

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF MECHANICAL, CHEMICAL AND MATERIALS ENGINEERING



Mechanical Engineering Department
Basic Workshop Practice (MEng 2101)

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Basic Workshop Practice



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1. Introduction

- General Safety and care of workshop facilities
- The need of safety
- Cause of accidents
- Accident prevention



What is Safety?

What is workshop?

- a room or building in which goods are manufactured or repaired.

What is Safety?

- Safety is the state of being safe.
- Safety is an altitude, that is, it is condition of mind.
- Safety is a state in which hazards and conditions leading to physical, psychological or material harm are controlled in order to preserve the health and well-being of individuals and the community.



Safety in Workshops /Basic metal and Machine Shop/

- Safety is the state of being safe “**Safety is everyone’s business and responsibility**”.
- The work shop is a work place. Keep it clean. Metal scraps/chips/ should be thrown in scrap box than just putting them drop in the floor. Therefore they may case you or fellow/members/ students to trip and fail.



The need of safety in workshops

- Safety working habits cannot bought or manufactured they must be learned through practice.
- Safety increased value of production with a minimum of time lost from on one job injury.
- The safety education today has become an important phase of every training program.
- The safety program prepared in different level. Workshops, Industrial, governmental agencies to reduce the number of accident.



The need of safety in workshops

General rules for safety in metal workshop have been established for **three very good reasons**.

1. **To protect you and your colleagues** from bodily harm.
2. **To minimize damage** to facilities, machinery and hand tools.
3. **To provides you with experience in safety concepts.**



Accidents and Causes of Accidents

- **Accidents** don't just happen; they are caused. The cause of an accident can usually be traced to carelessness on some one's part.
- Accidents can be avoided, if a safe work habits are developed.



Causes of Accidents

- Ignorance of the proper handling of hand tools and machineries.
- Ignorance of the danger existing at once working place.
- Ignorance of the proper working method and procedures.
- Carelessness.
- Lack of tidiness/Keeping things neat and orderly/.
- Horse play etc.

Generally causes of accidents

- Generally causes of accidents are categorized in to four major groups.

I. Personal grooming

II. House-keeping

III. Handling tools and materials/work-piece/

IV. Operating machine Tools

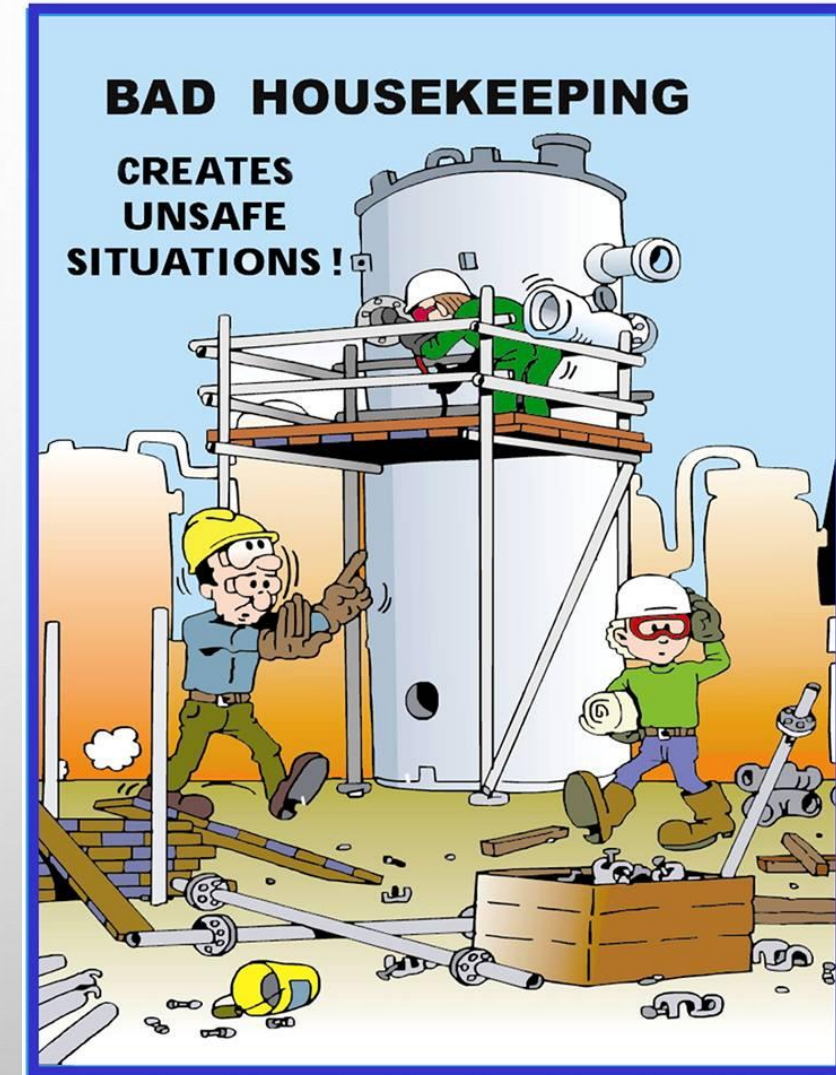
a) Causes of accidents from Personal Grooming categories:

1. Never wear loose clothing around any machine.
2. Remove any watches, rings or bracelets; these can get caught in the machine.
3. Long hair must be protected by hair net or an approved protective shop cap.
4. Always wear approved safety, glasses when cutting metals by machines.

Generally causes of accidents

b) Causes of accidents from House Keeping Categories:

1. Keep the floor free from oil and grease.
2. Sweep up the metal chips on the floor frequently.
4. Always keep the machine clean. Use brush and proper T-slot tool to remove any chips.
5. Always stop the machine before you attempt to clean it.
6. Do not place tools and materials on the machine body.



Generally causes of accidents

c) Causes of accidents from Handling Tools and Materials/Work-piece/Categories:

1. Be sure the work is clamped securely in the vise, chuck or to a machine table.
2. Before you handle any work piece, remove all burrs and sharp edges with a file.
3. Do not attempt to lift heavy or odd shaped objects which are difficult to handle on your own.
4. For heavy objects, follow safe lifting practices. Use your leg muscles for lifting and not your back.

Generally causes of accidents

c) Causes of accidents from Handling Tools and Materials/Work-piece/Categories:

5. Never start a machine until you are sure that cutting tools clear the work piece.
6. Use proper wrenches to tight the nut. Replace worn out nuts.

d) Causes of accidents from Operating Machine Tools Categories:

1. Do not operate any machine before understanding its mechanism.
2. Always stop a machine before measuring, cleaning or making any adjustments. It is dangerous to do any type of work around moving parts of a machine.
3. Never operate a machine unless all safety guards are in place.
4. Keep hands away from moving parts. It is dangerous practice to “feel” the surface of the revolving work or to stop a machine by hand.

Accidents Prevention

Accidents Prevention in House Keeping Categories

- Keep the floor around a machine free of tools or stocks.
- Keep the floor free of oil, grease and cutting fluids. Remove quickly as possible to prevent dangerous fell.
- Remove up the metal chips on the floor frequently.

Accidents Prevention

Accidents Prevention in Handling Tools and Materials Categories

- Always remove the burns or sharp edges from work-piece.
- Never handle a sharp tools or cutters by hand.
- Use the proper lifting Techniques, wherever lifting tools or materials.

The approved methods of lifting materials are as follows:

Step 1: Squat down, bending your knees, but be sure to keep your back straight.

Step 2: Grasp the material securely and use your leg muscles to raise the load. Keep your back straight.

Step 3: Lower the materials to the floor by bending.

Accidents Prevention

Accidents Prevention in Operating machine Tools Categories

- Never attempt to operate any machine tools until you fully understand its mechanism and know how to stop it quickly.
- Be sure that all the safety guards are in place before starting operation on any machine tools.
- Never wear loose clothing or jewellery around machine tools.
- Always wear approved safety glasses in machine shop, especially when operating machine tools.
- Keep your hand away from moving parts.
- Stop the machine before attempting to clean or measure the size of the work-piece.¹⁶

Hazard

- A Hazard is a potential source of harm or adverse health effect on a person or persons.



Cut you



Burn you



Crush you



Hurt your hearing



Hurt your eye

Workshop Safety Signs

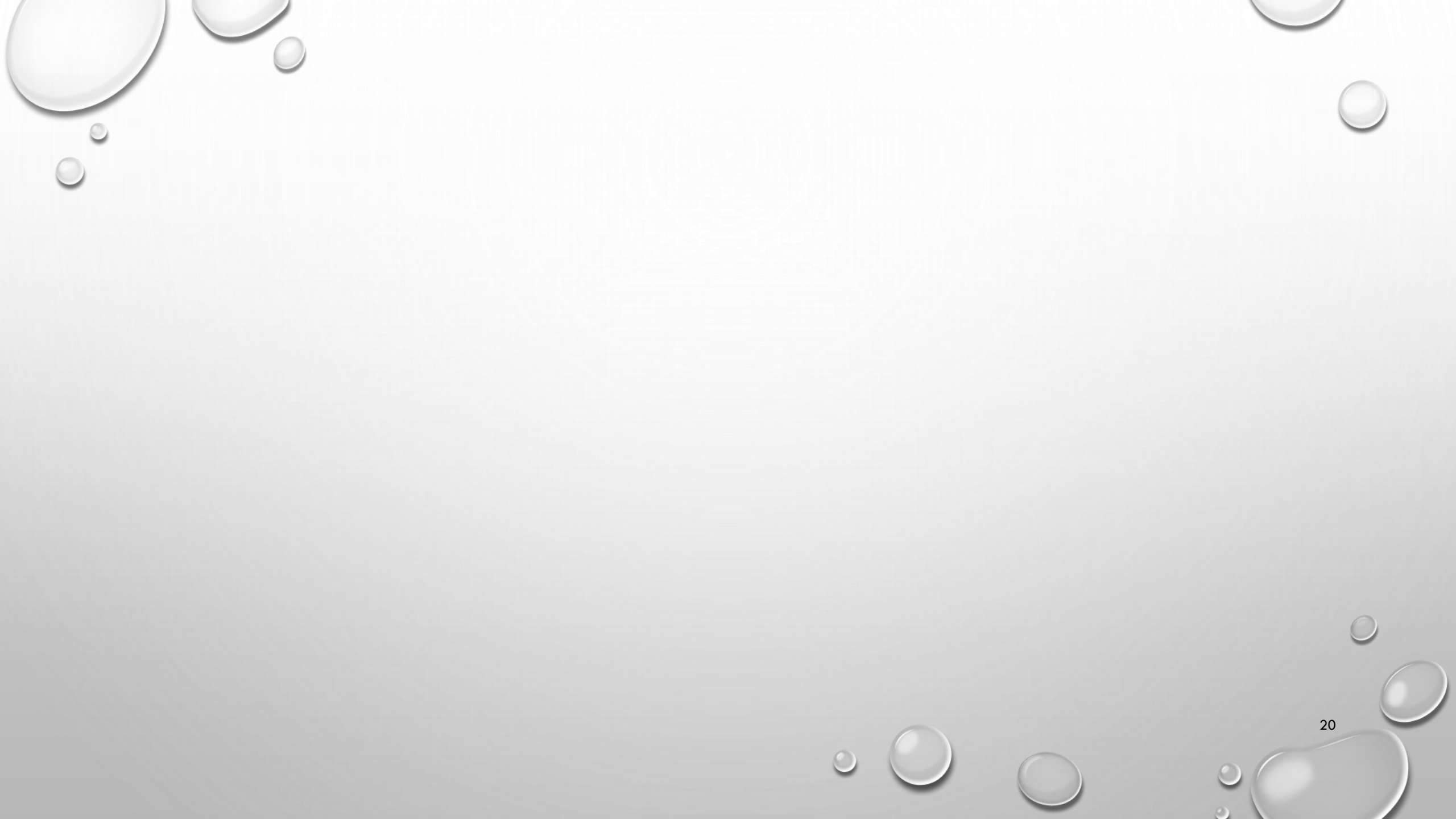


Before leaving the shop

The shop must be:

- Floors (Swept)
- Tools (Cleaned and put away)
- Desks & Tables (Brushed off)
- Machines (Cleaned)





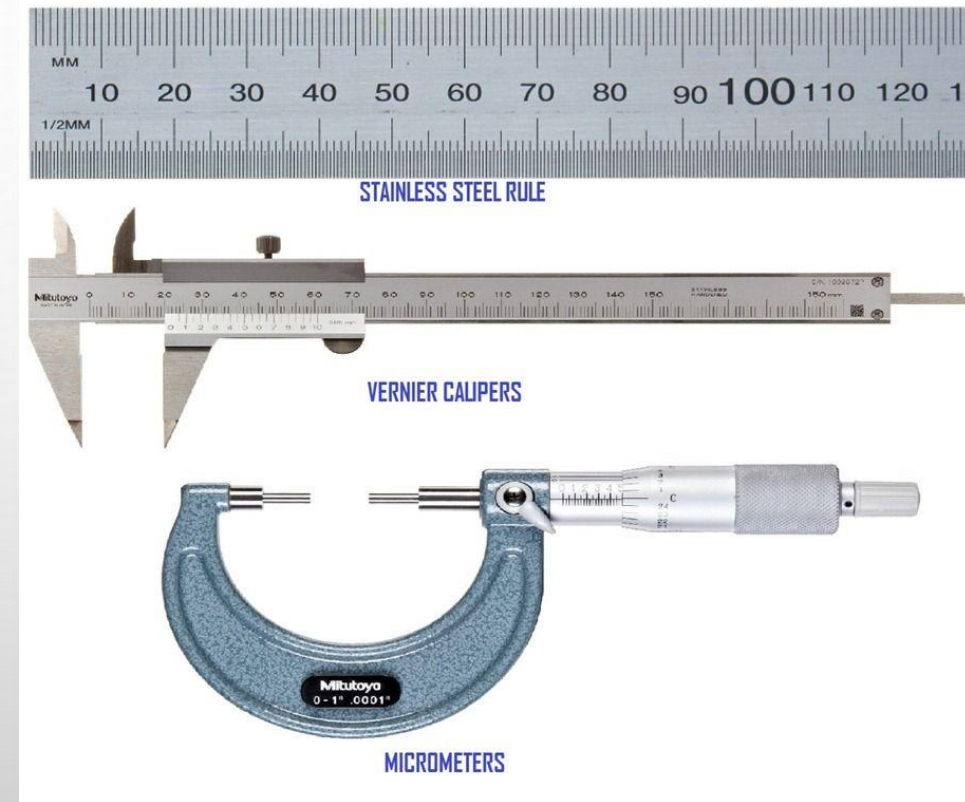
2. Measuring tools

What is measurement?

Measurement is defined as the process of comparison of an unknown quantity with a known or standard quantity.

Types of linear measuring tools (a measure of length):

- Steel rule
- Caliper
- Micrometer



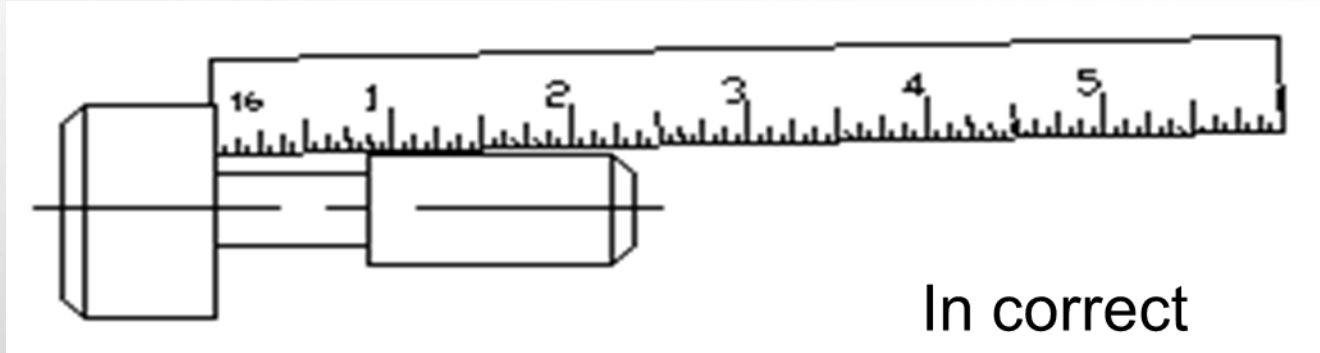
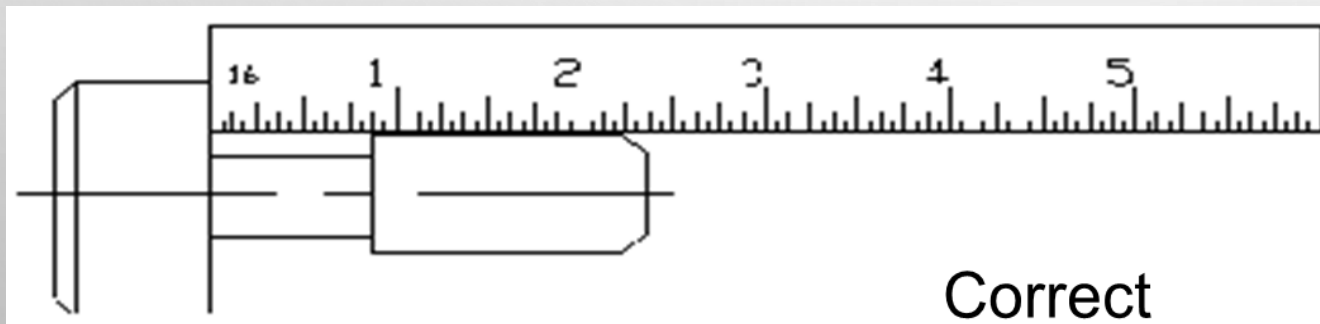
Steel rule

- A steel rule is the simplest and most common measuring tool.
- Available in different size.
- Most common units are:
 - **Metric system**
 - **Inch-pound system**



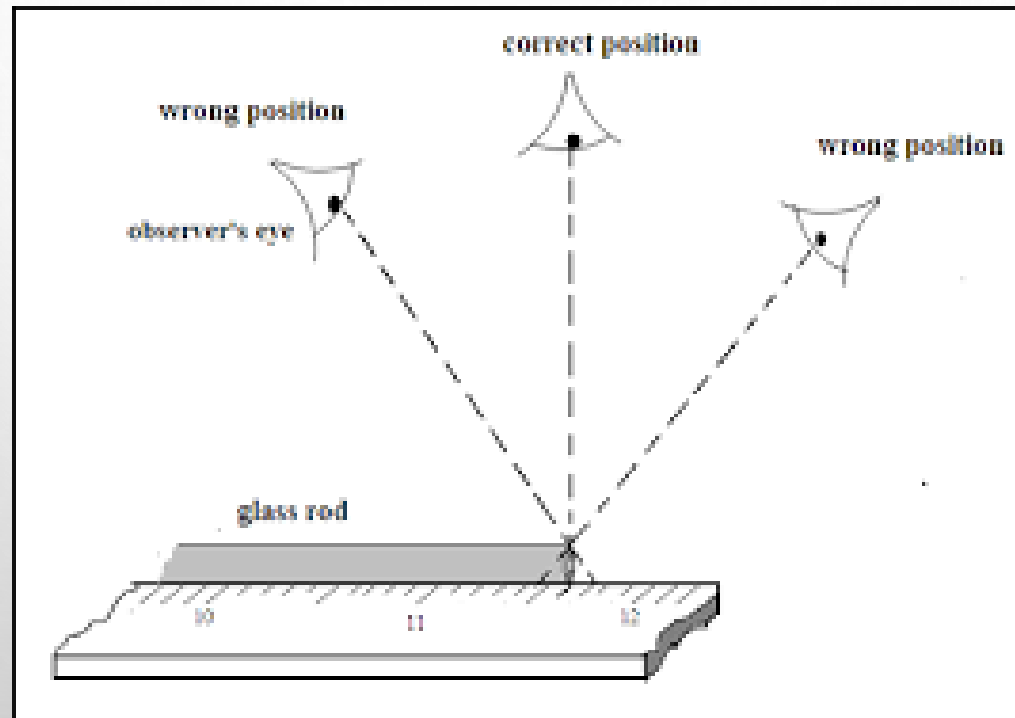
Using steel rule

- When measuring a length, the steel rule must be kept in straight line parallel to the centreline of the work piece.



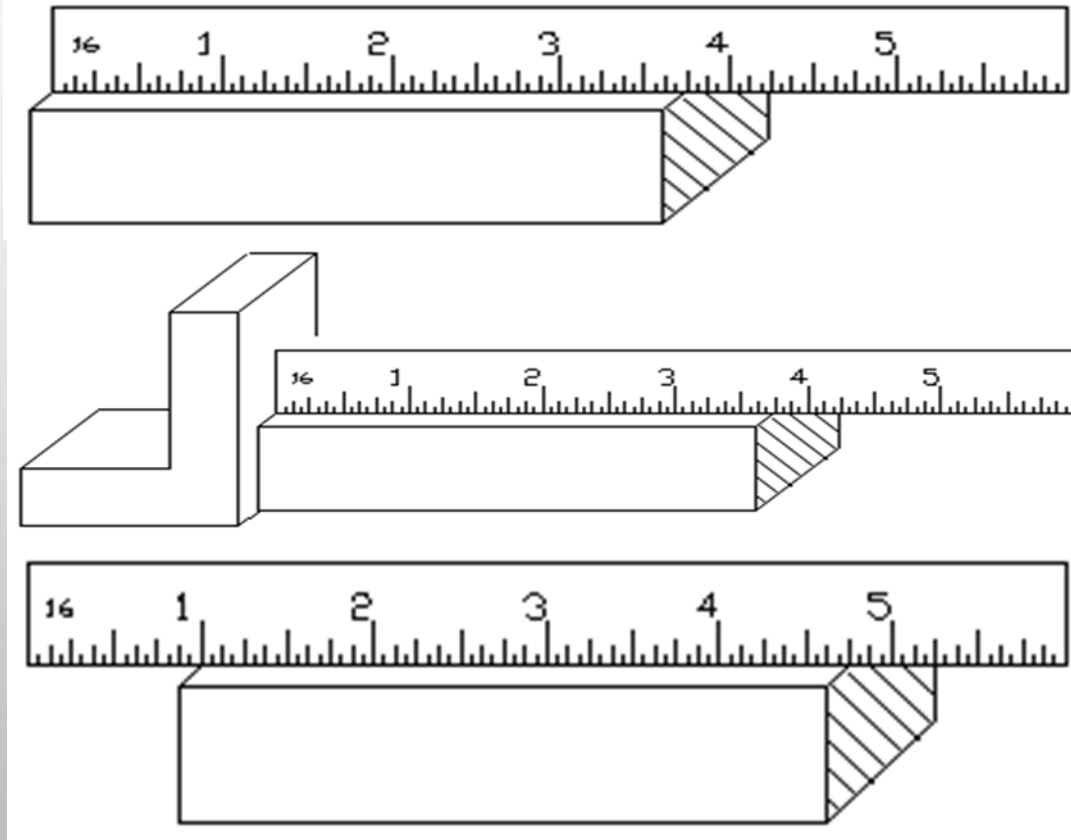
Using steel rule

- Avoid **parallax error** when taking measurement or holding the work piece.

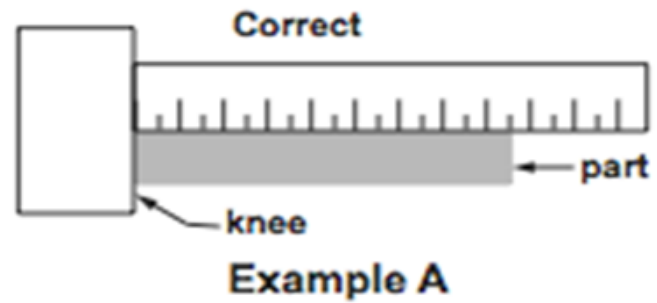
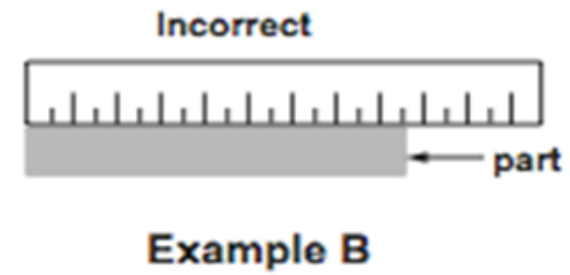
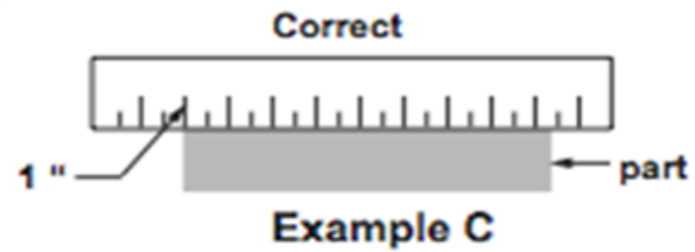
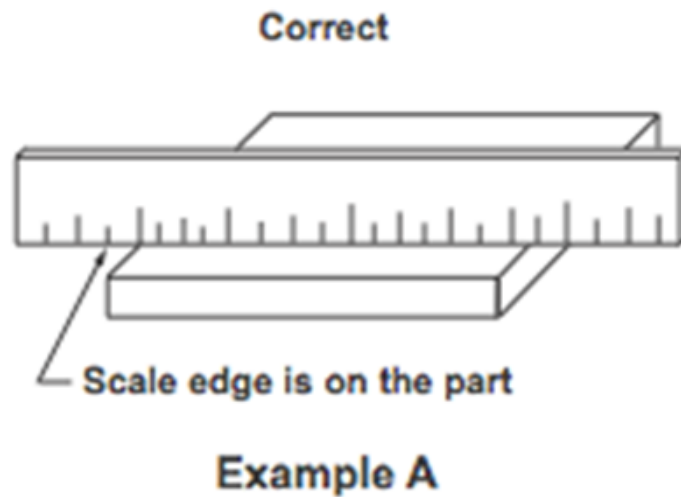
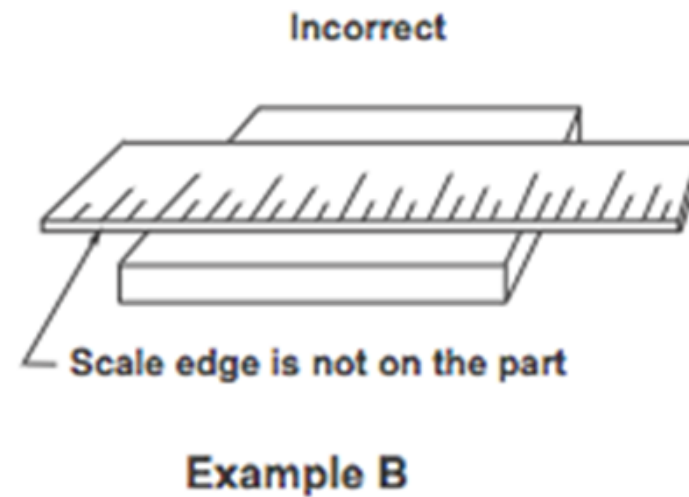


Using steel rule

- Never use the end of the rule to align with edge of the work piece.



Using steel rule



Types of steel rule

- **Hook rule:** automatically aligns the end of the rule with the end of the work piece.
- **Narrow rule:** used to measure the depth of narrow slots and small diameter holes.

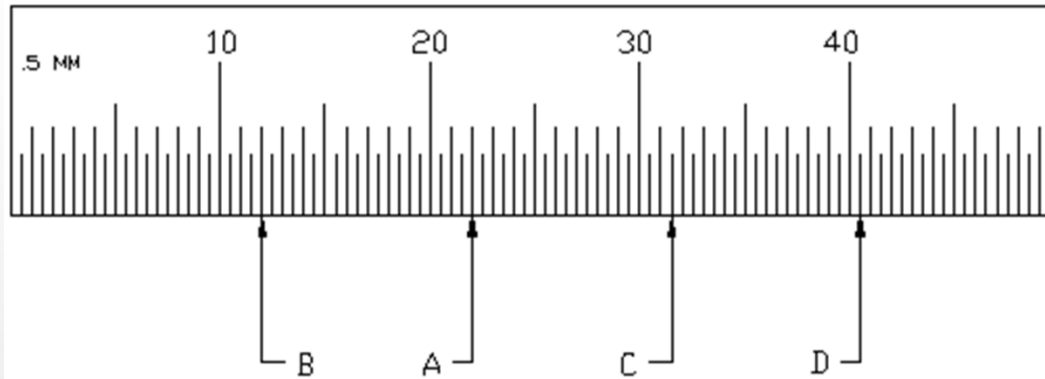


- **Flexible rule:** are designed to measure curves or round surfaces.
- **Narrow rule with holder:** used to measure grooves, recesses, keyways.

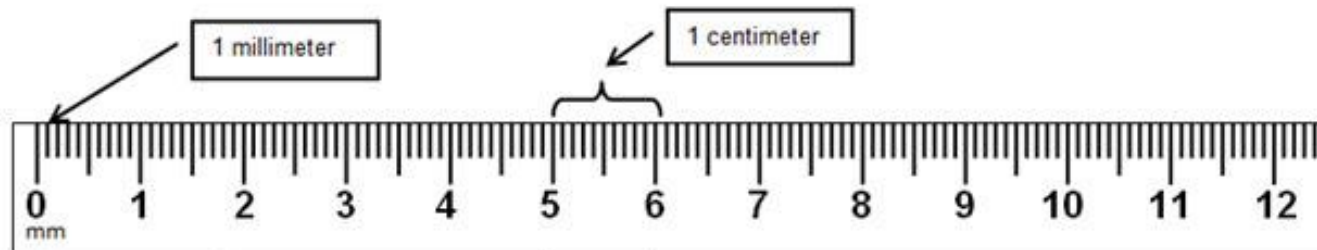
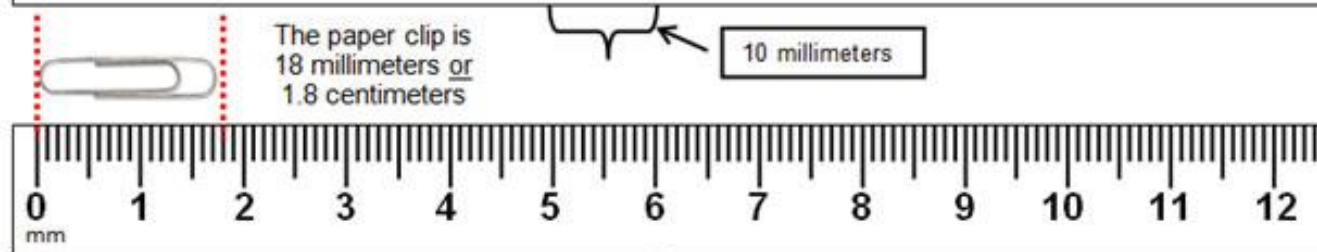
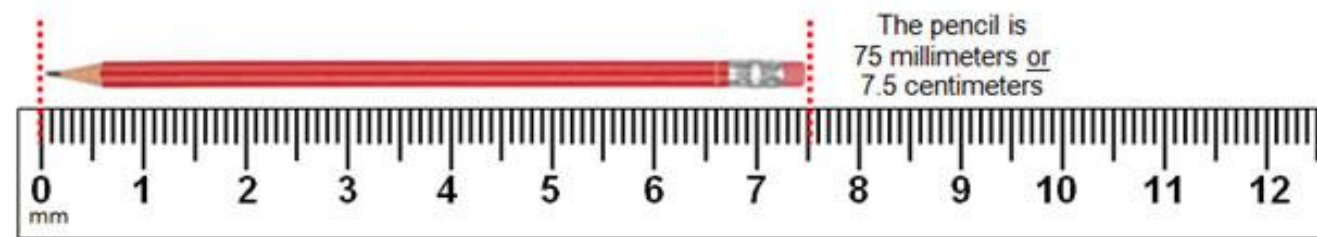


Flexible rule

Reading metric rules



A = 22mm, B = 12mm
C = 31.5mm, D = 40.5mm

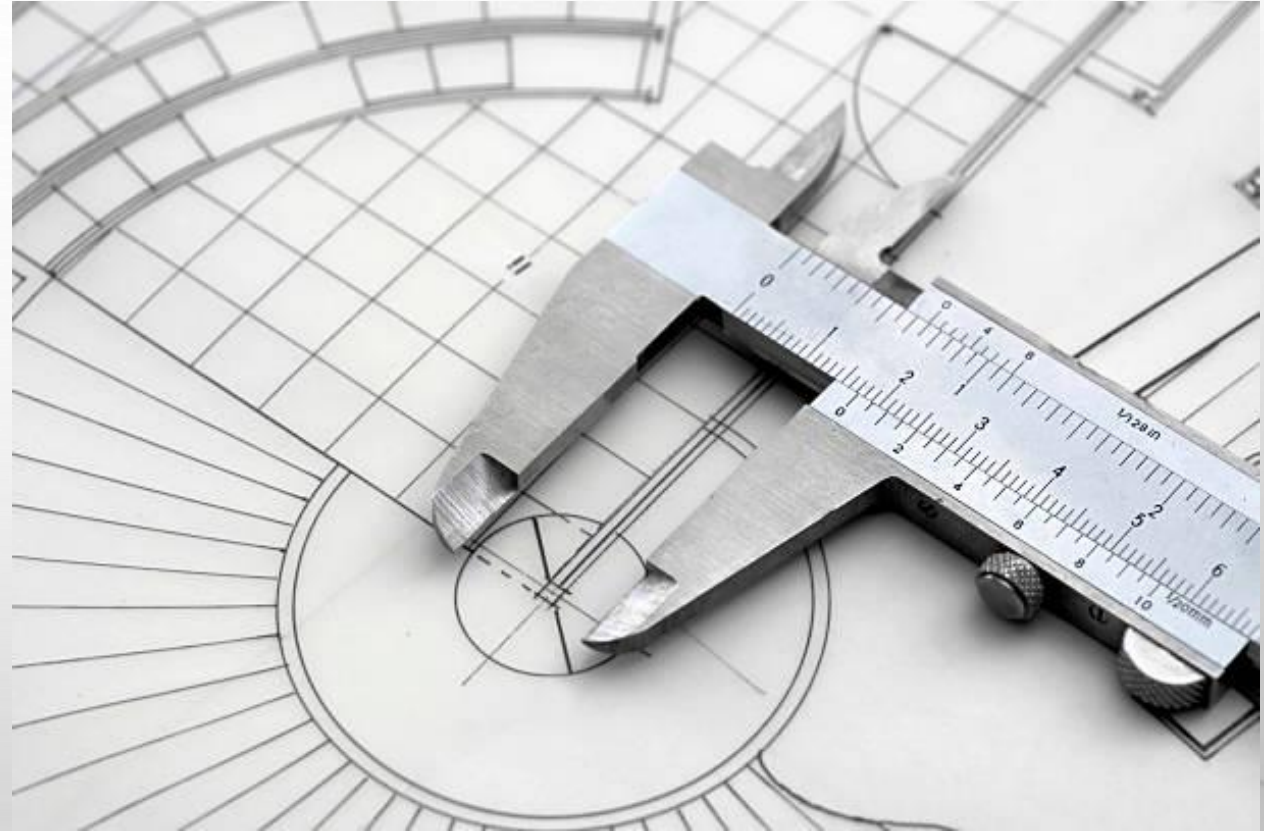


Errors in steel rule

- Parallax error
- Recording failure
- Line up error
- Unit conversion

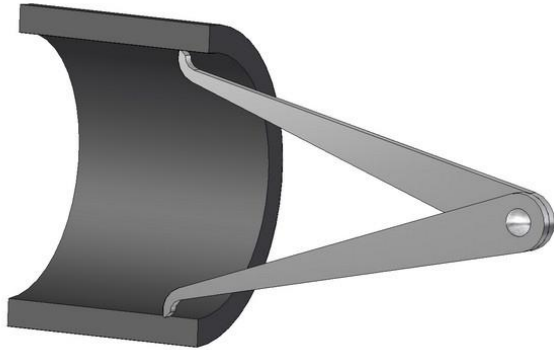
Caliper

- **Caliper** is a device used to measure the dimensions of an object.
- **Used to measure the distance between two opposite sides of an object.**
- Most calipers don't have graduation.
- Used in many fields like, Mechanical Engineering, Science, Medicine, Woodworking, Metalworking, etc.

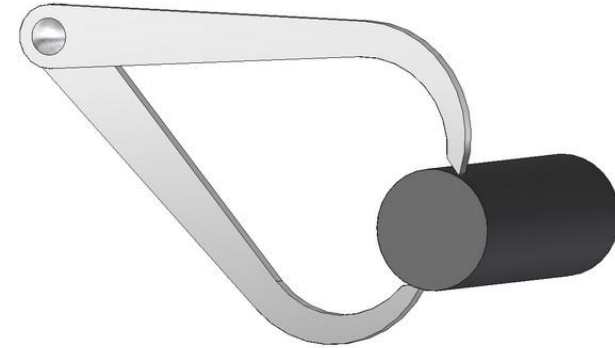


Types of Caliper

Inside caliper



Outside caliper



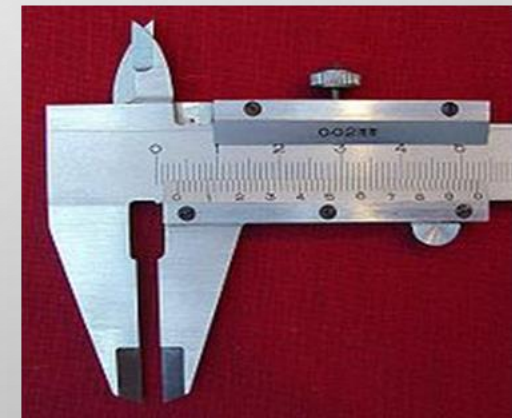
Divider caliper



Hermaphrodite caliper

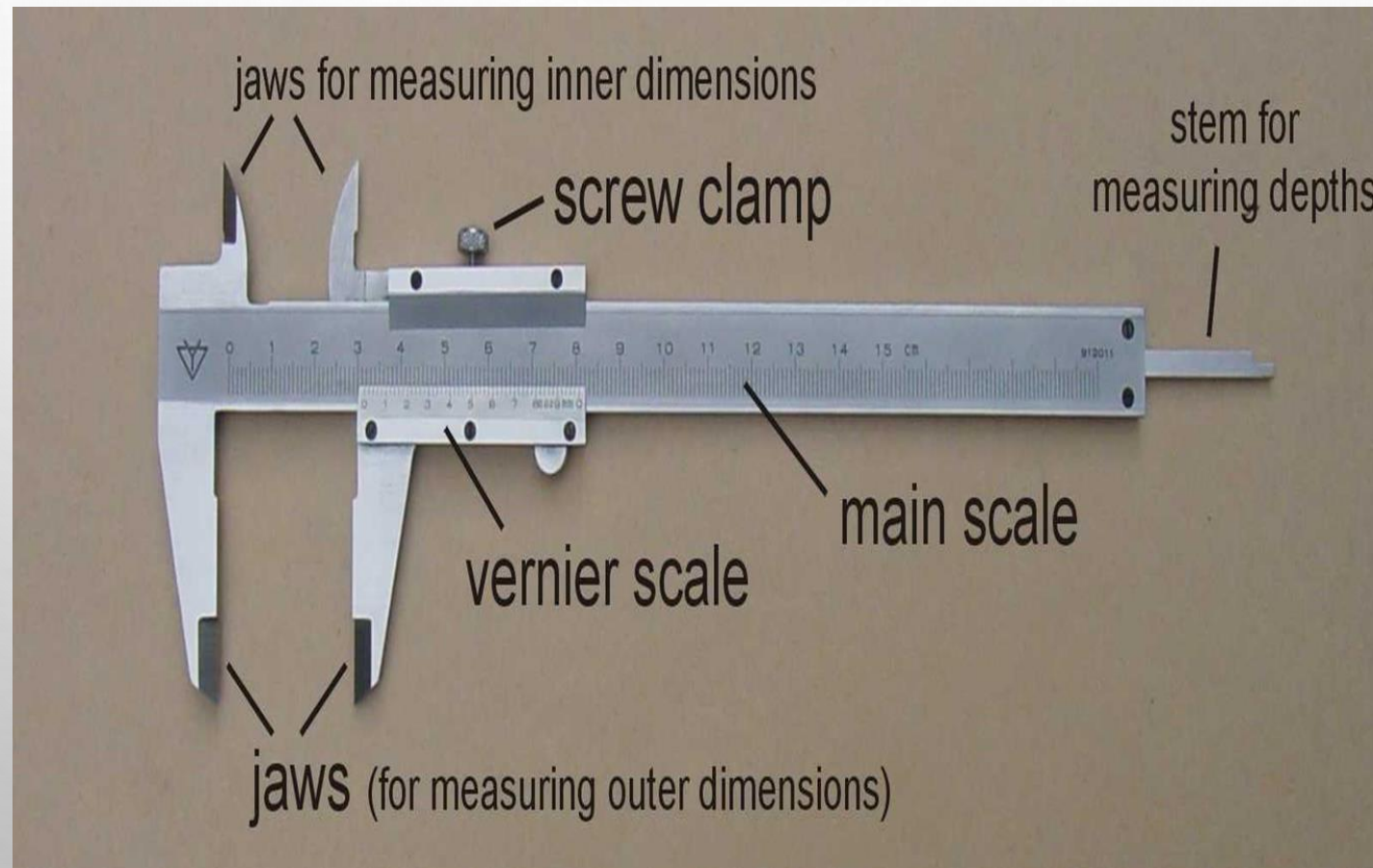


Vernier caliper



Vernier Caliper

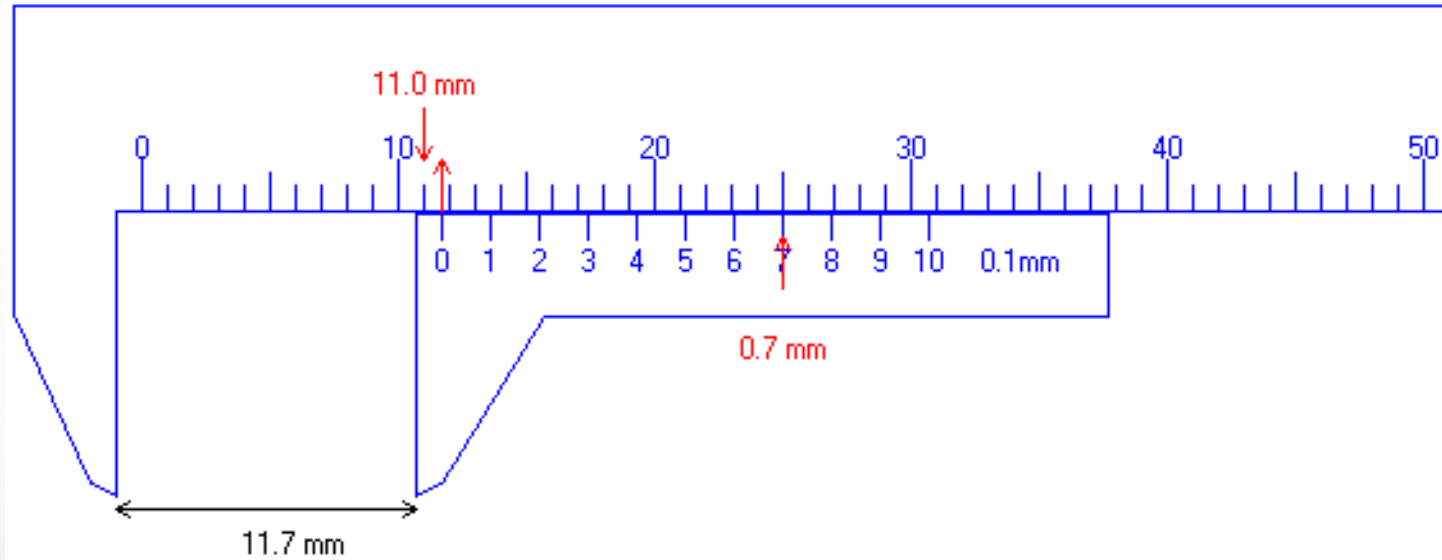
- Is sliding measuring device that can make **inside, outside, and depth measurements** with considerable accuracy.
- Measurements as small as 0.001" (0.025 mm) can be taken.



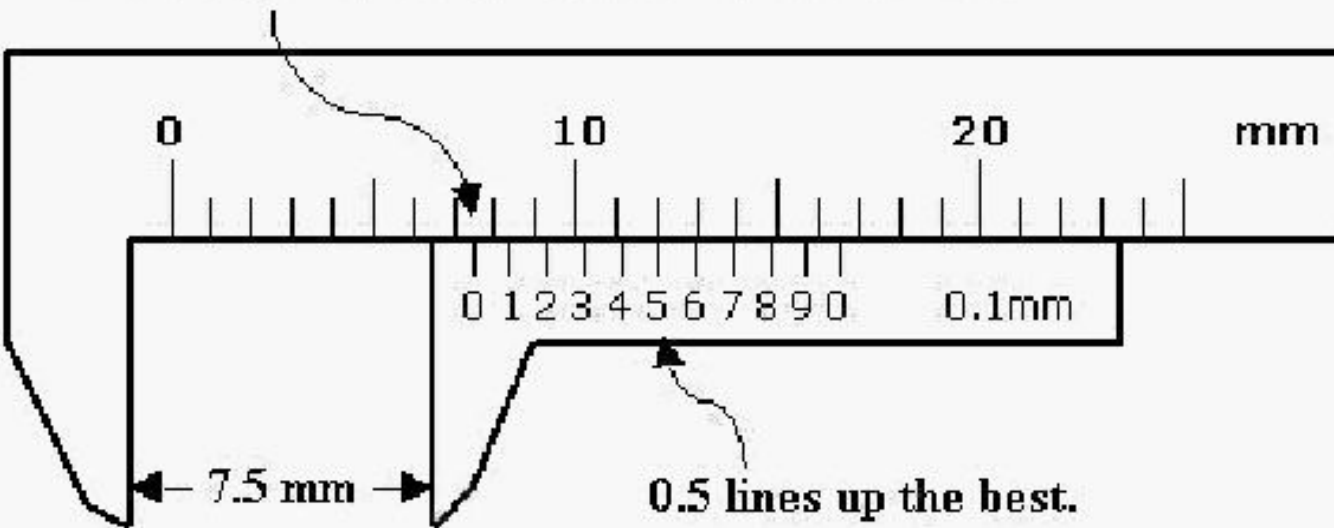
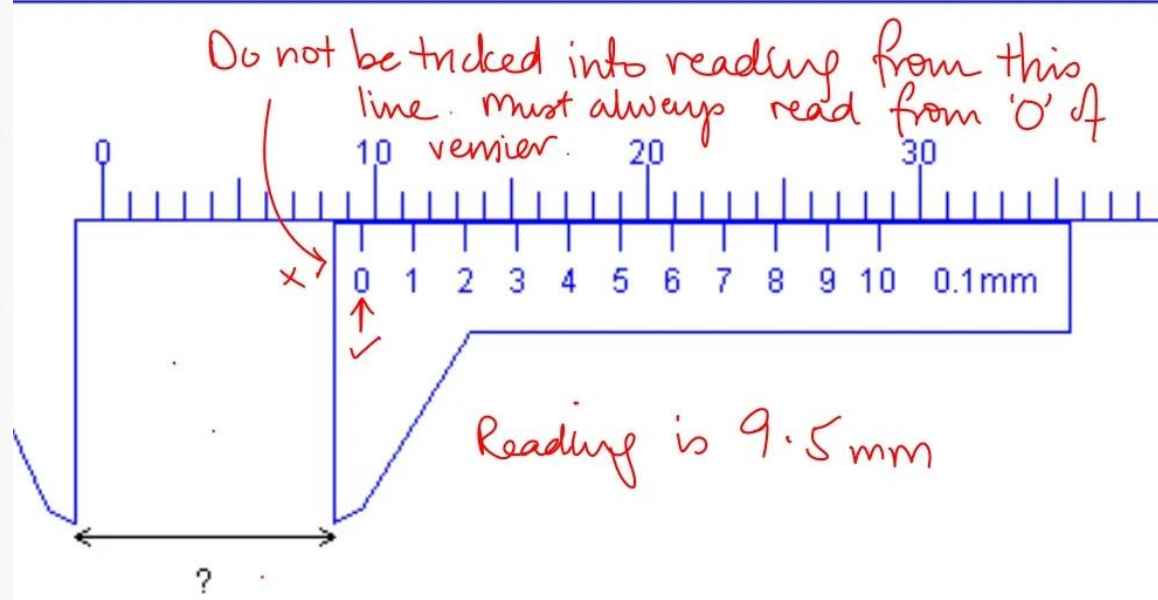
Vernier Caliper

Types Vernier based on accuracy

- **1/10th with accuracy of 0.1mm**
- 1/20th with accuracy of 0.05mm
- 1/25th with accuracy of 0.04mm
- 1/50th with accuracy of 0.02mm

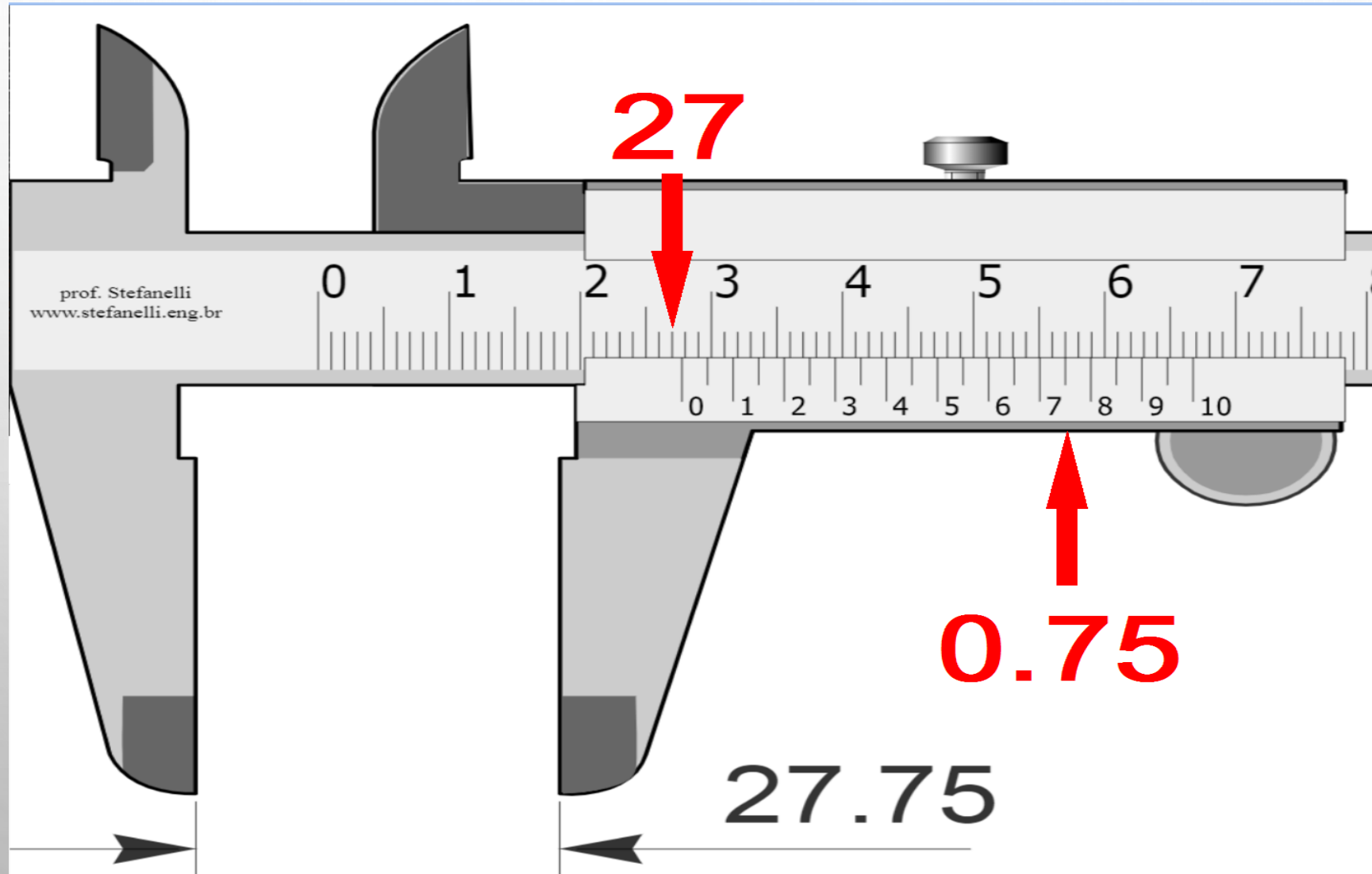


The moveable zero is between 7.0 and 8.0 mm



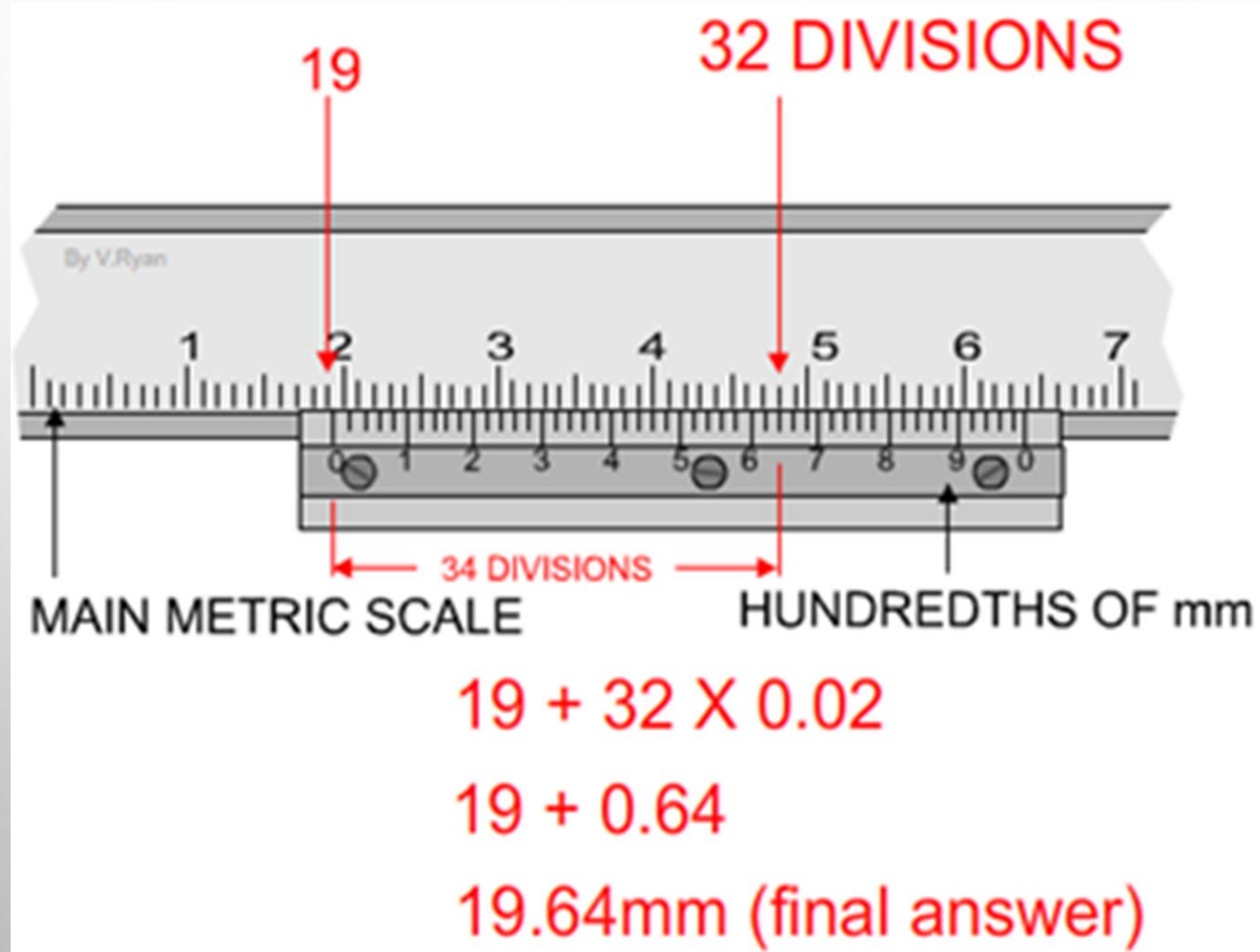
Vernier Caliper

1/20th with accuracy of 0.05mm

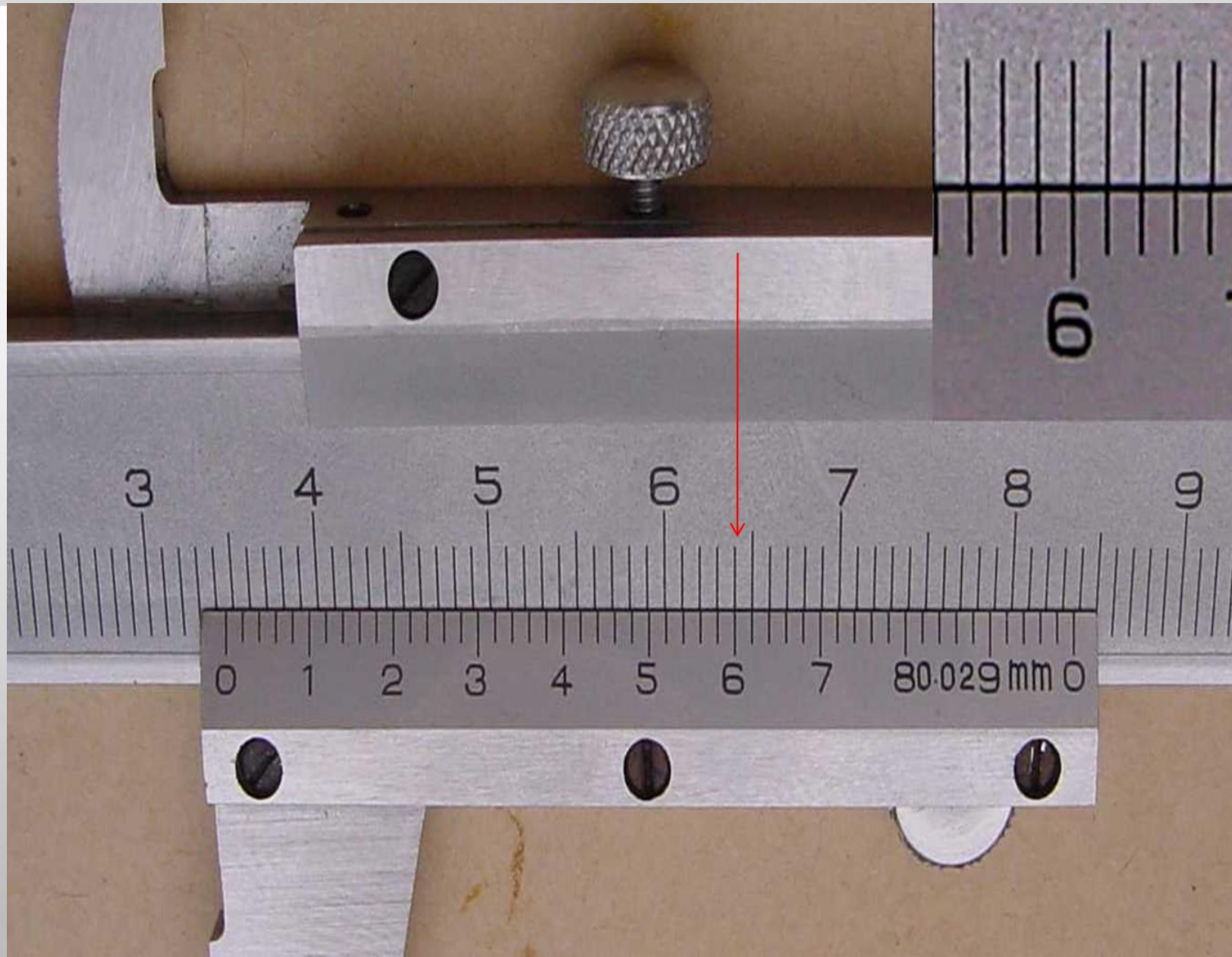


Vernier Caliper

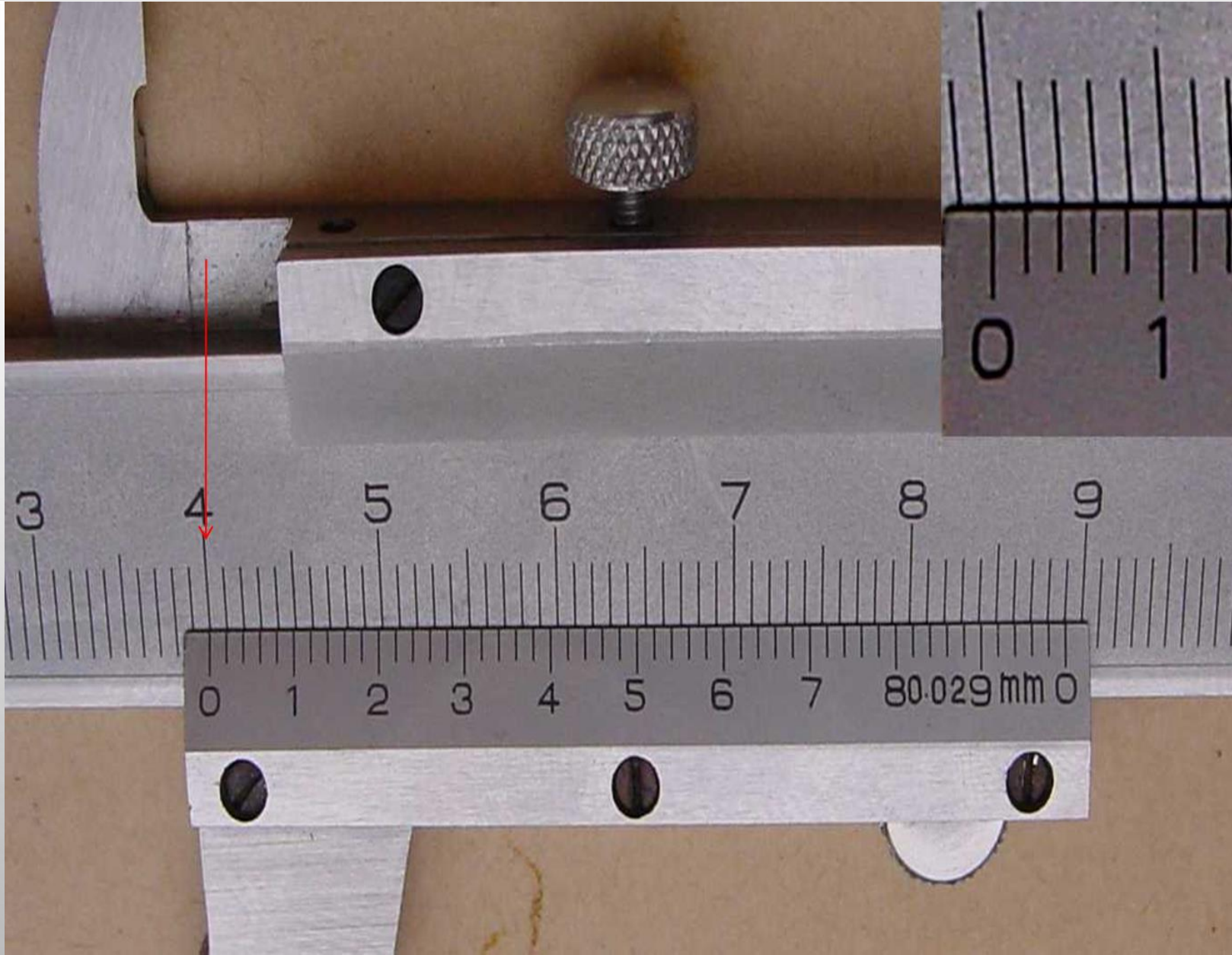
1/50th with accuracy of 0.02mm



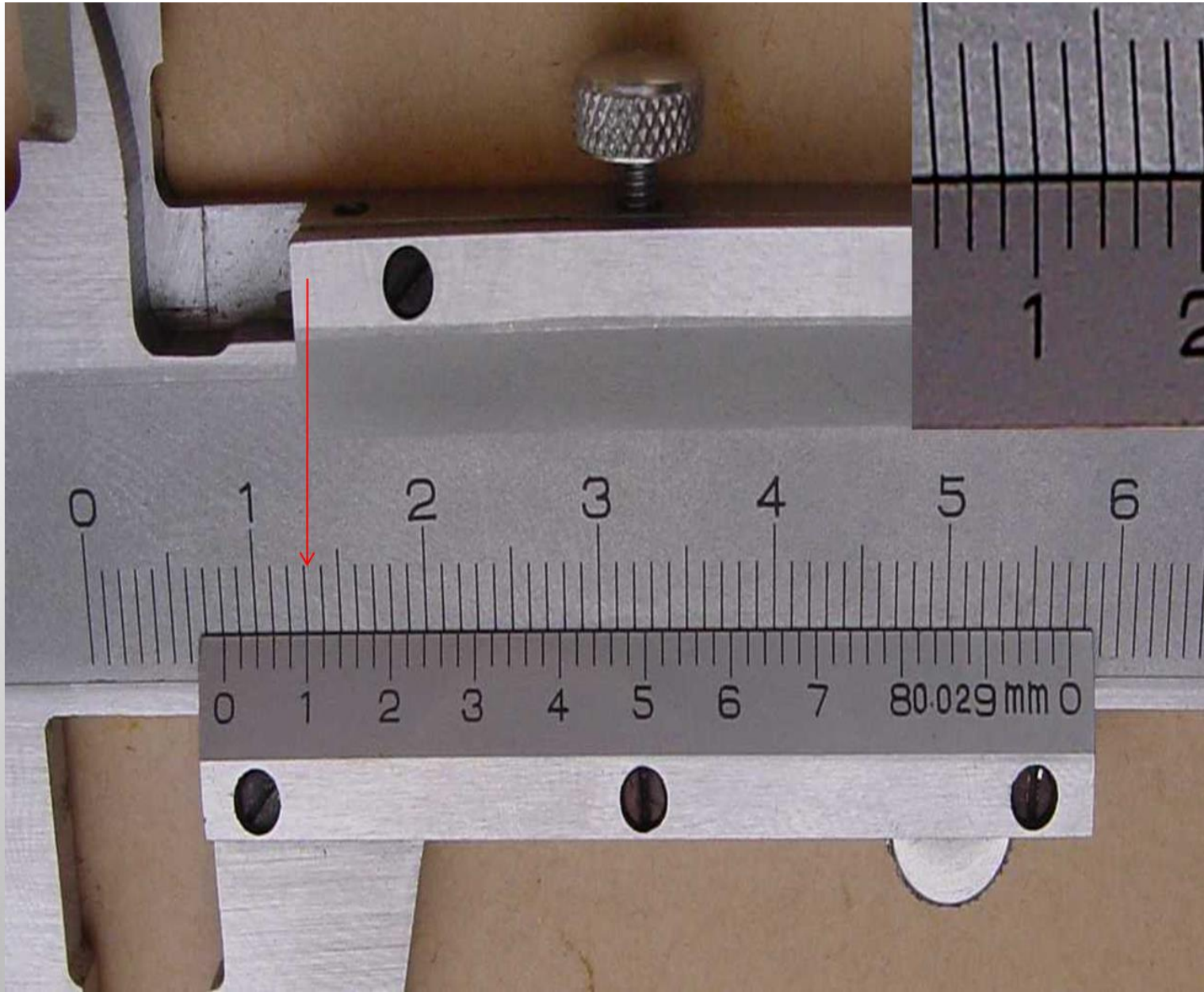
Vernier Caliper



Vernier Caliper

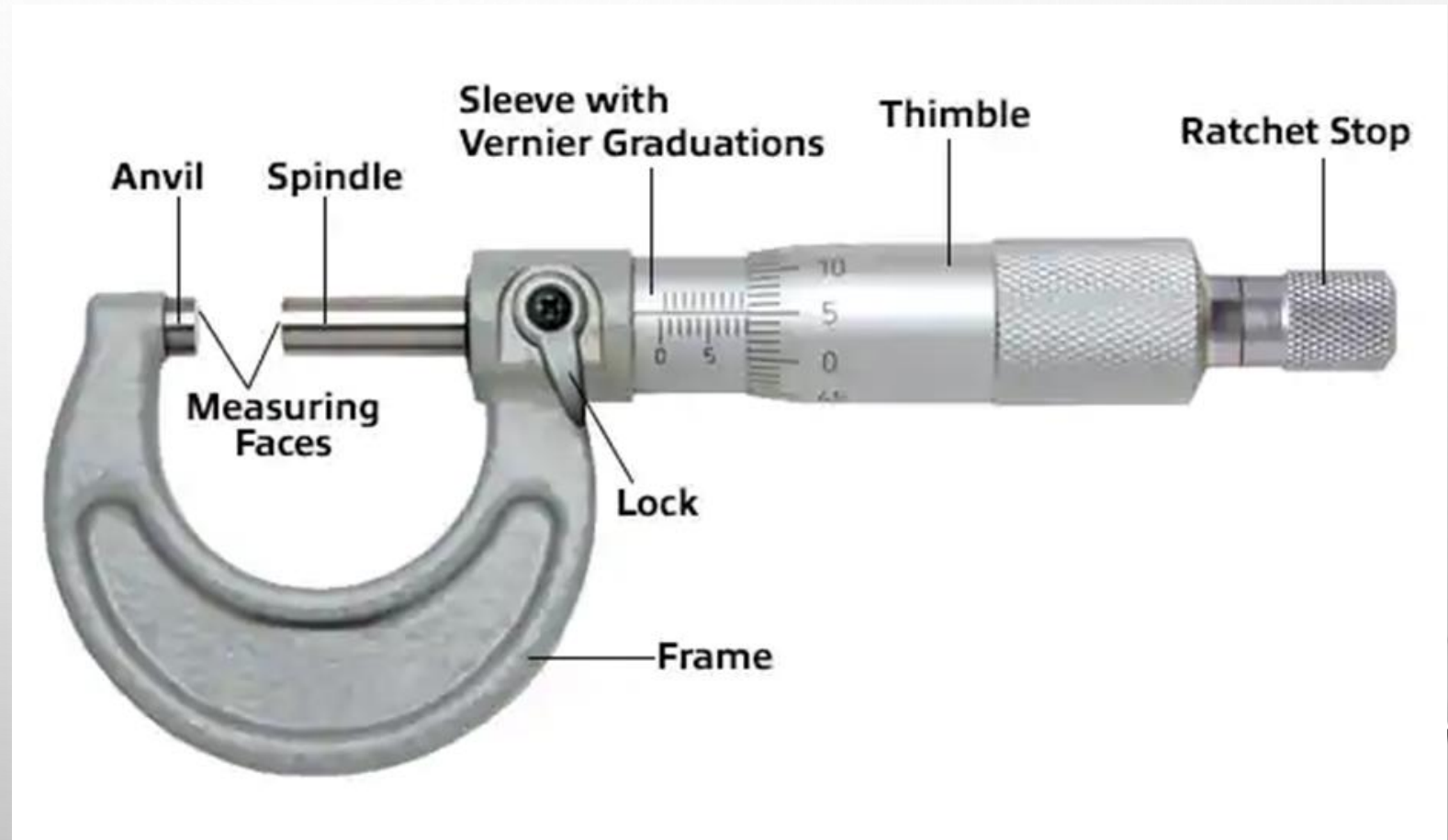


Vernier Caliper



Micrometer

- Is a measuring device used for precisely measuring **thickness, inner and outer diameters, depth of slots.**
- Available in sizes of, 0-25, 25-50, 50-75, 75-100mm.
- Types based on application;
 - Outside micrometer
 - Inside micrometer
 - Depth micrometer



Micrometer reading

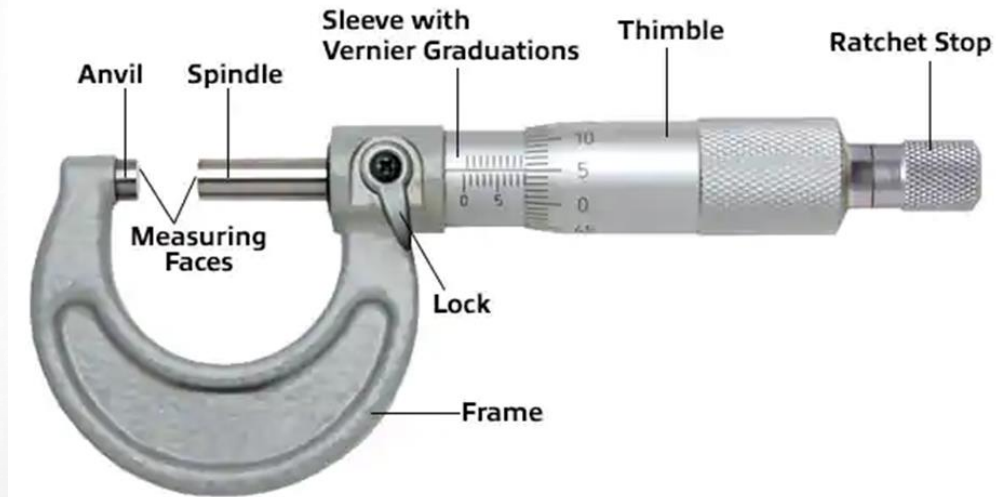
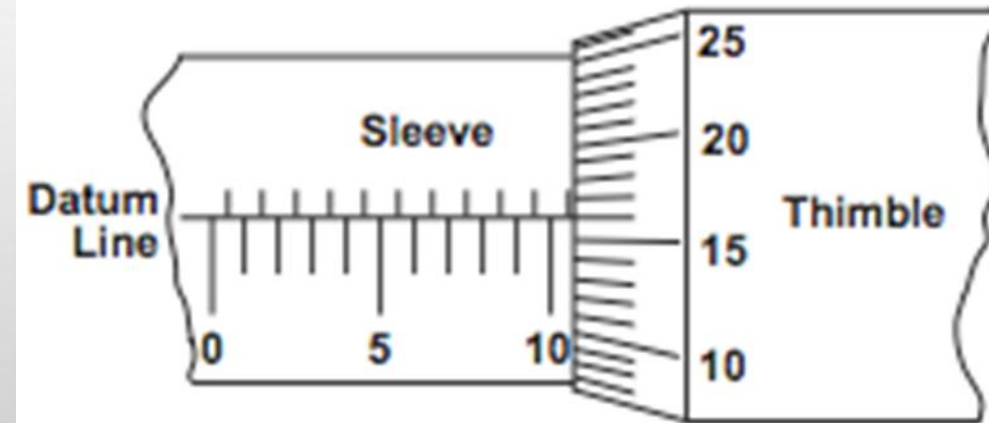
- Measure in hundredths of a millimetre (0.01 mm).
- **One complete turn of thimble = 1/2 mm.**
- **Sleeve marked in “millimetres” below the line.**
- **Marked in half-mm above line.**
- **Thimble marked in 50 divisions.**
- **Each division = 1/50 of a 1/2 millimetre or 1/100 (.01)mm.**

Step 1: Note whole millimetre mark on sleeve.

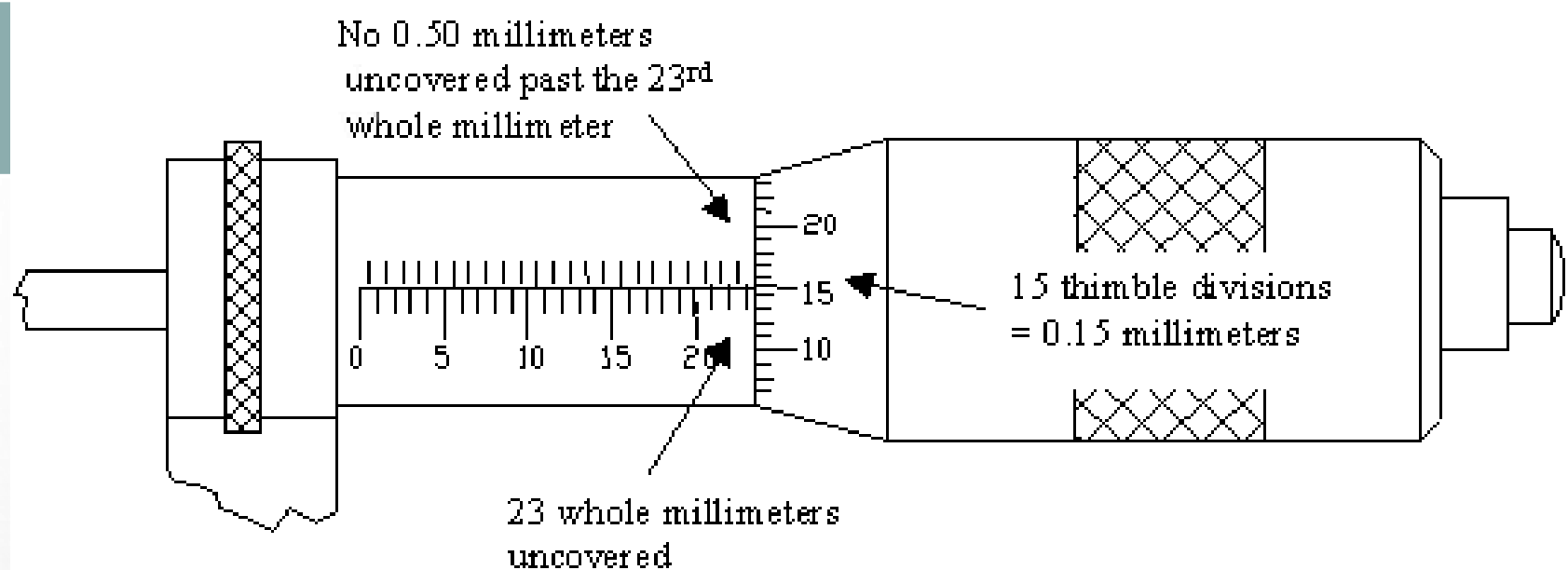
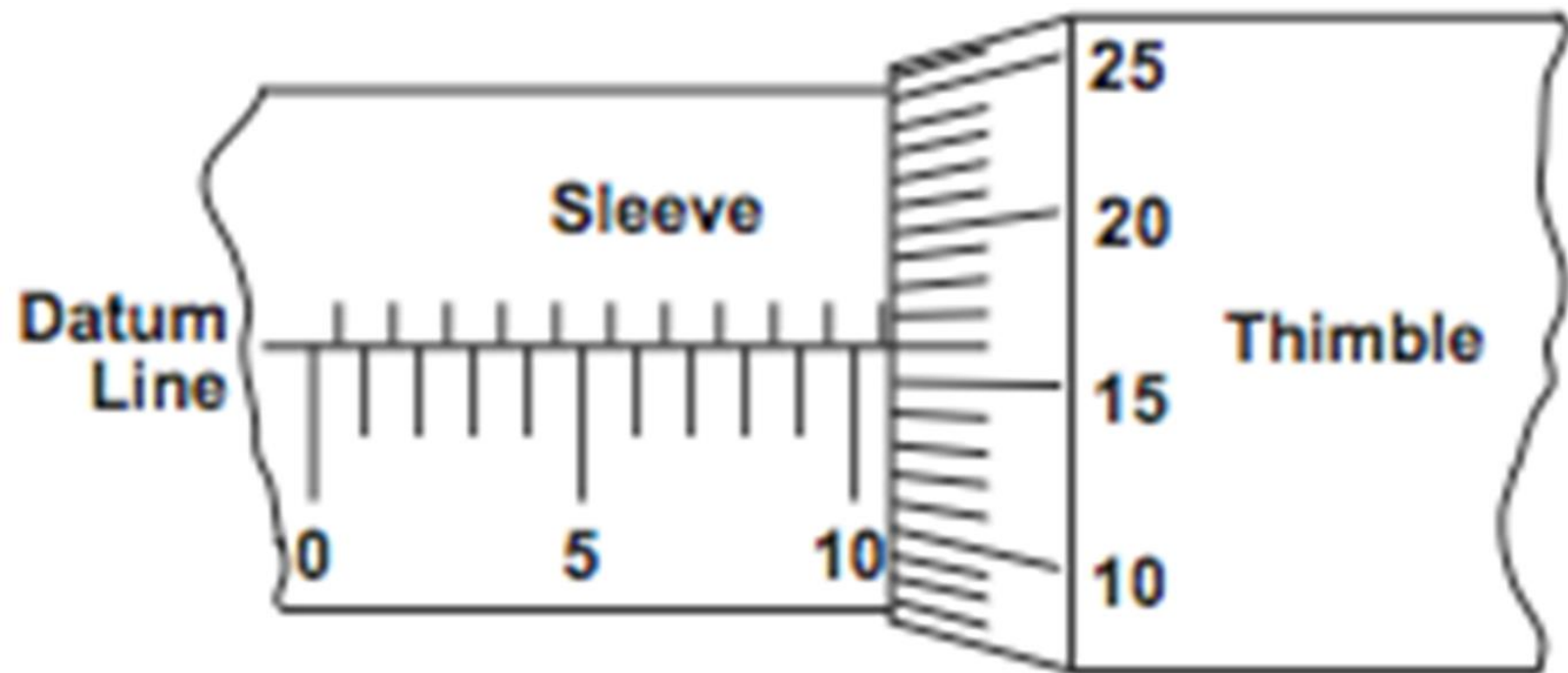
Step 2: Note whether a half-mm mark is showing between whole millimetre mark and thimble.

Step 3: Read thimble for hundredths reading.

Step 4: Add readings.

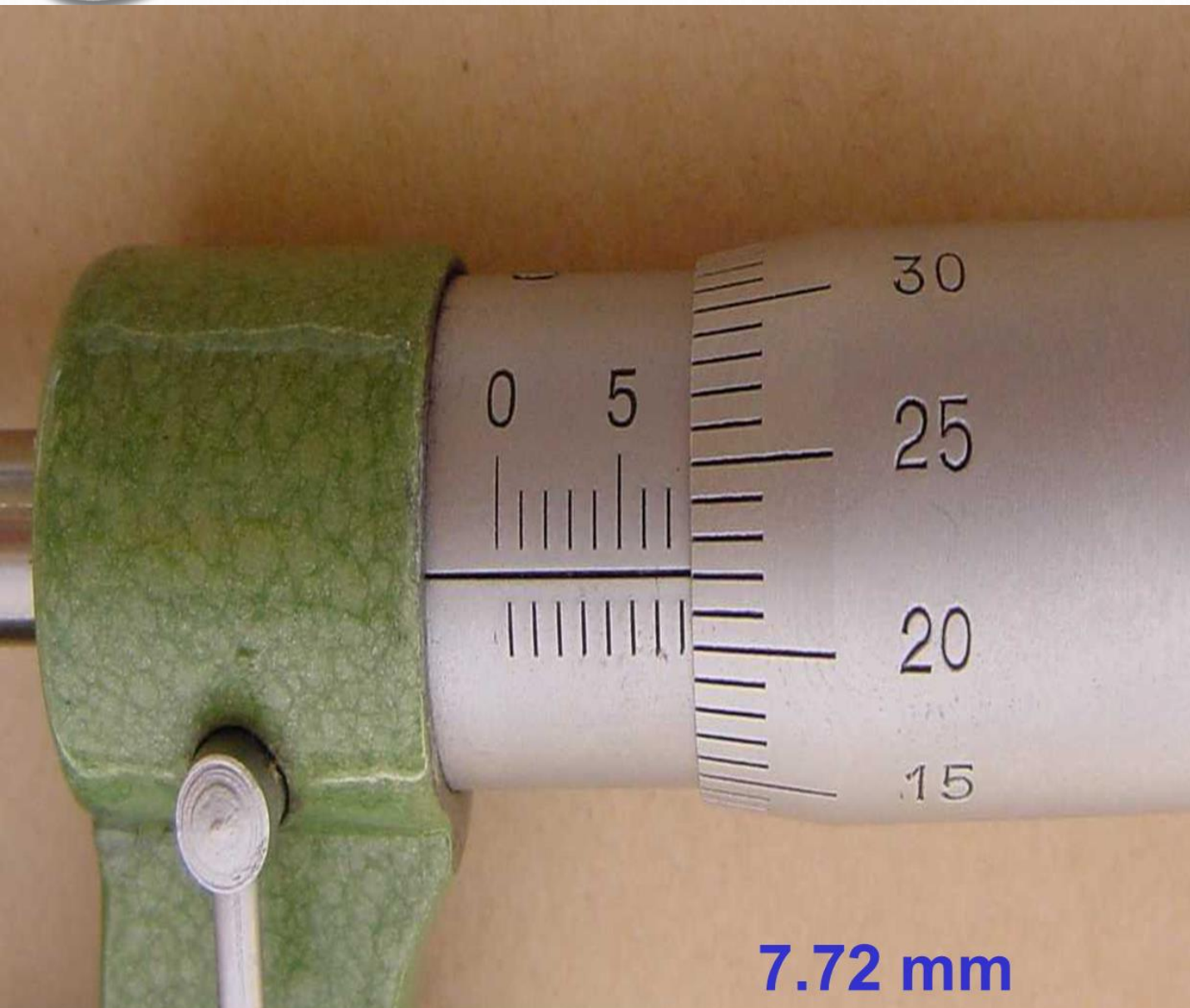


Micrometer reading



- **Whole millimeter marks:** $10 \times 1 \text{ mm} = 10.00 \text{ mm}$
- **Half millimeter marks:** $1 \times .50 \text{ mm} = .50 \text{ mm}$
- **Thimble Reading:** $16 \times .01 \text{ mm} = .16 \text{ mm}$
- **Reading = 10.66 mm**

Micrometer reading



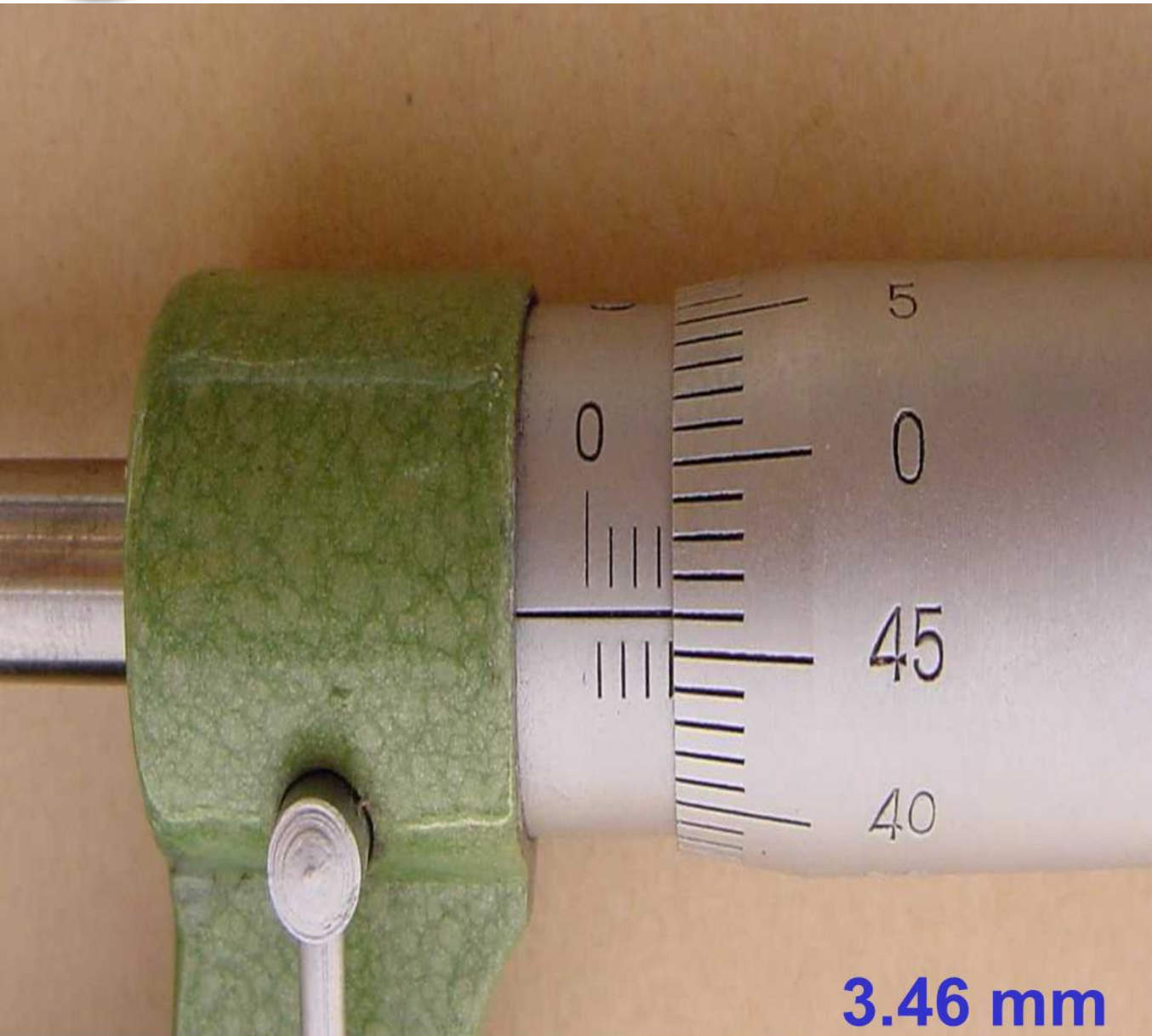
- **Whole millimeter marks:** $7 \times 1 \text{ mm} = 7.00 \text{ mm}$
- **Half millimeter marks:** $1 \times .50 \text{ mm} = .50 \text{ mm}$
- **Thimble Reading:** $22 \times .01 \text{ mm} = .22 \text{ mm}$
- **Reading = 7.72 mm**

Micrometer reading



- **Whole millimeter marks:** $3 \times 1 \text{ mm}$
 $= 3.00 \text{ mm}$
- **Half millimeter marks:** $0 \times .50 \text{ mm}$
 $= 0 \text{ mm}$
- **Thimble Reading:** $9 \times .01 \text{ mm}$
 $= .09 \text{ mm}$
- **Reading = 3.09 mm**

Micrometer reading



- **Whole millimeter marks:** $3 \times 1 \text{ mm} = 3.00 \text{ mm}$
- **Half millimeter marks:** $0 \times .50 \text{ mm} = 0 \text{ mm}$
- **Thimble Reading:** $46 \times .01 \text{ mm} = .46 \text{ mm}$
- **Reading = 3.46 mm**

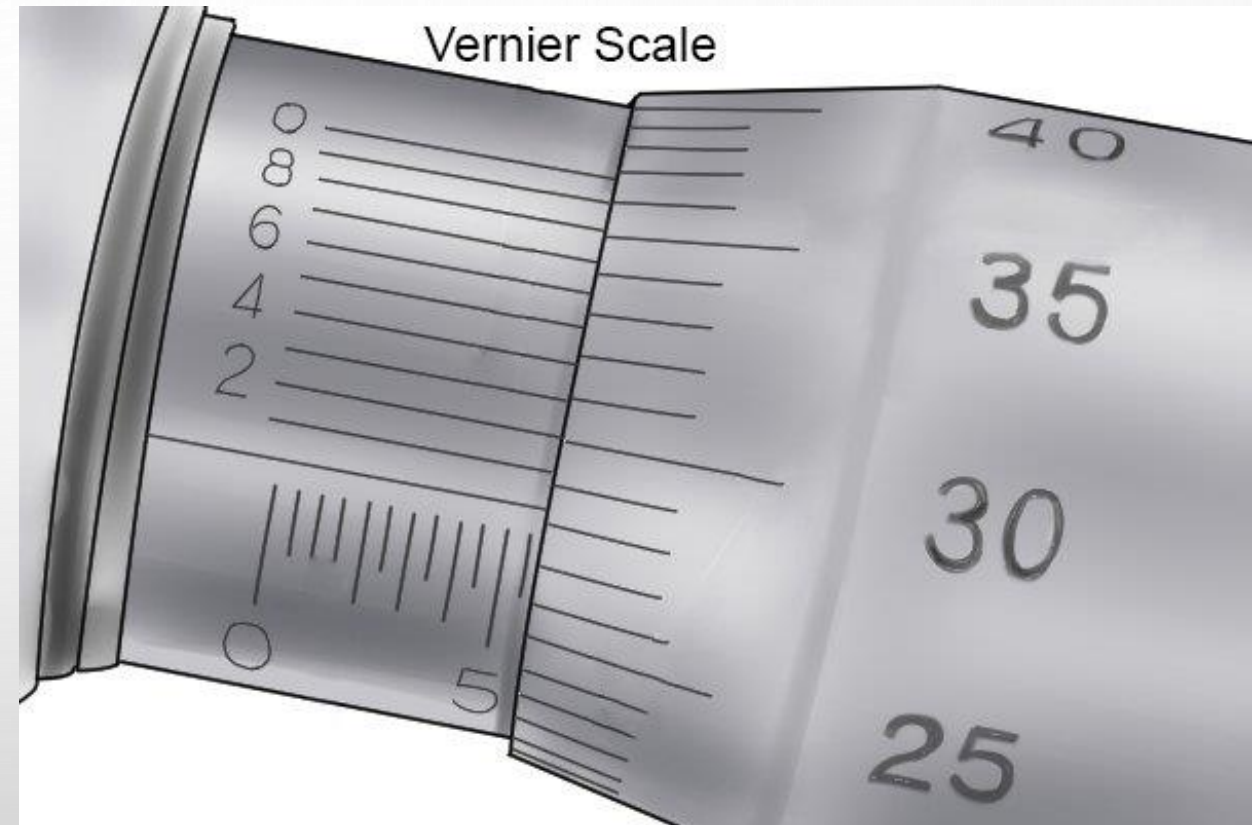
Micrometer reading



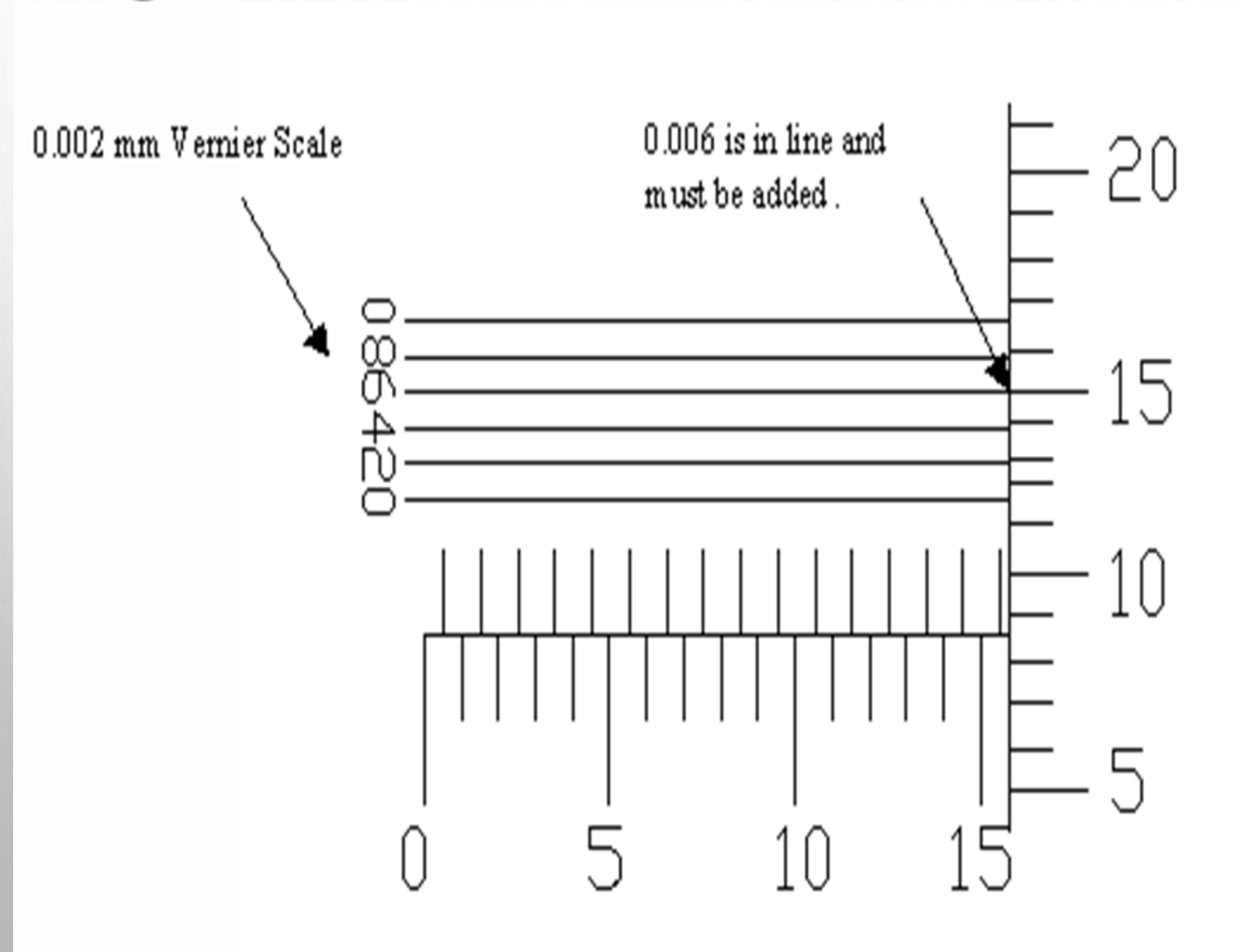
- **Whole millimeter marks:** $3 \times 1 \text{ mm} = 3.00 \text{ mm}$
- **Half millimeter marks:** $1 \times .50 \text{ mm} = 0.5 \text{ mm}$
- **Thimble Reading:** $6 \times .01 \text{ mm} = .06 \text{ mm}$
- **Reading = 3.56 mm**

Vernier Micrometer

- Has the **ability to measure to two thousandths of a millimeter (0.002-mm)**.
- The **vernier is graduated in increments of 0.002 mm starting and ending with 0**.
- If either 0 on the vernier graduation scale lines up with the thimble reading, **no additional thousandths of a millimeter are added to the reading**.

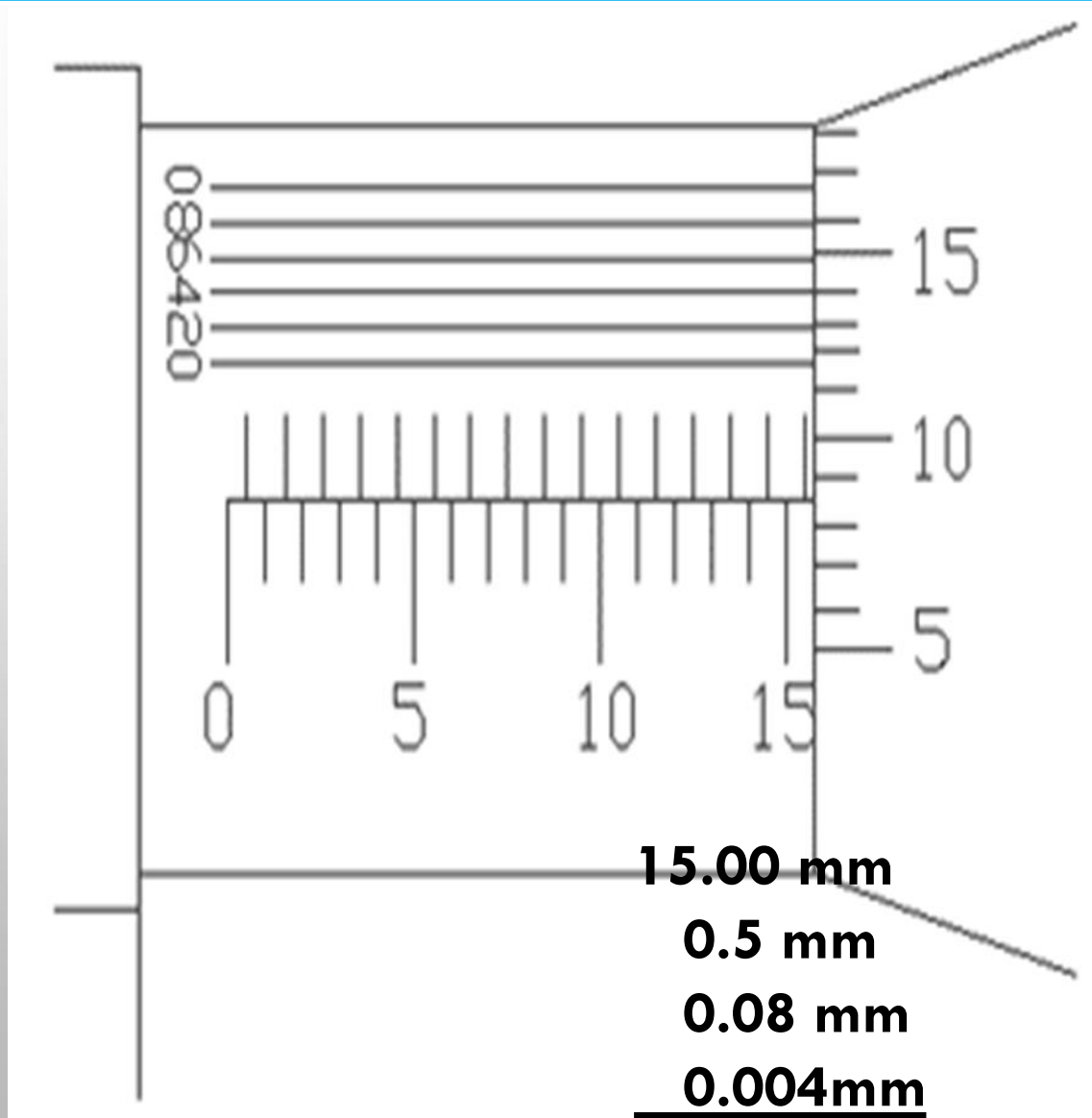


Reading Vernier Micrometer

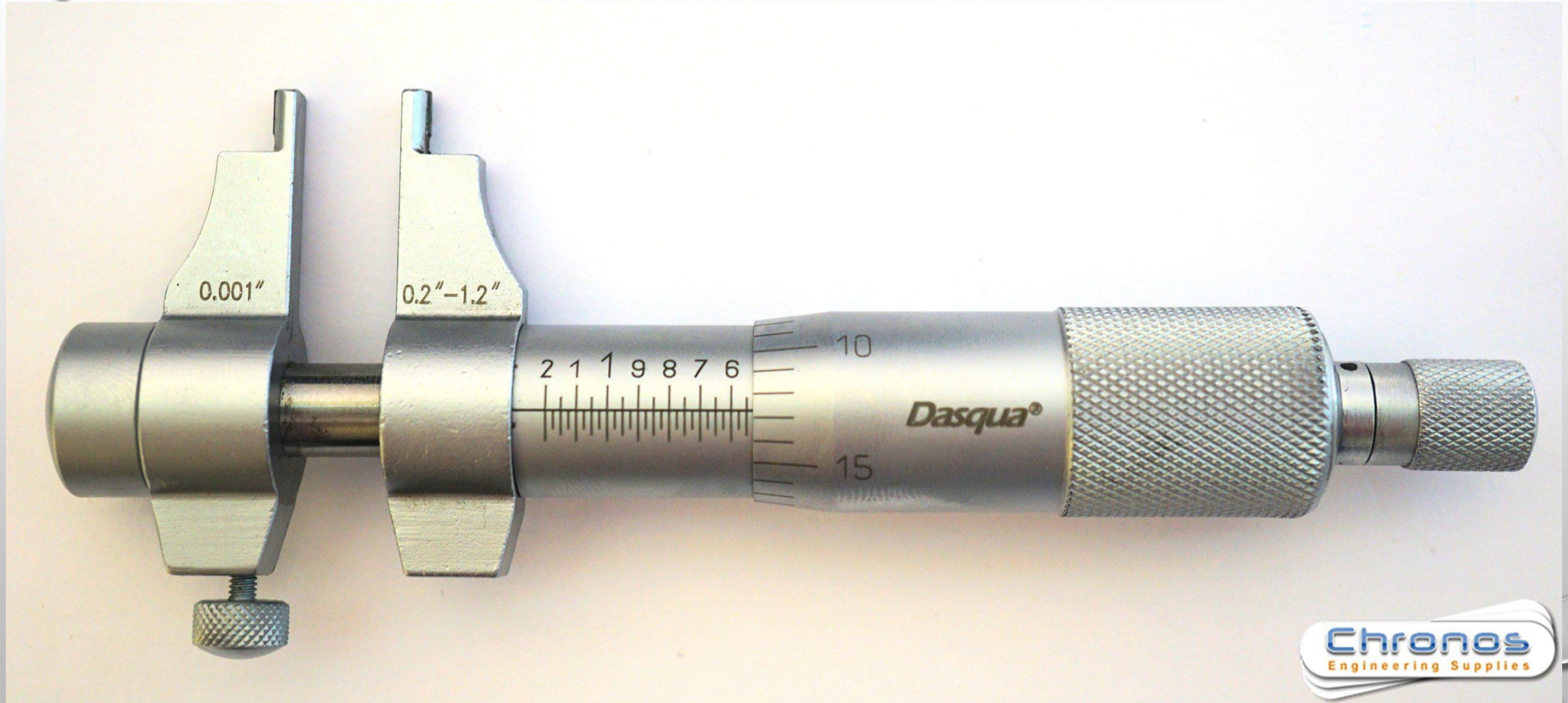


15mm
0.5mm
0.08mm
0.006mm
15.586mm

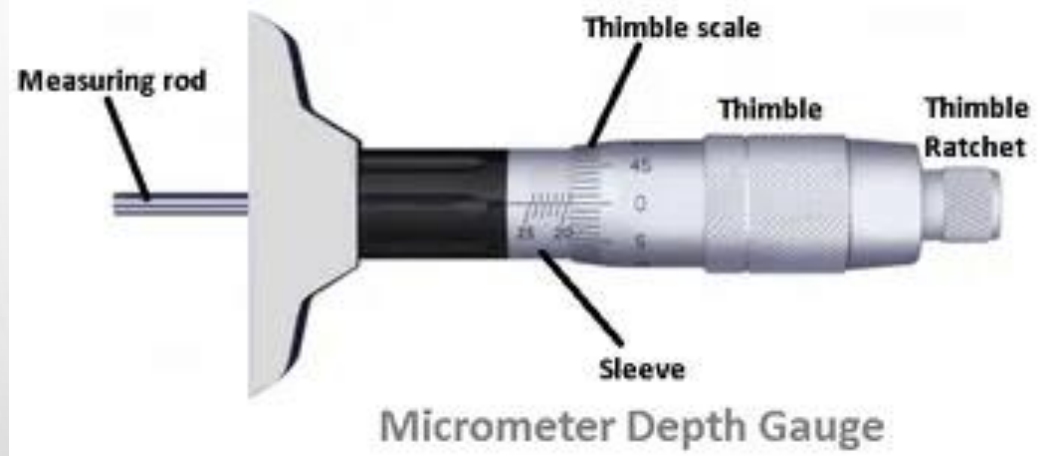
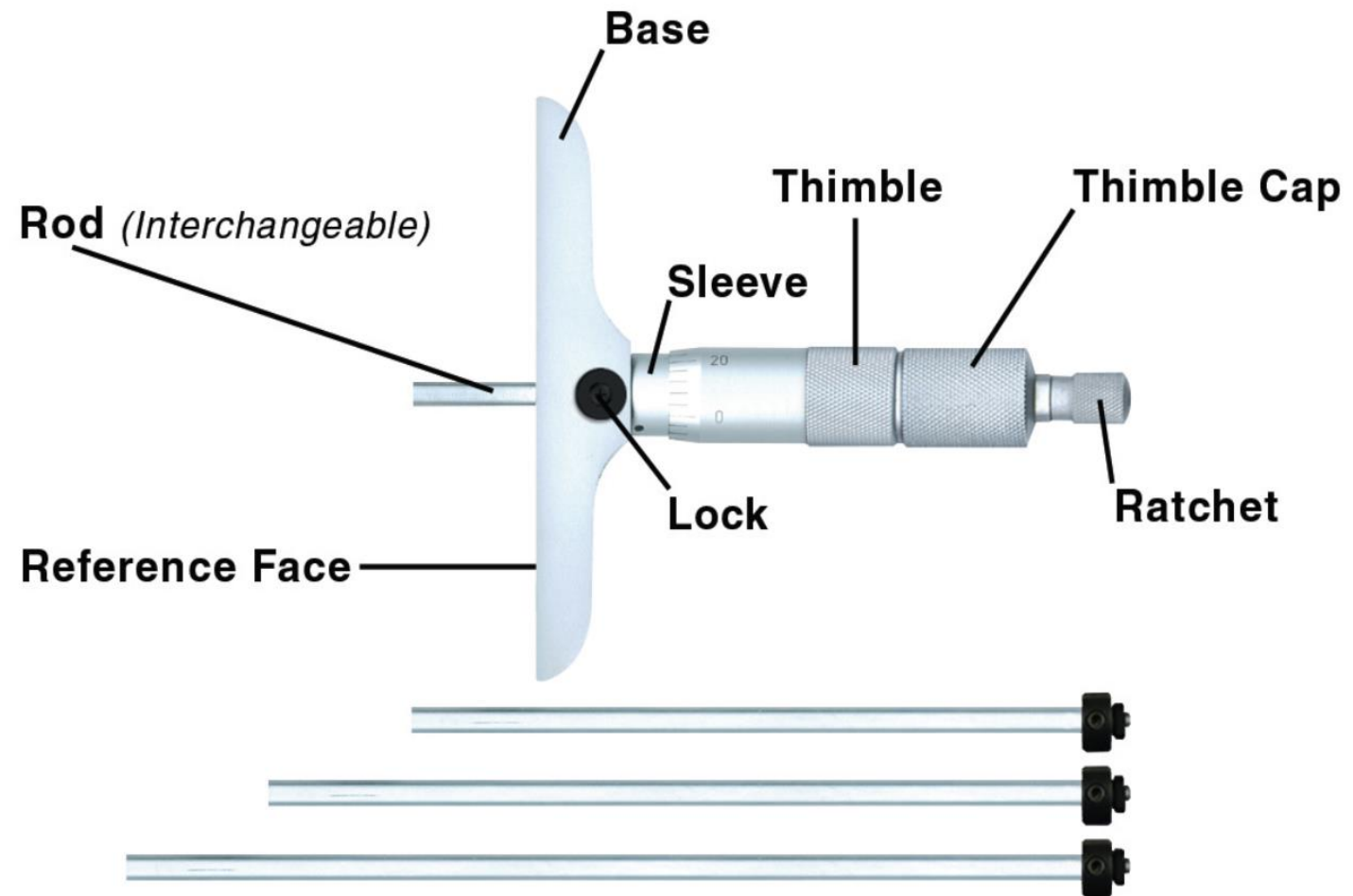
Reading Vernier Micrometer

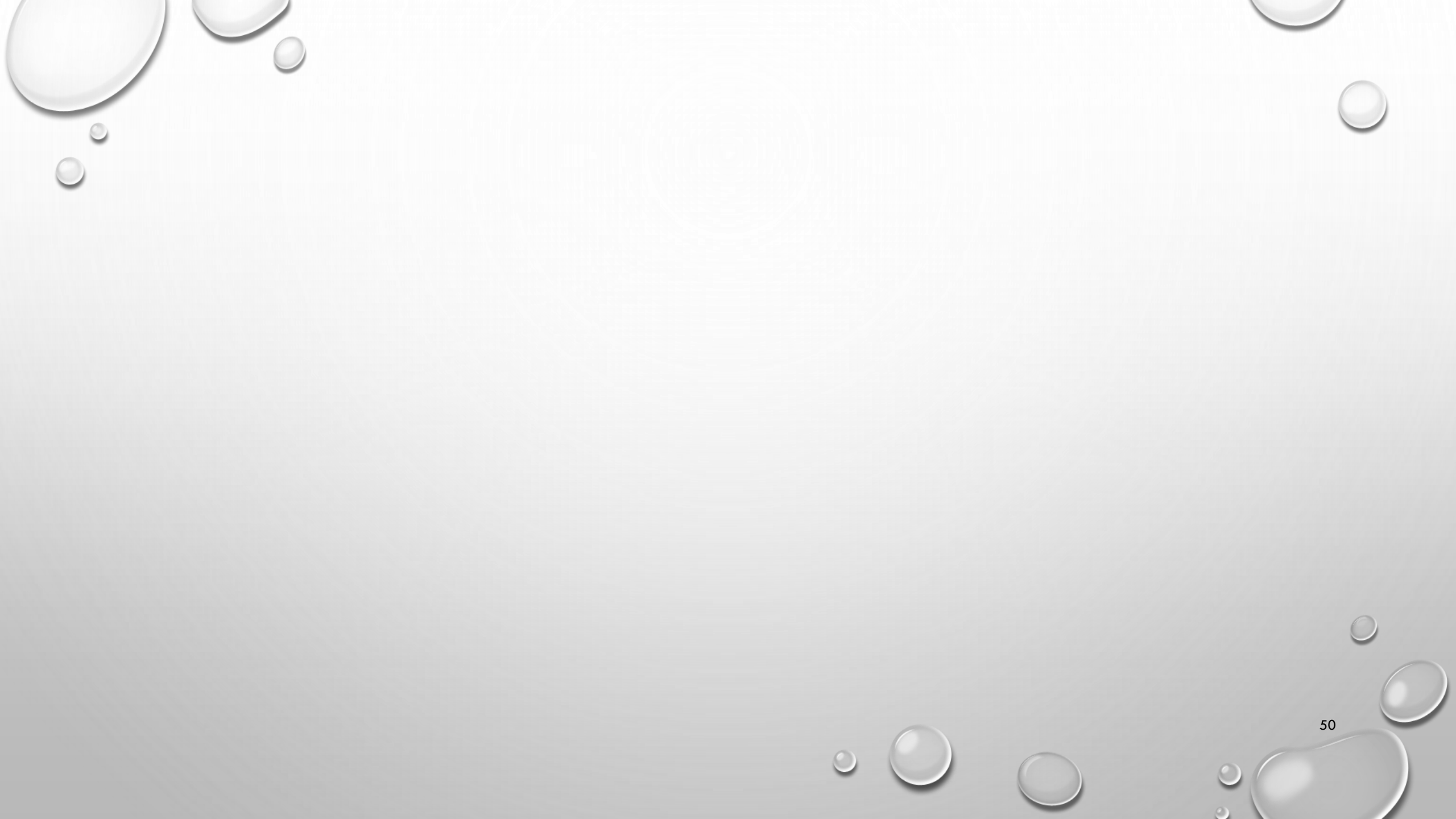


Inside micrometer



Depth micrometer





3. Layout

- Transferring of information from a working drawing to metal surfaces.
- Making of lines, circles, arcs and points on metal surfaces for drilling holes or making cuts.



Layout tools

Layout Dye

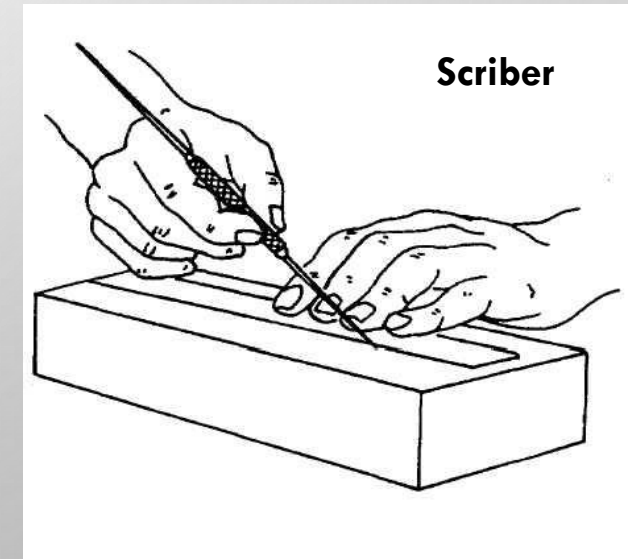
- Is a fast-drying coloured liquid.
- Is brushed onto a work-piece to prepare it for laying out guide lines.

Scriber

- Is a **sharp-pointed tool used for scribing lines** on metal pieces.
- are available in different size and shape.

Vernier height gauge

- Is **used for measuring height of an object or for marking lines on metal** of given distance from a datum base.
- Always used on a surface plate.



Layout tools

Surface plate (bench plate)

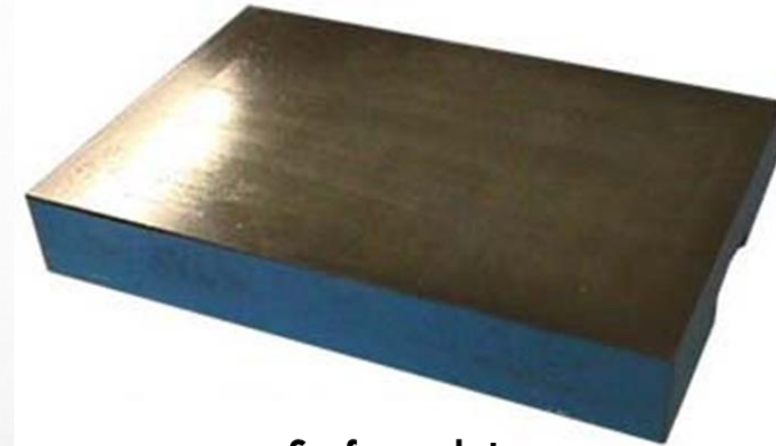
- Used as **accurate reference for layout** or inspection.
- They **should never be used for any job** that might damage or nick the surface.

Combination Square

- Consists of a steel rule, level, and 90 and 45 degree angles.
- Used to layout markings on metal.

V-block

- Used to **support round work for layout** work and inspection.



Surface plate



Combination Square



V-Block

Layout tools

Center Punch

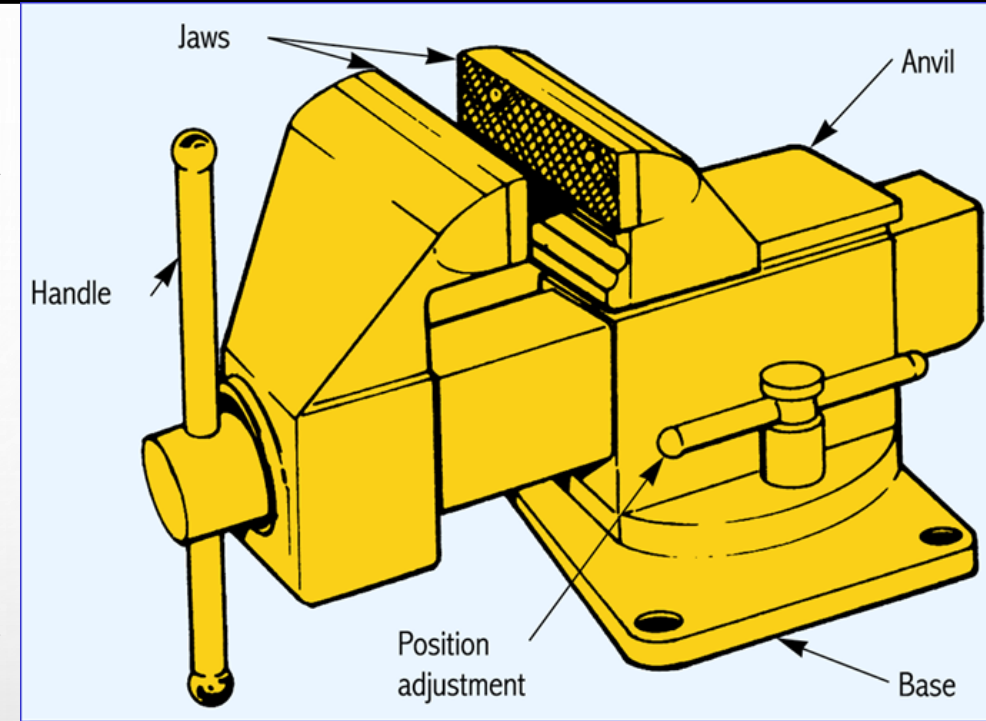
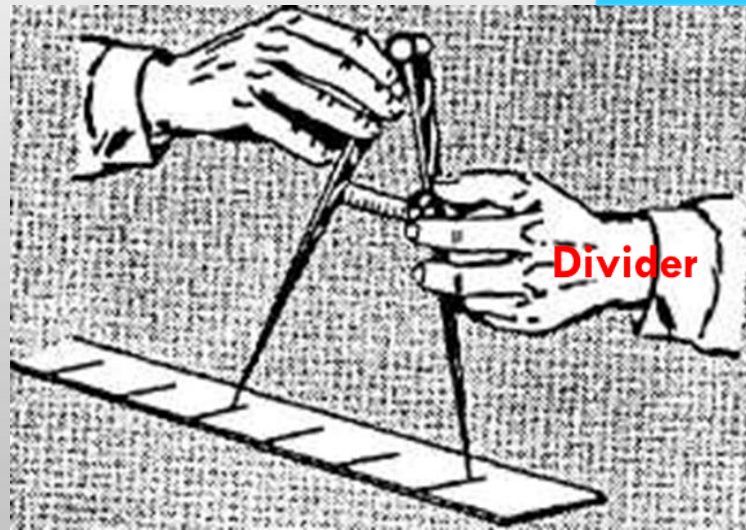
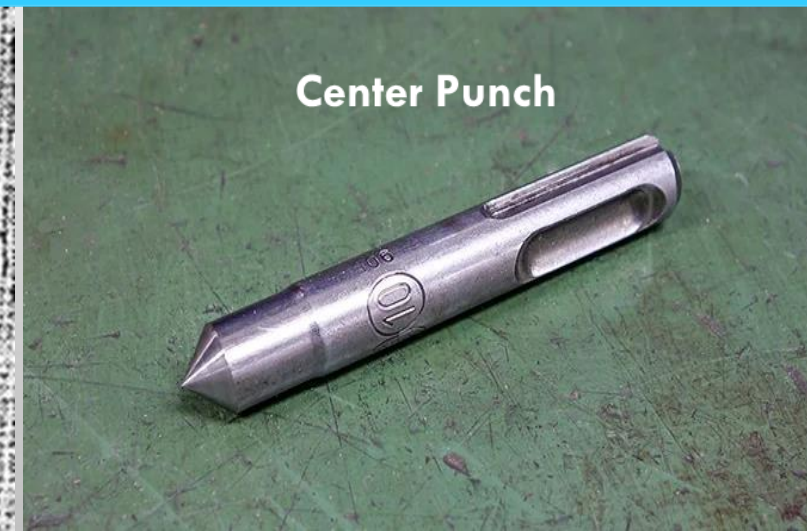
- Is used to **enlarge a mark for a drill** to follow in order to prevent wandering of the drill bit.

Divider

- Used to **transfer a dimension from a rule to the metal.**
- Used to **make circles or arcs** and to space holes or other dimensions on metal.

Vise

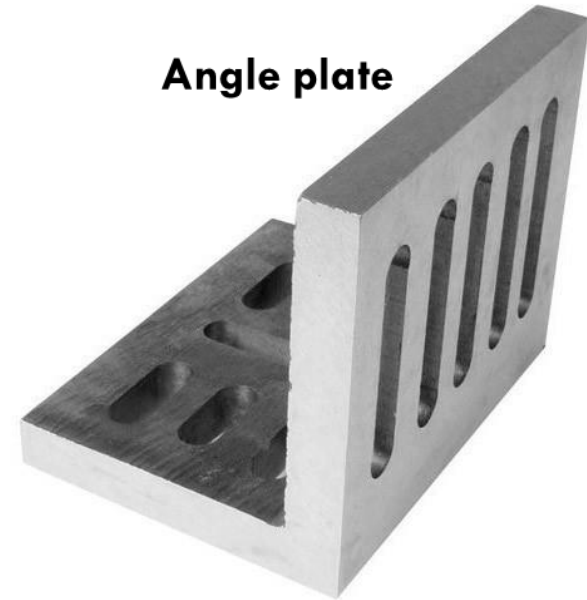
- Is a metal tool with movable jaws which are **used to hold an object firmly in place while work is done on it**, typically attached to a workbench.



Layout tools

Angle plate

- Used as a fixture for holding work which is to be laid out, inspected or machined.
- Used for supporting or setting up work vertically.

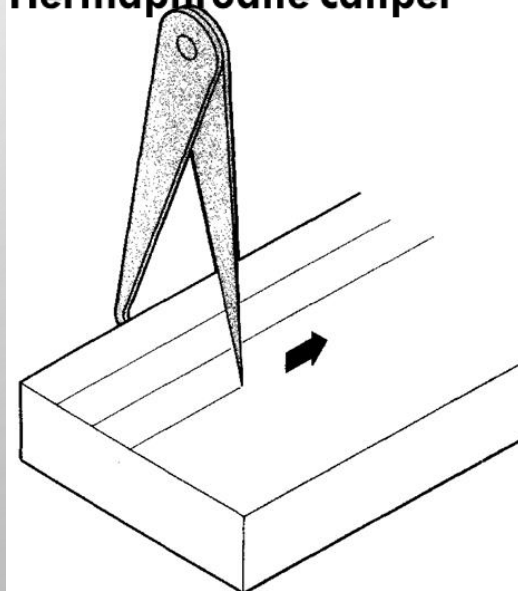


Angle plate

Hermaphrodite caliper

- Used to scribe a line a set distance from the edge of work-piece.

Hermaphrodite caliper



Prick Punch

- Is used to transfer directly from the drawing to the sheet metal.
- Used to mark the location of holes after the lines have been scribed.

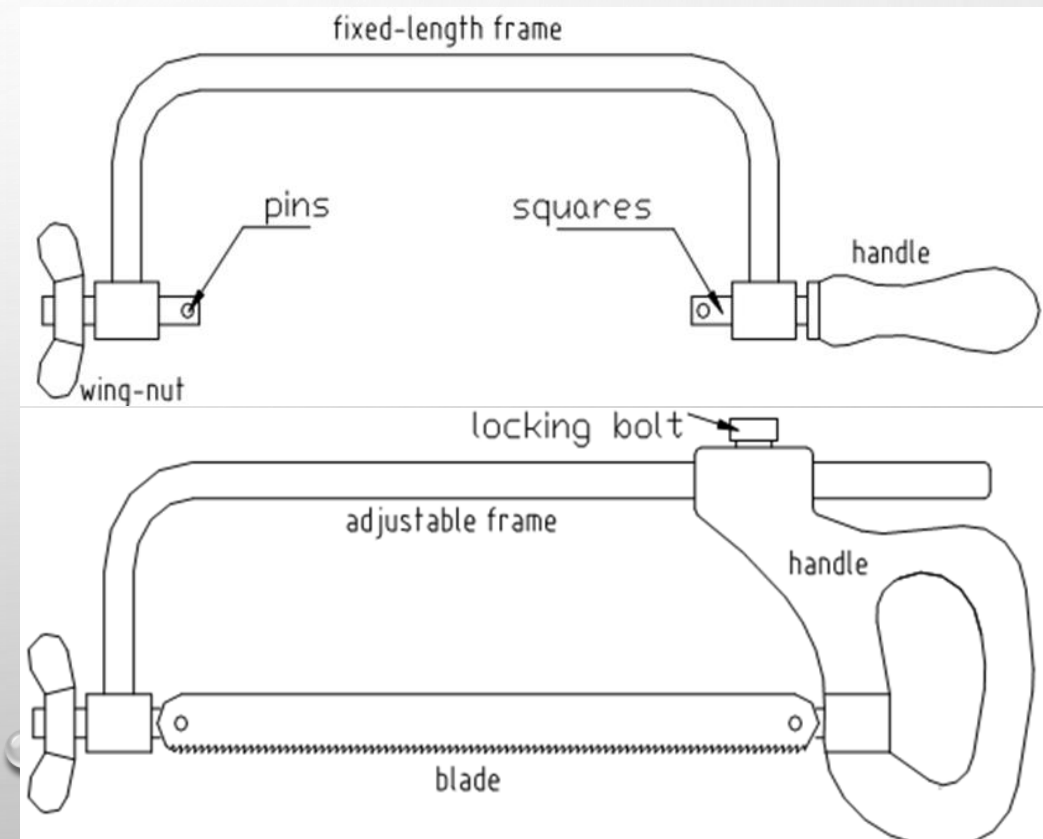


Prick Punch

Layout tools

Hand sawing

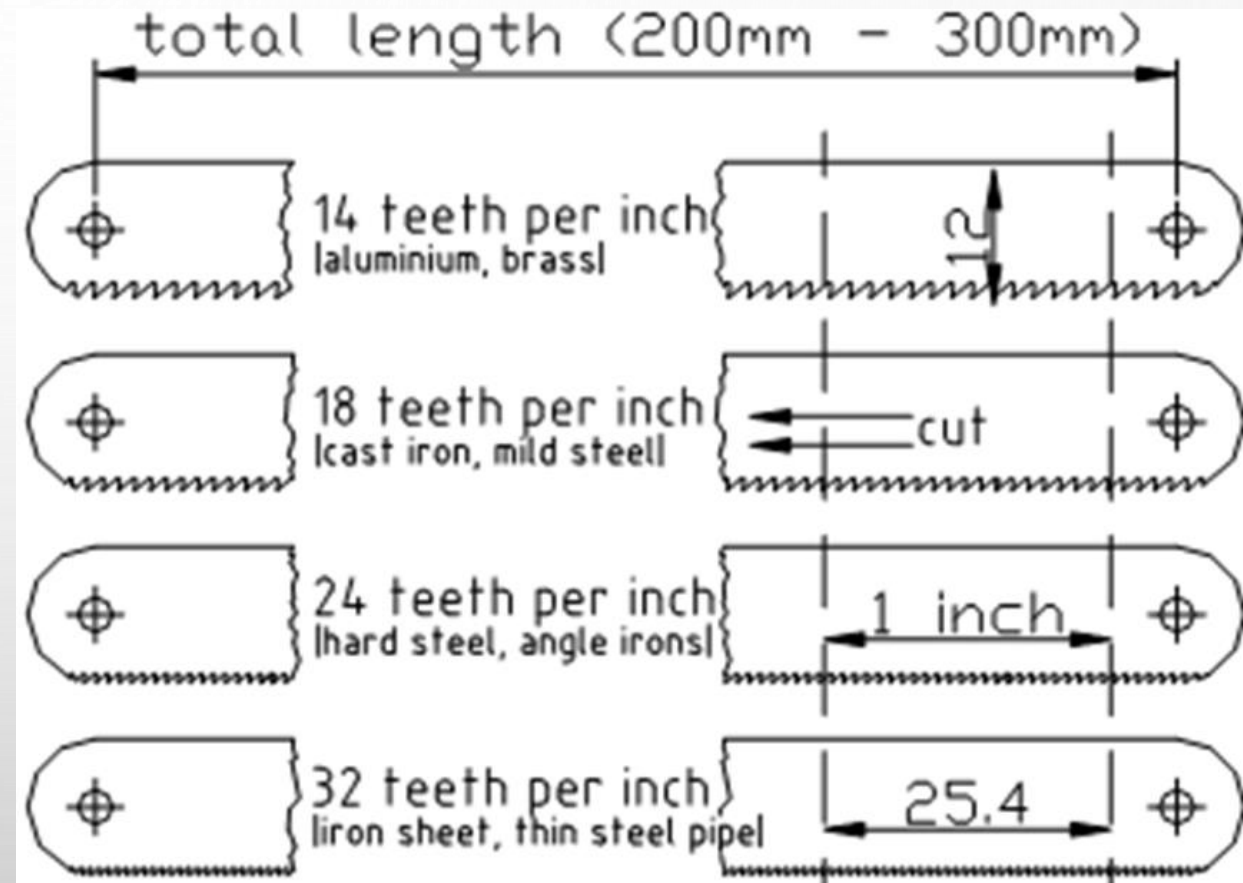
- **Sawing is a process of cutting metal stock** that is impractical to use a file, a chisel or a machine.
- **A hacksaw is a saw with a frame and a blade** designed for cutting metal.
- There are two types of frame:
 - **Fixed length**
 - **Adjustable**



Layout tools

Hacksaw blade

- Hacksaw blades vary in type and size
 - **All-hard blades** are hardened throughout and are **used for sawing heavy work, tool steel, cast iron, and brass.**
 - **Flexible blades** are hardened only the teeth and are **used for sawing light and hollow materials.**
- Hand hacksaw blades are made in 8 inch, 10 inch and 12 inch lengths, with 14, 18, 24, or 32 teeth per inch.



Layout tools

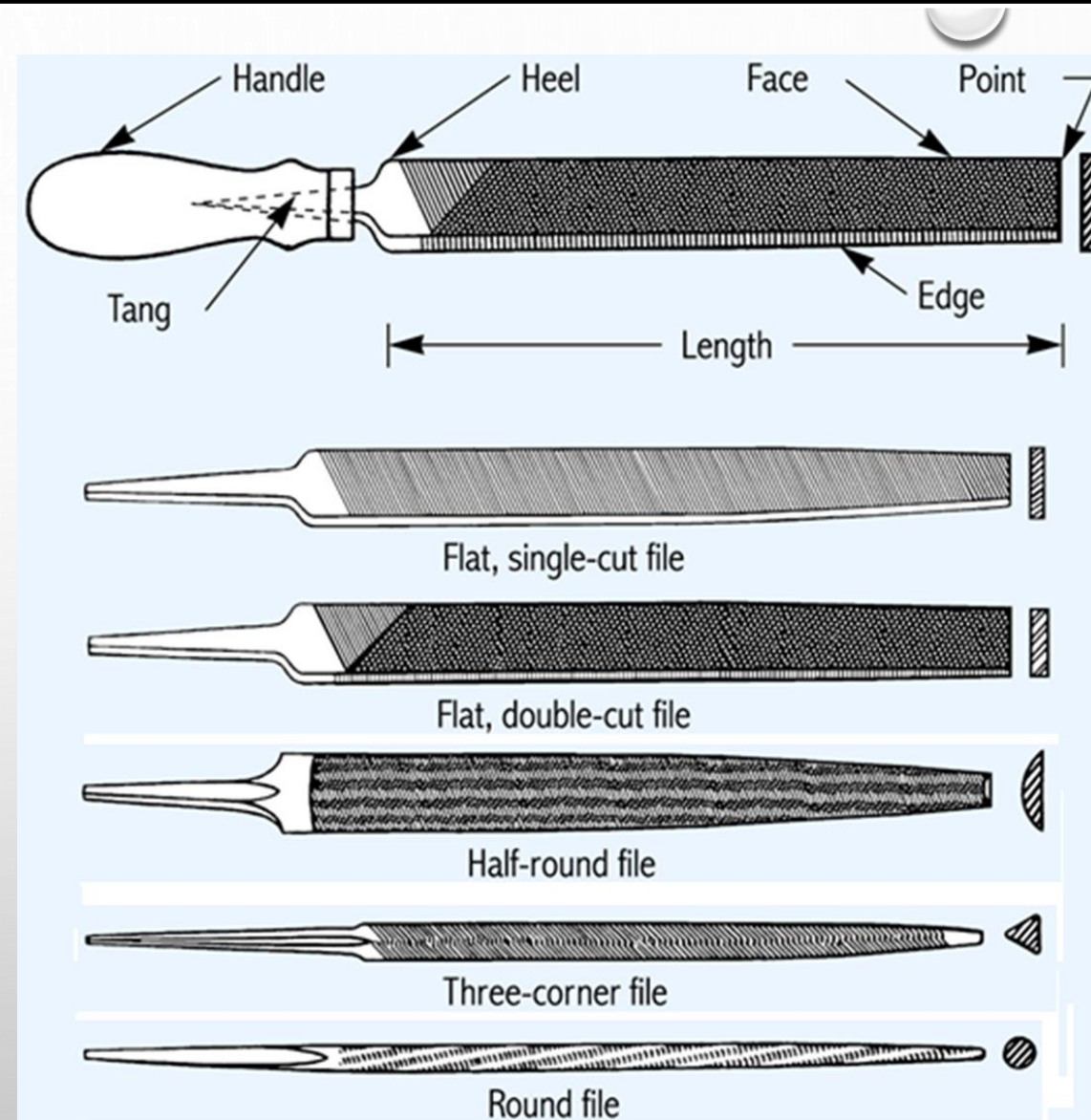
Using a Hacksaw

Press down lightly on the forward stroke. Use 50-60 strokes per minute.



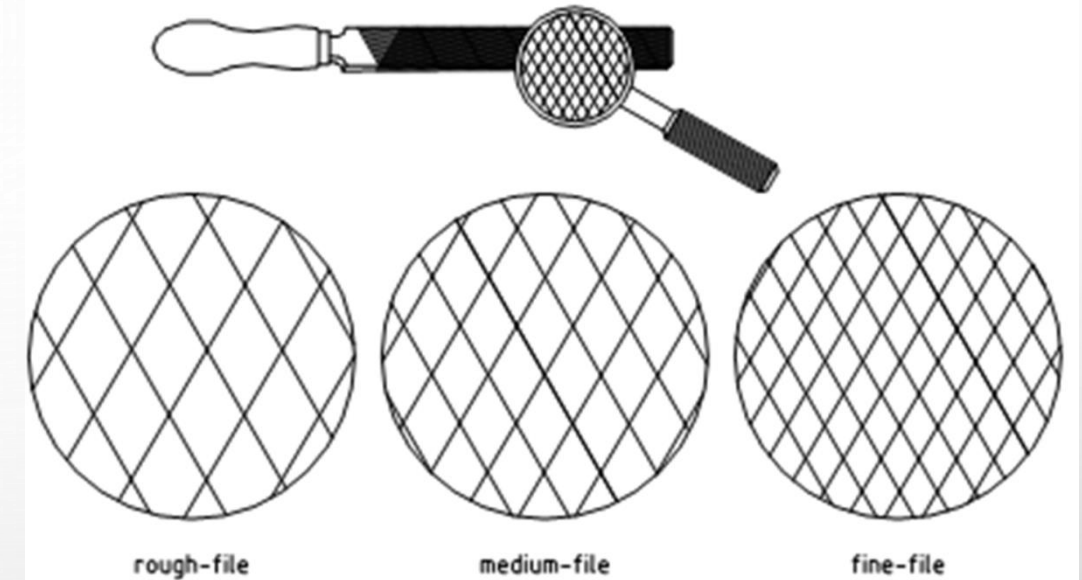
Files

- A file is made of hardened high-carbon steel, with flat or rounded surfaces that are made rough with teeth or grit.
- They are used for smoothing surfaces or sharpening metal objects.
- Files come in various shapes and sizes and in various sizes of cuts.
 - A file with straight teeth all going in the same direction is a **single cut file**.
 - A file with teeth in two directions is known as a **double cut file**.

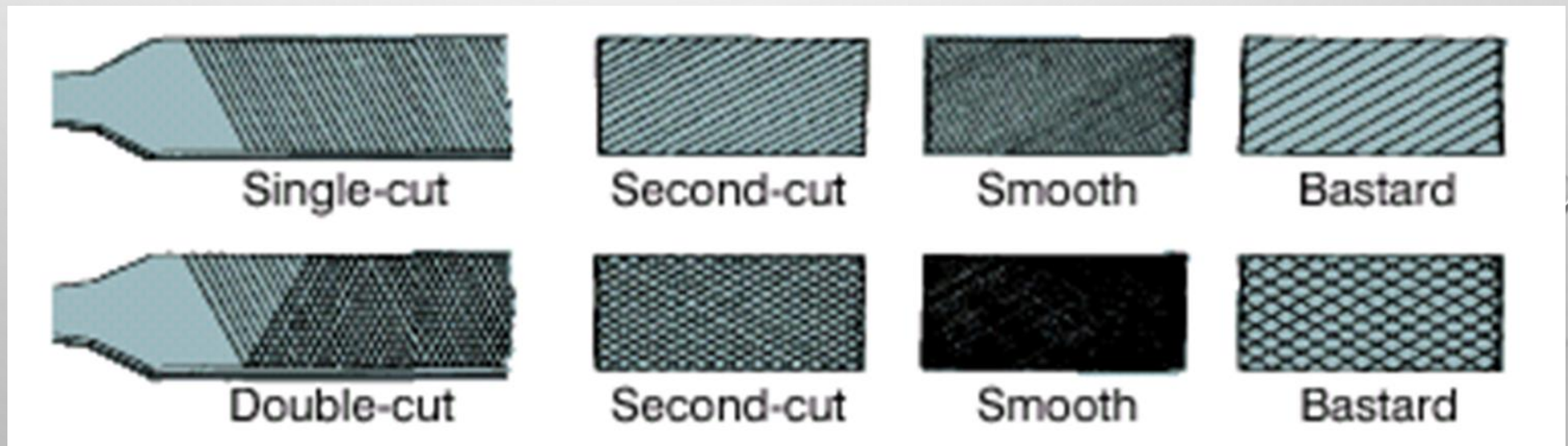


Files

- Both single cut and double cut files are made in different degrees of coarseness.
- Rough, middle, bastard, second cut, and smooth are examples of coarseness.
- The coarseness also varies with the length of the file.



Cuts of a File



Files

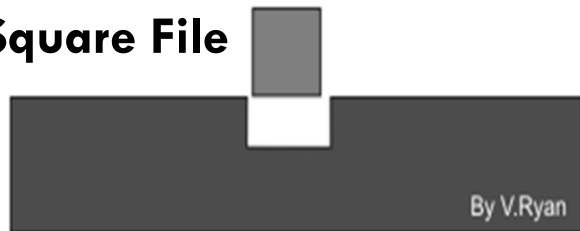
- Common files are flat, rasp, half round, round bastard, and taper triangular.
- **Flat files** are used for smoothing both wood and metal.
- **Rasp cut files** are used for smoothing coarse wood work.
- **Half round files** are used for both metal and wood.
- **Round bastard files** are used for enlarging and smoothing holes.
- **Taper triangular files** are used for filing saws or cleaning threads.



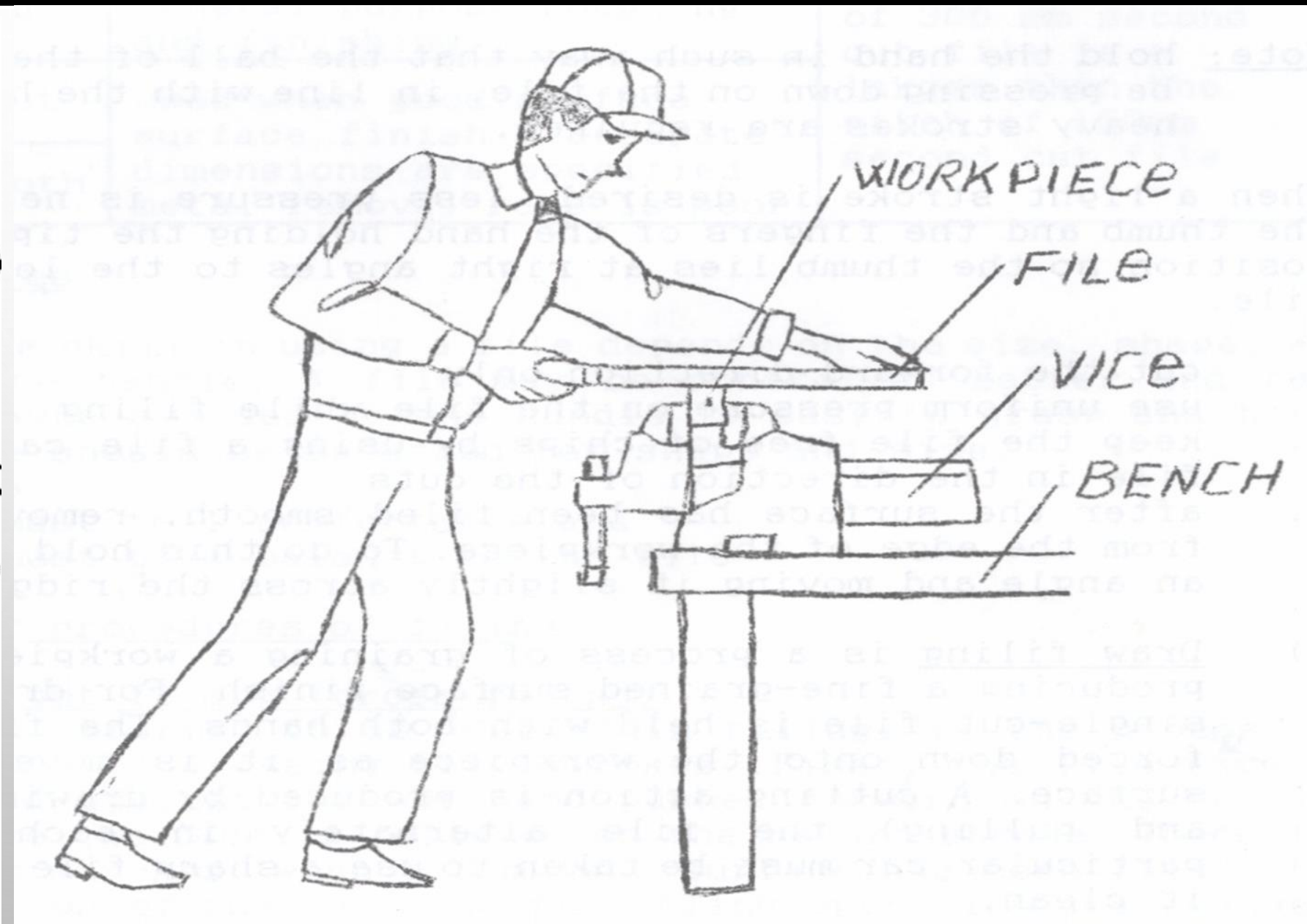
Files



Square File



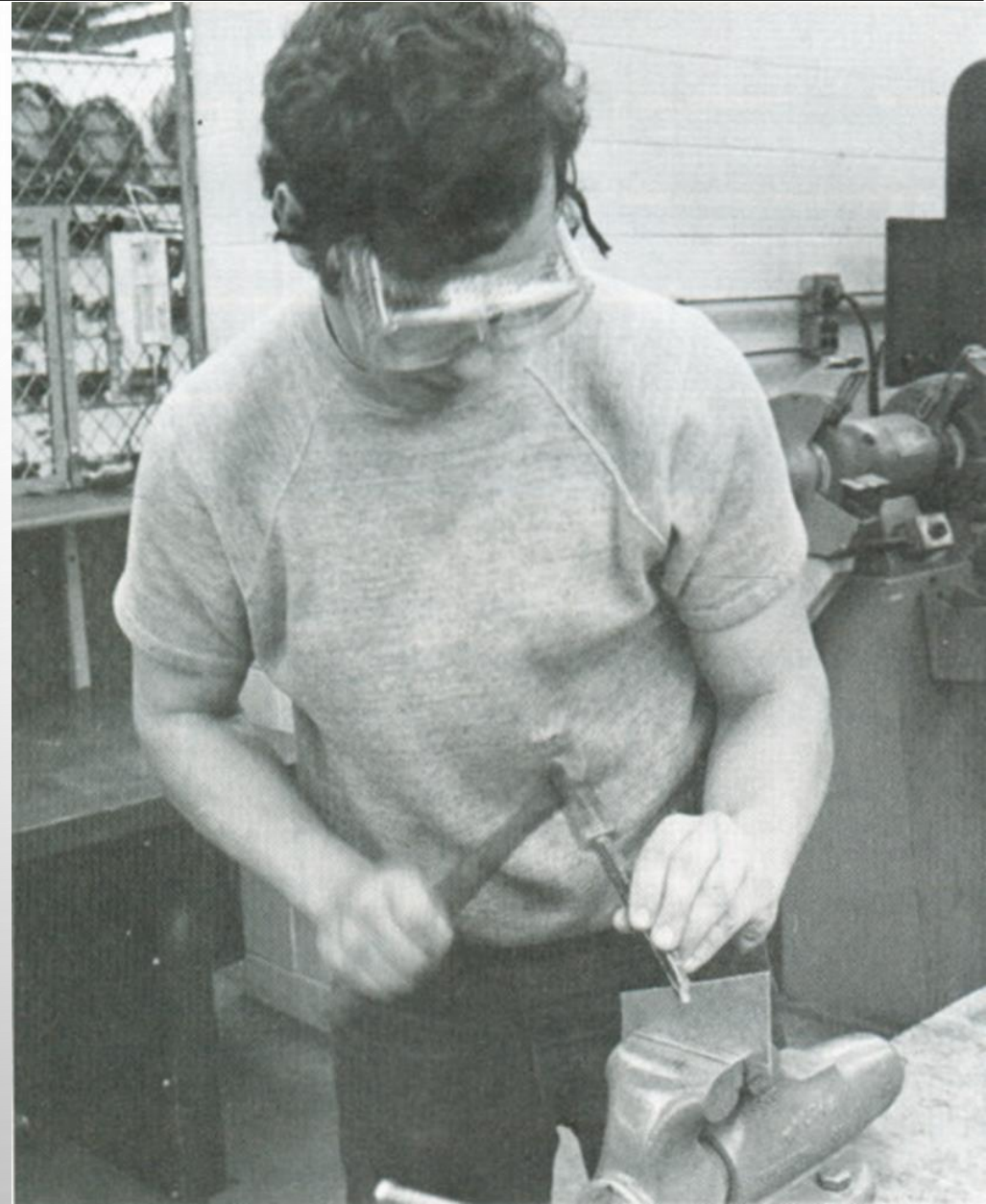
Files



Cold Chisels

- When using a cold chisel to cut cold metal, the chisel must be harder than the metal it is intended to cut.
- The four standard shapes for cutting edges for cold chisels are flat, cape, diamond-point, and half-round nose.

1. **Flat chisels:** are used for chipping, removing metal from a flat surface, and cutting sheet metal.



Cold Chisels

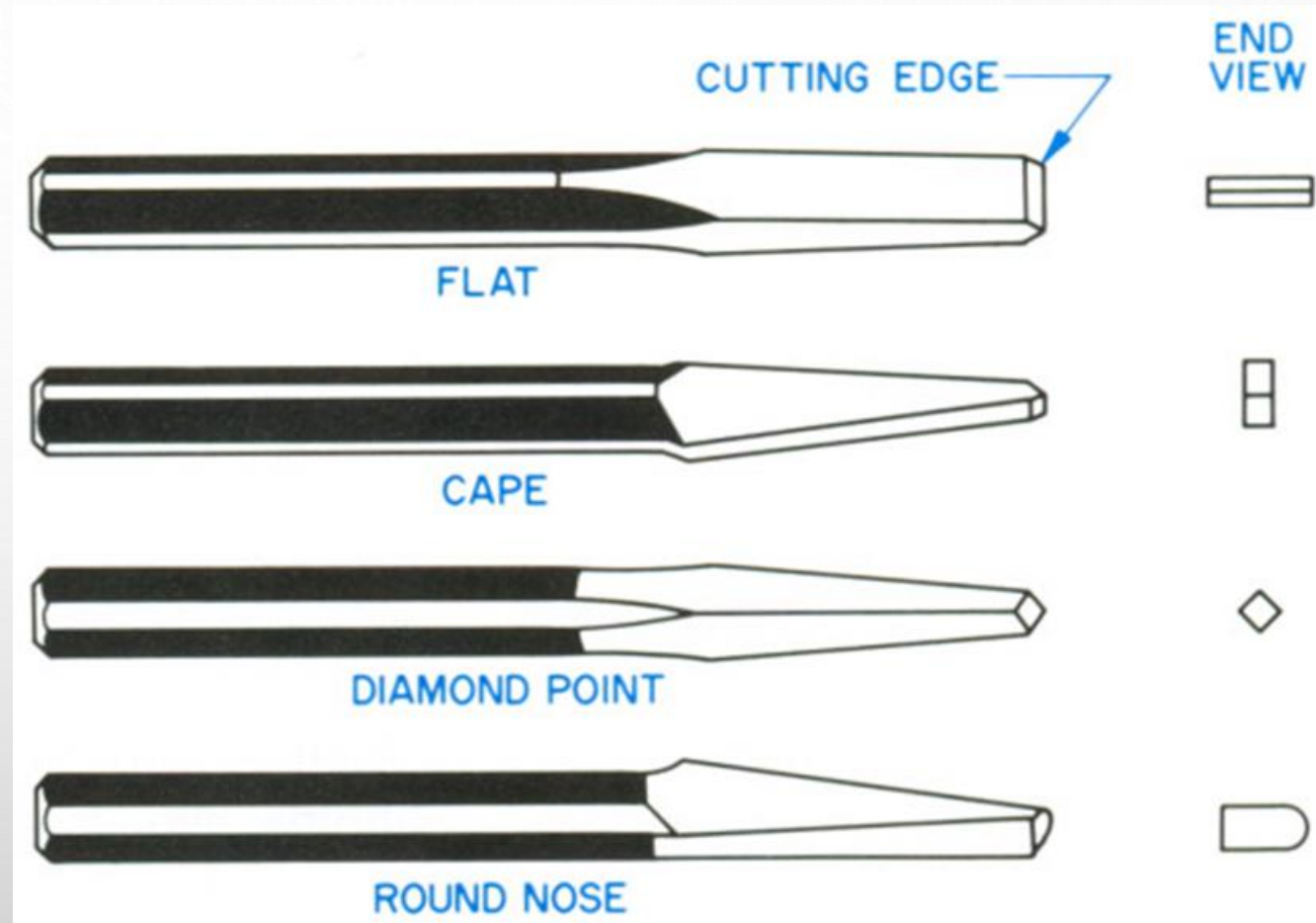
2. **Cape chisels:** are used for cutting narrow, flat grooves and slots.

3. **Round nose chisels:** are used to cut round corners and grooves.

4. **Diamond point chisels:** are used to cut v-shaped grooves and square inside corners.

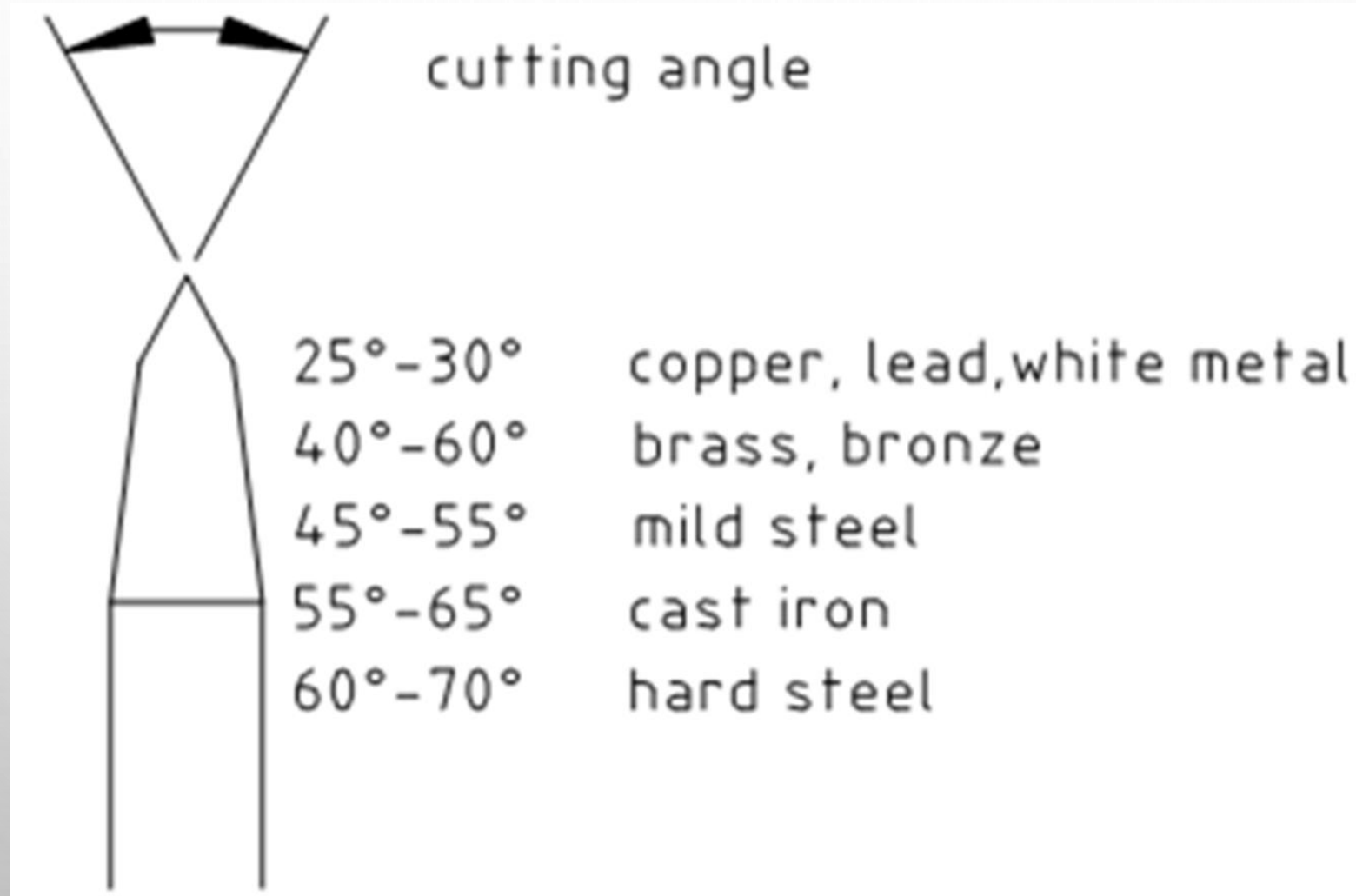


Cape chisels



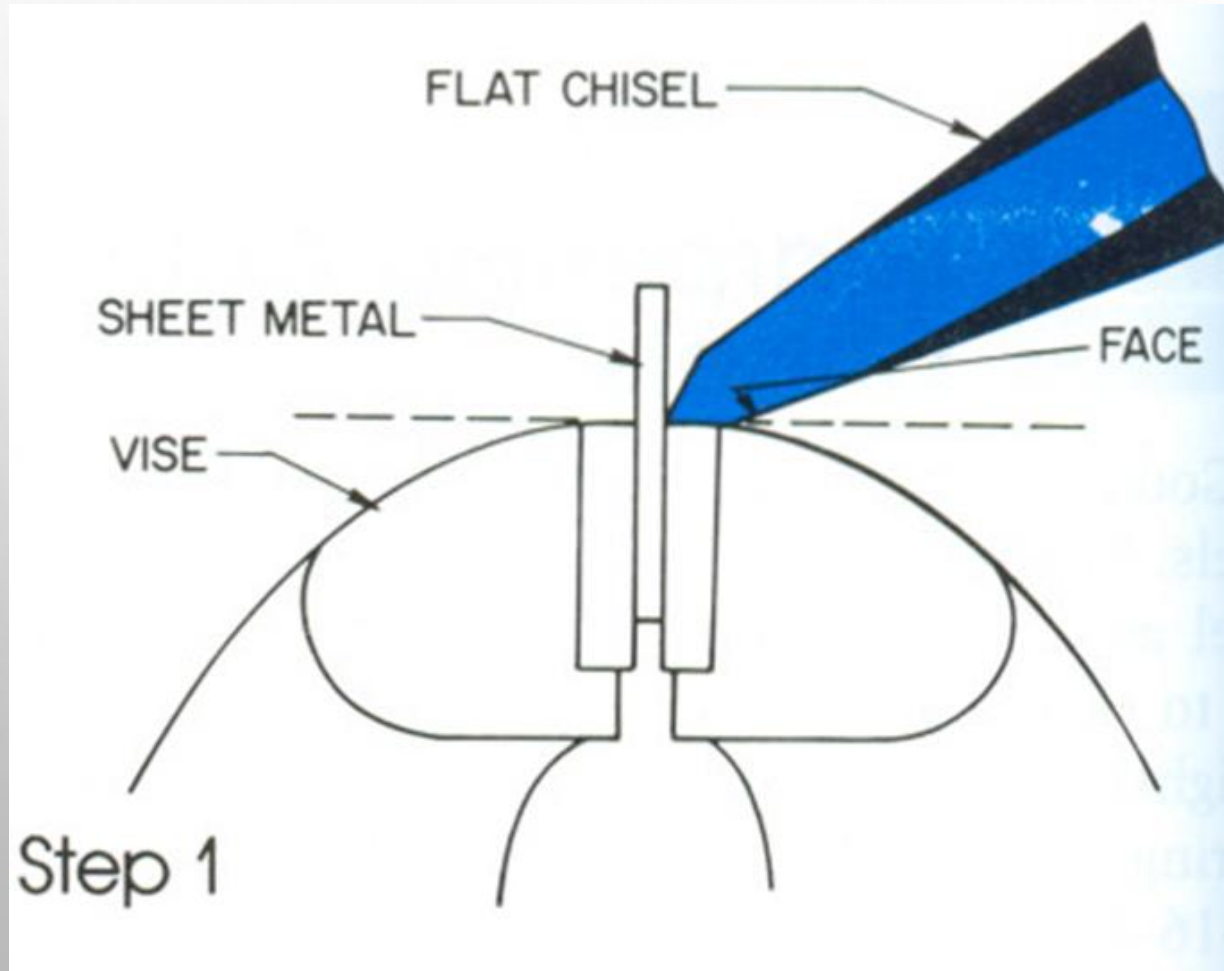
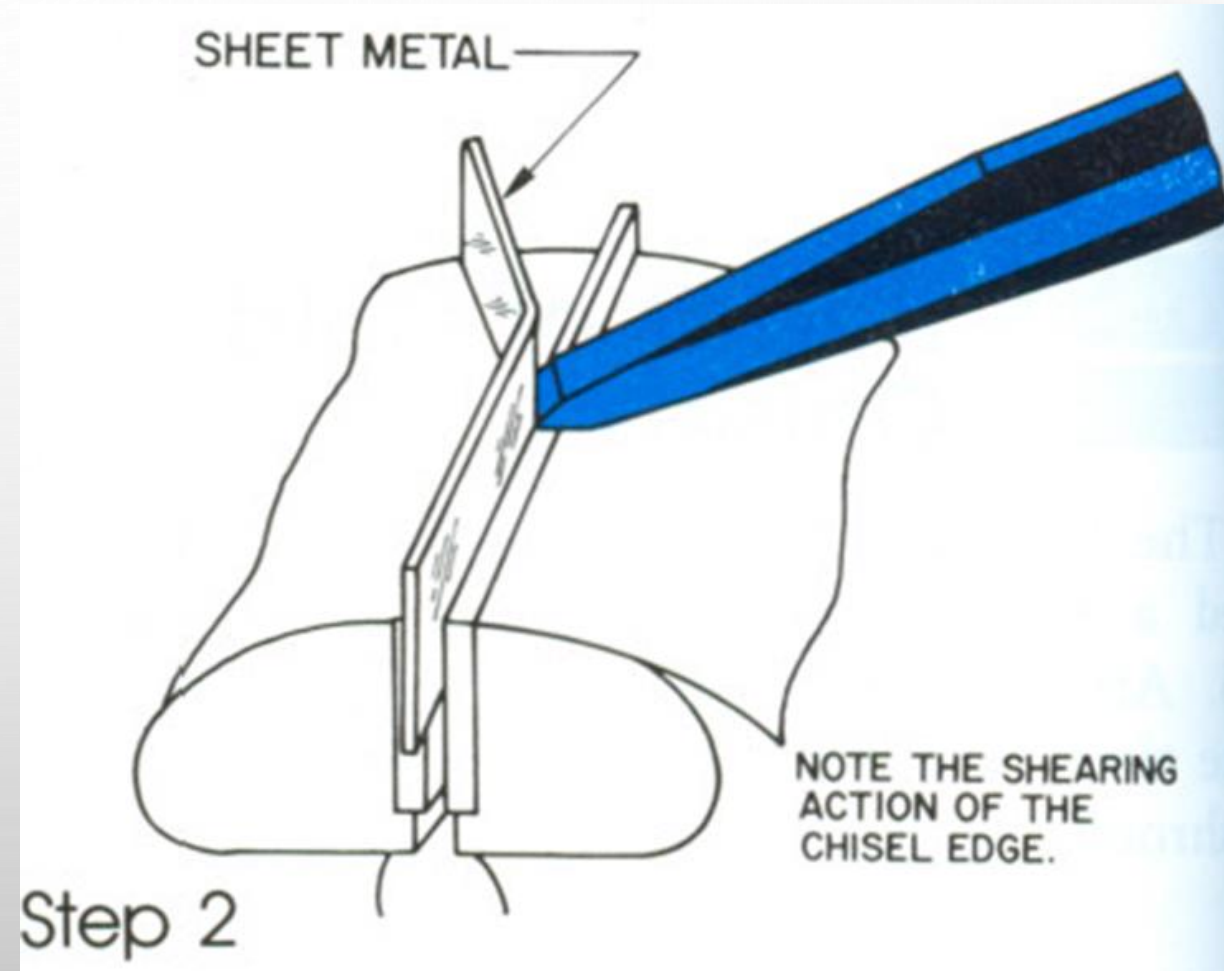
Cold Chisels

Cutting angle



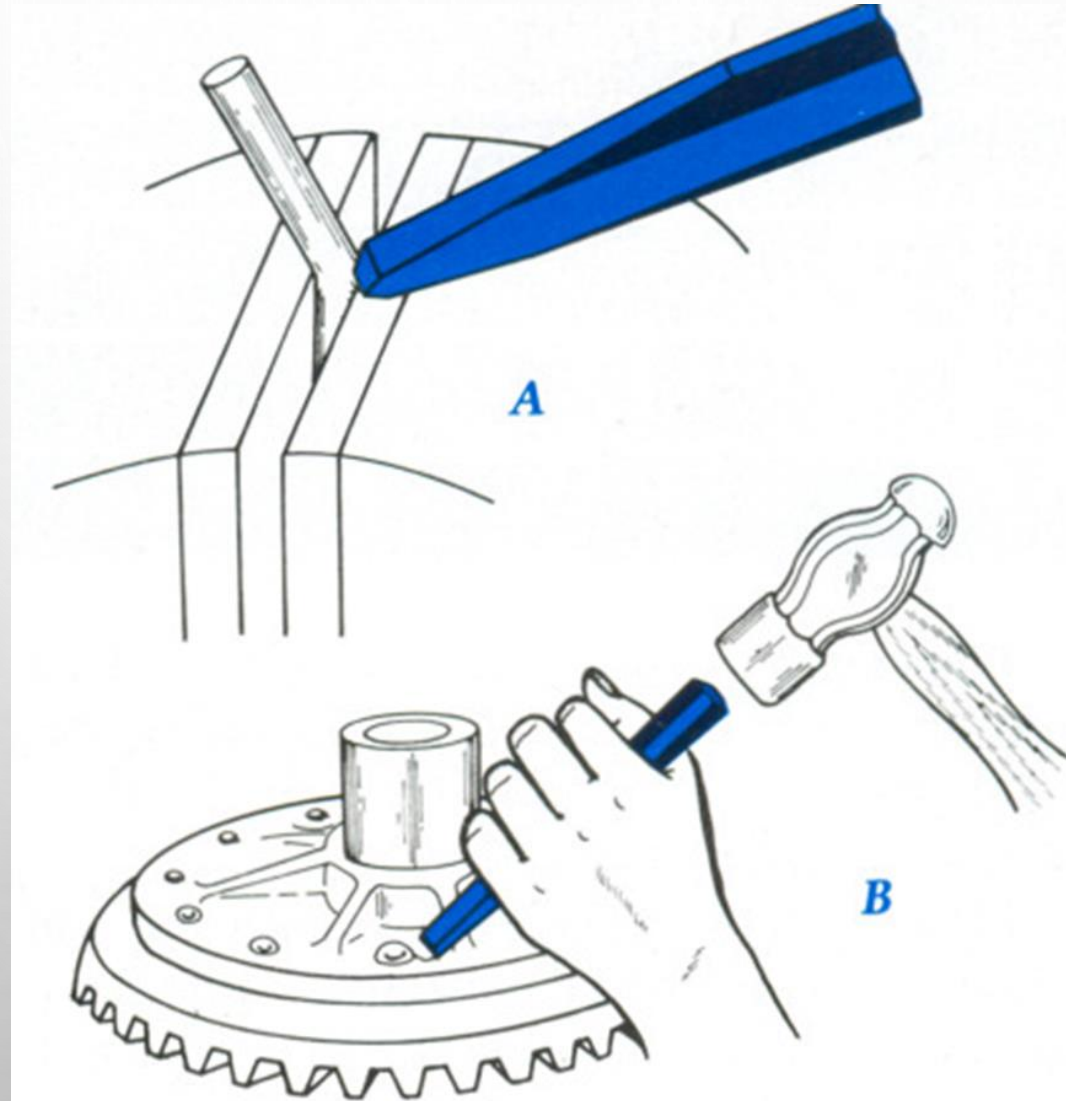
Cold Chisels

Shearing sheet metal



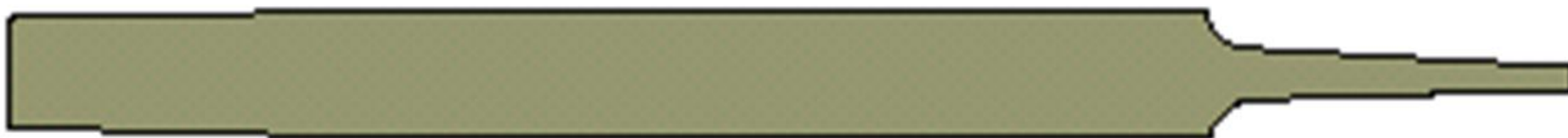
Cold Chisels

Cutting rods and rivets

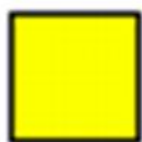




Tapered



Blunt



Square



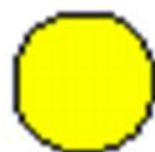
Pillar



Flat



Triangular



Circular



Half-Round



Knife



Oval