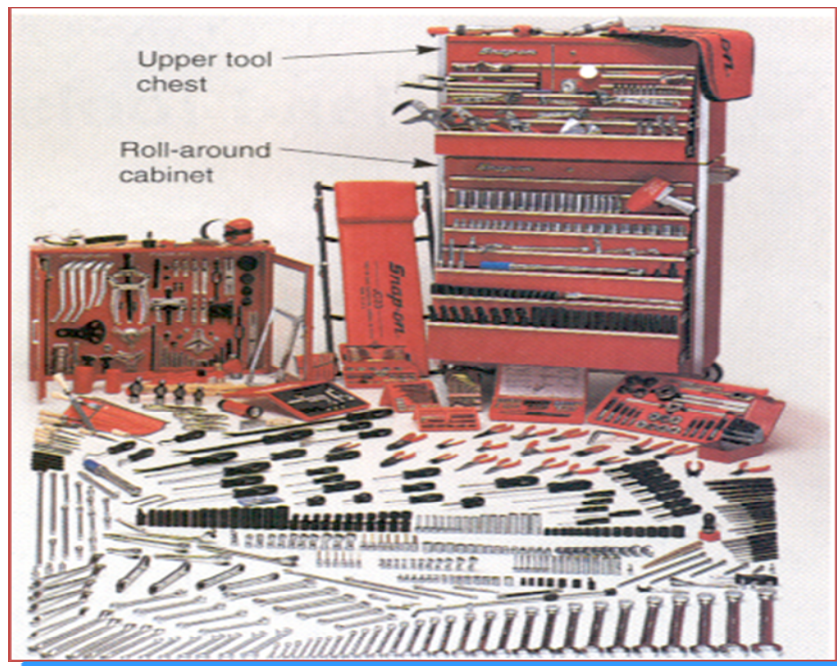


Automotive Electrical & Electronics

Level – I

Based on March 2022, Curriculum Version 1



Module Title:- Using Tools, Equipment and Measuring Instruments

Module code: EIS AEE1 M02 0322

Nominal duration: 50Hour

Prepared by: Ministry of Labour and Skill

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Acknowledgment

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Introduction to the Module

In automotive Electrical & Electronics occupation ; the Use of Tools, Equipment and Measuring Instruments helps to loose and fix different parts; put parts on the and check exact measurements of different automotive electrical and electronics parts on vehicles.

This module is designed to meet the industry requirement under the Automotive Electrical & Electronics occupation, particularly for the unit of competency: Use of Tools, Equipment and Measuring Instruments

This module covers the units:

- Preparing work station
- Carrying-out measurements
- Using hand tools and equipment
- Maintaining tools and equipment

Learning Objective of the Module

- Prepare work station
- Carry-out measurements
- Use hand tools and equipment
- Maintain tools and equipment

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Unit One: - Prepare work station

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

- Identifying and testing functionality of tools and equipment
- Common faults and/or defects in hand tools and equipment
- OHS measures and warnings

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:

- Identify and test functionality of tools and equipment
- Identify Common faults and/or defects in hand tools and equipment
- Observe OHS measures and warnings

1.1. Identifying and testing functionality of tools and equipment

1.1.1. Hand tools

Automotive service work requires a great variety of tools. It is said that using the right tools for the right job enables to do work with safety, speed, and efficiency. Thus this module identifies the various common kinds of automotive hand tools found the shop, to wit:

- Turning Tools
- Cutting Tools
- Gripping Tools
- Striking Tools

A. Turning Tools

This kind of hand tools includes the various types of wrenches and screwdrivers.

The word wrench means twist.

- Used to install and remove nuts and bolts
- Available in both conventional (inch) and metric (millimeter) sizes
 - ✓ size is stamped on the side of the wrench
- Wrench size is determined by measuring across the wrench jaws

Rules for wrench use

- Always select the right size wrench
 - ✓ wrench must fit the bolt head snugly
- Never hammer on a standard wrench

- ✓ use a longer wrench with more leverage or a special slug wrench, which is designed to be used with a hammer
- When possible, pull on the wrench
 - ✓ if the wrench slips, you are less likely to hurt your hand
- Never use a steel bar or pipe to increase the length of a wrench
 - ✓ excess force can bend or break the wrench.

Open-End Wrench: The jaws of the open-end wrench allow the wrench to slide around two sides of a bolt or nut head where there might be insufficient clearance above or on one side of the nut to accept a box wrench.



Fig.1.1. Open-End Wrench

Box-End Wrench: The end of the box-end wrench is boxed or closed rather than open. The jaws of the wrench fit completely around a bolt or nut, gripping each point on the fastener. The box-end wrench is not likely to slip off a nut or bolt. It is safer than an open-end wrench. Box-end wrenches are available as 6 point and 12 point. The 6-point box end grips the screw more securely than a 12-point box-end wrench can and avoids damage to the bolt head.



Fig.1.2. Box-End Wrench

Combination Wrench: The combination wrench has an open-end jaw on one end and a box-end on the other. Both ends are the same size. The combination wrench is probably the best choice for the second set. It can be used with either open-end or box-end wrench sets and can be used as an open-end or box-end wrench.



Fig.1.3. Combination Wrench

Flare Nut (Line) Wrenches: Flare nut or line wrenches should be used to loosen or tighten brake line or tubing fittings. Using open-ended wrenches on these fittings tends to round the corners of the nut, which are typically made of soft metal and can distort easily. Flare nut wrenches surround the nut and provide a better grip on the fitting.



Fig.1.1.1.4. Flare Nut (Line) Wrenches

Allen Wrench: Setscrews are used to fasten door handles, instrument panel knobs, engine parts, and even brake calipers. A set of fractional and metric hex head wrenches, or Allen wrenches, should be in every technician's toolbox. An Allen wrench can be L-shaped or can be mounted in a socket driver and used with a ratchet.

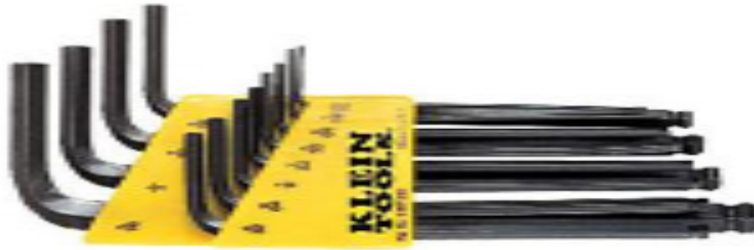


Fig.1.5. Allen Wrenches

Adjustable-End Wrench: An adjustable-end wrench (commonly called a crescent wrench) has one fixed jaw and one movable jaw. The wrench opening can be adjusted by rotating a helical adjusting screw that is mated to teeth in the lower jaw.

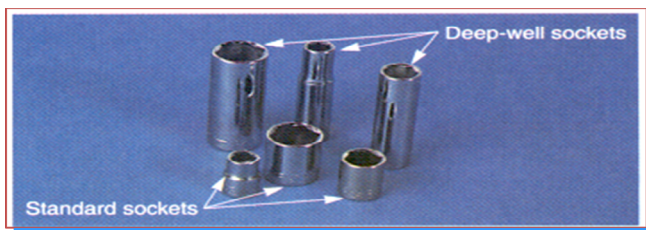


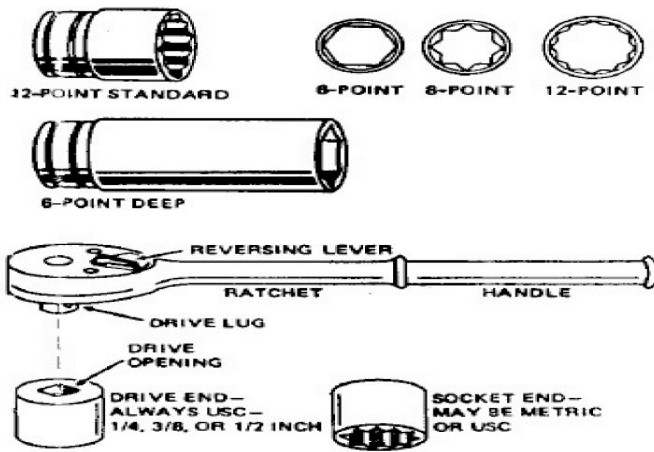
Fig.1.6. Adjustable-End Wrench

Sockets and Ratchets: A socket wrench is much safer, faster, and easier to use than any other wrench. In fact, sometimes it is the only wrench that will work.

The basic socket wrench set consists of a ratchet handle and several barrel-shaped sockets. Sockets are available in 6, 8, or 12 points. A 6-point socket has stronger walls and improved grip on a bolt compared to a normal 12-point socket. Six-point sockets are mostly used on fasteners that are rusted or rounded. Eight-point sockets are available to use on square nuts or square-headed bolts.

The square hole is the size of the hole and handle lug (1/4 inch, 3/8 inch, 1/2 inch, and so on) indicates the drive size of the socket wrench.





How a socket attaches to a ratchet handle.



Fig. 1 .7. Socket Wrench

Screwdrivers:

Screwdrivers are used to drive or turn screws. They are made in a variety of sizes, shapes and special purpose design. They are two kinds such as:

- 1.) Standard Screwdriver
- 2.) Philip Screwdriver



Fig. 1.8. Standard Screw Drivers



Fig. 1.9. Different Size of Philip screw drives

B. Cutting Tools

Cutting tools are used to cut or remove metal and they are classified according to its operation. These tools are as follows:

Hacksaw. It is basically a cutting tool use to cut metal. A hacksaw has an adjustable metal frame and holds detachable blades (250mm or 300mm long) held iplaced by a wing nut. The cutting occurs on the forward stroke as it push the blade across the metal. The teeth acted like tiny chisel and cuts off fine shaving or chips and after a long forward stroke, apply enough downward force so that the teeth cuts rather than slide.



Fig. 1.10. Hacksaw.

Chisel. Is classified as a cutting tool with a single cutting edge and they are of various sizes and shapes. Cold chisel is one of the most common type of chisel used is automotive shop.



Fig. 1.11, *Different Kinds*

Files. It is classified as a general purposed tools however often used in conjunction for cutting and shaping metal. They have many cutting edges or teeth and they are graded according to the number of teeth they have. The greater the number of teeth, the smaller is the cut.



Fig. 1.12. Different Kinds of Files

Punches. Are used to knock-out rivets and pins. It also used to align parts for assembly and the Center Punch is the most common type of punches used in automotive shop. Other types of punches are as follows:

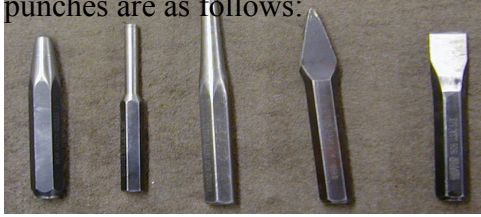


Fig.1.13. Different Kinds of Punches

Twist Drills. The drill bits or twist drills are tools for making holes. The materials being drilled determine the preferred shape of the cutting edges that form the points.



Fig.1.14. Set of Twist Drills

Taps and Dies. Most automotive shop has tap and die sets for cutting USC and METRIC threads. Taps cut inside threads and dies cuts outside threads on rods.

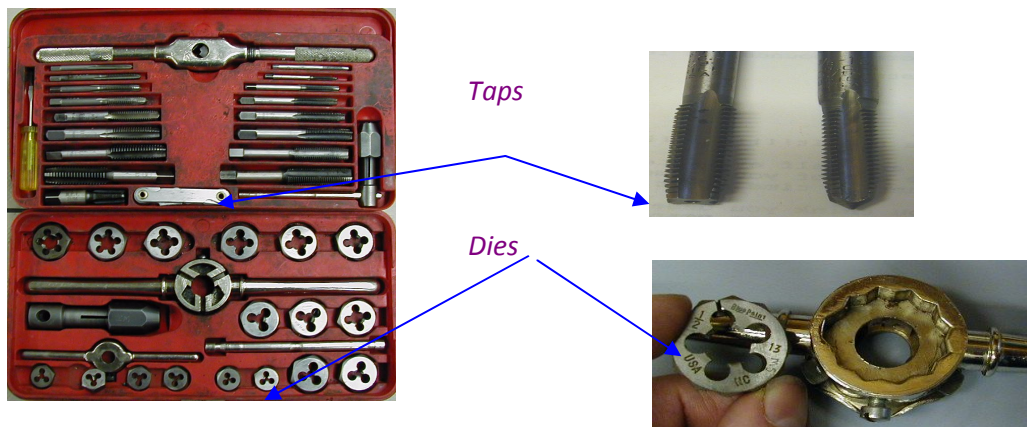


Fig. 1.15. Set of Taps and Dies

C. Gripping Tools

Pliers:

- Used to grip, cut, crimp, hold, and bend various parts
- Never use pliers when another type tool will work

- Pliers can nick and scar a part
- Are gripping tools used for working with wires, clips, and pins. At a minimum, an auto technician should own several types: standard pliers for common parts and wires, needle nose for small parts, and large, adjustable pliers for large items and heavy-duty work.

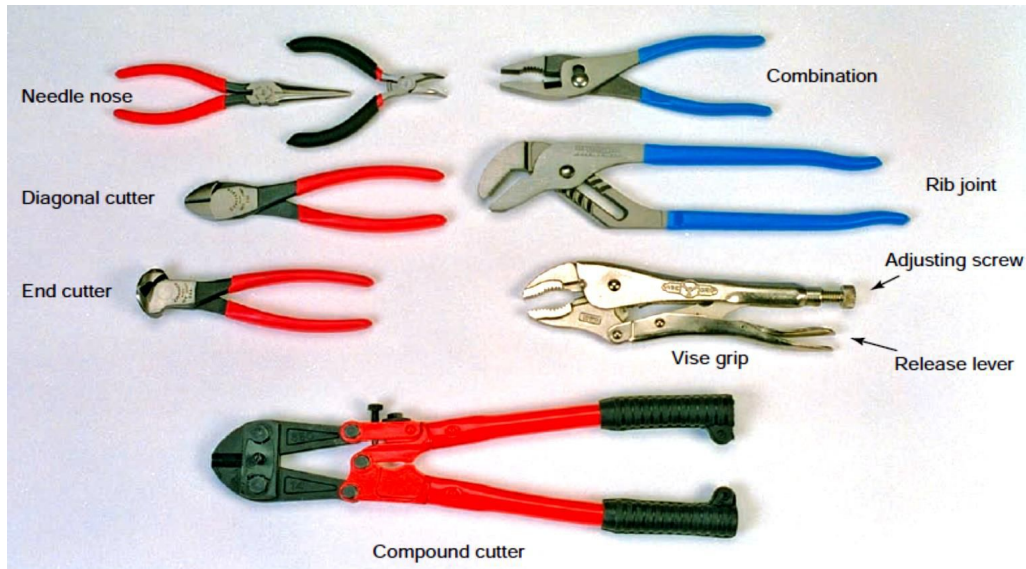


Fig.1.16. Different kind's pliers

- **Combination pliers** are the most common type of pliers and are frequently used in many kinds of automotive repair. The jaws have both flat and curved surfaces for holding flat or round objects.
- **Needle nose pliers** have long, tapered jaws. They are great for holding small parts or for reaching into tight spots. Many needle nose pliers also have wire-cutting edges and a wire stripper. Curved needle nose pliers allow you to work on a small object around a corner.
- **Locking pliers, or vise grips**, are similar to the standard pliers, except they can be tightly locked around an object. They are extremely useful for holding parts together. They are also useful for getting a firm grip on a badly rounded fastener that is impossible to turn with a wrench or socket. Locking pliers come in several sizes and jaw configurations for use in many auto repair jobs.
- **Diagonal-cutting pliers, or cutters**, are used to cut electrical connections, cotter pins, and wires on a vehicle. Jaws on these pliers have extra-hard cutting edges that are squeezed around the item to be cut

•

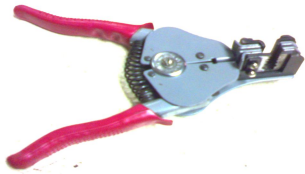


Fig. 1.17. Electrician plier



Fig. 1.18. *Wire Stripper*



Fig. 1.19. Diagonal
cutting plier



Outside Snap Ring Remover



Inside Snap Ring Remover

Fig.1.20. Different Kinds of Snap Ring removers

D. Striking Tools

Hammers

Hammers are identified by the material and weight of the head. There are two groups of hammer heads: steel and soft faced. The heads of steel-faced hammers are made from high-grade alloy steel. The steel is deep forged and heat treated to a suitable degree of hardness. Soft-faced hammers have a surface that yields when it strikes an object. Soft-faced hammers should be used on surfaces machined and when marring a finish is undesirable.



Fig.1.21. Different Kinds of hammers

Power tools

Automotive power tools are devices use to facilitate instructions and to do job efficiently. It can also save time and increase productivity. Automotive power tools are commonly termed as shop equipments, which are powered by electricity, compressed air, or hraulic pressure. Power tools are classified into three types, to wit:

- Electric Tools
- Pneumatic Tools
- Hydraulic Tools

A. Electric Tools

There are different kinds of electric power tools used in automotive shop. Below are some of the basic examples of electric tools, to wit:

Electric Grinder. This kind of power tool usually bolted to one of the shop work benches. It maybe used to sharpen or “dress” an object such as drill bits, screwdriver or chisel.

Bench Grinder

- Used for grinding, cleaning, or polishing
- Usually has two wheels:
 - ✓ Grinding wheel—used for sharpening and deburring

- ✓ wire wheel—used for cleaning and polishing
- ✓



Portable Grinder



Bench Grinder

Fig.1.22. Different Kinds of grinders

Drill Press.

- It refers to the vertical drilling machine powered by an electric motor. It has similar purpose to electric drill but the drill press is mounted permanently for heavy duty jobs.
- Large, floor-mounted or bench-mounted drill needed for drilling large holes, deep holes, or a great number of holes in several parts
- Handle allows the bit to be pressed into the work with increased force

Electric hand drill

It is used to drive drill bit so that holes can be drilled. The electric drill has an electric motor that drives the chuck. The chuck has jaws that can be opened and then closed to grip a drill bit.

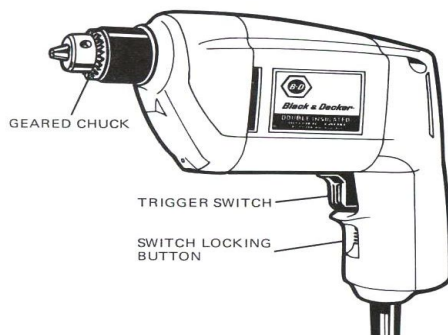


Fig.1.23. Electric hand drill



Fig.1.24. Drill press

Soldering gun/Iron

- It refers to device use for metal joining process. It is normally associated with soldering lead to complete the joining process.
- Used to join wires
- Electric current heats the tip of the gun

- The hot gun tip is used to heat the wires
- Solder is applied to the hot wires and it melts
 - ✓ Solder is a lead-tin alloy
- When the solder cools, it hardens into a strong, solid connection



Fig.1.25. Soldering iron gun

Battery Charger

- Used to recharge a dead car battery
- Forces current back into the battery to recharge the plates and battery acid
- The red charger lead connects to the positive (+) battery terminal
- The black charger lead connects to the negative (-) battery terminal
- Connect the leads before turning on the charger to avoid arcing



Fig.1.26. Kinds of Battery Charger

Pneumatic Tools

Pneumatic tool is another type of equipment, which is used in automotive shop.

Air compressor

A **compressed air**, which means an air under pressure greater than the atmosphere will serve as the prime mover to operate the said equipment.

An **air compressor** is an example of a pneumatic tool which produces compressed air and provides air supply system in the shop.

The air-compressor assembly is usually an air tank with an electric motor that drives a two (2) cylinder air compressor. The compressed air is stored under great pressure in the storage tank and ready to power the air-operated tool and equipment.

Compressed-air motors are widely used tools in which intermittent large forces are required, like the following:

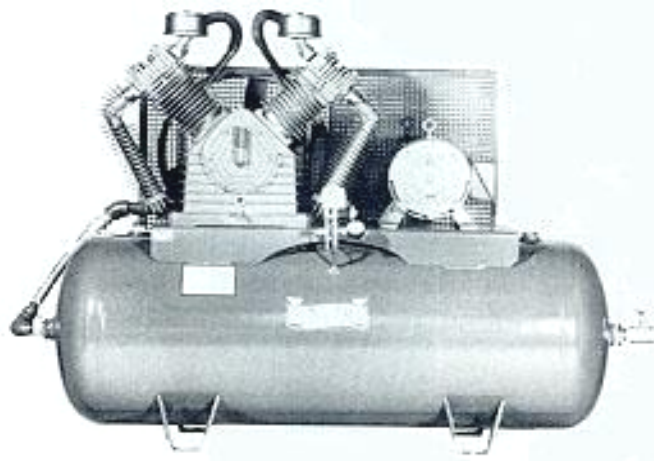


Fig.1.27. Air Compressor

Pressure Gauge.

- It is a pneumatic instrument use to measure the tire pressure.
- Used to measure air and fluid pressure
- Common units of measure found on the pressure gauge scale:
 - ✓ pounds per square inch (psi)
 - ✓ kilograms per square centimeter (kg/cm^2)
 - ✓ kilopascals (kPa)
- Common pressure measurements taken in the automotive shop:
 - ✓ Tire air pressure
 - ✓ Fuel pump pressure
 - ✓ Air conditioning system pressure
 - ✓ Engine compression pressure

Pneumatic Drills. It is classified as vertical drilling equipment.



Fig.1.28. Pneumatic Drill



Fig.1.29. Pressure Gauge

B. Hydraulic Tools

Hydraulic machines transmit power by means of working fluid, such as oil. Below are some of the hydraulic tools used in automotive shop, to wit:

Hydraulic Press. It is use for pressing heavy duty automotive parts.

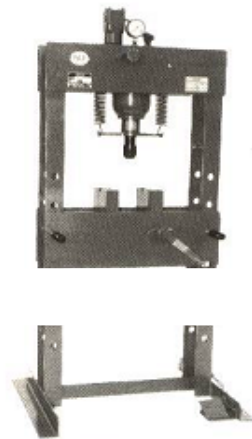


Fig.1.30. Hvdraulic Press

Hydraulic/floor Jack.

- It is equipment used to lift-up the vehicle off the ground to provide extra working space underneath.
- Used to raise either the front, sides, or rear of a vehicle
- To avoid vehicle damage, place the saddle under a solid part of the car, such as the frame, suspension arm, or axle housing

Portable Cranes

Portable cranes are mounted on wheels and allow lifting an engine and other heavy objects and transporting them to the desired place.

Wh`en using portable crane, stand clear of the component being lifted in case the component should slip or the lifting device topple. Never work on a component that is suspended in the air



Fig.1.31. Hydraulic Floor Jack (Crocodile Jack)



Fig.1.32. Hydraulic Lifter



Fig.1.33. Hydraulic Jack (Bottle Jack)

1.1.2. Special tools

❑ Ratchet wrench



❑ Flex-combination



❑ Half-moon



Fig.1.34. Special wrenches

Special Sockets: Screwdriver and Allen wrench attachments are also available for use with a socket wrench. A typical set of specialty socket drivers. These socket wrench attachments are very handy when a fastener cannot be loosened with a regular screwdriver.

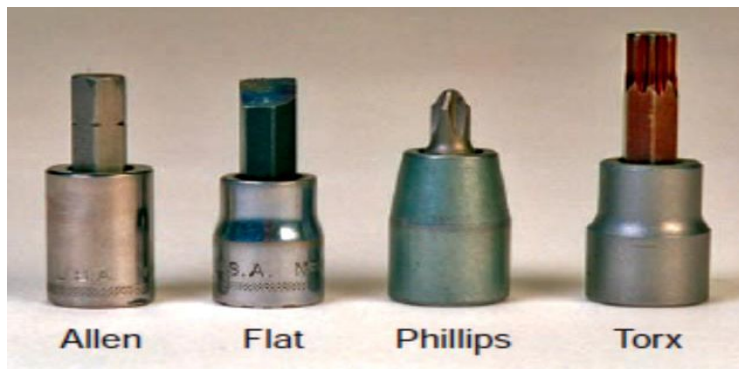


Fig.1.35. Different kinds of Special sockets

1.1.3. Measuring and testing tools

A. Measuring tools

Steel Rules

The simplest tool for measuring linear distances is the steel scale, or rule. It can be marked off in both or either metric and/or inch.

- Frequently used to make low-precision linear measurements
- Accurate to about $1/64"$ (0.5 mm)
- Customary rule has numbers that represent full inches
- Metric rule has numbers that represent 10 mm, or 1 cm

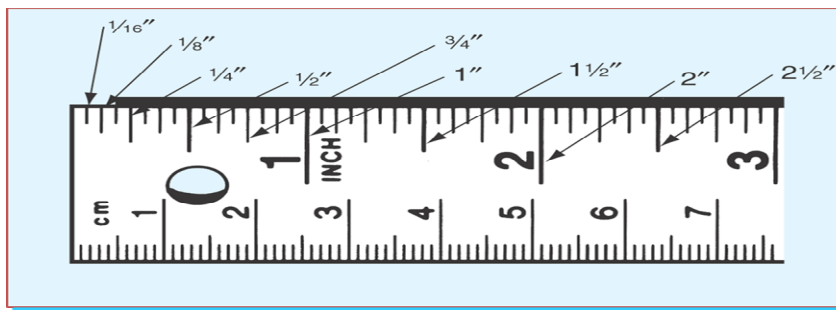


Fig.1.36. Steel Rules

Tape Measure

- Extends to several feet or meters in length
- Sometimes needed for large distance measurements during body, suspension, and exhaust system repairs

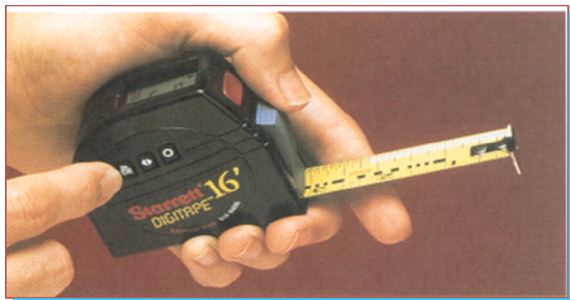


Fig.1.37. Digital reading tape measure

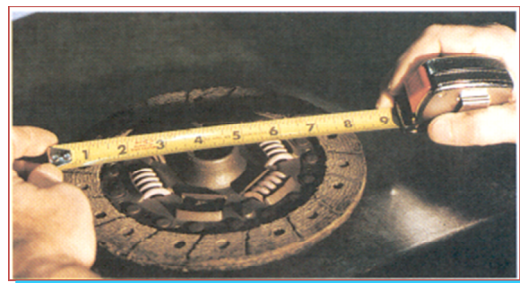
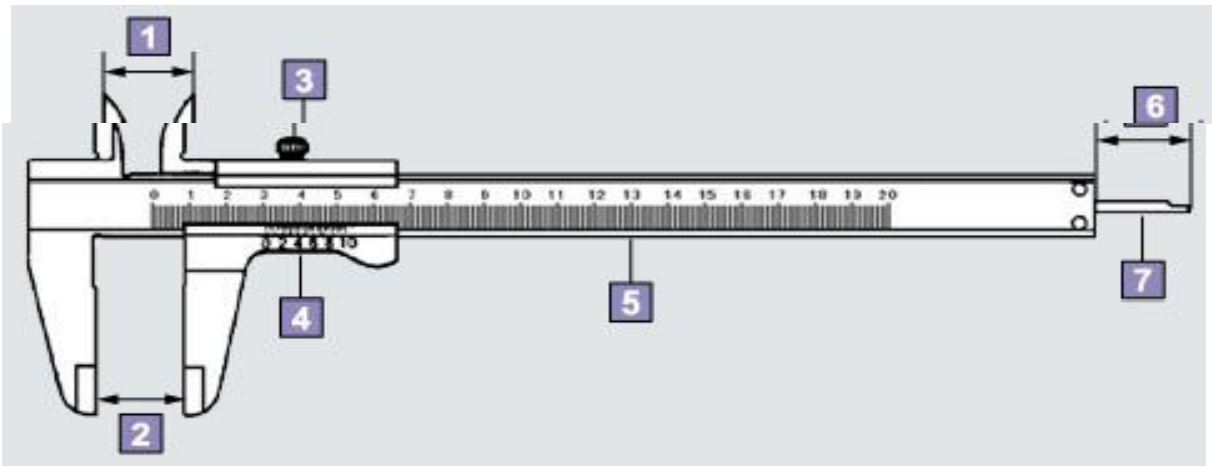


Fig.1.38. Digital reading tape measure large straight line measurements

Vernier Caliper

- 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

- May have a dial gauge attached
 - ✓ makes the “thousandths” part of a measurement easier to read
- Mostly, the vernier caliper is more convenient than the mike. The vernier caliper can take inside, outside, and depth measurements to within hundredths or thousandths of a millimeter or thousandths of an inch.



1. Inside diameter measuring jaws
2. Outside diameter measuring jaws
3. Stop screw
4. Vernier scale
5. Main scale
6. Depth rod measurement
7. Depth rod

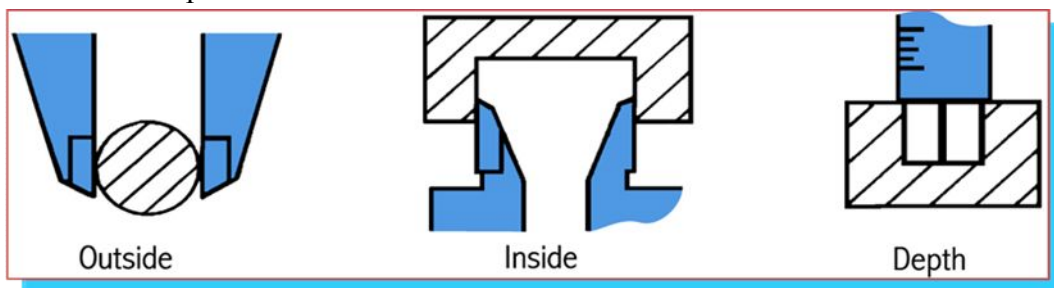


Fig.1.39. Vernier Caliper

Thickness Gauges

Thickness gauges or “feeler” gauges are strips or blades of metal of various thicknesses. Thickness gauges are used to measure small distances such as the clearance between two parts. For example, to check the clearance between the rocker arm and valve stem in an engine.

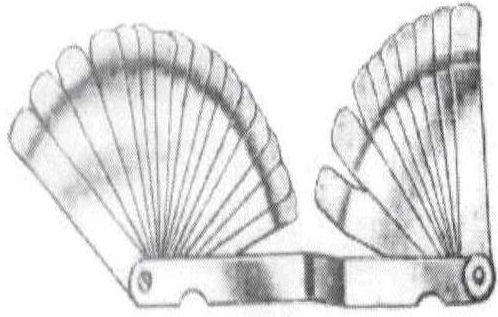


Fig.1.40. Thickness gauges

Micrometers

- Used to make very accurate measurements
- Measures to one ten-thousandth of an inch (0.0001") or one thousandth of a millimeter (0.001 mm)
- Outside, inside, and depth micrometers are available

The micrometer is a precision measuring tool that can measure thickness in hundredths of a millimeter (metric system) or in thousandths or ten-thousandths of an inch. There are three types, outside micrometers, inside micrometers and depth micrometers.

Outside Micrometers

The standard micrometer is the outside micrometer. The six major parts of a micrometer are anvil, frame, spindle, sleeve, thimble and ratchet screw. The outside micrometer is designed to measure the outside diameter of cylindrical forms and the thickness of materials. Its spindle is attached to the thimble on the inside often, a ratchet stop is provided. It can measure anything that will fit between the anvil and spindle. Micrometers come in many different frame sizes. The standard sizes are 0-25mm, 25-50mm, 50-75mm, 75-100 and so on.

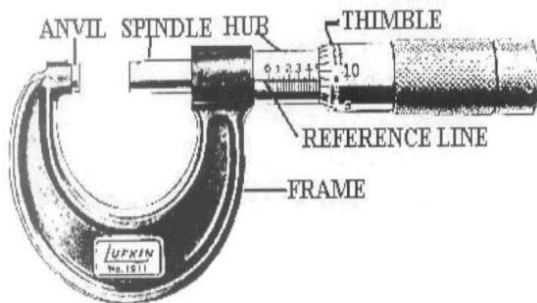


Fig.1.41. Parts of outside

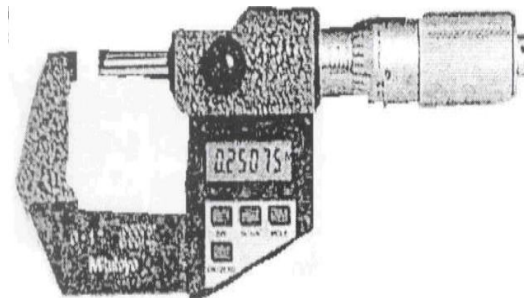


Fig.1.42. Digital micrometer

Inside Micrometer

The inside micrometer is used for measuring the distance between two parallel surfaces and for measuring the inside diameter of cylinders. Inside micrometers come with a micrometer body with a thimble, sleeve, and ratchet. Within the kit is an assortment of spindle of various lengths to use in holes of different sizes. To use this instrument, select a spindle that will just accommodate the inside of a cylinder or above when it is threaded to the thimble and sleeve. Extend the thimble until the spindle touches one side of the cylinder and the thimble end touches the other. Read the measurement in the same way you read outside micrometer and add to this reading the size of the spindle.

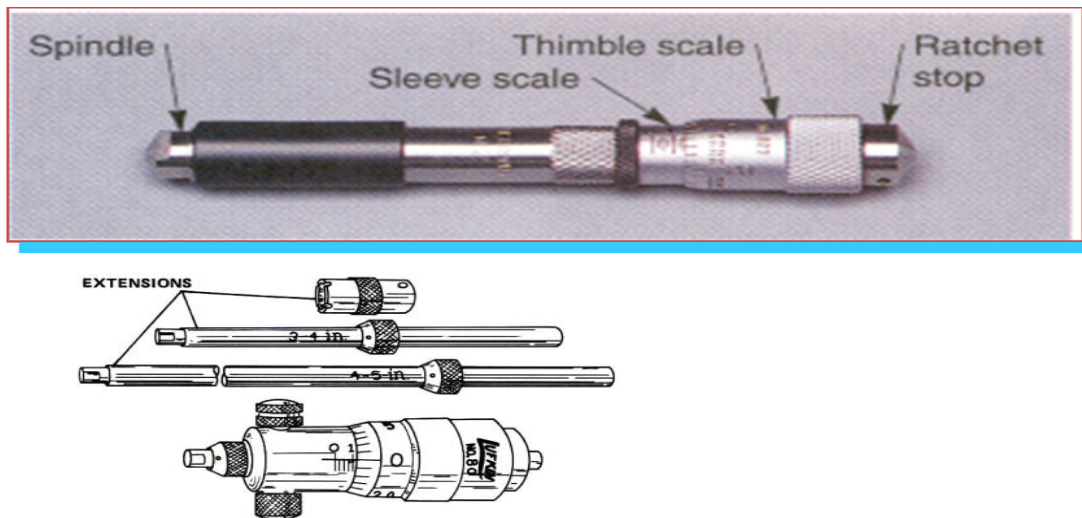


Fig.1.43. Components of inside micrometers

Depth Micrometers

Depth micrometers, as the name implies, measures the depth of an object. There are also dial depth gauges. These dial depth gauges are useful in checking end play and run out on a large number of parts

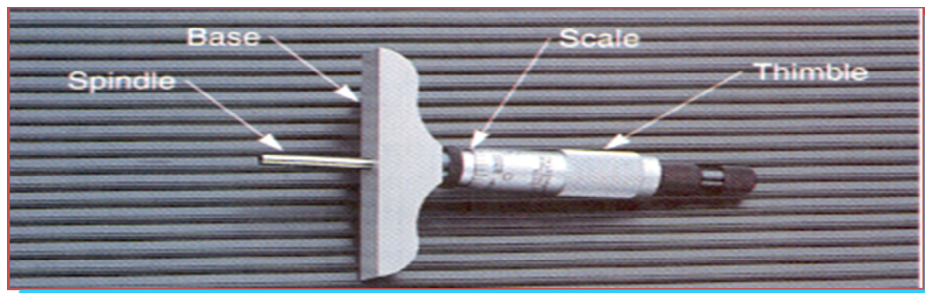


Fig.1.44. Depth micrometers

Dial Indicator

The dial indicator is a gauge that uses a dial face and a needle to register measurements. As the plunger or arm is moved, the needle rotates on the dial face to indicate the distance in hundredths of a millimeter or thousandths of an inch. The dial indicator can be used for checking the run-out, out-of-round and taper condition of the cylinder walls in an engine, to measure an endplay in shafts or gears, the amount of run out of a flywheel and numerous other measurements.

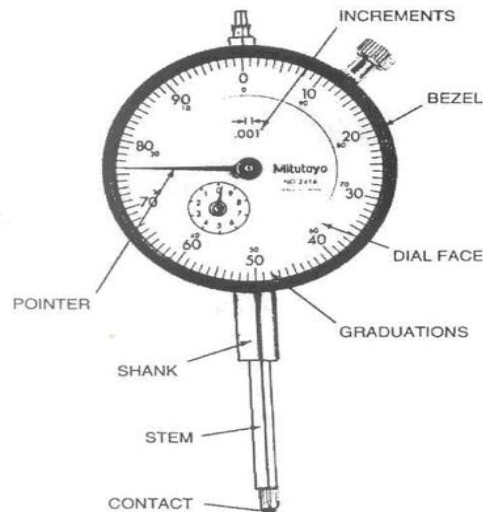


Fig.1.45. Dial Indicator

Telescopic Gauge

Telescopic gauge are measures the inside diameter of a hole or a bore and consists of two spring loaded telescoping members and a locking handle. In use, the gauge is placed in the hole or bore with the handle parallel to the sides of the bore. The gauge is moved up and down several times to center it in the bore. An inner coil spring holds the telescoping members against the sides of the wall. The handle is then turned to lock the gauge. Upon removal, the distance hole diameter across telescoping members are measured with a micrometer or caliper.

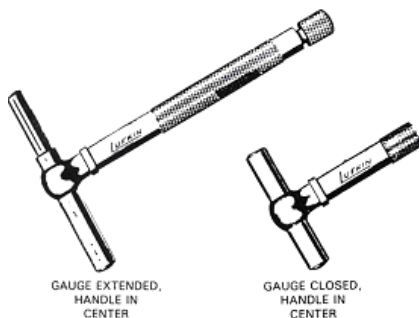


Fig.1.46. Telescopic gauge

Plastigage

Plastigage is used to determine clearances. It is a plastic thread which flattens when placed between the journal and bearing. To measure bearing clearance, place a piece of Plastigage along the width of the bearing cap. Install the bearing cap with the Plastigage between the bearing and the journal and tighten the cap to the proper torque value.

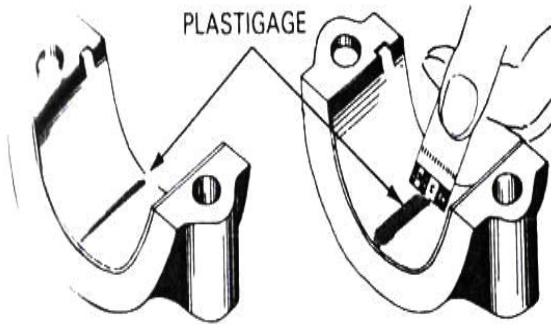


Fig.1.47. Plastigage

Remove the bearing cap and with the gauge provided, check the width of the flattened plastigage. The gauge has a number of different width graduations which are marked to indicate bearing clearances in hundredths of a millimeter or hundredths of an inch.

B. Testing Devices

Stethoscope

A stethoscope is used to locate the source of engine and other noises. The stethoscope pickup is placed on the suspected component, and the stethoscope receptacles are placed in the technician's ears. Some sounds can be heard easily without using a listening device, but others are impossible to hear unless amplified, which is what a stethoscope does. It can also help you distinguish between normal and abnormal noise. The best results, however, are obtained with an electronic listening device.



Fig.1.48. Stethoscope

Circuit Tester

Circuit testers are used to check for voltage in an electrical circuit. A circuit tester commonly called a test-light. Its handle is transparent and contains a light bulb. A probe extends from one end of the handle and a ground clip and wire from the other end. When the ground clip is attached to a good ground and the probe touched to a live connector, the bulb in the handle will light up. If the bulb does not light, voltage is not available at the connector.

A self-powered test-light is called a continuity tester. It is used on open circuits. It looks like a regular test-light but has a small internal battery. When the ground clip is attached to one end of the wire or circuit and the probe touched to the other end, the lamp will light if there is continuity in the circuit.



Fig.1.49. Statoscope

Scan Tools

A scan tool is a microprocessor designed to communicate with the vehicle's computer. Connected to the computer through diagnostic connectors, a scan tool can access diagnostic trouble codes (DTCs), run tests to check system operations, and monitor the activity of the system. Trouble codes and test results are displayed on a screen or printed out on the scanner printer.



Fig.1.50. Scan Tools

Engine Analyzer

With an engine analyzer, you can perform tests on the battery, starting system, charging system, primary and secondary ignition circuits, electronic control systems, fuel system, emissions system, and engine assembly. The analyzer is connected to these systems by a variety of leads, inductive clamps, probes, and connectors. The data received from these connections is processed by several computers within the analyzer.

The analyzer may compare the test results to the vehicle manufacturer's specifications. When the test series is completed, the analyzer prints a summary report. Many analyzers also provide diagnostic assistance for the problems indicated by their measurements.



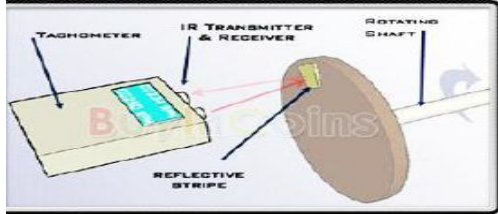
Fig.1.51. Engine Analyzer

Tachometer

A tachometer is used to measure engine speed. Like other meters, tachometers are available in analog and digital types. Digital meters are the most common. Tachometers are connected to the ignition system to monitor ignition pulses, which are then converted to engine speed by the meter. Several types of inductive pickup tachometers that simplify rpm testing are available. An inductive tachometer simply clamps over the number 1 spark plug wire. The digital display gives the engine rpm, based on the magnetic pulses created by the secondary voltage in the wire. This type of tachometer is suitable for distributor less ignition systems.



- Display: Large 5 digit, 18mm LCD
- Test Range: 2.5 to 99,999 RPM
- Resolution: 0.1 RPM (from 2.5 to 999.9 RPM)
1 RPM (over 1,000 RPM)
- Accuracy: $\pm (0.05\% + 1 \text{ digit})$
- Distance: 50 to 500mm/ 2 to 20 inch
- Memory: Last Value, Max Value, Min RPM
- Test Range Select: Automatic
- Battery: 9V



Working

Principle



- ① — Digital Laser Photo Tachometer
- ② — Carrying bag
- ③ — Battery 9v
- ④ — English Manual
- ⑤ — Reflective stripes

Contents



Fig.1.52. Tachometer

Timing Light

Timing light is used to check ignition timing. The timing light is connected to the battery terminals and has an inductive clamp that fits over the number 1 spark plug wire. While the engine is running, the timing light emits a beam of light each time the spark plug fires. Many timing lights have a timing advance knob that may be used to check spark advance. Some timing lights electronically measure timing advance as the engine rpm is increased and displays it on an LED display.



Fig.1.53. Timing Light

Spark Tester

A spark tester is a fake spark plug. The tester is constructed like a spark plug but does not have a ground electrode. In place of the electrode there is a grounding clamp. Using test spark plugs is an easy way to determine if the ignition problem is caused by something in the primary or secondary circuit. The spark tester is inserted in the spark plug end of an ignition cable. When the engine is cranked, a spark should be seen from the tester to a ground. `

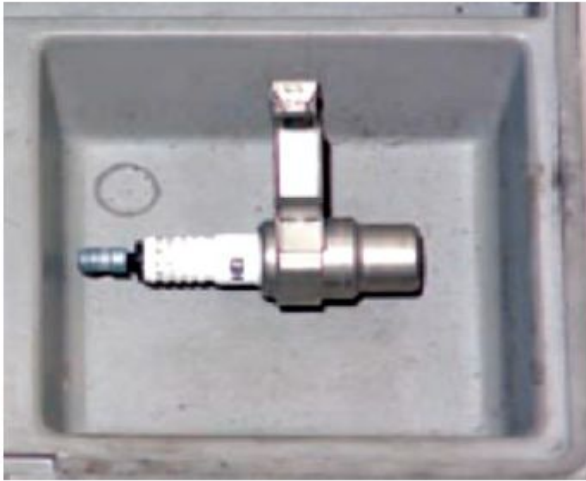


Fig.1.54. Spark Tester

Hydrometer Tester. It is used to measure the specific gravity of the battery solution.



Fig.1.55. Hydrometer

Tachometer/Dwell Angle Tester. It is a 2 in 1 instrument used to determine dwell angle and engine RPM at idle speed.



Fig.1.56;. Tachometer/Dwell Angle Tester

Wire Gauge. Is an instrument use to measure the size of the wire.



Fig.1.57. Wire Gauge

Feeler Gauges

- Used to measure small clearances or gaps between parts
- There are two basic types:
 - ✓ Flat feeler gauges
 - ✓ Wire feeler gauges



Fig.1.58. Flat feeler gauges

Wire Feeler Gauge

Used to measure the distance between unparallel or curved surfaces

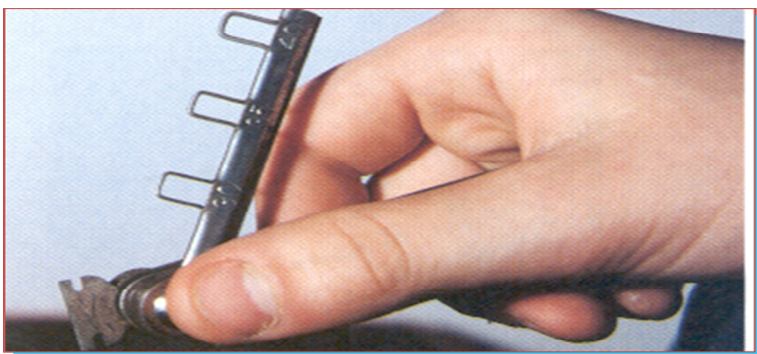


Fig.1.59. Wire feeler gauges

1.1.5. Electrical Measurement/device

Electrical measurements are the methods, devices and calculations used to measure electrical quantities.

Types of Electrical measuring instruments/devices

- Voltmeter: - measures the potential difference between the two elements in a circuit
- Ammeter:- measures the current flowing in a circuit
- Wattmeter:- measures the power flowing in a circuit
- Ohmmeter:- measures the resistance of an element in a circuit
- Mutimeter:- It is a multi function measurement device. It can measure voltage, current, and resistance. It is also known as VOM(volt-Ohm-milliammeter)

Multi-meters

A multi-meter is a must for diagnosing the individual components of an electrical system. A digital multi-meter (DMM) can measure volts, ohms, and low current such as direct current (dc) and alternating current (ac) amperes, diode continuity. DMMs provide great accuracy by measuring volts, ohms, or amperes in tenths, hundredths, or thousandths of a unit.



Fig.1.60. Multi-meters

Lab Scopes/Oscilloscope

An oscilloscope or lab scope is a visual voltmeter. A lab scope converts electrical signals to a visual image representing voltage changes over a specific period of time. This information is displayed in the form of a continuous voltage line called a waveform or trace. With a scope, precise measurement is possible. A scope displays any change in voltage as it occurs.

Dual-track oscilloscope can directly test the signal waveforms and data, AC and DC voltage, frequency, Pulse- Width and duty cycle.



Fig.1.61. Lab Scopes/Oscilloscope

1.2. Common faults and/or defects in hand tools and equipment

Check the handle and body casing of the tool for cracks or other damage. If the tool has auxiliary or double handles, check to see that they installed securely. Inspect cords for defects: check the power cord for cracking, fraying, and other signs of wear or faults in the cord insulation.

Procedures to be followed to inspect powered hand tools

- Inspect tools for any damage prior to each use.
- Check the handle and body casing of the tool for cracks or other damage.
- If the tool has auxiliary or double handles, check to see that they installed securely.
- Inspect cords for defects: check the power cord for cracking, fraying, and other signs of wear or faults in the cord insulation.
- Check for damaged switches and ones with faulty trigger locks.
- Inspect the plug for cracks and for missing, loose or faulty prongs.

Procedures to be followed to repair a defective tool

- If a tool is defective, remove it from service, and tag it clearly "Out of service for repair".
- Replace damaged equipment immediately – do not use defective tools "temporarily".
- Have tools repaired by a qualified person – do not attempt field repairs.

1.3. Observing OHS measures and warnings

Work Shop Safety

Safety means protecting yourself and others from possible danger and injuring in the shop, you are ' Safe' when you protect your eyes, your fingers, your hands all of yourself from danger as well as others.

Preparation of workshop helps as

- Keep environment well being
- Identify the work and its implementing tools, equipment and materials
- Decide the work procedure
- Keep tools, equipment and resource prevent ourselves from injury
- Do the work with quality
- Ready workstation for work activities.
- Acquire procedures and information such as workshop manuals and specifications are
- Observe dangers associated working with the removal and tagging of engine components

Maintaining a safe work place

Once safe systems and procedures are in place, they need to be maintained through an on going focus on health and safety.

Maintain a safe work place by:

- Carrying out regular workplace inspections
- Ensuring equipment and tools are safe to use and maintained
- Fixing high risks immediately and others as soonas possible in order of level of risk
- Discussing common injuries, work practices and procedures with workers
- keeping up-to-date knowledge of productlabels, Safety Data Sheets and manufacturer's instruction manuals
- Having an easy to use hazard, near miss and injury reporting process as well as reviewing incident reports
- Planning and regularly testing of emergencyprocedures (e.g. For fire, medical, chemical

leaks) providing training opportunities when anything new at work is introduced.

Key points to remember

Are there ways (other than PPE) in which the risk can be adequately controlled, that is engineering controls? If not, check that:

- PPE is provided;
- It offers adequate protection for its intended use;
- Those using it are adequately trained in its safe use;
- It is properly maintained and any defects are reported;
- It is returned to its proper storage after use.

Self-Check-1	Written Test
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Instructions: Read the following questions and choose the best answer (2points each)

I/ Choose the best answer

1. The word wrench means
A. Twist B. Bend C. socket D. none
2. -----is used to check ignition timing.
A. Timing light B. Tester light C. Hand Protection D. None
3. -----is a fake spark plug.
A. Test light B. Spark tester C. Exhaust analyzer D. All
4. -----is used to measure engine speed.
A. Tachometer B. Multi-meter C.A&B D. All
5. ----- is ameasuring device used to measure deflection, flatness, endplay, movement and run out. A. Veriner calipers s B. Micrometer C. Dialgauge. D. All
6. Which one of the following is the components of vernier caliper?
A. Stop screw B. Vernier scale C. Main scale D. All

II/ Give short answer/Fill in the blank space

7. List the four common kinds of automotive hand tools found the shop.
a. -----
b. -----
c. -----
d. -----
8. List about seven kinds of wrenches.
a. ----- e.-----
b. ----- f. -----
c. ----- g. -----
d. -----
9. Write the three types of power tools
a. -----
b. -----
c. -----

List of Reference Materials

- Automotive Mechanics, 10th edition By: Crouse/ Anglin
- Modern Automotive Technology By: James E. Duffy
- Automotive Technician Training (ATT) Level 1 ;Tom Denton, BA, FIMI
- Automotive Technology Principles, Diagnosis, and Service
Fourth Edition; James D. Halderman
- Modern Automotive Technology ; By Russell Krick
- Learning guides from module title Using Hand Tools and Equipment 2020 G.C.

Unit Two: - Carry-out measurements

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

- Selecting and Reading measuring tools
- Checking and adjusting Measuring/testing devices
- Conducting measurements & comparing measurement results

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:

- Select and Read measuring tools
- Check and adjust Measuring/testing devices
- Conduct measurements & comparing measurement results

2.1. Selecting and Reading measuring tools

Reading metric vernier calipers

- The main scale is graduated in millimeters with the centimeter (10mm) division marked with numerals. The vernier scale is graduated in 0.05mm units. It divides each of the 1mm sections on the main scale into 20 parts, each one being 0.05mm. Each second graduation is 0.10mm and is shown as longer lines, each alternate line is marked 1, 2, 3, 4, - - -, 10.

How to Take Reading

- Take the reading of the main scale that the zero on the sliding vernier scale lines up with, or to the left of the zero mark on the vernier scale, and
- Add to this the reading on the vernier that coincides with a graduation on the main scale.

Example-1

The main scale and the vernier scale are first set in such away the graduation **“0”** on one is aligned with the **“0”** on the other. When the vernier scale is moved to the right until the number **“1”** on it is aligned with the number **“1”** on the main scale, as shown below, there results a gap of **0.1mm** at the left end.

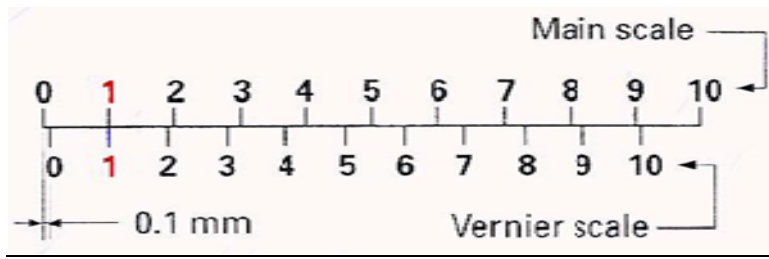
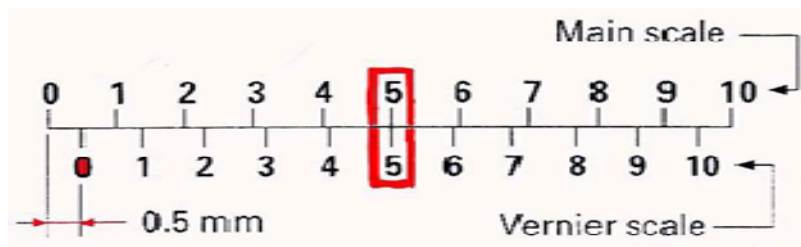


Fig.2.1. How To Take Reading vernier caliper reading

Example- 2

When the vernier scale is moved further to the right until the number “5” is lined up with “5” on the main scale, there results a gap of 0.5mm between two zeros at the left end. Generally, the main scale is graduated in subdivisions of 1mm each and the vernier scale has 10 equal graduations of 0.9mm (1/10mm) along 9 mm of the length of the main scale.



Reading Metric Micrometers

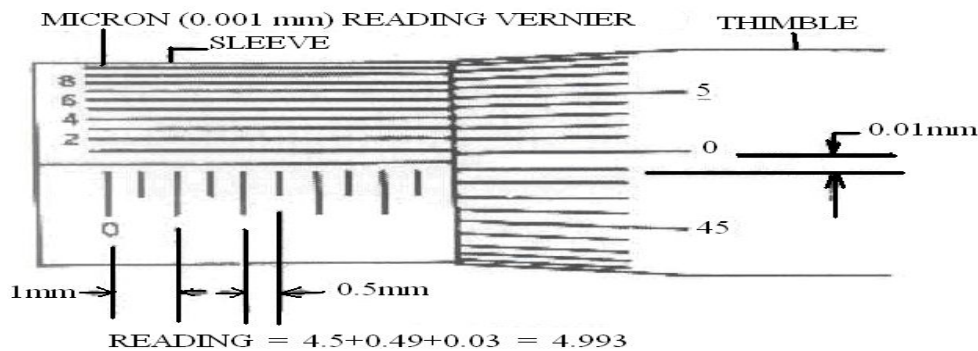
- With the metric mike, the measurements are read directly from the vernier (hub) line and the thimble in millimeters and hundredths of a millimeter (0.01mm).
- The vernier (hub) is marked off in millimeters above the datum line and half millimeters below the line. In some micrometers the hub is marked off in millimeters below the datum line and half millimeters above the line.
- The thimble is graduated into 50 divisions and one revolution of the thimble assembly along the barrel scale from one graduation of one scale to the next graduation on the adjacent scale and equals 0.5mm. Therefore, the 50 divisions have 0.01mm (0.5/50) each.

To take reading

- Note the last figure visible on the top scale on the barrel (hub) line and the thimble in millimeters and hundredths of a millimeter (0.01mm).

- Next note the line of the thimble which is adjacent to the datum line of the hub (vernier) to barrel.

Example-1



Number of divisions visible

Beyond 0 is 4 =

$$4 \times 1 = 4.000\text{mm}$$

Is a bottom scale line visible past the

Top scale line? If so, add 0.5 =

$$= 0.500\text{mm}$$

Thimble line number adjacent to the

Datum line is 49 =

$$49 \times 0.01 = 0.490\text{mm}$$

The vernier line coinciding with a

Thimble line is 3 =

$$3 \times 0.001 = 0.003\text{mm}$$

Total

4.993mm

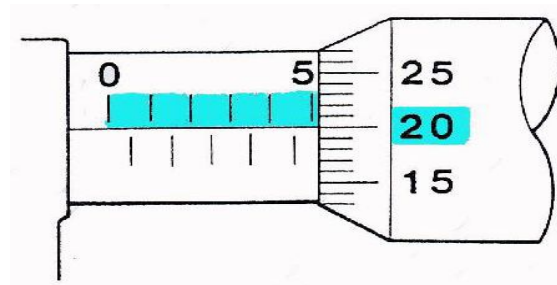
Example-2

Reading over the index line ----- 5.00mm

Reading below the index line----- 0.00mm

Reading on the thimble----- (+) 0.20mm

Final reading of micrometer-----**5.20mm**



Example-3

Reading over the index line -----7.00mm

Reading below the index line-----0.50mm

Reading on the thimble-----(+)0.15mm

Final reading of micrometer-----**7.65mm**

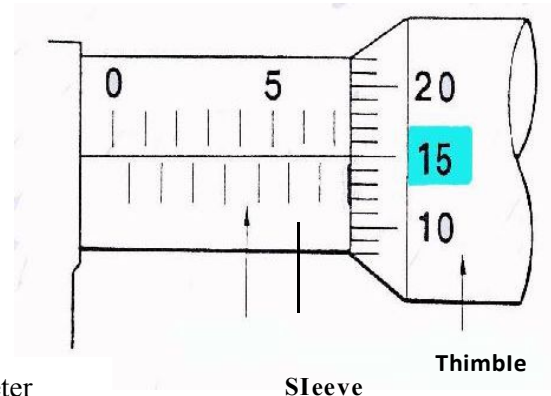


Fig.2.2. Reading with 0.001 mm micrometer

Dialgauge (indicator)

Dial Face

The scale and outer ring turns as a unit. The outer ring can be turned as needed

To set the “0” point of the scale to the pointer.



Fig.2.3. dial indicator

The dial face also has a revolution counter. The counter indicates the number of turns the pointer is turned by the dial gauge.

0.01~1.0mm The classification and measuring range are shown on the dial face of the gauge. The classification indicates the smallest graduation and measuring range shows the maximum reading of the gauge.

How to read dial indicators

- Make certain that you have selected the best mounting attachment and a suitable contact point.
- Make sure that the dial indicator and base are firmly attached and that the measuring rod is parallel to the object being measured.
- Check that the rod, spindle, and dial needle move freely and that dial range is adjusted so that the full movement of the object can be measured.
- Always turn the dial face so that the zero line is placed over the dial needle.
- Take at least two readings. Move or turn the object against its stop or end of travel to ensure the accuracy of measurement.

2.2. Checking and adjusting Measuring/testing devices

How to adjust vernier caliper

- Clean the legs and check the tool for accuracy.
- Clean the objects to be measured and slide the movable leg close to the surface. Lock it with the lock screw to the bar.
- Be certain that the legs are parallel to the object to be measured and do not force the legs together.
- Adjust the leg with adequate force so that the object just sits between the two legs.

How to Adjust and Calibrate an Inside Micrometer

Calibration of the tool is where it is compared against a standard, error quantified, and uncertainty determined. There is often a permissible limit for the error, and if this limit is not met, the tool must be adjusted.

Adjustment is when a property of the tool is changed to reduce error

The best way to calibrate an inside mic is with a calibration ring (Gauge ring). These often cost more than the micrometer, and for a wide range set, you need to have a lot of them

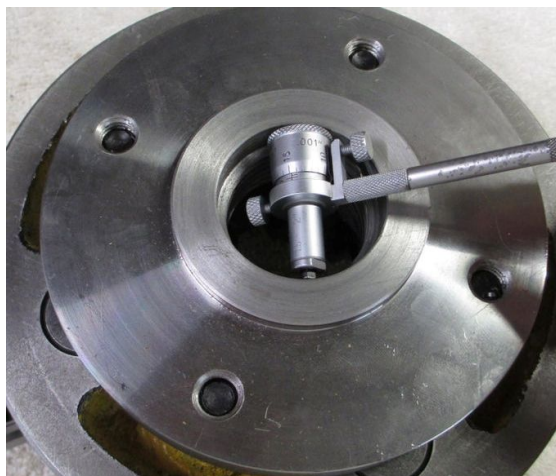


Fig.2.4. Adjusting and calibrating inside micrometer

2.3. Conducting measurements & comparing measurement results

Using the Caliper

- **Slide one of the jaws against the object.** The caliper has two types of jaws. The larger ones tighten around an object, to measure the distance across it. The smaller jaws fit into an opening, and can then be pushed outward to measure its internal diameter. You can adjust either pair of jaws by sliding the smaller scale. Once you've got one of the jaws in position, tighten the locking screw
- **Read the main scale where it lines up with the sliding scale's zero.** The main scale on a Vernier caliper typically tells you the whole number plus the first decimal. Read this just as you would a ruler, measuring to the zero mark on the *sliding* (Vernier) scale
 - ✓ For example, if the 0 on the sliding scale lines up with the 2 inch mark, your measurement is 2 inches. If it lines up past 2 inches by six tenth-inch marks, your measurement is 2.6 inches.
 - ✓ If the result is between two lines, just use the smaller value. Do not try to estimate a value between the two lines.
- **Read the Vernier scale.** Find the first mark on the Vernier scale that line up perfectly with any line on the main scale. That mark tells you the value of the additional digits.
 - ✓ For example, the 14 on the Vernier scale aligns with a line on the main scale. Let's say the scale represents 0.01 inch increments, so the 14 represents 0.014".
 - ✓ It makes no difference which line on the main scale it aligns with. We've already taken our reading from the main scale; don't take another one.
- **Add the numbers together.** Add the main scale and Vernier scale results together to get the final answer. Make sure you use the correct units as labeled on each scale, or you won't get the right answer.
 - ✓ In our example, we measured 2.6 inches on the main scale, and 0.014 inches on the Vernier scale. Our final measurement is 2.614 inches.
 - ✓ The digits don't always line up this neatly. For example, if the main centimeter scale reads 0.85, and the Vernier 0.01 cm scale reads 12, adding them together results in $0.85 + 0.012 = 0.862$ cm.

Using a Micrometer

Step 1 – Position object to be measured

Hold the object you are measuring in your non-dominant hand and the micrometer in your dominant hand with the frame in your palm.

Position the object on the anvil, that is, the fixed measuring face of the micrometer

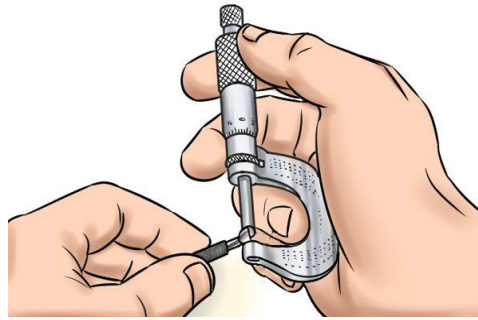


Fig.2.5. Positioning object to be measured

Step 2 – Clamp object between anvil and spindle

- Rotate the thimble using the ratchet speeder until the spindle is close to the object.
- Carefully turn the ratchet as you approach the surface to be measured and continue until the spindle stops rotating.
- The ratchet will keep turning, applying the correct amount of force for an accurate measurement. Using the micrometer thimble alone requires a degree of skill and practice to achieve the correct “feel”.

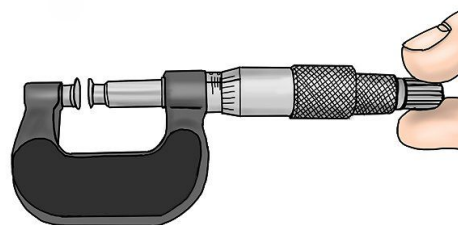


Fig.2.6. Clamp object between anvil and spindle

Step 3 – Read the measurement

- Read the measurement indicated on the scale.
- If you need to remove the object (or the micrometer), first secure the spindle by turning the locking device, remove object and then take your reading

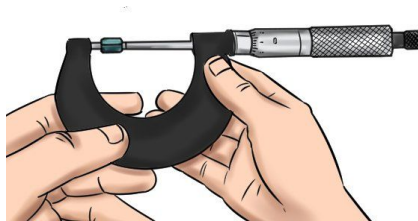


Fig.2.7. Read the measurement

Using a Telescoping Gauge

Compress the spring-loaded extensions and lock them with the thumb wheel

Insert the gauge into the opening and release the thumb wheel

After the extensions snap outward, lock them with the thumb wheel

Measure across the extensions with an outside micrometer

Using a Dial Indicator

Before measuring, fasten the stand near the measuring object. By adjusting the hinge extensions of the stand, the comparator is set so that the needle is at a right angle to the measuring surface.

Tighten all accessories to ensure comparator stability. During the measurement, we observe the dial at a right angle, because a side view can lead to a reading error (parallax).

The measuring object is rotated slightly and the minimum deviation of the pointer is located. In this position, zeroing is performed by turning the dial and placing the zero opposite the measuring needle. This resets the instrument. Further slight rotation observes the deviation of the measuring needle. When the maximum displacement is located during full rotation, it is set back to that position and the value is read on the dial. The read value is the maximum difference or runout of the rotating surface about the axial rotation. Runout is the side-to-side variation of movement when a component is turned.



Fig.2.8. Checking brake disc flatness



Fig.2.9. Dial indicator on stand

Using a Telescoping Gauge

Compress the spring-loaded extensions and lock them with the thumb wheel

Insert the gauge into the opening and release the thumb wheel

After the extensions snap outward, lock them with the thumb wheel

Measure across the extensions with an outside micrometer

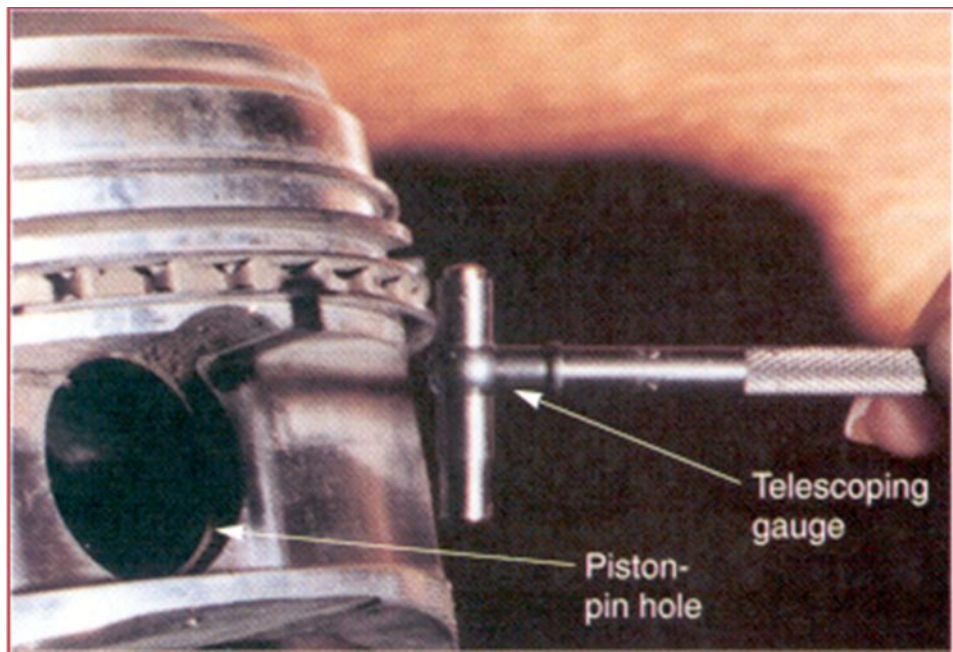
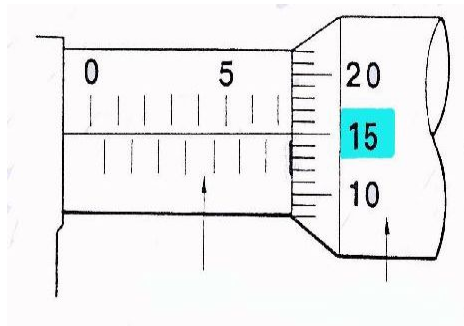
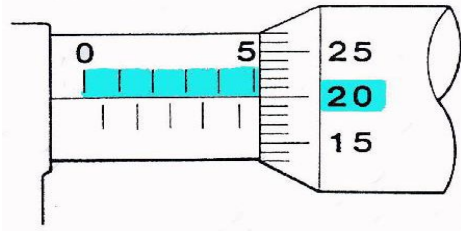


Fig.2.10. Using telescopic gauge

Self-Check-2	Written Test
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Instructions: Read the following questions and choose the best answer (4points each)

I/ Read the following given micrometers and give the results by showing the steps



Operation Sheet 2.1.	Adjusting Vernier caliper
----------------------	---------------------------

Purpose:- to make the vernier caliper work properly

Conditions or situations for the operations:-

- Safe working area
- Not adjusted vernier caliper
- Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments :

- Measuring tool: –vernier caliper
- Equipment :- benches

Procedures of adjustin vernier cliper.

Steps:-

Step 1. Clean the legs and check the tool for accuracy.

Step 2. Clean the objects to be measured and slide the movable leg close to the surface. Lock it with the lock screw to the bar.

Step 3. Be certain that the legs are parallel to the object to be measured and do not force the legs together.

Step 4. Adjust the leg with adequate force so that the object just sits between the two legs.

Operation Sheet 2.2.	Using vernier caliper to measure diameter of round bar
----------------------	--

Purpose:- to understand diameter of round objects are measured and read by vernier caliper

Conditions or situations for the operations:-

Safe working area

Properly operating vernier caliper

Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments :

Measuring tool: –vernier caliper

Equipment :- benches

Material :- round steel bars

Procedures of using vernier caliper to measure diameter of round bar

Steps:-

Step 1. Slide one of the jaws against the object. The caliper has two types of jaws.

The larger ones tighten around an object, to measure the distance across it.

The smaller jaws fit into an opening, and can then be pushed outward to measure its internal diameter.

You can adjust either pair of jaws by sliding the smaller scale. Once you've got one of the jaws in position, tighten the locking screw

Step 2. Read the main scale where it lines up with the sliding scale's zero.

- The main scale on a Vernier caliper typically tells you the whole number plus the first decimal. Read this just as you would a ruler, measuring to the zero mark on the *sliding* (Vernier) scale

Step 3. Read the Vernier scale.

- Find the first mark on the Vernier scale that line up perfectly with any line on the main scale. That mark tells you the value of the additional digits.

Step 4. Add the numbers together.

- Add the main scale and Vernier scale results together to get the final answer. Make sure you use the correct units as labeled on each scale, or you won't get the right answer.

Operation Sheet 2.3.	Using metric micrometers to measure diameter of round bar
----------------------	---

Purpose:- to understand diameter of round objects are measured and read by metric micrometer

Conditions or situations for the operations:-

- Safe working area
- Properly operating metric micrometer
- Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments :

- Measuring tool :- Metric micrometer
- Equipment's- benches
- Material :- round steel bars

Procedures of using metric micrometer to measure diameter of round bar

Steps:-

Step 1 – Position object to be measured

Hold the object you are measuring in your non-dominant hand and the micrometer in your dominant hand with the frame in your palm.

Position the object on the anvil, that is, the fixed measuring face of the micrometer

Step 2 – Clamp object between anvil and spindle

Rotate the thimble using the ratchet speeder until the spindle is close to the object.

Carefully turn the ratchet as you approach the surface to be measured and continue until the spindle stops rotating

The ratchet will keep turning, applying the correct amount of force for an accurate measurement. Using the micrometer thimble alone requires a degree of skill and practice to achieve the correct “feel”.

Step 3 – Read the measurement

Read the measurement indicated on the scale.

If you need to remove the object (or the micrometer), first secure the spindle by turning the locking device, remove object and then take your reading

Operation Sheet 2.4	Using dial indicator to measure the roundness/run out of round bar
---------------------	--

Purpose:- to understand roundness of objects are measured and read by dial indicator

Conditions or situations for the operations:-

- Safe working area
- Properly operating dial indicator
- Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments :

- Measuring tool :- Dial indicator
- Equipment's- benches
- Material :- round steel bars

Procedures of Using dial indicator to measure diameter of round bar

Steps:-

Step 1. Before measuring, fasten the stand near the measuring object.

- By adjusting the hinge extensions of the stand, the comparator is set so that the needle is at a right angle to the measuring surface.

Step 2. Tighten all accessories to ensure comparator stability.

- During the measurement, we observe the dial at a right angle, because a side view can lead to a reading error (parallax).

Step 3. The measuring object is rotated slightly and the minimum deviation of the pointer is located.

- In this position, zeroing is performed by turning the dial and placing the zero opposite the measuring needle. This resets the instrument.
- Further slight rotation observes the deviation of the measuring needle.
- When the maximum displacement is located during full rotation, it is set back to that position and the value is read on the dial.
- The read value is the maximum difference or runout of the rotating surface about the axial rotation.
- Runout is the side-to-side variation of movement when a component is turned.

LAP Test 2	Practical Demonstration
------------	-------------------------

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00hour.

Task 1. Adjust Vernier caliper

Task 2. Use vernier caliper to measure diameter of round bar

Task 3. Use metric micrometer to measure diameter of round bar

Task 4. Use dial indicator to measure roundness/ run out of round bar

List of Reference Materials

- Modern Automotive Technology By: James E. Duffy
- Automotive Technician Training (ATT) Level 1 ;Tom Denton, BA, FIMI
- Modern Automotive Technology ; By Russell Krick

Unit Three: - Use hand tools and equipment

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

- Using all safety procedures and Personal Protective Equipment (PPE)
- Hazards and control measures
- Using Tools and equipment
- Reporting malfunctions, unplanned or unusual events

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:

- Use all safety procedures and Personal Protective Equipment (PPE)
- Understand hazards and control measures
- Use Tools and equipment
- Report malfunctions, unplanned or unusual events

3.1. Using all safety procedures and Personal Protective Equipment (PPE)

Personal protective equipment includes those prescribed under legislation/ regulations/codes of practice and workplace policies and practices. Safe operating procedures include the conduct of operational risk assessment and treatments associated with workplace organization.

The goals of occupational safety and health programs include fostering a safe and healthy work environment. OSH may also protect co-workers, family members, employers, customers, and

many others who might be affected by the workplace environment. Occupational safety and health can be important for moral, legal, and financial reasons.

Personal protective equipment (PPE) Selection

PPE selection should be based on a job hazard analysis (JHA), which includes evaluation of hazards,

specific tasks, procedures and work practices, in consultation with area supervision as needed.

This PPE selection guidance is not intended to be a comprehensive resource on PPE.

- Eye Protection
- Hand Protection
- Skin and Body Protection
- Foot and Leg Protection

Eye Protection

Safety glasses, safety goggles, laser eyewear, face shields and helmets provide a level of protection as designated by the manufacturer. The hazard and the protection standards for each piece of eye and face protection PPE must be considered during selection.

Table 3.1. Eye protection

PPE	Specific Type	Characteristics	Applications
Safety glasses Comply with ANSI Z87.1		Polycarbonate lens, side shields [Note: Personnel with corrective lenses will need "over-prescription" safety glasses or prescription safety glasses. See Appendix B for procedure to obtain prescription safety glasses]	Working with chemical, biological, radiation, physical hazards
Goggles Comply with ANSI Z87.1	Direct vented 	Allows the flow of air into the goggle. Protection from impact	Working with particulates [Tends to fog less, but should not be used with liquid or fine dust hazards]
	Indirect vented 	Provides protection from splash entry by a hooded or covered vent	Protection from particulates and from chemical splash
	Non-vented 	Provides protection against the passage of dust, mist, liquid and vapors	Protection from particulates, chemical splash, and mist, liquid and vapors
Disposable medical eye shield		Provides protection from splash, spray, spatter or droplets of blood or other potentially infectious materials. [Not ANSI Z87.1 compliant]	Health care, biological hazards [Note: Not for protection from chemical, physical, and impact hazards]

Hand Protection

Gloves should be selected for each procedure to provide protection from the hazards. In some circumstances there may be several hazards and glove selection may involve different gloves for different steps of the procedure and/or several layers of gloves may be needed to address all hazards. In general, heavy loose gloves should not be worn around moving machinery.

Table 3.2. Hand protection

PPE	Specific Type	Characteristics	Applications
Disposable gloves, thin-gauge* (<8 – 10 mils) [Note: Avoid powdered gloves - banned in medical use, possible inflammation and allergic reactions]	Disposable nitrile gloves 	Some chemical resistance – consult glove resistance chart, incidental chemical contact only	Working with biological hazards and chemical hazards of small quantity
	Disposable vinyl gloves 	Economical and thin	Working with biological hazards, not for chemical handling
	Disposable latex gloves 	Some chemical resistance – consult glove resistance chart, incidental chemical contact only [Note: some workers may be allergic to latex]	Working with biological hazards (known or potentially infectious materials including work with animals)
Leather gloves		Protect and comfort hands from moderate temperatures, sharp objects, damage by friction	Handling sharp objects and metal, field work, welding
Wire mesh gloves		Cut resistant	Working with sharp instruments or live animals

Skin and Body Protection

Laboratory coats, scrubs, uniforms and disposable body coverings provide a level of protection from splash hazards. Special hazards and material qualities such as flame resistance, specific chemical resistance, and physical strength (e.g., leather) and visibility should be considered when selecting PPE for skin and body protection.

Table 3.3. Skin and Body Protection

PPE	Specific Type	Characteristics	Applications
Aprons	Flame resistant (FR) apron 	Flame resistant (e.g. Nomex or flame-resistant cotton)	Working with flammable solvents, welding or electrical systems
	Rubber-coated wash apron 	Chemical splash protection, good abrasion resistance	Working with apparatus under pressure, splash potential of hazardous liquids
	Neoprene apron and sleeves 	Chemical resistant, tear resistant, splash protection	Working with apparatus under pressure, splash potential of hazardous liquids

Foot and Leg Protection

Foot protection may be simple disposable shoe covers to minimize spread of contamination. In food service and slip resistant shoes may reduce the risk of slips, trips and falls. In shops and industrial activities, the supervisor must evaluate the hazards and select foot protection accordingly.

Table 3. Foot and leg Protection

PPE	Specific Type	Characteristics	Applications
Shoe cover		Protection from dirt, dust; maintenance of hygienic work environments, non-slip soles	Working with biohazards, animal facilities, or potential floor contaminants
Foot/shin guards, knee pads		Typically strap on to legs or feet If hazard is severe, use safety shoes with metatarsal guards.	Use of high-pressure washers, protection of shins and feet when handling heavy materials. Protection of knees when kneeling.
Slip resistant shoes		Shoe with sole designed to enhance traction in slippery work environments	Working in animal facilities, custodial applications, food service facilities, medical/clinical settings, and shops
Safety shoes		Toe, metatarsal, foot protection, steel reinforcements and inserts. There are numerous types of safety shoes for specific applications. See Appendix B for information on obtaining safety shoes.	Handling heavy items, construction, warehouse applications, agricultural field work

Chart 3.1.4. Foot and leg protection

3.2. Hazards and control measures

Hazards in the work shop

- Faulty work habits
- Misuse of equipment
- Misuse of hand tools

Faulty work habits

- Smoking around fuel and solvents
- Incorrect handling of paint, thinners, solvent
- Blocking exits. A block exit could mean serious injury or even death during an emergency case such as fire.

Misuse of equipment's

- Incorrect safety guarding of moving machinery
- Misuse of flexible electric cords or worn cords. When used through holes the May cause fire
- Improperly stored composed gas cylinders
- Using hand held electric tools improperly grounded

Misuse of hand tools

- Keeping hand tools dirty and in poor conditions
- Improper storing of hand tools
- Using defective hand tools
- Keeping sharp tools in pockets

The hazards and types of PPE

Personal protective equipment

For personal safety, proper closing, Safety shoes, Working clothes/apron, Safety poster and Fire extinguisher, overhauls and housekeeping are necessary. Workshops should be clean free from idle equipment, spilt oil or grease. Cover long hair so it does not get caught in moving equipment. Were safety glasses any time we are in the shop to protect your eye. Gloves should be worn when working on rough or sharp metal and hot parts. Identified/ selected tools and equipment are checked for functionality and readied for use.

- **Eyes**

- ✓ Hazards: chemical or metal splash, dust, projectiles, gas and vapor, radiation.
- ✓ Options: safety spectacles, goggles, face shields, visors.



Fig.3.1. Eye protection

- **Head**

- ✓ Hazards: impact from falling or flying objects, risk of head bumping, hair entanglement.
- ✓ Options: a range of helmets and bump caps.

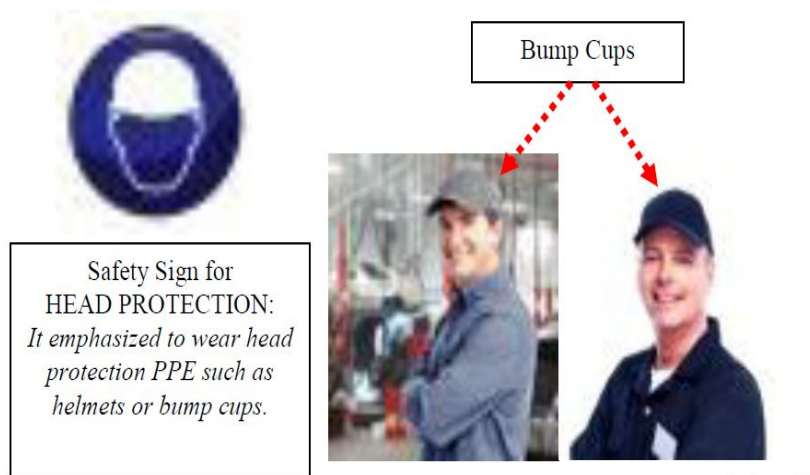


Fig.3.2. head protection

- **Protecting the body**

- ✓ Hazards: temperature extremes, adverse weather, chemical or metal splash, spray from pressure leaks or spray guns, impact or penetration, contaminated dust, excessive wear or entanglement of own clothing.
- ✓ Options: conventional or disposable overalls, boiler suits, specialist protective clothing, that is chain-mail aprons, high-visibility clothing.



Fig.3.3. Body protection

• Hands and arms

- ✓ Hazards: abrasion, temperature extremes, cuts and punctures, impact, chemicals, electric shock, skin infection, disease or contamination.
- ✓ Options: gloves, gauntlets, mitts, wrist cuffs, armlets.



Fig.3.4. Hand and arm protection

• Feet and legs

- ✓ Hazards: wet, electrostatic build-up, slipping, cuts and punctures, falling objects, metal and chemical splash, abrasion.
- ✓ Options: safety boots and shoes with protective toe caps and penetration-resistant mid-sole, gaiters, leggings, spat.



Fig.3.5. Feet and legs protection

Fire Prevention

- Store fuels properly
- Keep the shop doors open, will ventilation where fuel vapors can exit
- Wipe up the spilled fuel at once and keep the rags in a closed waste containers
- Never smoke or light a cigarette around fuels. (Do not smoke in the workshops!)
- Fix leaking carburetors, fuel pumps fuel lone and fuel tank immediately
- Make fine extinguishers available in the workshop and know perfectly well how to use them in case of fire

3.3.Using Tools and equipment

Rules for Wrench Use

- Always select the right size wrench
 - ✓ wrench must fit the bolt head snugly
- Never hammer on a standard wrench
 - ✓ use a longer wrench with more leverage or a special slug wrench, which is designed to be used with a hammer
- When possible, pull on the wrench
 - ✓ if the wrench slips, you are less likely to hurt your hand
- Never use a steel bar or pipe to increase the length of a wrench
 - ✓ excess force can bend or break the wrench

Rules for hammer use

- Select the right size hammer
- Always check that the hammer head is tight on the handle
- Use a brass, plastic, or dead blow hammer on parts and tools that can be damaged by a steel hammer
- Grasp the hammer near the end of the handle and strike the part or tool squarely

Using a bench grinder

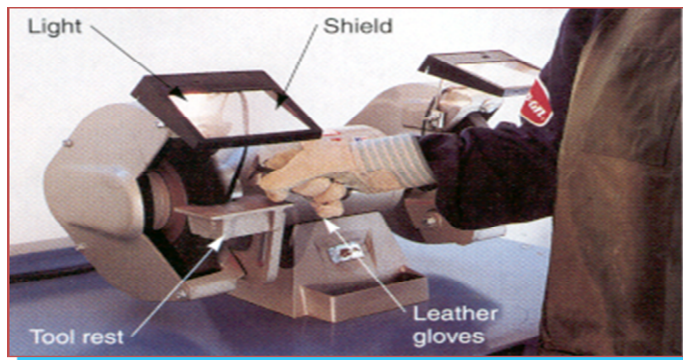


Fig.3.6. Using bench grinder

Bench grinder rules

- Always wear eye protection and keep your hands away from the wheel
- Make sure the grinder shields are in place
- Keep the tool rest adjusted close to the wheel
- Do not use a wire wheel to clean aluminum or brass parts

Using jumper cables

- Connect the red jumper to the positive terminal on the dead battery
- Connect the red jumper to the positive terminal on the good battery
- Connect the black jumper to the negative terminal on the good battery
- Connect the black jumper to a ground on the vehicle with the dead battery
- Remove the cables in reverse order



Fig.3.7. Using Jumper cables

Using floor jack

Raising a vehicle

- Place the transmission in neutral and release the parking brake
 - ✓ allows the vehicle to roll, preventing it from pulling off the jack
- Turn the jack handle clockwise and pump the handle
- After raising, secure vehicle on jack stands, shift it into park, apply the parking brake, and block the wheels

Lowering a Vehicle

- Use the jack to lift the vehicle off the jack stands
- Remove the jack stands, shift the vehicle into neutral, release the parking brake, and remove the wheel chocks
- Turn the handle counterclockwise slowly to release the pressure-release valve

3.4. Reporting malfunctions, unplanned or unusual events

Report is a document that presents information in an organized format for a specific audience and purpose

In the Reports tab, you can generate reports in Relativity to understand the progress and results of processing jobs. You can't run reports on processing sets that have been canceled. When you generate a processing report, this information is recorded in the History tab

Effective reporting

- The purpose of a report is to give an account of something, to offer a solution to a problem, or to answer a question.
- A good reporting process is a cyclical one that ensures that feedback and decision making can occur between organizations and contractors/funders.
- Reporting principles (transparency and inclusiveness) should be applied to any report preparation to ensure that both the writer and report user share a common understanding of the underpinnings of the report.

Types of reports

- Contractual reports are primarily required for accountability and performance assessment purposes. The key purpose of performance reporting and monitoring is to keep people focused on desired change and to help them decide what else needs to be done.

- Project reports should provide detail on the overall project at the point of completion. They should be written in a way that enables the reader to assess the quality and importance of the information with the aim of persuading the reader to agree with the conclusions and recommendations.
- Evaluation reports are normally prepared at the midpoint and at the end of a project/program. They generally cover most if not all evaluation indicators, including the relevance, efficiency, effectiveness, impact and sustainability of the project/program.
- An annual report is a good marketing tool that presents the actions and accomplishments of an organization during the financial year. It provides public evidence of financial stability and showcases the achievements of an organization.

Follow these three general principles to develop records and documents:

1. Keep it short and simple. Use bullet points and flow diagrams instead of long sentences and lengthy paragraphs.
2. Clarity is important. Step-by-step instructions are easily understood.
3. Use a standardized, consistent format. Although different programs may need different documents and records, using a similar approach will help staff learn quickly.

Problem reporting procedures

- Inspect/test the tools and equipment following correct procedures
- Record/ capture the problem with the necessary information
- Order the recorded problems in accordance with their damaging area
- Report to the assigned person for these problems
- Maintain damaging parts according to maintenance procedure
- Preparing reports have no error/discrepancy

Self-Check-3	Written Test
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Instructions: Read the following instructions and answer the questions. (2 points each)

I/ Choose the best answer

----- 1. Which of the following is true about fire prevention?

- A/ Storing fuels properly
- B/ Wiping up the spilled fuel at once and keep the rags in a closed waste containers
- C/ Not smoke or light a cigarette around fuels

D/ All are correct

----- 2. Which of the following are Problem reporting procedures includes are,

A/ Report to the assigned person for these problems

B/ Maintain damaging parts according to maintenance procedure

C/ Preparing reports have no error/discrepancy

D/ All are correct

II/ Match column “A” with column” B”

Column “ A”

----- 3. Safety glasses, safety goggles,

----- 4. Laboratory coats, scrubs, uniforms

----- 5. Gloves, gauntlets, mitts, wrist cuffs, armlets

----- 6. Safety boots and shoes with protective toe caps

Column “B”

A/ Feet and legs protection

B/ Eye Protection

C/ Skin and body protection

D/ Hands and arms protection

Operation Sheet 3.1	Jump starting a vehicle with dead battery by using jumper cables
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Purpose:- to start dead battery in the vehicle

Conditions or situations for the operations:-

- Safe working area
- Not Properly operating battery with vehicle
- Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments:

- Tool :- jumper cable

- Equipment's-
- Material/Machine :- a vehicle with dead battery

Procedures of using jumper cables to start a vehicle with dead battery

Steps:-

- Step 1. Connect the red jumper to the positive terminal on the dead battery
- Step 2. Connect the red jumper to the positive terminal on the good battery
- Step 3. Connect the black jumper to the negative terminal on the good battery
- Step 4. Connect the black jumper to a ground on the vehicle with the dead battery
- Step 5. Remove the cables in reverse order

Operation Sheet 3.2	Using Floor Jack to raise and lower a vehicle
---------------------	---

Purpose:- To raise and lower a vehicle

Conditions or situations for the operations:-

- Safe working area
- Properly operating floor jack
- Appropriate working cloths fit with the body

Equipment tools, materials and measurement instruments:

- Tool :- Floor jack
- Equipment's- Safety stand
- Material/Machine :- a vehicle

Procedures of using floor jack to raise and lower a vehicle

Steps:-

Step 1. Raise a Vehicle

- Place the transmission in neutral and release the parking brake
 - ✓ allows the vehicle to roll, preventing it from pulling off the jack
- Turn the jack handle clockwise and pump the handle
- After raising, secure vehicle on jack stands, shift it into park, apply the parking brake, and block the wheels

Step 2. Lower a Vehicle

- Use the jack to lift the vehicle off the jack stands

- Remove the jack stands, shift the vehicle into neutral, release the parking brake, and remove the wheel chocks
- Turn the handle counterclockwise slowly to release the pressure-release valve

LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4:00hour.

Task 1. Use Jumper cable to start a vehicle with dead battery

Task 2. Use a four jack to raise and lower a vehicle

List of Reference Materials

- Modern Automotive Technology By: James E. Duffy
- Automotive Technician Training (ATT) Level 1 ;Tom Denton, BA, FIMI
- Modern Automotive Technology ; By Russell Krick
- Learning guides from module using hand tools and equipment

Unit Four: - Maintain tools and equipment

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

- Cleaning and Lubricating tools, equipment and measuring instruments
- Repairing and adjusting simple tool
- Re-storing techniques of tools and Equipment

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:

- Clean and Lubricate tools, equipment and measuring instruments
- Repair and adjust simple tool

- Re-store techniques of tools and Equipment

4.1. Cleaning and Lubricating tools and equipment

Cleaning Tools

- Scrapers
 - ✓ Remove grease, gaskets, sludge, dried oil, and carbon on parts
 - ✓ Used on flat surfaces
 - ✓ When using a scraper, never scrape toward your body and keep your free hand out of the way
- Brushes
 - ✓ used to remove light rust and dirt on parts

Keep Tools Clean

- Wipe tools clean and dry after each use
- Greasy or oily tools can be dangerous!
 - ✓ it is easy to lose your grip on a dirty tool
- Cleaning also prevents corrosion from forming on **the tools**

Cleaning a caliper

Before using your caliper you should wipe the measuring faces with a rag to make sure that they are clean.

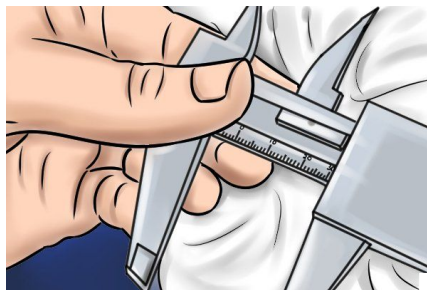


Fig.4.1. Cleaning vernier caliper

Cleaning Micrometers

The correct procedure for cleaning a stage micrometer is

- Remove as much dust and dirt as possible from the stage micrometer surface with a blower, compressed air, soft-bristle brush or cotton-tipped swabs (don't use a cloth or paper towel, or sponge)

- To further remove the remaining dirt and oil from the stage micrometer use only the following items: lens cleaning tissue, microfiber cleaning cloth or anti-static cleaning cloth with a lens cleaning solution (i.e. Reagent-Grade Isopropyl Alcohol, Reagent-Grade Acetone, etc. type solution).
- Put the lens cleaning solution on to the cleaning cloth (not directly on to the stage micrometer)
 - ✓ Gently rub the stage micrometer with the cleaning solution on the non-abrasive cloth
 - ✓ Use a second, dry, cleaning cloth to wipe off the excess liquid
 - ✓ Let the stage micrometer dry
 - ✓ Repeat as needed

A second option that can be used to clean a stage micrometer is just your breath and a clean cleaning cloth.



4.2.Repairing and adjusting simple tool

Fig.4.2. Cleaning micrometer

Routine Maintenance is a small scale activity to keep a piece of equipment in working order. Routine maintenance is the upkeep practices that an organization performs on a regular basis with an eye towards preventing harm to workers and large-scale, expensive repairs.

Routine maintenance, also called planned maintenance, often involves scheduling, at which time machines, including computer systems, or other assets are examined, updated or tuned up. This scheduled effort may require ordering spare parts or running diagnostics. Regular maintenance like this avoids catastrophic breakdowns in equipment and allays the greater costs associated with those repairs. Additionally, these precautions enhance worker safety, especially for those operating the equipment in question.

Before making the first set up of the day, visually inspect the instrument for cracks, bumps, and dents. Check the machined surfaces and the polished faces of the lenses and mirrors. Like,

Frequently clean the instrument externally.

Dirt and dust should be removed only with a clean soft cloth or with a camel hair brush.

Clean the external surfaces of lenses with a fine lens brush and, if necessary, use a dry lens tissue.

Cover an instrument whenever it is uncased and not being used for any length of time, particularly if there is dust or moisture in the air.

Apply 5S as work regulation.

Make sure equipment is:

Well looked after and properly stored when it is not being used, for example in a dry, clean cupboard, or in the case of smaller items, such as eye protection, in a box or case;

Kept clean and in good repair - follow the manufacturer's maintenance schedule (including recommended replacement periods and shelf lives).

Key points to remember

Are there ways (other than PPE) in which the risk can be adequately controlled, that is engineering controls? If not, check that:

PPE is provided;

It offers adequate protection for its intended use;

Those using it are adequately trained in its safe use;

It is properly maintained and any defects are reported;

It is returned to its proper storage after use.

4.3. Re-storing techniques of tools and Equipment

Proper storage of tools and equipment

The proper care and storage of tools and equipment's are not only the concern of the management but of the workers who use the equipment.

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis.

- The location of the stockpiles should not interfere with work but they should still be readily available when required.
- Stored materials should allow at least one meter (or about three feet) of clear space under sprinkler heads.

- Stored materials should not obstruct walkway, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.
- Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose.
- Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your authority.
- Before cleaning or repairing equipment check to make sure that tools and equipment's are in good condition.
- They should be stored in a separate secure place so that they are safe and easy to find. This is usually best done in a place which is separate from the office.



Fig.4.3.. Proper storage of tools and equipment

Importance of proper storage of tools and equipment's

- It is important factor for safety and health as well as good business.
- Improves appearance of general-shop and construction areas.
- Reduce overall tool cost through maintenance.
- This also ensures that tools are in good repair at hand.
- It is important factor for safety and health as well as good business.
- Teaches workers principles of tool account
- Each workers principles of tool accountability.

Fig.4.3.1. Proper storage of tools

All tools are stocked within the store.The "Tool distribution register" normally includes:

- Name of the person receiving thetool;
- Marking of the tool, part number, serial number (if applicable);
- Where the tool is going to be used (tail number of the aircraft);

- Date and time of delivery
- Date and time of return.

Pointers to follow in storing tools and equipment's,

- Have a designated place for each kind of tools.
- Store them near the point of use.
- Wash and dry properly before storing.
- Store sharp edge materials properly when not in use with sharp edge down.
- Put frequently used items in conveniently accessible conditions.
- Gather and secure electrical chord to prevent entanglement or snagging.
- Cutting boards should be stored vertically to avoid moisture collection
- Metal equipment's can be stacked on one another after drying.
- Make sure the areas where you are storing the equipment are clean, dry and not overcrowded.
- Tool Storage
- Toolbox
 - ✓ **Stores and protects a technician's tools when not in use**
- **Toolbox Parts**
 - ✓ **lower roll-around cabinet holds bulky, heavy tools**
 - ✓ **upper tool chest holds commonly used tools in easy reach**
 - ✓ **small carrying tray is placed in the upper tool chest and allows tools to be taken to the vehicle more easily**

Toolbox

Never open more than one drawer at a time

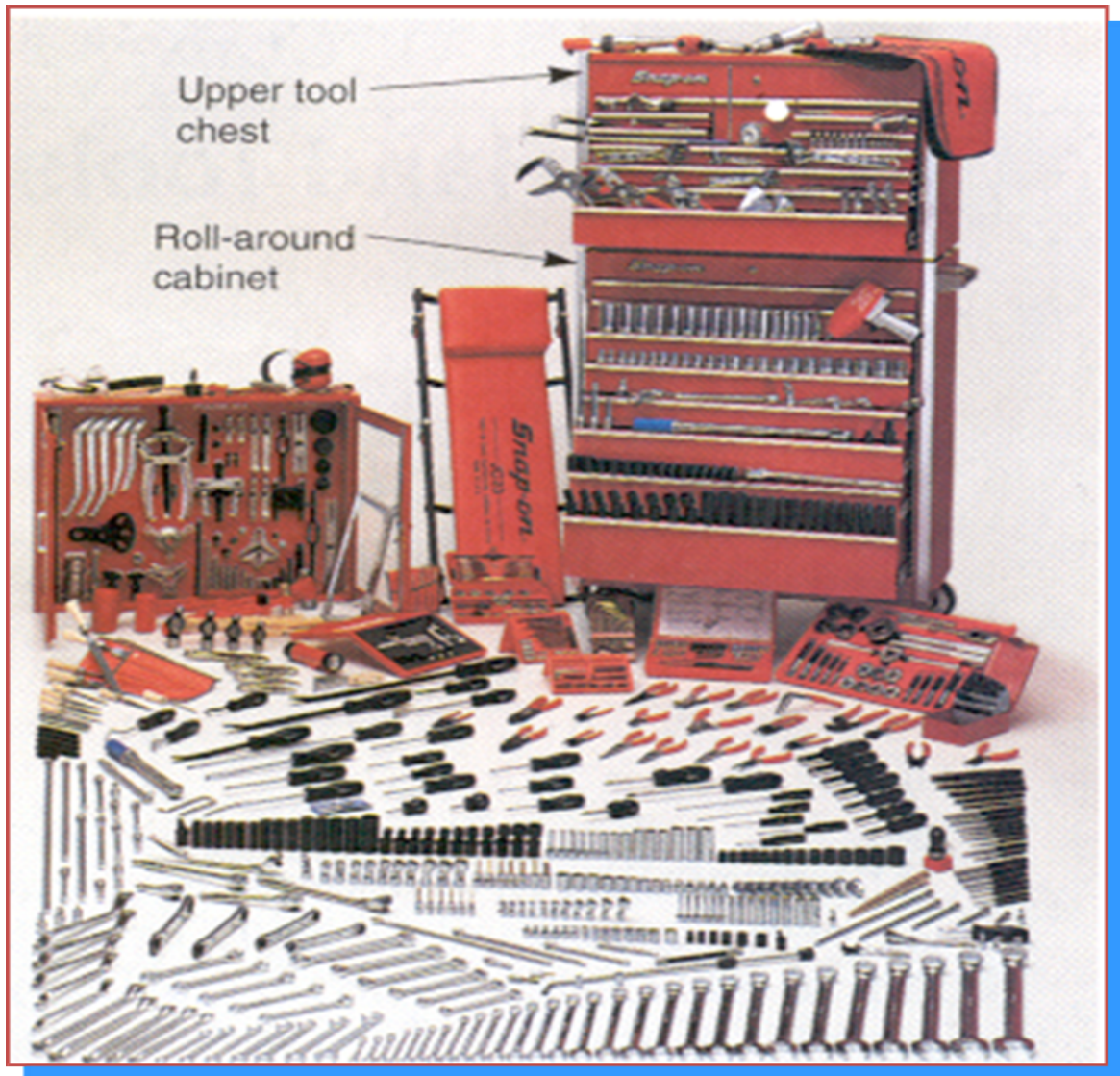


Fig.4.4. Tool box

Toolbox Organization

- Related tools are usually kept in the same drawer
 - ✓ various types of hammers may be stored in one drawer and all screwdrivers in another
- Small or delicate tools should not be kept with large, heavy tools to prevent damage
- Tool holders help organize small tools

Self check 4	Written questions
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Directions: Answer all the questions listed below (each 2 points).

I/ Choose the best answer

- 1. Storing tools and equipment's in the follows is
- A. Have a designated place for each kind of tools.
 - B. Label the storage cabinet or place correctly.
 - C. Store them near the point of use.
 - D. All
- 2. Which of the following is importance of proper storage of tools and equipment?
- A. Improves appearance of general-shop and construction areas.
 - B. Reduce overall tool cost through maintenance.
 - C. Ensures that tools are in good repair at hand.
 - D. All
- 3. Routine maintenance, also called-----.
- A. planned maintenance
 - B. Preventive maintenance
 - C. Corrective maintenance
 - D. All

II/ Give short answer

4. Write the two kinds of cleaning tools mostly used
- a/ -----
- b/ -----
4. List about five things that The "Tool distribution register" normally includes:
- a/ -----
- b/ -----
- c/ -----
- d/ -----
- e/ -----

Operation Sheet 4.1	Cleaning Micrometer
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Purpose:- to make graduations seen clearly and to extend its service life

Conditions or situations for the operations:-

- Safe working area
- Dirty micrometer
- Appropriate working cloths fit with the body

Equipment tools and materials an measurement instruments:

- Tool :- micrometer
- Equipment's- blower, Compressor bench
- Material/Machine :- Brushes, cotton-tipped swabs

Procedures of cleaning micrometer

Steps:-

Step 1. Remove as much dust and dirt as possible from the stage micrometer surface with a blower, compressed air, soft-bristle brush or cotton-tipped swabs (don't use a cloth or paper towel, or sponge)

Step 2. To further remove the remaining dirt and oil from the stage micrometer use only the following items:

- Lens cleaning tissue, microfiber cleaning cloth or anti-static cleaning cloth with a lens cleaning solution (i.e. Reagent-Grade Isopropyl Alcohol, Reagent-Grade Acetone, etc. type solution).

Step 3. Put the lens cleaning solution on to the cleaning cloth (not directly on to the stage micrometer)

- Gently rub the stage micrometer with the cleaning solution on the non-abrasive cloth
- Use a second, dry, cleaning cloth to wipe off the excess liquid
- Let the stage micrometer dry
- Repeat as needed

LAP Test 4	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00hour.

Task 1. Clean a micrometer

List of Reference Materials

- Modern Automotive Technology By: James E. Duffy
- Automotive Technician Training (ATT) Level 1 ;Tom Denton, BA, FIMI
- Modern Automotive Technology ; By Russell Krick
- Learning guides from module using hand tools and equipment

Participants of this Module (training material) preparation

No	Name	Qualification (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Mathewos Markos	A(MSC)	AutomotiveTechnology/TVET Leadership and management	Durame P. T.C	0911062645	Birukmark2009@gmail.com
2	Tesfaye Bedada	A(MSC)	Automotivetechнологy	Hawassa P.T. C	0927831195	Tesfayebedada51@gmail.com
3	Biratu Desalegn	A(MSC)	Automotive	Ambo PTC	0913033783	Biratudesalegn01@Gmail.com
4	SenaitWagshumAsmar	A(MSC)	Automotive technology	w/ro shieen poly technical collage	0913282217	Senaitwagshum2@gmail
5	Zinabu solomon	B(Bsc)	Motor vehicle engineering	MGMBPTC	0960964523	zinabusolomon565@gmail.com

