

Biomedical Equipment Servicing

Level – II

Based on September 2021, curriculum Version-II



MODULE TITLE: Identifying and Hand Tools and Measuring
Instruments

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Acronyms

AC	Alternating Current
DC	Direct Current
DMM	Digital Multi-meter
MoH	Ministry of Health
MoLS	Ministry of Labor and Skill
PCB	printed circuit board
PPE	personal protective Equipment
LCD	Liquid crystal display
OSHS	occupational safety and health standard

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Introduction to Hand Tools and Measuring Instrument

A tool is a piece of equipment that can be utilized to complete tasks without being consumed during the process. It can be considered as an extension of the human hand, increasing speed, power, and accuracy. Tools can be either hand tools or power tools. Almost any tool can be a hand tool, though many have also been adopted as power tools, which are propelled by electric power rather than people. A hand tool is a device for performing a specific task that does not need electric power to use and is driven solely by the person using it. Electrical and electronics hand tools, which are manipulated by hands without using electrical energy, are: screw driver, wrench, pliers, hammer, and others. Power tools are tools manipulated by our hands and with the use of electrical energy. These are electric drill, grinding wheels, vacuum cleaner and others. Besides hand tools in electrical and electronics, test equipment is necessary to establish the existence of an electric flow and measure electrical quantities and establish safe conditions for the use of electrical apparatus. Electrical test instruments therefore are devices which establish the existence and value of electrical force or electrical operation. So, a user must have, choose, and use the correct tools in order to do the work quickly, accurately, and safely. Without the proper tools and knowledge of how to use them, the user wastes time, reduces efficiency, and may face injury.

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Module units:

1. Hand tools and measuring instruments
2. Hand tools and measuring instrument preparation
3. General hand tools and measuring instrument operations
4. Hand tools and measuring instruments maintenance

Learning objectives of the Module

At the end of this session, the students will be able to:

- Identify hand tools and measuring device
- Plan and prepare hand tools and measuring device used at work station
- Use hand tools and measuring device at workstation
- Provide quality service for measuring instruments and manage hand tools

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Unit One: Hand Tools and Measuring Instrument

This learning guide is developed to provide you the necessary information regarding the follow content coverage and topics –

- Electrical and electronic hand tools and test instruments
- Identification of tasks to be undertaken by test tools
- Electrical tools and measuring instrument work station preparation

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, completion of this Learning Guide, you will be able to –

- Identify Tasks to be undertaken properly
- Identify and select Appropriate hand tools and test instruments according to the task requirement
- Make Workstation ready in accordance with job requirements or specifications.

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below 3 to 6.
- Read the information written in the information Sheet
- Accomplish the “all self-checks respectively
- If you earned a satisfactory evaluation from the “Self-check” proceed to the next information sheet
- Do all “LAP test” (if you are ready).

1.2 Electrical and Electronic Hand Tools and Test Instruments

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When working in electrical and electronic equipment repair, you must be familiar with how the tools work. A tool is a device that can be used to make something or complete a task but is not consumed in the process. It can be thought of as an extension of the human hand, increasing speed, power, and accuracy, and it also includes any machine powered by electricity.



Figure 1: Electrical and electronics hand tools and measuring instruments

1.2 Classification of Electrical and Electronic Tools

Tools are classified based on energy they consume when using at work station.

1. Hand tools are tools manipulated by hands without using electrical energy. These are puller, hacksaw, pull-push rule, pliers, hammer, and others.
2. Power tools are tools manipulated by our hands and with the use of electrical energy. These are electric drill, grinding wheels, vacuum cleaner and others.
3. Pneumatic tools are tools or instruments activated by air pressure. Pneumatic tools are designed around three basic devices: air cylinder, vane motor, and sprays

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Figure 2: Different types of electrical and electronic tools

1.2.1 Hand Tools

1. Screw Drivers

A screwdriver is a device used to tighten or loosen screws. It has a head or tips that connect with a screw, mechanism to apply torque by rotating that tip, and a way to position and support the screwdriver. A typical manual screwdriver is made up of a roughly cylindrical handle, with a shaft fixed to the handle, including a tip shaped to fit a particular type of screw. The handle and shaft support and position the screwdriver, and apply torque when rotated. The blade is made of tempered steel so it will resist wear, bending, and breaking.

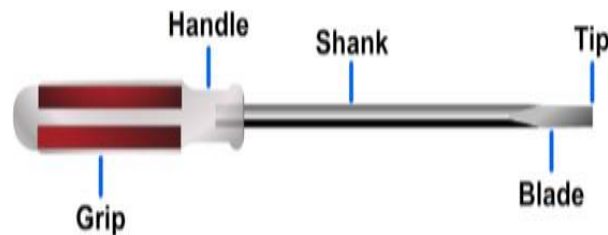


Figure 3: Parts of screwdrivers

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Screwdrivers are classified as slotted, Phillips head, or Robertson (square recess) head, with round or square shanks available for all three types. The type of metal in the blade, the finish, and the amount of grinding on the tip all contribute to the overall quality of a screwdriver. Other quality indicators include the material used in the handle and the bar's attachment to the handle. Under pressure, low-quality blade metal will chip and crumble. If the tip is improperly ground and flares excessively, it will protrude from the screw slot. If the blade is not securely attached to the handle, it will eventually loosen and slip inside. A wide range of screwdriver tips are available: regular, cabinet, Phillips, Frearson, Torx®, clutch-head, hex and square-tipped and others.



Figure 4: Different types screwdrivers based on their shape of tip

Regular or slotted tips are used with large, heavy screws. The tip is flared so it is wider than the driver bar. Quality drivers with regular tips should be accurately ground for uniformity. Blades should not taper too sharply from the tip because an improperly tapered tip has a tendency to rise out of the screw slot.

Cabinet tips are similar to regular tips, but they have no flare. They are straight for use with small screws and countersinking screws where regular tips with a flare would mar the wood or material on the side.

Phillips head drivers are used on cross-slotted screw heads with modified, U-shaped slots of uniform width. Sizes range from 0 to 4, with 0 being the smallest.

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Frearson screw heads are similar to Phillips. They have cross-slots, but they are V-shaped slots with tapered sides. While a cross-slotted driver will fit many sizes of the type of screw for which it is intended, it is best to use drivers of the proper sizes.

Torx® drive system provides six lobular drive surfaces mated from lobes of the driving and driven elements. Drive surfaces have vertical sides that permit the maximum torque application to assure reliable clamping force.

Clutch-head tips have four points of contact. They lock into the screw head when turned counter - clockwise. The driver is unlocked by turning it in the opposite direction. Because of the many contact points, the tip will not damage the screw head.

Hex (hexagonal) tips are used in repair work in the electronics field, particularly in radio and television repair. They are used to tighten socket set screws and usually come in sets. Some sets are attached to and fold into a metal carrying case. Other variations include T-shaped hex tools with vinyl grips and L shaped keys for greater torque power.

Square-tipped (Robertson) screwdrivers have become more common recently because of increased do-it-yourself decking projects. The screwdrivers have a square head and range in sizes from 0 to 3 and jumbo. The square head on the driver helps grip the screw on all four sides to provide maximum torque.

Multi-bit screwdrivers allow the user to have a number of different types of tips in one tool. Some products keep the interchangeable bits in a self-contained unit.

Offset screwdrivers are designed for removing and inserting screws in places where it is impossible to use a straight shank screwdriver. They are available in many combinations of slotted and Phillips head tips and with ratchet type mechanisms.

Some screwdrivers are designed with magnetized tips, convenient when guiding screws to holes or otherwise inaccessible areas. They also retrieve dropped screws and nuts. Other have split-points that can be expanded in width to fill the screw slot and hold screws when guiding into inaccessible areas. A spring clamp that fits over the screw head, holding the bit in the slot, serves a similar purpose. There are even screwdrivers that feature lights on the handles to allow the user to work in dimly lit areas.

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Specialty Screwdrivers: This group includes offset screwdrivers, used in places impossible to reach with ordinary drivers, screwdrivers with external screw-gripper or screw-holder blades to start screws in hard-to-reach spots, and offset screwdrivers with ratchets.

Hex Nut Drivers Hex nut drivers are similar to screwdrivers, but have a hex opening more like wrench sockets than screw tips. They are used to drive or remove small hex nuts or bolts and in confined areas such as electronic equipment, car ignitions and plumbing jobs. They come in several sizes and styles, with a fixed size or variable-size "socket" at the end.

Spiral-Ratchet Screwdrivers A spiral-ratchet screwdriver uses a mechanism similar to a push-pull drill. It has an adjustable chuck to permit interchanging of different tips and points. Ratchets drill and remove screws. Pushing straight down on the handle provides driving action.

High-Torque Ratchet Screwdrivers These screwdrivers feature a 360-degree ball as a handle with a ratchet mechanism that eliminates the need to grip and re-grip during the driving process. The wider gripping surface generates more torque than conventional screwdrivers. The amount of additional torque varies with the model. These high-torque ratchet screwdrivers come with interchangeable blades.

SCREW NUMBER	0	1	2	3	4	5	6	7	8	9
REGULAR BLADE WIDTH	3/32"	1/8"	1/8"	1/8"	5/32"	3/16"	3/16"	7/32"	1/4"	1/4"
CROSS- SLOT BLADE	No. 0		No. 1			No. 2				
SCREW NUMBER	10	12	14	16	18	20	24	7/16	1/2	9/16
REGULAR BLADE WIDTH	5/16"	3/8"	3/8"	3/8"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
CROSS-SLOT BLADE	No. 3				No. 4					

Figure 5: Size of Drivers to Use for Different Size Screws

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2. Pliers

Pliers are used to hold, turn and cut objects and they are varying in length from 4" to 20". Some pliers are available with factory applied, plastic-coated handles, providing an attractive appearance and comfortable grip. However, these pliers should not be relied on for electrical work. **Pliers fall into two broad categories:** solid-joint and slip-joint, either of which may have cutters. **Solid-joint pliers** have a joint fixed with a solid pin or rivet and are not adjustable. **Slip-joint pliers** are of two designs: multiple hole and tongue and groove. The slip or adjustable joint enables the tool to adjust to the size of the object being held. **Solid-joint pliers** have a joint fixed with a solid pin or rivet and are not adjustable.

Cutting pliers can be side, end or diagonal types. Side cutters have a cutting blade on one side only and are available in long-, curved- and short-nose types. End cutters have cutting blades on the end and are used to make sharp, clean cuts close to the surface on wires, bolts and rivets. Diagonal cutters have two cutting blades set diagonally to the joint and/or handles. Some cutting pliers are made with a spring in the handle to open them automatically after each cut, providing ease and comfort for the user.

Other pliers commonly found in home improvement stores include:

Regular slip-joint pliers: General utility pliers with two jaw-opening adjustments. Some have shear-type wire cutter.

Thin jaw slip-joint pliers: Like slip-joint, but made with a slim nose to reach into tight places.

Multiple slip-joint or box-joint pliers: General utility tool with up to eight adjustments, allowing for jaw openings up to 4-1/2", either multiple hole or tongue and groove. Straight and curved jaw are available. Most common is 10" water pump pliers.

Crimper stripper pliers: multi-purpose electrician's pliers to crimp solder less connectors, strip most common gauge wire, cut and hold or bend wire. They also have sheaving holes that cut common sizes of screws without deforming threads.

Needle-nose pliers: Also called long nose pliers, they have a pointed nose for reaching place with restricted clearance, may have side cutters. A standard item for most electrical and electronics work.

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Thin-nose pliers: Also called bent-nose pliers, since the nose is bent at about an 80-degree angle for reaching around objects.

Duck bill pliers: have long, tapered, flat noses for work in restricted areas. Used by jeweler's telephone workers and weavers.

Midget pliers: Include straight, chain, round, end-cutting, diagonal-cutting and flat-nose pliers in extra-small sizes.

End-cutting nippers: Feature powerful leverage for sharp, clean cuts close to the surface of wires, bolts and rivets.

Lineman's or electrician's pliers: Heavy duty, side-cutting pliers designed for all regular wire cutting needs. Have gripping jaws in addition to cutting edges. High-leverage lineman's pliers have rivet placed closer to the cutting edges to provide more leverage.

Fence pliers: Pull and cut staples in fencing. Feature two wire cutters and heavy head for hammering.

Locking pliers: Adjustable, vise-type locking pliers can be locked on to a work piece, leaving both hands free. They are versatile tools that can be used as pliers, a pipe wrench, an adjustable wrench, wire cutters, a ratchet or a clamp. Locking pliers are available in various sizes and shapes: curved jaw with wire cutter, straight jaw, long nose with wire cutter and bent nose with wire cutter. The locking principle also applies to locking clamps, which come in 4", 6", 11", 18" and 24" sizes. Some locking pliers use a mechanism that allows one-handed release; others require two hands to disengage. In addition, many locking pliers provide a wire-cutting function, some from a full range, and others from a restricted range of jaw settings.

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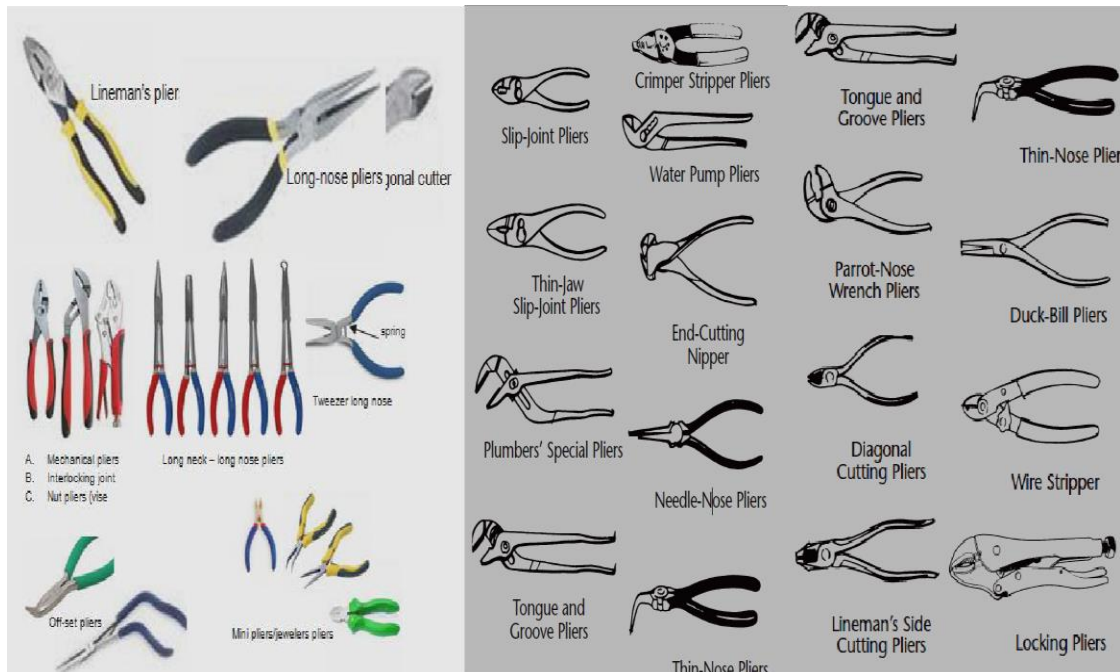


Figure 6: different types of pliers

Wire strippers: Feature adjustable stops to cut insulation without damaging wire



Figure 7: multi-purpose wire striper

3. Hammers

Nail Hammers

There are two basic nail hammers are curved claw and straight claw. A **curved claw hammer** is used most often in a home for general carpentry and household chores. It should be used

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only with non-hardened, common or finishing nails. The curved claw offers leverage in removing nails and can also cradle a 2x4. A **straight claw (ripping hammer)** is more likely to be used by professionals to rip apart nailed wooden components. It is a slightly heavier tool, used for heavier carpentry, framing and ripping. It should also be used only with non-hardened, common or finishing nails. Common head weight is 7 oz. for light duty driving; 10 oz. and 13 oz. for cabinetmakers and householders; 16 oz. for general usage and 20 oz. for heavy crating or framing. All sizes are available with curved claw while the straight claw comes in 10-, 12-, 16, 20-, 24-, 28- and 32-oz. weights. Straight claw hammers are now available with milled or checkered faces to grip the nail head and reduce the effect of glancing blows and flying nails. Two innovations in the field of nailing hammers are hammers with interchangeable striking faces and hammers that hold nails. The interchangeable striking faces allow one Hammer to be used for several different applications. The striking faces include milled and checkered. The hammer with a nail-holding notch makes it safer and easier to start a nail and also extends the reach of the user. Nail hammers may have handle made of a number of materials—wood, fiberglass, graphite, solid steel or tubular steel. Each offers a different combination of stiffness for efficiently delivering the force of the blow to the target and shock absorption to reduce shock and stress on the user's hand, wrist and arms.

Wood flexes and offers some degree of shock absorption. Stiffer materials such as graphite or steel deliver the full force of the blow but require cushioning in the jacketing and grip to provide long term user comfort. Steel handles are the heaviest, while wood-handled hammers are the lightest and least expensive. Nail hammer handles are available in a variety of lengths from 13" to 18".

Ball Peen Hammers Ball peen (ball peen) hammers are used with small shank, cold chisels for cutting and chipping work, rounding over rivet ends, forming unhardened metal work and similar jobs not involving nails. The striking face diameter should be approximately 3/8" larger than the diameter of the head of the object being struck. The hammer is designed with a regular striking face on one end and a rounded or half ball or peen on the other end taking the place of a claw. The hammer face is heavier than the peen end. Hammer sizes range from 2 oz. to 48 oz. Twelve and 16 oz. are most popular.

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Hand Drilling Hammers Hand drilling hammers, weighing between 2 lbs. and 4 lbs., are easy to handle with a powerful punch. They have short handles and are recommended for pounding hardened nails into concrete or for using with tools that drive nails and pins into concrete or brick. They are the only hammers to use with star drills, masonry nails, steel chisels and nail pullers. A larger striking surface, generous bevel and special heat-treating minimize the chance of chipping the striking face.

Sledge hammers Sledgehammers are used for extremely heavy jobs where great force is required. They have long handles ranging from 14" to 36" and heavy heads that weigh from 2 lbs. to 20 lbs. Sledges can be double-or single-face. Many sledgehammers are now available with lighter, balanced, reinforced plastic handles for easier use and better weight distribution.

Mallets have rubber, plastic, wooden or rawhide heads and are used to drive chisels or hammer joints together. With the exception of wooden mallets, sizes are specified in either head weight or diameter, such as 2-1/4". Wooden mallets are specified by head diameter only. There are variety of mallet shapes and sizes for specific tasks. A carpentry mallet with an angled head provides a natural strike resulting in less wrist and arm fatigue. A shop mallet with an octagonal head is used for flat strikes, while a pestle-shaped mallet with a round horizontal strike is generally used with a chisel or other carving tools. A rawhide mallet is used in furniture assembly shaping soft sheet metals or any task that requires non-marring blows.



Figure 8: Hammers

Specialty Hammers include riveting hammers to set rivets; setting hammers to close and open seams and dress edges in tin work; straight and cross-peen hammers for riveting, stretching and bending metal; scaling and chipping hammers for general chipping in welding and cleaning torch cuts; brick hammers for cutting and setting brick and tile hammers to set tile. Others

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include soft-face hammers for assembling furniture and wood projects and setting dowels (won't mar the surface with the blow); dead blow hammers that contain lead shot for additional power and reduced tendency to bounce (many features non-marring and non-sparking striking faces); magnetic tack hammers for furniture upholstery; drywall hammers that score, sheet and set nails for drywall work and finishing hammers for cabinet making, finishing and other fine carpentry and light chores.



Figure 9: different types of hammers

4. Wrench

A **wrench** is a tool specially designed to tighten or loosen nuts, bolts, studs, and pipes. **Wrenches** are forged from steel alloy to prevent breakage. Wrenches can be classified as general use or plumbing wrenches. Top-quality wrenches are forged from fine grade tool steel, machined to close tolerances, hardened and tempered for long life service. Most types are sold individually and in sets of various sizes. Because most imported products are made to metric specifications, a set of metric wrenches has become a must in many home workshops.

A wrench's main function is to hold and turn nuts, bolts, caps, screws, plugs and various threaded parts. Applying excessive torque will strip or damage those threads, so quality wrenches are designed to keep leverage and intended load in safe balance. Users should not put "cheaters" on wrenches to increase leverage. The proper size wrench should be used. Too

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large a reach will spread the jaws of an open-end wrench or damage the points of a box or socket wrench. When possible, a wrench should be pulled, not pushed.

Open-end wrenches provide gripping power on two sides of the head with another side open so the wrench can be placed on a nut, which might not be accessible to a closed or box wrench. Open-end wrenches have different size openings on each end and should fit the nut exactly to prevent mutilating the nut edges.



Figure 10: Open end wrench

Box (box-end) wrenches have enclosed heads and provide more leverage by completely enclosing the nut. Some are offset to provide knuckle room and clearance over obstructions. They range in size from 4" to 16" long and are available with either 6- or 12-point rings.

Combination wrenches have a box and an open end on opposite sides of the same wrench. Both ends are usually the same size. They are used for working on machinery and are the most popular of all fixed end wrench styles. Also available is a reversible ratcheting combination wrench that allows the user to quickly tighten nuts and bolts without lifting the wrench off a repositioning it after each rotation.

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Figure 11: Combination wrench

Adjustable wrenches come in two styles: locking and non-locking. Non-locking styles feature an adjustable end opening with little provision made for slippage. The locking style also has an adjustable head, but uses a locking mechanism to secure jaws in desired position, eliminating the need for constant readjustment. When properly adjusted to a nut or bolt, it will not slip.



Figure 12: Adjustable wrench set

Pipe (Still son) wrenches screw pipes into elbows or other threaded devices. Jaws actually bite into the surface to hold it for turning. They should never be used on plated pipe installation because they will badly scar the finish. Aluminum pipe wrenches are popular among professionals because of their lighter weight, but they are more expensive.

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Socket wrenches combine an offset handle with a male drive piece that has a spring-loaded bearing to lock on various size sockets. They can be used at almost any angle since handles may be attached to the head by a jointed hinge device. Many socket wrenches have a ratchet handle making reversing possible in confined spaces. The most common type is the detachable socket wrench, with square drive for hand use. Common square drive sizes are 1/4", 3/8" and 1/2", and these are normally used in conjunction with a ratchet wrench. Sockets are available with 6-, 8- and 12- point gripping ends, in a full range of inch and metric sizes. A socket wrench combined with ratchet wrench makes the job of tightening or loosening nuts and bolts faster and easier than conventional wrenches.

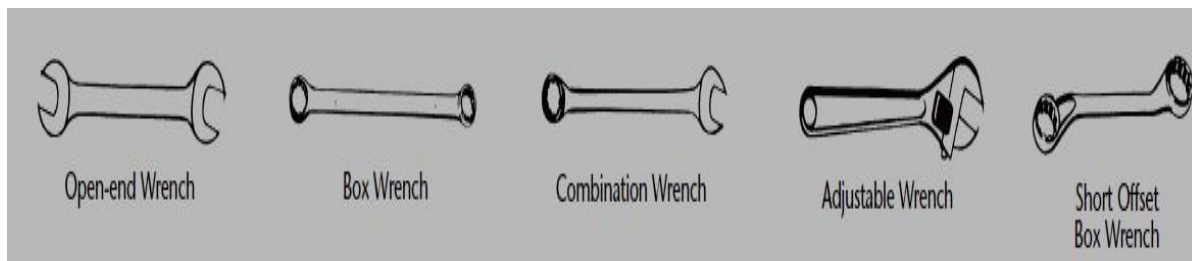


Figure 13: Types of Wrenches

Flare nut wrenches are flared to fit hex fittings.

Hex-key wrenches are short, L-shaped tools designed to turn bolts or screws with hexagonal heads. They also come in sets of different-sized wrenches.

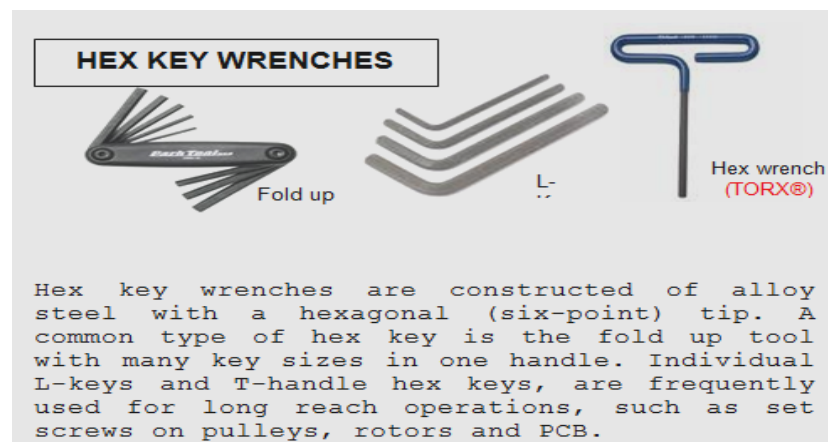


Figure 14: Type of Hex-key wrenches

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Ratchet wrenches are available in 1/4", 3/8" and 1/2" drive sizes and are used with socket wrenches. They are available with a round or teardrop-shaped head and contain a reversing mechanism to facilitate tighten tightening or loosening a fastener. Ratchet wrenches are available in a variety of handle shapes and lengths. Accessories that can provide a drive means to socket wrenches include flex handles, speeder handles and T-handles. Extensions of various length and universal joints can be used with ratchet wrenches and socket wrenches to work o fasteners in hard-to reach locations.

Locking wrenches are among the most versatile hand tools found in the home or shop. Through a locking action, jaws can be locked in a holding position with pressure up to 1 ton. They can also be used as hand vises, holding clamps, pipe wrenches and hand-vise pliers. They are available with both curved and straight jaws.

Torque wrenches are designed to permit an operator to determine applied torque on bolts, nuts and other fasteners. They measure torque in ounce-inches, pound-inches and pound-feet, as well as metric measure. However, many manufacturers express torque in foot-pounds (rather than pound feet) since this nomenclature is more familiar to the average tool user. Two basic hand torque wrenches are audible signal and visual display. The audible signal type signals applied torque by momentarily releasing the wrench for a few degrees of free travel. The release is usually accompanied by a click sound, which gives the wrench its popular names: click torque wrenches or clickers. Torque value is set to a micrometer scale on the handle or preset by an adjusting screw in the handle cavity. The visual display type indicates applied torque on a dial or electronic display. Some models have memory pointers that remain at the maximum reading attained until manually reset. For low-torque application, torque screwdrivers are usually used. They are available in either the release or indicating type. The most widely used torque wrenches have square drives to use standard detachable sockets. Both ratcheting and non-ratcheting types are available. Torque wrenches are used in various operations where proper torque of nuts, bolts and other fasteners is critical, for example, assembly and inspection of get rains and bearings, setting of clutches and brakes, overhaul and experimental work.

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Figure 15: Different type of wrenches

Most technical and servicing work/job requires the use of various types of wrenches. Many fasteners and parts are copper or brass, aluminum and alloy, and therefore, are rather.

Proper uses:

- ✓ Always work with clean threads free of corrosion.
- ✓ Follow the product manufacturer's instructions for specific torque loadings, particularly whether recommendations are for dry, oiled or plated threads.
- ✓ Avoid over tightening a nut or bolt with a conventional wrench before applying a torque wrench.
- ✓ When not in use, set at lowest torque.
- ✓ Never use it as a hammer, pry or conventional wrench.
- ✓ Avoid dropping. If dropped, check accuracy on a torque tester.
- ✓ When using adjustable wrenches, do not
- ✓ Over-torque by applying torque past the release point. Learn the feel of the release rather than relying on the sound.

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5. Cutting Tool

Punches/Chisels

Chisels are grouped according to the material they cut, either wood, metal, stone or brick. The two main types are wood and cold. Quality **wood chisels** have large, ergonomically shaped handles for a comfortable, sure grip and better control. Blades should be of high-quality carbon, heat-treated steel with precision-ground cutting edge. In addition, woodworking chisels should have crowned steel strike caps to help center the blow. One type of wood chisel—the **butt chisel**—has a short blade that ranges from about 2-1/2" to 3" long. It is used by pattern makers, cabinetmakers, carpenters and do-it-yourselfers for carving and paring, particularly in tight spots. It can be used with hard-faced hammers.

A **firmer chisel** is square-sided and has a longer blade, usually from 3-1/2" to 6" and is used mainly for cutting deeply into wood. It should be used with soft-faced hammers.



Figure 16: Firmer chisels

Paring chisels are for light-duty, detailed work such as trimming cabinets.



Figure 17: paring chisels

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Cold chisels have several styles—**flat** (the most widely used), **cape**, **diamond-point** and **round-nose**. They should be used only for cutting and chipping cold metal (unhardened steel, cast and wrought iron, aluminum, brass, copper), never masonry.

Bricklayer's chisels should be used when cutting masonry. Cold chisels should be struck only with a hand drilling, ball peen or similar heavy hammer with a face diameter approximately 3/8" larger than the struck tool head. Chisels have wood or plastic handles. Wood handles are available in both tang (the end of the blade or tang fits into the handle) and socket type (a projection from the handle fits into a socket in the blade). Plastic handles fit only tang construction. Like chisels and planes, gouges are used for removing material from a block of wood, plastic or metal. Gouges come in two primary types: inside and outside gouges. All steel chisels and punches (not wood chisels having wooden or plastic handles) are subject to chipping that can cause bodily injury much the same as steel hammer faces. Therefore, applicable safety standards require the warning "Wear Safety Goggles" on each tool. Nearly all domestic manufacturers comply by stamping those words into the shank.



Figure 18: Bricklayer's chisels

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Utility Knives Utility knives are designed to cut heavy materials such as carpet, flooring roofing, cardboard cartons, laminates and plastic. Blades can be replaced by disassembling the handle or ejecting them by depressing a spring-release button on the handle. Some knives swivel open to permit blade replacements

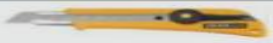

Type	Example
Snap-off bladed knives	
Multi-tools	
Pocket knives	
Box cutter utility knife	

Figure 19: Different types of utility knives

Bolt Cutters Heavy-duty cutters cut bolts, threaded rods, cables and other metals from 1/16" to 5/8" thick. They are made from drop-forged tool steel from 12" to 36" long. The longer cutter has greater strength. Special leverage joints allow great pressure to be applied with minimum effort. End-cut cutters operate similarly to end cut pliers, with special jaws available to cut special metals.



Figure 20: Bolt cutter

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6. Saws

Saw tool is used for cutting solid materials to prescribed lengths or shapes. There are different types of saws. Hand Saws is the most common used saw tool and it has 14" to 26" blades. Fineness of cut depends on the number of cutting teeth (points) per inch and tooth shape. The higher the number of points, the finer the cuttings. A coarse crosscut saw with seven or eight teeth per inch is best for fast, rough work or for use on green wood. A fine-tooth crosscut saw with 10 or 11 teeth per inch is best for smooth, accurate cutting on dry, seasoned wood. Some handsaws are available with special “aggressive design” teeth—three cutting edges instead of the conventional two. They cut on both the forward and backward stroke, thereby cutting several times faster than saws with traditional teeth. They may also have the teeth induction-hardened to help keep them sharp longer.

Saws also come with a wide range of handle styles, but the three most common are **pistol grip**, **closed handles** and **straight handle**. Pistol grip handles are used primarily on smaller saws that have thinner blades. Closed handles are incorporated more often on larger saws and help to add support to the larger blades. Drywall saws and other small-bladed saws often use straight handles that are in line with the saw’s blade. Most saws require minimal maintenance other than oiling of the blades to prevent rust. They should be hung up by their blade or handle since blades have a tendency to bend when stored flat.

Quality features in saws include:

- ✓ Tempered alloy blades. Lower-grade steel quickly loses its sharp edge but is easy to sharpen.
- ✓ Rust-resistant or Teflon™-coated blade finish. Teflon™-coated hand saws reduce many binding and residue buildup problems inherent to wood cutting.
- ✓ Reduced friction or drag makes for smoother, easier cutting.
- ✓ Hardwood or sturdy plastic handle. Special aluminum or plate steel nuts and bolts to fasten blade to handle. Cut edge to prevent binding in the cut.
- ✓ Bevel-filed teeth evenly set in two alternate rows, one row to the right of center, and one row to the left; produces a groove or kerfs slightly wider than the thickest part of the blade; prevents or reduces binding while sawing.

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Hacksaws

Hacksaws are fine-toothed saws designed to cut metal or plastic. The saws consist of a blade held in a steel frame with relatively high tension. High-tension models (with tension to 32,000 psi.) are also available. High tension holds the blade more rigidly straight, which enables the user to make fast, straight cuts. Blade life is also increased.

Look for a quick-release blade change mechanism, tension guide and rugged frame on these models. Blades come in several designs, such as course-, medium-, fine- and very fine toothed. Regular or standard blades are used for general-purpose cutting; high speed or bi-metal blades for cutting hard, extra-tough steel. The medium blade has 18 teeth per inch and is good for cutting tool steel, iron pipe and light angle iron. A fine blade, which has 24 teeth per inch, cuts drill rod, thin tubing and medium- weight materials.

Compass or Keyhole Saws

compass saws cut curved or straight sided holes. Saw blades are narrow, tapered nearly to a point to fit into most spaces. Blades come in three or four styles that can be changed to fit the job. Some models have induction-hardened teeth for longer life without sharpening.

Keyhole saws are small compass saws with finer teeth that can cut metal. Turret head keyhole blades can be rotated and locked in several positions for easier cutting in tight, awkward spots.



Hacksaw



compass saw

Figure 21: Hacksaw and Compass saw

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Coping Saws

Coping saws cut irregular shapes, curves and intricate decorative patterns. They consist of a thin blade and a C-shaped steel tension frame. The removable blade is typically 6-1/2" long.

Backsaws

A backsaw is a thick-bladed saw with a stiff, reinforced back to provide the rigidity necessary in precision cutting. It varies in length from 10" to 30" and is found in tooth counts from seven to 14 teeth per inch. They are used with miter boxes to cut miters.

Bow Saws

Bow (buck) saws consist of a tubular steel frame and a saw blade for fast cutting of all woods. The bow saw's frame is important, since the thin blade, usually 3/4" wide must be held under high tension for fast cutting. Advantages of this general-purpose saw are its all-around utility and light weight. In 21", 24" and 30" lengths, bow saws normally have teeth placed in groups. Within each group, distance between teeth varies, ensuring a smooth, vibration less cut. Wide gullies provide ample space for sawdust to accumulate without binding the saw. In the 36", 42" and 48" lengths, the most popular tooth pattern provides for two cutter teeth to each rakes tooth. This combination of teeth ensures maximum cutting ability in these longer lengths, regardless of wood hardness.

Some bow saws are designed to hold hacksaw blades as well as standard bow saw blades. These multi-purpose saws can be used to cut wood, metal or plastic.

Specialty Saws

Wallboard or drywall saws resemble a kitchen knife in design. They will cut plasterboard in the same fashion as a keyhole saw and are used for sawing holes for electric outlets and switch plates. The saw is self-starting with a sharp point for plunge cuts. It may also have induction teeth for longer life without sharpening.

Veneer saws are specially designed for sawing thin materials such as wood paneling. The blade is curved downward at the end, with cutting teeth on the curved part of the back to saw slots or grooves in the panel with minimum damage. Standard saw lengths are 12"-13", with 14 teeth per inch.

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Rod saws are a form of hacksaw-type blade, used in regular hacksaw frames and capable of cutting through most hard materials—spring and stainless steel, chain, brick, glass and tile. The blade consists of a permanently bonded tungsten carbide surface on a steel rod. Because the blade is round, it can cut in any direction.

Pull saws are similar to most traditional saws except the teeth are designed to cut with a pulling motion. Pull saws cut wood faster and with less effort because of the thinner and more flexible blade. The saws feature teeth diamond- ground on three cutting edges. Because of the flexibility of the blade and the minimal set to the teeth, the saws are excellent for flush cutting. Mini pull saws that cut sharply on the pull stroke are used for precision carpentry.

Retractable and **folding saws** come in a variety of designs and are engineered for the blades to either retract or fold back into a plastic or wooden handle.

Flooring saws are designed to precision cut floorboards and baseboards. These short, crosscut saws feature a curved cutting edge on the bottom. Information on saws used for outdoor purposes such as pruning can be found in the Lawn & Garden section.

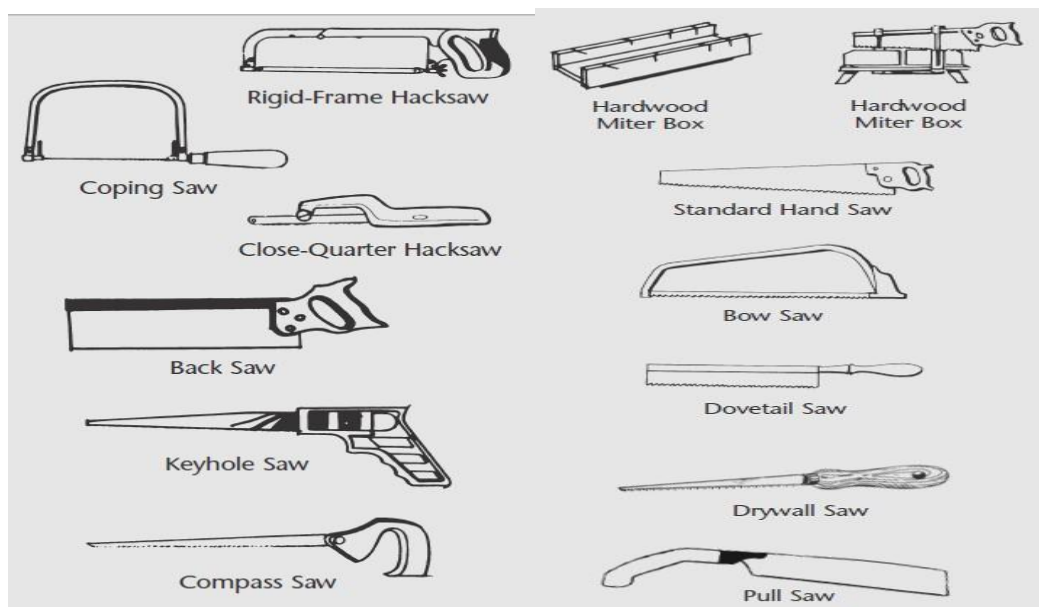


Figure 22: Different types of saws

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7. Fastening Tools

Clamps

Clamps are used in a number of different applications to hold items in place or secure items. Most clamps are constructed from wood, steel, cast iron, high-impact plastic or glass-reinforced nylon, and some have rubber or nylon straps. The most significant innovation to come about recently in the area of clamps is the development of **one-handed bar clamps**. These clamps work with a pistol grip and allow the user to tighten or loosen the clamp by using just one hand on a trigger switch. They are available in jaw openings from 6" to 50" and a variety of sizes.

C-clamps—the most common type of clamp consist of a C-shaped frame, made of either forged steel or cast iron, into which an adjustable screw is assembled to change the jaw opening. The size of a C-clamp is measured by its capacity—the dimension of the largest object the frame can accommodate with the screw fully extended. Also important is depth of throat, the distance from the center line of the screw to the inside edge of the frame. C-clamps range from 1" to 12".

Bar clamps have a clamping device built on a flat bar (usually steel). The length of the bar determines the capacity of the clamp, which is the dimension of the largest object that can be accommodated between its clamping jaws. "Reach" is the distance from the edge of the bar to the end of the clamping jaws. Screw pressure applies the final clamping load. Bar clamps are used for clamping large objects, making them popular with woodworkers and hobbyists.

Pipe clamps can be mounted to standard threaded or unthreaded pipe. Clamping can be performed from one end or both, and jaws can be positioned at the ends or anywhere along the pipe. Pipe clamps can also be quickly converted from a clamp to a spreader.

Thread less pipe clamp fixtures are designed so ends of pipe don't need threads. A hardened steel set screw holds the head firmly on the pipe, but is easily loosened. The 3/4" size has a crank handle, and depth from screw center to pipe is 11/16". The 1/2" size has a cross pin handle, with depth from screw center to pipe of 7/8".

A **hand screw clamp** consists of two hardwood clamping jaws adjusted to the work by two steel screw spindles assembled into the jaws. The jaws adjust to a variety of angles and come in a wide range of sizes. They are used for clamping wood, metal, plastic and fabrics. Hand screw

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adaptors can be used to convert hand screws into miter clamps. Also available are hand screw kits so woodworkers can make their own jaws.

Corner clamps are designed to hold miter or butt joints at a 90° angle. They can be used for gluing picture frames, cabinets, molding and trim.

- ✓ A **spring clamp** consists of two metal jaws to which clamping pressure is applied by use of a steel spring. They are designed for use with thin materials. Spring clamps are versatile enough for home, hobby or professional use indoors or outdoors, holding round or odd-shaped objects. They typically come with 1", 2" or 3" jaw openings.
- ✓ **Web clamps (also called band clamps)** apply even clamping pressures around irregular shapes or large objects and hold tight by means of a spring-loaded locking fixture.
- ✓ A **hold-down clamp** is the screw portion of a "C" clamp, designed to be secured onto any surface, with the screw used to apply clamping pressure.
- ✓ **Edging clamps** are used for installing molding and trim on furniture and countertops, holding work at right angles, and for welding or soldering. They are designed to hold edging strips, molding and trim firmly when fastening to the edge or side of work, leaving hands free.
- ✓ Welding clamps are a unique type of bar clamp ideal for quick tacking and other welding jobs. Welding Clamps are available in 6" and 18" jaw opening.
- ✓ Heavy-duty press screws can be used for deep-reach surface clamping. Available in three different lengths, they can be useful for gluing, welding or other assembly applications.

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Figure 23: Different types of fastening (clamps) tools

8. Tweezers

Tweezers (or Forceps) are **an extension of our fingers and they allow us to grab, grip, place, remove or hold items that are too small or delicate for our fingers to manipulate**. The size and shape of the items we grab, grip, place or hold necessitate the need for a variety of tweezer tip styles and shapes.

In order to assist in the selection of suitable tweezers for any particular application, we have included information about the materials used and the tip profile and dimensions. We offer three grades of tweezers:

- **High precision grade** is suitable for most laboratory and fine engineering use.
- **Biology grade** has the thinnest tips, and is used for the most demanding laboratory applications including microscopic work.
- **Electronic grade** offers high quality for electronics and general-purpose use. Most of the electronic grade tweezers are coated with a coloured epoxy resin which is insulating, shock resistant and provides better grip.



Figure 24: Tweezers

1.2.2 Power Tools

1. Soldering iron

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined and this bonds to the metal parts and forms a connection when the solder solidifies. It is different to welding in that the parts being joined are not melted and are usually not the same material as the solder.

Soldering is a common practice for assembling electrical components and wiring. Although it can be used for plumbing, sheet metal fabrication or automotive radiator repair the techniques and materials used are different to those used for electrical work. This document is intended to provide guidance on the safe working methods and proper tools and techniques for soldering of electrical components.

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There are different types of solder used for electrical work. They are broadly classified as **tin/lead solders** or **lead-free solders**. Tin/lead solders have been used for many years because of their ease of use however they have been phased out of commercial use due to the harmful effects on humans and the environment. When using tin/lead (or leaded) solder there are additional safety precautions that must be observed

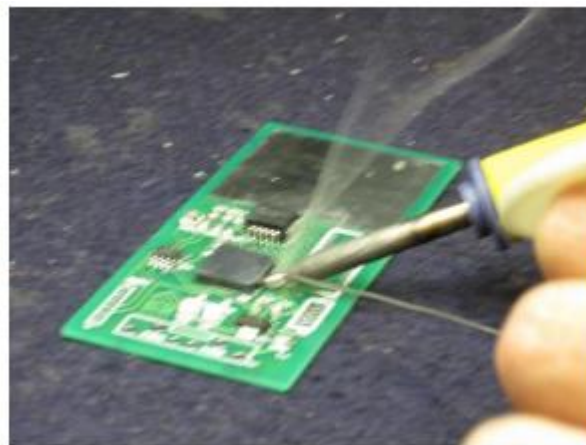


Figure 25: Soldering electrical PCB

Soldering irons come in many varieties and sizes. Soldering irons may be electric, gas powered or externally heated. Most common types are electric. Simple electric soldering irons have no controls and you simply plug them in and wait for them to heat up. Their temperature is regulated by the power of the heating element and heat loss to the environment. Some soldering irons have temperature controls which allow the user to set a desired operating temperature for the soldering iron. This is useful if the soldering iron is being used for different types of solders which have different melting points or if the soldering iron is being used for other purposes such as heating heat shrink. Some temperature-controlled soldering irons use interchangeable tips to change the temperature at which they operate.

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Figure 26: Soldering irons

2. De soldering

If a part that has been soldered needs to be replaced it needs to be “de-soldered”. Depending on the part and type of joint it may be possible to simply re-melt the solder and remove the part, or it may be necessary to remove the solder from the joint so the part can be freed. Some methods for removing solder are solder wick, solder sucker or de-soldering tool. Solder wick is a copper braid which is applied to the joint and heated with a soldering iron. As the solder in the joint is melted it is drawn into the solder wick like a sponge and is removed from the joint. A solder sucker is a spring-loaded syringe or rubber bulb. The tip of the solder sucker is placed near the joint as the joint is melted by a soldering iron. When the sucker is operated a vacuum is created which draws the molten solder from the joint into the body of the sucker. A de-soldering tool is a type of soldering iron with a hollow tip and is connected to a pump or vacuum source. The tip of the de-soldering tool is placed onto the joint, typically over a component lead, and once the solder has melted the pump is operated to draw the molten solder away.

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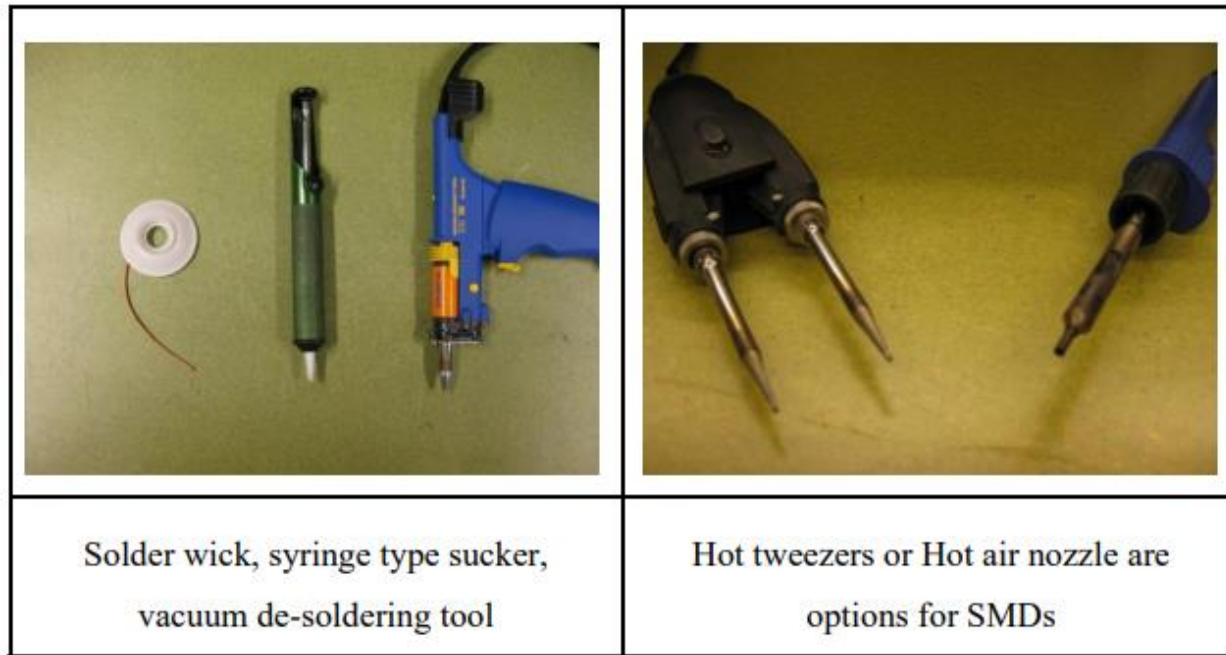


Figure 27: De soldering tools and tweezers for surface mount devices

3. Electric Drill Machine

Electric drill should be grounded for safety. The metal frame of the drill should be electrically connected to a good ground. Most electric drills are equipped with a three-pong grounded plug. If the circuit to which the drill is connected is not provided with a three-pong grounded socket, a grounded adaptor should be used. Some hand drills have the electric motor insulated from the case, and do not need grounding.

- **Mini drill press** – used for drilling small item and PCB for electronic products
- **Improvised mini drill press** – fabricated by copying the original drill press using only the double pinion drill, used for small items that needs a controlled rpm movement
- **Drill - Grinder** – the double purpose machine that can be used for both drilling and grinding
- **Pedestal drill press** - A drill press is a fixed style of drill that may be mounted on a stand or bolted to the floor
- **Double pinion/"eggbeater" hand drill** – the later version of the old hand drill, used for drilling small items and wood
- **Hand drill** – the manually operated drill, used commonly used on wood
- **Electric hand drill** – the boring or holing equipment using electricity for easiness of work and having a faster rpm for faster work

- **Cordless/battery operated hand drill** – used for holing or drilling where electricity is not available, but usually used for screw application.



Figure 28: Electrical drills

1.3 Measuring Instrument

A. Ammeter

An instrument called an ammeter is used to measure current flow in a circuit. The ammeter is inserted into the path of the current flow, or in series, to measure current. This means the circuit must be opened and the meter leads placed between the two open points. Although the ammeter measures electron flow in coulombs per second, it is calibrated or marked in amps or amperes. For most practical applications, the term amps are used instead of coulombs per second when referring to the amount of current flow.

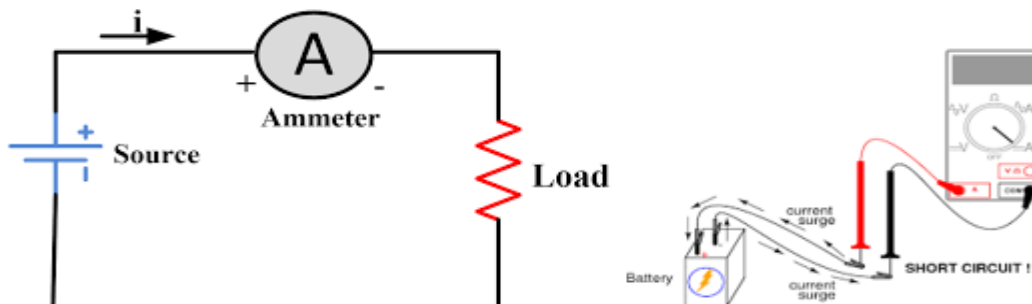


Figure 29: Current flow measuring connection (Ammeter)

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B. Voltmeter

A voltmeter is used to measure the voltage, or potential energy difference of a load or source.

Voltage exists between two points and does not flow through circuit as current does. It is

Possible to have voltage without current, but current cannot flow without voltage. A voltmeter is connected across, or in parallel, with the two points.

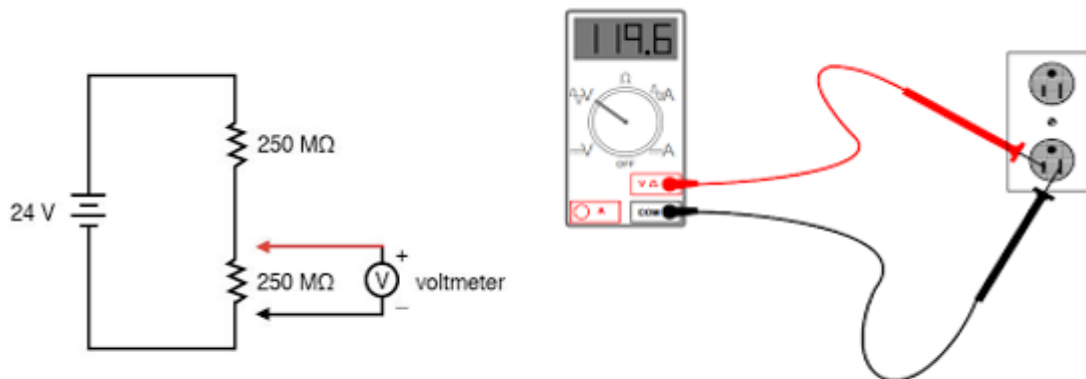


Figure 30: Voltage measurement connection (voltmeter)

C. Multi-meter

A Multi-meter is an electronic instrument, every electronic technician and engineer's widely used piece of test equipment. A multi-meter is mainly used to measure the three basic electrical characteristics of voltage, current, and resistance. It can also be used to test continuity between two points in an electrical circuit. It can measure current flowing in the current carrying conductor, potential difference (voltage) between two points, resistance of the current carrying conductor. It used as ammeter, voltmeter, ohmmeter and etc.

Types of Multi-meter

There are two types of multi-meters: **Analog and Digital multi-meter.**

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I. Analog Multi-meter

The Analog Multi-meter or VOM (Volt-Ohm-Milliammeter) is constructed using a moving coil meter and a pointer to indicate the reading on the scale. The moving coil meter consists of a coil wound around a drum placed between two permanent magnets.



Figure 31: Analog Multi-meter

II. Digital Multi-meters

We mostly used a Multi-meter is a digital Multi-meter (DMM). The DMM performs all functions from AC to DC other than analog. It has two probes positive and negative indicated with black and red color is shown in the figure. The black probe connected to COM JACK and the red probe connected by user requirement to measure ohm, volt, or amperes. The jack marked $V\Omega$ and the **COM** jack on the right of the picture are used for measuring voltages, resistance, and for testing a diode. Overload protection prevents damage to the meter and the circuit and protects the user.

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Figure 32: Digital Multi-meter

III. Wattmeter

Power can be measured using a wattmeter. The wattmeter is basically a voltmeter and ammeter combined into one instrument. The ammeter terminals are connected in series, and the voltmeter terminals are connected in parallel with the circuit in which the power is being measured. The wattage rating of a lamp indicates the rate at which the device can convert electric energy into light. The faster a lamp converts electric energy to light, the brighter the lamp will be.

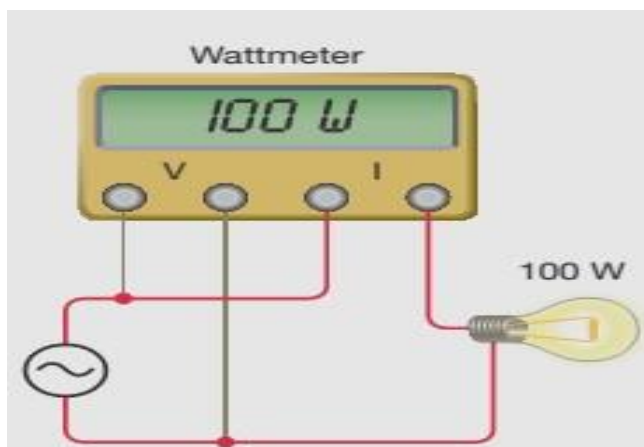


Figure 33: Wattmeter connected to measure power

IV. Oscilloscope

The oscilloscope, or scope for short, is a device for drawing calibrated graphs of voltage vs time very quickly and conveniently. Such an instrument is obviously useful for the design and repair of circuits in which voltages and currents are changing with time. There are also many devices, called transducers, which convert some non-electrical quantity such as pressure, sound, light intensity, or position to a voltage. By using a transducer, the scope can make a plot of the changes in almost any measurable quantity.

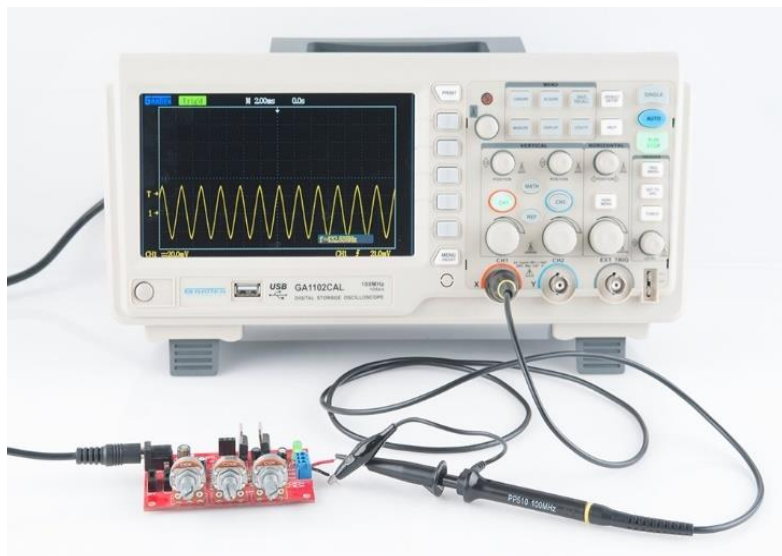


Figure 34: Oscilloscopes

V. Megger Tester (insulation tester)

Megger is basically a D.C. generator operated manually and Ammeter calibrated as k Q & m Q is generally used to measure the insulation resistance or continuity in the line. These are available in various voltage ranges such as 500V, 1000Volts. 2500 V megger is also available in motor operated form Now a day's electronic insulator meters are also available which works with 6 cells of 1.5V each and hence do not require hand operation. It can also measure resistance between 0 - 2 k Q high resistance 0.05 M Q to 100 M Q and A.C. voltage up to 500 V.

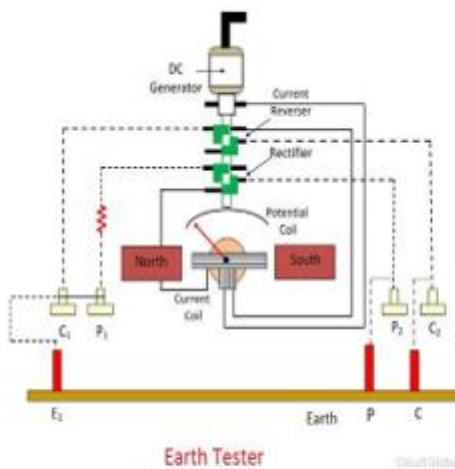
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Figure 35: Insulation tester (megger)

VI. Earth Tester

Earth tester is used to measure the earth resistance. The value of earth resistance is small therefore any instrument which measures high resistance such as megger cannot be used for measuring earth resistance.



Earth tester circuit



analog earth tester



digital earth tester

Figure 36: Earth tester

VII. Clamp meters

A combined meter for measurement of Voltage, Current; Resistance and Temperature. It gives the reading in digital form. It can measure even under strong magnetic field. It has LED display which provides low power consumption and also has Automatic zero adjustment in display.



Figure 37: digital clamp meter

VIII. Function generator

The function generator is used to generate a wide range of alternating-current (AC) signals. A *function generator is a signal source that has the capability of producing different types of waveforms as its output signal.* The most common output waveforms are sine-waves, triangular wave, square wave and sawtooth wave. The frequencies of such waveforms may be adjusted from a fraction of a hertz to several hundred kHz.



Figure 38: function generator

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Equipment Required for Outdoor Installation & Maintenance Work

The majority of the accidents, which occur at present, are preventable roughly; causes of accident may be put into three classes: first accidents resulting from lack of supervision or lack of knowledge; second- accidents resulting from personal carelessness; third accidents resulting from the contributory negligence of others. It is essential that safety be considered and practiced in all departments at all times. ~ Lineman is called on to handle a great many jobs, each under different condition (different poles, wire arrangement, installation of equipment and fixtures, etc.). By using different safety devices/tools, great benefits can be realized by linemen.

Equipment and Materials

- ✓ Ropes forming yoke of dead men.
- ✓ Rubber gloves.
- ✓ Ladders and Belt tools.
- ✓ Canvas tool bag containing screw drivers, insulated pliers etc.
- ✓ Axes, saws, soldering equipment.
- ✓ Helmets
- ✓ Operating rods.
- ✓ Protective clothing and footwear.
- ✓ Portable lamps.

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1.4 General Safety Rules

There will undoubtedly be a safety program to follow for the shop or area in which you will be working. The following general safety rules are furnished as a guide.

- Support: your local safety program and take an active part in safety meetings.
- Inspect: tools and equipment for safe conditions before starting work.
- Advice: your supervisor promptly of any unsafe conditions or practices.
- Learn: the safe way to do your job before you start.
- Think: safety and ACT safety at all times.
- Obey: safety rules and regulations-they are for your protection.
- Wear: proper clothing and protective equipment.
- Conduct: you properly at all times-horseplay is prohibited.
- Operate: only the equipment you are authorized to use.
- Report: any injury immediately to your supervisor.

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Self-check 1

Written Test

Directions: Answer all the questions listed below.

Test I. Choose the best answer

- Which of the following tools are used in a number of different applications to hold items?
 - Clamps
 - Calipers
 - Chisels
 - Reamers
- Which of the following tools are to cut insulation without damaging wire?
 - Cutting nippers
 - Flat-nose pliers
 - Wire strippers
 - Center cut cutters
- Is a device used to insert and tighten screws or loosen?
 - Screwdriver
 - Chisels
 - Pliers
 - Wrenches
- Which of the following tools are designed to hold, turn and cut objects?
 - Offset screwdrivers
 - Pliers
 - Multi-bit screwdrivers
 - Reamers
- Which of the following tools have rubber, plastic, wooden or rawhide heads and are used to drive chisels or hammer joints together
 - Sledge hammers
 - Hand Drilling Hammers
 - Mallets
 - Specialty Hammers

Test II. Short answer

- Discuss the difference between digital multi-meter and oscilloscope
- Write hand tools used to tighten or loosen bolts or nuts.
- What is clamp meter? Explain?

Test III. Say true if the statements correct and say false if the statements incorrect

1. When working in electrical and electronic equipment repair, you must be familiar with how the tools work
2. Wattmeter function is a signal source that has the capability of producing different types of waveforms as its output signal
3. Analog multi-meter is simple to operate than digital multi-meter
4. The information displayed on digital and analog multi-meter are the same
5. Soldering is a common practice for assembling electrical components and wiring
6. The unexpected starting of electrical equipment can cause severe injury or death.

Note: Satisfactory rating - 3 and 5 points Unsatisfactory - below 3 and 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____

Date: _____

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Unit Two: Hand Tools and Measuring Instrument Preparation

This learning guide is developed to provide you the necessary information regarding the follow content coverage and topics –

- hand tools preparation
- measuring instruments preparation

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, completion of this Learning Guide, you will be able to –

- operate hand tools properly and safely
- operate measuring instruments properly and safely

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below 3 to 6.
- Read the information written in the information Sheet
- Accomplish the “all self-checks respectively
- If you earned a satisfactory evaluation from the “Self-check” proceed to the next information sheet
- Do all “LAP test” (if you are ready).

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2.1 Safe and Proper Operation of Hand Tools

The skilled technician must be familiar with the proper use of the tools-of-the-trade. As a general rule, higher quality tools tend to be in the higher price ranges but are safer to work with. Cheaper, low-quality tool material and poor design features often put great stress on the tool and the operator.

NOTE: always use the right tool for the right job.

Take time to plan your work, by yourself and with others. Safety planning is an important part of any task. It takes effort to recognize, evaluate, and control hazards. If you are thinking about your work tasks or about what others think of you, it is hard to take the time to plan for safety. But you must plan! Planning with others is especially helpful. It allows you to coordinate your work and take advantage of what others know about identifying and controlling hazards. The following is a list of some things to think about as you plan.

- ✓ Work with your partner-Do not work alone. Both of you must know what to do in an emergency.
- ✓ Know how to shut off and de-energize circuits. You must find where circuit breakers, fuses & switches are located. Then, the circuits that you will be working on (even low-voltage circuits) **MUST BE TURNED OFF!** Test the circuits before beginning work to make sure they are completely de-energized.
- ✓ Plan to lock out and tag out circuits and equipment. Make certain all energy sources are locked out and tagged out before performing any work on an electrical circuit or electrical device. Working on energized (“hot”) circuits is one of the most dangerous things any worker could do. If someone turns on a circuit without warning, you can be shocked, burned, or electrocuted. The unexpected starting of electrical equipment can cause severe injury or death.
- ✓ Before ANY work is done on a circuit, shut off the circuit, lock out and tag out the circuit at the distribution panel, then test the circuit to make sure it is de-energized. Before ANY equipment inspections or repairs even on so called low voltage circuits- the current must be turned off at the switch box, and the switch must be padlocked in the OFF position. At the same time, the

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equipment must be securely tagged to warn everyone that work is being performed. Again, test circuits and equipment to ensure they are de-energized. A locked-out switch or feeder panel prevents others from turning on a circuit. The tag informs other workers of your action.

- ✓ Remove jewelry and metal objects. Remove jewelry and other metal objects or apparel from your body before beginning work. These things can cause burns if worn near high currents and can get caught as you work.
- ✓ Plan to avoid falls- Injuries can result from falling off scaffolding or ladders. Other workers may also be injured from equipment & debris falling from scaffolding & ladders.
- ✓ Do not do any tasks that you are not trained to do or that you do not feel comfortable doing!

1. Screw Driver

Screwdrivers are available in many different shapes, sizes, and materials. Check whether the screw driver is designed to loosen or tighten screws. Properly designed screw drivers are used for driving or removing screws or bolts with slotted, recessed, or special heads.

For instance; **flat-head or standard screwdriver** is designed for use on screws with **slotted heads**. This type of screw is often used on the terminals of switches, receptacles, and lamp holders. The figure depicted below shows how the right screw driver fit into the screw needed to be tightened or removed. Phillips Screwdriver is designed for use on screws with an X-shaped insert in their heads. This type of screw is often used on the outside of electrical appliances because there is less likelihood of the screwdriver head slipping out of the slot and damaging the metal finish of the appliances.

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Figure 39: proper selection of screwdriver for screws

Note: The screwdriver's blade should fit the slot of the fastener. This prevents damage to the screwdriver's blade and fastener's slot, as well as possible injury to the user's hand or surrounding equipment should the tip slip out of the slot.

2. Pliers

Plier is used to cut and shape electric conductors and to grip a variety of objects has caused many types of pliers to be developed.

Lineman's Side-Cutting Pliers are used for gripping, twisting, and cutting wires. The lineman's side cutting pliers have serrated jaws, a rod-gripping section, side cutters, wire cropper, a fixed pivot, and parallel handles. The flat serrated jaws are used to bend sheet metal and twist electrical wire. The rod-gripping section is used to hold rods and bend small rods. The side cutters are located just above the pivot point, where maximum pressure may be applied. They are ground at an angle permitting sharp flush cuts on electrical wire. A pair of croppers is located above the pivot. They are used to shear larger wire. Lineman's pliers used around electrical circuits have insulated sleeves over the handles to reduce the possibility of electrical shocks.

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Figure 40: side cutter

Diagonal-Cutting Pliers are designed specifically for cutting wire. They are used for close cutting jobs such as trimming the ends of wire on terminal board connection. The diagonal cutting pliers have a fixed pivot. The jaws are offset by about 15 degrees and are shaped to give enough knuckle clearance while making flush cuts. The diagonal cutting pliers are used for cutting small, light materials such as wire, cotter pins, and similar materials. These pliers are not to be used to hold or grip objects.



Figure 41: side cutter plier

Long-Nose Pliers are used to make loop ends on wire for connection to terminal screws



Figure 42: Long nose pliers

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End Cutting Pliers The end cutting pliers are used to crop wire flush to the working surface. They are designed to keep hands and fingers safely away from the wire ends.



Figure 43: End cutting pliers

Safety When Using Bolt and Electrical Cable Cutter

- ✓ Wear safety glasses when cutting.
- ✓ When using bolt cutters, make sure your fingers are clear of the jaws and hinges.
- ✓ Take care that the bolt head or piece of rod cut off does not fly and injure you or someone else.
- ✓ When the cutters are brought together rapidly, sometimes a bolt-head or piece of rod being cut off will fly some distance. The harder the material, the more it will fly.
- ✓ If it is necessary to cut electrical cable or wire which is already installed, be sure that the power is disconnected before using the cable cutter on it.
- ✓ Bolt cutters are fairly heavy, so make sure that they are stored in a safe place where they will not fall and injure someone.

3. Hammers

Hammers are produced in a variety of head weights and are an important part of any tool kit. Hammers and other striking tools are widely used and often abused. It is made for specific purposes in various types and sizes, and with striking surfaces of varying hardness. For example, hammers are used for general carpentry, framing, nail pulling, cabinet making, assembling furniture, upholstering, finishing, riveting, bending or shaping metal, striking masonry drill and steel chisels, and so on. Hammers are designed according to the intended purpose.

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- Select a hammer that is comfortable for you and that is the proper size and weight for the job. Misuse can cause the striking face to chip, possibly causing a serious injury.
- Choose a hammer with a striking face diameter approximately 12 mm (0.5 inches) larger than the face of the tool being struck (e.g., chisels, punches, wedges, etc.).
- Choose a hammer with a cushioned handle to protect you from vibration, impact, and squeezing pressure.
- Use hammers with electrically insulated handles for work on or around exposed energized parts.
- Ensure that the head of the hammer is firmly attached to the handle.
- Replace loose, cracked or splintered handles.
- Keep the work area clear of debris.
- Discard any hammer with mushroomed or chipped face or with cracks in the claw or eye sections.
- Wear safety glasses or goggles, or a face shield (with safety glasses or goggles).
- Strike a hammer blow squarely with the striking face parallel to the surface being struck. Always avoid glancing blows and over and under strikes. (Hammers with bevelled faces are less likely to chip or spall.)
- Look behind and above you before swinging the hammer. Keep enough clearance from fellow workers.
- Maintain a secure footing and keep good balance while using a hammer.

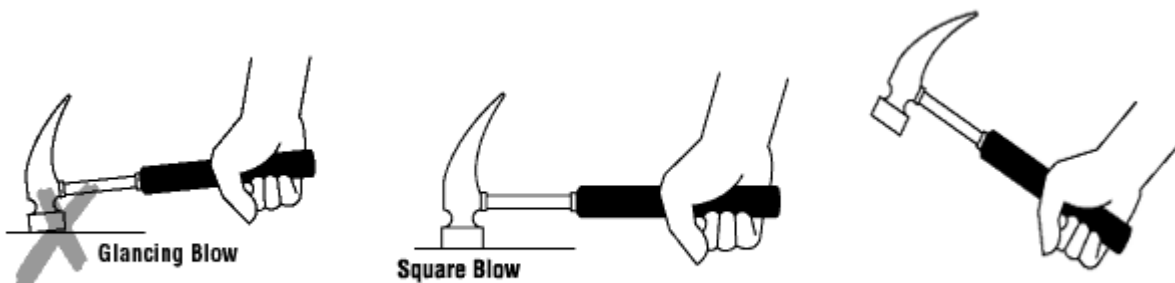


Figure 44: Hammer safety use

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4. Insulation-Removing Devices

Wire and cables preparation requires the removal of a certain amount of insulation.

Wire Stripper Is used to remove insulation from small-diameter wire

Cable Insulation Stripper Is used to remove the insulating sheath from nonmetallic sheath cable



Wire stripper



cable insulation stripper

Figure 45: Insulation remover

Knives: Most knives have cutting edges and are used to cut, pare, notch, and trim wood, leather, rubber, and other materials. However, putty knives are used to apply and spread putty when installing glass.

Shop Knife: The shop knife is used to cut wallboard, paper, cardboard, and linoleum, canvas, and upholstery materials. Most shop knives have an aluminum handle and have storage space for five interchangeable blades in the 5-inch handle



Figure 46: Insulation remover knife

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Safety of Insulation-Removing Devices

- ✓ Do not use knives which are larger than can be handled safely to cut work.
- ✓ Use knives only for the purpose for which they were designed.
- ✓ Do not carry open knives in your pocket.
- ✓ Do not leave knives in such a position that they will cause injury to others.
- ✓ Carefully put knives in a sheath or container after use to protect the sharp cutting edges from contacting other hard objects.
- ✓ Always cut away from the body, except when using the draw knives

5. Files

File used by electrical technician are available in different shape and size. For instance, **round files** taper slightly toward the point. Bastard-cut files 6 inches and longer are double-cut. The second-cut files, 12 inches and longer, are double cut. All others are single-cut. Round files are used for filing circular openings or concave surfaces.

Square File

Square files taper slightly toward the point on all four sides and are double-cut. They are used for filing rectangular slots and keyways.

Safe Operation of Files

- ✓ If a file is designed to be used with a handle, do not attempt to use it without the handle. Holding the sharp tang in your hand while filing can cause serious injury.
- ✓ Do not use a file for prying. The tang end is soft and it bends easily.
- ✓ The body of the file is hard and very brittle.
- ✓ A light bending force will cause it to snap.
- ✓ Do not hammer on a file. This is very dangerous because the file may shatter.

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6. Electric Drills

Electric are used for drilling holes in wood, metal, and concrete. The size of a drill is determined by the chuck size and the power of the motor. The *chuck* is the part of a drill that holds the twist drill bit. A 3/8-inch drill will hold a bit of any size up to 3/8-inch in diameter. Reversible and battery-powered electric drills are also available.

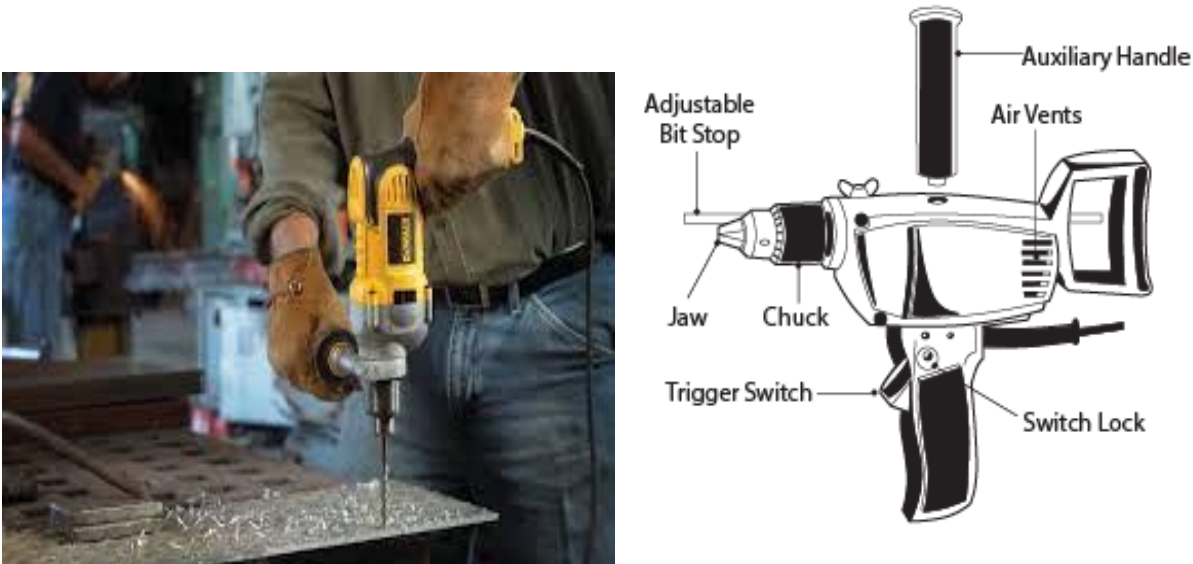


Figure 47: Safe operation of electric drills

What should you do when working with powered hand drills?

- Wear safety glasses or a face shield (with safety glasses or goggles).
- Keep drill air vents clear to maintain adequate ventilation.
- Keep drill bits sharp always.
- Keep all cords clear of the cutting area during use. Inspect for frays or damage before each use.
- Disconnect power supply before changing or adjusting bit or attachments.
- Tighten the chuck securely. Remove chuck key before starting drill.
- Secure work piece being drilled to prevent movement.
- Slow the rate of feed just before breaking through the surface.
- Drill a small "pilot" hole before drilling large holes.

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7. Soldering iron Equipment

The power consumption or wattage of a soldering iron is often quoted. The wattage can vary. **For basic non-temperature-controlled irons, a wattage of 200 watts may be good for general work, and higher if heavy soldering is envisaged.** For small PCB work, 150 or 250 watts is a good value.

General soldering safety notes

1. Never touch the element or tip of the soldering iron. They are very hot (about 400°C) and will burn. The solder itself also gets hot.
2. Hold wires to be heated with tweezers or clamps.
3. Keep the cleaning sponge wet during use.
4. Always return the soldering iron to its stand when not in use. Never put it down on your workbench. Be sure that the stand is weighted enough or attached to your worktable so that it doesn't topple over if you brush against the cord.
5. Turn unit off or unplug it when not in use.
6. Soldering irons come in models that use different wattages. Use the right size soldering iron for your projects; too much heat can ruin your board or components.
7. Never, ever try to catch a hot soldering iron if you drop it. Let it fall, buy a new one if you have to — just don't grab it!
8. Give any soldered surface a minute or two to cool down before you touch it.

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Figure 48: Safe operation and proper selection of soldering irons

2.2 Unsafe or Faulty Tools for Repair

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Safety

Safety: Hazards may occur due to improper handling of tools and equipment's, unsafe work areas, operating machines without knowing how to operate and using materials out of their intended purpose etc...

Marking

Each machine should bear, legibly and indelibly, the following information: the name and address of the manufacturer, mandatory marks, designation of series and type, the serial number (if any), the engine power (in kW), the mass of the most usual configuration (in kg) and, if appropriate, the maximum drawbar pull and maximum vertical load.

Warning signs

When the movement of a machine creates hazards not obvious to a casual spectator, warning signs should be affixed to the machine to warn against approaching it while it is in operation.

Verification of safety requirements

It is necessary to verify that safety requirements have been incorporated in the design and manufacture of an earth-moving machine. This should be achieved through a combination of measurement, visual examination, tests (where a method is prescribed) and assessment of the contents of the documentation that is required to be maintained by the manufacturer.

A handbook giving instructions for operation and maintenance should be supplied and specify when personal protective equipment (PPE) is needed. A service manual giving adequate information to enable trained service personnel to erect, repair and dismantle machinery with minimum risk should also be provided.

Operating conditions

In addition to the above requirements for design, the instruction handbook should specify conditions that limit use of the tool and/ or machine (e.g., the machine should not travel at a greater angle of inclination than is recommended by the manufacturer). If the operator discovers faults, damage or excessive wear that may present a safety hazard, the operator should immediately inform the employer and shut down the test machine/tools until the necessary repairs are completed.

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Positioning a machine for work

When positioning a test machine, the hazards of overturning, sliding and subsidence of the ground beneath it should be considered. When these appear to be present appropriate blocking of adequate strength and surface area should be provided to assure stability.

Defective Tools

Defective tools must be removed from service, tagged “DO NOT USE – Repair required”, and quarantined until they can be repaired by a qualified person.

Power Supply

Use the OEM recommended size, gauge and end connector type of extension cord for line power tools.

- ✓ Ensure corded electrical tools have a 3-wire (grounding) cord and plug, excluding double insulated tools.
- ✓ Ensure on/off switches for power tools are functional and positioned in a manner that is easily accessible by the operator.
- ✓ Ensure Ground Fault Circuit Interrupters (GFCIs) are used and tested in the supply circuit to power tools used outside.

Maintenance, Repairs and Storage

- ✓ Maintenance records must be kept for all active power tools.
- ✓ Chisels, punches, hammers, screwdrivers, etc., must have tips properly dressed.
- ✓ Cracked and/or splintered handles must be replaced.
- ✓ Tools should be clean and any required repairs completed prior to being properly stored.
- ✓ Repairs to tools must be performed by qualified personnel, using OEM parts or equivalent.

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Ergonomic Considerations

Consider ergonomics when selecting and using tools:

- ✓ Hold the tool close to the body and do not overreach.
- ✓ Keep good balance and proper footing at all times to better control the tool, especially in response to unexpected situations.
- ✓ Secure work with clamps or securing devices, freeing hands to operate the tool.
- ✓ Reduce the settings on power hand tools to the lowest setting possible to complete the task safely. This will reduce tool vibration at the source

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Self-check 2

Written exam

Directions: Answer all the questions listed below.

Test I. Choose the best answer

1. Which of the following tools are a widely used by electrician for measuring physical quantity of electrical such as current, voltage and resistance?

A. Soldering iron B. micrometer C. Multi-meter D. Thermo- meter

2. Which of the following is safety of insulation-removing devices is not correct?

- A. Use knives which are larger than can be handled safely to cut work.
- B. Use knives only for the purpose for which they were designed.
- C. Do not carry open knives in your pocket.
- D. Do not leave knives in such a position that they will cause injury to others.

3. Which of the following is used to remove insulation from small-diameter wire

A. Cable Insulation Stripper B. Wire Stripper C. Knives D. Shop Knife

4. Which of the following is used to remove the insulating sheath from nonmetallic sheath cable

A. Cable Insulation Stripper B. Wire Stripper C. Knives D. Shop Knife

5. Which of the following is used to cut, pare, notch, and trim wood, leather, rubber, and other materials?

A. Shop Knife B. Cable Insulation Stripper C. Wire Stripper D. Knives

Test II. Say True if the Statements Correct and Say False if the Statements Incorrect.

1. Hazards may occur due to improper handling of tools and equipment.
2. Defective tools must be removed from service
3. Before leaving the machine at the end of the shift, the operator should place all operating controls in the Phase position.

4. Tools should be clean and any required repairs completed prior to being properly stored.

Test III. Subjective question

1. Write at least 5 general safety you have to consider when using soldering iron?
2. How do you check whether the screw driver is designed to loosen or tighten screws?

Note: Satisfactory rating - 3 and 5 points Unsatisfactory - below 3 and 5 points

Score = _____

Rating: _____

You can ask you teacher for the copy of the correct answers.

Name: _____

Date: _____

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Unit three: Measuring Tools and Test Instruments operation

This learning guide is developed to provide you the necessary information regarding the follow content coverage and topics –

- Tools and measuring instruments operation
- Safety procedures in using tools and measuring instruments
- Unsafe or faulty hand tools and measuring instruments identification
- Maintenance work report on malfunctioning hand tools and measuring instrument

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, completion of this Learning Guide, you will be able to –

- Use tools and measuring instruments according to tasks undertaken
- Use safety guide line during tools and measuring instruments operation
- Identify unsafe or faulty hand tools and measuring instruments
- Report malfunctions, unplanned or unusual events to supervisor

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below 3 to 6.
- Read the information written in the information Sheet
- Accomplish the “all self-checks respectively
- If you earned a satisfactory evaluation from the “Self-check” proceed to the next information sheet
- Do all “LAP test” (if you are ready).

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3.1 Measuring Tools and Test Instruments Safe Operation Tasks




Remember, a worker's efficiency is often a direct result of the condition of the tools being used. Workers are often judged by the manner in which they handle and care for their tools. You should care for hand tools the same way you care for personal property. Always keep hand tools clean and free from dirt, grease, and foreign Matter. After use, return tools promptly to their proper places in the tool box. Improve your own efficiency by organizing your tools so that those used most frequently can be reached easily without sorting through the entire contents of the box. Avoid accumulating unnecessary items. Remember, a worker's efficiency is often a direct result of the condition of the tools being used. Workers are often judged by the manner in which they handle and care for their tools. You should care for hand tools the same way you care for personal property. Always keep hand tools clean and free from dirt, grease, and foreign matter. After use, return tools promptly to their proper places in the tool box. Improve your own efficiency by organizing your tools so that those used most frequently can be reached easily without sorting through the entire contents of the box. Avoid accumulating unnecessary items.

Measurement is the process or the result of determining the ratio of a physical quantity, such as a length, time, temperature, pressure voltage, current, frequency and etc., to a unit of measurement, such as the meter, second or degree Celsius, volt, ampere, hertz. The science of measurement is called metrology.

Electrical measuring tools and instruments are sensitive and delicate so extra care is necessary in handling them. These are used to measure currents, voltages, resistances, wattages and other important elements in electrical works. This topic, will tackle the function/use of each measuring tool and instrument used in doing an electrical task. Test equipment is necessary for determining proper set-up, adjustment, operation, and maintenance of electrical systems and control panels. Different kinds of measuring tools and precision measuring instruments are as follows:

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Table: 1 list of electrical measuring instruments and their descriptions

Measuring tools/instruments	Description
 <p>digital Multi-meter</p>	<p>Measure electrical quantity</p> <ol style="list-style-type: none"> 1. Current 2. Voltage 3. Resistance 4. Capacitance of capacitor 5. Continuity of electric line 6. Temperature rise inside PCB
 <p>Digital oscilloscope</p>	<p>drawing calibrated graphs of voltage vs time very quickly and conveniently for AC/DC power source</p>
 <p>Function generator</p>	<p>The function generator is used to generate a wide range of alternating-current (AC)</p>
<p>Test light</p>	<p>Check whether or not the current is the circuit line</p>
<p>Ground tester</p>	<p>Check the current leakage to ground and ground resistance</p>
<p>Tapper meter</p>	<p>Measure the length of something's</p>

Different types of use Multi-meter (Test instruments) and their measurements

The Multi-tester or multi-meter is sometimes called the VOM (voltmeter, ohmmeter, and milliammeter). It is the best instrument that can measure voltage, resistance and current.

It is generally made of two types:

- ✓ The analog and
- ✓ The digital.

Common symbols of DMM

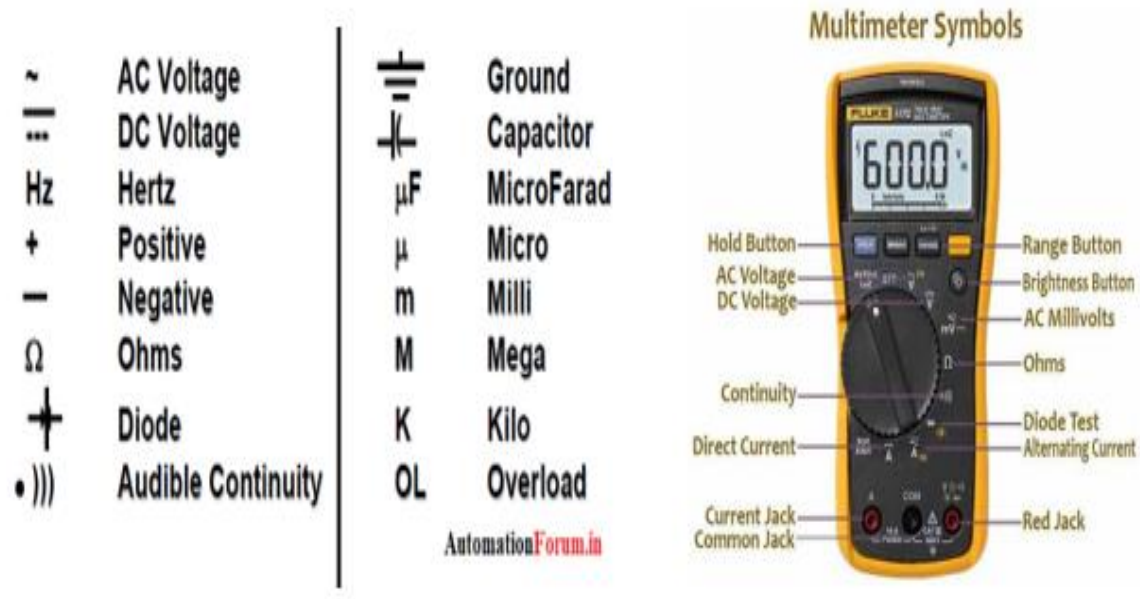


Figure 49: Common symbols of DMM and their function

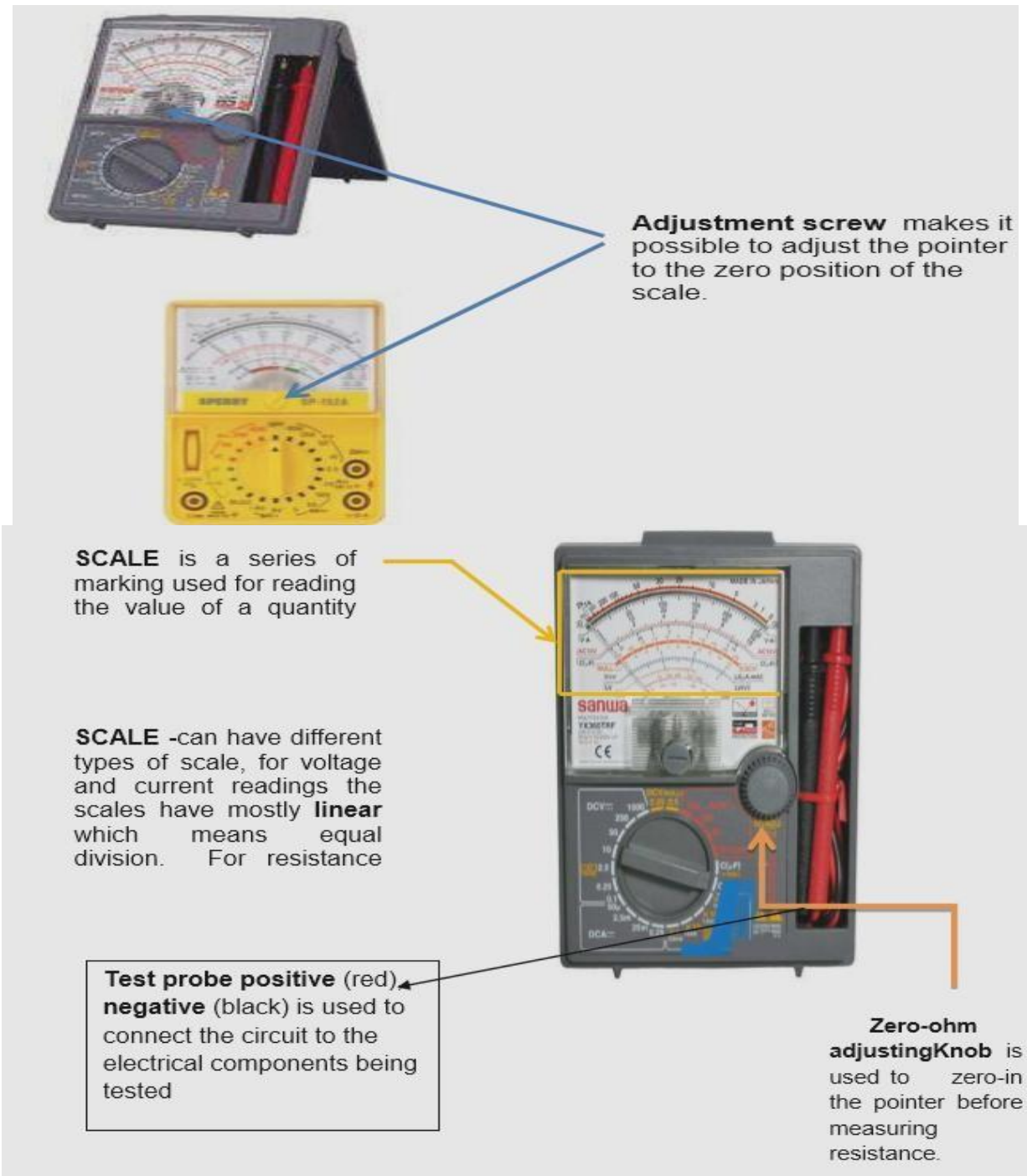


Figure 50: Parts of Analog-Multi-Meter

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Proper care and maintenance of the multi-meter

- Read manual of instructions on how to operate the multi-tester.
- In reading the amount of voltage, always start with the highest range to avoid reading voltage higher than the tester setting. Be sure that the tester is set to the correct range setting: resistance range when measuring the ohm, voltage range when measuring voltage and ammeter range when measuring the value of electric current.
- Always check the condition of its battery. Worn out batteries will damage the internal setting of the tester.
- When the tester is not in used or will be stored, set the selector switch to 1000V or to OFF position.
- Never drop the tester.

How to read the meter scale of the Analog multi-meter

To read the resistance range of the multi-tester, the given table below will be used. The unit of measurement to be used to determine its resistance is ohm.

Range	0-2	2-10	10-20	20-50	50-100	100-200
Range x1	0.2	0.5	1	2	5	20
Range x10	2	5	10	20	50	200
Range x1k	20	50	100	200	500	2K
Range x 10k	200	500	1K	2K	5K	20K

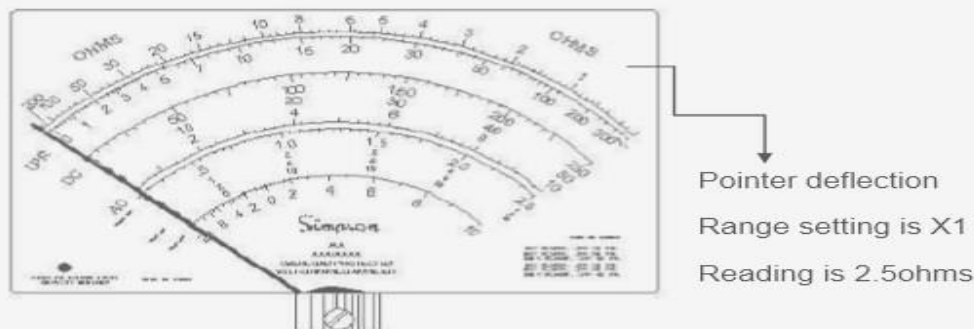


Figure 51: How to read the meter scale of the Analog multi-meter

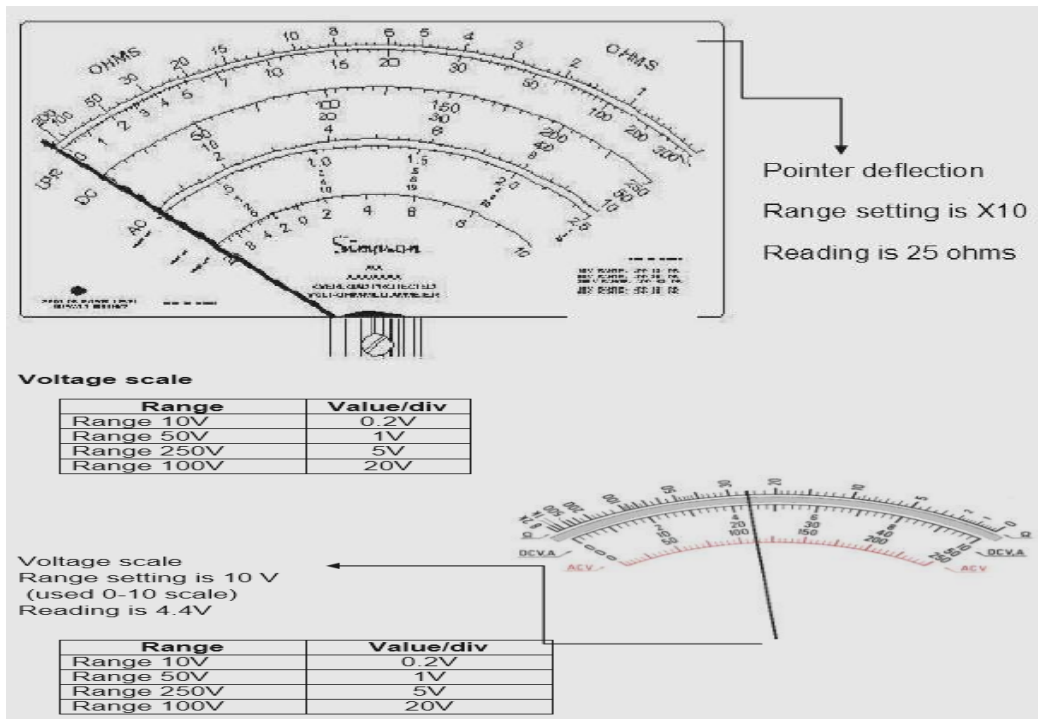


Figure 52: How to read the meter scale of the Analog multi-meter

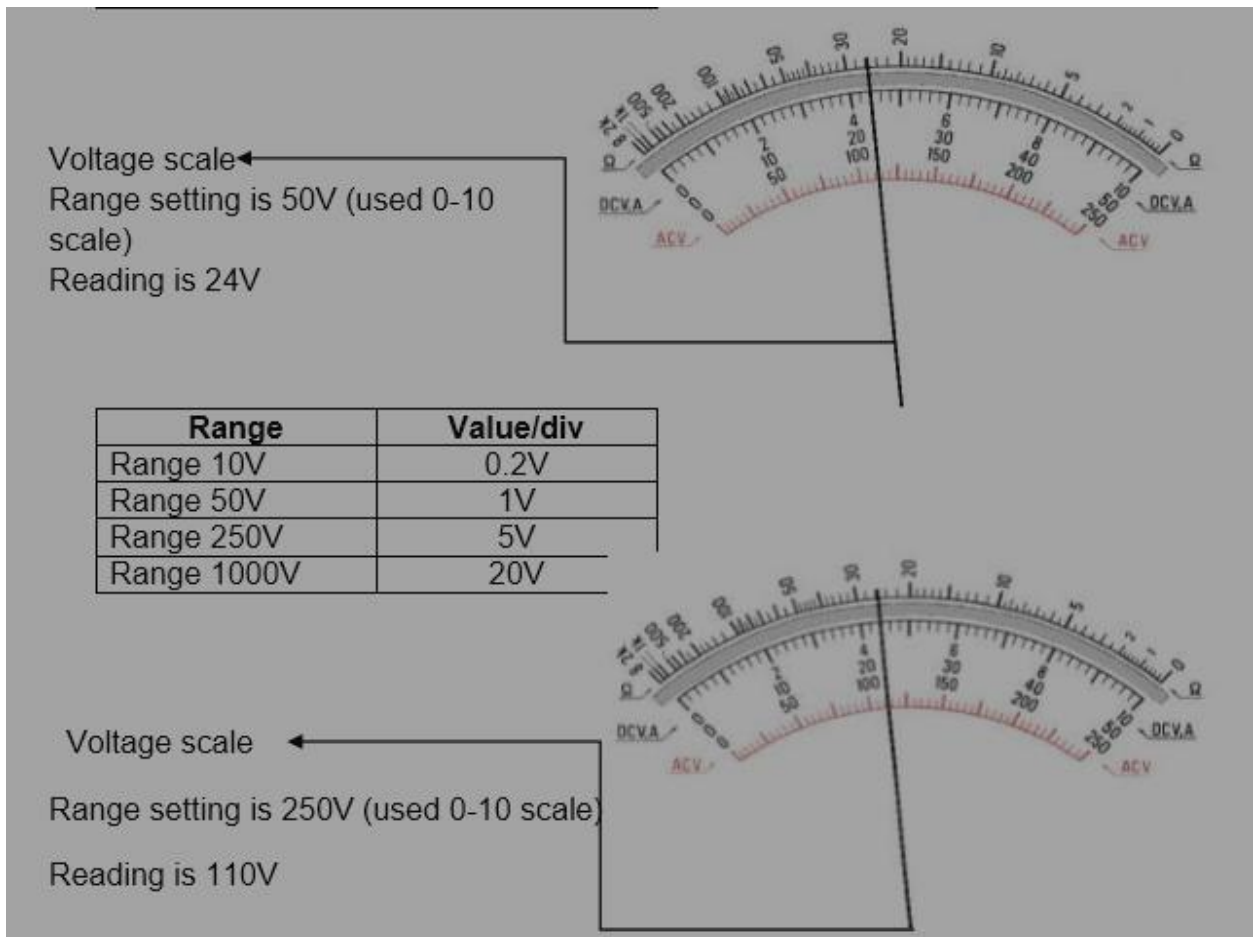


Figure 53: Reading meter scale of the Analog multi-meter

Voltmeter

For measuring differences of potential (voltage) between two points in an electrical circuit. The instrument is connected in parallel with the circuit being measured. Ranges vary from a few tenths volt to a few thousand volts. Instruments are capable of measuring both **A.C. and D.C voltage**.

Ohmmeter

For measuring the electrical D.C. ohm resistance of a circuit, circuit part, or component. Calibrated from zero ohms to infinite. Measures either series or parallel resistance. An **ohmmeter** is an electrical instrument that measures electrical resistance, the opposition to an electric current. Micro-ohmmeters make low resistance measurements.

Meg-ohmmeters (also a trademarked device Megger) measure large values of resistance. The unit of measurement for resistance is ohms (Ω).

Ammeter

Measure magnitude of electrical current flow in an electrical circuit. When measuring D.C. currents, some types must be inserted in series with the circuit. A.C. ammeters are of two types. One requires that it be connected in series with the circuit; the other needs only to be clamped around the current carrying conductor.

A **multi-meter** is a device used to measure voltage, resistance and current in electronics & electrical equipment. It is also used to test continuity b/n two points to verify if there is any break in circuit or line. There are two types of multi-meter: analogue and digital.

- *Analogue has needle style gauge*
- *Digital has LCD display*

There are 2 styles of multi-meter

- **Switched Manually:** switches b/n ranges to get most accurate reading.
- **Auto Range:** Switches b/n ranges automatically for best reading.



Figure 54: types of DMM

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Meter leads

- ✓ **Red meter lead:** Is connected to Voltage/ Resistance or Amperage port. Is considered the positive connection.
- ✓ **Probes:** Are the handles used to hold tip on the tested connection.
- ✓ **Tips:** Are at the end of the probe and provides a connection point.
- ✓ **Black meter lead:** Is always connected to the common port.

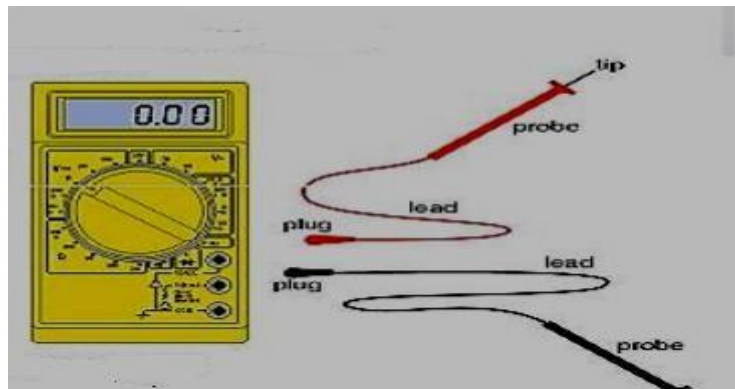


Figure 55: multimeter leads

Measuring Voltage

Voltage is the unit of electrical pressure; one volt is the potential difference needed to cause one amp of current to pass through one ohm of resistance.

There are two types of voltages: AC & DC

- ✓ Alternating Voltage (AC) is the house voltage (220v)
- ✓ Direct Current (DC) is the battery voltage (12v dc).

Be very careful not to touch any other electronic components within the equipment and do not touch the tips to each other while connected to anything else.

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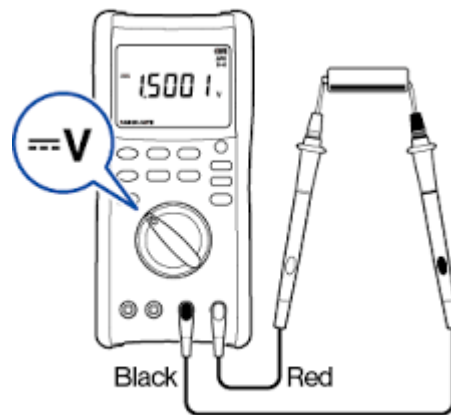


Figure 56: Measuring voltage

Measuring Resistance and Continuity

Resistance

Resistance is the opposition to current. It is measured in ohm. Testing for continuity is used to verify if a circuit, wire or fuse is complete with no open. Audible continuity allows an alarm if circuit is complete. If there is no audible alarm resistance of 1 ohm to 0.1 ohm should be present.

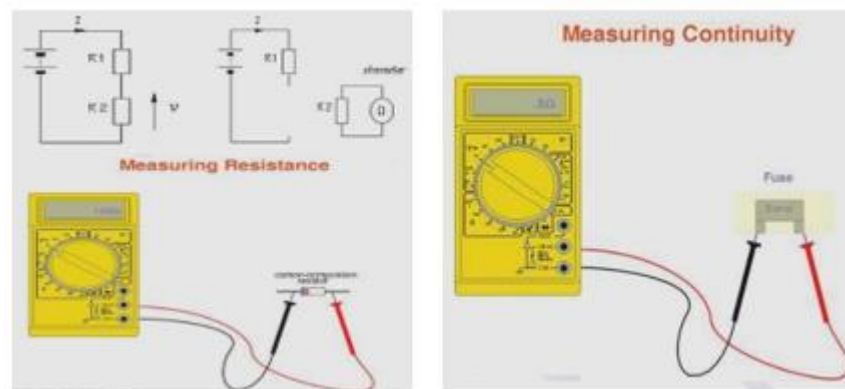


Figure 57: Measuring Resistance and measuring continuity

Measuring Current

Current is the flow of electrical charge through a component or conductor. It is measured in amps or amperes.

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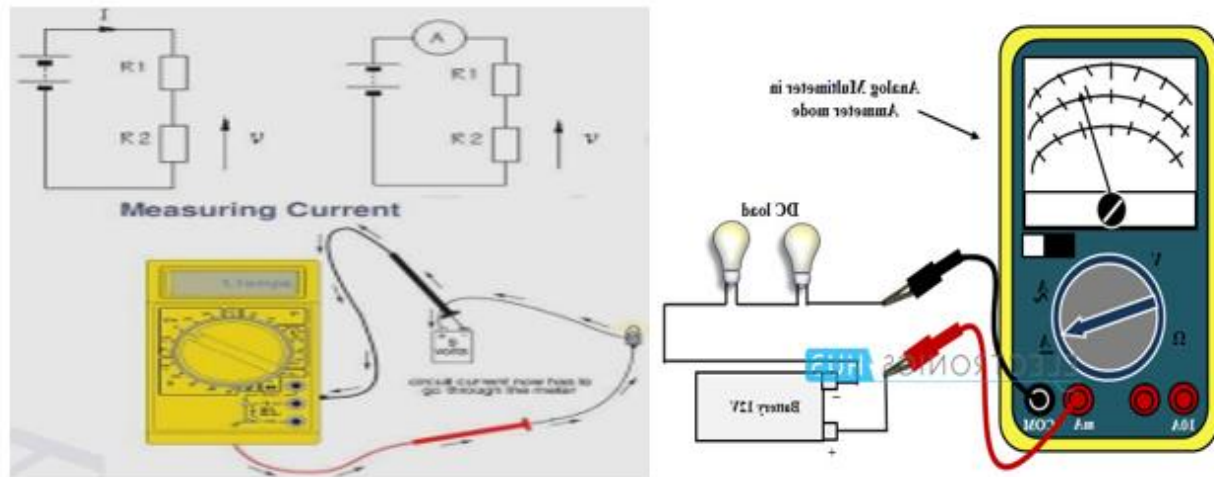


Figure 58: Measuring Current

Measuring insulation resistance

Insulation resistance testers can be used to determine the integrity of windings or cables in motors, transformers, switch-gear, and electrical installations. The test method is determined by the type of equipment being tested and the reason for testing. For instance, when testing electrical cabling or switchgear (low-capacitance equipment) the time-dependent capacitive leakage and absorption leakage currents become insignificant and decrease to zero almost instantly. A steady conductive leakage current flow is reached almost instantly (a minute or less) providing perfect conditions for the spot-reading/short- time resistance test.

Maintenance Tests

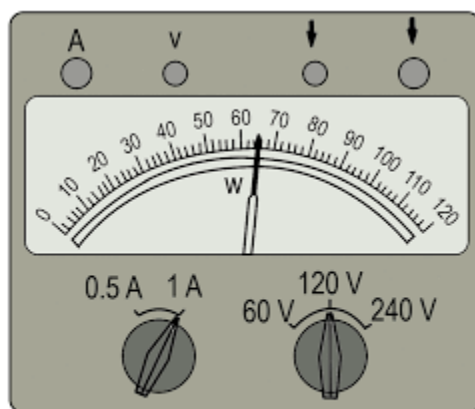
On the other hand, when the equipment to be tested is a long run of cable, large motor, Or generator (high-capacitance equipment) the time-dependent currents will last for hours. These currents will cause the meter readings to change constantly, making it impossible to obtain an accurate steady reading. This condition can be overcome by using a test that establishes a trend between readings, such as the step voltage or dielectric-absorption test. These tests do not depend on a single reading but on a collection of relative readings. It would be a waste of time to perform these tests on low-capacitance equipment since the Time-dependent currents diminishes quickly, resulting in all the measurements being the same.



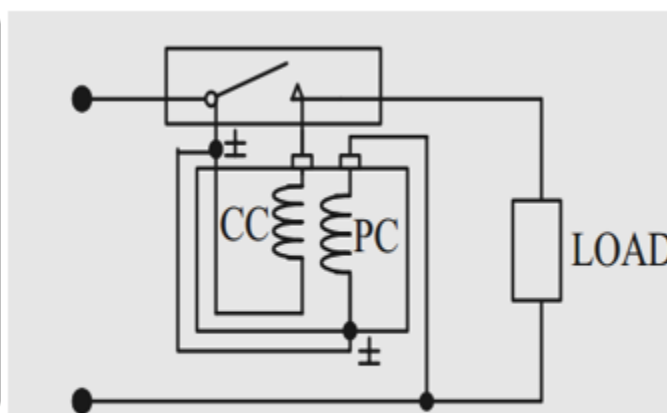
Figure 59: Measuring insulation resistance

Watt-Meter

Wattmeter is used for measuring powers in AC circuits. For DC circuits, powers can be found simply from multiplying voltage by current. The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeter are used for measurement of utility frequency and audio frequency power; other types are required for radio frequency. A wattmeter consists of a current coil, connected in series with the line like an ammeter, and a potential coil, connected in parallel with the line like a voltmeter. There is a shunt switch for the current coil similar to an ammeter, while the potential coil has no shunt switch.



Analog wattmeter



circuit diagram of wattmeter

Figure 60: Wattmeter

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Frequency meter

A **frequency meter** is an instrument that displays the frequency of a periodic electrical signal. Many are instruments of the deflection type, ordinarily used for measuring low frequencies but capable of being used for frequencies as high as 900 Hz. These operate by balancing two opposing forces. A **frequency counter** is an electronic instrument, or component of one, that is used for measuring frequency. Frequency counters usually measure the **number of cycles of oscillation**, or pulses per second in a periodic electronic signal. Changes in the frequency to be measured cause a change in this balance that can be measured by the deflection of a pointer on a scale. Deflection-type meters are of two types, **electrically resonant circuits and radiometers**. An example of a simple electrically resonant circuit is a moving-coil meter. In one version, this device has two coils tuned to different frequencies and connected at right angles to one another in such a way that the whole element, with attached pointer, can move. Frequencies in the middle of the meter's range cause the currents in the two coils to be approximately equal and the pointer to indicate the midpoint of a scale. Changes in frequency cause an imbalance in the currents in the two coils, causing them, and the pointer, to move.



Figure 61: Frequency counter and frequency meter

LCR meter

An **LCR meter** is a type of electronic test equipment used to measure the inductance (L), capacitance (C), and resistance (R) of an electronic component.

In the simpler versions of this instrument the impedance was measured internally and converted for display to the corresponding capacitance or inductance value. Readings should be reasonably accurate if the capacitor or inductor device under test does not have a significant resistive

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component of impedance. More advanced designs measure true inductance or capacitance, as well as the equivalent series resistance of capacitors and the Q factor of inductive components.



Figure 62: Handheld LRC meter

Use of oscilloscope as test instruments

Oscilloscopes are used in the sciences, medicine, engineering, automotive and the telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an electrical signal or to display the waveform of the voltage. The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. A storage oscilloscope can capture a single event and display it continuously, so the user can observe events that would otherwise appear too briefly to see directly

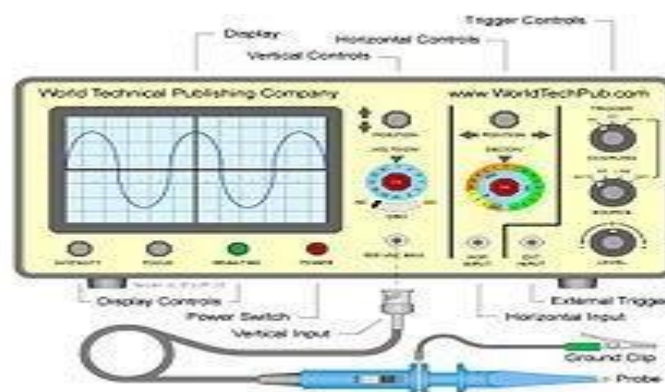


Figure 63: Basic oscilloscope

The basic oscilloscope, as shown in the illustration, is *typically divided into four sections*:

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- ✓ The display,
- ✓ Vertical controls,
- ✓ Horizontal controls and
- ✓ Trigger controls.

The display is usually a CRT (historically) or LCD panel laid out with horizontal and vertical reference lines called the *graticule*. CRT displays also have controls for focus, intensity, and beam finder. The vertical section controls the amplitude of the displayed signal. This section has a volts-per-division (Volts/Div) selector knob, an AC/DC/Ground selector switch, and the vertical (primary) input for the instrument. Additionally, this section is typically equipped with the vertical beam position knob. The horizontal section controls the time base or "sweep" of the instrument. The primary control is the Seconds-per-Division (Sec/Div) selector switch. Also included is a horizontal input for plotting dual X-Y axis signals. The horizontal beam position knob is generally located in this section. The trigger section controls the start event of the sweep. The trigger can be set to automatically restart after each sweep, or can be configured to respond to an internal or external event. The principal controls of this section are the source and coupling selector switches, and an external trigger input (EXT Input) and level adjustment.

In addition to the basic instrument, most oscilloscopes are supplied with a probe. The probe connects to any input on the instrument and typically has a resistor of ten times the oscilloscope's input impedance. This results in a .1 (-10X) attenuation factor; this helps to isolate the capacitive load presented by the probe cable from the signal being measured. Some probes have a switch allowing the operator to bypass the resistor when appropriate.

Front panel controls

Focus control

This control adjusts CRT focus to obtain the sharpest, most-detailed trace. In practice, focus must be adjusted slightly when observing very different signals, so it must be an external control. The control varies the voltage applied to a focusing anode within the CRT. Flat-panel displays do not need this control.

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Intensity control

This adjusts trace brightness. Slow traces on CRT oscilloscopes need less, and fast ones, especially if not often repeated, require more brightness. On flat panels, however, trace brightness is essentially independent of sweep speed, because the internal signal processing effectively synthesizes the display from the digitized data.

Astigmatism

This control may instead be called "shape" or "spot shape". It adjusts the voltage on the last CRT anode (immediately next to the Y deflection plates). For a circular spot, the final anode must be at the same potential as both of the Y-plates (for a centred spot the Y-plate voltages must be the same). If the anode is made more positive, the spot becomes elliptical in the X-plane as the more negative Y-plates will repel the beam. If the anode is made more negative, the spot becomes elliptical in the Y-plane as the more positive Y-plates will attract the beam. This control may be absent from simpler oscilloscope designs or may even be an internal control. It is not necessary with flat panel displays.

Beam finder

Modern oscilloscopes have direct-coupled deflection amplifiers, which means the trace could be deflected off-screen. They also might have their beam blanked without the operator knowing it. To help in restoring a visible display, the beam finder circuit overrides any blanking and limits the beam deflected to the visible portion of the screen. Beam-finder circuits often distort the trace while activated. These markings, whether located directly on the screen or on a removable plastic filter, usually consist of a 1 cm grid with closer tick marks (often at 2 mm) on the centre vertical and horizontal axis. One expects to see ten major divisions across the screen; the number of vertical major divisions varies. Comparing the grid markings with the waveform permits one to measure both voltage (vertical axis) and time (horizontal axis). Frequency can also be determined by measuring the waveform period and calculating its reciprocal. On old and lower-cost CRT oscilloscopes the graticule is a sheet of plastic, often with light-diffusing markings and concealed lamps at the edge of the graticule. The lamps had a brightness control. Higher-cost instruments have the graticule marked on the inside face of the CRT, to eliminate parallax errors; better ones also had adjustable edge illumination with diffusing markings. (Diffusing markings

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appear bright.) Digital oscilloscopes, however, generate the graticule markings on the display in the same way as the trace. External graticules also protect the glass face of the CRT from accidental impact. Some CRT oscilloscopes with internal graticules have an unmarked tinted sheet plastic light filter to enhance trace contrast; this also serves to protect the faceplate

Time base controls

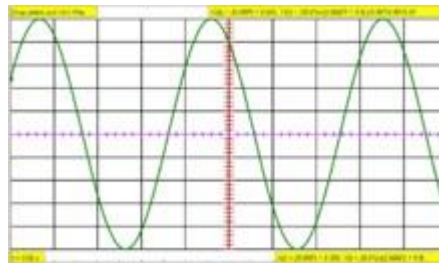


Figure 64: Time Base Controls

These select the horizontal speed of the CRT's spot as it creates the trace; this process is commonly referred to as the sweep. In all but the least-costly modern oscilloscopes, the sweep speed is selectable and calibrated in units of time per major graticule division. Quite a wide range of sweep speeds is generally provided, from seconds to as fast as picoseconds (in the fastest) per division. Usually, a continuously-variable control (often a knob in front of the calibrated selector knob) offers uncelebrated speeds, typically slower than calibrated. This control provides a range somewhat greater than the calibrated steps, making any speed between the steps available.

Hold off control

Some higher-end analog oscilloscopes have a hold off control. This sets a time after a trigger during which the sweep circuit cannot be triggered again. It helps provide a stable display of repetitive events in which some triggers would create confusing displays. It is usually set to minimum, because a longer time decreases the number of sweeps per second, resulting in a dimmer trace.

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Vertical sensitivity, coupling, and polarity controls

To accommodate a wide range of input amplitudes, a switch selects calibrated sensitivity of the vertical deflection. Another control, often in front of the calibrated-selector knob, offers continuously-variable sensitivity over a limited range from calibrated to less-sensitive settings.

Often the observed signal is offset by a steady component, and only the changes are of interest. An input coupling switch in the "AC" position connects a capacitor in series with the input. This passes only the changes (provided they are not too slow ("slow" would mean visible. However, when the signal has a fixed offset of interest, or changes quite slowly, the user will usually prefer "DC" coupling, which bypasses any such capacitor. Most oscilloscopes offer the DC input option. For convenience, to see where zero volts input currently shows on the screen, many oscilloscopes have a third switch position (usually labeled "GND" for ground) that disconnects the input and grounds it. Often, in this case, the user centers the trace with the vertical position control. Better oscilloscopes have a polarity selector. Normally, a positive input moves the trace upward; the polarity selector offers an "inverting" option, in which a positive-going signal deflects the trace downward.

Horizontal sensitivity control

This control is found only on more elaborate oscilloscopes; it offers adjustable sensitivity for external horizontal inputs. It is only active when the instrument is in X-Y mode, i.e. the internal horizontal sweep is turned off.

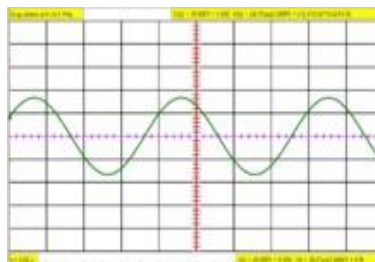


Figure 65: Vertical position control

The vertical position control moves the whole displayed trace up and down. It is used to set the no-input trace exactly on the center line of the graticule, but also permits offsetting vertically by a limited amount. With direct coupling, adjustment of this control can compensate for a limited DC component of an input.

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Horizontal position control

Computer model of Horizontal position control from X offset increasing. The horizontal position control moves the display sidewise. It usually sets the left end of the trace at the left edge of the graticule, but it can displace the whole trace when desired. This control also moves the X-Y mode traces sidewise in some instruments, and can compensate for a limited DC component as for vertical position.

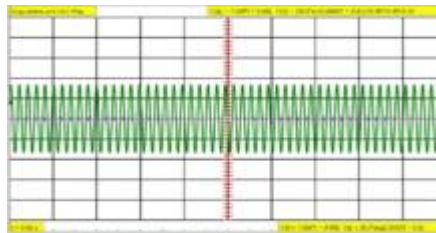


Figure 66: Horizontal position control

Dual-trace controls

Dual-trace controls green trace = $Y = 30 \sin(0.1 \cdot t) + 0.5$ teal trace = $Y = 30 \sin(0.3 \cdot t)$ Each input channel usually has its own set of sensitivity, coupling, and position controls, though some four-trace oscilloscopes have only minimal controls for their third and fourth channels.

Dual-trace oscilloscopes have a mode switch to select either channel alone, both channels, or (in some) an X-Y display, which uses the second channel for X deflection. When both channels are displayed, the type of channel switching can be selected on some oscilloscopes; on others, the type depends upon time base setting. If manually selectable, channel switching can be free-running (asynchronous), or between consecutive sweeps. Some Philips dual-trace analog oscilloscopes had a fast analog multiplier, and provided a display of the product of the input channels. Multiple-trace oscilloscopes have a switch for each channel to enable or disable display of the channel's trace.

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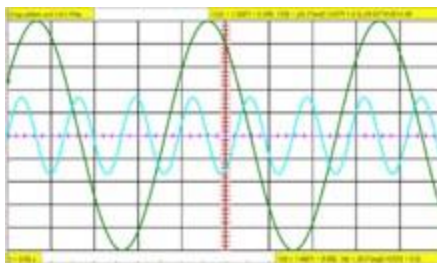


Figure 67: Dual and Multiple-trace Oscilloscopes

Maintenance testing

The second most important reason for insulation testing is to protect and prolong the life of electrical systems and motors. Over the years, electrical systems are exposed to environmental factors such as dirt, Grease, temperature, stress, and vibration. These conditions can lead to insulation failure, resulting in loss of production or even fires. Periodic maintenance tests provide valuable information about the state of deterioration and will help in predicting possible failure of the system. Correcting problems will result not only in a trouble-free system, but will also extend the operating life for a variety of equipment.

3.2 Safety Procedures in Using Tools and Personal Protective Equipment (PPE)

1. Introduction to General Safety Precautions

Read and follow your department's safe work practices guidelines.

Employees and employers have a responsibility to work together and establish safe working practices. Always use the Personal Protective Equipment (PPE) necessary to protect you from exposure to potential hazards, such as;

- ✓ Falling, flying, abrasive or splashing objects.
- ✓ Sharp edges (use caution around when and when not to wear gloves)
- ✓ Harmful dusts, fumes, mists, vapors, or gases.
- ✓ Biological and chemical hazards

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If a hazardous situation is encountered, immediately bring it to the attention of your supervisor or designated safety coordinator. Keep floors as clean and dry as possible to prevent accidental slips or trips when working with or around hand and power tools.

Clear your workspace of accumulated saw dust, debris, and volatile gases reduces the chance that sparks could cause fire or explosion.

- ✓ Avoid Horse play. Use tools for their intended purpose only.
- ✓ Handle hand tools with care.

When can PPE be used?

PPE is one of the least effective ways of controlling risks to work health and safety and should only be used:

- ✓ when there are no other practical control measures available (as a last resort)
- ✓ As an interim measure until a more effective way of controlling the risk can be used
- ✓ To supplement higher level control measures (as a back-up).

What standard of PPE is required? PPE used at a workplace must be:

- ✓ Selected to minimize risk to work health and safety.
- ✓ Suitable for the nature of the work and any hazard associated with the work.
- ✓ A suitable size and fit and reasonably comfortable for the person wearing it.
- ✓ Maintained, repaired or replaced so it continues to minimize the worker's health and safety risk, and
- ✓ Used or worn by the worker, so far as is reasonably practicable.

How do I choose the right PPE for the job?

Selection processes for choosing the right PPE must involve consultation with workers and their representatives and should also include:

- ✓ A detailed evaluation of the risk and performance requirements for the PPE.
- ✓ compatibility of PPE items where more than one type of PPE is required (for example ear muffs with a hard hat)
- ✓ Consultation with the supplier to ensure PPE is suitable for the work and

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- ✓ Workplace conditions, and preference for PPE that complies with the relevant Australian Standard or equivalent standard.

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What Must Be Done to Be Safe?

Use the three-stage safety model: **recognize, evaluate, and control hazards**. To be safe, you must think about your job and plan for hazards. To avoid injury or death, you must understand and recognize hazards. You need to evaluate the situation you are in and assess your risks. You need to control hazards by creating a safe work environment, by using safe work practices, and by reporting hazards to a supervisor or teacher.

If you do not recognize, evaluate, and control hazards, you may be injured or killed by the electricity itself, electrical fires, or falls. If you use the safety model to recognize, evaluate, and control hazards, you are much safer.

Recognize hazards

The first part of the safety model is recognizing the hazards around you. Only then can you avoid or control the hazards. It is best to discuss and plan hazard recognition tasks with your co-workers. Sometimes we take risks ourselves, but when we are responsible for others, we are more careful. Sometimes others see hazards that we overlook. Of course, it is possible to be talked out of our concerns by someone who is reckless or dangerous.

Evaluate hazards

When evaluating hazards, it is best to identify all possible hazards first, then evaluate the risk of injury from each hazard. Do not assume the risk is low until you evaluate the hazard. It is dangerous to overlook hazards. Job sites are especially dangerous because they are always changing. Many people are working at different tasks. Job sites are frequently exposed to bad weather. A reasonable place to work on a bright, sunny day might be very hazardous in the rain. The risks in your work environment need to be evaluated all the time. Then, whatever hazards are present need to be controlled.

Control hazards

Once electrical hazards have been recognized and evaluated, they must be controlled. You control electrical hazards in two main ways: (1) create a safe work environment and (2) use safe work practices. Controlling electrical hazards (as well as other hazards) reduces the risk of injury or death. **Personal protective equipment** is vital to the safety of employees that work with hand

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and power tools. The type of PPE needed is determined by the tool used and the work being performed. Your employer will provide all necessary PPE at no cost to you. You have a responsibility to use the PPE properly and when required

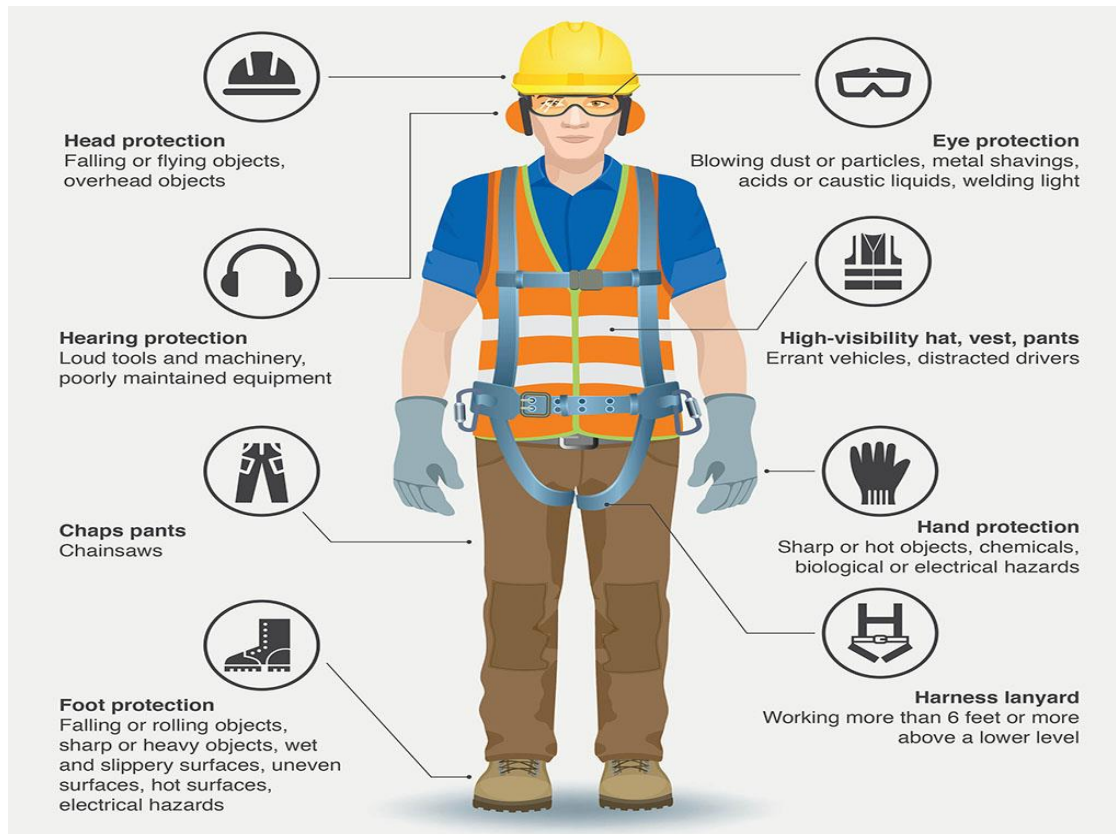


Figure 68: Personal protective equipment

Safety shoes

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there. Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

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Figure 69: Safety shoes

Belts and Straps

The safety strap and body belt, might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring (called a D-ring because of its shape) on the body belt. When you are at working position, you unsnap one end of the safety strap, pass it around the supporting structure so there is no danger of its slipping (at least 18 inches from the top of the part on which it is fastened), and hook it to the right D-ring on the body belt. The safety strap must be placed around a part of the structure that is of sufficient strength to sustain an Abs weight and his or her equipment, and must rest flat against the surface without twists or turns. It must not be placed around any part of a structure that is being removed. Before placing your weight on the strap, determine VISUALLY that the snap and D-ring are properly engaged. Do not rely on the click of the snap-tongue as an indication that the fastening is secure. The body belt and safety strap require inspection before use. Look for loose or broken rivets; cracks, cuts, nicks, tears or wear in leather; broken or otherwise defective buckles, such as enlarged tongue-holes, defects in safety-belt snap hooks and body belt D-rings. If you discover any of these or other defects, turn in your equipment and replace it. Perform maintenance periodically according to applicable procedures. Remember that leather and nylon belts are treated in different manners

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Goggles: Are used to protect the form of the eye .During welding or from flying objects (chips) during grinding and burring materials or wooden surface.

Glove: hand covering for protection warmth, etc usually with separate fingers.



Figure 70: Hand protecting glove

Apron/overall;-Airport of the overall development & to facilitate tourist traffic.



Figure 71: Leather apron

Eye protection

Proper eye protection is of the highest importance for all personnel. Eye protection is necessary because of hazards caused by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood, etc. These hazards are always present during welding, cutting, soldering, chipping, grinding, and a variety of other operations.

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Figure 72: Eye protection

3.3 Reporting events to the supervisor

Concepts of reports

A **report** is a part of a documentation which is sharp and short and specially written for a particular purpose and audience. A report consists of specific and important information which is analyzed and applied to a particular problem or issue, often making recommendations for future action.

Characteristics of reports

Requirements and content of a report may vary business to business and departments to a department. Thus, to understand the information that written, a report has possessed the following;

- ✓ Clear and well-structured format
- ✓ Provides a brief of instruction and guideline
- ✓ Outline of the purpose of report, audience, and issue or problems.
- ✓ Easy to locate and follow.

Reporting emergency situations

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Reporting emergency situations are rare but do occur, so having a plan for handling them is helpful. If the practitioner(s) believe his/her client is in imminent danger of killing or injuring themselves or another person,

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- ✓ Phone the local police or emergency services immediately
- ✓ Stay with the person until help arrives
- ✓ Ask what is the root cause of emergency situation
- ✓ If the root cause is being known:
 - Instruct the client to give the object to someone for safekeeping
 - Discuss who can be notified of the risk and weapon and follow up
 - Listen, but do not judge, argue, threaten, or yell

Inspection Report

Inspector will prepare a formal report to document the inspection findings. This report will consist of the completed checklist. All inspection reports will contain the information and be presented in the format described as follows. (See Attachment C for an example report format):

- **Heading** - This indicates the type of inspection performed.
- **Facility Identification** - This includes the name, location, telephone number, AIRS Facility Subsystem (AFS) Plant I.D., the date of the inspection and the regional office conducting the inspection.
- **Participants** - This section includes the name, title and affiliation of each participant.
- **Inspection Procedures** - This section briefly describes the activities conducted during the inspection.
- **Process/Facility Description** - This section should contain a description of the process including the Standard Industrial Classification (SIC) number and a description of the facility, its process and air pollution control equipment. The detail included will depend on the facility inspected and the extent to which information is current and available in the files from previous inspections. Applicable previous inspection information should be referenced.
- **Discussion of Inspection Procedures** - This section contains discussion of the specific inspection procedures used by the state/local inspector. This section should include specific procedures used by the state/local inspector and comments on those procedures. Any problems, discrepancies and deficiencies, as well as positive aspects should be

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discussed. The discussion should be based on observations of the inspector's activities and the information contained on the Joint Overview Air Compliance Inspection and Report Checklists.

- **Summary/Recommendations** - This is based upon the previous sections and should include conclusions which can be made about the state/local agency inspector's activities and state/local agency inspection policies. Both positive and negative comments should be included. Also discuss any influence your actions might have had on the state/local inspector's inspection. This section should be oriented toward improving the state/local agency's air compliance inspections.
- **Signatures** - The inspector will sign the report. The date signed will be included, e.g.:
(Inspector's Name) Environmental Engineer and Date:
- **Attachments** - These are identified by a number (e.g., Attachment 1) and placed in numerical sequence in the report. They may include: (1) Joint Air Compliance Overview
- **Inspection Checklist.** (2) Joint Air Compliance Overview Inspection Report Checklist.
(3) State/local Agency Inspection Report. (4) Other appropriate documents, i.e.,
photographs and any documents obtained during the inspection.

What do you need to report?

The following are reportable, if they arise 'out of or in connection with work':

- The death of any person, whether or not they are at work
- accidents which result in an employee or a self-employed person dying, suffering a specified injury, being absent from work or unable to do them
- their normal duties for more than seven days
- accidents which result in a person not at work (e.g a patient, service user, visitor) suffering an injury and being taken directly to a hospital for treatment, or if the accident happens at a hospital, if they suffer a specified injury
- an employee or self-employed person has one of the specified occupational diseases or is exposed to carcinogens, mutagens and biological agents
- Specified dangerous occurrences, which may not result in a reportable injury, but have the potential to do significant harm

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When to report

Although the Regulations specify varying timescales for reporting different types of incidents, it is advisable to report the incident as soon as possible. In cases of a reportable death, specified injury, or dangerous occurrence, you must notify the enforcing authority without delay. You must report within 10 days of the incident. Over-seven-day injuries must be reported within 15 days of the incident. Diseases should be reported as soon as a registered medical practitioner (RMP) notifies you in writing that your employee suffers from a reportable work-related disease.

Keeping records

You must keep a record of any reportable injury, disease or dangerous occurrence for three years. This must include:

- ✓ The date and method of reporting
- ✓ The date, time and place of the event
- ✓ Personal details of those involved
- ✓ The injury
- ✓ A brief description of the nature of the event or disease.
- ✓ You must still keep a record of all over-three-day injuries. If you are required to keep an accident book, under the Social Security.

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Self-check 3

Written exam

Directions: Answer all the questions listed below.

Test I. Choose the best answer

- Which of the following instrument is used to displays a periodic signal of electrical circuit.
A. frequency meter B. energy Meter C. KWH –Meter D. digital multi-meter
- Which of the following **is not true** about Function of Digital multi-meter, in electronics & electrical equipment testing system.
A. device used to measure voltage B. a device used to measure resistance and current
C. is a device used to measure Continuity b/n two points D. none
- Which of the following is used for measuring differences of potential (voltage) between two points in an electrical circuit?
A. Ohmmeter B. Voltmeters C. Ammeters D. Wattmeter
- The cost of electricity bill is calculated by multiplying the number of kWh that were consumed by the cost of -
A. 1kWh B. 2KWH C. 3KWH D. 1.5KWH
- Which of the following is used for measuring powers in AC circuits?
A. Ohmmeter B. Voltmeters C. Wattmeter D. Ammeters

Test II. Say true if the statements correct and say false if the statements incorrect

- The first part of the safety model is recognizing the hazards around you.
- Some safety shoes are **NOT** designed to limit damage to your toes from falling objects.
- PPE** is vital to the safety of employees that work with hand and power tools.
- Proper eye protection is one of the best highest important for all personnel.

Test III. Match the items in column “A “to “B”; write the letter only in the space provided

	<i>Column – A</i>		<i>Column - B</i>
1	Goggles	A	Hold or secured parts of device
2	Gloves	B	Measure ground resistance
3	Earth/ground tester	C	Protect eye from the hazards
		D	hand covering for protection

Note: Satisfactory rating - 3 and 5 points Unsatisfactory - below 3 and 5 points

Score = _____

Rating: _____

You can ask you teacher for the copy of the correct answers.

Name: _____

Date: _____

Operation sheet 1	Measuring Resistance
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Operation title: Measuring Resistance

Instruction: check test instrument functionality and follow proper guide line to do the task.

Purpose: proper use of test device and reduce hazardous event due to electric shock

Required tools: PPE, DMM, resistor, tester light, PCB current carrying conductor

Precaution: use necessary PPE before start operating any test equipment and Handle hand tools with care

Procedure:

Steps 1 – wear PPE and check DMM for safe functionality

Step 2 - Adjust the pointer of DMM on Ohm range of to measure resistance

Step 3 – connect the black lead cable in to Common terminal and red cable into voltage terminal

Step 4 – connect tips of black cable on one terminal and tips of red cable to another terminals of resistor under test

Step 5- record the resistance value of resistor on the information display of DMM

Step 6- If 0L is displayed on information display of DMM, change the range of ohm on DMM then record the value of resistor again.

Quality criteria:

Operating digital multi-meter

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Operation sheet 2	Techniques to reporting events to the supervisor
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Operation title: techniques for writing reports of events to the supervisor

Instruction: prepare short, sharp and brief written document for a particular purpose and audience

Purpose: to reduce the risk due to malfunction and unsafe operation

Required tools: computer

Precaution: identify the problem before you report and do not operate unsafe and malfunctioning hand tools before reports to you supervisor

Procedure

Step 1- Provide nature of the incident/action/measures:

Make sure the reliability and validity of Information sources a like who, when and where

Step 2- record the place of the event.

Step 3- Description of suspect involved

Step 4- documenting injuries that have occurred

Step 5- report of any harm involved

Step 6- report of material goods involved

Quality criteria:

Report writing skill

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LAP 1	Practical demonstrations
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Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1: Perform proper Measurement of resistance measurement by using electrical electronic's test Equipment

Task 2: Report the hazardous events /incident/action/measures happen in workshop to the supervisor.

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Unit Four: Maintain Hand Tool Test Equipment

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Hand tools handling.
- Routine maintenance of tools and measuring instrument
- Safe storage of hand tools and test instrument in appropriate locations

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

- handle Tools without damage according to procedures
- Undertake Routine maintenance of tools and measuring instrument
- store Tools safely in appropriate locations in accordance with manufacturer's

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below 3 to 6.
- Read the information written in the information “Sheet 1, Sheet 2, and Sheet 3
- Accomplish the “Self-check 1, Self-check 2 and, Self-check 3
- If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 & 2,
- Do the “LAP test”

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4.1 Introduction of Handling Electrical Hand Tools

Handling of electrical hand tools without damage means the way work of keeping something in proper condition. This would imply that maintenance should be actions taken to prevent a device or component from failing or to repair normal equipment degradation experienced with the operation of the device to keep it in proper working order. Properly maintained tools help improve efficiency of operation while minimizing opportunities for injuries and extending tool life. Time spent in tool maintenance (sharpening, cleaning, lubrication etc.) is time well spent. Prior to use, always inspect the tools for defects or damage. Check for loose, bent, or cracked tool handles, mushroomed tool heads, sprung tool joints or worn teeth. If a hand tool fails the initial inspection, inform the crew leader, tag the tool clearly as “defective”, and remove it from service. Allow adequate time at the end of each work day to clean the tools and properly pack and secure for transportation or storage. Maintaining a safe and efficient work environment will help avoid injuries and unnecessary expenditures in the long run.

Handling of electrical hand tools /Maintenance/ should be:

- ✓ Keep metal blades of all tools sharp and well-oiled.
- ✓ Check for loose and worn out parts on tools regularly, and replace if necessary.
- ✓ Identify damaged tools and store them in a designated location to allow either the supervisor or maintenance person to arrange for their repair.
- ✓ Workers should know that the job is not complete until the tools are cleaned and stored in a designated location.

There are four principal causes of electrical failure:

- ✓ Dust and dirt accumulation; moisture.
- ✓ Loose connections; and friction of moving parts.
- ✓ An effective maintenance program should aim to minimize these effects by keeping equipment clean and dry, keeping connections tight and minimizing friction.
- ✓ Tools that are unsafe/faulty can be categorized in to two

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- ✓ those having minor faults such as loose handle, rusted hinges, damaged blade, bent ends & dirt edges, Dismantled casing, missing screws etc
- ✓ Those fully damaged include broken teeth, broken blade, tool with missing parts, worn tools, burned elements, open circuits inside the tool, frayed or damaged flexible cords etc...

The method of identifying faulty and functional tools is done either by visual inspection or by performing different tests using test instruments.

Powered hand tools are visually inspected before use and electrically tested by a competent person as necessary

Visual Checks Are Carried Out As Follows:

- **Tools/appliance**
 - On/off switch is working correctly
 - No signs of damage to casing
 - No loose parts or missing screws
 - Live parts are properly guarded so as not to be inadvertently accessible
 - Ensure equipment is disconnected when not in use
- **Cables**
 - ✓ Securely anchored to the plug with no signs of cuts, frays, brittleness, leads kinked or coiled, taped joints, overloading (overheating indicated by color change or smell), cable cores not externally visible.
- **Plug: Securely** anchored no sign of cracked casing, overheating, loose or bent pins. Socket outlet
- **No cracks or damage or sign of overheating.**

While identifying malfunctions any tool that is unsafe for work must be marked as faulty and the recommended corrections that must be taken to make the tool functional have to be identified clearly. Damaged tools must be marked and tagged out as damaged and stored in a different place from functional tools in order to protect other people from using them and thus avoid accident & hazards in the work area.

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Hazards and risks induced by lack of or inadequate maintenance include:

1. Hand tools

Mechanical failure or loss of control when using a tool with defective parts. Examples of unsafe tools are hammers with loose or damaged heads, screwdrivers with broken handles or blunt edges, chisels with mushroomed heads, and blunt saws.

2. Power tools

- **Malfunctioning of safety devices** such as emergency button (red button), protective covers, guards, etc. In case of emergency these devices will not work properly or will provide limited protection to the worker, which in some cases can be worse than no protection at all because it gives a false sense of security.
- Risks of electrocution shock or burn due to electrical malfunctions, torn cables and lack of proper insulation or proper earthing.
- Cracked or broken grinding wheels or cracked blades can cause injuries. E.g. cracked abrasive wheels could fly apart in operation, which could lead to serious injury or death.
- Emissions of chemical substances such as toxic fumes or dust, etc.
- Noise and vibration emitted by almost all portable tools that can lead to hearing loss and hand–arm vibration syndrome respectively. Vibration can cause “white-finger” disease, which arises from damage to the muscles and nerves that control the blood flow. Poorly maintained tools can cause a significant increase in noise and vibration emissions (e.g. a cutting tool that is not sharp emits higher levels of vibration). Also, damaged anti-vibration mountings in a tool can increase transmission of vibration to the worker.

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4.2 Maintenance and Inspection Programmers

The key to safe maintenance is putting in place a maintenance program me, integrating safety and health aspects of maintenance and including inspection, reporting and record keeping procedures. Records must be kept to provide information for planning maintenance and replacement activities so that they occur at the proper time. Proper maintenance management of equipment requires a detailed inventory of all major items, including among other things information on manufacturer, model, year and number, and a list of the parts required for normal service and major repairs respectively.

An important part of the maintenance programme is the inspection programme setting out the frequency of formal inspections to be carried out by competent and trained maintenance technicians.

Portable tools must be checked:

- ✓ Before the tool is put into use for the first time
- ✓ After servicing and changing parts
- ✓ At regular intervals appropriate for each tool.

The period between inspections can vary, depending on the type of tool, the conditions of use and the environment. In Germany there are technical rules and accident prevention regulations that give advices on how to identify and set maintenance intervals for powered portable tools.

Factors to consider when making the maintenance plan

- ✓ Type of tool and power source
- ✓ Manufacturer's instructions and recommendations
- ✓ Frequency of use and the work cycle of the tool
- ✓ Working environment in which the tool is used (e.g. wet or dusty), or likelihood of mechanical damage
- ✓ Foreseeable misuse of the tool
- ✓ Effects of any modifications or repairs to the tool

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- ✓ Analysis of previous records of maintenance.

Test Tools Final Check

When maintenance is complete workers have to check if the maintenance has left the portable tools in a safe and functioning condition:

- ✓ Test the functionality of the tool
- ✓ Replace all guards and safety devices
- ✓ Record your inspection and actions, sign out and pass the tool to the worker or store it safely.

Basic Maintenance of Electrical Tools and Equipment

To ensure that your electric tools work when you need them, you must take proper care of them. A good routine of maintenance for your tools is one thing that you can do to make sure that the tool you need is working when you need it ***Clean out the Dust.*** To make sure that your electric tools are ready to go when you are keep them clean and free of dust. Spend some time to clean out the dust every once in a while on your tools while they are inactive in storage.



Figure 73: Clean out the Dust

Check the Cords. Look for tear/cut insulator on the power cords on your electric tools. This will ensure that your electric tool can get the power that it needs to function without an accident.

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Figure 74: Check the Cords.

Use the right tool correctly. Use tools correctly and for their intended purposes. Follow the safety directions and operating procedures recommended by the manufacturer. When working on a circuit, use approved tools with insulated handles.



Figure 75: Right tool correctly

Protect your Tools. Keep tools and cords away from heat, oil, and sharp objects. These hazards can damage insulation. If a tool or cord heats up, stop using it. Report the condition to a supervisor or instructor immediately.



Figure 76: Protect your Tools

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Use double-insulated tools - Portable electrical tools are classified by the number of insulation barriers between the electrical conductors in the tool and the worker.



Figure 77: Double-insulated tools

Storing Your Tools- Keep your electric tools stored in their original cases and containers. This will keep them free of dust and dirt while they are not being used.



Figure 78: Storing tool box

Non-Functional Tools and Equipment Identification Approaches

- ✓ **Visual inspection.** It refers to the visual observation of an expert on the appearance of the tools and equipment.
- ✓ **Functionality.** Vibration or extra noise from the operation means problems on parts and accessories started to develop.
- ✓ **Performance.** When there is something wrong with the

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performance of either hand tools or equipment they need an immediate repair or maintenance.

- ✓ **Power supply (for electrically operated only).** Failure to meet the required power supply, malfunction will occur in the part of hand tools or equipment.
- ✓ **Persons involved.** It refers to the technical person who has the knowledge and skills about the technology.

Classifications of tools and equipment according to their uses:

- ✓ Measuring tools
- ✓ Holding tools
- ✓ Cutting tools
- ✓ Driving tools
- ✓ Boring tools
- ✓ Electrical equipment
- ✓ Miscellaneous tools/instrument/equipment
- **Non-functional tools and equipment** are those that are not able to perform its regular function because of impaired and damaged part. Examples of these are the following.

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Figure 79: Non-functional tools and equipment

- **Functional tools and equipment** are those that are in good condition and can perform its regular functions. Examples of these are the following.



Figure 80: Functional tools and equipment

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4.3 Routine maintenance of Test Instruments and Hand Tools

Maintenance can be defined as working on something to keep it in a functioning and safe state and preserving it from failure or decline. The “something” could be a workplace, work equipment, or means of transport. These are:

1.Preventive – or proactive – maintenance is carried out to keep something functional.

This type of activity is usually planned and scheduled.

2.Corrective – or reactive – maintenance is repairing something to get it working again.

This is an unscheduled, unplanned task, usually associated with greater hazards and higher risk levels. Maintenance is not the exclusive domain of fitters and mechanics. It is the responsibility of almost all workers in every sector and is carried out in almost every working environment. Workers’ health and safety can be affected during the maintenance process, but also by lack of maintenance or inadequate maintenance.

Design of equipment and the work area also has a significant impact on the health and safety of workers performing maintenance.

1.For the purpose of this e-fact, portable tools are defined as tools which can be carried by hand. These tools can be divided into non-powered portable (hand) tools and powered portable tools.

2.Non-powered portable (hand) tools include saws, hammers, screwdrivers, pliers, axes and spanners. The greatest hazards posed by these tools result from misuse and improper maintenance. Blunt tools, for example, can make the work more difficult and result in more injuries.

3.Powered portable tools there are several types of power tools, based on the power source they use: electric power operated tools (e.g. circular saws, drill machines), pneumatic power tools (e.g. hammers, chippers, and compressed air guns), liquid fuel (gas) powered tools (e.g. saws), hydraulic power tools (jacks), and powder-actuated tools (nail guns). Powered portable tools are present in nearly every industry. They help to perform tasks that otherwise would need exhausting manual work. But these everyday tools can cause serious injuries, such as finger or hand injuries or severe eye injuries, when they are not used or maintained properly. Broken (defective) tools, or tools that

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have been modified unprofessionally can be dangerous. For instance, defective electric powered tools can cause burns and shocks or even death through electrocution.

Pneumatic tools can be very noisy and cause hearing loss. Portable tools are used intensively on construction sites, so that the workers are constantly exposed to hazards associated with their use.

4.3.1 Basic preventive maintenance

- Lubricants are identified according to types of equipment.
- Tools and equipment are lubricated according to preventive maintenance schedule or manufacturer's specifications.
- Measuring instruments are checked and calibrated in accordance with manufacturer's instructions.
- Tools are cleaned and lubricated according to standard procedures.
- Defective equipment and tools are inspected and replaced according to manufacturer's specification.
- Work place is cleaned and kept in safe state in line with OSHC regulations

4.3.2 Standard Operating Procedure of electrical hand tools

Work Environment

- ✓ Ensure that the floor of a work place is clean to avoid tripping or other possible instances that could lead to a worker losing his or her balance.
- ✓ Keep the workspace clean and tidy to avoid clutter, which may cause accidents.
- ✓ Use clamps to secure a work piece, which is liable to move, into a stable position.
- ✓ Do not carry a sharp or pointed tool in your pocket. Carry tools securely and safely.
- ✓ Keep close track of tools when working at heights. A falling tool can cause serious injury. 6. Pass a tool to another person by the handle; never throw it to them.
- ✓ Store tools properly when not in use.

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All Tools

- ✓ Use the correct hand tool for the job. Do not use tools for jobs they are not intended for. Do not use your wrench as a hammer. Do not use a screwdriver as a chisel, etc.
- ✓ Keep tools in good condition at all times. Do not use broken or damaged tools, dull cutting tools or screwdrivers with worn tips.
- ✓ Inspect tools for defects before use. Replace or repair defective tools.
- ✓ Do not wear bulky gloves to operate hand tools.
- ✓ Do not apply excessive force or pressure on tools.
- ✓ Replace cracked, splintered, or broken handles on files, hammers, screwdrivers, or sledges.
- ✓ Ensure that the handles of tools like hammers and axes fit tightly into the head of the tool.
- ✓ Flat head screwdrivers should have square edges on their blade tips and undamaged handles. Phillips and similar screwdrivers should have clearly defined tips without chips missing and undamaged handles.
- 9. Spanners should be in good condition with undamaged jaws to reduce the risk of slipping.
- ✓ Torque spanners should be checked for accuracy once a year and adjusted or replaced as required.

Pre-Operational Safety Checks

- ✓ Ensure that risk assessment has been read.
- ✓ Ensure no slip/trip hazards are present in workspaces and walkways.
- ✓ Always check the condition of tools prior to use
- ✓ Faulty equipment must not be used.
- ✓ Immediately report suspect equipment or tools.

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Operational Safety Checks

- ✓ Use tools that are the right size & right type for your job.
- ✓ Follow the correct procedure for using every tool.
- ✓ Keep your cutting tools sharp and in good condition.
- ✓ . Don't work with oily or greasy hands.
- ✓ Cut away from yourself when using chisels and other edged tools.
- ✓ Handle sharp-edged and pointed tools with care.
- ✓ Always carry pointed tools by your side with the points and heavy ends down.
- ✓ Never carry tools in your pockets.
- ✓ Do not use tools which are loose or cracked.
- ✓ Always place tools or materials where they cannot fall or trip other personnel when not in use.
- ✓ Don't force screws; make sure that the correct screw or fixing for the job is being used.
- ✓ Where possible, secure work with clamps or a vice, freeing both hands to operate the tool used.
- ✓ Keep your balance and proper footing when working, being careful not to overreach.

Tool Handles:

- ✓ Handles should fit the hand well.
- ✓ Handles must have a good gripping surface e.g. dimpled, and be made of compressible material e.g. not hard plastic or metal.
- ✓ Handles must have no sharp edges or areas that dig into the fingers or palm of the hand.
- ✓ Tool handles should have a grip span about 6 cm and not more than 9 cm.
- ✓ Where possible, tools such as knives or soldering irons should have a guard/stopper at the front.

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Impact Force:

- ✓ Reduce repeated shocks to the hand and wrist from hand tools with shock absorbing gloves.
- ✓ Limit torque reaction by using clutch-type tools, shut-off tools and external devices such as torque bars or articulating bars.

Knives and Sharp Cutting Tools:

- ✓ Use a knife only for the correct purpose.
- ✓ Keep hands behind the cutting edge at all times.
- ✓ Never cut towards yourself, always cut away from your body.
- ✓ Where possible, use a cutting board underneath the material being cut.
- ✓ Always pass knives to others handle first.
- ✓ Never run with knives or push/shove people around using knives.
- ✓ Ensure knives are kept sharp – blunt knives can be dangerous.
- ✓ To clean, wipe the blade with a cloth keeping the knife's sharp edge turned away from the hand
- ✓ Do not substitute knives for can openers, screwdrivers, or ice picks.
- ✓ Replace or sharpen any cutting tool that has lost its correctly angled cutting edge.
- ✓ Dispose of all broken or blunt blades in a sharps container.
- ✓ Only use wire cutters for cutting light gauge wire or component leads. Do not use to cut sheet metal.
- ✓ Hand shears used for cutting sheet metal should be selected for the type of cut based on the side the waste material lies.

Files:

- ✓ Select the proper file for the work.
- ✓ Ensure that tangs are protected by handles and that teeth are sharp and clean.
- ✓ Ensure the file used is fitted with a smooth, crack-free handle.
- ✓ The correct way to hold a file is to grasp the handle firmly in one hand and use the thumb and forefinger of the other to guide the point. Push the file forward while bearing down on it. Release the pressure and bring the file back to its original

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position.

- ✓ Don't pry or hammer with a file.

Pliers:

- ✓ Pliers may be used for gripping and cutting operations, but they are not a substitute for a wrench.
- ✓ Don't use pliers to turn nuts or bolts.
- ✓ Replace adjustable pliers if the jaws slip or bind.
- ✓ Replace pliers if the jaw grooves are worn too much for an effective grip.

Wrenches/Spanners:

- ✓ Safe use of all wrenches requires that the user always be alert and prepared for the possibility that the wrench may slip, the fastener may suddenly turn free, or the wrench or fastener may break.
- ✓ Where possible, use penetrating oil to loosen tight nuts.
- ✓ The user must always inspect the wrench for flaws. Keep jaws sharp and clean. Gripping teeth or smooth jaws should not be worn or damaged.
- ✓ Place the wrench so the pull on the handle tends to force the jaws further into the nut (lower jaw leads).
- ✓ Pulling on a wrench is safer than pushing
- ✓ Open end wrenches have strong jaws and are satisfactory for medium-duty turning.
- ✓ Replace an open end wrench if the jaws are no longer square.
- ✓ Box and Socket Wrenches are necessary for a heavy pull. Never overload the capacity of a wrench by using a pipe extension on the handle or be striking the handle with a hammer.
- ✓ Replace a box end wrench if the box edges aren't sharp or true.
- ✓ Socket and Adjustable Wrenches should be kept clean of dirt and grime inside the socket to ensure that the tool fits securely on the bolt or nut.
- ✓ Replace an adjustable wrench if the jaws have noticeable play, the

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mechanism slips or binds, or the jaws are rounded.

- ✓ Shift wrenches must work freely and adjust properly. Always use the proper size wrench for the job.
- ✓ Replace a socket wrench if the wrench binds, if the locking mechanism no longer holds or the wrench won't easily switch from forward to reverse.
- ✓ Replace individual sockets if they are cracked, they don't stay on the wrench or extension, or if the faces or corners are no longer true.

Screw Drivers:

- ✓ Select the correct size screw driver for the job.
- ✓ Don't carry screw drivers in your pocket.
- ✓ Pass a screw driver to another person handle first.
- ✓ When using a slotting screwdriver, use the correct size blade for the given slot.
- ✓ Use Phillips head tools for Phillips head fasteners.
- ✓ Use Positive head tools for Positive head fasteners.
- ✓ Don't use screwdrivers as a pry-bar.
- ✓ Do not use screwdrivers as levers, chisels, or scrapers.
- ✓ During the cutting process, apply downward force only on the forward cut not when drawing back.
- ✓ As the cut approaches completion, reduce the force applied to the saw to avoid breaking through the material and injuring hand

Hand Drills:

- ✓ Tighten drills correctly in the chuck.
- ✓ Before starting the drill, always remove the chuck key (if applicable) from the chuck – never leave the key in the chuck.

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- ✓ Only sharp drill bits should be used. Never use dull, chipped, rounded, or tapered drill bits.
- ✓ Remove the drill bit before storing drill.

Hammers, Mallets and hitting tools:

- ✓ Use pliers to hold small nails.
- ✓ Choose the correct size hammer for the job.
- ✓ Never hit hammer faces together.
- ✓ Never ask other people to hold things you are hitting unless using tongs or a chisel holder.
- ✓ Keep clean and free from oil, glue or debris which might cause the handle to slip or the face to glance from the object being struck.
- ✓ Make sure the head is wedged securely and that the head and handle are not chipped or broken.
- ✓ Grasp handle firmly near the end and keep your eye on the point to be struck.
- ✓ Reduce strain when pulling nails by placing a piece of wood under the hammer to increase leverage.
- ✓ Don't use a screwdriver, wrench, or other tool as a hammer as this will damage the tool.

Punches / Chisels:

- ✓ Keep punches and chisels in good condition. Mushroomed heads can chip & cause injuries.
- ✓ Punches are designed to mark metal and other materials that are softer than the point end, to drive and remove pins, and to align holes.

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4.4 Introduction Tools and Equipment Inventory and Store

Storage

- ✓ Store tools in a dry, sheltered environment.
- ✓ Place tools on a rack for easy safety and easy access.
- ✓ Place similar tools close together so that workers can see easily the available tools.

Inventory of tools, instruments, and equipment

- ✓ They are conducted and recorded as per company practices
- ✓ Tools are inspected, and replaced after use
- ✓ Tools and equipment are stored safely in accordance with manufacturer's specifications or company procedures.

Why Maintain Inventory of Tools and Equipment?

The most significant point to think at the start of your career is to acquire branded tools. They must be made out of high-quality steel and manufactured for precision. Special consideration is given to balance so that the tool/equipment will be properly maintained and prevent loses. Since the technician must work with his tools daily, regular inventory of tools/equipment is very significant.

The initial cost of a minimum number of tools is high but there is accompanying warranty guarantees satisfaction and many years of service. It is better, in the long run, to start with a few cautiously selected tools that will take care of your most common needs and then slowly build-up to a complete set. It is sometimes hard to identify and memorize the huge number of tools and equipment in the workshop, maintaining the inventory record is of great value.

Hand tools

- ✓ Clean dirt and debris from tools after each use.
- ✓ Oil metal parts to prevent rust.

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- ✓ Lightly sand rough wooden handles and apply linseed oil.
- ✓ Repair loose handles.
- ✓ Sharpen blades of cutting tools.
- ✓ Store tools in a clean dry storage area.
- ✓ Protect surfaces of cutting tools in storage.

Power tools

- ✓ Read and follow the maintenance schedule in the owner's manual for each piece of power equipment.
- ✓ Change the oil.
- ✓ Clean the air filter.
- ✓ Lubricate moving parts.
- ✓ Sharpen dull blades or replace worn blades according to the owner's manual.
- ✓ Replace spark plugs.
- ✓ Drain oil and gasoline before long-term storage.
- ✓ Check electric cords and connections on electric-powered tools.
- ✓ Store tools in a clean dry storage area.

Equipment storage

- ✓ Store equipment in a clean dry storage area.
- ✓ Rinse and clean spray equipment after each use.
- ✓ Clean spreaders and check wheel-driven gears.
- ✓ Clean carts and wheelbarrows after use.

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Sample Proper Arrangement and storage of tools and equipment



You can see in the pictures that all tools and equipment are arranged and stored properly in their own racks. Like for example the screw drivers are arranged by type and sizes, hammers, saws, c-clamps, etc. are in their racks.

Figure 81: Proper arrangement and storage of hand tools and equipment

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Self-check 4	Written exam
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Directions: Answer all the questions listed below.

Test I. Choose the best answer

- Which of the following Method of identifying non-functional tools is something wrong with the routine?
 - Visual inspection
 - Functionality
 - Performance
 - Power supply
- Which of the following Method of identifying non-functional tools is Vibration or extra noise from the operation?
 - Visual inspection
 - Functionality
 - Performance
 - Power supply
- Which of the following Method of identifying non-functional tools refers to the visual observation of an expert on the appearance?
 - Visual inspection
 - Functionality
 - Performance
 - Person's involved.
- Which of the following method of identifying non-functional tools failure to meet the required power supply,
 - Visual inspection
 - Functionality
 - Performance
 - Power supply
- When you need to work by tools the basic maintenance of electrical tools to be sure to check is
 - Clean out the Dust
 - Check the Cords
 - Keep tools and cords away from heat
 - Check double-insulated tools
 - All

Test II: write the short answer for the following questions.

- Write the appropriate safety guide line you have to follow while using electric drills.
- List the basic preventive maintenance of measuring/test equipment

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Test III: filling the bank space

1. The method of identifying faulty and functional tools is done either by _____ or _____
2. _____ is repairing something to get it working again.
3. _____ is carried out to keep something functional.

Note: Satisfactory rating - 3 and 5 points Unsatisfactory - below 3 and 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____
Rating: _____

Name: _____

Date: _____

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Operation sheet 3	Techniques to undertaking routine maintenance of tools based on operational procedures, principles and techniques
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Operation title: Techniques for undertaking routine maintenance of tools based on operational procedures, principles and techniques

Instruction: follow appropriate safety guide line

Purpose: to prevent test equipment failures and reduce the down time of test equipment

Required tools and equipment: lubricants and PPE

Procedure:

Step 1 - Lubricants are identified according to types of equipment.

Step 2 - Tools and equipment are lubricated according to preventive maintenance schedule or manufacturer's specifications.

Step 3 - Measuring instruments are checked and calibrated in accordance with manufacturer's instructions.

Step 4 - Tools are cleaned and lubricated according to standard procedures.

Step 5 - Defective equipment and tools are inspected and replaced according to manufacturer's specification.

Step 6 - Work place is cleaned and kept in safe state in line with OSHS regulations

Quality criteria:

OHS safety guide line

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LAP Test 2	Practical demonstrations
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Name: _____ Time started: _____

Date _____ Time finished: _____

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

Task 1 - Determine routine maintenance of tools based on operational procedures, principles and techniques

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