RQF LEVEL 3

MATBW301

MANUFACTURING TECHNOLOGY

Bench Work

TRAINEE'S MANUAL

October, 2024

BENCH WORK

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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Under Financial and Technical support of

COORDINATION TEAM

RWAMASIRABO Aimable

MARIA Bernadette M. Ramos

NIKUZE Bernadette

Production Team

Authoring and Review

NDAGIJIMANA Vincent

NIYITEGEKA Yves

Validation

NTEZIRYAYO Abdoulkalim

NIYONKURU Theophile

Conception, Adaptation and Editorial works

HATEGEKIMANA Olivier

GANZA Jean Francois Regis

HARELIMANA Wilson

NZABIRINDA Aimable

DUKUZIMANA Therese

NIYONKURU Sylvestre

UMEREWENEZA Naasson

Formatting, Graphics, Illustrations, and infographics

YEONWOO Choe

SUA Lim

SAEM Lee

SOYEON Kim

WONYEONG Jeong

AMIZERO Patrick

Financial and Technical support

KOICA through TQUM Project

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ACRONYMS

#: Quantity

APA: American Psychological Association

BOM: Bill of Materials

CBT/A: Competency-Based Training and Assessment

IC: Indicative Content

ICT: Information and Communication Technology

KOICA: Korea International Cooperation Agency

MLA: Modern Language Association

PASS: Pull Aim Squeeze Sweep

PPE: Personal Protective Equipment

Qty: Quantity

RQF: Rwanda Qualification Framework

RTB: Rwanda TVET Board

TQUM: Tvet Quality Management Project

TVET: Technical and Vocational Education and Training

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in manufacturing technology specifically for the module of "**MATBW30, Bench Work**". Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies. The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainee's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainee, you will start by addressing questions related to the activities, which are designed to foster critical thinking and guide you towards practical applications in the labor market. The manual also provides essential information, including learning hours, required materials, and key tasks to complete throughout the learning process.

All activities included in this training manual are designed to facilitate both individual and group work. After completing the activities, you will conduct a formative assessment, referred to as the end learning outcome assessment. Ensure that you thoroughly review the key readings and the 'Points to Remember' section.

MODULE CODE AND TITLE: MATBW301, BENCH WORK

Learning Outcome 1: Prepare the work.
Learning Outcome 2: Carry out bench work operations.
Learning Outcome 3: Perform post-operation activities.

Indicative contents
1.1 Introduction to bench work
1.2 Identification of safety and security measures
1.3 Application of safety and security measures
1.4 Selection of materials, tools, and equipment
1.5 Preparation of tools and equipment

Key Competencies for Learning Outcome 1 : Prepare the Work

Knowledge	Skills	Attitudes
• Definition of key terms related to bench work activities. • Identification of safety and security measures at a bench work place. • Description of the application of safety and security measures at the bench work workplace.	• Applying safety and security measures at the bench work workplace • Preparing bench work materials, tools and equipment • Selecting bench work materials, tools, and equipment	• Having a teamwork spirit by collaborating with welders, machinists, or engineers especially when preparing and selecting bench work materials, tools, and equipment • Having proper safety-consciousness in prioritising safety by following proper protocols, wearing protective gear, and being aware of potential hazards so as to prevent potential accidents at the bench work workplace.

Duration: 15 hrs.

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Define correctly key terms used in bench work.
2. Identify properly the application of bench work found in bench works.
3. Identify properly the types of hazards found in bench work activities.
4. Control efficiently hazards found at the workplace during bench work.
5. Indicate efficiently Safety signs and symbols found in the workshop for bench work.
6. Apply efficiently safety and security measures used in bench work.
7. Select efficiently materials, tools, and equipment used in bench work activities.
8. Perform properly tools adjustment, sharpening and setting up equipment.

Resources

Equipment	Tools	Materials
● Bench ● Vices ● Surface plate ● Anvil ● Bench drilling machine ● Bench grinding machine ● Tap and dies ● V block ● Hand shearing machine	● Spirit Level ● Marking gauge ● Tape measure ● Vernier calliper ● Steel ruler ● Square ● Protractor ● Punches ● Divider ● Vernier calliper ● Trammel ● Surface gauge ● Hermaphrodite calliper ● Combination square ● Chisel ● Hacksaw ● Hand file ● Hand shearing machine ● Scissors ● Hammer ● Gripping pliers	● Sheet metal ● Flat bar ● Tube ● Pipes

	• Vices • Clamps • Screwdriver • Spanner • Pliers	

Indicative content 1.1: Introduction to Bench Work

Duration: 3 hrs.

Theoretical Activity 1.1.1: Introduction to bench work

Tasks:

1. You are requested to answer the following questions:
    i. What do you understand by the following terms?
        a) Workbench
        b) Work piece
        c) Fitter
        d) Fitting
    ii. Explain the applications of bench work
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary.
5. Read the key readings 1.1.1.

Key readings 1.1.1.: Introduction to bench work.

Bench work refers to a variety of manual operations carried out on a workbench. These tasks include measuring, marking, cutting, filing, drilling, tapping, and assembling parts. A fitter's work is unavoidable when different parts are to be assembled in position after they have been finished. Alignment of machine parts, bearings, engine slide valves and similar other works call for a fitter's work. Reconditioning and refitting of machines and machine parts cannot be done without a skilled fitter.

All the above types of work require the use of a large number of hand tools and a fitter must have good working knowledge of all these tools and instruments.

- **Definition of key terms**
    - ✓ **Bench work:**

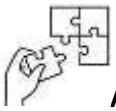
        They are the work carried out by hand on the workbench
    - ✓ **Work piece:**
        - ➢ In bench work, a work piece refers to the object or material that is being worked on or modified during the manufacturing process.
        - ➢ The raw or semi-finished component undergoes various operations on the workbench or bench-mounted equipment to achieve the desired shape, size, or characteristics.

- ✓ A workbench: It is a sturdy table at which manual work is done by fitter
- ✓ Fitter: It is a person who fits shop worker
- ✓ Fitting: It is the assembling of parts together after same hand operation called fitting operations

- **Application of bench work:**
  - ✓ **Prototyping:**
    - ➢ Bench work is frequently used in the prototyping phase of product development.
    - ➢ Engineers and designers use manual tools such as files, saws, drills, and sandpaper to shape and refine prototypes made from different materials.
  - ✓ **Assembly:**
    - ➢ Bench work plays a crucial role in assembly operations, especially for small-scale or custom manufacturing.
  - ✓ **Finishing and Polishing:**
    - ➢ After machining or fabrication processes, bench work is often employed for finishing and polishing operations.
    - ➢ Workers use abrasive materials, such as sandpaper, files, and polishing compounds, to remove imperfections, smooth surfaces, and achieve desired textures or shine.

Point to remember:

- Retain that bench work is mainly applied in prototyping, assembling, finishing and polishing operations.



Application of learning 1.1.

Visit any metal bench work workplace located in your surrounding area. Referring to the previous activity 1.1.1., You are requested to take notes on the following applications of bench work:

a) Prototyping
b) Assembling
c) Finishing
d) Polishing

Indicative content 1.2 : Identification of Safety and Security Measures

Duration: 3 hrs.

Theoretical Activity 1.2.1: Identification of safety and security measures in bench work activities

Tasks:

1. You are requested to answer the following questions:
   i. Define the term 'hazard' in bench work.
   ii. What are the types of possible hazards in bench work activities?
   iii. Explain any strategies of preventing / controlling hazards.
   iv. Identify safety signs and symbols related to bench work activities

2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary.
5. Read the key readings 1.2.1.

Key readings 1.2.1.: Identification of safety and security measures

- **Definition of the key concepts**

✔ **Safety measures:**
- They involve protocols to prevent accidents and ensure safe working conditions.
- This includes using protective gear, maintaining tools properly, and adhering to safety procedures to minimize risks.

✔ **Security measures:**
- They refer to actions taken to protect tools, equipment, and materials from theft or damage.
- This includes securing workspaces, using locks, and monitoring access to the work area.

✔ **Hazard:**
- It is any element that could cause harm, such as sharp tools, toxic substances, or unstable work surfaces.
- Identifying and mitigating these hazards is crucial for safety.

✔ **Workplace:**

- It is the designated area where tasks are performed.
- This includes workbenches, tool stations, and any other locations where bench work activities take place

- **Types of hazards found at workplace during bench work activities**

✔ **Physical hazards:**

Physical hazards are associated with the physical properties of the work environment and can cause injury without direct contact. Examples include:

- Slip, trip, and fall hazards from uneven surfaces, cluttered walkways, or wet floors.
- Falling objects or materials that can moving parts that can crush or entangle body parts.
- Exposure to extreme temperatures, high noise levels, or vibration.
- Contact with sharp objects, such as tools or equipment with sharp edges.
- Strike workers.
- Machinery and equipment with

✔ **Chemical hazards:**

Chemical hazards arise from exposure to hazardous substances in the workplace. These

Substances can be in the form of liquids, gases, vapours, or particulates. Examples include:

- Toxic chemicals that can cause harm through inhalation, skin contact, or ingestion.
- Flammable or combustible substances that can ignite or explode.
- Corrosive substances that can cause burns or damage to skin and eyes.
- Irritants that can cause respiratory or skin irritation.
- Carcinogens, mutagens, or teratogens that can lead to long-term health effects.

✔ **Biological hazards**:

Biological hazards involve exposure to biological agents, such as bacteria, viruses, fungi, Or parasites that can cause illness or disease. Examples include:

- Exposure to infectious diseases, such as those transmitted through contact with bodily fluids or contaminated materials.
- Allergens from plants, animals, or insects that can cause allergic reactions.
- Exposure to mould or fungi can lead to respiratory issues.

✔ **Ergonomic hazards:**

Ergonomic hazards arise from the design of work tasks, workstations, tools, and

equipment, which can lead to musculoskeletal disorders or injuries. Examples include:

- Awkward or repetitive movements that strain muscles and joints.
- Poorly designed workstations or seating arrangements that result in poor posture
- Lifting or carrying heavy loads without proper equipment or techniques.
- Inadequate lighting or improper positioning of displays that cause eyestrain

✔ **Psychosocial hazards**:

Psychosocial hazards are related to the social and organizational aspects of work, which can affect mental and emotional well-being. Examples include:

- Excessive workload or high job demands can lead to stress or burnout.
- Workplace violence or harassment.
- Lack of control over work tasks or decision-making.
- Poor communication or lack of support from supervisors or colleagues.

- **Causes of hazards**

Hazards can have various causes, including,

✔ **Human factors:**

This can include errors made by people, such as inadequate training, poor decision-making, fatigue, and lack of concentration.

✔ **Equipment or machinery failures:**

This can include issues with equipment design, maintenance problems, and defects in machinery or tools.

✔ **Environmental factors:**

This can include extreme temperatures, noise, vibration, and poor lighting.

✔ **Physical factors:**

This can include slippery or uneven surfaces, falling objects, and electrical or fire hazards.

✔ **Chemical or biological factors:**

This can include exposure to toxic or hazardous substances, such as chemicals, fumes, dust, and biological agents.

✔ **Poor ergonomic design:**

This can include poor workstation layout, repetitive motions, and awkward postures.

✔ **Organisational factors:**

This can include poor communication, inadequate safety policies, and insufficient resources for safety measures.

- **Strategies of preventing/controlling of hazards**

Hazard prevention is crucial to ensuring the health and safety of workers in the workplace. Here are six strategies for preventing hazards:

- ✔ **Eliminate the hazard:**

  This can involve redesigning processes, substituting hazardous materials or equipment with safer alternatives, or implementing new technologies that eliminate the need for hazardous tasks.

- ✔ **Substitute the hazard:**

  If it is not possible to eliminate the hazard, consider substituting it with a safer alternative.

  This involves identifying and using materials, substances, or equipment that are less hazardous or have a lower risk of harm.

- ✔ **Isolate the hazard:**

  If elimination or substitution is not feasible, isolate the hazard to minimise exposure.

- ✔ **Use engineering controls:**

  Engineering controls involve modifying the work environment or equipment to reduce or eliminate the hazard.

  Examples include installing machine guards, implementing ventilation systems, using automated processes, or incorporating noise reduction measures.

- ✔ **Use administrative controls**:

  Administrative controls involve implementing policies, procedures, and work practices to minimise the risk of hazards.

  This can include implementing safety protocols, providing training and education to workers, establishing clear work procedures, and conducting regular inspections and maintenance.

- ✔ **Use Personal Protective Equipment (PPE**):

  Personal protective equipment is the last line of defence and should be used when all other measures are insufficient in controlling the hazard.

  PPE includes items such as safety goggles, gloves, respirators, helmets, earplugs, and protective clothing.

- **Basic dress rules that you should always follow are:**

✔ **Proper clothing:**

You must not wear loose clothes that can be caught in moving machinery. You must wear tight fitting overalls

✔ **Proper eye protection**

You must always wear goggles to protect your eyes while you are working in the workshop. A safety goggles

✔ **Remove tie and jewellers**

Ties, watches, rings and other jewellers increase the chance to get caught by moving machinery. You must remove them before entering the workshop.

✔ **Cut or secure long hair**

Long hair is also dangerous as it may be caught by the machine and pulls you into it.

✔ **Proper shoes**

You must not wear sandals or soft shoes inside the workshop, as they will not protect your feet from falling objects. A safety shoe (steel-toe shoes) will protect your feet if you accidentally drop something.

- **Classification of safety signs and symbols**

Class of safety signs	symbols
Mandatory signs	
Prohibition sings	
Emergency signs	
Warning signs	
Firefighting signs	

- **Types of fire-fighting equipment**

✔ **Fire-fighting equipment**

They refer to the tools, devices, and protective gear used by firefighters to combat and extinguish fires. Here are some common types of firefighting equipment:

✔ **Fire Extinguishers:**

Portable devices that contain firefighting agents such as water, foam, carbon dioxide (CO2), dry chemical, or wet chemicals. They are used to suppress small fires or prevent them from spreading.

Choosing the right fire extinguisher:

The first thing you need to know is the different classifications of fires, and the second thing you need to understand is what types of fires you may have to deal with and make sure your extinguisher can get the job done. Most household fires fall into one of the following categories:

Class A: solid combustibles like wood, paper, and cloth fuel these fires.

Class B: flammable liquids such as oil, petroleum, and gasoline fuel these fires.

Class C: These fires are started or fuelled by faulty wiring, fuse boxes, and appliances.

Class K: These fires are started or fuelled by cooking oils and greases, animal fats, and vegetable fats.

✔ **Fire hoses:**

Flexible tubes designed to deliver large amounts of water or other extinguishing agents from a water source to the fire. Fire hoses are typically connected to fire hydrants, standpipes, or fire engines.

✔ **Fire hydrants:**

Fixed water outlets located on streets or buildings, connected to the municipal water supply. Fire fighters can attach hoses to hydrants to access a water source for

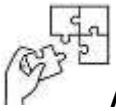
firefighting operations

✔ **Fire pumps:**

Devices used to deliver water at high pressure to fire hoses. They can draw water from various sources, such as hydrants, lakes, or dedicated water tanks.

Points to Remember

- For effective prevention of hazards at the bench work workplace, take into consideration safety and security measures which include wearing appropriate personal protective equipment, the use of right signs and symbols as well as firefighting equipment.



Application of learning 1.2.

Visit any metal bench work workplace located in your surrounding area. Referring to the previous activity 1.2.1., take notes on the following:

a) Types of potential hazards at that workplace
b) Causes of hazards at that workplace
c) Basic dress rules to be followed by metal bench workers at that workplace
d) Safety signs and symbols available at that workplace place

Indicative content 1.3 : Application of Safety and Security Measures

Duration: 3 hrs.

Practical Activity 1.3.1: Applying safety and security measures

Task:

1. You are requested to go to the metal bench workplace/workshop and individually do the following:
    i. Apply safety and security measures

2. Present your work to the trainer, workshop assistant and /or classmates
3. Read the key readings 1.3.1 and ask questions for clarifications if any
4. Perform the task provided in application of learning 1.3

Key readings 1.3.1: Application of safety and security measures

- **Definition of fire extinguisher**

  It is a portable device designed to extinguish small fires by discharging a substance that cools the burning material, deprives the fire of oxygen, or interrupts the chemical reaction at the fire's core.

- **General steps of using a fire extinguisher:**

1. Select the right type of fire extinguisher

- Different types of fire extinguishers are designed for specific classes of fires (e.g., Class A, B, C, D, or K).
- Make sure you have the appropriate type of fire extinguisher for the fire you are dealing with.

2. Apply PASS technique

- Pull the pin: Pull the pin at the top of the fire extinguisher to break the tamper seal.
- Aim low: Aim the nozzle or hose at the base of the fire, not at the flames.
- Squeeze the handle: Squeeze the handle to release the extinguishing agent.
- Sweep from side to side: Sweep the nozzle of hose from side to side while aiming at the base of the fire until it is extinguished.

3. **Stand at a safe distance**

- Stand approximately 6 to 8 feet away from the fire to maintain a safe distance while operating the fire extinguisher.
- Do not stand too close to the fire, as it may spread or cause burns.

4. **Control the fire**

- Start by directing the extinguishing agent at the base of the fire, not at the flames, to cut off the fire's oxygen supply.
- Use a sweeping motion from side to side to cover the entire area of the fire with the extinguishing agent.

Remember we have to:

✔ **Assess the situation**

- Before attempting to use a fire extinguisher, evaluate the fire to ensure it is small, contained, and not spreading rapidly.
- Ensure you have a clear escape route and that the fire is not blocking your way.

✔ **Continue monitoring**

- Even after the flames are extinguished, watch for any signs of re-ignition or smouldering.
- Stay vigilant and be prepared to use the fire extinguisher again if needed.

Point to remember:

- While applying safety and security measures; steps of using fire extinguisher, wearing PPEs and locating safety signs and symbols should be taken into considerations

Application of learning 1.3.

Visit any metal bench work workplace located in your surrounding area: it can be a school manufacturing workshop or any other manufacturing industry that performs bench work operations. Then, referring to the previous activity 1.3.1, you are requested to apply strategies for hazards prevention.

Indicative content 1.4: Selection of Materials, Tools, and Equipment

Duration: 3 hrs.

Theoretical Activity 1.4.1: Identification of tools, materials and equipment used in bench work.

Tasks:

1. You are requested to answer the following questions:
   i. Classify materials used in bench work?
   ii. Differentiate properties of ferrous and nonferrous materials.
   iii. Explain where ferrous and nonferrous metals are applied
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary.
5. Read the key readings 1.4.1.

Key readings 1.4.1.: Description of tools, materials, and equipment used in bench work.

- **Materials classifications**

The materials fall into one of three classes that are based on the atomic bonding forces of a particular material. These three are metallic, ceramic, and polymeric.

✔ **Metallic materials:**

Metallic materials are ferrous which contain Iron and non-ferrous metals which do not contain iron content.

- **Ferrous materials**

Carbon steels: composed of iron and carbon in varying proportions, steels are classified according to their carbon content as illustrated in the following table:

Steel Types	Carbon Content in %	Properties	Application
Low-carbon steel (Mild Steel)	0 - 0.3	i. Soft, ductile, malleable but not strong. ii. Does not crack iii. -Machines readily. iv. It can be cast, forged, and welded. v. It corrodes in the atmosphere.	i. Suitable for deep pressings ii. Stampings are used for car bodies iii. For construction purposes General workshop use.
MediumCarbon Steel	0.4-0.6	i. Can be forged and welded ii. When properly heat-treated, it is hard, ductile and strong	i. Agriculture tools ii. hammerheads iii. rivets sets iv. Forged steel vice bodies
High-Carbon Steel	0.7-1.4	i. Less ductile but combines hardness with high strength. ii. Hard but can be heat-treated. iii. Can be welded	Suitable for all kinds of cutting tools as shown: i. 0.7% carbon: cold chisels, punches ii. 0.9% carbon: lathe tools, milling cutters, saw blades. iii. 1.0% carbon: drills, tapes dies.

			iv. 1.2 % carbon: carpenter's chisels, plane blades v. 1.3% carbon: engineer's files, scrapers, ball bearing

Cast iron: alloy of iron that contains 2 to 4 per cent carbon, along with varying amounts of silicon and manganese and traces of impurities such as sulphur and phosphorus. It is made by reducing iron ore in a blast furnace. types of cast irons are white cast, grey cast iron, malleable cast iron, ductile cast iron and Wrought Iron

Alloy steels:

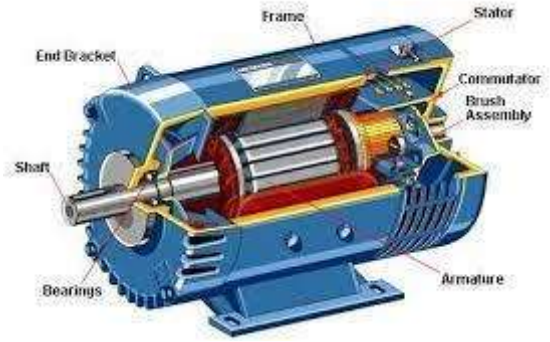
This type of metal contains multiple elements to enhance various properties. Metals such as manganese, titanium, copper, nickel, silicon, vanadium, cobalt, molybdenum, tungsten and aluminium may be added in different proportions. This improves steel's: hardenability, weld ability, corrosion resistance, ductility, and formability.

- ✔ **Properties of ferrous metals**
  - **Colou**r: this helps in identifying metals and enhances their appearance when polished. It is useful in beaten metalwork and jewellers.
  - **Fusibility**: the characteristic of becoming liquid when a metal is heated.
  - **Conductivity**: the easy with which a metal allows heat or electricity to flow through it
  - **Hardness**: the ability of a metal to resist scratching and wear.
  - **Ductility:** the ability of a metal to be stretched cold without breaking.

- **Toughness**: this enables the material to be bent or twisted to resist to shock without
- Breaking.
- **Malleability**: is a property of a material by which it can be beaten to form thin sheets. Most metals are malleable. Examples of malleable metals are zinc, iron, and aluminium, copper, gold, and silver.
- **Elasticity**: is the ability of a metal to go back to its original shape or size after being stretched, compressed or deformed, as in spring for example

- Application of ferrous materials
  - ✓ Applications for alloy steels

- **Electric motors:**



An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft.
https://www.mathaelectronics.com/different-types-of-electric-motor-a-complete-guide/

- **Bearings**

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts.

- **Heating elements**

A heating element is a material or device that directly converts electrical energy into heat or thermal energy through a principle known as Joule heating.

- **Gears:**

A gear is a rotating circular machine part having cut teeth or, in the case of a cogwheel or gearwheel, inserted teeth, which mesh with another toothed part to transmit torque and speed. The basic principle behind the operation of gears is analogous to the basic principle of levers.

✔ **Non-ferrous metals**

Non-ferrous metals do not contain iron. Examples of non-ferrous metals are explained as follows:

Aluminium, lead, zinc and tin (in pure state): derives primarily from its ore bauxite. It is light, strong, and functional. It is the most widespread metal on Earth and its use has permeated applications everywhere.

.

Copper and its alloys: Copper are brownish-pink and has a melting temperature 1080^0c. It is used in pure state and in making alloys such as brass.

- **Brass:**

It is an alloy of copper (Cu) and zinc (Zn) in varying proportions, with not more than 5 or 6 percent other metals.

10-20% Zn alloys are known as gilding metals that are used in the jewellery industry and in the production of heat exchangers.

30% Zn alloys are called cartridge brass for a self-explanatory reason.

Adding other alloying elements can further improve brass's properties. So (Tin) and Al (Aluminium), for example, increase their corrosion resistance in seawater.

- **Bronze:**

It is a copper and Tin alloy, bronze is mostly applied on: Springs, Coins, Arts bronze sheets, Parts of pumps, Pressure-resistant castings, Bearings, etc.

- **Lead:**

It is the heaviest of the common metals and has a low melting point(3300C), it is in blue grey colour

- **Zinc:**

It is a bluish-white metal, which melts at 4220C. You often see zinc used on iron or steel in the form of a protective coating called galvanising. Zinc is mostly applied for Soldering fluxes, Die-castings.

✔ **Properties of non-ferrous materials:**

Properties of copper include good electric conductivity, high thermal conductivity, a remarkable mixture of strength and plasticity, corrosion resistance in many environments, attractive finish when polished

Properties of aluminium include durability, light weight, corrosion resistance, electrical conductivity, ability to form alloys with metals, not magnetise and is easy to machine

- **Ceramics:**

It is fabricated into products through the application of heat,

- ✔ **Properties of ceramics**: hardness, strength, low electrical conductivity, and brittleness.
  - **Applications of ceramics:**
    - ❖ They are used in the space industry because of their low weight
    - ❖ They are used as cutting tools
    - ❖ They are used as refractory materials
    - ❖ They are used as thermal insulators
    - ❖ They are used as electrical insulators

- **Polymers:**

A polymeric solid can be thought of as a material that contains many chemically bonded parts or units which themselves are bonded together to form a solid. The word polymer literally means "many parts." Two industrially important polymeric materials are plastics and elastomers.

Plastics:

There are a large and varied group of synthetic materials, which are processed, by forming into shape. Just as there are many types of metals such as aluminium and copper, there are many types of plastics, such as polyethylene and nylon. The polymer plastics can be divided into two classes, thermoplastics and thermosetting plastics, depending on how they are bonded.

Thermoplastics:

Thermoplastic polymers comprise the four most important commodity materials: polyethene, polypropylene, polystyrene and polyvinyl chloride. There are also several specialised engineering polymers.

Elastomers or rubbers:

They can be elastically deformed by a large amount when a force is applied to them and can return to their original shape when the force is released.

Composites:

A composite is commonly defined as a combination of two or more distinct materials, each of which retains its own distinctive properties, to create a new material with properties that cannot be achieved by any of the components acting alone. Using this definition, it can be determined that a wide range of engineering materials fall into this category.

✔ **Properties of polymers**

- resist atmospheric and other forms of corrosion,
- offer good compatibility with human tissue,
- exhibit excellent resistance to the conduction of electrical current, and less dense than metals or ceramics

✔ **Applications of polymers/plastics:**

- Polymeric materials are used in and on soil to improve aeration, provide mulch, and promote plant growth and health.
- Many biomaterials, especially heart valve replacements and blood vessels, are made of polymers like Dacron, Teflon and polyurethane.
- Plastic containers of all shapes and sizes are lightweight and economically

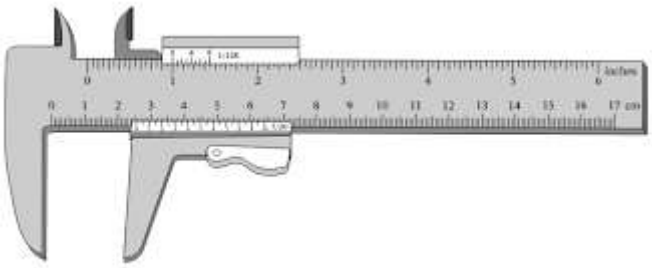
less expensive than the more traditional containers. Clothing, floor coverings, garbage disposal bags, and packaging are other polymer applications.

- Automobile parts, windshields for fighter planes, pipes, tanks, packing materials, insulation, wood substitutes, adhesives, matrix for composites, and elastomers are all polymer applications used in the industrial market.
- Playground equipment, various balls, golf clubs, swimming pools, and protective helmets are often produced from polymers.

- **Tools**
  - ✔ **Measuring tools**
    - **Tape measure:**

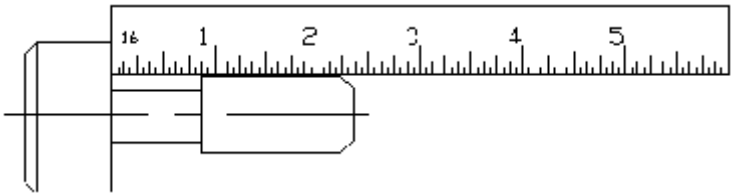
Steel tape measure rules often have a small sheet-metal angle that makes it easy to apply it at the workpiece edge (fig. below).

- **Vernier caliper**



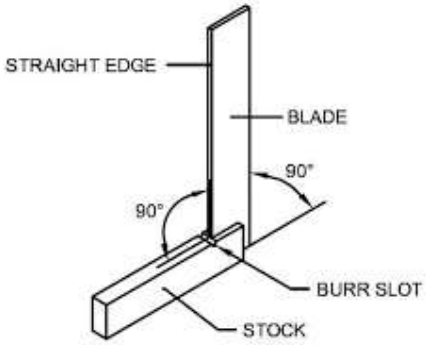
It is a device used to measure the distance between two symmetrically opposing sides. A calliper can be as simple as a compass with inward or outward-facing points. The tips of the calliper are adjusted to fit across the points to be measured, the calliper is then removed and the distance read by measuring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

- **Steel ruler:**



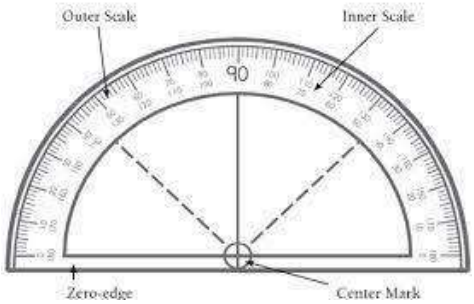
For marking out, measuring is required in short lengths; the steel rule is given preference in metalworking. It is handier and its graduation is more precise than steel tape rule. The simplest length measuring tools are steel rule and steel tape rule. The steel rule (fig. below) has a length of 300 mm or 500mm

- **Square:**



It is used for checking the straightness and the sureness of a work piece. It can also be used for marking perpendicular lines onto a work piece.

- **Protractor:**

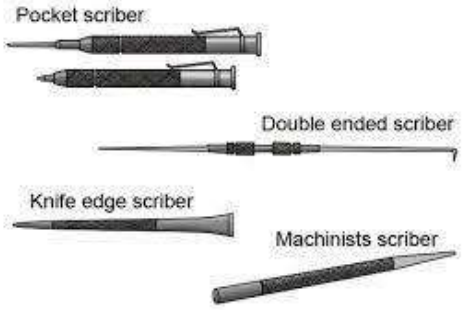


Protractors are used for measuring or constructing angles that cannot be obtained by set squares. Protractor can be flat, circular or semi-circular. Protractor is usually made from boxwood or ivory.

- ✓ **Marking tools:**

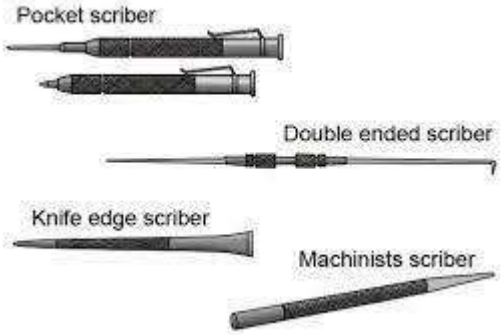
They are tools that help in the marking out process.

- **Scriber**:



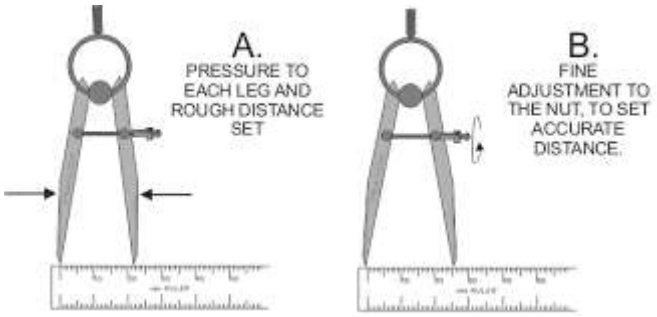
It is a widely used scribing tool with hardened or carbide points which are straight or angular. It is used for rough or rough-machined steel parts and leaves a fine notch.

- **Punches (centre punch):**



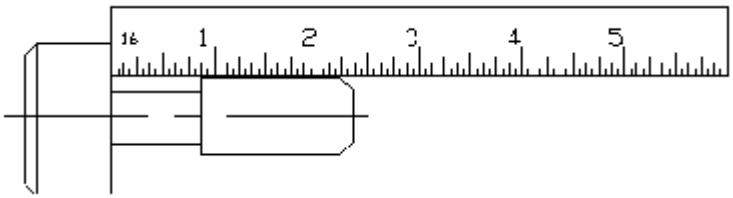
In order to be able to recognize clearly a scribed line up to the end of working, prick punch marks are set on the scribed line. This is carried out by means of a prick punch that intrudes with its tip into the workpiece metal after a light hammer blow. The punch marks are put in larger distances on straight lines than on curved scribed lines. Crossings and transitions of straight lines to curves are always punched.

- **Dividers:**



Scribing tool is used for scribing circular arcs and curvatures. The use of dividers always necessitates a punch mark for the guiding point. It leaves a fine notch.

- **Steel rule:**



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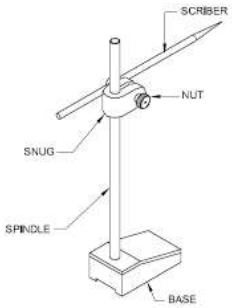
- **Trammel:**

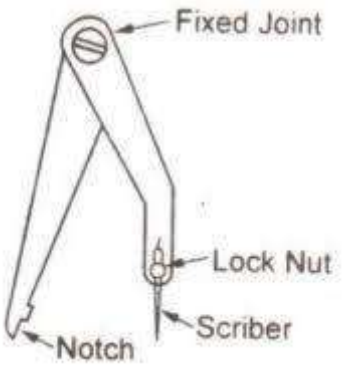
Fishing net in three sections, the two outer nets having a large mesh and the middle one a fine mesh.

- **Surface gauge:**



Surface gauge is a scriber mounted in an adjustable stand for marking off castings or testing the accuracy of plane surfaces and used with surface plates. Also, is a gauge for measuring ordinates of points on a surface of the work from a reference plane.

- **Hermaphrodite calliper:**

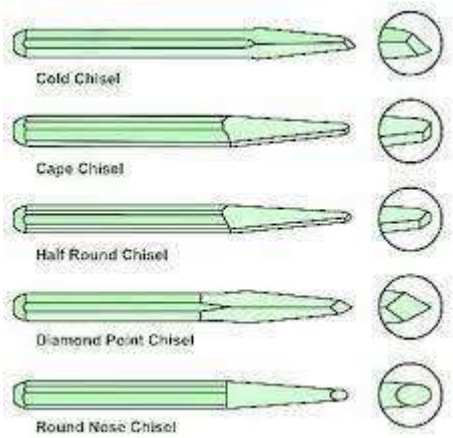


It is a measuring instrument having one leg bent inward and one straight leg ending in a sharp point; this type of calliper is used for scribing lines at a specified distance from a flat or curved surface.

- **Cutting tools:**

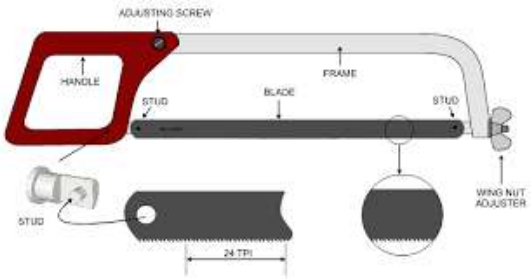
They are tools used in the cutting process by dividing into many parts. Those tools are described as under:

- **Chisel:**



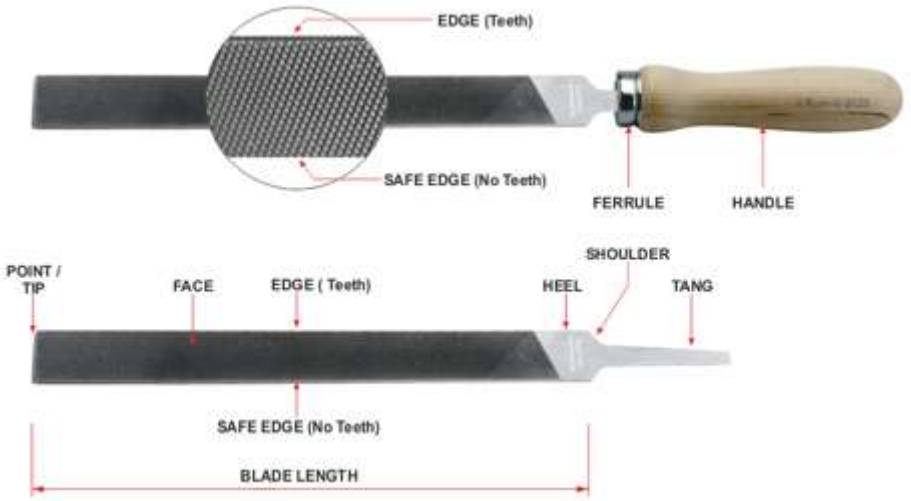
A chisel made of tool steel of a strength, shape, and temper suitable for chipping or cutting cold metal.

- **Hacksaw:**



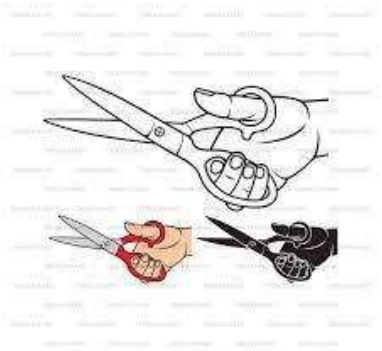
A hand hacksaw or power hacksaw mainly serves to separate materials and to produce grooves and slits. It is generally used for cutting metal into pieces. It consists of a frame and a saw blade as shown below. It is a "U" shaped steel frame with a pistol handgrip and a saw blade as shown below. The frame may be of fixed type to take only one length of blade, or adjustable to take different blade lengths. It has a wing nut to adjust the tension of the blade.

- **Hand files:**



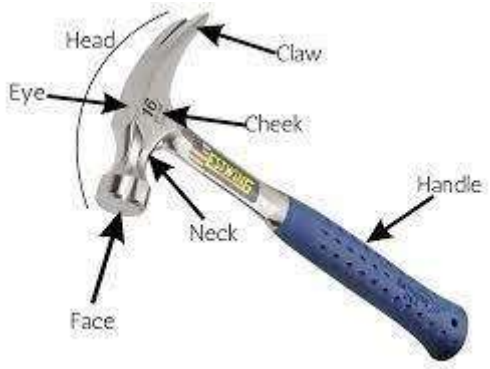
The file is a cutting tool to work materials. It has many cutting edges, which are like small chisels (file teeth) and are harder than the material being worked upon. For cutting metals normally Cross-Cut files are used. These files have an overcut, and an up cut. When using a file, several cutting wedges always act at the same time.

- **Scissors:**



Hand shears are used for various operations in sheet-metal working such as cutting off, cutting in and out. For thin sheet metal up to a thickness of 1 mm, there are three types of hand shears in various versions. The hand plate shears (Fig. below.) are used for shearing off small strips and corners and for cutting in.

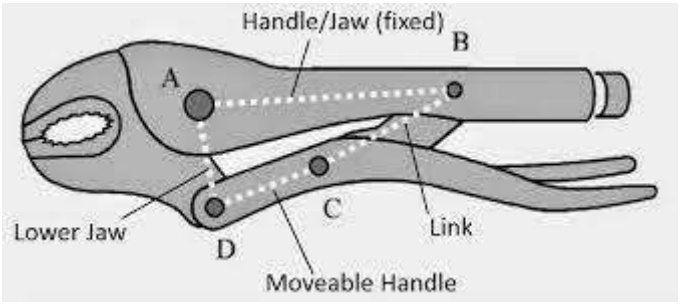
- **Hammer:**



The type most commonly used is the ball pen hammer, which has a flat striking face and a ball-shaped end (call the pen). Hammerheads are made from medium carbon steel. The two ends must be hardened and tempered, the center of the head with the eye being left soft. It is specified according to its weight.

✔ **Clamping tools:**

- **Gripping pliers**:

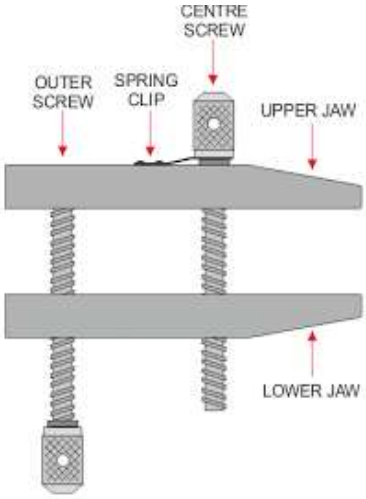


Combination pliers are heavy-duty, side-cutting pliers, also known as lineman pliers or side cutters, which are designed for all regular wire-cutting needs. They have gripping jaws, a cutting edge, and insulating handle grips that reduce (but do not eliminate) the risk of electric shock from contact with live wires.

- **Vices:**

Any of various devices, usually having two jaws that may be brought together or separated by means of a screw, lever, or the like, used to hold an object firmly while work is being done on it.

- **Clamps:**



A device designed to bind or constrict or to press two or more parts together to hold them firmly. In addition, are any of various instruments or appliances having parts brought together for holding or compressing.

✔ **Miscellaneous tools:**

- **Screw drivers:**

A hand tool for turning a screw, consisting of a handle attached to a long, narrow shank, usually of metal, which tapers and flattens out to a tip that fits into the slotted head of a screw. It was a tool you used to perform a function, like a screwdriver.

- **Spanner:**

A wrench is a tool used to provide grip and mechanical advantage in applying torque to turn objects, usually rotary fasteners, such as nuts and bolts or keep them from turning.

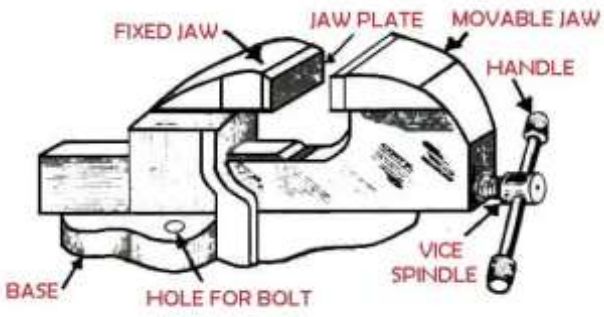
- **Pliers:**

Pliers are a hand tool used to hold objects firmly, possibly developed from tongs used to handle hot metal. They are also useful for bending, cutting and compressing a wide range of materials.

- **Equipment**
  - **Bench table:**

A bench table is a platform that is at waist level and it works like a workbench. You use it when you are working in metal fabrication with manufacturing. A bench table is very useful because it gives the manufacturer a stable place to work and also can provide assistance with both squaring and measuring.

- **Vices:** (parallel jaw vice):

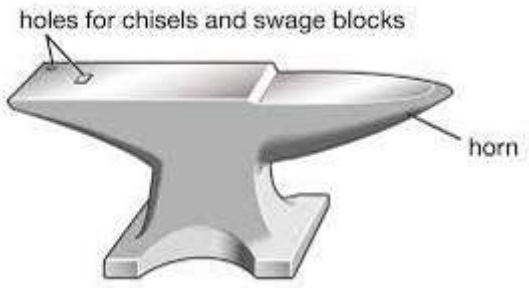


It is the most commonly used vice sometimes also known as. It essentially consists of a cast steel body, a movable jaw, a fixed jaw, both made of cast steel, a handle, a square threaded screw and a nut all made of mild steel. A separate cast steel plate known as jaw plates with teeth are fixed to the jaws by means of set screws and they can be replaced when worn. The movement of the vice is caused by the screw which passes through the nut fixed under the movable jaw. The screw is provided with a collar inside to prevent it from coming out and handle at the outer end. The width of the jaws suitable for common work varies from 80 to 140 mm and the maximum opening being 95 to 180 mm

- ✓ **Surface plate:**

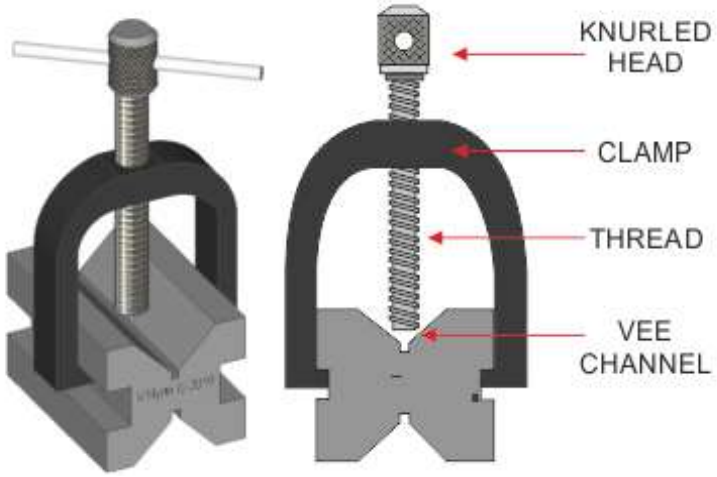
Its specific use is in testing the trueness of a finished surface, testing a try square, providing adequate bearing surface for V-block and angle plates, etc., in scribing work. It is a cast iron plate having a square or rectangular top perfectly planned true and square with adjacent machined faces. The top is finished true by means of grinding and scraping. This plate carries a cast iron base under it and the bottom surface of the base is also machined true to keep the top surface of the plate in a perfect horizontal plane.

- ✓ **Anvil:**



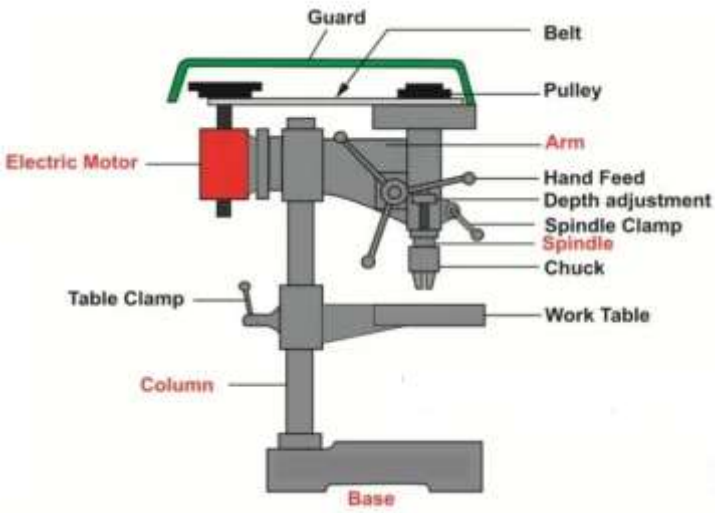
An anvil is a metalworking tool consisting of a large block of metal, with a flattened top surface, upon which another object is stuck. Anvils are as massive as practical, because the higher their inertia, the more efficiently they cause the energy of striking tools to be transferred to the work piece.

✓ **V block:**



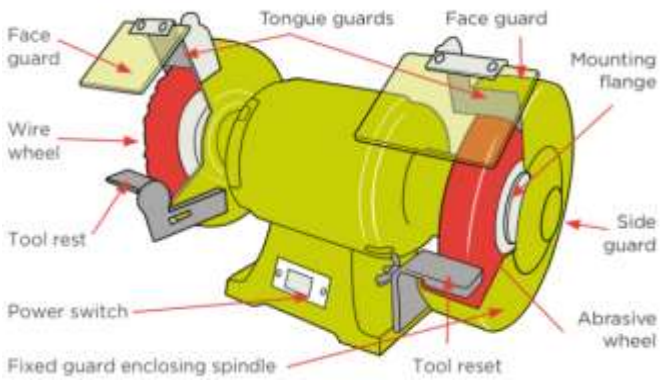
A 'V" blocks serve as a very useful support to the work in marking. It usually works in conjunction with a U-clamp. Round bar is placed longitudinally in the block and the screw in the clamp tightened. Its specific use is in holding the round bars during marking and centre drilling their end faces, which are to be held between centres on the lathe. In addition, it is very suitable for holding round bars in drilling operations when the axis of the drill is to be kept normal to the axis of the bar.

✓ **Bench drilling machine:**



The bench drill is used for drilling holes through materials including a range of woods, plastics, and metals. It is normally bolted to a bench so that it cannot be pushed over and that larger pieces of material can be drilled safely. The larger version of the machine drill is called the pillar drill.

✓ **Bench grinding machine:**



A bench grinder is a bench top type of grinding machine used to drive abrasive wheels. A pedestal grinder is a similar or larger version of grinder that is mounted on a pedestal, which may be bolted to the floor or may sit on rubber feet.

✓ **Hand shearing machine:**

A shearing machine is a versatile hand power tool, which is used to cut through hard metal sheets, cloth, bar or plates of metal or any other material.

Practical Activity 1.4.2: Selecting tools, materials and equipment used in preparation of bench work activities

Task:

1. You are requested to go in the bench work workshop and perform the task below:
   i. Select the right tools, materials, and equipment required for bench work activities.
2. Wear appropriate PPE.
4. Present your work to the trainer, workshop assistant and/or classmates
5. Read the key readings 1.4.2.
6. Perform the task provided in the application of learning 1.4

Key readings 1.4.2.: Criteria for selecting tools, materials, and equipment

- **Tools, materials, and equipment are selected according to:**

✔ **Types:**

- Different types of tools, materials, and equipment are available for bench work, each specifically designed for particular tasks or operations.
- For example, you may require cutting tools like saws or shears for shaping or trimming materials, measuring tools such as callipers or rulers for precision measurements, fastening tools like screwdrivers or clamps for assembly, and finishing tools such as sandpaper or files for smoothing surfaces.

✔ **Sizes:**

- Tools, materials, and equipment come in various sizes to accommodate different work pieces and requirements.
- For instance, the size of a cutting tool, such as a saw or drill bit, should be selected based on the thickness or diameter of the material being worked on.
- Similarly, the size of fasteners, such as screws or nails, should match the thickness and strength requirements of the materials being joined.

✔ **Shapes:**

- The shape of tools and equipment can play a significant role in their suitability for specific bench work tasks.
- For instance, a chisel with a specific shape may be needed for carving or shaping wood, while a specific shape of a wrench or pliers may be required for accessing and manipulating components in confined spaces.
- Additionally, the shapes of materials, such as sheets, rods, or blocks, can affect the selection of tools and equipment needed to work with them effectively.

✔ **Uses:**

- Understanding the specific uses of tools, materials, and equipment is crucial when selecting them for bench work.
- Different tools are designed for specific purposes, such as cutting, shaping, drilling, fastening, or finishing.
- Materials may have different properties that make them suitable for particular applications, such as strength, hardness, or electrical conductivity.

Point to remember:

- Consider classifications, properties and application, while describing materials needed for bench work activities.
- For best practices, be aware of selecting right tools and equipment to be used before starting bench work activities.

- Ensure that the tools, materials, and equipment selected are not only suitable for the task but also contribute to the overall success and safety of the project.

Application of learning 1.4.

Visit any metal bench work company located in your surrounding area. Suppose that the company has recently hosted internees whose job includes selecting and arranging materials in a metal bench workshop. By Referring to the previous activity 1.4.1 and 1.4.2, You are requested to work with those aforementioned internees to select materials and tools.

Indicative content 1.5 : Preparation of Tools and Equipment

Duration: 3 hrs.

Theoretical Activity 1.5.1: Describing tools and equipment used in bench work activities.

Tasks:

1. You are requested to answer the following questions:
    i. Describe the tools used for bench work adjustment.
    ii. Describe the tools used for sharpening.
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 1.5.1.

Key readings 1.5.1.: Description of tools and equipment used in bench work activities

- **Definition of key concepts**

✔ **Tools:**

- Tools are handheld devices or instruments used to perform specific tasks.
- Tools include items like hammers, screwdrivers, and pliers, which help users manipulate objects or materials to achieve desired outcomes.

✔ **Materials:**

- Materials are the substances or components used to create, build, or manufacture products.
- Examples include wood, metal, plastic, and fabric.

✔ **Equipment:**

- Equipment refers to larger, often more complex machinery and devices used to carry out tasks.
- Equipment includes machines like computers, industrial machinery, and laboratory apparatus that aid in efficient and effective work processes.

- **Tools used for bench work adjustment.**

✔ **Bench Vise**

Adjusting the vice handle to apply the right amount of clamping force, depending

on the material of the work piece (e.g., tighter for metal, less tight for delicate materials).

✔ **Calipers (Vernier or Digital)**

Measuring the diameter of a drilled hole to ensure it meets the required specifications.

✔ **Hand Files**

Angle Control: Adjusting the angle at which the file is held to achieve the desired material removal rate and finish.

Smoothing the edges of a metal piece after cutting**.**

✔ **Bench Grinder**

Tool Rest Positioning: Adjust the tool rest to be at the correct angle and distance from the grinding wheel for safe and effective grinding.

Wheel Alignment: Ensuring the grinding wheel is properly aligned and securely mounted to prevent wobbling during operation.

✔ **Torque Wrench**

Torque Setting: Adjusting the wrench to the correct torque value to ensure bolts and screws are tightened to the manufacturer's specifications without over-tightening**.**

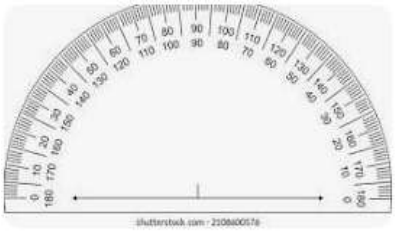
✔ **Drill Press**

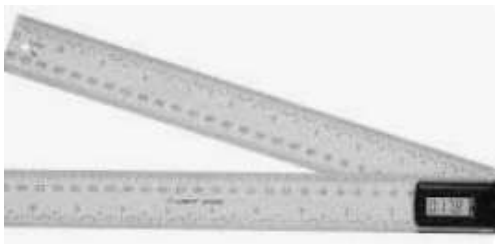
Depth Stop: Setting the depth stop to control how deep the drill bit goes into the material, ensuring consistent whole depth.

Speed Setting: Adjusting the speed of the drill press according to the material being drilled (e.g., slower for metals, faster for wood).

✔ **Protractor or Angle Gauge**

Angle Setting: Adjusting the protractor to the required angle for tasks that involve cutting or assembling parts at precise angles.





✔ **Adjustable Wrench**

Jaw Width: Adjust the width of the wrench's jaws to fit the size of the nut or bolt being worked on.

✔ **Clamp or C-Clamp**

Clamping Pressure: Adjusting the clamp to apply the right amount of pressure to hold pieces together during gluing or assembly without damaging them.

✔ **Screwdriver (Torque or Manual)**

Torque Setting (for torque screwdriver): Setting the torque level to avoid over-tightening screws.

- **Tools used for sharpening.**

✔ **Bench grinder:**

- A bench grinder is a versatile tool used for sharpening various types of cutting tools, including chisels, knives, drill bits, and blades.
- It consists of a motor-driven grinding wheel(s) that spins at high speed, allowing for efficient material removal and sharpening.

✔ **Sharpening stones:**

- Sharpening stones (whetstones), are abrasive stones used for sharpening edges on tools.
- They come in various grits, ranging from coarse to fine, allowing for different levels of sharpening and polishing.
- They are commonly used for sharpening knives, scissors, and other handheld tools.

✔ **Honing guide:**

- A honing guide is a tool used to maintain a consistent sharpening angle while sharpening blades or chisels.
- It holds the tool securely and guides it along the sharpening stone at the desired angle, ensuring even and accurate sharpening.

✔ **Leather strop:**

- A leather strop is a tool used for the final stage of sharpening, often after using Sharpening stones.

✔ **Sharpening guides:**

- Sharpening guides are devices that help maintain a consistent angle while sharpening.
- They can be attached to the tool being sharpened or used separately to guide the sharpening process.
- Sharpening guides are particularly useful for beginners or those who want to achieve precise and consistent results.

✔ **Diamond files:**

- Diamond files are abrasive tools coated with diamond particles.
- They are ideal for precision sharpening and shaping of small tools or hard material
- Diamond files come in various shapes and sizes, allowing for versatile sharpening applications.

✔ **Grinding jigs:**

- Grinding jigs are specialised fixtures used with a bench grinder to achieve specific angles profiles on cutting tools.

Practical Activity 1.5.2: Performing tools adjustment, sharpening and equipment setting up.

Task:

1. You are requested to go in manufacturing workshop and individually perform the following tasks:
   i. Adjust tools
   ii. Sharpen tools
   iii. Set up equipment
2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant, or your classmates.
4. Read the key readings 1.5.2
5. Perform the task provided in application of learning 1.5

Key readings 1.5.2.: Performing tool adjustment, sharpening and equipment setting up.

- **Definition of key concepts.**

✔ **Tools adjustment:**

- Adjusting tools involves calibrating and fine-tuning tools to ensure precise operation.
- This step is crucial for maintaining accuracy in measuring, cutting, or assembling components.

✔ **Sharpening:**

- Sharpening in bench work refers to honing the edges of cutting tools like chisels, knives, and saw blades.
- Regular sharpening ensures these tools remain effective, allowing for clean and accurate cuts in various materials.

✔ **Equipment setting up:**

- Equipment setting up in bench work involves assembling, configuring, and preparing machinery and devices for use at the workbench.

- **Steps for sharpening cutting tools**

✔ **Step 1: Clean the blades**

- Make sure to remove all the dust, dirt, or other debris from the tool surface before sharpening using a stiff wire brush and soapy water.
- If any rust, make sure to get rid of the rust.

✔ **Step 2: Examine the sharpness**

- Check for the sharpness of your tool. You can choose the sharpening method depending on the tool type and its condition.
- Blunt tools will require more sharpening at a greater sharpening angle while a quick fix will do for less damaged ones.

✔ **Step 3: Choose the sharpening method**

- The choice of sharpening tools is largely a matter of preference and the tool you want to sharpen.
- A grinding wheel, whetstones or diamond stone is good for knives and chisels, honing rods (sharpening steel) are a good choice for scissors and pliers while a flat file will be good for spades and other gardening tools.

✔ **Step 4: Lubricate your sharpening tool**

- If you are using a grinding wheel or whetstones, remember to apply water or lightweight oil to the sharpening surface.
- Oil is usually a better option because water will evaporate quickly.
- The oil will act as a lubricant and carry away all the grit produced during sharpening.
- This will help you get a correct and constant angle while giving smooth strokes.

✔ **Step 5: Choose a coarser grit**

- Start with a coarser grit; this will help to grind the steel down before you move to a finer grit for further sharpening.
- Sharpen the knife by dragging it across the stone until you slice a thin layer of the stone. Flip your tool and continue grinding until you create a new edge on the tool surface.

✔ **Step 6: Move to a finer grit**

- Now it is time to move to a finer grit. Your goal is to eliminate the burrs created by the coarse grit and smoothen out the surface thereby creating a sharp edge.
- First, sharpen one side of the tool and then turn over to the other side.
- Once you think your tool is sharp enough, give alternating swipes flipping it repeatedly with a single stroke each time for razor-sharp results.
- Remember not to reduce the sharpened edge to less than 1 mm thickness. A sharper edge will not improve the ability to sharpen, but will instead make the blade more brittle and vulnerable to fracture.

✔ **Step 7: Test the sharpness**

- Test the sharpness of your blades before you end the process. Start by cutting with the tool.
- If your blades are sharpened properly, they will make clean, easy cuts.
- The blades are not sharp enough if they pull or catch.
- Then keep using the fine whetstone or switch to an extra-fine stone to finish honing.

- Test again as necessary, taking extra care to avoid over sharpening the blades.

✔ **Step 8: Finish with a coat of oil**

- Finish off by rubbing your tool with light-based oil for rust protection.
- Protect the wooden handles with a coat of linseed oil or varnish.
- Your tools' dirt behaves like a sponge, soaking up moisture and rusting as a result.
- Make sure to clean off any dirt from your tools when not in use.

- **Steps for setting up bench work equipment:**

✔ **Step1: Read the manual:**

- Start by thoroughly reading the equipment's user manual or any provided instructions.

✔ **Step 2: Clear the workspace:**

- Ensure that your workspace is clean, organised, and free from any clutter or obstacles.

✔ **Step3: Gather required tools and materials:**

- Identify the tools and materials needed for the equipment setup.

✔ **Step4: Assemble the equipment:**

- Follow the manufacturer's guidelines to assemble the equipment.
- This may involve attaching various components, fastening screws or bolts, or connecting cables or hoses.

✔ **Step5: Adjust settings:**

- Common adjustments include blade height, cutting depth, speed, tension, or pressure settings.
- Consult the manual for specific guidance on adjusting these settings and use any provided indicators or measuring tools to ensure accuracy.

✔ **Step6: Check safety features:**

- Verify that all safety features of the equipment are operational and correctly set.
- This may include emergency stop buttons, safety guards, or interlocks.
- Ensure that these features are in place and functioning as intended to promote a safe working environment.

✔ **Step7: Test equipment functionality:**

- Before starting any actual work, conduct a test run of the equipment to ensure that it operates smoothly and without any issues.
- Test all relevant functions and observe for any abnormal noises, vibrations, or malfunctions.
- Make any necessary adjustments or troubleshooting as required.

✔ **Step8: Follow safety precautions:**

- Throughout the setup process, adhere to all safety precautions mentioned in the

manual or instructions.

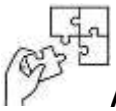
- Wear appropriate personal protective equipment (PPE) such as safety glasses, gloves, or ear protection, if necessary.

✔ **Step9: Document and maintain:**

- Keep a record of the equipment setup process, including any adjustments or settings you made.
- This documentation can be useful for future reference or troubleshooting.

Points to remember:

- Before starting bench work activities, ensure that you understand the specific tools and equipment that need to be adjusted and sharpened.
- Determine the types of adjustments and sharpening that your tools require and what type of the setting up your equipment needs.
- While performing tools adjustment and sharpening, ensure that you understand the steps that can help you to do that work safely. Otherwise, you are at high risk of getting serious injuries



Application of learning 1.5.

Visit any metalwork fabricator located in your surroundings. The fabricator should be fabricating various types of products made of metals. By referring to the previous activities 1.5.1 and 1.5.2, you are requested to:

a) Handle the preparation of tools and equipment
b) Perform equipment setting up for maintenance purposes

Learning outcome 1 end assessment

Theoretical assessment

Q1. Match the terms of (column A) with their corresponding meaning in (column B) by writing the answers in (column C)

Column A	Column B	Column C (Answers)
1.Bench work	A. Refers to the object or material that is being worked on or modified.	1……
2.Work pierce	B. They are the work carried out by hand on the workbench	2. ……
3.Workbench	C. Assembling of parts together after same hand operation called fitting operations	3. ……..
4.Fitter	D. It is a sturdy table at which manual work is done by fitter	4…… ..
5.Fitting	E. assembling of parts together after same hand operation	5……

Q2. Identify any four major types of hazards related to bench work activities.

Q3. Write down any eight (8) steps for wearing PPEs in the bench work workshop.

Q4. Read the following statement and circle the letter corresponding with the correct answer:

i. Application of bench work includes the following elements, **EXCEPT**

a) Assembling
b) Prototyping
c) Finishing and polishing
d) Fitting

ii. The primary purpose of a fire extinguisher is:

a) To cool down a fire
b) To spread the fire

c) To extinguish a fire
d) To create more smoke

iii. Types of fire extinguishers are identified based on **ONE** of the following specifications:

a) Type A, B, C, D
b) Type X, Y, Z
c) Type 1, 2, 3, 4
d) Type Red, Blue, Green

Practical assessment

WWW Metal Store Ltd. was awarded to supply personal protective equipment, measuring tools, marking tools, cutting tools, striking tools, tightening tools, holding tools and equipment of KL mechanical workshop. Suppose that you are the Head technician at WWW Metal Store Ltd, you are requested to apply safety and security measures, select required tools, materials and equipment and prepare tools and equipment by adjusting, sharpening and setting up within three hours.

END

References

Adams, R. G. (2020). Preparing materials for bench work. In B. H. Davis (Ed.), Manual of bench work operations (pp. 50-75). Elsevier

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Johnson, A. B. (2022). Preparing the work for bench operations: Essential steps and best practices. Journal of Mechanical Engineering, 60(4), 350-365.

Indicative contents
2.1 Interpretation of drawing **2.2 Execution of bench work operations** **2.3 Application of bench work** **2.4 Verification of work done** **2.5 Finishing work done**

Key Competencies for Learning Outcome 2: Carry out Bench Work Operations.

Knowledge	Skills	Attitudes
● Definition of part list element used in bench work operations ● Identification of part list format of the bench work activities ● Explanation of bench work operations ● Identification of bench work finished works	● Applying bench work operations ● Verifying the bench work done ● Finishing the bench work done.	● Being patient while dealing with intricate designs (drawings) or complex assemblies. ● Paying attention to details while executing bench work operations to ensure accuracy in measurements, cuts, and assembly. ● Being adaptable in handling different tasks, materials, and tools in a bench work workshop where applications can vary greatly ● Having willingness to learn as the field of metalworking is constantly evolving with new techniques and technologies related to verifying and finishing metal products.

Duration: 30 hrs.

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly part list element found in bench work
2. Identify the correct part list format found in bench work
3. Explain clearly bench work operations
4. Apply effective bench work operation
5. Perform effectively finishing of the work done on bench work
6. Verify correctly the work done in bench work activities
7. Check effectively finished bench work done.

Resources

Equipment	Tools	Materials
● Bench table ● Vices ● Surface plate ● Anvil, Bench drilling machine ● Bench grinding machine ● Tap and dies	● Scribing block ● Universal surface gauge ● Try square ● Files ● Scrapers ● Hammers ● Hack-saw ● Punch ● Drills ● Dies and taps ● Chisels ● Hand saw ● Marking knife ● Pencil ● Marking gauge	● Sheet metal ● Bar ● Rods ● Structure shapes ● Tubes

Indicative content 2.1: Interpretation of Drawings

Duration: 5 hrs.

Theoretical Activity 2.1.1: Description of drawings used in bench work operations

Tasks:

1. You are requested to answer the following questions:
   i. Describe the following elements of a part list:
      a) Part number
      b) Specification
      c) Quantity
   ii. Prepare the sample of part list format
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 2.1.1.

Key readings 2.1.1.: Description of drawings used in bench work operations

- **Definition of part list:**

(Also known as a bill of materials (BOM)**,** It provides a detailed breakdown of the parts used in the design. When interpreting a drawing, the part list element is important for identifying and organising the components or parts required for the project.

- **Elements of part list:**

✔ **Part number**

- The part number uniquely identifies each component in the part list.
- It serves as a reference for ordering, tracking, and identifying specific parts.
- Part numbers can consist of alphanumeric characters or a combination of numbers and letters.
- It provides a brief description or name of the component.
- It helps in identifying the purpose or function of the part.
- The description might include information such as the part's shape, size, material, or any distinguishing features.

✔ **Specification or specifications**

- The specification column provides additional information about the characteristics, properties, or requirements of the part.
- It may include details such as size, material type, weight, tolerance, voltage rating, or any other relevant specifications that define the part's specifications.

✔ **Quantity**

- The quantity column specifies the number of each part required for the project.
- It indicates how many units of each component need to be produced, or assembled.
- The quantity can be represented as a numerical value or a symbol, such as "Qty" or "#" followed by the number.

- **Part list format**
- Examples of part list format

Part Name	Description	Primary Vendor	Contract Number	Units	Unit of Measure	Unit Cost	Revision Number	Rev Date

Points to Remember

- Interpretation of the drawing by looking at its part list elements helps the bench work operator to ensure that the final product meets the required standards.

Application of learning 2.1.

Visit any metal bench work company located in your surrounding area. Make an observation of their activities. Referring to the key readings 2.1.1, You are requested to use the template below to collect all data concerning the part list elements

Part Name	Description	Primary Vendor	Contract Number	Units	Unit of Measure	Unit Cost	Revision Number	Rev Date

Indicative content 2.2 : Execution of Bench Work Operations

Duration:5 hrs.

Theoretical Activity 2.2.1: Description of bench work operations

Tasks:

1. You are requested to answer the following question:
   i. Describe bench work operations.
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
2. Read the key readings 2.2.1.

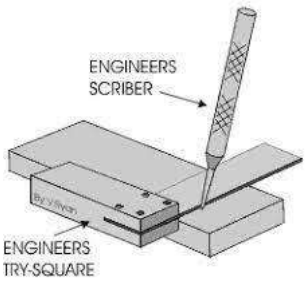
Key readings 2.2.1.: Description of bench work operations

- **Measuring:**

✔ A key element of the plan is to decide how to measure the selected response and explanatory on the units in the sample.

✔ To determine the value of any variety on a unit, we call the measuring devices, methods and individuals involved in the measuring process.

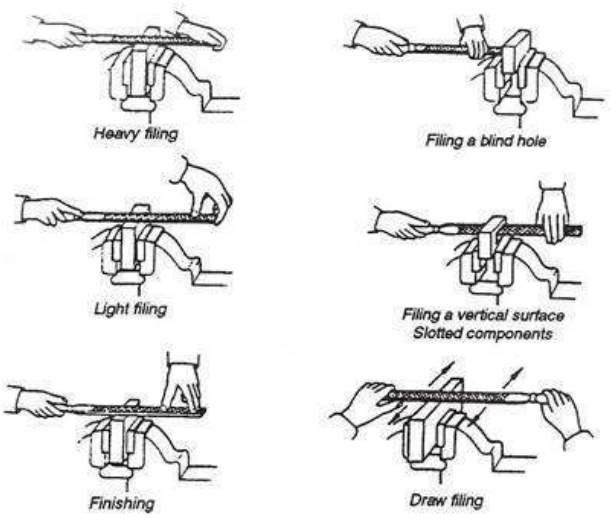
- **Marking:**



✔ Marking out or layout means the process of transferring a design or pattern to a work piece, as the first step in the manufacturing process.

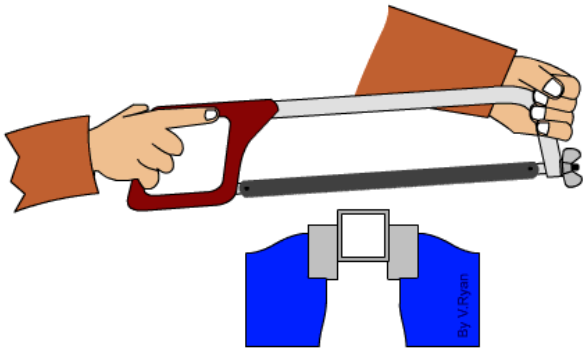
✔ It is performed in many industries or hobbies although in the repetition industries the machine's initial setup is designed to remove the need to mark out every individual piece.

- **Filing:**



- ✔ Filing is a material removal process in manufacturing.
- ✔ Similar, depending on use, to both sawing and grinding in effect, it is functionally versatile, but used mostly for finishing operations, namely in debarring operations.

- **Hacksawing:**



- ✔ Hacksaws work by moving the blade through the metal backwards and forwards in a regular 'sawing' action.
- ✔ The C-shaped handles are relatively cheap to buy and the wide range of blades available enables a wide range of profile thickness and metal grades to be easily.

- **Chiselling**:

- ✔ Chiselling use involves forcing the blade into some material to cut it.

- ✔ The driving force may be applied by pushing by hand, or by using a mallet or hammer.
- ✔ In industrial use, a hydraulic ram or falling weight ('trip hammer') may be used to drive a chisel into the material.

- **Hammering:**

- ✔ The metal is placed in a die and attached to an anvil.
- ✔ The hammer is dropped onto the metal, causing it to flow and fill the die cavities.
- ✔ The hammer is timed to meet the metal in quick succession on a scale of milliseconds.
- ✔ Excess metal is pushed out from the die cavities, resulting in a flash.

- **Stamping:**

- ✓ Turning metal sheets into a useful part or component is called sheet metal stamping.
- ✓ The metal is fed into a press, where the stamping tool, also known as a die, creates the desired shape.
- ✓ The die is pressed into or through the metal with tremendous force.

Common metal stamping steps

Disregarding steps such as design and prototyping, which are necessarily performed prior to stamping, there are nine primary processes involved in the actual stamping of metal parts.

- **Blanking:**

- ✓ When required, blanking is the first step of the stamping process.
- ✓ Blanking is the process of cutting larger sheets or coils of metal into smaller, more manageable pieces.
- ✓ Blanking is usually performed when a stamped metal piece will be drawn or formed.

- **Piercing:**

- ✓ If a part requires slots, holes, or other cut out, piercing can be employed.
- ✓ Piercing, which can be performed simultaneously with blanking, punches the requisite shapes out of the metal sheet: drawing is the actual stamping in the

metal stamping process.

- ✓ A punch forces a section of metal through a die, providing the primary shape of the part.
- ✓ When the depth of the part is less than the primary opening, it is considered shallow drawing; parts with a depth greater than the opening are deep drawn.
- ✓ **Bending:**
- ✓ Bending is a self-explanatory process.
- ✓ The part in progress is placed on a specially designed die and a ram push against the metal, providing the required bend.
- ✓ Bending is performed after drawing, as attempting to punch an already bent piece of metal causes the entire part to deform.

- **Air bending:**

- ✓ Air bending is when the flat surface of a part is bent by a punch into a die, often V-shaped.
- ✓ The space between the punch and die is larger than the metal thickness, resulting in a bend that relaxes slightly when the part is released.
- ✓ Air bending uses less power and pressure than other bending methods.

- **Bottoming and coining:**

- ✓ Bottoming and coining are bending processes that are similar to air bending, but use anywhere from two to 30 times the pressure, and the material is forced fully into a tight-fitting die, resulting in a more permanent bend.

- **Forming:**

- ✓ Forming is a bending process similar to bending, bottoming, and coining.
- ✓ It creates parts with multiple bends, such as U-bends, in one-step.

- **Pinch trimming:**

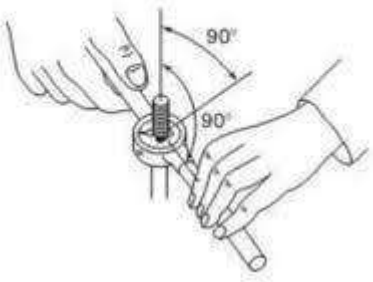
- ✓ Pinch trimming is a method of cutting a piece from the metal sheet, separating it from the scrap metal.
- ✓ It is an unconventional process: the metal is pinched against a flat vertical surface.
- ✓ It is often, but not exclusively, used to cut deep drawn round cups from the sheet.

- **Lancing:**

- ✓ It is a type of metal cutting used to make vents or tabs.
- ✓ A section of a part is cut along three edges and simultaneously bent.
- ✓ This creates the opening or hook-like feature required but eliminates a scrap collection or secondary machining step.

- **Tapping:**

Cutting External Threads



- ✓ Tapping is the process of cutting a thread inside a hole so that a cap screw or bolt can be threaded into the hole.
- ✓ In addition, it is used to make thread on nuts.
- ✓ Tapping can be done on the lathe by power feed or by hand.

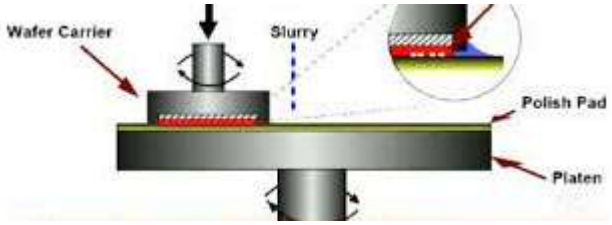
- **Drilling:**

✔ Drilling, same as milling is a cutting process that uses a drill bit to cut a hole in metal, Steal, high strength steel, aluminium or stainless steel.

✔ The drill bit is pressed against the work piece and rotates at rates from hundreds up to even thousands of rotations per minute.

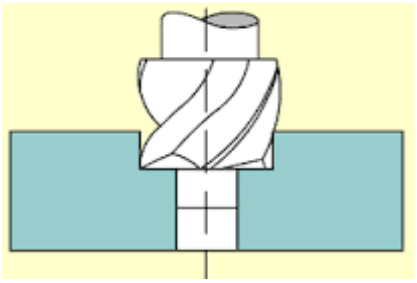
Common operations performed on drilling machines

- **Lapping:**



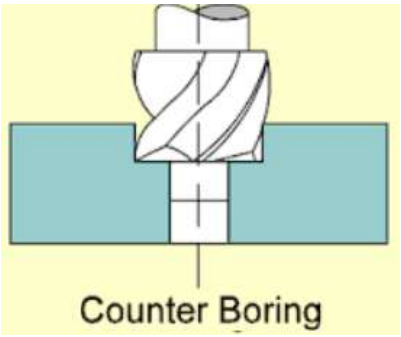
- ✓ It is a specialised process that makes metal part surfaces as close to uniformly flat as possible.
- ✓ Lapping can also be used to polish metal surfaces to a fine finish; a mirror finish can be achieved with certain metals.

- **Boring:**



- ✓ Boring is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a boring head containing several such tools), such as in boring a gun barrel or an engine cylinder.

- **Counter-boring:**

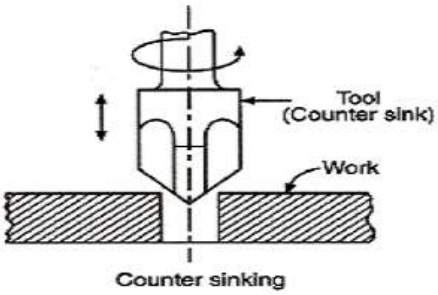


✓ Counter boring is a method used to create an even surface on the inside wall of a pipe end

✓ The process to make piping often results in an uneven surface on the inside wall.

✓ When joining two pipes together, the uneven surface creates gaps, which are difficult to weld.

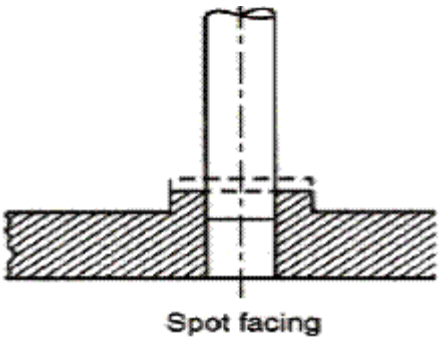
- **Countersinking:**



✓ A countersink is a conical hole cut into a manufactured object, or the cutter used to cut such a hole.

✓ A common use is to allow the head of a countersunk bolt, screw or rivet, when placed in the hole, to sit flush with or below the surface of the surrounding material.

- **Spot facing:**



✓ A spot face or spot face is a machined feature in which a certain region of the work piece is faced, providing a smooth, flat, accurately located surface.

- **Shearing:**

✓ Shearing is a metal fabrication process that is used to trim and remove unwanted

material from sheet metal.

- ✓ It involves the use of a machine or tool, such as a bench shear, to slice through sheet metal with extreme precision.
- ✓ Shearing is performed by slicing through a piece of sheet metal with a blade that is most often affixed to a tool or machine.
- ✓ A squaring arm that allows a sheet of metal to be placed in a precise location controls the location of the cut.
- ✓ Shearing, also known as die cutting, is a process that cuts stock without the formation of chips or the use of burning or melting.
- ✓ Strictly speaking, if the cutting blades are straight, the process is called shearing; if the cutting blades are curved then they are shearing-type operations.

Phases of shearing process:

- ➢ Phase1: Contact engaging
- ➢ Phase2: Penetration stage
- ➢ Phase3: Fracturing stage
- ➢ Phase4: Full material separation

Most common shearing operations:

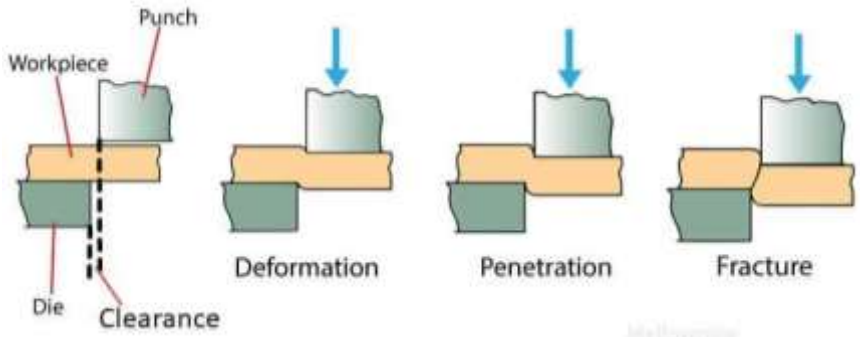
- ➢ Punching-where the sheared slug is scrap or may be used for some other purpose, blanking-where the slug is the part to be used, and the rest is scrap.
- ➢ Shearing performs straight-line cuts without forming chips, burning, or melting the material. This allows the process to work well with softer metals, such as aluminium, brass, bronze, and mild (low carbon) steel.

Factors affecting the configuration of the sheared edge:

- ➢ The cutting clearance
- ➢ Cutting angle
- ➢ Cutting blade sharpness
- ➢ Cutting speed
- ➢ Lubrication
- ➢ Sheet material parameters
- ➢ Tooling condition
- ➢ Tool wear, and strain rate

- The machine used in shearing is called a squaring shear, power shear, or guillotine.

Guillotine shears allow you to produce uniform and relatively burr-free sections of sheet metal or metal, which are then shaped on a press brake or bending machine.



- **Punching**

✓ It involves creating holes or shapes in materials using a punch and die set

✓ A punch is a tool used to indent or create a hole through a hard surface.

✓ They usually consist of a hard metal rod with a narrow tip at one end and a broad flat "butt" at the other.

Types of punch tools:

✓ Centre punch

✓ Prick punch

✓ Pin punch

✓ Drift punch

- **Grinding:**

✓ It is the process of removing metal by the application of abrasives, which are bonded to form Rotating wheel then the moving abrasive particles contact the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the work piece.

✓ A grinding machine, often shortened to a grinder, is a power tool (or machine tool) used for grinding.

✓ It is a type of machining using an abrasive wheel as the cutting tool.

Grinding procedure:

✓ Ensure the proper wheel for the stock is being used.

✓ Clean the bed before placing the work piece onto it.

✓ Place magnetic parallels around the work piece to ensure the work piece does not shift during grinding.

- ✓ Turn the magnetic chuck on to secure the pieces onto the bed.

Various grinding methods:

- ✓ Surface grinding
- ✓ Cylindrical grinding
- ✓ Internal grinding
- ✓ Centre less grinding
- ✓ Contour grinding
- ✓ Gear grinding
- ✓ Thread grinding

- **Reaming**

- ✓ It is a cutting process that involves the use of a rotary cutting tool to create smooth interior walls in an existing hole in a work piece.
- ✓ The rotary cutting tool used in reaming is known as a reamer. Like drill bits, reamers also remove material from the work piece on which they are used.
- ✓ Multiple teeth enable users to use much faster feed rates, and therefore increase productivity over machining with a single-tooth tool.
- ✓ Reaming is also a good choice for materials that cannot withstand high levels of heat and therefore require slower machining and longer cycle times.

Factors that influence the choice of reamers:

- ✓ Material to be reamed
- ✓ Diameter of hole
- ✓ Amount of stock to be removed
- ✓ Accuracy and finish desired
- ✓ First cost
- ✓ Maintenance costs
- ✓ Salvage value

- **Cutting:**

- ✓ The process of metal cutting involves the removal of excess material from a workpiece in the form of a chip using a wedge-shaped tool.
- ✓ Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling.

Metal cutting machines include:

- ✓ Lathe, drilling machine
- ✓ Milling machine
- ✓ Boring machine
- ✓ Grinding machine and machining centre

- **Rolling:**

✓ It is a metal forming process in which metal stock is passed through one or more pairs of rolls to reduce the thickness, to make the thickness uniform, and/or to impart a desired mechanical property: the concept is similar to the rolling of dough.

✓ In rolling, the metal is plastically deformed by passing it between rollers rotating in opposite directions.

- **Bending:**

✓ Metal bending is a process by which metal can be deformed when applying force to the subject, which causes it to bend at an angle and form the anticipated shape which often results in it being in a 'V' or a 'U' shape.

Basic types of metal cold bending processes:

✓ Air bending
✓ Bottom bending/bottoming
✓ Coining
✓ Folding
✓ Wiping
✓ Rotary bending
✓ Roll bending
✓ Stretch bending and roll forming

Different types of bending machines:

✓ Bus bar bending-cutting-punching machine
✓ Hydraulic and mechanical profile bending machine
✓ Hydraulic hand/motorised pipe bending machine
✓ Sheet folding machine
✓ Sheet metal bending machine
✓ Pipe bending machine

Points to Remember

- Effective bench work operation conducted within a manufacturing process has proven to be a critical component in ensuring the precision and quality of the final products.

Indicative content 2.3: Application of Bench Work Operations

Duration: 5 hrs.

Theoretical Activity 2.3.1: Identifying steps of performing bench operations

Tasks:

1. You are requested to answer the following question:
    i. Identify steps of performing bench work operations
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 2.3.1.

Key readings 2.3.1: Identification of steps of performing bench operations

- **Steps of performing bench work operations**

✔ **Drawing interpretation:**

- This step involves studying and understanding the technical drawings or specifications provided for the work piece.
- The drawings may include dimensions, tolerances, and other relevant information necessary for the operation.

✔ **Measuring and marking:**

- Measurements are taken using appropriate measuring tools such as calipers, rulers, or micrometres.
- The measurements are used to mark the work piece accurately, indicating areas where material needs to be removed or added.

✔ **Work in process:**

- This step involves carrying out various operations on the work piece to shape it according to the desired specifications.
- The specific operations performed will depend on the nature of the workpiece and the required outcome.
- Some common bench work operations include filing, sawing, drilling, grinding, milling, and turning.
- The work piece is gradually shaped and refined through these operations.

✔ **Finishing product:**

- Once the desired shape and dimensions are achieved, the work piece undergoes finishing operations to enhance its appearance and functionality.
- Finishing techniques may include sanding, polishing, debarring, or coating the work piece with protective materials.

- Additionally, there may be other steps involved depending on the specific requirements of the bench work operation. These additional steps could include:

✔ **Assembly:**

- If the work piece is part of a larger assembly, it may be necessary to perform assembly operations.
- This involves joining different components together using techniques such as welding, soldering, or fastening with screws, bolts, or adhesives.

✔ **Quality inspection:**

- Before considering the work complete, a thorough inspection is conducted to ensure that the work piece meets the required standards and specifications.
- This may involve visual inspection, dimensional measurements, or functional testing.

✔ **Packaging and labelling:**

- For storage, transportation, or further processing. Once the work piece has been inspected and approved, it can be packaged and labelled

Practical Activity 2.3.2: Performing bench work operations

Task:

1. Referring to the previous activity 2.2.1, you are requested to go in manufacturing workshop/workplace and individually do the task below:
   i. Apply bench work operations
2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant, or your classmates.
4. Read the key readings 2.3.2.
5. Perform the task provided in the application of learning 2.3

Key readings 2.3.2 Performing bench work operations

- **Applications of bench work operations**

✔ **Measuring:**

- Measuring is used to ensure accurate dimensions and alignment of components in industries such as: Manufacturing, woodworking, metalworking, engineering

✔ **Marking:**

- Marking is used to indicate measurements, reference points, or guidelines on

materials or components, ensuring precise cuts, drilling, or assembly.

- **Filing:**
  - Filing is used to shape or smooth rough edges, remove burrs, or refine surfaces of materials in metalworking, woodworking, and jewellery making.
- **Hacksawing:**
  - It is used to cut through metal, plastic, or wood using a hacksaw.
  - It finds applications in various industries for cutting stock material or producing specific components.
- **Chiseling:**
  - Chiselling involves using a chisel to remove material or create grooves in materials like wood or metal.
  - It is used in woodworking, masonry, and sculpting.

- **Stamping:**
  - Stamping involves using a die and press to imprint or shape materials like metal sheets.
  - It finds applications in industries such as automotive, aerospace, and manufacturing.
- **Tapping:**
  - Tapping is used to create internal threads in holes using a tap.
  - It is commonly used in metalworking, machining, and plumbing.
- **Drilling**:
  - Drilling involves creating holes in materials using a drill bit.
  - It is used across industries for various purposes, including assembly, fastening, or creating openings.
- **Shearing**:
  - Shearing is used to cut through sheet metal or other materials using a shear machine.
  - It is employed in industries such as metal fabrication, construction, and automotive.
- **Punching:**
  - Punching involves creating holes or shapes in materials using a punch and die set.
  - It is employed in metalworking, fabricating, and manufacturing processes.
- **Grinding:**
  - It is used to remove material or achieve a smooth finish on surfaces using abrasive wheels or belts.
  - It is employed in industries like metalworking, manufacturing, and tool making.
- **Reaming**
  - It is the process of enlarging and refining existing holes using a reamer.
  - It ensures accurate sizing and smoothness and is used in machining and

metalworking operations.

- ✔ **Cutting:**
  - Cutting involves dividing materials into desired shapes or sizes using various tools such as saws, shears, or plasma cutters.
  - It is in multiple industries, including manufacturing, construction, and crafting.
- ✔ **Rolling:**
  - Rolling is used to shape metal sheets or bars into desired forms using rolling mills or machines.
  - It is common in metalworking, construction, and manufacturing processes.
- ✔ **Bending:**
  - Bending is to create curved or angled shapes in materials like metal or plastic.
  - It is used in industries such as fabrication and automotive.

Points to Remember

- While performing bench work operations, follow specific steps which mainly include drawing interpretation, finishing the product and doing proper packaging
- Understanding proper application of each type of bench work operations helps to get the desired product

Application of learning 2.3.

Visit any metalwork fabricator located in your surroundings. The fabricator should be manufacturing various types of furniture. By referring to the previous activities 2.3.1.and 2.3.2, you are requested to perform bench work operations in relation to the fabrication of the aforementioned furniture.

Indicative content 2.4: Verification of Work done

Duration: 5 hrs.

Theoretical Activity 2.4.1: Description of work done on verification elements in bench work.

Tasks:

1. You are requested to answer the following questions:
   ii. What do you understand by verification elements?
   iii. Explain the following verification elements:
      a) Dimension
      b) Angularity
      c) Straightness
      d) Flatness
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 2.4.1.

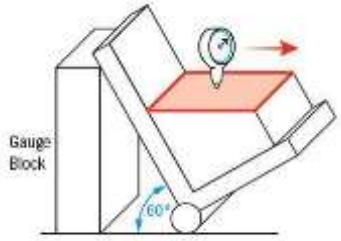
Key readings 2.4.1.: Description of work done on verification elements in bench work.

Introduction:

Work done encompasses various hands-on tasks performed at a workbench to build, modify, repair, or assemble items.

Verification elements involve ensuring the accuracy, functionality, and quality of tools, materials, and assembled components.

- **Dimension:**
  - ✔ Check existing and/or adjoining work, if any, to see if existing dimensions are correct;
  - ✔ Report all discrepancies in the drawings or existing work to Buyer's Field Engineer.
- **Angularity:**



- ✔ Flatness can be analysed by quantifying deviations from a least squares reference plane.

- **Straightness:**
  - ✔ In actual production, the commonly used methods for measuring the straightness of guide rail are the micrometer method, level instrument method and straightness instrument method.

- **Flatness:**
  - ✔ Flatness can be measured using a height gauge run across the surface of the part if only the reference feature is held parallel.
  - ✔ You try to make sure that any point along the surface does not go above or below the tolerance zone.

Practical Activity 2.4.2: Verifying work done in bench work

Task:

1. You are requested to individually verify the following elements on the work done:
   i. Dimension
   ii. Angularity
   iii. Straightness
   iv. Flatness
2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant or your classmate
4. Read the key reading 2.4.2.
5. Perform the task provided in application of learning 2.4

Key readings 2.4.2.: Verifying work done in bench work

- **Verification process during bench work activities**

1: Verification planning

✔ **Verification method and level assignments:**

- It defines the relationships between the specified requirements method and level of verification.
- This activity typically yields a verification cross reference matrix for each level of the architecture and serves as the basis for the definition of the verification tasks.
- The level of verification is assigned consistent with the level of the requirement (e.g., system-level, subsystem level, etc.).
- Verification activities include analysis, inspection, demonstration, and test. (see below) Choice of verification methods must be considered an area of potential risk.

✔ **Verification task definition:**

- It defines all verification tasks with each task addressing one or more requirements.
- The ability to define good verification tasks requires the test engineer to have a sound understanding of how the system is expected to be used and its associated environments.

✔ **Verification configuration definition:**

- It defines the technical configuration, resources, including people, and environments needed to support a given verification task.
- This may also include hardware or software to simulate the external interfaces to the system to support a given test.

✔ **Verification scheduling:**

- It defines the schedule for the performance of the verification tasks and determines which verification tasks are in sequence or in parallel and the enabling resources required for the execution of the verification tasks.

Typical verification methods:

- Analysis: the use of mathematical modelling and analytical techniques to predict the compliance of a design to its requirements based on calculated data or data derived from lower-level component or subsystem testing.
- Inspection: the visual examination of the system, component, or subsystem.
- Demonstration: the use of the system, subsystem, or component operation to show that a requirement can be achieved by the system.
- Test: the use of the system, subsystem, or component operation to obtain detailed data to verify performance or to provide sufficient information to verify performance through further analysis.

2: Verification execution

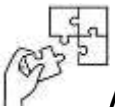
- ✔ The performance of a given verification task with supporting resources.
- ✔ The verification task results, whether from a test, analysis, inspection or simulation, are documented for compliance or non-compliance with data supporting the conclusion.

3: Verification reporting

- ✓ Reports the compiled results of the executed verification plan and verifies the materials employed in system solutions can be used in a safe and environmentally compliant manner.

Points to Remember

- While describing verification of the products, take into consideration elements and the right way to use them for safety purposes.
- For the final bench work product to be accurately completed, ensure that you have scrupulously gone throughout required steps



Application of learning 2.4.

Visit any metal bench work workshop/workplace located in your surrounding area. The metal bench workers in that workshop/workplace should be fabricating screwed parts of stands in steel T-bars. By referring to the previous activities 2.4.1 and 2.4.2, You are requested to:

a) Select appropriate materials, tools and equipment
b) Verify the dimensions, angularity, straightness and flatness of the stands

Indicative content 2.5: Finishing Work done

Duration: 5 hrs.

Theoretical Activity 2.5.1: Explanation of finishing work

Tasks:

1. You are requested to answer the following questions:
   i. Describe finishing techniques used on edge and surface of bench work product
   ii. Explain the importance of edge and surface finishing
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 2.5.1.

Key readings 2.5.1.: Finishing work done during bench work activities

- **Definition of finishing**

Finishing refers to the final steps or processes carried out to complete or enhance the appearance, functionality, or durability of a product, surface, or project.

- **Finishing techniques**

✔ **Edge finishing**

- It refers to the process of refining and smoothing the edges of metal components.
- It helps prevent injuries from sharp edges, enhances visual appeal, and facilitates assembly.
- Common edge finishing techniques include filing, debarring, chamfering, and rounding.
- For example, debarring removes burrs or rough edges, chamfering creates bevelled edges, and rounding creates rounded edges for improved safety.

✔ **Surface finishing**

- Surface finishing involves enhancing the texture, appearance, and performance of metal surfaces.
- It helps remove imperfections, improve corrosion resistance, and create desired surface characteristics.
- Common surface finishing methods include sanding, polishing, grinding, and coating.

- For example, sanding smooth rough surfaces, polishing creates a reflective finish, grinding removes surface irregularities, and coating applied protective layers.

- **Importance of edge and surface finishing:**
  - ✔ Edge and surface finishing contribute to the overall quality and functionality of metal components.
  - ✔ They ensure proper fit and assembly, minimize the risk of injury, and enhance the product's visual appeal.
  - ✔ Additionally, surface finishes can offer specific properties like increased corrosion resistance or improved paint adhesion.

- **Safety considerations during edge and surface finishing:**
  - ✔ When performing edge and surface finishing, wearing appropriate personal protective equipment (PPE) like gloves and safety glasses is crucial.

  Ensuring proper tool handling and technique is essential to prevent accidents or injuries.

Practical Activity 2.5.2: Perform edge and surface finishing.

Task:

1. Referring to the previous activity 2.5.1, you are requested to go to the manufacturing workplace/workshop and individually do the task below:
   i. Perform edge finishing
   ii. Perform surface finishing
2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant and/or classmate
4. Read the key readings 2.5.2.
5. Perform the task provided in application of learning 2.5

Key readings 2.5.2.: Performing edge and surface finishing.

- **Steps of performing edge finishing**

✔ **Step1: Preparation**

- Ensure you have the necessary tools, equipment, and materials for the finishing tasks.
- Clean and prepare the work area, removing any debris or obstructions.
- Put on appropriate personal protective equipment (PPE) such as gloves, safety glasses, or a face shield.

✔ **Step2: Surface preparation**

- Inspect the metal component's surface for imperfections, roughness, or unwanted marks.
- Use sandpaper, abrasive pads, or a grinding wheel to smooth rough areas and remove any unwanted material.
- Clean the surface to remove any dirt, grease, or contaminants that may affect the finishing process.

✔ **Step3: Finishing techniques:**

- Select the appropriate finishing technique based on the desired outcome and the type of metal.
- Examples of finishing techniques include sanding, polishing, buffing, grinding, or applying coatings.
- Follow the proper sequence of grits or polishing compounds to gradually refine the surface.
- Apply the chosen technique using consistent pressure and motion to achieve an even and desired finish.

✔ **Step4: Final inspection and quality control:**

- Thoroughly examine the finished work for any remaining imperfections, scratches, or inconsistencies.
- Ensure that the finished product meets the required specifications and quality standards.
- Make any necessary adjustments or refinements to achieve the desired level of finish.
- Verify that the finished work matches the intended design and desired aesthetic appearance.

- **Performing finishing techniques on the punched product**

✔ **Performing grinding operation**

- Before work begins, ensure the guard is in the proper place, positioned

between the operator and the wheel

- The guard should be easily adjustable as needed. Do not allow anyone else to stand near or in front of your grinding work task.
- Wear PPE that provides the best protection for the task.
- Always wear approved safety glasses or goggles when using a portable grinder.
- Face protection is highly recommended to protect against flying debris.
- Do not wear loose clothing or jewellery and make sure long hair is secured.
- Evaluate the task and work environment to determine if additional PPE is required like gloves, a dust mask or hearing protection

When grinding you must be carefully of:

Figure 2: Grinding operation

Precaution to take when using a grinder:

- Make your work environment safe
- Use personal protective equipment (PPE)
- Check your grinder is in good condition and safe to use
- Choose the right disk for the job
- Use the grinder correctly

Procedure for using a grinding machine:

- Stand to the side of the wheels when starting up.
- Let the wheels gain maximum speed before starting to grind.
- Work piece must never be held with gloves, cloth, apron or pliers.
- Do not grind on the side of the wheel.
- Small objects must not be held by hand.

Working with the handheld portable grinder requires:

- Setting up a safe, clean and stable workspace.
- Selecting the right tool and wheel for the job.
- Inspecting the grinder, the wheel and the guard.
- Conducting a ring test on the abrasive wheel.
- wearing appropriate PPE that provides the best protection for the task

Procedures for using hand held angle grinder:

- Hold the grinder so that any sparks fly away from you and anyone nearby, and away from all flammable materials.

- Allow the grinder to reach operating speed, then apply load gradually.
- Maintain a constant pace to avoid uneven surfaces.
- Do not apply excessive force and avoid prolonged use.

Figure 3: Inserting disc in angle grinder

✔ **Performing filing operation:**

Figure 4: Cross filing

- Cross Filing (Straightforward filing): This technique involves pushing the file across the edge of the material. It can be used for finishing, shaping or sharpening.

Draw filing:

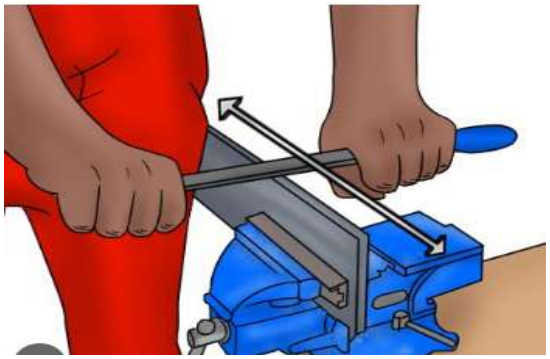


Figure 5: Draw filing

- This technique is a little more unusual and involves holding a file at each end and using it in a similar way to sandpaper.
- This technique is only used for finishing, and only with single-cut files.
- This is because the long, uninterrupted teeth of a single cut file act like a series of knives at shear material away from the surface of the workpiece with each stroke.
- Double cut and cut teeth are much shorter and would be more prone to digging channels in the material, which makes them unsuitable for draw filing. Other types of cut are throng shape to be used in both directions, which also

rules them out

Lathe Filing:

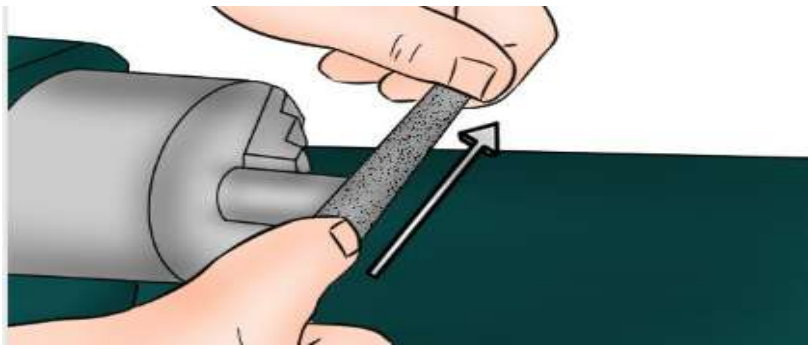


Figure 6: Lathe filing

- Lathe filing is used to smooth and shape cylindrical pieces of material, such as wooden chair Legs.
- This is a tricky technique that involves mounting your work piece in a lathe, which will rotate it when activated.
- The lathe must be spun faster than usual to ensure maximum filing consists

Stages of filing process:

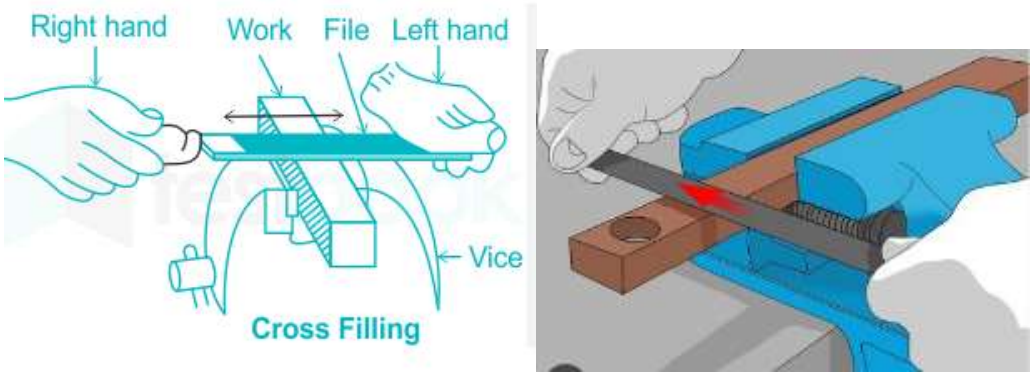


Figure 7: Filing procedures

Stage1: Ensure that the material is securely held in the vice and is not going to get damaged due to the grip in the vice

Stage2: Select the bastard file and file diagonally to as close to the construction line as you can by adding force in order to remove access material

Stage3: Once you have removed the majority to access material, begin to use the flat face of the half-rounded file in order remove fewer obstructing pieces of waste material.

Stage4: When you are extremely close to your construction line change to the flat file and begin the straightforward and back strokes in order to smooth the edges of the metal

Stage5: Repeat these steps on each edge of your material

✔ **Performing sanding procedures/step**

Figure 7: Sandpaper

Step1: Selection of sandpaper:

- ✓ Best sand for hard metals such as iron or steel is aluminium oxide, while the best sand for softer metals such as aluminium or brass is silicon carbide.

Figure 8: Polishing pad

Step2: Positioning the product:

Figure 9: Positioning product for sanding and polishing

Step3: Sanding the product:

Figure 10: Sanding work piece

- ➢ The sanding process is the process of smoothening and flattening the surface of the workpiece using coated abrasive.
- ➢ It is a necessary operation not only to remove surface blemishes, but also to prepare the surface for the subsequent application of finishes or coatings.

Step4: Check the product surface:

Check on the product surface by using:

Surface comparators, Replica tape, Surface profile gauges, and Surface roughness gauges

- **Performing polishing of the product:** Polishing is the process of creating a smooth and shiny surface on the product by using a polishing pad

Figure 11: Polish the product

Polishing procedures:

Figure 12: Inserting polishing pad in angle grinder

Polishing pad used for paint cleaning, removing swirl marks, light scratches, fine sanding scratches, and other defects in the workpiece. Polishing is the process of creating a smooth and shiny surface on the product by using a polishing pad.

✔ **Performing painting of the product**

Selecting the correct type of paint:

When it comes to a metallic surface, there are only two types of paints that can practically be used: (1) Oil paints, (2) Anti-corrosive paints

The process of applying metal paint:

- Firstly, the paints have to be mixed thoroughly before use.
- Then, they can be applied with the help of a brush, roller or a sprayer, depending on the nature of the metal surface.
- Note that anti-corrosive paints are not ready-to-use: solvents have to be added to it, such as benzene or white spirit before application, along with a good quality thinner. (If the thinner is of sub-par quality, then there are chances of appearance **of various defects on finished paint walls)**

Painting procedures / steps :

- **Step 1:** Inspection: Inspect the metal surface for cracks and peeling or chipped paint before painting.
- **Step 2**: Removing the dust/Sanding

✓ Remove all the dust on the surface.

✓ After removing all rust and old paint, proceed to sanding the metal. (Use either a sanding block or a square of fine-grit sandpaper)

✓ After sanding the metal, it is better to wipe down the metal surface, to clean all the sanding dust off the surface.

- **Step 3:** Metal primer:

✓ Now it is the right time to apply the primer and make the surface smoother than before.

- **Step 4:** Painting:

✓ Now it's finally time for paint. Use a brush or roller, or use a spray paint formulated for application on metal.

✓ It is better to apply several light coats, letting the paint dry for a few hours between coats.

Figure 13: Applying anti corrosion coating product

Methods of anti-corrosion coatings application

- Brush application*:* Brush application is a relatively slow method and is generally used for the coating of small complicated or complex areas or where the need for 'clean' working with no overspray is the use o f spray application. Brushes are also used for applying surface tolerant primers, where good penetration of rusty steel surfaces can be achieved with operator persistence. Brushes are a commonly used method for "touch up" of coatings during service.
- Roller application: Application by roller is faster than with a brush on large, flat surfaces, such as walkways and deck areas, but it is not so good for complex shapes. It is hard to control film thickness and high film build is generally obtained by applying multiple coats.
- Conventional spray: This is a method commonly used for applying single component zinc silicates to large surfaces. The equipment is relatively simple and inexpensive and is usually confined to fairly low-viscosity coating. Coating under pressure and air are fed separately to the spray gun and mixed at the nozzle. The coating is atomized and air is mixed with these droplets forming a fine mist of paint, which is carried by the air pressure to the work surface.

Point to remember:

- Safety considerations during edge and surface finishing is key to the achievement of the overall expected bench work product
- Application of edge and surface finishing techniques such as grinding, filing, sanding and painting contributes to the overall quality and functionality of metal components.

Application of learning 2.5

Visit any metal bench work workshop/workplace located in your surrounding area. Ask the metal bench workers in that workshop/workplace to let you help them carry out finishing operations on the produced doors, windows, and chairs. Referring to the previous activities 2.5.1 and 2.5.2, you are requested to perform:

a) Edge finishing
b) Surface finishing

Learning outcome 2 end assessment

Theoretical assessment

Q1. Read the following statement properly and circle the correct answer.

i. The following are parts of a part list elements, EXCEPT one:

a) Part number
b) Rolling
c) Specification
d) Quantity

Q2. Match a bench work operation in (column A) with its corresponding uses in (column B) by writing the answer in (column C)

Column A	Column B	Column C (Answers)
1.Reaming	A. it is used to ensure accurate dimensions and alignment of components in industries such as: Manufacturing, woodworking, metalworking, engineering	1……
2.Shearing	B. it is used to shape or smooth rough edges, remove burrs, or refine surfaces of materials in metalworking, woodworking, and jewellery making.	2……
3.Measuring	C. it is used to create internal threads in holes using a tap.	3…… ……
4.filling	D. It is the process of enlarging and refining existing holes using a reamer.	4…… ……
5.Tapping	E. It is used to cut through sheet metal or other materials using a shear machine	5…… …….

Q3. Read the following statement and answer by TRUE if the statement is correct or FALSE if the statement is incorrect:

a. In bench work operations, it is acceptable to use any type of file regardless of the material being worked on.
b. A surface plate is commonly used in bench work to check the flatness of a surface
c. Bench work operations do not require any special consideration for safety since the tools used are mostly hand tools.

Practical assessment

KAMANA furniture company ltd has received a tender from MUHANGA District to produce ten (10) office mild steel chairs, with help of the mentioned dimensions on the picture below. As a Bench work metal worker, you are tasked to prepare the work pieces required to make those chairs by applying bench work operations properly.

END

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Indicative contents
3.1 Maintaining tools and equipment
3.2 Storing tools and equipment
3.3 Report the work done

Key Competencies for Learning Outcome 3: Perform Post-Operation Activities

Knowledge	Skills	Attitudes
● Identification of cleaning techniques for maintaining bench work tools and equipment ● Description of lubrication to maintain bench work tools and equipment ● Description of metal waste disposal	● Applying cleaning techniques of the bench work workplace ● Storing metal bench work tools and equipment. ● Preparing written reports on bench work operations	● Having safety consciousness by following protocols while cleaning metal bench work tools and equipment ● Taking pride in proper storing of metal bench products which reflects a strong work ethic and leads to better outcomes. ● Being accountable by preparing regular reports about the work done during bench work activities

Duration: 10 hrs.

Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify properly cleaning techniques for maintaining tools and equipment
2. Define clearly the term lubrication as used to maintain tool and equipment
3. Describe appropriately the ways of waste disposal found in bench work.
4. Apply effectively cleaning techniques at the workplace
5. Store properly tools and equipment used in bench work activities
6. Report efficiently the work done by bench work.

 **Resources**

Equipment	Tools	Materials
● Personal protective equipment (safety shoes, overall, gloves, earmuff and mask) ● Bench table ● Anvil ● Bench drilling machine ● Bench grinding machine	● Filter's vices ● Surface plates ● Callipers ● Screw drivers ● Hand saw ● Spirit level ● Marking gauge	● Oil ● Rugs ● Soap and water ● Shelves ● Petrol

Indicative content 3.1: Maintaining Tools and Equipment

Duration: 4 hrs.

Theoretical Activity 3.1.1: Description of tools and equipment maintenance

Tasks:

1. You are requested to answer the following questions**:**
   i. Explain these cleaning techniques below:
      a) Chemical cleaning
      b) Dust cleaning
      c) Wire brush cleaning
   ii. Define the term “lubrication”
   iii. Explain methods of waste disposal
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer’s clarifications and ask questions where necessary
5. Read the key readings 3.1.1.

Key readings 3.1.1.: Maintaining tools and equipment

- **Introduction**

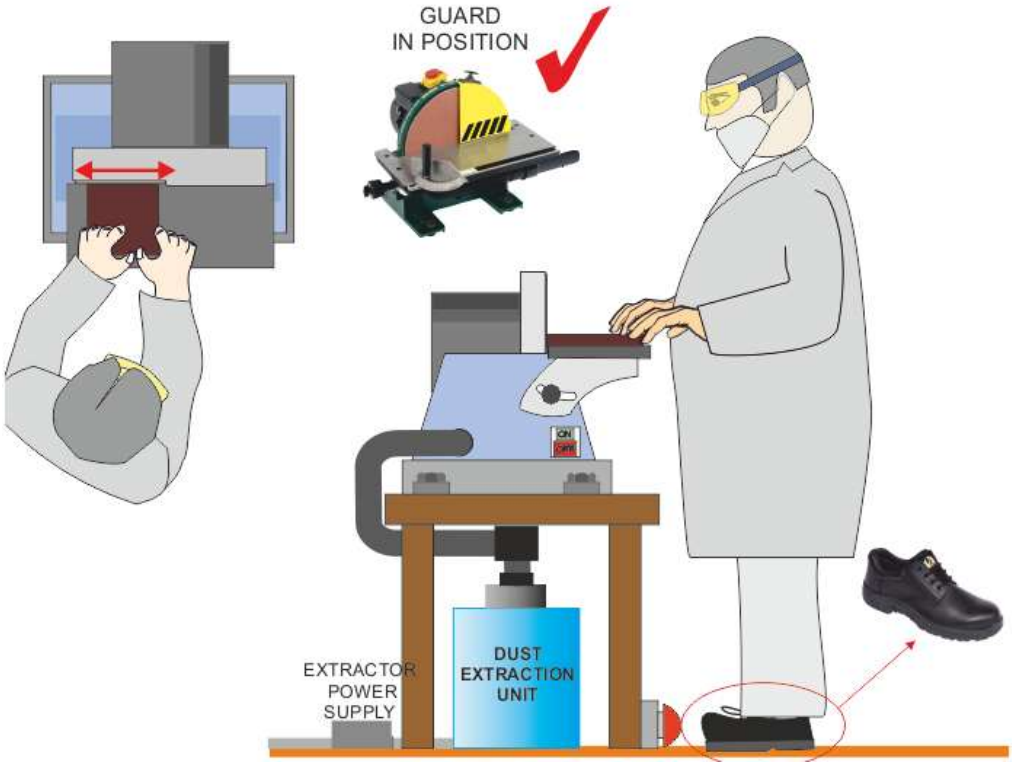
Maintenance refers to the activities and processes undertaken to keep equipment, tools, or systems in good working condition. This includes routine tasks like cleaning, lubricating, and inspecting to prevent breakdowns and ensure optimal performance.

Cleaning techniques in bench work

✔ **Chemical cleaning**

- It is a process that uses specific chemicals to remove contaminants, scale, rust, or other unwanted substances from surfaces, equipment, or components.
- It can also be applied to a wide range of materials, including metals, plastics, ceramics, and more.

✔ **Applications of chemical cleaning:**



- Boiler cleaning: In power plants, chemical cleaning is often used to remove scale and deposits from boiler tubes and heat exchangers.
- Metal Surface preparation: Before painting, plating, or welding, metal surfaces are cleaned to remove oils, rust, and other contaminants.
- Pipeline maintenance: To remove scale, corrosion, or debris from pipelines.
- Equipment maintenance: Cleaning and maintenance of industrial equipment, such as pumps, valves, and heat exchangers.

✔ **Dust cleaning**

This cleaning technique includes:

- Dust collection systems: Install dust collection systems, such as industrial vacuum cleaners, dust extractors, or localised exhaust systems, near workstations or machinery to capture dust at the source.
- Ventilation**:** Ensure good ventilation in the work area to help disperse and remove airborne dust particles. Use exhaust fans or natural ventilation as needed.
    - Wet cleaning: Use damp or wet cleaning methods to capture and remove dust effectively. Dampen a cloth or mop with water or a suitable cleaning solution and wipe down surfaces.
    - Compressed air: Use compressed air with a low-pressure nozzle to blow away dust from equipment, work pieces, and other surfaces.
    - Brushing and sweeping Use brooms, brushes, and dustpans to sweep up dust

from the floor and work surfaces. Sweep in a way that minimises the re-suspension of dust into the air.

- Vacuum cleaners: Use vacuum cleaners equipped with HEPA (High-Efficiency Particulate Air) filters, which are effective in capturing fine dust particles and preventing them from being released back into the environment.
- Dust suppressants: In some cases, applying dust suppressants, such as water or dust-control chemicals, can help control dust in the work area.
- Regular filter replacement: If you use filtration systems, ensure that filters are replaced or cleaned regularly to maintain their efficiency.

✔ **Wire brush cleaning**

Wire brushes are available in different shapes and sizes, with various types of wire bristles, and can be used manually or attached to power tools.

- **Cleaning the bench workplace:**

✔ Cleaning the workplace in bench work is crucial for maintaining a safe, organised, and efficient working environment. A clean workspace helps prevent accidents, improves productivity, and ensures the quality of the work. Here's a guide on cleaning the workplace in bench work:

- **Lubricating**

✔ Lubricating refers to the process of applying a lubricant, such as oil or grease.

The primary purposes of lubrication are:

- ➢ Reducing Friction: Lubricants create a thin film or layer between moving surfaces, which minimizes direct contact and friction. This friction reduction helps to improve efficiency, reduce heat generation, and prevent excessive wear and damage to components.
- ➢ Preventing wear and tear: Lubrication helps protect the surfaces of mechanical components from wear and corrosion. By maintaining a protective barrier,

lubricants extend the life of parts and reduce maintenance requirements.

- Heat dissipation: In addition to reducing friction, lubricants also aid in dissipating heat generated by moving parts. This is particularly important in high-speed and heavy-load applications to prevent overheating and component failure.
- Contaminant control: Lubricants can help keep contaminants, such as dust, dirt, and debris, away from critical components. They can trap these particles and prevent them from causing damage.

✓ **Lubrication process**

1. Selection of Lubricant

✓**Type: Choose the appropriate lubricant (oil, grease, solid lubricants) based on the application.**

✓**Viscosity:** Consider the operating temperature and speed to determine the right viscosity.

✓**Additives:** Look for additives that enhance performance, such as anti-wear, anti-oxidation, and corrosion inhibitors.

2. Preparation of Equipment

✓**Cleaning**: Ensure surfaces are clean before lubrication to prevent contamination.

✓**Inspection**: Check for wear and tear on components that may require additional maintenance.

3. Application of Lubricant

✓**Method:** Depending on the equipment, lubricants can be applied manually, via automatic systems, or through centralized lubrication systems.

✓**Quantity:** Apply the correct amount of lubricant; too much or too little can cause problems.

- **Waste disposal**

✔ It is the process of managing and getting rid of waste materials in an environmentally responsible and safe manner.

- **Methods of waste disposal:**

✓ **Landfill**: Landfills are designated areas where solid waste is disposed of in a controlled manner.

✓ **Recycling:** Recycling involves collecting and processing materials like paper, plastic, glass, and metals to convert them into new products. Recycling reduces the need for new raw materials, conserves energy, and reduces waste sent to landfills.

✓ **Incineration:** Waste incineration involves burning waste materials at high temperatures, which can generate energy in the form of heat or electricity.

✓ **Composting**: It is the biological decomposition of organic waste, such as food scraps and yard waste, into nutrient-rich compost. It reduces the volume of waste going to landfills and can improve soil quality.

✓ **Hazardous waste disposal:** Hazardous waste, including chemicals, toxins, and medical waste, must be managed with special care to prevent harm to the environment and human health.

✓ **Waste-to-energy**: This converts non-recyclable waste into heat and electricity, using various technologies like incineration or gasification.

✓ **Open dumping**: Open dumping is the least desirable and most environmentally damaging waste disposal method. It involves the unauthorized and unregulated dumping of waste in open areas, which can lead to pollution, disease, and habitat destruction. It is illegal in many places due to its negative impacts

Practical Activity 3.1.2: Performing preventive maintenance on bench work tools and equipment

Task:

1. You are requested to go in the manufacturing workshop/workplace and individually perform the following cleaning techniques:
   i. Perform chemical cleaning
   ii. Perform dust cleaning
   iii. Perform wire brush cleaning
   iv. Apply lubricating
   v. Apply methods of waste disposal

2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant and/or classmates
4. Read the key readings 3.1.2.
5. Perform the task provided in application of learning 3.1.

Key readings 3.1.2.: Performing preventive maintenance on bench work tools and equipment

- **Steps for wire brush cleaning:**

✔ Step1: Safety precautions:

Before beginning the cleaning process, ensure that you are wearing appropriate personal protective equipment (PPE) such as gloves and safety goggles to protect yourself from any potential hazards.

✔ Step2: Pre-clean the wire brush:

Start by removing any loose debris or particles from the wire brush.

✔ Step3: Wash with soap and water:

Fill a container or sink with warm water and add a mild detergent or cleaning solution.

✔ Step4: Rinse and dry the wire brush:

After scrubbing, rinse the wire brush under running water to remove any soap residue.

✔ Step5: Inspect and store the wire brush:

Once the wire brush is clean and dry, inspect it for any signs of damage or wear.

- **Steps for disposing of the waste in bench work activities**

✔ Assess household waste
✔ Sort and segregate
✔ Reduce waste generation
✔ Reuse and repurpose
✔ Compost organic waste
✔ Recycle appropriately
✔ Handle hazardous waste
✔ Opt for sustainable product
✔ Monitor waste disposal

- **Methods of lubricating during bench work activities**

✔ **Oil lubrication:**

➢ In this method, liquid oil is applied to the moving parts, ensuring a continuous film of lubricant.
➢ It is commonly used in engines, hydraulic systems, and many industrial machines.

✔ **Grease lubrication:**

➢ Grease is a semi-solid lubricant consisting of oil, thickening agents, and additives.
➢ It is often used in applications where a more viscous lubricant is needed, such as in wheel bearings and various types of bearings.

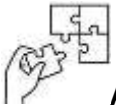
✔ **Solid lubrication:**

➢ Some materials, such as graphite and molybdenum disulphide, can act as solid lubricants.

- They are used in specific applications where traditional liquid lubricants may not be suitable.

Points to Remember

- Ensure that your tools and equipment remain in optimal working condition. Thus, your desired bench work product will automatically fulfil the required standards
- Always remember to apply cleaning techniques, methods of lubricating and waste management to keep your tools and equipment in good working condition



Application of learning 3.1.

Visit any metal bench work workshop/workplace located in your surrounding area. The visited workshop/workplace should be performing preventive maintenance on its bench work machines. Referring to the previous activities 3.1.1 and 3.1.2, you are requested to:

a) Apply cleaning techniques
b) Clean the workshop/workplace
c) Apply methods of lubricating

Indicative content 3.2 : Storing Tools and Equipment

Duration: 3 hrs.

Theoretical Activity 3.2.1: Explanation on storing tools and equipment used in bench work activities

Tasks:

1. You are requested to answer the following questions:
   i Explain storing procedures of tools, materials and equipment during bench work operations.
   ii Describe the methods of storing materials tools and equipment
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 3.2.1.

Key readings 3.2.1.: Explanation on methods of storing tools and equipment

- **Introduction:**

Storing tools and equipment properly is essential for maintaining their functionality and longevity. In order to keep good order in the workshop and to be an efficient worker, (e.g: marking tools should be kept to the left of the vice and files and saws should be kept to the right.)

- **Methods of storing tools, materials and equipment**

✔ **Re-arranging:**

The first step to organising tools is to do a thorough inventory.

- Once you have a general idea of the tools on hand, sort them into categories.
- Group all of the power tools, the small hand tools, and so on.
- Next, create zones and use cabinetry to keep the like items together

✔ **Shelving:**

- Shelf is a flat, horizontal plane used for items that are displayed or stored in a home, business, store, or elsewhere.
- It is raised off the floor and often anchored to a wall, supported on its shorter length sides by brackets, or otherwise anchored to cabinetry by brackets, dowels, screws, or nails.

✔ **Hanging:**

- Execution by strangling or breaking the neck by a suspended noose. Something hung.

✔ **Benefits of organising the tools in your workshop:**

- Saves time
- Enhances safety
- Extends tool lifespan
- Maximises space
- Boosts productivity
- It prevents misplacement and gives a professional appearance.

Practical Activity 3.2.2: Storing tools and equipment after bench work activities.

Task:

1. You are requested to go to the manufacturing workshop/workplace and individually perform the task below:
    i. Apply methods of storing tools, materials and equipment
2. Wear appropriate PPE
3. Present your work to the trainer, workshop assistant and/or classmates
4. Read the key readings 3.2.2 and ask questions for clarification where necessary
5. Perform the task provided in application of learning 3.2

Key readings 3.2.2.: Storing tools and equipment after bench work activities

- **Introduction:**

Storing tools and equipment properly is essential for maintaining their functionality and longevity.

- **Methods of storing tools and equipment**

✔ **Re-arranging:**

Figure 14: Tool re-arranging

- The first step to organising tools is to do a thorough inventory.
- Once you have a general idea of the tools on hand, sort them into categories.
- Group all of the power tools, the small hand tools, and so on.

- Next, create zones and use cabinetry to keep the like items together

✔ **Shelving:**

Figure 15: Shelving

- A shelf is a flat, horizontal plane used for items that are displayed or stored in a home, business, store, or elsewhere.
- It is raised off the floor and often anchored to a wall, supported on its shorter-length sides by brackets, or otherwise anchored to cabinetry by brackets, dowels, screws, or nails.

✔ **Hanging:**

Figure 16: Tool hanging

- Execution by strangling or breaking the neck by a suspended noose. Something hung.

Benefits of organising the tools in your workshop:

- Saves time
- Enhances safety
- Extends tool lifespan
- Maximises space
- Boosts productivity
- Prevents misplacement and gives a professional appearance

Points to Remember

- While storing tools and equipment, take into consideration re-arranging, shelving and hanging as crucial methods to improve the inventory /workshop control.
- Select a storing methods depending on the type of tools, materials or equipment

Application of learning 3.2.

Visit any metal bench work workshop/workplace located in your school or in the surrounding area. By referring to the activities 3.2.1 and 3.2.2., you are requested to:

a) Apply methods of storing materials, tools and equipment
b) Store appropriately materials, tools and equipment

Indicative content 3.3: Reporting the Work done

Duration: 3 hrs.

Theoretical Activity 3.3.1: Introduction to technical report

Tasks:

1. You are requested to answer the following questions:
   i. What do you understand by work report?
   ii. Explain steps of reporting the work done.
   iii. Identify types of technical reports.
   iv. What are the advantages of reporting?
2. Write your answers on papers, blackboard, flipcharts or whiteboard.
3. Present your findings/answers to your trainer and/or classmates
4. Pay attention to the trainer's clarifications and ask questions where necessary
5. Read the key readings 3.3.1.

Key readings 3.3.1.: Introduction to technical report

- **Definition of a work report**

A work report is a simple and cohesive document that outlines the fundamental activities and tasks conducted by an employee throughout the day, week, month, quarter, year, or any time mandated by the management of the company or organisation. A report can be a written document or electromagnetic record. The purpose of a work report is to explain a certain topic based on a specific aspect of one's job.

Steps to write a professional report:

Step 1: Find the appropriate template and follow instructions
Step 2: Plan the structure of the report
Step 3: Construct a summary of the accomplished tasks and activities
Step 4: Write with conciseness and accuracy
Step 5: Proofread and revise the overall report
Step 6: Prepare the final work report

- **Types of report**

✔ **Informational reports**

- This report type aims to give factual data about a specific topic.
- This can include performance reports, expenses reports, and justification reports, among others.

✔ **Analytical reports**

- This report type contains a mix of useful information to facilitate the decision-making process through a mix of qualitative and quantitative data as well as real-time and historical data.
- Unlike informational reports that purely inform users about a topic, this report type also aims to provide recommendations about the next steps and help with problem solving.

✔ **Operational reports**

- These reports track every pertinent detail of the company's operational tasks, such as its production processes.
- They are typically short-term reports as they aim to paint a picture of the present.

✔ **Product reports**

- It is used to monitor several aspects related to product performance and development.
- Businesses often use them to track which of their products or subscriptions are selling the most within a given time period, calculate inventories, or see what kind of product the client values the most.
- Another common use case of these reports is to research the implementation of new products or develop the existing ones.

✔ **Department reports**

- These reports are specific to each department or business function.
- They serve as a communication tool between managers and team members who need to stay connected and work together for common goals.

✔ **Progress reports**

- Progress reports provide critical information about the status of a project.
- Employees or managers who track performance and fine-tune tasks for the better development of the project can produce these reports daily, weekly, or monthly.

✔ **Vertical & Lateral reports**

- It refers to the direction in which a report travels.
- It is meant to go upward or downward in the hierarchy.

- **Forms of report**

✔ **Oral report**

- An oral report is presented verbally, typically in a face-to-face or virtual setting, where the information is communicated orally to an audience.
- This report form involves delivering information, findings, or updates through spoken words, often accompanied by visual aids such as slides or charts.
- Oral reports can be delivered in meetings, presentations, or discussions.

✔ **Written report**

- A written report is a document that presents information, findings, or recommendations in a written format.
- It involves organising and documenting information in a structured manner, often following a specific report format.
- Written reports are commonly used for documentation, formal communication, and sharing information with a wider audience

Sample report template:

daily work report					
Name		Position		department	
serial number	work today	work content		Completion	Remark
1					
2					
3					
4					
5					
Today's work summary:					

✔ **Advantages of reporting**

- Ensure enhanced control and visibility.
- Ensures that teams and departments remain self-driven
- Defines clearly who each person should report to or refer certain projects to
- Defines levels of responsibility and authority clearly
- Measure and evaluate work performance
- Determine strengths, and weaknesses
- Build up work reputation

Practical Activity 3.3.2: Reporting the work done

Task:

1. Referring to the previous activities 3.3.1, you are requested to individually do the task below:
   i. Prepare a technical report about bench work activities
2. Use appropriate template for reporting
3. Present your work to the trainer, classmates
4. Read the key readings 3.3.2

Perform the task provided in application of learning 3.3

Key readings 3.3.2.: Writing a work report

- **Parts of a written report:**

✔ **Title and introduction:**

- Start with a clear and informative title that reflects the purpose of the bench work activity.
- Write an introduction that provides background information on the experiment and its objectives.
- State the hypothesis or research question being investigated.

✔ **Materials and methods:**

- Describe the materials, equipment, and reagents used in the experiment.
- Explain the experimental setup and procedure in detail, including any specific techniques or steps followed.
- Mention any controls or variables that are measured.

✔ **Results:**

- Present the data collected during the bench work activity.
- Organise and display the data using appropriate tables, graphs, or charts.
- Include any observations, measurements, or calculations made during the experiment.

✔ **Analysis and discussion:**

- Analyse and interpret the results obtained.
- Discuss any patterns, trends, or relationships observed in the data.
- Compare the results with the expected outcomes or theoretical predictions.

- Consider any sources of error or limitations that may have influenced the results.

✔ **Conclusion:**

- Summarise the main findings and outcomes of the bench work activity.
- State whether the results support or refute the hypothesis or research question.
- Discuss the significance and implications of the findings.
- Suggest possible areas for further investigation or improvement.

✔ **References:**

- Cite any sources of information or references used in the report.
- Follow the appropriate citation style (e.g., APA, MLA) recommended by your institution or supervisor.

✔ **Appendices:**

- Include any additional information that supports the understanding of the experiment but is not crucial to the main report.
- This may include raw data, calculations, photographs, or detailed diagrams.

✔ **Formatting and proofreading:**

- Ensure that the report follows the required formatting guidelines, such as font size, line spacing, and margin sizes.
- Proofread the report for spelling, grammar, and clarity.
- Check that the report is well organised and flows logically

Points to Remember

- While reporting the work done ensure that the report is comprehensive, well-organized, and useful for current and future use.
- Make sure you make regular reports of your daily bench work activities: This helps in documentation, communication, and quality control. The absence of making regular reports results in time consumption, potential for errors, and documentation fatigue.

Application of learning 3.3.

Suppose that you have been conducting your internship in one of the manufacturing companies located in your home district. By referring to the activities 3.3.1 and 3.3.2, you are requested to prepare an internship report on the performed activities.

Learning outcome 3 end assessment

Theoretical assessment

Q1. Read the following statement properly circle the correct answer.

i. Cleaning techniques in mechanical bench work include:

a) Chemical cleaning
b) Dust cleaning
c) Wire brush cleaning
d) None of the above
e) All of the above

ii. Benefits of proper storage of tools and equipment in mechanical bench work are as follows, **EXCEPT** one:

a) Saves time
b) Enhances safety
c) Extends tool lifespan
d) Minimise space

iii. The list below are parts of a written report, **EXCEPT** one

a. Title and introduction
b. Material and methods
c. Grammar
d. Analysing and discussion
e. Conclusion

Q2. Answer by TRUE if the statement is correct or by FALSE if the statement is incorrect

i. Lubrication helps to reduce friction between moving parts.
ii. Lubrication increases the wear and tear on mechanical components.
iv. Water can be used as a lubricant in most mechanical system

Q3. Match each picture in (column B) with its corresponding storing method in (column A)

Column A	Column B
Storing method	**Picture**
A…….	
B……	
C……..	

Q4. What do you understand by the term" maintenance" of bench work tools and equipment?

Q5. What are the steps to write a professional report?

Practical assessment

HU metal bench Work Company located in Nyaruguru District has been operating for five years ago. It is now planning to increase a number of its workers in the department of store keeping. Suppose that you are now hired and by then requested to arrange all about cleaning, storing and preparing regular reports

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