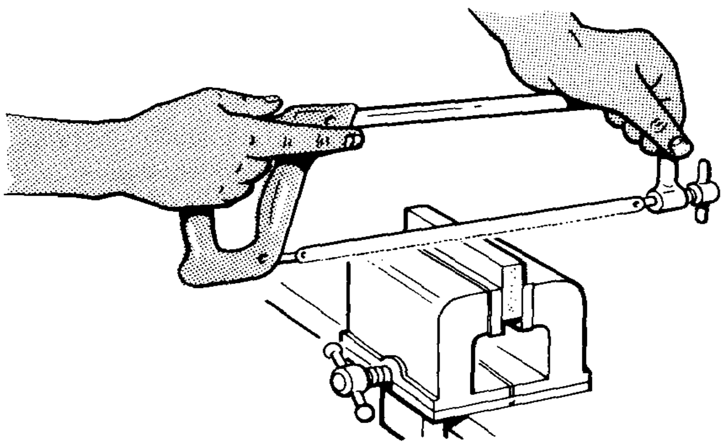
MINISTRY OF LABOR
AND SKILLS

Foundary works

Level-I

Based on March, 2022 Curriculum Version 1



Module Title: Perform Bench Work

Module Code: IND FDW1 M02 0322

Nominal duration: 110 Hours

Prepared By: Ministry of Lobar and Skill

August, 2022

Addis Ababa, Ethiopia

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Acknowledgments

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronyms

ECG	Electrocardiogram
TTLM	Teaching training learning material
LAP	Learning activity performance

Introduction to the module

The term '**bench work**' refers to the production of components by hand on the **bench**, whereas fitting deals which the assembly of mating **parts**, through removal of **metal**, to obtain the required fit. Both the **bench work** and fitting requires the use of number of simple hand tools and considerable manual efforts.

Bench work and fitting have important roles to play to complete the production of our articles by hand on the bench. Fitting if the assembling to gather of parts and remove metal to secure the necessary fits and may or may not be carry out at the bench .The working of metals is made possible by the manipulation of tools and machines. Hand tools are the basic tools normally used in the school and college workshop to realize designed artifacts. The first part of this chapter covers bench work tools such as files, saws and chisels; the second part deals with tools for marking out, measurement and inspection.

This module is designed to meet the industry requirement under the **Foundry works** occupational standard, particularly for the unit of competency: **perform bench work**

This module covers the units:

- Measurements
- Laying-out
- Filling and work holding device
- Hand hack saw
- Drill and ream holes
- Thread cutting
- Assembling components

Learning Objective of the Module

- Apply Measure dimensions or variables using appropriate instrument
- Perform Lay-out and mark dimensions/ features on work piece
- Apply Cut, chip and file flat rectangular and / or round blocks
- Apply Cut different work pieces using hand hacksaw
- perform Drill and ream holes
- Perform Cut threads using tap, stock and die
- Apply Assemble components mechanically

Module Instruction

- ✓ For effective use this modules trainees are expected to follow the following module instruction:
- ✓ Read the information written in each unit
- ✓ Accomplish the Self-checks at the end of each unit
- ✓ Perform Operation Sheets which were provided at the end of units
- ✓ Perform the “LAP test” giver at the end of each unit and
- ✓ Read the identified reference book to get more knowledge and to do examples and exercise

Unit one: Measuring instrument

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- safety and OHS requirement
- Measurement of Dimensions and Variables
- Appropriate Measuring Instrument
- Measuring Techniques and Recording Results
- Measuring Activities

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- safety and OHS requirement
- Complete measurement of dimensions and variables
- Select appropriate measuring instrument
- Use relevant measuring techniques and recording results
- Carrying out all measuring activities accordingly

1.1. Safety and OHS requirement

1.1.1. Metal work shop safety

Definition of General safety

Safety means the right way of doing things.

The safety in Workshops has been written not only to provide appropriate safety procedures but also to assist trained workshop personnel with the provision of a reference document outlining the general principles of safe working practices relevant to the mechanical engineering aspects. It relates to specific areas where definite safety measures are required for workshop operations.

General safety rules are established for three good reasons:-

- ✓ To protect you and your colleagues from badly harm.
- ✓ To minimize damage to facilities, machinery and tools with which you work.
- ✓ To enable you experience a positive safety attitude not only in the work shop but also in your entire professional career.

Safety is not only the responsibility of a single fellow. It is the responsibility of every one.

1.1.2. Classification of Safety

1. Personal safety:

- Wear approved safety glasses or goggles at all times.
- Wear approved foot wears at all times.
- Remove all rings, Watches, or bracelets.
- Long hair must be protected by a hair net or an approved protective shop cap.
- Avoid horse play at all times, since an accidental slip or fall can cause a serious cut or body injury.
- Never handle sharp tools or cutters by hand.
- Use proper lifting techniques whenever lifting tools or machines.
- Do not carry sharp tools on pockets.
- Remove all rings, Watches, or bracelets.
- Don’t wear loose clothes.
- Do not use a file without handle.

2. Bench work and fitting shop safety:

- Keep hands and tools wiped clean and free of dirt, oil and grease.
- Always keep the work shop clean.
- Do no keep working tools at the edge of the table.
- Keep the floor free of oil and grease
- While sawing, keep the blade straight; otherwise it will break
- Clean the vice after use.
- Keep the floor around a machine or bench free of tools or stock.
- Sweep up the metal chips on the floor frequently.

3. **Machine and tool safety**
   - Do no keep working tools at the edge of the table.
   - Never place tools or materials on machine tools.
   - Always keep the machine clean.
   - Always stop a machine before attempting to clean it.
   - Do not use vice as an anvil.

Cause of accidents

1. improper dressing
2. poor house keeping
3. insensible behavior
4. incorrect procedure

Preventing accidents

1. proper dressing
2. good house keeping
3. sensible behavior
4. correct procedure

1.1.3. Completing measurement of dimensions and variables

1.2.1. Measurement

Accurate measurement is the basic for all shop-work and modern manufacturing. Measurement is the comparison of an unknown dimension to a known standard. Good measuring instruments were a key to high accurate production. Today, measuring tools are essential for most machining operations from initial part layout to final inspection.

1.2.2. Measurement tools

Measuring tools are tools used when taking measurements or to transfer measurements to metal parts or components that are being worked on in the workshop. Some tools are used in conjunction with other tools when taking measurements. E.g. measuring tape, steel rule, gauges, Vernier caliper, micrometers etc.

1.3. Selecting appropriate measuring instrument

A **measuring instrument** is a device to measure a physical quantity. In the physical sciences, quality assurance e, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events. Established standard objects and events are used as units, and the process of measurement gives a number relating the item under study and the referenced unit of measurement. Measuring instruments, and formal test methods which define the instrument's use, are the means by which these relations of numbers are obtained. All measuring instruments are subject to varying degrees of instrument error and measurement uncertainty.

These instruments may range from simple objects such as rulers and stopwatches to electron microscopes and particle accelerators. Virtual instrumentation is widely used in the development of modern measuring instruments.

1.3.1. Steel rules

- **How to Read a Steel Ruler**

Figure 1. 1 steel ruler

The accuracy and durability of steel rulers make them the ideal measuring tool for making crafts, drafting and performing household tasks. They provide more reliable measurements on small projects than tape measures or wooden rulers. Steel rulers are available in either U.S. customary units (inches) or metric units, or both. They come in a range of lengths and widths, and vary in accuracy and quality. Steel rulers most commonly come in one-foot, 18-inch, three-foot (yardsticks) and four-foot lengths.

Instructions

Figure 1. 2 Stainless steel rule

Things you'll Need: -

- Steel ruler
- Object to measure
- Pencil or pen

1. Place your ruler against the object, making sure that the first line of the ruler's gauge lines up exactly with your object's leading edge. Some gauges don't start right at the edge of the ruler, so make sure this slight gap is not included in your measurement.

2. Since rulers measure left-to-right, you will normally start at the object's left edge. But if the object is fixed in a place that won't accommodate the ruler, it may be necessary to flip the ruler around and read it from right to left. Make sure to place the unit gauge you're most comfortable with (e.g., inches) against the object's edge.

3. Read the gauge carefully. If you are measuring to determine the object's overall length, record the closest graduation marking that lines up with the end of the object.

Figure 1. 3 marking work piece

4. To measure an object for cutting, mark the edge of the object with a fine pencil line at the desired dimension. Remember that sloppy marks will decrease accuracy, so avoid wide, slanting lines that obscure your measurement.

5. Inches are shown by the largest graduation markings along the ruler's edge and are numbered consecutively. Half-inches are indicated by the second-longest markings along the ruler, and quarter-inches, by the third-longest markings. Eighth-inches are shown by the fourth-longest markings, and sixteenth-inches are the shortest markings on the ruler. To keep it simple, just remember each unit is half the size of the next largest unit. So, if your desired piece is to be 6 1/4 inches long, mark your object at the first, third-longest marking, beyond the sixth inch. Or, if 6 1/16 inches is required, mark the object at the first, shortest marking, after the sixth inch.

6.Metric rulers work the same way, but are divided into centimeters, indicated by large, numbered markings along the edge. Each centimeter is further divided into 10 millimeters, shown by smaller markings. So, an object that measures to the fifth small marking past the first centimeter would be 1.5 cm (or 15 mm) long. There are 100 centimeters in a meter, which is about three inches longer than a yard.

To get the full accuracy out of a rule, it is important to use it correctly. Never use the end of the rule to align with the edge of the work for a measurement (Figure 4). The end of a rule is often rounded off from misuse, and a true measurement will not be made.

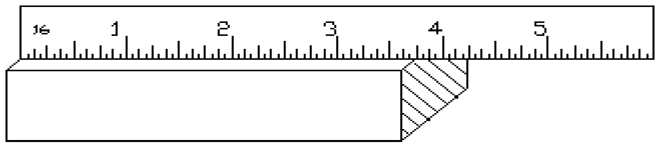


Figure 1. 4 **Measuring work piece**

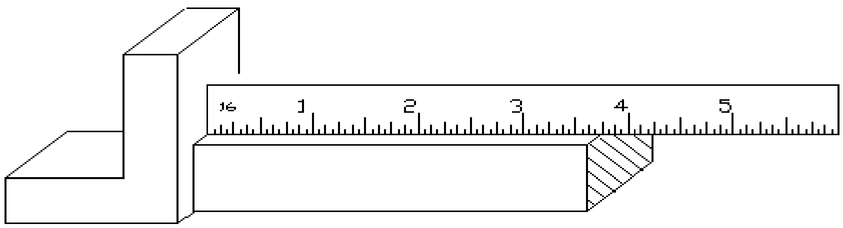


Figure 1. 5 **Measuring work piece**

Even if the work piece is held firmly against a reference surface such as an angle plate (Figure 5), this will not assure an accurate measurement if the end of the rule is worn off.

To offset this, use an inch graduation as a reference point on the rule (Figure 3). Precision and reliable measurements are possible this way. With the graduation directly on the edge of the work and by not using the end of the rule, wear is inconsequential.

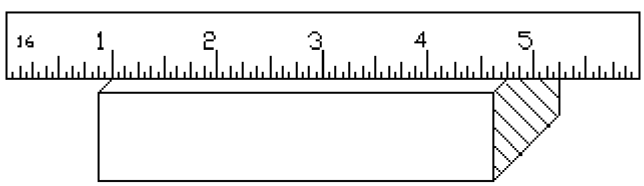
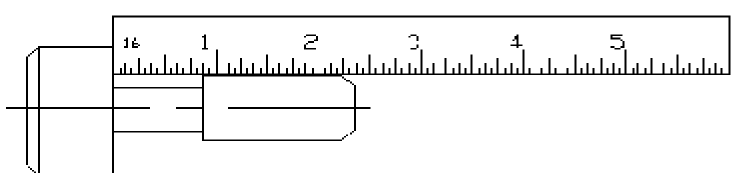
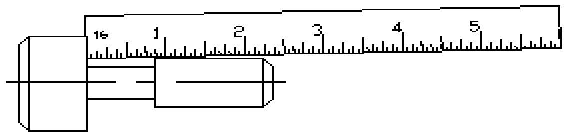


Figure 1. 6 **Correct Ruler using**

When measuring a length, the rule must be kept in a straight line parallel to the centerline of the work. If it is tilted, the measurement will be longer than the actual part. See Figure 4.



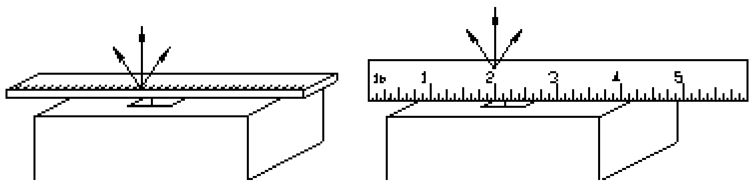
Correct



Incorrect

Figure 1. 7 **Measurement using Steel rule**

One other important factor in using the rule is to be aware of parallax. This is an observation error from the person measuring or holding at the part in relation to the part being held.



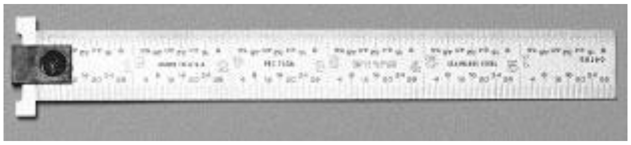
Incorrect **(Rule Lying Flat)** **Correct** **(Rule Standing on Edge)**

Figure 1. 8 **Measurement using Steel rule**

The figure on the left is an incorrect way of measuring, and parallax is greatly increased because of the thickness of the rule. The graduations do not come in direct contact with the work. The arrows pointing to the right and left will cause parallax, and even though the arrow pointing straight up is the correct way to view the rule, there is a chance for error in reading due to the thickness of the rule.
The figure on the right is used with the rule on edge. As can be seen, the graduation comes in contact with the work which is the correct way of measuring. Although the arrows pointing to the right and left will cause an improper reading, it will not be as great an error as when used like the figure on the left. The proper way is to view the graduation straight up as the center arrow.

Types of steel rules

The six-inch rule is considered to be the most convenient size to carry around. Many steel rules have a "hook" feature that provides an accurate "stop" at the end of the rule (figure 6). This can be used to set calipers, dividers, etc. and for taking measurements where it is not possible to be sure that the end of the rule is even with the edge of the work. Some workers refer to steel rules as "machinists scales."



Automatically aligns the end of the rule with the end of the work piece.

Figure 1. 9 Hook Rule:

Is used to measure the depth of narrow slots and small diameter holes

where the standard rule is to wide too be used.

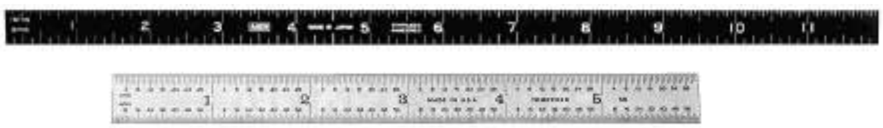


Figure 1. 10 **Flexible Rule**

Flexible Rule. Can be bent to the contour of arcs and curved lengths permitting measurements impossible to obtain with a rigid rule.

Narrow Rule with Holder- Used to measure grooves, recesses, keyways, and short lengths from shoulders. The rule sections are interchangeable in the holder and can be set at various angles (sometimes referred to as a short recess rule with holder).

Figure 1. 11 **Narrow Ruler with holder**

Reading Metric Rules

Many products are made in metric dimensions and require workers to be able to use a metric rule. The typical metric rule has millimeter (mm) and half-millimeter graduations (figure 10). Meters are typically divided into centimeters (1 /100 meter) and millimeters (1 /1000 m). All metric measures are expressed in mm. Thus 1.5 meters (m) would be 1500mm**.**

What Is The Most Common Source Of Error When Making Measurements With Steel Rules?

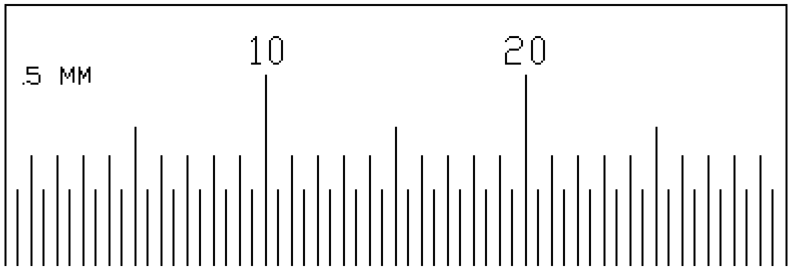


Figure 1. 12 **Metric ruler**

Examples of Reading Metric Rules

Distance "A" falls at the 22nd graduation on the mm rule. The reading is 22 mm. Distance "B" falls at the 12th graduation on the mm rule. The reading is 12 mm.

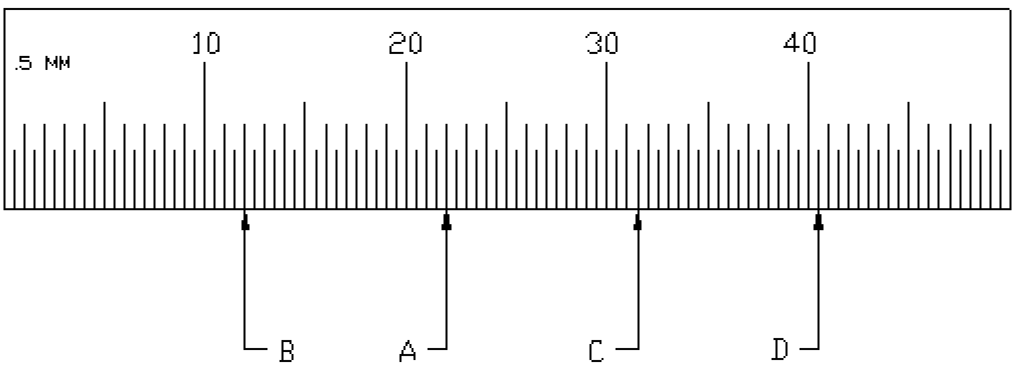


Figure 1. 13 **Millimeter rule with .5 mm graduations.**

Distance "C" falls at the half-mm mark between 31mm and 32 mm. The reading is 31mm plus one half mm or 31.5mm.

Distance "D" falls one half mm past the 4 cm graduation. Since 4 cm are equal to 40mm, the distance is 40.5

Answer: Probably parallax. This is the failure to have your eye or eyes directly lined up parallel to the relevant graduation mark when you observe the alignment. If you are at an angle, the measure will appear different than it really is.

What are the other sources or error?

Answer: There are a few common errors that often make measuring with a steel rule less simple than it should be. One is the failure to record the measurement accurately. This occurs when the measurer thinks one measurement, but writes a different value down. This occurs when the worker is tired, trying to hurry, or is not focused on the task at hand.

Another common error is the failure to precisely line up the graduation mark with the exact appropriate location on the piece being measured. If a finer graduation needs to be used, it is better to take the time to change rules or rule edges rather than estimate the distance between graduations.

A **third** source of error is confusion on the worker's part resulting from switching from inch to decimal to metric systems. This can only be solved by extended practice using each system, and being careful to note the appropriate system and use it carefully.

How do I take care of a steel rule?

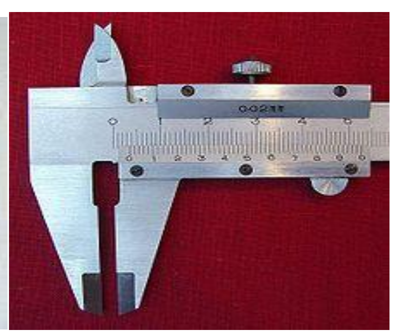
Answer: Like other precision measurement devices, steel rules must be treated with respect and care. They should be wiped clean after each use. They should also be lubricated from time to time to protect their surfaces. They should be stored carefully in a location that protects them from foreign objects. If they are bent or damaged in any way, they should be turned in to the quality assurance department for calibration or disposal. Follow these guidelines concerning steel rules:

- Never use a rule to open cans.
- Never use a rule as a screwdriver to loosen screws.
- Never use a rule to clean chips in tight comers.
- Take as good care of a rule as you would an expensive measuring tool**.**

1.3.2. Calipers

A caliper (British spelling also caliper) is a device used to measure the distance between two opposing sides of an object. A caliper can be as simple as a compass with inward or outward-facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring tool, such as a ruler.

It is used in many fields such as metalworking, mechanical engineering, gun-smithing, hand loading, woodworking, woodturning and in medicine.

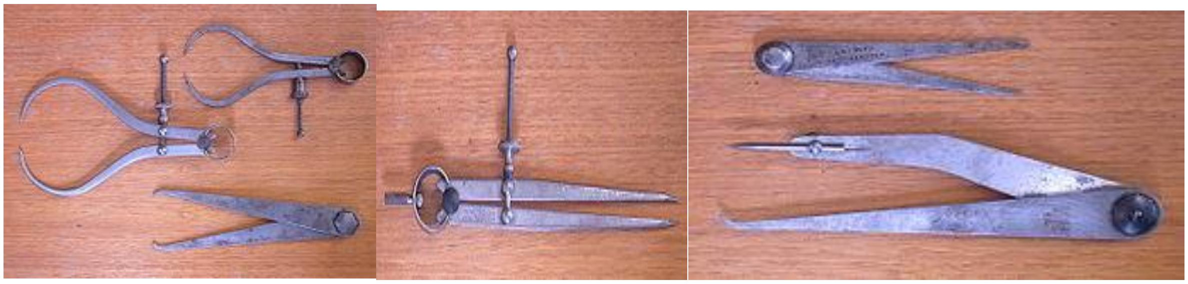



Figure 1. 14 Different types of calipers

Types of caliper .

Inside caliper

Figure 1. 15 **Inside calipers**

Two inside calipers

The **inside calipers** are used to measure the internal size of an object.

The upper caliper in the image (at the right) requires manual adjustment prior to fitting, fine setting of this caliper type is performed by tapping the caliper legs lightly on a handy surface until they will *almost* pass over the object. A light push against the resistance of the central pivot screw then spreads the legs to the correct dimension and provides the required, consistent *feel* that ensures a repeatable measurement.

The lower caliper in the image has an adjusting screw that permits it to be carefully adjusted without removal of the tool from the workpiece.

Outside caliper

Figure 1. 16 **Outside calipers**

Three outside calipers.

Outside calipers are used to measure the external size of an object.

The same observations and technique apply to this type of caliper, as for the above inside caliper. With some understanding of their limitations and usage these instruments can provide a high degree of accuracy and repeatability. They are especially useful when measuring over very large distances, consider if the calipers are used to measure a large diameter pipe. A vernier caliper does not have the depth capacity to straddle this large diameter while at the same time reach the outermost points of the pipe's diameter.

Divider caliper

Figure 1. 17 **divider calipers**

Pair of dividers

In the metalworking field divider calipers are used in the process of marking out suitable work pieces. The points are sharpened so that they act as scribers, one leg can then be placed in the dimple created by a center or prick punch and the other leg pivoted so that it scribes a line on the work piece’s surface, thus forming an arc or circle.

A divider caliper is also used to measure a distance between two points on a map. The two caliper's ends are brought to the two points whose distance is being measured. The caliper's opening is then either measured on a separate ruler and then converted to the actual distance, or it is measured directly on a scale drawn on the map. On a nautical chart the distance is often measured on the latitude scale appearing on the sides of the map: one minute of arc of latitude is approximately one nautical mile or 1852 meters.

Dividers are also used in the medical profession. They are used to measure electrocardiogram (ECG) lines. This instrument is called an *ECG caliper* or *EKG caliper*. These calipers have changed through the years, and there are even pocket calipers, invented 20 years ago by cardiologist Robert A.

Figure 1. 18 **ECG Caliper**

Odd leg calipers

Oddleg calipers, **Hermaphrodite calipers** or **Oddleg jennys**, or Ol' Jennys, as pictured on the left, are generally used to scribe a line a set distance from the edge of workpiece. The bent leg is used to run along the workpiece edge while the scriber makes its mark at a predetermined distance, this ensures a line parallel to the edge.

In the diagram at left, the uppermost caliper has a slight shoulder in the bent leg allowing it to sit on the edge more securely, the lower caliper lacks this feature but has a renewable scriber that can be adjusted for wear, as well as being replaced when excessively worn.

1.3.3. Vernier caliper

Vernier calipers are measuring devices used to measure inside, outside and depth of holes. They can also measure thickness and the opening of slots.

The vernier is a convenient tool to use when measuring the length of an object, the outer diameter of a round or cylindrical object, the inner diameter of a pipe, and the depth of a hole.

The vernier consists of a main scale engraved on a fixed ruler and moving vernier scale engraved on a movable jaw.

The main parts of vernier calipers

- **Outside jaws**: used to measure external lengths
- **Inside jaws**: used to measure internal lengths
- **Depth Gauge**: used to measure depths
- **Main scale** (cm)
- **Main scale** (inch)
- **Vernier** (cm)
- **Vernier** (inch)
- **Retainer**: used to block movable part to allow the easy transferring a measurement.

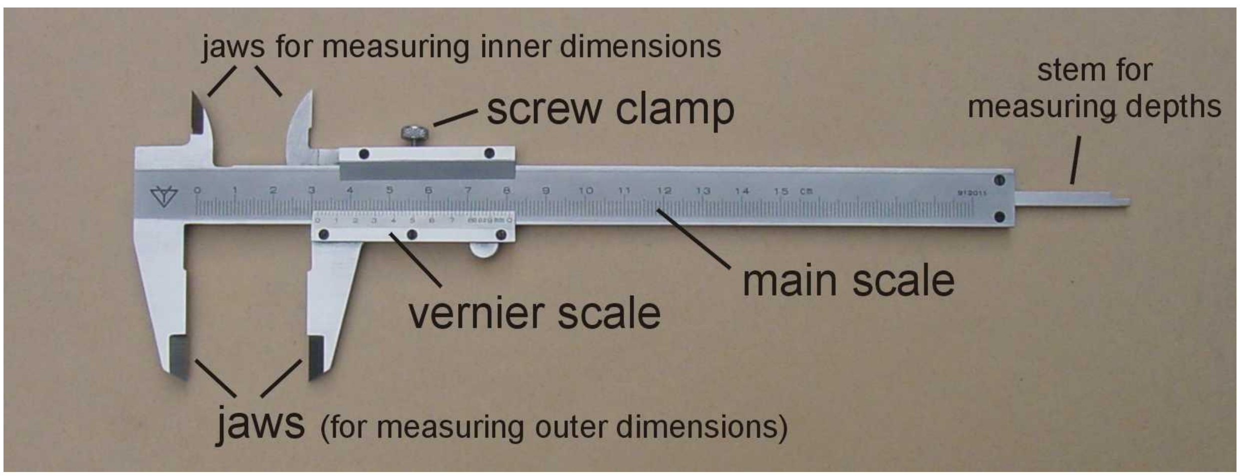


Figure 1. 19 **vernier caliper**

In metric vernier calipers there are different vernier scales and have different accuracy basis on their moving venier scales on the moving scale of the vernier caliper.

- One tenths (1/10th) vernier scale – the minimum measurement 0.1 mm.
- One twenty (1/20th) vernier scale – the minimum measurement 0.05mm.
- One twenty fifths (1/25th) vernier scale – the minimum measurement 0.04mm.
- One fifths (1/50th) vernier scale – the minimum measurement 0.02mm.

The Most common type of vernier calipers are the 1/20th i.e. 0.05mm and 1/50th of a 0.02mm.

1.4. Using relevant measuring techniques and recording results

1.4.1. Reading Vernier caliper

Reading 1/20th Vernier caliper has 1we'nj.in scales such as:

a) Main scale: On this scale 1cm is divided into 10mm. Therefore one graduation is equal to one mm.

b) Moving scale : - On the moving scale there are 20 graduations, which equals to 19mm. One graduations on the moving scale equal to 0.95 (20 x 19mm).

Hence, the difference is 1 mm - 0.95mm = 0.05mm, which is the minimum measuring increment that the gage provides.

Example **A 1/20th VERNIER CALIPER**

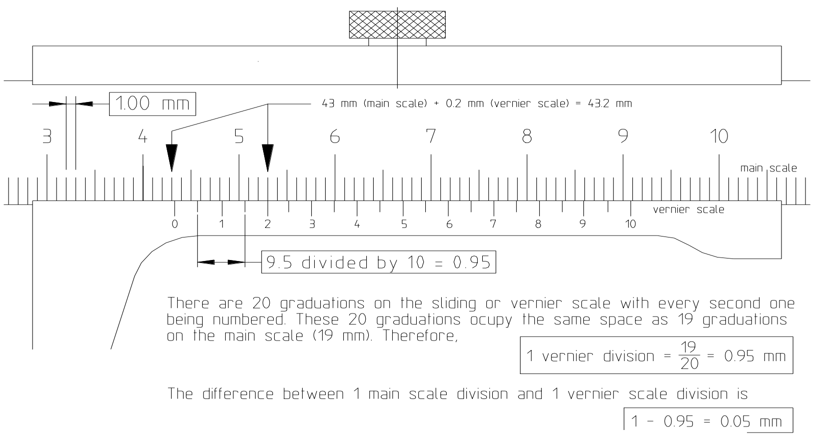


Figure 1. 20 **reading Vernier scale**

Reading 1/50th Vernier caliper

On the moving scale there are 50 graduations which equals to 49mm. One graduation on the moving scale equals to 0. 98mm (1/50 x 49). Hence the difference is 1mm - 0.98mm = 0.02mm, which is the minimum measuring increment that the gage provides.

A 1/50th VERNIER CALIPER

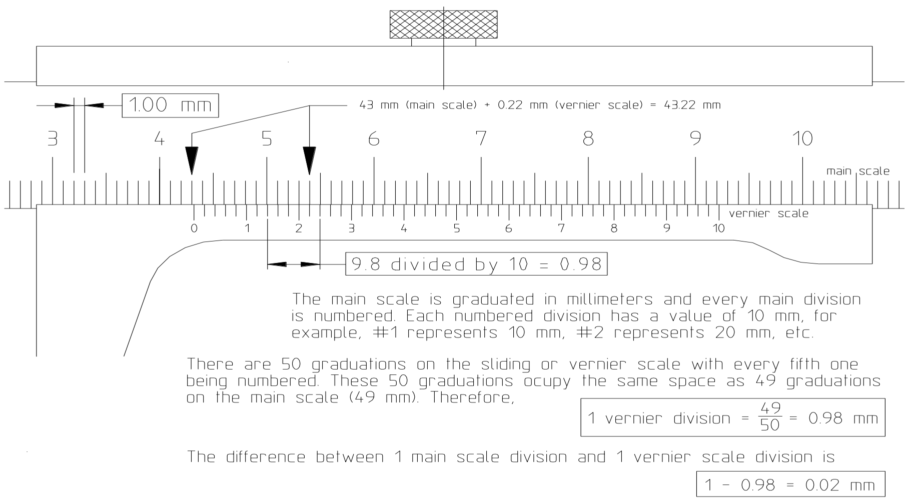


Figure 1. 21 **reading Vernier scale**

How to read a measurement from the scales:

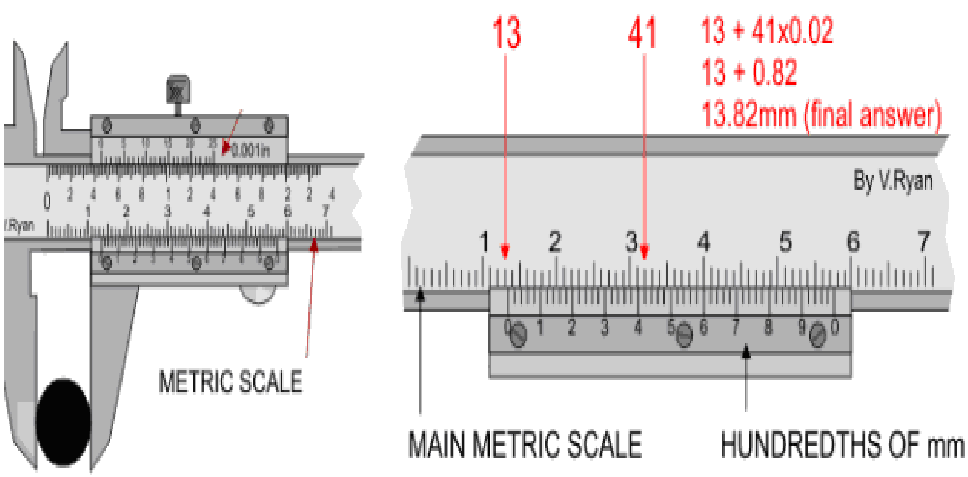


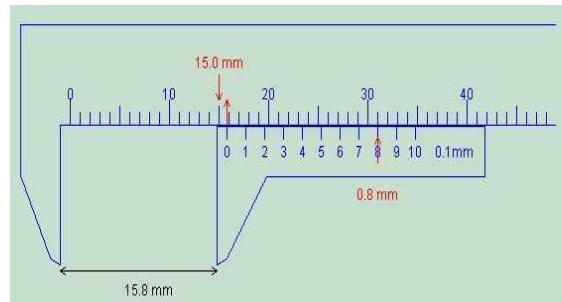
Figure 1. 22 **metric reading scale**

Exercises:1

Coincide line

1

3



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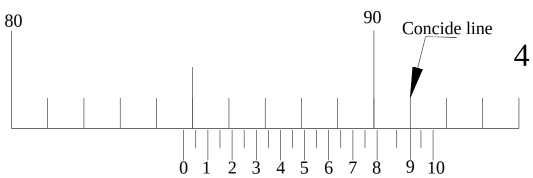

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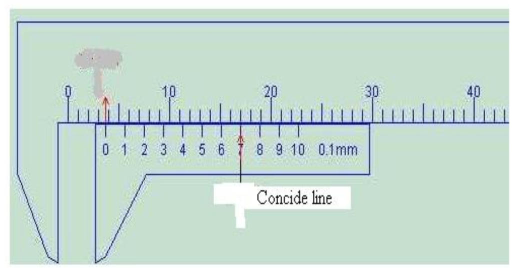


Some examples:

Note that the important region of the vernier scale is enlarged in the upper right hand corner of each figure.

Figure 1. 23 The reading is 37.46 mm

In figure 1.23 above, the first significant figures are taken as the main scale reading to the left of the vernier zero, i.e. 37 mm. The remaining two digits are taken from the vernier scale reading that lines up with any main scale reading, i.e. 46 on the vernier scale. Thus the reading is 37.46 mm.

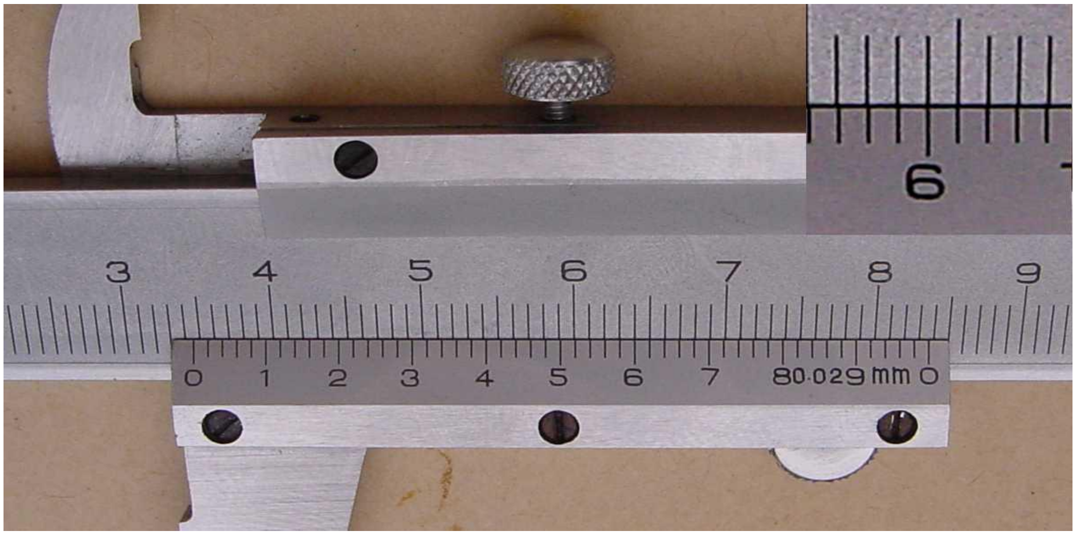


Figure 1. 24 The reading is 34.60 mm

In figure 1.24 above, the first significant figures are taken as the main scale reading to the left of the vernier zero, i.e. 34 mm. The remaining two digits are taken from the vernier scale reading that lines up with any main scale reading, i.e. 60 on the vernier scale. Note that the zero must be included because the scale can differentiate between fiftieths of a millimetre. Therefore the reading is 34.60 mm.

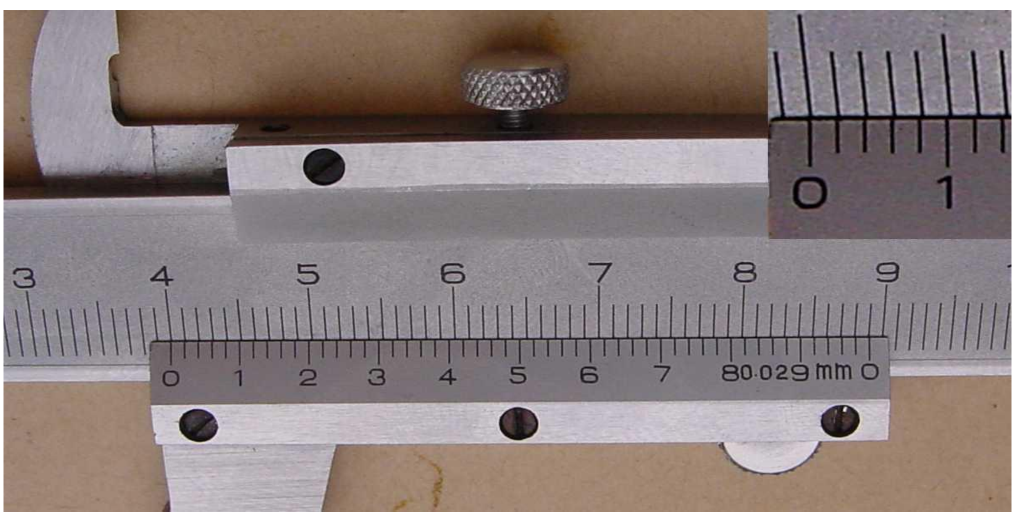


Figure 1. 25 The reading is 40.00 mm.

In figure 1.25 the zero and the ten on the vernier scale both line up with main scale readings, therefore the reading is 40.00cm.

Try the following for yourself.

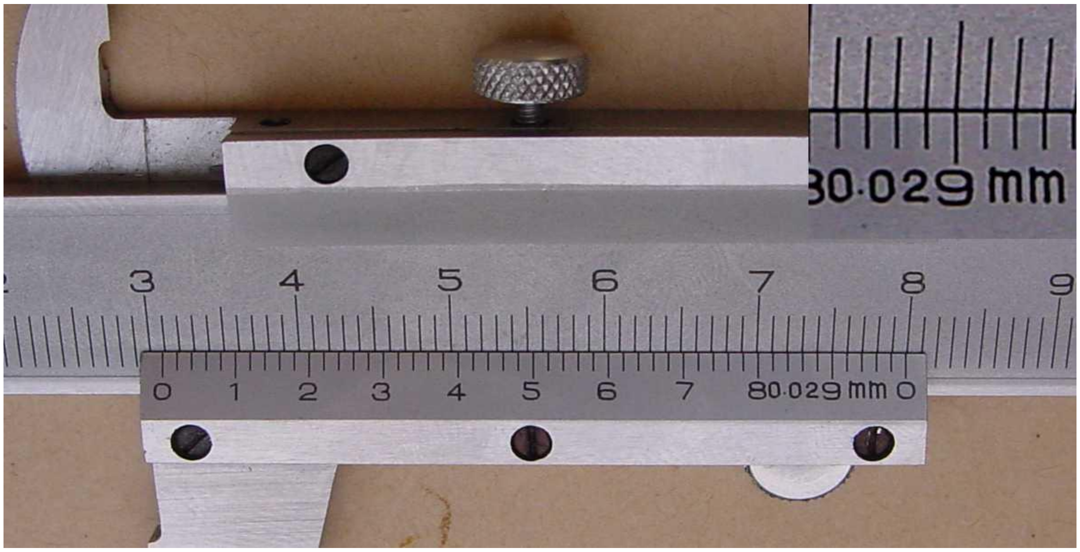


Figure 1. 26Click here for the answer.

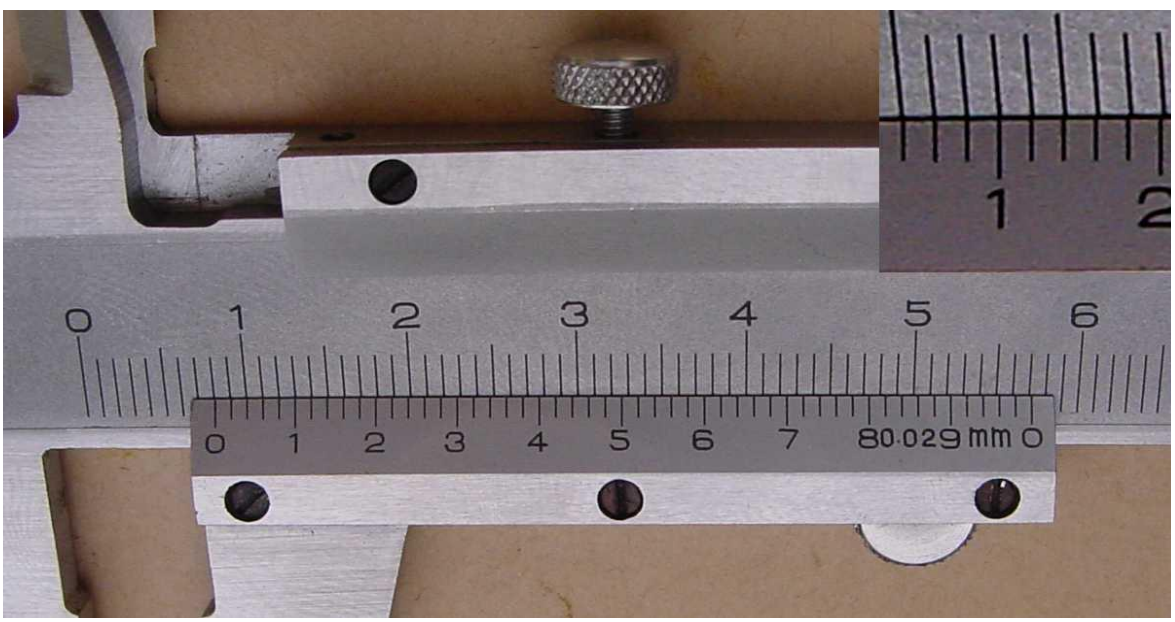


Figure 1. 27Click here for the answer.

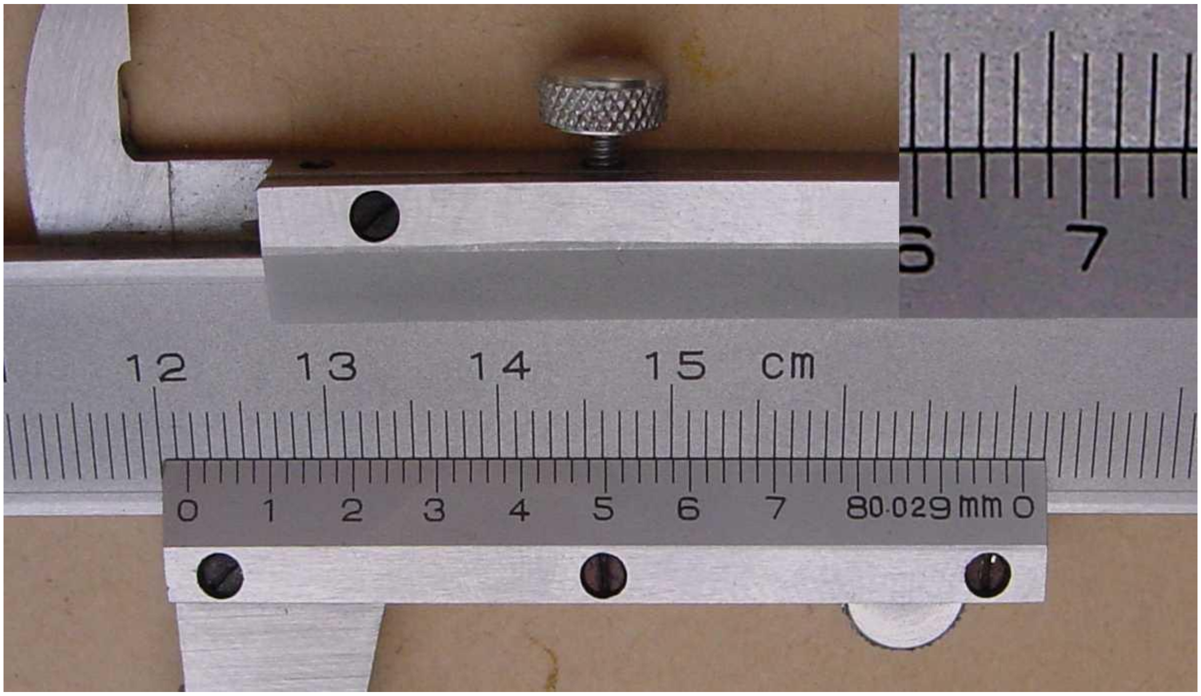


Figure 1. 28 Click here for the answer.

1.5. Carrying out all measuring activities accordingly

1.5.1. Micrometer

A micrometer is a more precise measuring instrument than the vernier calipers. The accuracy is come from the fine thread on the screw spindle. The ratchet prevents excess force from being applied. Generally, the screw spindle has a pitch of 0.5mm. The thimble is divided into 50 equal divisions. The precision of a micrometer is achieved by a using a fine pitch screw mechanism.

The Main Parts of Micrometers:

Anvil: The shiny part that the spindle moves toward, and that the thing to be measured rests against.

Barrel: The stationary round part with the linear scale on it.

Frame: The C-shaped body that holds the anvil and barrel in constant relation to each other. It is thick because it needs to minimize flexion, expansion, and contraction, which would distort the measurement.

Lock-ring: The knurled part that one can tighten to hold the spindle stationary, such as when momentarily holding a measurement.

Screw (not seen): The heart of the micrometer, as explained under "Operating principles". It is inside the barrel. (No wonder that the usual name for the device in German is *Messschraube*, literally "measuring screw".)

Spindle: The shiny cylindrical part that the thimble causes to move toward the anvil.

Thimble: The part that one's thumb turns.

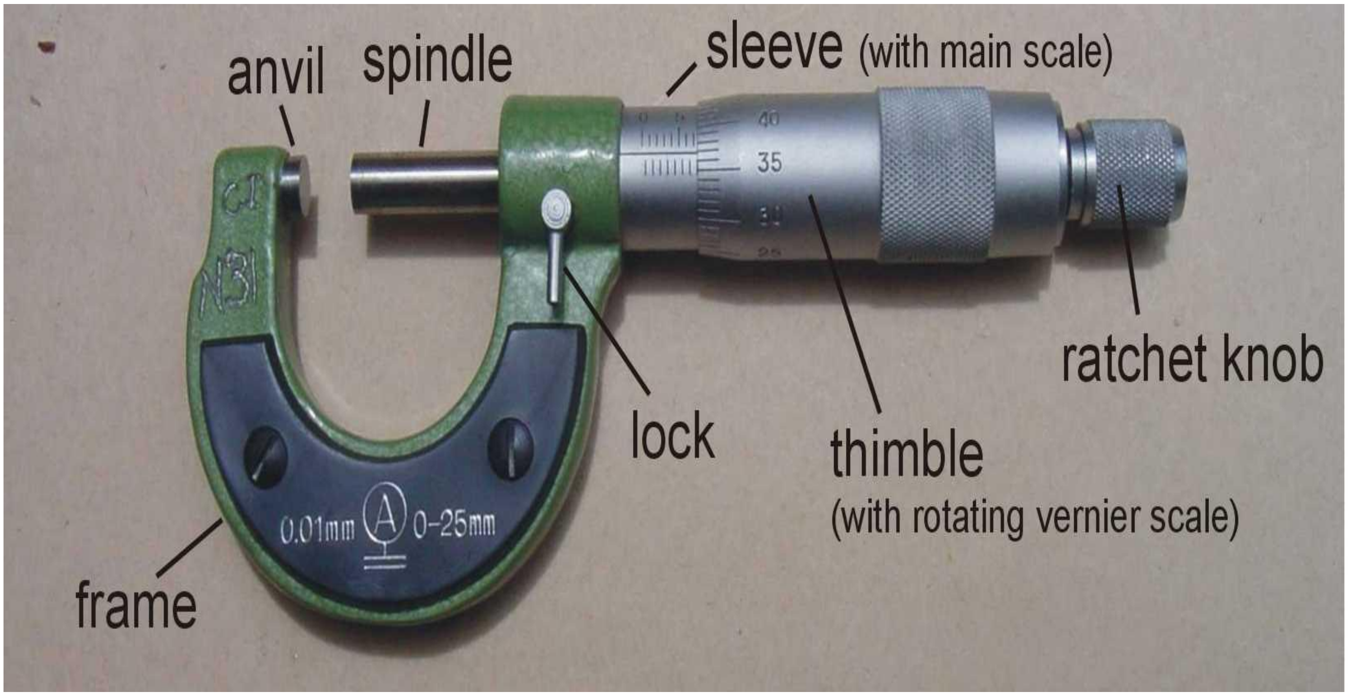


Figure 1. 29 A **main parts of micrometer**

Types of micrometer

There are three common types of micrometer; their names are based on their application**:-**

- Outside micrometer
- Inside micrometer
- Depth micrometer

I**. Outside micrometer**

Outside micrometers are used to measure the thickness or the outside diameter of parts. They are available in different range of sizes. (Fig. A)

a) Reading of outside micrometers

The most commonly used micrometer screw pitch is 0.5mm with 50 divisions on the thimble. The reading line on the sleeve is graduated in MI millimeters and each millimeter is also divided into half. Every fifth millimeter is numbered. It takes two revolutions of the thimble to move the spindle 1mm.

The beveled edge of the thimble is graduated. In 50 divisions and every fifth line is numbered. One revolution of the thimble moves the spindle 0.5mm. Thus, each thimble graduation equals l/50 or 0.5mm or 0.01mm.

To read the micrometer, read the number of millimeters and half-millimeters visible on the sleeve. Add these to the number hundredths of a millimeters indicated by the thimble graduation that coincides with the reading line the sleeve.

Example:-

Figure 1. 30 B The reading is 7.72 mm.

In figure B the last graduation visible to the left of the thimble is 7.5 mm; therefore the reading is 7.5 mm plus the thimble reading of 0.22 mm, giving **7.72 mm.**

II. **Inside micrometer**

An inside micrometer (fig. C) is used to measure inside diameters or between parallel surfaces.

Figure 1. 31 **C inside Micrometer**

b) Reading of inside micrometers,

The readings of inside micrometer are the same the outside micrometers.

III. **Depth micrometer**

A depth micrometer (fig D) is used to measure the depth of holes, slots, counter bores, and recesses, and the distance from a surface to some recessed part. This type of micrometer is read exactly opposite from the method used to read an outside micrometer. The zero is located toward the closed end of the thimble. The measurement is read in reverse and increases in amount (depth) as the thimble moves toward the base of the instrument.

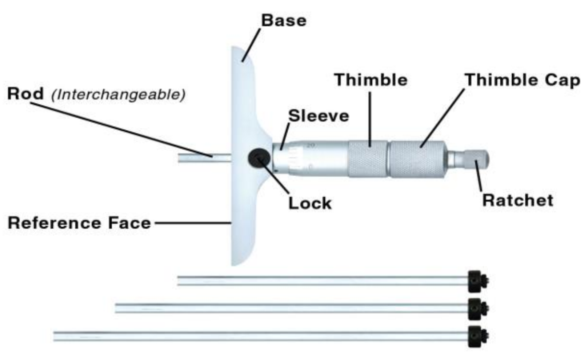


Figure 1. 32 Depth Micrometer

c) Reading of depth gauge micrometer

An important point to remember with the depth micrometer is that it measures in reverse from other micrometers

The zero reading of the depth micrometer appears when the thimble is at the top most position.

The depth micrometer graduations are in reverse order.

The thimble reads in clockwise direction.

1.5.2. Vernier micrometer

Some micrometers are provided with a vernier scale on the sleeve in addition to the regular graduations. These permit measurements within 0.001 millimeter to be made on metric micrometers.

Its purpose is to measure objects with extreme accuracy.

The additional digit of these micrometers is obtained by finding the line on the sleeve vernier scale which exactly coincides with one on the thimble. The number of this coinciding vernier line represents the additional digit.

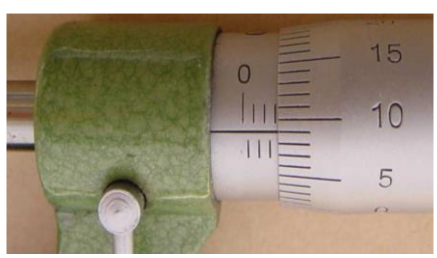
Thus, the reading for metric micrometers of this type is the number of whole millimeters (if any) and the number of hundredths of a millimeter, as with an ordinary micrometer, and the number of thousandths of a millimeter given by the coinciding vernier line on the sleeve vernier scale.

Figure 1. 33 E Vernier Micrometer

Exercise 2

Read the following Micrometer measurements:

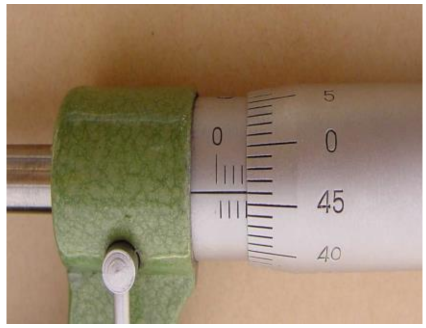
1.



2.

3.

4.



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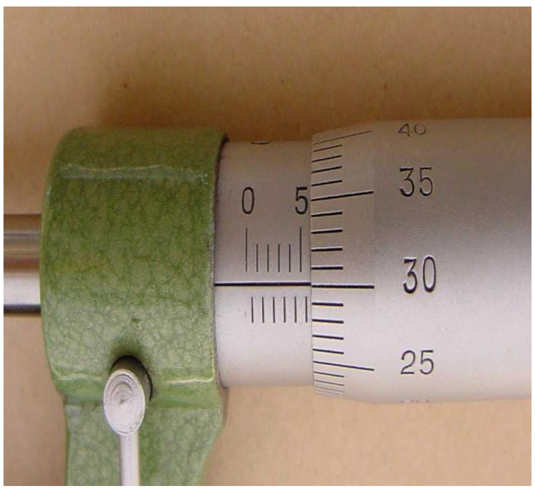

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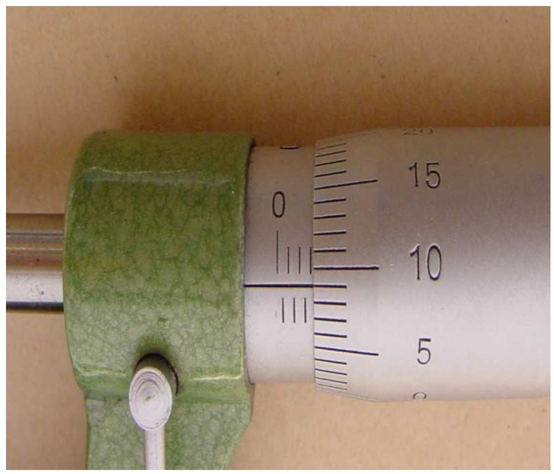


Self-check 1 **Written test**

Directions: Choose the best answer for the questions (**2 point each**):

A marking out tool used for checking the square ness of many types of small works when extreme accuracy is not required is _________ .

Scriber b. Try square c. Caliper d. Punch

_______ Is a marking out tool used to scratch on the surface of metals and plastics lightly.

a. punch b. Steel rule c. Try square d. Scriber

3. Which one of the following steel is a more precise measuring instrument than the others?

Micrometer c. Steel rule

Vernier caliper d. Divider

4.A marking (laying) out tool used for marking (making) circles and arcs on metal surface Is?

Center punch b. Divider c. prick punch d. chisel

5.Which one of the following is used to make an indent in the surface where holes are to be drilled in metal?

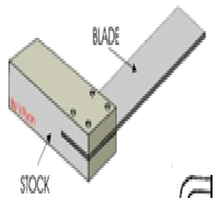
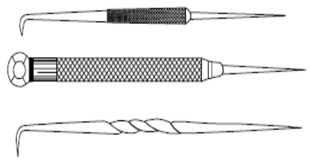
a. Chisel c. Center punch

b. Drilling machine d. Hack saw

true or false

1. Safety means the right way of doing things?
2. safety measures are required for workshop operations?
3. Safety is not only the responsibility of a single fellow?

Matching Type

A	B
Scribers	A. 
Dial Indicator	B. 
Try square	C. 

Operation sheet 1.1 Measuring work pieces

1.1.1. To Measuring work pieces using different measuring instruments;

Steps 1- Use bench work tools and equipment.

Step 2- Use measuring instruments.

Step 3- Prepare work piece to be measured.

Step 4- Select the appropriate measuring instruments.

Step 5- Measure the work piece.

Step 6- Record the results.

1.1. 2. To Marking out the hack sawing and filling lines:

- **Steps 1-** Locate the reference plane.
- **Step 2-** Use the surface plate, surface gauge and steel ruler to set the required height as shown in Fig.2.1.
- **Step 3-** Use the angle plate, surface gauge to scribe the first line and Repeat the same procedure to scribe the other three lines.
- **Step 4-** Punch the scribed lines by using the prick punch.

Lap test practical demonstration

Name: ______________________________ Date: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **3-4** hours.

Task 1: You will be given a V- Block similar to the one shown in Fig.1.1, use the steel rule to measure the dimensions shown in Fig. 1.2. Record your measurements in the table below.

Fig.1.1: V-Block

NOTE:

The accuracy of your readings should be in a range of 0.5 mm.

Table of measurements:

Dimension	A	B	C	D	E	F
Dimension in (mm)						

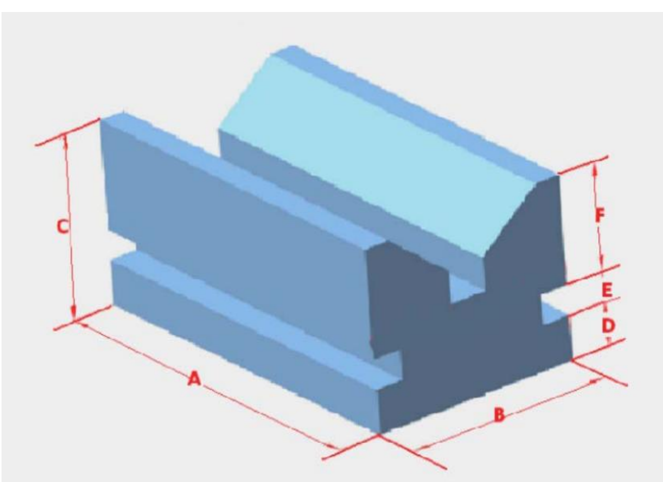


Fig.1.2: dimensions A to F to be measured on a V-Block.

Task 2: Marking out the hack sawing and filling lines.

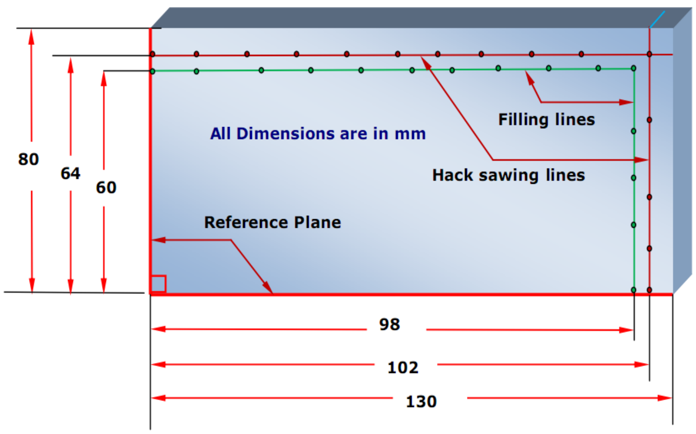


Fig.2.1. The filling and hack sawing lines.

NOTE:

Use a Vernier caliper with 0.02 mm accuracy

Task 3: You will be given a work piece similar to the one shown in Fig.3.1. Use the micrometer to measure the dimensions shown in Fig. 3.2. Record your measurements in the table below.

NOTE:

The accuracy of the micrometer is 0.01 mm

Fig.3.1 a copper work piece

Table of measurements

Dimension	R1	R2	A	B
Dimension in (mm)				

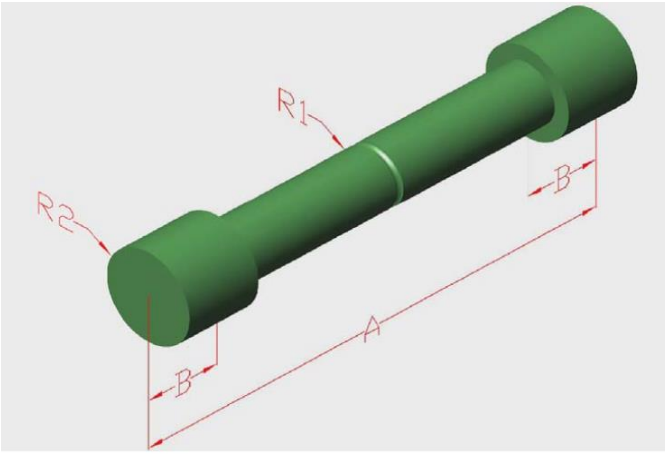


Fig.3.1 work piece

Unit two: Lay-out and mark dimensions/ features on work piece

This unit to provide you the necessary information regarding the following content coverage and topics:

- Selecting materials specification
- Marking dimensions using tools
- Lay outing and lay outing tools

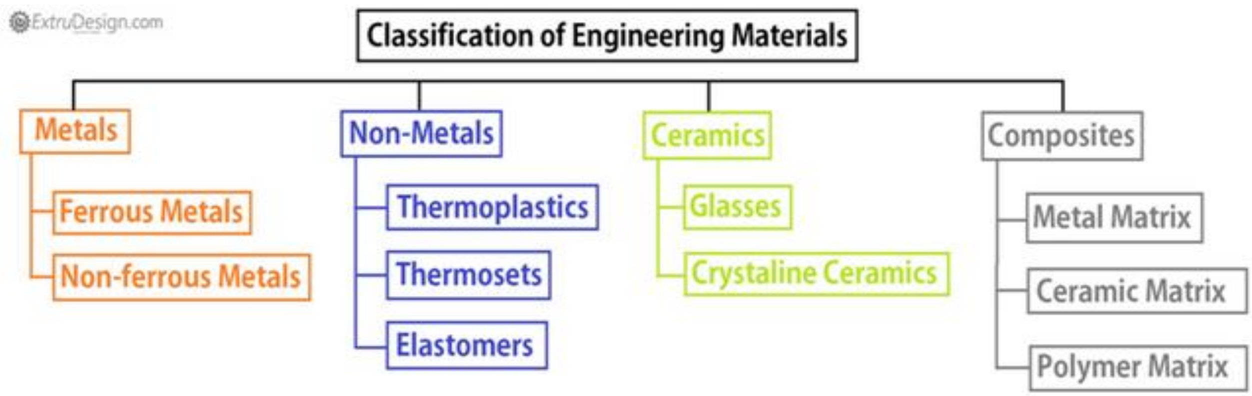
This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select materials specification
- Mark dimensions using tools
- Apply Lay outing and lay outing tools

2.1. Selecting materials specification

2.1.1. Concepts of engineering materials

The knowledge of materials and their properties is significant for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operation.



Properties of ferrous and nonferrous metals:-

Metals are an element that can conducts heat & electricity. Metals have the following properties:

- Solid at room temperature
- Reflective when polished
- Expand up on heating &contract on cooling
- Good conductor of heat & electricity

Metals can be classified in to two groups:-

1. **Ferrous metals**: - are those which contain iron as the main content.
   - ✓ Pig iron, wrought iron, cast iron, steel, alloy steel etc.
2. **Nonferrous metals**: - are those which don't contain an iron.
   - ✓ Copper, zinc, tin, lead, brass, bronze, etc…

The basic source of iron is iron ore. The separation of iron from iron ore is by smelting in blast furnace.

- **Pig iron**: all iron and steel products are derived from pig iron. The principal raw materials of used to produce pig iron are iron ore, coke; lime stone, coal, fluxes etc. Pig iron produce in a blast furnace is the first product in the process of converting by melting iron ore in to useful metals.

- **Steel**:-is an alloy of iron and carbon. It has high compressive strength & corrosion resistance compare to other elements. It is used for cutting tools, hand tools, building frame structure etc.

The main difference b/n pig iron & steel is the carbon content. Pig iron contains 3%-4%carbon. To make steel the carbon has to be reduced & other additional impurity to be burnt out , the carbon content varies from 0.1%- 1.5% .

Classification of Steels on their carbon content is:-

- Low carbon steel:-have less than 0.25% carbon content.
  It is used for making wires, rivets, nails etc.
- Medium carbon steel:-have b/n 0.15%-0.25% c- content.
  It is used for garden hoes, cranes, bolts, dies etc.
- High carbon steel: - have b/n 0.5% & 1.5% c- content. It is used for making hammers, springs, chisels, punches, hand files, reamers, screw drivers etc.

Section of steels: - steel ingots are worked in to their final shapes by rolling to produce various shapes. For example Sheet, plate, rod, square, hexagonal angle, channel

- **Cast iron**: - is an easily broken iron which contains some carbon & other impurities. It contains small amount of silicon, phosphorous, sulfur, manganese, etc. it has carbon content between 2%-4%

2.2. Marking dimensions using tools

Marking out and measuring is a critical part of manufacturing and is usually subject to a number of quality control checks. If components are marked out and measured wrongly before being cut out, there is no chance of them fitting together when they are assembled. Always take marking out measurements from a datum as indicated . A datum edge is a flat face or straight edge from which all measurements are taken. This prevents cumulative errors being made. If you are using timber, choose the face side carefully, before marking it with a small symbol for identification purposes. Then select a face edge that is at right angles to the face side. Take all your measurements from this side and/or edge.

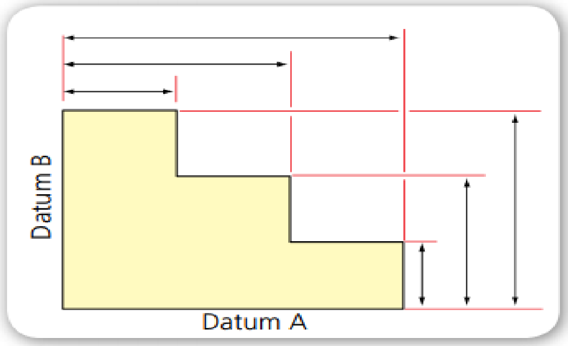


Figure 1. 34 **Datum edges**

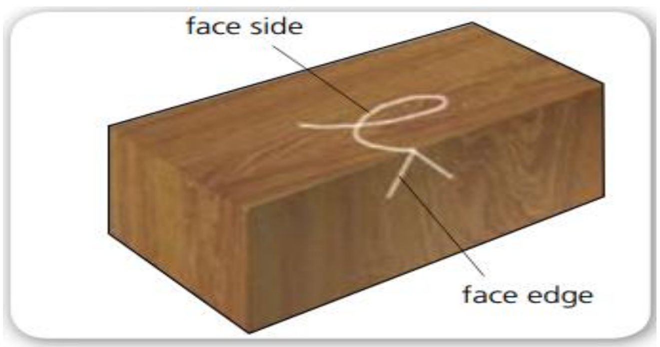


Figure 1. 35 **Face edges**

2.3. Laying out and laying out tools

I . Laying out

Layout is the process of making lines, circles, and other marks with a variety of hand tools to represent the features on the blueprint. These marks act as a reference for the operator during machining. They indicate features such as hole locations, dimensions, and other specific areas to be machined. The work piece is coated with a special layout dye, which helps the lines appear more clearly. Layout lines guide the operator to ensure the part fits within the acceptable tolerances. By preventing errors, layout reduces costs.

II. Laying out tools

- **Squares:**

  There are a number of squares:

  - ✓ Try square
  - ✓ Miter square
  - ✓ Engineer's square.

Both the try square and engineers square are used to mark lines at 90° to an edge. A try square is used on timber and an engineer's square is used on metals. Both can be used for marking out plastics. You can also use try squares and engineer's squares to check that a cut or an edge has been made at right angles to another. Hold the stock part of the square tightly against the edge that you have just cut. If you can see light between the two edges then the cut is not square. A miter square is used for marking out 45° or 135° angles on wood and plastic. Take great care when using any form of square for marking out or checking, and ensure that it is being held firmly and tightly against the surfaces or edges of the material.

In practice, try is used for checking the square ness of many types of small works when extreme accuracy is not required .The blade of the try square is made of hardened steel and the stock of cast Iron or steel. The size of the try square is specified by the length of the blade.

Item	Name and use
	try square marking out or checking right angles on wood or plastic
	engineer's square marking out or checking right angles on metal or plastic
	mitre square marking out or checking angles of 45° or 135°

Figure 1. 37 The uses of squares

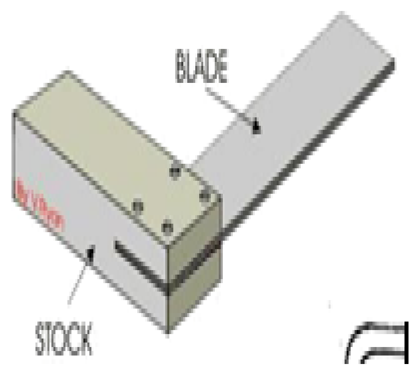


Figure 1. 36 Try square

:

There are three basic types of gauge:

- ✓ marking gauge,
- ✓ mortise gauge
- ✓ cutting gauge.

A **marking gauge** is used for marking lines parallel to the face edge and side on wood. It consists of a stock that slides up and down the stem, allowing various measurements to be set. The gauge should be set using a steel rule that has a zero end. The spur (sharp point) is pushed into the wood as the gauge is pushed or pulled along the length of the timber. It is important to hold the stock tightly against the edge of the timber to ensure that you mark a parallel line.

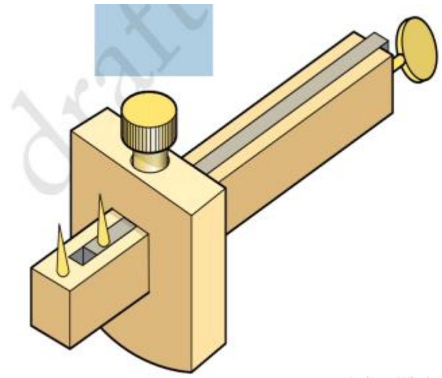


Figure 1. 38 Mortise gauge

A **vernier height gauge** is used for measuring height of an object or marking lines onto an object of given distance from a datum base.

A **cutting gauge** is used for cutting across the grain. It is used in the same way as a marking gauge, but has a blade instead of a spur. The blade cuts the fibers across the grain, making it easier and neater to cut with a saw.

A **mortise gauge** has two pins; one pin is fixed and the other is adjustable. It is used for marking two parallel lines where a mortise and tenon joint is to be cut. The process of marking out is exactly the same tise gauge as with the two other gauges.

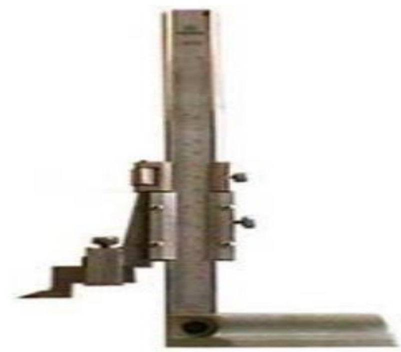


Figure 1. 39 Vernier Height Gauge

- **Scribers:**

A scriber is used to scratch on the surface of metal and plastic lightly. If you are using a scriber on metal, it is a good idea to apply a coat of engineer’s blue. This is a spirit-based liquid that is applied to a metal surface. When the scriber is dragged across the engineer‘s blue it leaves a clean line, which can be easily seen.

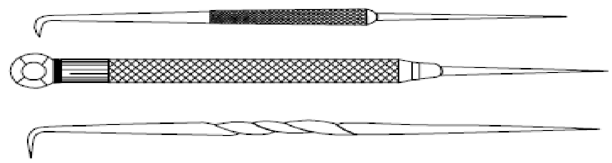


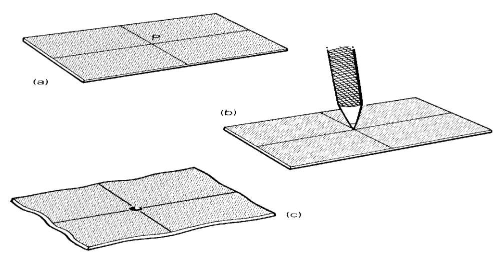
Figure 1. 40 **Scribers**

- **Punches:**

Centre punches are used to make an indent in the surface where holes are to be drilled in metal, as shown in Figure 4.19. They provide a starting point for the drill and stop it skidding over the surface. Dot punches are used for marking the centers where dividers are to be used. They are similar to a center punch, except that the tips are ground to a 60° rather than a 90° point.

Center Punch Procedure

1. Make sure that the point of the punch is sharp before starting.
2. Hold the punch at a 45 degree angle and place the point carefully on the layout line.
3. Tilt the punch to a vertical position and strike it gently with a light hammer.
4. If the punch mark is not in the proper position, correct it as necessary.



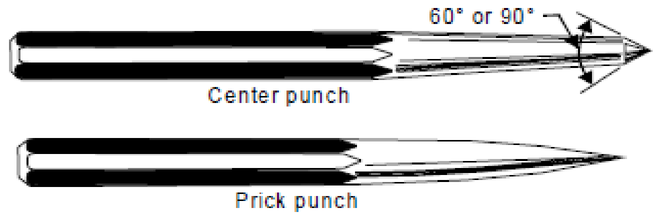


Figure 1. 41 **Center punch, and the punch in use.**

- **Hammer:**

Hammer is a common work shop hand tools used for striking purpose. There are different types of hammers based on their function.

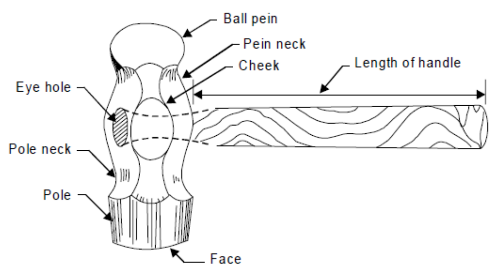


Figure 1. 42 **Common types of ball peen hammer and its parts**

- **Divider:**

It is basically similar to the calipers except that its legs are kept straight and pointed at the measuring edge. This is used for marking circles, arcs laying out perpendicular lines, by setting lines. It is made of case hardened mild steel or hardened and tempered low carbon steel. Its size is specified by the length of the leg.

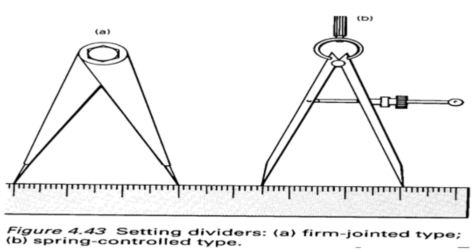


Figure 1. 44 Setting dividers

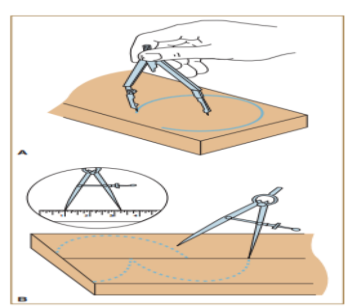


Figure 1. 43 place and wing the compass on the center of the circle or arc

B-Use the Divider to Step off Measurement

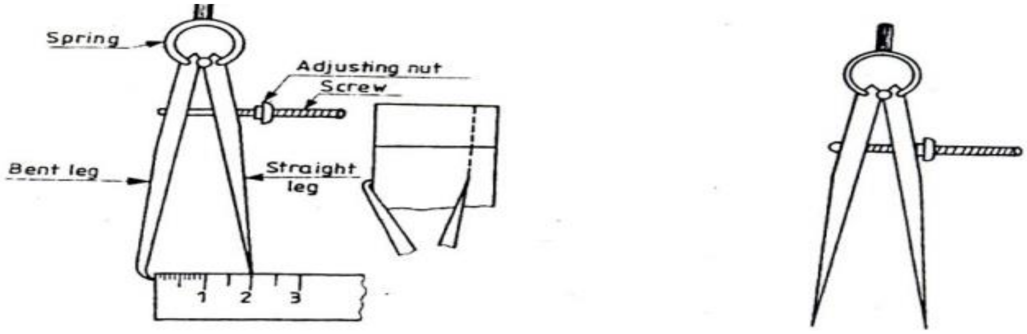


Figure 1. 45 **Odd leg caliper and divider.**

- **Trammel Points**:

Trammel points are used to mark large circles or make arcs that have large radii. They are used similarly to dividers. The beam is usually made of metal.

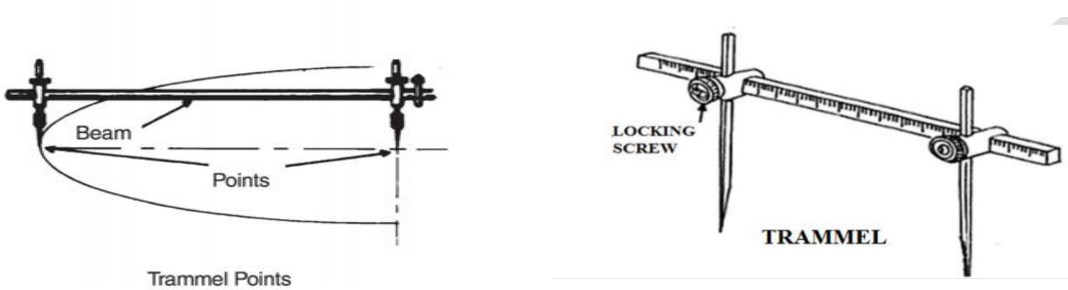


Figure 1. 46 **Trammel Points**

- **Surface plate**

The surface plate provides a 'plane of reference' for checking other surfaces. The plate is made from an iron casting. Its top surface is perfectly flat, and the underside is ribbed to prevent distortion of the plate (Figure 1.47). It is used generally for setting up work for marking out and testing. The surface table allows larger work to be checked for flatness.

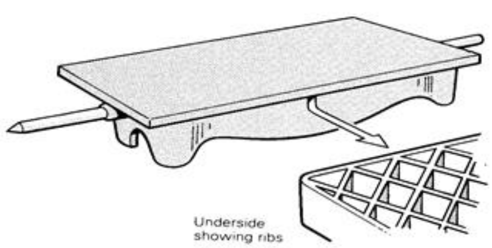


Figure 1. 47 **Surface plate**

- **Surface gauge:**

You use the surface gauge for marking parallel lines and finding centers. shows the procedure:

1. Set the scriber at the height you want, using the rule
2. Hold the work against an angle plate or on a vee block.
3. Move the block until the scriber touches the work.

- **Angle Plate**:

The angle plate is made from a good-quality casting.

It consists of two faces machined at 90° to each other. You can fix work to the plate using bolts, which can pass through the slots provided. You can also use the angle plate to support work when you are using the surface gauge for marking out.

- **Vee Blocks:**

You use vee blocks to support cylindrical work when you are testing it or marking it out. The blocks, which are supplied in pairs, are made from cast iron. There are grooves along the sides, which allow the clamp to be used. If the work is long, you will need a 'matching pair'.

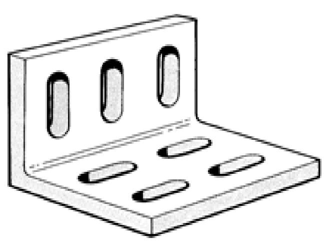


Figure 1. 49 a Angle plate

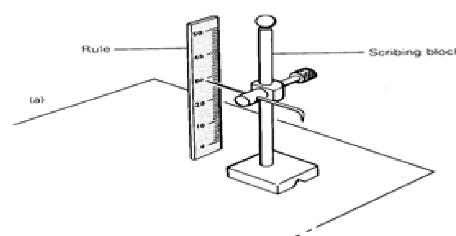


Figure 1. 48 b Surface gauge

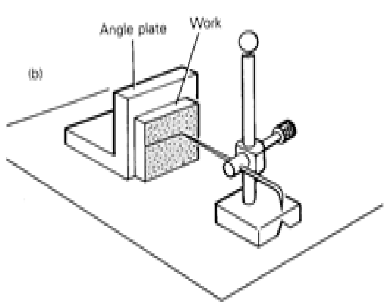


Figure 1. 51 c Using the surface gauge

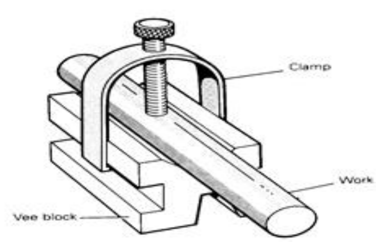


Figure 1. 50 Using the Vee block

- **Combination Set:**

The combination set is an important tool in the workshop, because you can use it as a center square, a try square, a protractor for marking out, measuring and testing. There are three heads (protractor, square and center), which slide onto a rule, which can be fixed at any position using the nut provided.

The main parts of the combination set are used as follows.

1. The try square has angles of 45° and 90°, which you can use to mark out, or to check that a surface is vertical. You can also use it as a square (Figure 4.30(a)).
2. You can use the center square to find the center of circular pieces (Figure 4.30 (b)).
3. You use the protractor with the rule to mark out or measure angular surfaces (Fig 4.30 (c)).

Measuring and inspection tools

You can obtain detailed dimensions of work pieces using measuring tools such as the rule, or the combination set. You can also test existing features (such as holes) for accuracy using inspection tools such as plugs and gauges.

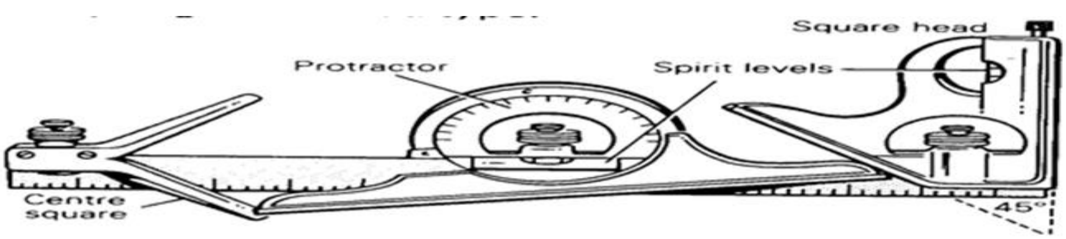


Figure 1. 52 **Combination set.**

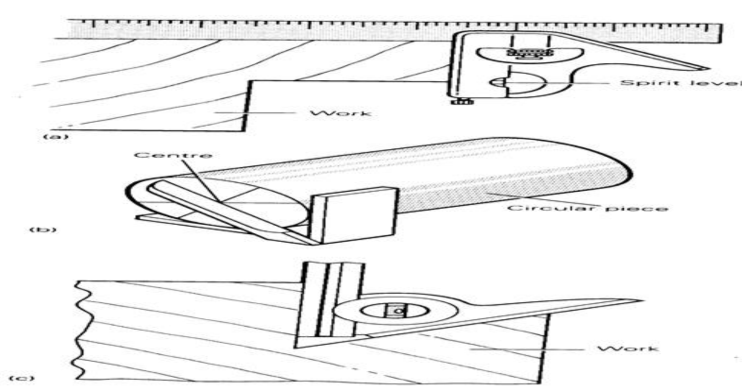


Figure 1. 53 **Using the combination set: (a) try square**

Figure 7

These are tools used for marking out and measuring that you need to know about:

- rules
- punches
- squares
- templates
- gauges
- micrometers
- Scribers.

Self check 2 Multiple choice

Directions: Choose the best answer for the following questions. (**2 point each**)

1. The ability to do whatever we expected of us as promptly accurately and economically as possible is: __________.
   a. Skill b. Knowledge c. Attitude d. Efficiency
2. Why planning is necessary?
   a. To provides direction b. To reduces uncertainty
   c. To minimize waste and redundancy d. All

3______ Is a marking out tool used to scratch on the surface of metals and plastics lightly.

a. punch b. Steel rule c. Try square d. Scriber

4. Which one of the following steel is a more precise measuring instrument than the others?
   a. Micrometer c. Steel rule
   b. Vernier caliper d. Divider

Directions: filling the blank

5.____________ is a moral goodness, which is to be practiced very well punctuality is nothing but courtesy to others.

6_________ ability to do whatever we expected of us as promptly accurately and economically as possible

Directions: give short answer

7. What is lay out

8.what the deference between marking and measuring tool

Directions: matching

A	B
9.____Combination Set	A. consists of two faces machined at 90° to each other
10.____Surface gauge	B. There are three heads protractor, square and center,
	C.marking parallel lines and finding centers

Unit Three: Hand Tool Operations
This unit to provide you the necessary information regarding the following content coverage and topics: • Clamping work pieces • using hand tools for bench work • Cutting, chipping, filing and scraping work pieces with in specification • Cutting Threads • bench work operations This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Perform Clamp the work pieces • Select and using hand tools • Cut , chipping, filing and scraping work pieces with in tolerances • **Cut** Threads properly • Perform bench work operations

3.1 Clamping work pieces

Concepts of clamping

Once work piece is located, it is necessary to press it against locating surfaces and hold it there against the force acting upon it. The tool designer refers to this action as clamping and the mechanisms used for this action are known as clamps. It is necessary that the work should be properly and securely held on for machining operations, a VISE is an effective work holding device.

Vises: Vises are the most common appliances for holding work on table due to its quick loading and unloading arrangement.

a/ **Types of work holding devices**

- **Bench vice**

A **bench vise** is like an extra hand and is a common tool found in any shop or garage. It is attached to a **workbench** and its purpose is to hold material steady, allowing you to use both hands to work on the material with other tools. They are ideal for sawing, sanding, planing, drilling, screwing, soldering and more.

Bench Vises with Swivel Base

There are mainly three types of vises commonly used:

- Plain vise
- Swivel vise
- Tool makers universal vise

1 Removable hardened alloy steel jaw inserts.

2 Completely enclosed center screw.

3 Attractive hammered enamel finish *Machine vice*

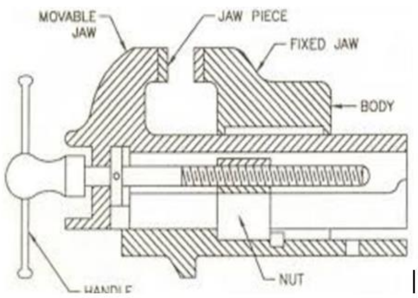


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Figure 1. 54 Bench vice

- **V-block**

V-block is rectangular or square block with a V-groove on one or both sides opposite to each other. The angle of the 'V' is usually 90^0. V-block with a clamp is used to hold cylindrical work securely, during layout of measurement, for measuring operations or for drilling for this the bar is faced longitudinally in the V-Groove and the screw of V-clamp is tightened. This grip the rod is firm with its axis parallel to the axis of the v-groove

- **C-Clamp**

This is used to hold work against an angle plate or v-block or any other surface, when gripping is required. Its fixed jaw is shaped like English alphabet 'C' and the movable jaw is round in shape and directly fitted to the threaded screw at the end .The working principle of this clamp is the same as that of the bench vice.

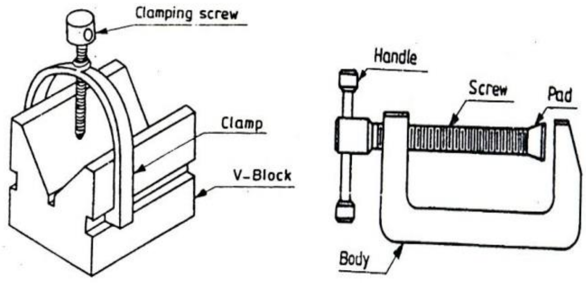


Figure 1. 55 V-Block **and C-Clamp**

Pliers

There is a vast range of pliers used in the vehicle body building industry, with the most common being combination pliers, slip joint pliers, side cutters, circle pliers, long-nosed pliers and multi grips. The correct pliers to use depend on the type of vehicles being built. For example, long-nosed pliers are used to hold and grip small work in awkward places so these may be used extensively with hydraulic or electrical work. However, they may not be much use when building a semitrailer. Name these pliers:

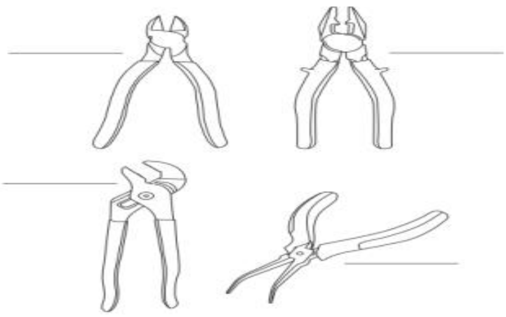


Figure 1. 56 Pliers

- **Parallel Clamps**

Jaws are made of hardened and tempered steel. Clamps are equipped with spring clips

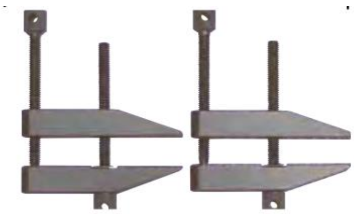


Figure 1. 57 parallel clamp

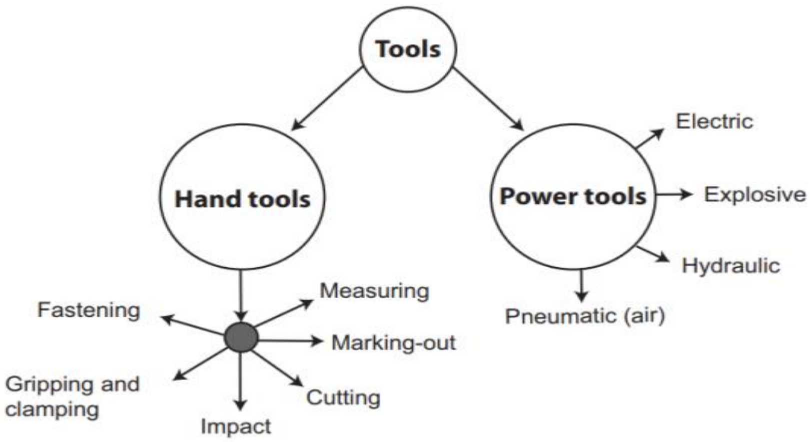
3.2 Selecting and using hand tools

Introduction to selecting and using hand tools

Vehicle body building is a very diverse trade and therefore requires the tradesperson possess many and varied skills. This person must be able to use and operate a wide range of tools and equipment, possibly a wider range than in any other trade. This learning resource covers a selection of hand tools and equipment used in the vehicle body building trade.

Tools

Tools can be divided into two main groups: hand tools and power tools. Hand tools are operated by the physical strength of the user. Power tools require an external source of power such as electricity or compressed air to operate. Each of these groups can also be divided into sub groups.



Division of tool

a. **Hand tools**

Hand tools have been devised to enable trades people to carry out a job more efficiently, quickly and safely than would otherwise be possible. Some tools are quite simple, such as a screwdriver, which is almost indispensable for undoing a countersunk screw located in a recess. Others are more complicated, such as a micrometer; these are indispensable are when measuring fine tolerances.

Hand tools can be classified into several groups:

- fastening tools
- gripping and clamping tools
- impact tools
- cutting tools
- marking-out tools
- Measuring tools

Fastening tools

Spanners

There are several types of spanners, each suitable for a specific job. The most commonly used spanners in a vehicle body building workshop are:

- ✓ open-ended spanners
- ✓ ring spanners
- ✓ combination spanners
- ✓ sockets and their accessories
- ✓ hook spanners
- ✓ pin spanners
- ✓ adjustable spanners
- ✓ ratchet spanners
- ✓ Flare nut spanners.

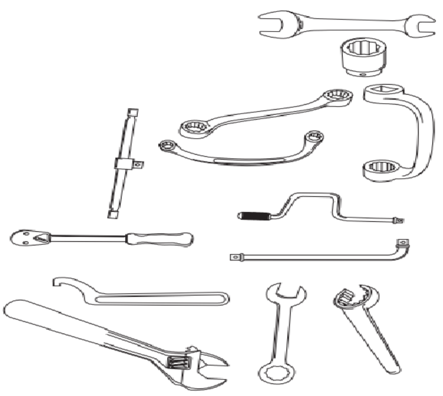


Figure 1. 58 Types of spanners

Wrenches

Wrenches are tools used for holding and turning. A variety of wrenches are used in the vehicle body building industry. Adjustable pipe wrenches are sometime called still son wrenches. Typically, they are used on cylindrical objects such as pipes and rails where there are no flats on which to use a spanner. Another type of wrench is the hexagon wrench, which would typically be used for undoing hexagonal recessed drain plugs. Smaller hexagon wrenches are called Allen keys. Torque wrenches are used to tighten nuts or bolts to a specific tension and are sometimes called tension wrenches. They are used to correctly tension down the bolts holding engineering components such as power take-off units or bolts on kingpins. Never use a torque wrench to undo nuts or bolts, as this may damage or alter the accuracy of the wrench.

Torque wrench

Figure 1. 59 Torque wrench

Screw drivers are accurate precision tools and are not designed to be used as punches or cold chisels. The most common types of screwdrivers are the standard (straight blade or flat) type and the Phillips screwdriver, and they are available in many different sizes and lengths. There are also special screwdrivers designed for hard-to-get screws, for example right-angle screwdrivers.

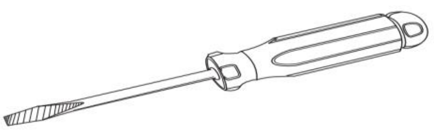


Figure 1. 60 Flat screw driver

Keys

Keys used in the trade include drill chuck keys, lathe chuck keys and hexagon keys. Hexagon keys are also called Allen keys and include ball driver keys which can be used at an angle, unlike straight hexagon keys, which must be inserted squarely into the hexagonal recess.

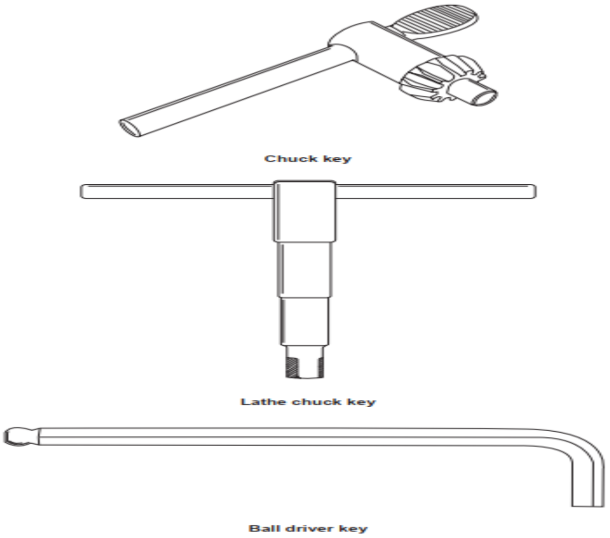


Figure 1. 61 Keys, (a) Chuck key, (b) Lathe Chuck key,(c)Ball driver key

Hand snips

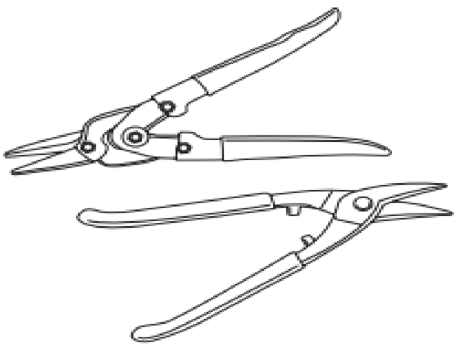


Figure 1. 62 Hand snips

Taps and wrenches

Taps are used to cut internal threads in holes which are usually drilled for the purpose of attaching an item with bolts or metal threads. Taps come in all sizes and threads to match the wide variety of bolts and metal threads available in the trade.

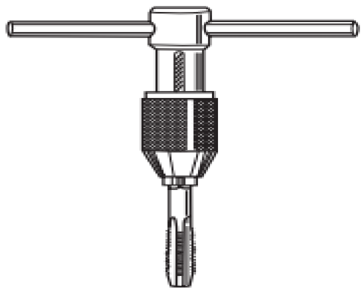


Figure 1. 63 **Stock and dies**

Dies are used to cut external threads on rods, studs, shafts or bolts. They can also be used to clean up or repair damaged external threads.

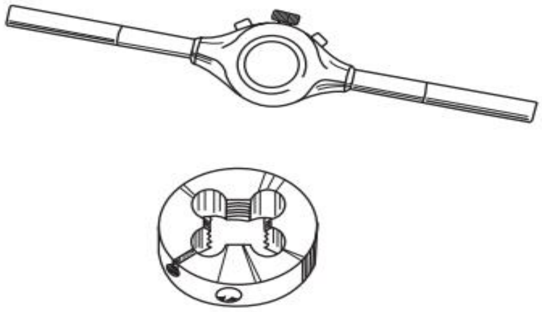


Figure 1. 64 Die and die- stock

3.3 Cutting, chipping, filing and scraping work pieces within tolerances

Concepts of Cutting metals

Sawing is the process of cutting metal stock that is impractical to use a file, a chisel or a machine with a multi-point cutting tool called a hand hack saw. A hand hack saw can also be used for cutting off a jammed bolt, pipes, tubing and rods for special or custom fittings on the job (on the field work).

Some of the most common tools used to cut metals are **hacksaws**, **band saws**, **cold chisels**, **bolt cutters, tin snips, and abrasive saws**. Large stock is sawed, while bar stock is either sawed or cut with a cold chisel. Sheet metal is usually cut with metal snips. In fabrication facilities, large amounts of metal are cut with horizontal band saws or metal shears, commonly called "ironworkers. Layout tools are used to measure and mark metal stock before cutting, shaping, and doing other types of work with cold metal.

A. Saws

Saws are used to cut material that is not needed away from material which is. Saw blades have alternate teeth bent out or 'set' in opposite directions. This is so that when they cut, they make a gap, called the kerfs. The kerfs must be wider than the saw blade so that the blade cannot get stuck. When using a saw, you should always cut to the waste side of the marked line so that you leave a small amount for finishing by either sanding or filing. Whatever you are cutting, it is important to keep as many teeth in contact with the piece being cut as possible. You should choose the correct saw for the type of material you are using. Table 2.3 on the next page shows the most common types of saws used in school workshops.

B. Cutting process

The saw is moved from the right to left and shows how the chip is formed. The cutting process is the result of the horizontal cutting direction and the pressure on the work piece. The angle of the teeth enables the saw to cut the material effectively. The teeth are set (bent out) that they do not get jammed in the cut.

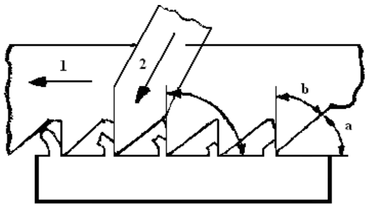
a = clearance **b = cutting angle**

Teeth setting

Forces on a saw blade:

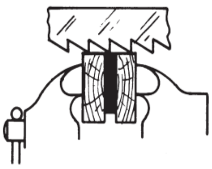
1 = indicates the cutting direction

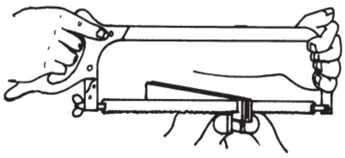
2 = indicates the pressure on the work piece



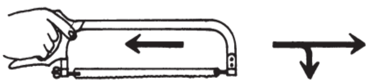
C. Steps to Follow in Making the Cut with a Hacksaw

Place the metal to be cut in a vise and mark it. The mark should be placed near the jaws, especially if the metal is thin. It may be necessary to use boards between the vise jaws to prevent scarring the work. Mark over the original mark with a file.





. Using a hack saw

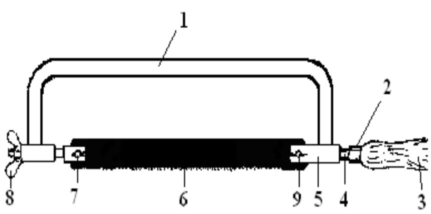


Depending upon the direction of cut, blades are classified as:

Forward cut

Backward cut.

Depending upon the pitch of the teeth (Distance between the two consecutive teeth) blades is classified as:



- Coarse (8-14 teeth per Inch)
- Medium (16-20 teeth per inch)

- Fine (24-32 teeth per inch)

D. Parts of a hacksaw

1. Saw frame
2. Handle protector
3. Handle
4. Tang
5. Blade holder
6. Blade
7. Pins
8. Wing-Nut
9. Pins

E. Types of blades for hacksaws

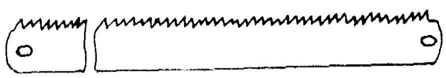


Figure 1. 65 Parts of hack saw

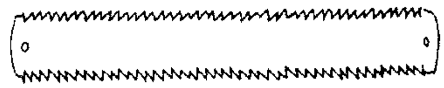


Figure 1. 66 **One side toothed**

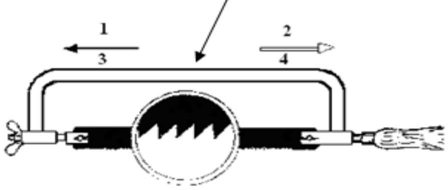
Both sides toothed

Types of hack saw blades.

How to handle a hacksaw?

1 and 3 Indicate the forward stroke with pressure

2 and 4 The backward stroke without pressure the circle shows the direction of teeth (facing the front of the hacksaw) all strokes should be in a straight line and along the whole length of the blade.



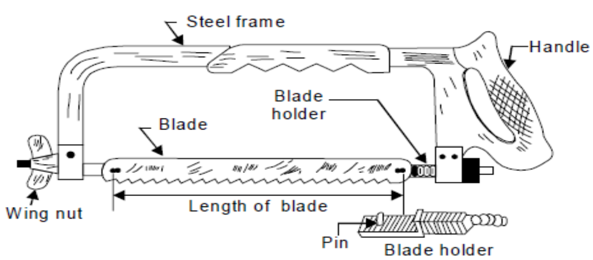
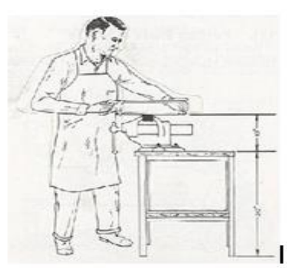


Figure 1. 67 fixed and adjustable frame

Non- adjustable frame (fixed frame) . Aadjustable frame

The work piece must be clamped to allow free movement when sawing. Left-handed people clamp their work to the right of the vice and right-hander people to the left.



Body position when sawing.

Working Position

F. Saw teeth for different materials

No of teeth /inch	Functions
14	For solid sections of soft materials
18	Suitable for general use. Solid sections of soft materials and large sections of hard materials (e.g. alloy steel)
24	Small solid sections, between 3 and 6 mm(e.g. heavy tubing and sheets)
32	For sections less than 3 mm thick

Note: At least three consecutive teeth should be in contact with the material. If the material is soft and has a large section, use a blade with few teeth per 25 mm (14 or 18 teeth per 25 mm) Use a fine-tooth blade when cutting a fairly thin section.

H/ Hacksaw blades are made of high-speed steel.

There are two types: all-hard and flexible. The difference between the two is that the all-hard snaps easily, and it is therefore not recommended for school work. The blades come in the following lengths: 200, 250 and 300 mm. They are also available with 14, 18, 24 and 32 teeth per 25 mm for cutting different materials

3.2. Chipping

Removing the metal with a chisel is called chipping and is normally used where machining is not possible. While chipping, safety goggles must be put on to protect eyes from the flying chips. To ensure safety of others, a chip guard is placed in position. Care should be taken to see that the chisel is free from mushroom head.

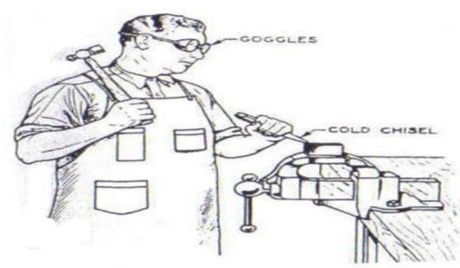


Figure 1. 68 Proper body position when chipping

1. **Types of chisels:**

These are sometimes referred to as cold chisels because they are used to cut cold metals. They are made of cast steel or alloy steel, with a hardened and tempered cutting edge.

The common types of chisel (Figure 3.8) include:

1. **The flat chisel**: used for general-purpose chiseling;

2. **The cross-cut chisel**: used for cutting grooves such as keyways, and for chipping;

3. **The half-round-nosed chisel**: used for cutting grooves (which are either curved or half-round);

4. **The diamond-pointed chisel**: used for working into corners and cutting small grooves.

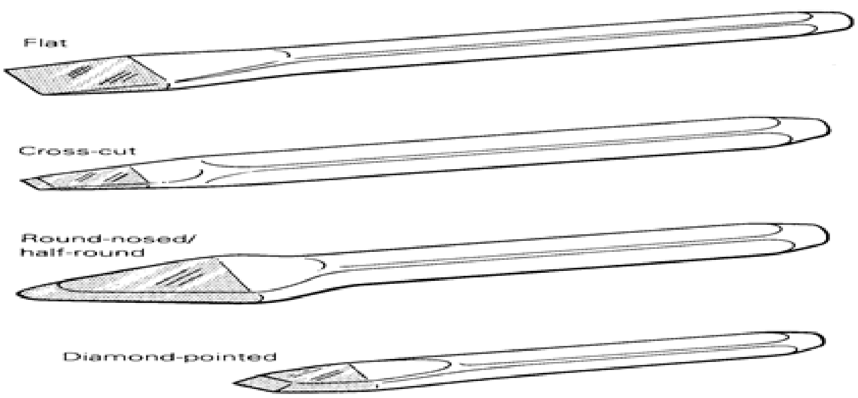


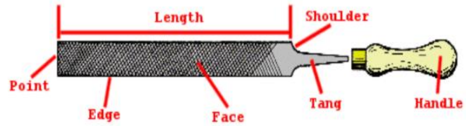
Figure 1. 69 Common types of chisel

Filing

Filing is a method of removing metal, and the file (Figure1.69), which is the most widely used hand tool in the school workshop, is used for this cutting operation. It is made of carbon tool steel containing about 1.3 per cent carbon.

- The Main Parts

A file is a hand cutting tool made of high-carbon steel, having a series of teeth cut on the body by parallel chisel cuts. The parts of a file are shown in figure. 1.69. Files are used to remove surplus metal and to produce finished surfaces.



3.4 Cutting Threads

Cut threads using tap and stock and die

Introduction

Threads may be cut internally using a tap externally using a die. The proper selection and use of these threading tools is an important phase of machine shop work.

A/ Dies

Dies are made either of high-carbon steel or of high-speed steel. Unlike taps, dies are used for cutting external (male) threads. There are three types (Figure blow). The circular split die is a circular piece with a split across one of the flutes. The split is provided to enable small adjustments to be made, using three set screws in the stock. The half die comprises two loose pieces, which are held in the stock. There is a small screw on the stock for adjustment. The die nut has a hexagonal body. This type, strictly speaking, does not cut new threads but is used to 'clean up' threads that are damaged.

B/ Taps and dies

Screwing is a temporary method of fastening parts together. Methods for cutting screw threads include the use of the centre lathe. For bench work, however, taps and dies are used.

C/ Taps

These are the tools used for cutting internal (female) threads. They are made of high-carbon steel or high-speed steel. The tap has a shank with a square end to take the tap wrench or holder. The shank is smaller than the threaded portion. The tap has four rows of threads, cutting edges or teeth, which suit a particular thread form. They perform the cutting action. The grooves between the cutting edges are called flutes. They allow waste material (chippings) to escape. They also allow cutting oil into the work.

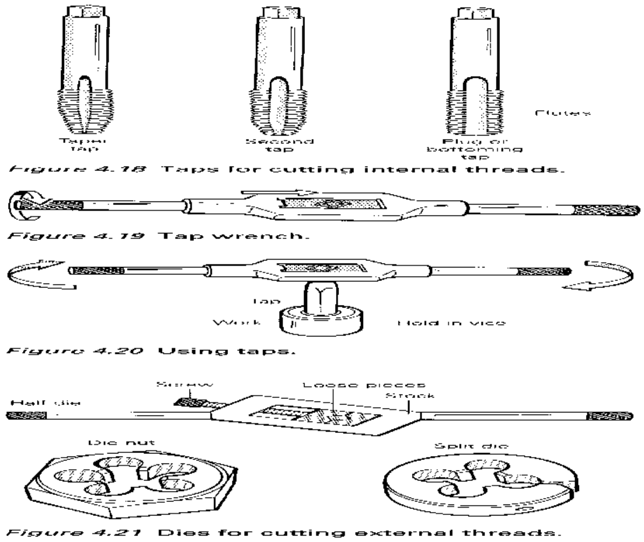


Figure 1. 70 Taps and dies

A/ The procedure for cutting external threads is as follows:

1. Square the end of the work and chamfer it (using a file, grinding machine or centre lathe) for an easy start.
2. Grip the die, held in the stock, firmly and squarely on the work.
3. Turn clockwise, about a quarter-turn, and ease back to remove chippings.
4. Apply a good supply of oil (lubricant).
5. Make adjustments of the screws after making a full cut until the depth required is achieved.

B/ Care and maintenance is important:

1. Do not use either the stock or the die as a hammer; the threads may be broken.
2. Remove the die from the stock after every thread cutting, clean them and pack them into their boxes.
3. Use plenty of oil during cutting to reduce friction.

C/ Tap Drill Size

Before a tap is used, the hole must be drilled to the correct tap drill size. This is the drill size that would leave the proper amount of material in the hole for a tap to cut a thread. When a chart is not available, the tap drill size for the ISO (International Standards Organization) thread can be found easily by applying this simple formula:

	TDS	= tap drill size
$\boxed{TDS = M - P}$	M	= metric diameter of the tap
	P	= pitch of the thread in millimeters

D/ Hand Tap

A tap is a cutting tool used to cut internal threads. Normally it’s made of high-speed steel (HSS). Hand taps are usually made in sets of three, because it is better to distribute all the cutting work during the thread−process to three taps.

No. 1 (taper) tap: 1 ring on shank

No. 2 (plug) tap: 2 rings on shank

No. 3 (bottoming) tap: without ring

The most common taps have two or three flutes in order to form the cutting edges, transport the chips out of the hole and give way for the lubricant. The end of the tap is square so that a tap wrench can be used to turn it into a hole.

E/ Tapping a Hole

Before a tap is used, a hole must be **drilled** in the work piece to the correct tap drill size. The tap drill size (T.D.S.) is the size of the drill that should be used to leave the proper amount of material in the hole for a tap to cut threads. Then **countersink** both sides of the hole.

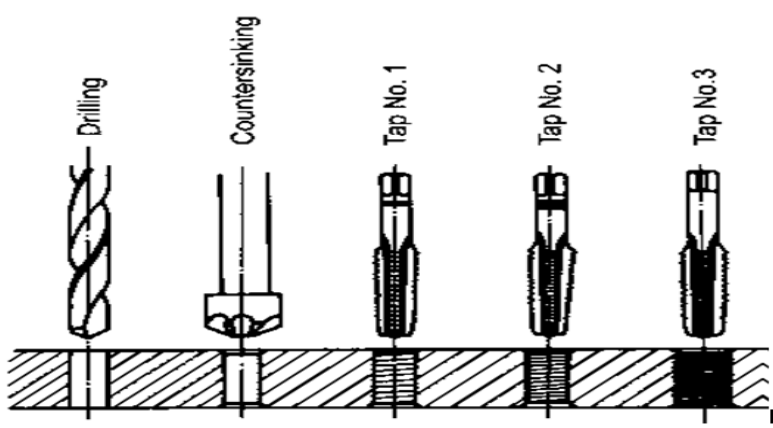


Figure 1. 71 Drill, Countersink and tapping a hole

Working Steps for Hand Tapping

1. Select the correct size and type of tap for the job (blind hole or through hole).
2. Select the correct tap wrench for the size being used.
3. Use a suitable cutting fluid (No cutting fluid for brass or cast iron).
4. Place the tap in the hole as near to **vertical** as possible.
5. Apply equal down pressure on both handles, and turn the tap clockwise (for right-hand thread) for about two turns.
6. Remove the tap wrench and check the tap for square knees. Check at two positions 90 degree to each other.
7. If the tap has not entered squarely, remove it from the hole and restart it by applying slight pressure in the direction from which the tap leans. Be careful not to exert too much pressure in the straightening process, otherwise the tap may be broken.
8. Turn the tap clockwise one−half turn and then turn it backward about one−quarter of a turn to break the chip. This must be done with a steady motion to avoid breaking the tap

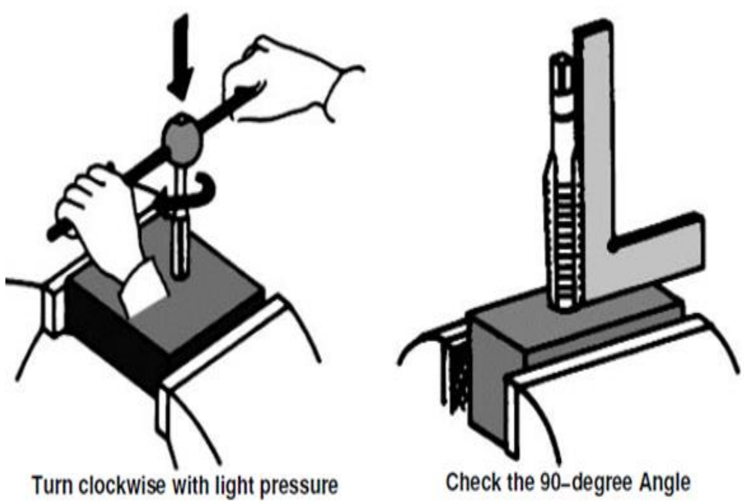


Figure 1. 72 Tapping operation

Metric	Pitch mm	Drill Ø mm		UNC	TPI	Drill Ø mm		UNF	TPI	Drill Ø mm
M 3	0.50	2.5		1/4"	20	5.1		1/4"	28	5.5
M 4	0.70	3.3		5/16"	18	6.6		5/16"	24	6.9
M 5	0.80	4.2		3/8"	16	8.0		3/8"	24	8.5
M 6	1.00	5.0		7/16"	14	9.4		7/16"	20	9.9
M 8	1.25	6.8		1/2"	13	10.8		1/2"	20	11.5
M 10	1.50	8.5		9/16"	12	12.2		9/16"	18	12.9
M 12	1.75	10.2		5/8"	11	13.5		5/8"	18	14.5
M 16	2.00	14.0		3/4"	10	16.5		3/4"	16	17.5
M 20	2.50	17.5		7/8"	9	19.5		7/8"	14	20.4
M 24	3.00	21.0		1"	8	22.25		1"	12	23.25

Table 1. 73 Drill size

Tread calculation

example

External	**Internal**
D-P/5	**D-P**
M10	**M10**
10-1.5/5=9.7	**10-1.5=8.5**

Threading Dies

A threading die is used to cut external threads on round work pieces. The most common threading dies are the adjustable and solid types. The round adjustable die is split on one side and can be adjusted to cut slightly over or undersized threads. It is mounted in a die stock, which has two handles for turning the dies onto the work. The solid die, cannot be adjusted and generally used for re cutting damaged or oversized threads. Solid dies are turned onto the thread with a **special** diestock, or adjustable wrench.

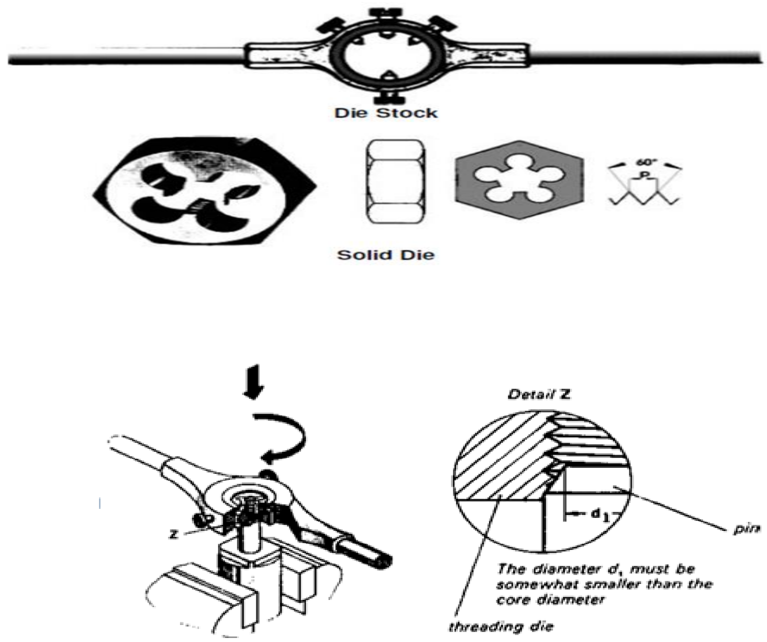


Figure 1. 74 Die and its operatio

Thread with a Hand Die Working Steps

The threading process requires the machinist to work carefully to produce usable parts and avoid damage. The following describes the procedure to be used.

1. Chamfer the end of the work piece with a file or on the grinder. Consider that a 3/4” thread requires a bolt with an outside diameter of 3/4”.
2. Fasten the work piece securely in a vise. Hold small diameter work short to prevent it from bending.
3. Select the proper die and die stock.
4. Lubricate the tapered end of the die with a suitable cutting lubricant.
5. Place the tapered end of the die squarely on the work piece.
6. Apply down pressure on both die stock handles and turn clockwise several turns. Check the die to see if it has started squarely with the work.
7.
8. If it is not square, remove the die from the work piece and restart it squarely, applying slight pressure while the die is being turned.

9. Turn the die forward one turn, and then reverse it approximately one half of a turn to break the chip.
10. Apply cutting fluid frequently during the threading process.

Metric Threads

These threads are identified by the letter „M", the nominal diameter, and the pitch. For example, a metric thread with an outside diameter of 5mm and a pitch of 0.8mm would be identified as follows: M5x0.80

nom. dia.	pitch	nom. dia.	pitch
M3	0.50	M9	1.50
M4	0.70	M10	1.75
M5	0.80	M11	2.00
M6	1.00	M12	2.50
M8	1.25	M13	3.00

Table1. 75 Pitch of metric thread

3.4 Performing bench work operations

- **Concepts of bench work operations**

Bench work operations for the manual mill often occur before and after the machining of the part. These operations are commonly performed on a standard workbench with the part secured in a **vise**, or secured to the worktable depending on the operation. Bench work operations involve processes that allow the work piece to achieve the accuracies specified by the blueprint. These operations require operator skill and attention to detail.

✓ Follow safety and correct working procedures to perform bench work operations.

- Bench work operations performed prior to machining include the following: Layout
- Cutting: in the metal work shop materials (especially metals) are cut to shape before filing. There are numerous types of cutting operations.

✓ Points to watch when using the hack saw:

1. Hold the work securely in the vice.

2. Grip the hack saw firmly, using both hands.
3. Use the same stance as filing.
4. Use the full length of the blade.
5.

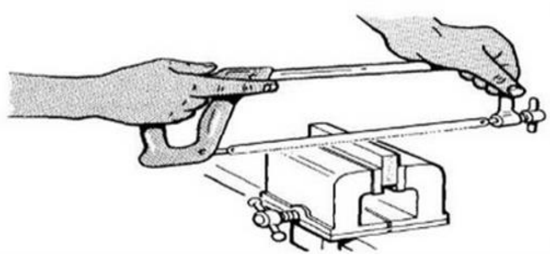


Figure 1. 75 Sawing operation

- Chipping:
  - ✓ chipping metal (chiseling)

Chiseling is one of the methods of cutting materials.

-you can chip the metal to produce grooves or to reduce the width or thickness.

Procedures to chip metal:

1. hold the metal in the vice
2. Hold the chisel at an angle of about 45^0 to the work.
3. Hammer to remove the chip.

- Filing: is a method of removing metal.
- Filing: is a skill that is difficult to learn. It is not easy to explain how to use a fil

Self check

part-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point

Part II choose the best answer

1Which one of the following is not clamping tools?

a/Vice b/ V- block c/ hacksaw d/ C- clamp

2 One of the following is not the parts of bench vice.

a/Jaw face b/ Thimble c/ Fixed jaw d/ Movable jaw

3______is used for clamping work piece.

a/ Bench vice b/ C-clamp c/ V-block d/ All

4_______is used to cut internal threads in holes which are usually drilled for the purpose of attaching an item with bolts or metal threads.

a. Tap Die c. snips d. all

5 Some of the most common tools used to cut metals are_______

a/Hacksaws b/ tin snips c/ cold chisels d/ all

Operation Sheet 3.1

Operation title: Perform Cut the work piece to produce a drill and file to make a T-fitting

Purpose: To practice and demonstrate the knowledge and skill required in **cut the work piece to produce a drill**

Instruction: perform the required tapping and threading in the given dimension

Procedures:

1. Wear the safety clothes required.
2. Measure the stock to the required dimension.
3. Mount the work piece firmly on the vice.
4. Choose the correct blade according to the type of material and thickness being cut.
5. Install the hacksaw blade.
6. Use the blade check list to ensure proper installation.
7. Use the hacksaw to cut the work piece. Use the marked sawing lines to guide the cutting process.

2 To make a T-fitting from the given two M.S pieces.:

Procedures:

1. Filing
2. Checking flatness and square ness
3. Marking and measuring
4. Punching
5. Sawing
6. Chipping
7. Finishing

Lap Test-

Task- Install the hacksaw blade properly

Task-1 Measure the stock to the required dimension

Task-1 Measure a hole by using caliper to the given dimension

Unit Four: Cut different work pieces using hand hack saw
This unit to provide you the necessary information regarding the following content coverage and topics: • Cutting metal bars, pipes and other materials • Measuring and cutting wooden components This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Cut metal bars ,pipes and other materials • Measure and cutting wooden components

4.1. Cutting metal bars, pipes and other materials

4.1.1 How to cut metal with a hacksaw

Hacksaws are a hand tool that is a very versatile addition to any workshop. Hacksaws work by simply moving the blade through the metal backwards and forwards in a regular 'sawing' action. The C shaped handles are relatively cheap to buy and the wide range of blades available enables a wide range of profile thickness and metal grades to be cut easily. The handles range from basic varieties that simply, yet securely, hold the hack saw blade in place through to professional varieties that have easy to use features such as; thumb dial tensioners in the handle to provide 150kg or 30,00 psi blade tension, adjustment to accommodate 250mm or 300mm blades, and secondary blade positioning to enable 45° blade angle for flush cutting or 90° for general cutting.

Figure 1. 76 cutting metal bar

Hacksaw blades are selected by choosing the correct tpi (teeth per inch) for the type of metal that needs to be cut. The higher the tpi, the more aggressive the cut. The teeth are configured to face towards one end of the blade and the blades can be mounted in the handle with the teeth facing forwards or backwards- the benefit of this is that the power of the 'towards' or 'away' stroke can be focused to provide the user with the best cutting ergonomics. Many metal workers prefer to focus the main cutting stroke as the 'away' stroke as this provides a clearer view of the cut because the chips are moved forwards during operation.

Hacksaw blade tpi recommendations.

Tpi (teeth per inch / 25mm of blade)	Suggested usage
14	Large profiles, aluminum, softer metals
18	General workshop projects
24	Steel plate up to 5/6mm thickness
32	Hollow sections and steel tubing

Tips for cutting metal using a hacksaw.

- Always wear eye protection and gloves when cutting metal.
- Select the correct blade for the project being undertaken and ensure it is securely inserted in the frame/ handle with the teeth facing either forwards or backwards depending on preference.
- Check the blade is rigid, correctly aligned, and taut.
- Clamp the work piece or place it in a vice; if this is not possible as the metal is joined to another object, ensure the piece you are not wishing to remove will remain secure once the other piece has been cut off.
- To begin the cut, make a series of one-way strokes against the direction of the teeth – this will create a narrow incision that the blade can sit in. Once the blade has gained purchase in a millimeter or so of the surface, the full forward and backwards sawing action will soon enable the cut off to be completed.
- Try not to rush; a smooth, steady sawing action will provide the best cut and will reduce the likelihood of the blade overheating and breaking. A little machine oil or cutting fluid placed on the blade will reduce friction

4.2. Measuring and cutting wooden components

respecting the small measures and cutting with pure precision with **wood cutting hacksaw** is the perfect art. The Japanese saws are the true accurate razor. The main characteristic that differentiates them from the normal saws we all know is that the teeth are reversed and much finer. Cutting with Japanese saws is like cutting through butter, which allows us to be much more attentive to precision.

there is no doubt that a good garden must necessarily consist of well-trimmed hedges and well-shaped shrubs. All this will require the use of the pruning saw with the latest features in our wholesale **wood cutting hacksaw**. This equipment is used to cut, to saw, to slice the tree trunks, but also the branches. It has the advantage of being easy to handle thanks to its lightness. With a sharp and thin blade, this tool is small enough to fit between the branches

Woodworking

Woodworking covers various applications, with different saws suited to each. The most

common handsaws used in woodworking are the crosscut saw, rip saw, and coping saw.

Figure 1. 77 wood cutting hacksaw

Self ckeck 1 multiple choice

1. A sharp-pointed tool for marking wood or metal.

a. hacksaw

b. back saw

c. scraper

d. scratch awl

A wood worker's tool used to glue boards together. Is made up of a long metal bar with a clamp jaw at each end.

e. bar clamp

f. wood clamp

g. quick clamp

h. back saw

2.

A carpenter's plane for rough surfacing.

. jack plane

a. hack saw

b. block plane

c. chalk line

3.

A tool with an indicator that establishes the horizontal or vertical, when a bubble is centered in a tube of liquid.

. level

a. scraper

b. rip saw

c. nail set

4.
A small portable drill held and operated by hand.

. wood chisel

a. hack saw

b. chalk line

c. hand drill

5.
A tool having one end of the head hemispherical and used in working metal.

. claw hammer

a. ball peen hammer

b. tack hammer

c. rubber hammer

6.

Tool used to drive nail heads below the surface.

. ○ hack saw

a. ○ rip saw

b. ○ back saw

c. ○ nail set

A tool used to put in slotted screws.

d. ○ cloth measuring tape

e. ○ claw hammer

f. ○ flat head screw driver

g. ○ phillips head screw driver

7.
A frame with legs, used to support pieces of wood being sawed.

. ○ nail set

a. ○ sawhorse

b. ○ metal vise

c. ○ scraper

8.
A carpenter's plane for finish work.

. ○ smoothing plane

a. ○ block plane

b. jack plane

c. measuring tape

9.
A woodworking tool for cutting, shaping, or smoothing wood.

. wood clamp

a. hand drill

b. face shield

c. wood chisel

10.
Eye protection to protect eyes from the impact of foreign objects.

. jack plane

a. block plane

b. safety goggles

c. safety glasses

11.
Short hand saw with a tapered blade used to cut curves or irregular shapes.

. ○ key hole saw

a. ○ hack saw

b. ○ back saw

c. ○ crosscut saw

.

Unit Five: Drill and ream holes
This unit to provide you the necessary information regarding the following content coverage and topics: • Hole is drilled and reamed to drawing specification. • Drilling and reaming of holes are performed • Using PPE This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Drill and ream hole to drawing specification • Perform Drilling and reaming of holes • Use PPE

5.1.Introduction to drilling and reaming holes

5.1.1.Drilling: is a process of producing round holes in a solid material or enlarging existing holes with the use of multi tooth cutting tools called drills or drill bits. In other words it is the process of making holes of cylindrical shape on metals and other materials using drill bits and drilling machines.

Drilling machine: are driven either manual or by electrical power.

5.1.2. Classification of drilling machines

Drilling machines: are classified into hand and breast drill, portable electrical drill, bench drill, pillar dills and others.

5.1.3. The hand and breast drill: are driven by hand and are commonly used where electricity is unavailable and are used for light work

5.1.4. Portable electrical drill: are most suitable to work which cannot be done with bench drill.

1. **Bench drill:** is one of the most common used machines in the work shop. This machine has the following parts. The base, the column, the head, the spindle, the pulleys, the motor, the belt, the safety swatch, the feed handle, the depth gauge, the head locking handle, the gear lever, the collar, the chuck and the main switch.
2. **Pillar dills:** is similar in design to the bench drill. But it is floor mounted and usually much large.

Various cutting tools are available for drilling, but the most common is the *twist drill*.

- **Standard Operations**

Drilling machines may be used for performing a variety of operations besides drilling a round hole. A few of the more standard operations, cutting tools and work set-ups will be briefly discussed.

A. **Drilling** – may be defined as the operation of producing a hole by removing a metal from a solid mass using a cutting tool called a twist drill.

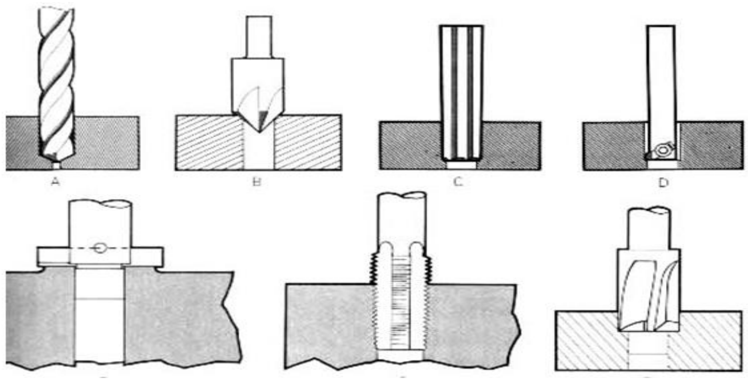


Figure 1. 78 Variety of operations of drilling machine.

B. Countersinking – is the operation of producing a tapered or cone shaped enlargement to the end of the hole.

C. Reaming – is the operation of sizing and producing a smooth round hole from a previously drilled or bored hole with the use of a cutting tool having several cutting edges.

D. Boring – is the operation of enlarging and truing a hole by means of a single-point cutting tool which is usually held in a boring bar.

E. Spot-facing – is the operation of smoothing and squaring the surface around a hole to provide a seat for the head of a cap screw or a nut. For the spot facing operation, the work being machined should be securely clamped and the machine set approximately ¼ of the drilling speed.

Spot facing is a process of machining a flat surface around the mouth of a hole in order to provide a flat seat for the head of a bolt or a nut.

F. Tapping – is the operation of cutting internal threads in a hole with a cutting tool called a tap. Special machine or gun taps are used with a tapping attachment when this operation is performed by power in a machine.

G. Counter boring – is the operation of enlarging the top of a previously drilled hole to a given depth to provide a square shoulder for the head of a bolt or a cap screw. Counter boring is used to form a flat, recessed seating for a cheese head bolt or cap screw.

Sensitive Drill Presses

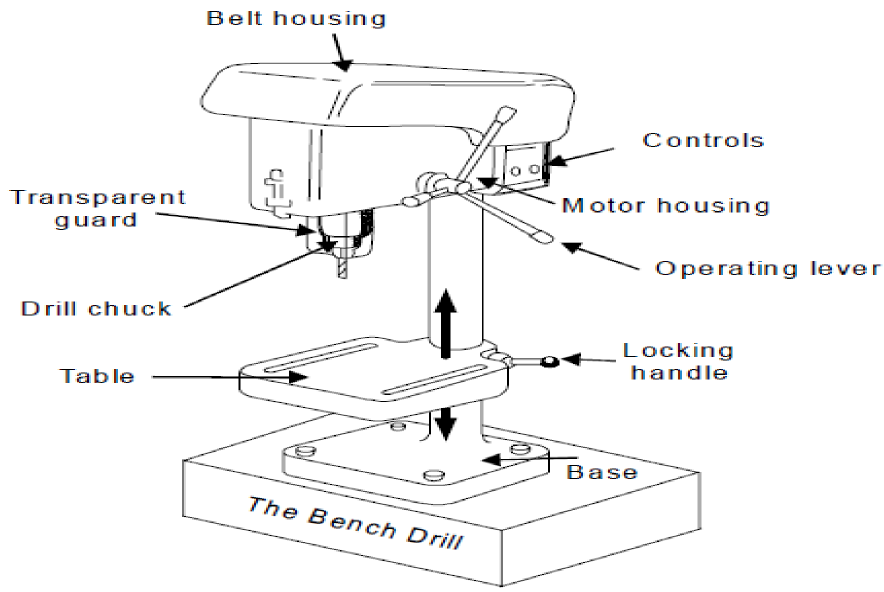


Figure 1. 79 Parts of drill Presses

Cutting Speed	$Vc = \dfrac{\pi \times D \times n}{1{,}000}$
Spindle Speed	$n = Vc \div \pi \div D \times 1{,}000$
Feed	$Vf = n \times fz \times Z$
Feed per Tooth	$fz = \dfrac{Vf}{n \times Z}$

Vc	=	Cutting Speed (m/min)
π	=	3.14 [The Circular Constant]
D	=	Diameter (mm)
n	=	Spindle Speed (min^{-1})
Vf	=	Feed (mm/min)
fz	=	Feed per Tooth (mm/tooth)
Z	=	Number of Flutes

5.1.5. Drill Bits

Introduction

Twist drills are end-cutting tools used to produce holes in most types of material. On standard drills, two helical grooves, or flutes, are cut lengthwise around the body of the drill. They provide cutting edges and space for the cuttings to escape in the drilling process. Since drills are one of the most efficient tools, it is necessary to know the main parts, how to sharpen the cutting edges, and the correct speeds and feeds for drilling various metals in order to use them most efficiently and prolong their life.

5.2. Parts of Twist drills

Shank

Most twist drills used in machine shop work today are made of high-speed steel. High-speed drills have replaced carbon-steel drills since they can be operated at double the cutting speed and the cutting edge lasts longer. A drill may be divided into three main parts: the shank, the body and the point.

Generally drills up to 13mm in diameter have straight drill shanks, while those over this diameter usually have tapered shanks. Straight-shank drills (fig. 08/02) are held in a drill chuck; tapered-shank drills (fig. 08/01) fit into the internal taper of the drill press spindle.

- A tang (fig. 08/01) is provided on the end of tapered-shank drills to prevent the drill from slipping while it is cutting and to allow the drill to be removed from the spindle or socket without the shank being damaged by using a drill drift.

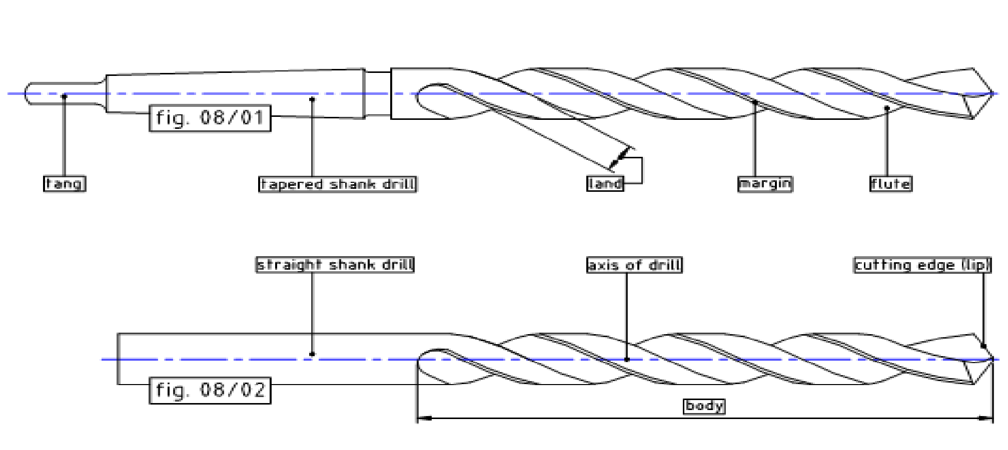


Figure 1. 80 Twist drills bit

Body

The body is the portion of the drill between the shank and the point. It consists of a number of parts important to the efficiency of the cutting action.

The flutes are two or more helical grooves cut around the body the body of the drill. They form the cutting edges, admit cutting fluid, and allow the chips to escape from the hole.

- The margin is the narrow, raised section on the body of the drill. It is immediately next to the flutes and extends along the entire length of the flutes. Its purpose is to provide a full size to the drill body and cutting edges.
- The lip clearance is the undercut portion of the body between the margins and the flutes. It is made smaller to reduce friction between the drill and the hole during the drilling operation.
- The web is the thin partition in the center of the drill which extends the full length of the flutes. This part forms the chisel edge at the cutting end of the drill. The web gradually increases in thickness toward the shank to give the drill strength.
- Point The point of a twist drill consists of the chisel edge, the lips, the lip clearance angle and the heel.

  The chisel edge (web) is the chisel-shaped portion of the drill point.
- The lip (cutting edge) a formed by the intersection of the flutes. The lips must be equal length and have the same angle so that the drill will run true and will not cut a hole larger than the size of the drill.

5.3 Performing all operations using safety procedures

Perform basic drilling, reaming and honing operations applying safety procedures and using personal protective devices.

When performing drilling, reaming and honing operation safety precaution and personal protective equipment (PPE) is necessary to protect ourselves, machines, tools and equipment.

Following the right safety procedures and personal protective device perform the operations listed below:

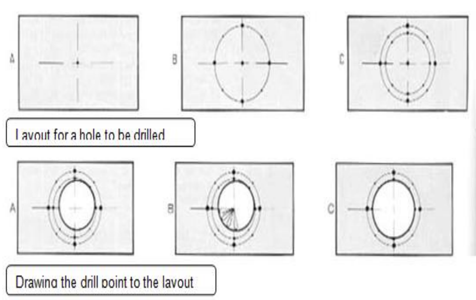
Drilling

Drilling operations

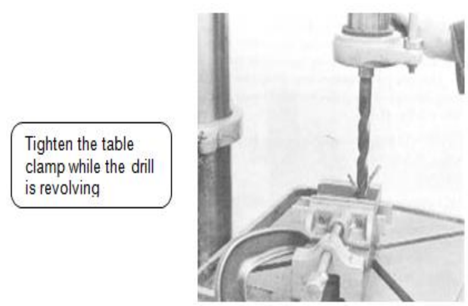
To practice drilling, counter boring, counter sinking, reaming.

Procedure

- Prior to drilling a hole, locate the hole position and put a punch mark to aid the drill in starting the hole.
- Select the proper drill bit according to the size need.
  Select cutting fluid.
- Select the correct rpm.
  Use an interrupted feed, called peck drilling, to break up the chips being produced.
- Counter sinking and counter boring operations are performed with the same procedure by changing the tools.
- Select the reamer.
- Drill a pilot hole that is a bit smaller to a reamer.
- Drive the reamer at a slow, constant speed. The cutting speed for reaming should be 1/3 of drilling.



Layout for a hole to be drilled.



Tighten the table clamp.

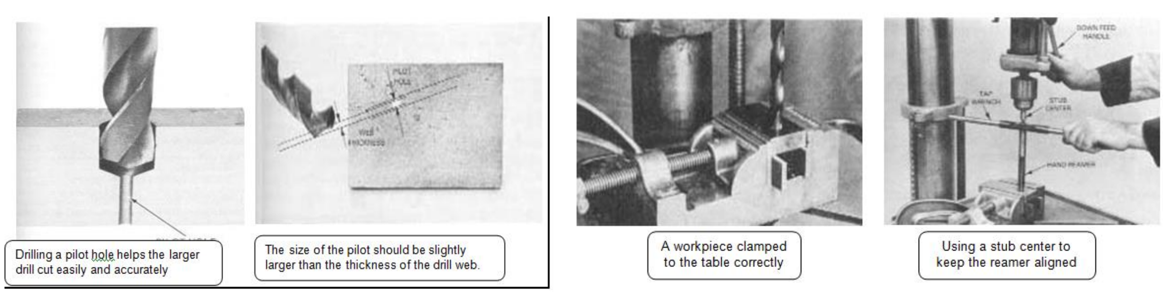


Figure 1. 81 Clamping a work piece to the table and drill

Self check

part-I Choose

Instruction: select the correct answer for the give choice. You have given <u>1 Minute</u> for each question. Each question carries <u>2 Point</u>

Directions: Answer all the questions listed below:

1____is the process of producing round hole in a solid material or enlarging existing holes.

a. Reaming b. Drilling c. Honing d. Filling

2Which one of the following is a finishing process of drilled holes?

a. Honing b. filling c. Sawing d. Drilling

3____is the process of enlarging a hole that has already been drilled.

a. Drilling b. Honing c. Boring d. None

1/ What mean by PPE? (**2 points**)

2/ Write the steps to provide drilling operation. (**2 points**)

3/ Write the importance of PPE in the work shop. (**2 points**)

4/ List out the types honing tools. (**2 points**)

5/Write the function of honing operation. (**2 points**

Operation Sheet 5.1

Operation title: drilling, tapping and reaming

Purpose: To practice and demonstrate the knowledge and skill required in **drilling, tapping and reaming to produce a drill**

Instruction: perform carried out: filing, checking, marking, punching, cutting, drilling, tapping, reaming, and finishing in the given work piece

Procedure:

1. Hold the mild steel flat piece of 50 x 50 x 6mm between the jaws of the bench vice.
2. Start filing on first flat surface after removing the rust with the tip of flat file.
3. Straight filing is continued till the surface is formed perfectly flat.
4. Check the straightness by using straight edge.
5. Turn to the adjacent side which is narrow and make it straight, flat and 90° with flat surface prepared.
6. File the next adjacent side and make it flat and perpendicular to both flat surface and first narrow side which is already prepared.
7. Apply chalk on the finished flat surface and mark dimensions
8. Use surface plate V-block and venire height gauge for marking.
9. Marked lines are punched by using dot punch and ball peen hammer.
10. File to correct dimensions in length and width and check the dimensions using an outside caliper and steel rule.
11. Mark two curve on the edge of M.S flat using divider.
12. Make curve using round file.

Operations: to make a Square cutting.

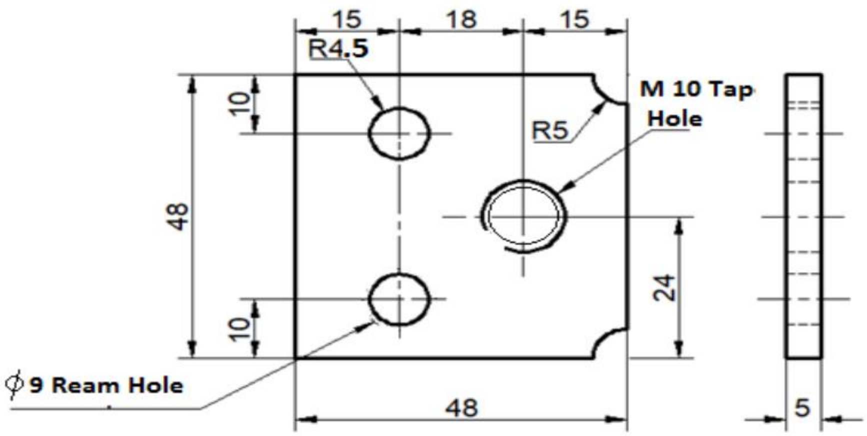
Procedure:

1. The given mild steel flat piece is checked for given dimensions.
2. One edge of given is filled to straightness with rough and smooth files and checked with try square.
3. An adjacent is also filled such that is square to first edge and checked with try square.
4. Wet chalk is applied on one side of the flat and dried for making.

5. Lines are marked according to given figure, using odd leg caliper and steel rule.
6. using the dot punch are made along the marked lines.
7. The excess materials removed from the remaining two edges with try square level up to half of the marked dots.
8. Finally buts are removed by the filling on the surface of the fitted job

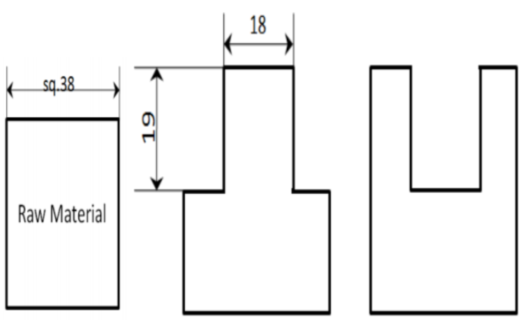
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2-5** hours.

Task 1: Cut the work piece to produce a drill gauge according to the dimensions given.



All dimensions are in mm.

Task 2: Make a Square fit from the given mid steel pieces.



* All dimensions are in mm.

Materials required: mild steel flat (40*40*3mm).

Unit Six: Cut threads using tap, stock and die

This unit to provide you the necessary information regarding the following content coverage and topics:

- Thread is cut to fit gage or mating screw with tolerance
- Thread is cut with tapping sequence
- Applying thread cutting using safety device procedure

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- cut Thread to fit gage or mating screw with tolerance
- cut Thread with tapping sequence
- Apply thread cutting using safety device procedure

6.1. Thread is cut to fit gage or mating screw with tolerance

Whether you're repairing a damaged thread or threading virgin material, there are a number of factors to consider and procedures to follow to produce the best job, with the least amount of wear and tear and breakage, on your tooling. Threading is divided into two types, internal and external. Internal threading is done by using a tool called a TAP in a hole drilled to a specific diameter for the thread size and pitch you want to cut. External threads, such as for bolts and studs, are made by using a tool called a DIE, which is applied to a specific diameter of rod for the size and pitch of the threads you want to cut. Both taps and dies can be used to either cut new threads or repair damaged threads. Taps and dies come in various on figurations and materials, the most common being High Speed Steel (HSS) for softer materials and Cobalt for hard materials like stainless steel. Some manufacturers apply platings or coatings designed to increase the cutting ability and life of their products, beneath that, it is usually one of the two materials for most applications. The threads found on most mass produced externally threaded products such as bolts, studs and screws, are formed by a process known as thread rolling. A headed, but unthreaded blank is squeezed between two opposing dies, much the same way you would roll a twig between the palms of your hands. This rolling action displaces the metal of the blank, forming threads. Machine produced threads are what is referred to as a Class 2A fit and has considerable variation in tolerance compared to a cut thread.

In manufacturing, threading is the process of creating a screw thread. More screw threads are produced each year than any other machine element.[1] There are many methods of generating threads, including subtractive methods (many kinds of thread cutting and grinding, as detailed below); deformative or transformative methods (rolling and forming; molding and casting); additive methods (such as 3D printing); or combinations there

6.2. Thread cutting with tapping sequence

Thread cutting, as compared to thread forming and rolling, is used when full thread depth is required, when the quantity is small, when the blank is not very accurate, when threading up to a shoulder is required, when threading a tapered thread, or when the material is brittle.[5]

Taps and dies

Main articles: Tap and die and Die head

A common method of threading is cutting with taps and dies. Unlike drill bits, hand taps do not automatically remove the chips they create. A hand tap cannot cut its threads in a single rotation because it creates long chips which quickly jam the tap (an effect known as "crowding"[citation needed]), possibly breaking it. Therefore, in manual thread cutting, normal wrench usage is to cut the threads 1/2 to 2/3 of a turn (180 to 240 degree rotation), then reverse the tap for about 1/6 of a turn (60 degrees) until the chips are broken by the back edges of the cutters. It may be necessary to periodically remove the tap from the hole to clear the chips, especially when a blind hole is threaded.

For continuous tapping operations (i.e., power tapping) specialized spiral point or "gun" taps are used to eject the chips and prevent crowding

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Figure 1. 82 tap and die

6.3. apply thread cutting using safety device procedure

Thread cutting by hand operated tools

Usually small threads in few pieces of relatively soft ductile materials, if required, are made manually in fitting, repair or maintenance shops

External screw threads

Machine screws, bolts or studs are made by different types of dies which look and apparently behave like nuts but made of hardened tool steel and having sharp internal cutting edges.shows the hand operated dies of common use, which are coaxially rotated around the pre machined rod like blank with the help of handle or diestock

Solid or button die

: used for making threads of usually small pitch and diameter in one pass.

Spring die

: the die ring is provided with a slit, the width of which is adjustable by a screw to enable elastically slight reduction in the bore and thus cut the thread in number of passes with lesser force on hands

Split die

: the die is made in two pieces, one fixed and one movable (adjustable) within the cavity of the handle or wrench to enable cut relatively larger threads or fine threads on harder blanks easily in number of passes, the die pieces can be replaced by another pair for cutting different threads with in small range of variation in size and pitch.

Pipe die

: pipe threads of large diameter but smaller pitch are cut by manually rotating the large wrench (stock) in which the die is fitted through a guide bush as shown in

.(a) solid die (c) split die

(b) spring die (d) pipe die

Different types of thread cutting dies.

Internal screw threads :

Internal screw threads of usually small size are cut manually, if needed, in plates, blocks, machine parts etc. by using taps which look and behave like a screw but made of tool steel or HSS and have sharp cutting edges produced by axial grooving over the threads as shown in

Three taps namely, taper tap, plug tap and bottoming tap are used consecutively after drilling a tap size hole through which the taps are axially pushed helically with the help of a handle or wrench.

Hand operated taps for cutting internal threads.

Threads are often tapped by manually rotating and feeding the taps through the drilled hole in the blank held in lathe spindle as shown in

.The quality of such external and internal threads will depend upon the perfection of the taps or dies and skill of the operator.

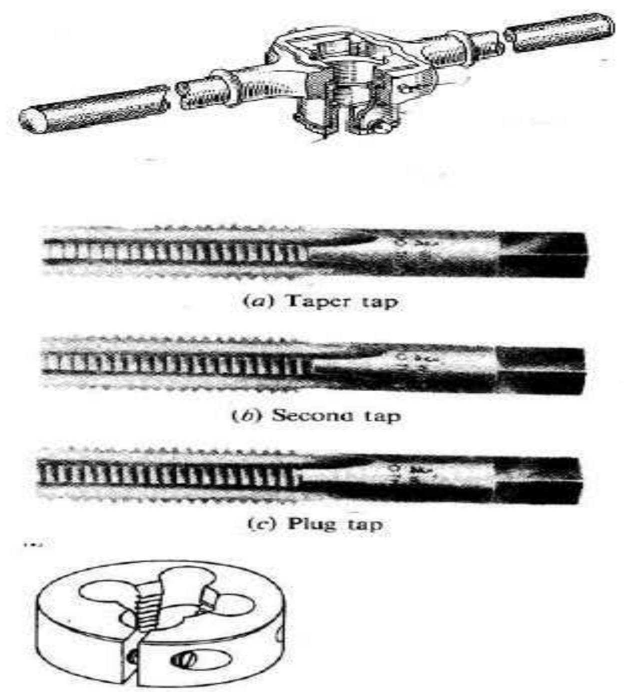


Figure 1. 83 Job tap handle

Self check 1

Hand operated tapping in center lathe.

How do you cut metal threads

What is a threading tool called?

What tool is used to cut external threads?

What do you use to cut threads in a drilled hole?

What is the tool used to for external threads?

Which tools is used to cut the internal thread?

How are threads cut?

What is used for cutting threads?

Unit seven: Assemble components mechanically

This unit to provide you the necessary information regarding the following content coverage and topics:

- Mechanical fastening operations are performed by using rivets, screw as well as bolt and nuts
- Worn-out screws and studs are removed by ***Extractor*** carefully

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Mechanical fastening operation by using rivets, screw as well as bolt and nuts
- Worn-out screws and studs are removed by ***Extractor*** carefully

7.1. Mechanical fastening operations are performed by using rivets, screw as well as bolt and nuts

7.1.1. Rivets

Rivets are non threaded fasteners that are usually manufactured from steel or aluminum. They consist of a preformed head and shank, which are inserted into the material to be joined, and a second head that enables the rivet to function as a fastener is formed on the free end by a

7.1.2. Fastening and Power Screws

variety of means known as setting. A conventional rivet before and after setting is illustrated. Rivets are widely used to join components in aircraft, boilers, ships, boxes, and other enclosures. Rivets tend to be much cheaper to install than bolts, and the process can be readily automated with single riveting machines capable of installing thousands of rivets per hour. Rivets can be made from any ductile material, such as carbon steel, aluminum, and brass. A variety of coatings are available to improve corrosion resistance. Care needs to be taken in the selection of material and coating in order to avoid the possibility of corrosion by galvanic action. In general, a given size rivet will be not as strong as the equivalent threaded fastener. The two main types of rivet are tubular and blind, and each type is available in a multitude of varieties. The advantage of blind rivets is that they require access to only one side of

the joint. Another type of rivet with potentially many overall advantages, from a productionperspective, is self-piercing rivets that do not require predrilled holes. The rivet is driven in to the target materials with high force, piercing the top sheets and spreading outward into the bottom sheet of the material under the influence of an upsetting die to form the joint. Factors in the design and specification of rivets include the size, type, and material for the rivet, the type of joint, and the spacing between rivets. There are two main types of riveted joint: lap joints and butt joints; see Figure 16.18. In lap joints, the components to

be joined overlap each other, while for butt joints an additional piece of material is used tobridge the two components to be joined, which are butted up against each other. Rivet scan fail by shearing through one cross section known as single shear, shearing through two cross sections known as double shear, and crushing. Riveted plates can fail by shearing, tearing, and crushing. For many applications, the correct use of rivets is safety-critical and their use is governed by construction codes. For information and data concerning joints for pressure vessels, reference to the appropriate standards should be made, such as the ASME Boiler Code.

Before setting After setting

Conventional rivet before and after setting.

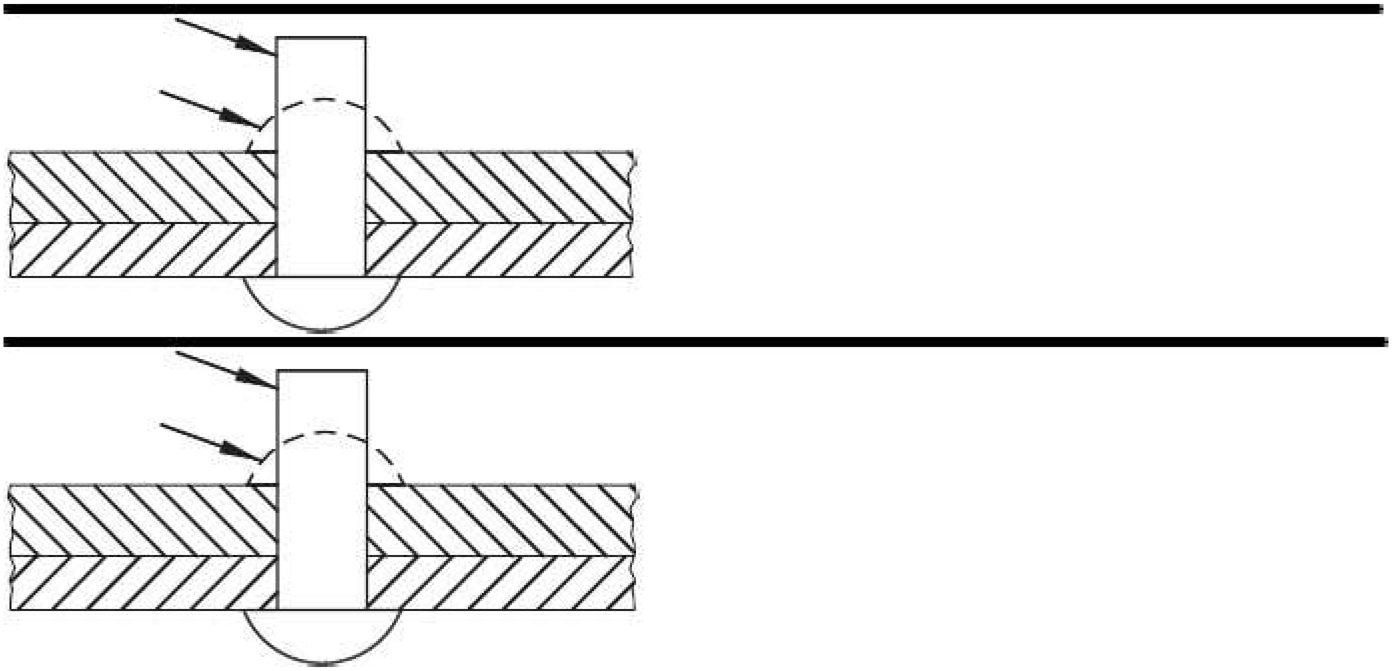


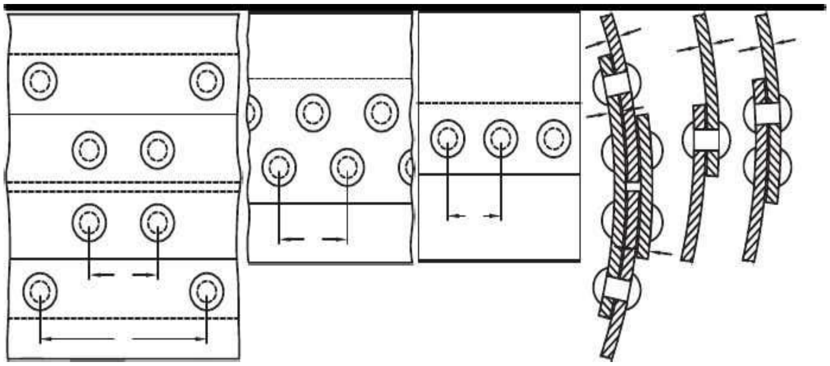
Figure 1. 84 conventional riveting

Riveted joints can be designed using a simple procedure (Machinery’s Handbook)

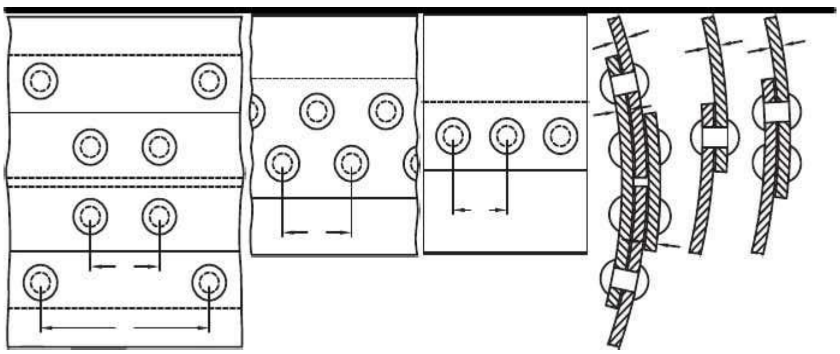
assuming that:• the load is carried equally by the rivets• no combined stresses act on a rivet to cause failure• the shearing stress in a rivet is uniform across the cross section• the load that would cause failure in single shear would have to be double to cause failure in double shear

Some types of riveted joints.

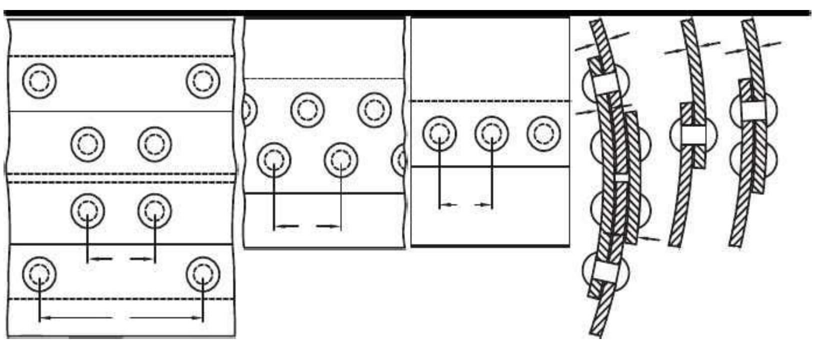
Fastening and Power Screws



Single riveted lap joint



Double riveted lap joint



Double riveted butt joint

7.1.3. Power Screws

Power screws, which are also known as lead screws, are used to convert rotary motion in to linear movement. With suitably sized threads, they are capable of a large mechanical advantage and can lift or move large loads. Applications include screw jacks and traverses in production machines. Although suited to fasteners, thread forms such as the ISO metric standard screw threads, UNC, and UNF series described in Section 16.2 may not be strong enough for power screw applications. Instead square, Acme, and buttress thread forms have been developed and standardized.

Some of the principal dimensions for standard Acme threads.

Fastening and Power Screws

A fastener is a device used to connect or join two or more components. Traditional forms of fasteninginclude nuts, bolts, screws, and rivets. In addition, welding and adhesives can be used to formpermanent joins between components. The aim of this chapter is to introduce a wide selection of fastening techniques. While considering threaded fasteners, the subject of power screws, which areused for converting rotary motion to linear motion, is also presented

Thejoiningofcomponentsisafrequentnecessityinthedesignofproducts.Forexample,theBoeing747hasover2.5 millionfasteners.Fasteningtechniquescanalsobeamajorfeatureindesign.Currentstylingforautomotivevehiclesdictatesanabsenceofthemeanstofastencomponentstogetherunderacursoryinspection.Therangeoffasteningtechniquesisextensive.Itincludesadhesives,welding,brazing,soldering,threadedandunthreadedfasteners, specialpurposefasteners,andfrictionjoints.Someofthesetechniquesarepermanentinnatureandsomeallowthe jointtobedismantled.Avarietyofbasictypes ofjointisillustratedin.Design considerations include the following:• whether the joint should be permanent or nonpermanent• cost

Threaded Fasteners

There is a largevariety offasteners available that use a threaded form to connect components.The common element of screw fasteners is the helical thread that causes a screw toadvance into a component or nut when rotated.In the case of a two-part threaded fastener, common notation used for the two components isas follows:• A male component, the screw, with a helical thread or groove formed on its outer diameter• A female component, the nut, with a helical thread or groove formed on its inner diameterFor a two-part threaded fastener, the two helical grooves are defined with the same pitch,hand, and nominal diameter. A slight clearance is required to allow assembly between thediameter for the screw and nut. Rotation of, for example, the screw component causes it toadvance into the nut component forming a threaded assembly. Screw threads can be eitherleft-handed or right-handed depending on the direction of rotation desired for advancingthe thread, as illustrated in Figure 16.2. Generally, right-hand threads are normally used, withleft-handed threads being reserved for specialist applications. The shape of the grooveformingthe helixiscalled thethreadformor profile.Alarge numberof threadforms exist andare available, but the vast majority of threads and threaded fasteners use the so-called “vee”thread. The detailed aspects of a thread and the specialist terminology used are illustratedin Figure 16.3 and defined in Table 16.1.Specific thread forms, angle of helix, etc., vary according to specific standards.

Commonstandards developed include Unified National Standard (UNS) series threads andInternational Standards Organization (ISO) threads. Both of these use a 60

included anglebut are not interchangeable. The form for an ISO metric thread for a nut is illustrated i

(a) Right-hand thread; (b) left-hand thread.

Fastening and Power Screws 679

In practice, the root of the nut and the crest of the mating bolt are rounded. Bothmale and female ISO threads are subject to manufacturing tolerances, which are detailedin BS 3643. A coarse series thread and fine series threads are defined in the ISO standard, butfine series threads tend to be more expensive and may not be readily available from allstockists. Table 16.2 gives the standard sizes for a selection of ISO coarse series hexagonbolts, screws, and nuts. ISO metric threads are designated by the letter M, followed by thenominal diameter and the pitch required, for example, M6

Specialist terminology used for describing threads. Thread terminology.

Term Description

Pitch The thread pitch is the distance between corresponding points on adjacent threads.Measurements must be made parallel to the thread axis.Outside diameter Theoutsideormajordiameteris thediameteroverthecrests ofthethreadmeasuredat right angles to the thread axis.Crest The crest is the most prominent part of the thread, either external or internal.Root The root lie s at the bottom of the groove between two adjacent threads.Flank Theflankofathreadisthestraightsideofth ethreadbetweentherootandthecrest.Rootdiameter The root, minor, or core diameter is the smallest diameter of the thread measured atright angles to the thread axis.Effective diameter Theeffectivediameter isthediameterinwhichthewidthofthespacesisequaltothewidt h of the threads. It is measured at right angles to the thread axis.Lead The lead of a thread is the axial movement of the screw in one revolution.

7.2. Worn-out screws and studs are removed by Extractor carefully

7.2.1.Removing Stripped Screws From Metal, Wood, and Plastic: Why the Material Matters

Most of the methods described below will work if a stripped screw is embedded in metal, wood, or plastic. Removing a stripped screw from each material, however, presents its own challenges.

- **Stripped screws in metal** need to be removed carefully, otherwise you risk scratches or damage. Be extra diligent when using power tools and cutting materials.
- **A stripped screw in wood** will likely be flush with the material or slightly lower than the surface, so using a stripped screw extractor may be your best bet to retrieve the screw.
- **Plastic** is a fairly soft material, and a light touch is a must if you want to reuse a hole in plastic after removing a screw. Hammering, grinding, and cutting to remove the screw may render the hole unusable.

No matter which material you're working with, you'll need a bit of muscle to remove stripped screws. You must use firm pressure and patience, moving the screw a fraction of a turn at a time, otherwise you risk breaking the screw and making the removal process all the more challenging.

1. Use rubber bands.

Figure 1. 85 use rubber bands

Photo: istockphoto.com

Before trying any other methods, try this one:

- Put a rubber band—the wider, the better—over the top of the stripped screw.
- Firmly insert the point of your screwdriver, then slowly unscrew the fastener. The rubber band adds traction, creating a better grip for your screwdriver to twist the screw. Expect to go through a few rubber bands when using this method, as they tend to break from the pressure of the screwdriver.

If you don’t have a rubber band handy, substitute a bit of steel wool or some of the abrasive material from the scouring side of a sponge.

2. Size up your driver bit.

Figure 1. 86 size driver bit

Photo: istockphoto.com

If you're trying to remove a stripped screw using a driver bit that's sized for a screw in pristine condition, you're likely wasting your time. When the slots in the head of the screw have worn out, the driver bit you'd typically use won't fit properly. Try a bit that's a little larger to see if it fits better.

Related: the most useful power drill attachments

3. Use a stripped screw extractor.

Figure 1. 87 **Use a stripped screw extractor**

Photo: Amazon.com

Do you come across a lot of stripped screws in your projects? A dedicated set of stripped screw extractors may be the only solution you need. These attachments for your drill come in different types and sizes, and they involve a two-step process. You first use the drill bit to create a hole in the screw head, then you use the extractor to remove the screw.

4. Try a left-handed drill bit.

Figure 1. 88 **Try a left-handed drill bit**

Photo: istockphoto.com

Typical screws loosen by turning to the left. The less common left-handed drill bit has flutes that twist in a counterclockwise direction. The torque applied by a left-handed drill bit can be more effective than a right-handed bit at loosening a stripped screw. For it to work, however, the drill must be set in reverse.

Related: how to change a drill bit

5. Drill deeper into the screw head.

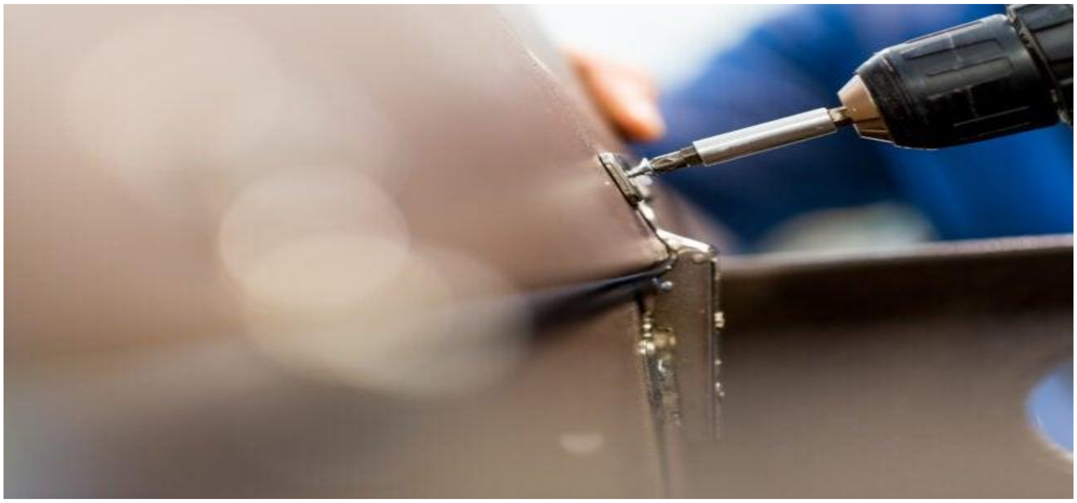


Figure 1. 89 **Try a left-handed drill bit**

Photo: istockphoto.com

Sometimes drilling a small hole into a stripped screw can allow your screwdriver to reach deeper into—and achieve a better grip on—the stuck fastener. If you're going to try this approach, make certain to use a drill bit designed for use on metal, not wood. And don't drill too far down; the screw head could pop off!

6. Pull the screw with pliers.

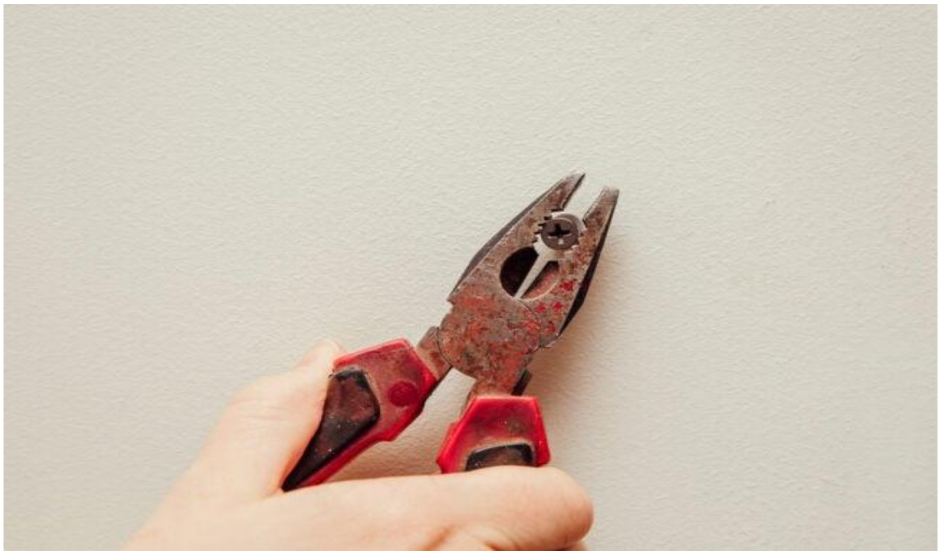


Figure 1. 90 **Pull the screw with pliers**

Photo: istockphoto.com

Inspect the screw head closely. If there's any daylight between the screw head and the surface to which it's fastened, see if you can get hold of the screw with a pair of locking pliers (these are also known as vise grips). If you can get the tool to grab a firm hold of the screw, you should be able to turn the pliers until the screw loosens and pulls away.

Self-Check Written Test

Directions: Answer all the questions listed below:

1 What mean by PPE? (**2 points**)

2 Write the steps to provide drilling operation. (**2 points**)

3 Write the importance of PPE in the work shop. (**2 points**)

3 List out the types honing tools. (**2 points**)

4 Write the function of honing operation. (**2 points**)

1. _____is the process of producing round hole in a solid material or enlarging existing holes.
   b. Reaming b. Drilling c. Honing d. Filling
2. Which one of the following is a finishing process of drilled holes?
   b. Honing b. filling c. Sawing d. Drilling
3. ____is the process of enlarging a hole that has already been drilled.
   b. Drilling b. Honing c. Boring d. None

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https://www.ccohs.ca/oshanswers/hsprograms/house.html

DEVELOPERS PROFILE

Name	Qualification (Level)	Field of Study	Organization/ Institution	Mobile number
JN NEGASH	**A**	Manufacturing Technology Management	Ethio-Italy PTC	0913798642
MAMO	**B**	Manufacturing Technology Management	Harar PTC	0985543902
EGN AHIMED	**A**	Manufacturing Technology Management	Fedral TVT Institute	0924549941