Basic Metal Works

Level-I

Learning Guide-36

Unit of Competence: Cut and Join Sheet Metal

Module Title: Cutting and Joining Sheet Metal

LG Code: IND BMW1 M11 LO1-LG-36

TTLM Code: IND BMW1 M11 TTLM 1019v1

LO 1: Analyze work task

Instruction Sheet	Learning Guide: 36

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

- Analyzing tasks
- Identifying and adhering Quality assurance
- Associating OHS requirements
- Adhering workplace environment

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

- Analyze task according to applied requirements and expertise needed
- Identify and adhere quality assurance requirements based on task specifications
- Associate and Adhere OHS requirements with cutting and joining sheet metal, and the workplace environment to throughout the work

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4” in page 4,6,9 and 12 respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” in page -5, 8, 11 and 13respectively.

Information Sheet-1	Analyzing tasks

1.1. Concepts about sheet metal

Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. It is thin steel, aluminum, or other alloyed metal that is used in both manufacturing and construction. Also, **sheet metal** is **metal** formed by an industrial process into thin, flat pieces.

Sheet metal is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Many objects are fabricated from **sheet metal**. The larger the gauge number, the thinner the **metal**. The thickness of sheet metal is not above 3.5mm a metal thickness above 3.5mm is called a plate not sheet metal. Thicknesses can vary significantly; the **extremely thin** thicknesses are considered **foil or leaf.**

Cutting and forming operations performed on relatively thin sheets of metal

- Thickness of sheet metal = 0.4 mm to 3.5 mm
- Thickness of plate stock > 3.5 mm
- Operations usually performed as cold working

1.2. Uses of sheet metal

Sheet metal is used in automobile and truck bodies, airplane wings, medical tables, roofs for buildings (architecture) and also used to make products such as rain gutters, outdoor signs, siding and many other applications. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines.

1.3. Identifying tasks in a sheet metal

A sheet metal worker is a skilled tradesman who creates, installs, and repairs sheet metal products. Most commonly these products include elements of heating, cooling, and ventilation systems, although sheet metal workers also fabricate and repair products for drainage and roofing applications etc.

As a sheet metal worker you are required to operate sheet metal tools and equipment and to apply sheet metal layout techniques first has to read and understand working drawing

Working drawing is drawing in isometric projection, orthographic projection or detailed views that show the shape of the object to be produced. Drawing has dimension to which size the

object to be made. You have to read the dimension accurately to produce the product as the given standard.

For carrying out sheet metal work, great skill and knowledge of geometry, mensuration and properties of metal is most essential because nearly all patterns come from the development of the surfaces of a number of geometrical models such as cylinder, prism, cone, and pyramid. In sheet metal work, various operations such as shearing, blanking, piercing, trimming, shaving, notching, forming, bending, stamping, coining, embossing etc. are to be performed on sheet metal using hand tools and press machines to make a product of desired shape and size.

Sheet metal workers typically do the following tasks:

- Studying blueprints, drawings and specifications to determine job, material and equipment requirements
- Select types of sheet metal, such as stainless steel, galvanized iron, mild steel, aluminum and copper, and checking sizes, gauges and other dimensions of metal stock against specifications
- Measure and mark dimensions and reference lines on metal sheets by using templates, gauges and other measuring instruments.
- Drill holes in metal for screws, bolts, and rivets, along guidelines using hand and power shears, guillotines and drills.
- Shaping and forming cut metal stock into products using folding and bending machines, rollers, presses and hammers.
- Fasten and assembling seams or joints by welding, bolting, riveting, soldering, brazing and otherwise into final products.
- Finishing products by polishing, filing, sanding and cleaning assembled products

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. On the first activities to make works or project to fabricate in sheet metal workshop is___
   A. Read and understand working drawing
   B. Apply sheet metal layout techniques
2. To make a product of desired shape and size has to consider _____
   A. Interpret work as needed
   B. Make layout on sheet metals
   C. Read the dimension accurately
3. The extremely thin thicknesses are considered _____or _____.
   A. Sheet metal B. Foil or leaf C. Plates
4. Drawing has dimension that show the shape of the object to be produced.
   A. True B. False

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 2	Identifying and adhering Quality assurance

2.1. Definition of quality

Quality is the acceptable slandered. Once standard has been selected, a method is chosen for ensuring that the product meet the specification. Check the quality without affecting the product. A good product properly developed may lead to saving of time and money.

2.2. Quality assurance

Quality Assurance is defined as all the planned and systematic implemented within the quality system that can be demonstrated to provide confidence that a product or service will full-fill requirements for quality.

The Quality Assurance worker is charged with the responsibility for acquiring and analyzing data using appropriate statistical methods to facilitate process analysis and improvement. The Quality Assurance worker will develop standardized inspection methods for like process groups that will ensure critical characteristics are clarified and captured for statistical analysis.

2.3. Quality of Sheet Metal Working

A metal plate of thickness less than 4 mm is considered as sheet. The size of the sheet is specified by its length, width and thickness in mm. In British system, the thickness of sheet is specified by a number called Standard Wire Gauge (SWG). The commonly used gauge numbers and the equivalent thickness in mm are given below.

SWG (No.)	16	17	18	19	20	22	24	27	30
Thickness (mm)	1.62	1.42	1.22	1.02	0.91	0.71	0.56	0.42	0.37

One of the most important decisions when working with sheet metal is deciding what thickness you will need. Sheet metal thickness is measured in gauges, with a higher number indicating a thinner sheet. To measure the thickness, you can use a sheet metal gauge, which will show you thickness in both gauge number. One important note is that ferrous and non-ferrous sheet metals of the same gauge have different thicknesses, so you'll need one gauge for ferrous metals, and one for non-ferrous.

Then the quality requirement for sheet metal work should depend on the thickness, accuracy of measurements, the accuracy of cutting, types of joints and the types of materials of sheet metals.

The thickness of sheet metal is in the USA commonly specified by a traditional, non-linear measure known as its gauge. The larger the gauge number, the thinner the metal.

Commonly used steel sheet metal ranges from 36 gauges to about 0 gauges. Gauge differs between ferrous (iron based) metals and a nonferrous metal such as aluminum or copper; copper thickness, for example are measured in ounces (and represents the thickness of 1 ounce of copper rolled out to an area of 1 square foot). In the rest of the world the sheet metal thickness is given in millimeters. Do not attempt to cut metal heavier than the designed capacity of the shears.

The maximum capacity of the machine is stamped on the manufacturer's specification plate on the front of the shears. Check the gauge of the metal against this size with a sheet metal gauge. This figure below shows the gauge used to measure the thickness of metal sheets. The gauge is a disc-shaped piece of metal, having slots of widths that correspond to the U.S. gauge numbers from 0 to 36 each gauge number is marked on the front and the corresponding decimal equivalent is marked on the back.

The video: https://youtu.be/BsOxAt88PBk

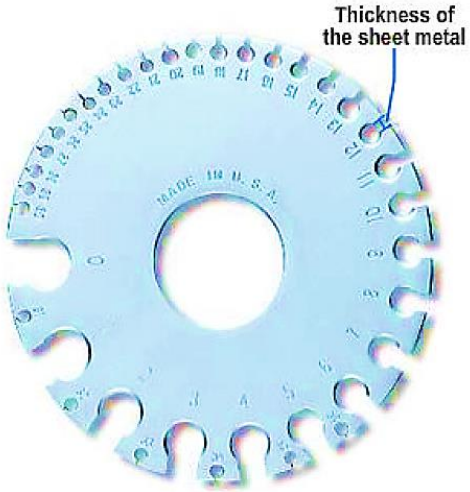


Fig.2.1: **Sheet metal gauge.**

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. _____is the acceptable slandered.
   A. Quality
   B. Quality assurance
2. A method is chosen for ensuring that the product meets the specification on producing of part by part.
   A. Quality
   B. Quality assurance
3. Larger the gauge number, shows the thinner the sheet metal.
   A. True B. False
4. The quality requirement for sheet metal work should depend on:
   A. The thickness B. Accuracy of measurements C. the accuracy of cutting
   D. Types of joints and the types of materials of sheet E. All are answer

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Associating OHS requirements

3.1. OHS in cutting and joining sheet metal

Occupational Health and Safety require workers to assess, eliminate and control risks associated with plant. The Occupational Health and Safety require employers to assess employee and staff exposure to accident and to take measures to control that accident to minimize any risk to health and safety.

Many injuries in the sheet metal fabrication industry a result of carelessness. Severe injuries can occur due to improper handling of tool or machines or other reasons. These injuries can be easily controlled by adopting various safety measures. To get the desired output, and for safe operation, you are required to follow some basic safety norms while using a sheet bending machine. Here are some of the major ones:

a. Protective Equipment

Personal Protective Equipment (PPE) is a term for equipment that is designed to protect the user against safety risks at the workplace. PPE can include items such as gloves, safety helmets, eye protection, safety harnesses, and safety footwear of various types. Metal sheet fabricators should always wear appropriate protective clothing to cut down the risk of injuries. Teachers at the training workshop and job site should ensure that adequate PPE is available for all students. For example, there should be adequate gloves, goggles, shirts, and pants for employees. It is important that only quality equipment is used for the purpose. Also, students must be taught about their right use.

b. Proper Use of Tools

Every student should be skilled the proper use of a sheet metal fabrication tool. This is because improper use of these tools may lead to severe injuries. It should be ensured that the tool or the machine is in good working condition before an employee starts working with it. This can be easily done by launching a daily or regular inspection. Also, trainees must be instructed to avoid wearing accessories or clothing that may get caught in the machine. All necessary guards and safety features of the equipment should be used, while working with them.

c. Hold the Sheet Parallel to the Bender

Placement of the sheet is very important. For a safe operation, you should always hold the sheet at a proper angle. Before you start the bending process, always ensure that the sheet

is parallel to the bender. The wrong placement may cause the sheet to hit your body, and cause injury.

d. Mind your Hands

You should be careful while operating the bender. When you place the sheet on the bender, you should ensure that your hands are away from getting hurt. Lack of attention can lead to severe accidents, or even permanent injuries.

3.2. Safety precautions

Sheet metal work causes damage / accident. Sheet metal and plate metal worker should follow safety precautions required in terms of personal safety, work shop safety, and tools and equipment safety

Some of the safety precautions applicable to sheet metal tools and equipment have been mentioned throughout this module. Here are a few additional precautions that should be carefully observed when you are working with sheet metal.

- Sheet metal can cause serious cuts. Handle it with care. Wear steel-reinforced gloves whenever feasible.
- Treat every cut immediately, no matter how minor.
- Remove all burrs from the metal sheet before attempting to work on it further.
- Use a brush to clean the work area. NEVER brush metal with your hands.
- Use tools that are sharp.
- Keep your hands clear squaring shears
- A serious and painful foot injury will result if your foot is under the foot pedal of the squaring shears when a cut is made.
- Do not run your hands over the surface of sheet metal that has just been cut or drilled. Painful cuts can be received from the burrs.
- Get help when large pieces of sheet metal are being cut. Keep your helper well clear of the shears when you are making the cut.
- Keep your hands and fingers clear of the rotating parts on forming machines.
- Place scraps pieces of sheet metal in the scrap box.
- Always remember to keep a clean shop. Good housekeeping is the key to a safe shop.
- Do not use tools that are not in proper working condition: hammer heads loose on the handle, chisels with mushroomed heads, power tools with guards removed, and so forth.
- Wear goggles when in the shop.

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. _____ require workers to assess, eliminate and control risks associated with in work area/plant.

   A. PPE B.OHS C. Measuring tools D. Using tools and equipment

2. Many injuries in the sheet metal fabrication industry a result of_____.

   A, Wearing gloves B. Placing scraps in scrap box C. Carelessness D. All

3. Which one is the safety norm while using a sheet bending machine and equipment in the work shop?

   A. Mind your Hands B. Proper Use of Tools

   C. Wear a Protective Equipment D. All

4. Which one not the safety precautions that should be carefully observed when you are working with sheet metal?

   A. Wear goggles when in the shop
   B. Use tools that are sharp
   C. Place scraps pieces of sheet metal in the scrap box
   D. Use a brush to clean the work area and also brush metal with your hands
   E. None of the above

Note: **Satisfactory rating 2 points** **Unsatisfactory below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Adhering workplace environment

4.1. Adhering workplace environment

Workplace environment is to be maintained neat and clean, and spread happiness, cheerful, love & affection around your work place, at home and also to the community. Workplace is a place of work for preparing variety of jobs/products by using different kinds of Instruments, hand tools and Machines.

Sheet metal workers usually work a 40-hour week. Those who fabricate sheet metal products work in shops that are well-lighted and well-ventilated. However, they stand for long periods and lift heavy.

Sheet metal workers must follow at work environments materials and finished pieces. Safety practices because working around high-speed machines can be dangerous. They are also subject to cuts from sharp metal, burns from soldering and welding, and are required to work at heights with the potential of falls from ladders and scaffolds. They may also work around general dust and fumes. They usually wear safety glass, hard hats, safety shoes, and hearing protection, but must not wear jewelry or loose-fitting clothing that could easily be caught in a machine. Those performing installation work do considerable bending, lifting, standing, climbing, and squatting, sometimes in confined spaces or awkward positions.

Work health and safety (WHS) and environmental requirements associated with cutting and joining sheet metal are adhered to throughout the work is to be according to common wealth, state and territory legislation and regulations and may include:

- Tools and equipment, including personal protective equipment, are selected and checked for serviceability.
- Sheet metal is joined to comply with plans and specifications, avoiding damage to surrounding surfaces.
- Tools and equipment are cleaned, checked, maintained and stored according to manufacturer recommendations and workplace procedures.
- The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance.

Cleaning scrap metal means that we avoid the environmental accident of dumped rubbish and the risk of scraps of sheet metal at work area. In addition, Scrap metal can be recycled at local council refuse stations, through on site pickups or at scrap metal merchants.

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

1. Workplace environment is to be kept:

   A. Neat and clean B. Spread happiness C. Cheerful, love D. All are answer

2. Sheet metal workers must follow at work environments _____.

   A, Materials B. Finished pieces C. PPE D. All of the above

3. _____ and _____ associated with cutting and joining sheet metal are adhered to throughout the work

   A. Work health and safety (WHS) C. Environmental requirements C. A&B

4. The common wealth, state and territory legislation and regulations.

   A. Selecting and checking t**ools and equipment**, for serviceability.

   B. Avoiding damage to surrounding surfaces.

   C. Cleaning workplace procedures.

   D. All of the above

Note: **Satisfactory rating 3 points** **Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

1. “Layout and Fabrication of sheet metal and fiberglass duct”, NAVEDTRA 14250A, Chapter 13.
2. “student safety guidelines”: Technology,
3. Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”, PHASE 2, Module 1, Michael Kelly, © SOLAS 2014
4. http://www.bing.com/videos/search?q=how+to+use+a+box+and+pan+brake&&view=detail&mid=0B5F895025F7C74515AE0B5F895025F7C74515AE&&FORM=VRDGAR

Basic Metal Works

Level-I

Learning Guide-37

Unit of Competence: Cut and Join Sheet Metal

Module Title: Cutting and Joining Sheet Metal

LG Code: IND BMW1 M11 LO2-LG-37

TTLM Code: IND BMW1 M11 TTLM 1019v1

LO 2: Plan and prepare work

Instruction Sheet	Learning Guide: 37

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

- Planning and sequencing tasks
- Selecting and checking tools, equipment and materials
- Preparing work area
- Checking sealants, fixing and sheet metal materials

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

- Plan and sequence tasks in conjunction with others involved or affected by the work
- Select and check tools, equipment and materials, including personal safety equipment for serviceability and compliance with plans/specifications
- Prepare work area to support the efficient cutting and joining of sheet metal
- Check sealants, fixing and sheet metal materials for compatibility and appropriateness for the job

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described below 3 to 6.
7. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4” in page 17,20,41 and 44 respectively.
8. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self-check 4” in page -19, 40, 43 and 50 respectively.
9. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, and Operation Sheet 2” in page -51.
10. Do the “LAP test” in page- 52(if you are ready).

Information Sheet-1	Planning and sequencing tasks

1.1. Planning tasks

It means a set of preparation is to do in order to achieve something or any kind of task/work. Preparation means programmes, drawings, Materials requirement and their sources, time schedule, cost estimate, scheme and design and method of preparation etc.

- It is a management function of defining goal of an individual / organizations.
- It determines the task/work and resources necessary to achieve set goals.
- It helps to save materials, labor, time, money efforts and process etc. so that any kind of work/task can be performed successfully without having any difficulty with full confidence.

Job planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The work piece is marked out using the dimensions and datums as specified on the drawing. A basic level of mathematics is required such as addition, subtraction, multiplication, division, fractions, decimals and percentages.

One of the first steps in preparing to layout a pattern on metal is to square the bottom left hand side of the piece of material. A steel square may be used for this purpose, or a sheet maybe squared using the squaring arm on the guillotine. The next step is to ensure that the sheet lies perfectly flat on the bench as a sheet that is not flat will cause measurements to be inaccurate.

Sheet metal articles are made of flat pieces of metal cut according to outlines that are drawn or traced on the sheets of metal. To obtain the current size and shapes, patterns are used. These patterns may be drawn on paper first, and then transferred to the metal, or they may be laid out directly on the metal.

- Templates or master pattern- patterns that are used repeatedly and are made of metal.
- Stretch-out – the distance across the flat pattern or flat piece of metal before it is formed into shape. The illustration in Figure 1 shows the stretch-outs for square and cylindrical jobs.

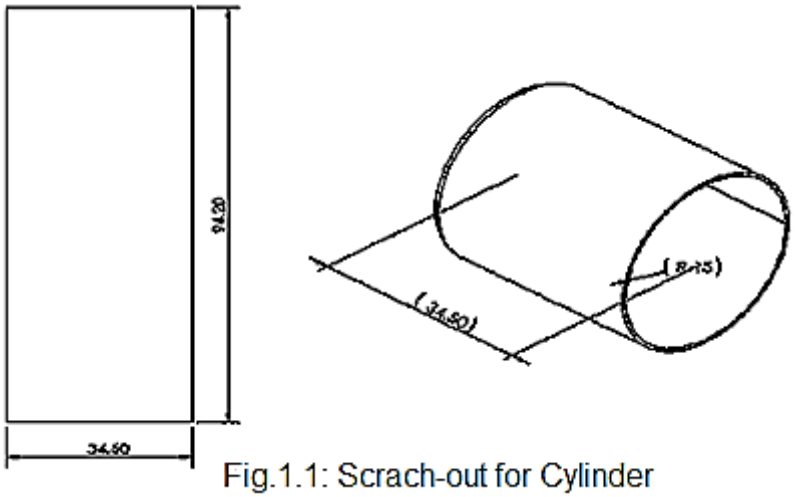


Fig.1.1: Scrach-out for Cylinder

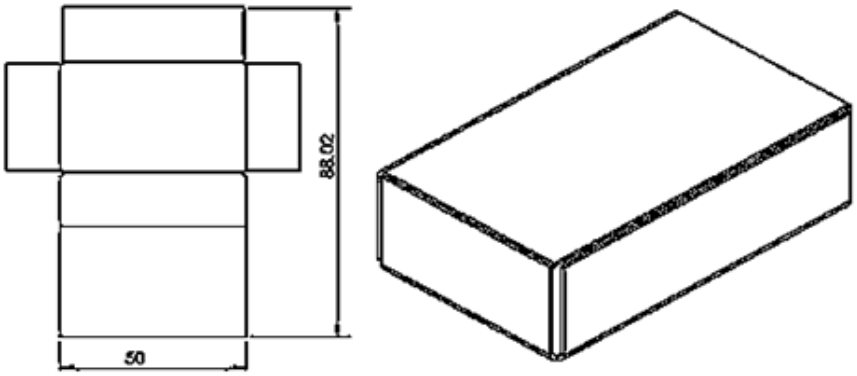


Fig. 1.2: scrach-out for box/cube

- Pictorial drawings – show the object as it actually appears after formed into shaped. This is illustrated in Figure 3. Such a drawing cannot serve as means of giving accurate information for the fabrication of the project because the true shape and size of the object is not shown.

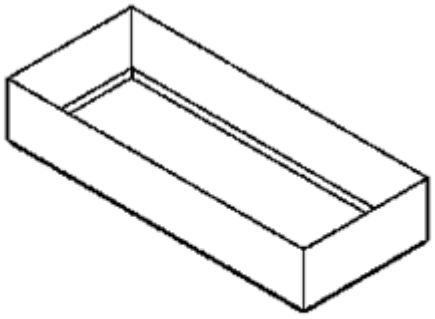


Fig.1.3: Pictorial drawing show the type of objects as they appear after forming

1.2. Sequencing Tasks

Sheet metal workers first study plans and specifications to determine the kind and quantity of materials they will need. Then measure, cut, bend, shape, and fasten pieces of sheet metal

to make ductwork, counter tops and other custom products. In an increasing number of shops, sheet metal workers use computerized metalworking equipment. This enables them to compare different layouts which use the least materials to minimize waste and to select the one that results in the least waste of material.

They cut or form parts with computer-controlled saws, lasers, shears, presses, and plasma cutters. In shops without computerized equipment, and for products that cannot be made on such equipment, sheet metal workers use hand calculators to make the required calculations and use tapes, rulers, and other measuring devices for layout work. They then cut or stamp the parts on machine tools.

Before assembling pieces, sheet metal workers check each part for accuracy. After the parts have been inspected, workers fasten seams and joints together with welds, bolts, cement, rivets, solder, specially formed sheet metal drive clips, or other connecting devices.

Before starting to any operation, you must plan the sequence of your tasks. While you are planning you have to set the sequences of operation to be performed that are listed in the plane. During planning you have to consider factors that affect your working procedure.

- Plans, drawings and specifications are obtained from supervisor for planned work activity.
- Tasks are planned and sequenced in conjunction with others involved in or affected by the work.
- Sheet metal is marked out according to plans and specifications.
- Work area is prepared to support efficient cutting and joining of sheet metal.
- Selected sheet metal is checked for compliance with plans and specifications
- Surface is prepared and cleaned of grease and other contaminants.
- Laps are measured and shaped for joining using appropriate tools and equipment according to plans and specifications.
- Work area is cleared and materials disposed of, reused or recycled according to legislation, regulations, and codes of practice and job specification.
- Information is accessed and documentation completed according to workplace requirements.
- Make a list of all of the tasks that you need to complete, and break everything down into single activities.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Choose the best answer.

1. Preparation of task/work includes:

   A. Drawings B. Materials requirement and their sources

   C. Time schedule D. Cost estimate E. All

2. _____is important prior to starting any task.

   A. Job panning B. patterns C. A&B

3. To make sheet metal work or project the first things you do is

   A. Read and Understanding of drawing B. Prepare Sequence of operation

4. Before starting to any operation sheet metal worker has to prepare_____.

   A. Read and Understanding of drawing B. Sequence of operation

5. It is the distance across the flat pattern or flat piece of metal before it is formed into shape.

   A. Stretch-out B. Templates C. Master pattern D. Pictorial drawings

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Selection of tools, equipment , materials, and PPE

2.1. Personal Protective equipment (PPE) used for sheet metal work

It is very important to select the correct PPE. Just as important, the PPE must be working correctly every time you use it, either alone or in combination with other PPE. When several pieces of PPE are used together, they must not interfere with each other. For example, protective goggles must not interfere with the operation of a respirator.

Sheet metal worker fabricate in the sheet metal workshop a number of operations such as cutting, folding/ bending, edging, making seams, forming, crimping, beading and swaging.

So that it must have to safe from hazards. Sheet metal workers are recommended to wear protective clothing, such as gloves, goggles and hard hats, at all times while working in the steel making environment.

Goggles are particularly important, because debris and small metal shards can be emitted from the machinery, and hit the unprotected worker, which can possibly cause blindness. Safety goggles when grinding and drilling. Safety shoes and clothes/ overall at all time; gloves when needed; also ear protection etc.

Fig.2.1: Leather Gloves

Fig.2.2: Safety Google

Fig.2.3: Safety closes, shoes, hardhat

2.2. Sheet metal tools and equipment

Sheet metal hand tools are used to scribe or measure lines, perform layout operations and shape or cut metals. Some of the hand tools in the following notes actually perform these operations while others, such as stakes and punches, serve as aids in performing them. It is important to keep tools in good shape. Avoid tools going rusty by giving steel tools an occasional oiling. Tools with a sharp point should be stored carefully.

1. Layout tool and measuring Tools

Layout tools are used for drawing fabrication jobs on metal. Some of the more common layout tools are scriber, flat steel square, combination square, protractor, prick punch, dividers, trammel points, and circumference ruler.

Scratch awls (also called scribers)

This is used to mark lines on metal. It can be used in conjunction with a straight edge and square. There are three types Scratch awls perform the same function of marking lines on metals. Lines are marked on metal for a variety of purposes in laying out patterns.

- **Ring Scratch Awl: -** the ring scratch awl is made of one solid piece of steel approximately eight inches long with a tapered point on one end and a ring on the other.
- **Socket Scratch Awl**: - the socket scratch awl ha a steel blade approximately five inches long and is made with a replaceable wooden handle.
- **Shank Type Scratch Awl: -** for general purposes, this shank type of scratch awl is preferred by most sheet metal mechanics since the steel blade passes through the handle, reinforcing the top. https://www.youtube.com/watch?v=8sNGlWjgMQc

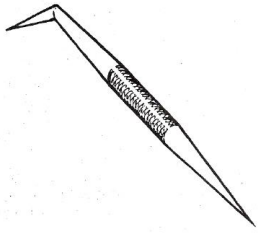


Fig. 2.4: Scriber

Steel Rule

Steel rules are manufactured in a variety of types and lengths; each of which is designed for measuring or laying out different work. Available in lengths from 100mm to 1000mm.

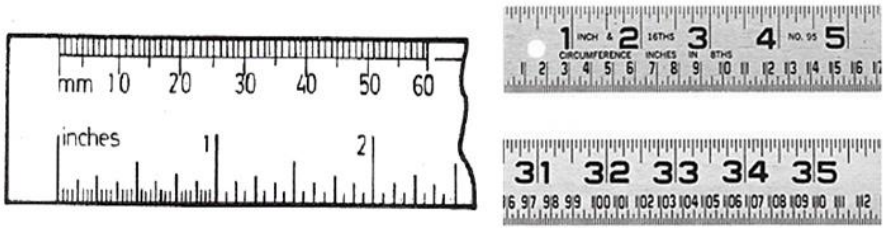


Fig.2.5: Steel Rules

Straight Edge

The Straight Edge is used as a guide for a scriber or pencil when marking or drawing a straight between two points. It is also used in conjunction with square to draw lines at right angles.

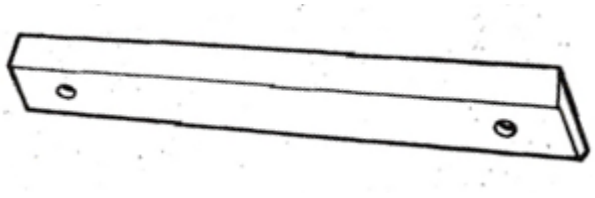


Fig.2.6: Straight edge

Dividers

This is made with each straight leg tapered to a needle point. Dividers are manufactured in various sizes and types and are used to space off equal distances, to divide lines into equal parts and to scribe arcs and circles. Spring loaded screw dividers are also available. Supplied in lengths from 150mm to 500mm. Spring dividers are also available in sizes from 75mm to 300mm.

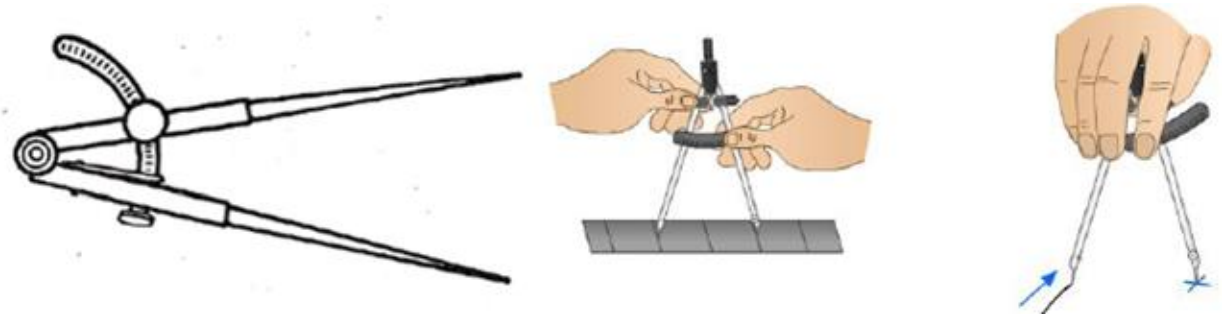


Fig.2.7: divider and method of uses

Steel Square

The flat Steel Square is used to layout right angles (90°) and can also be used as a scale. It is an invaluable tool for accurate layout work in pattern drafting since all layouts must start from a square corner. The long arm is known as the body or blade, the short arm is known as the heel or tongue. These squares come in various sizes.

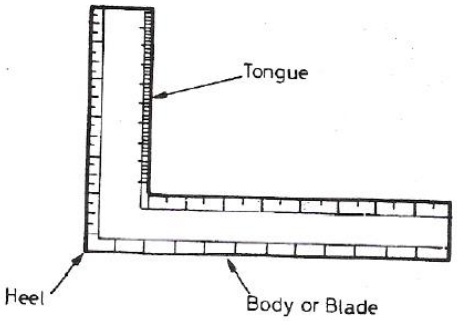


Fig.2.8: steel square

Steel Try Square

It is used for marking and checking right angles (90°). These squares come in various sizes from 75mm to 300mm.

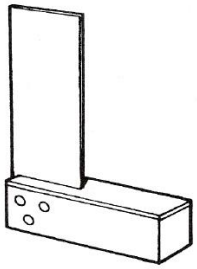


Fig.2.9: Steel Try Square

Combination Square

This is one of the most useful and convenient tools for laying out small work. It is used as a square for measuring or laying out 90° or 45° angles. A spirit level is mounted in the stock. It is available in 300mm lengths.

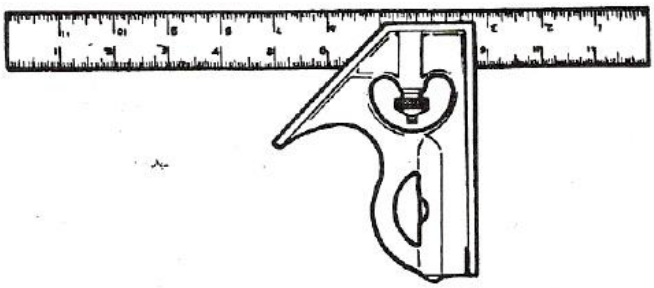


Fig.2.10: Combination square

Protractor

This is a device for measuring and laying out angles from the edge of the work. This protractor consists of a head and a movable blade. The head of the protractor has a semicircular scale graduated from zero to 180°.

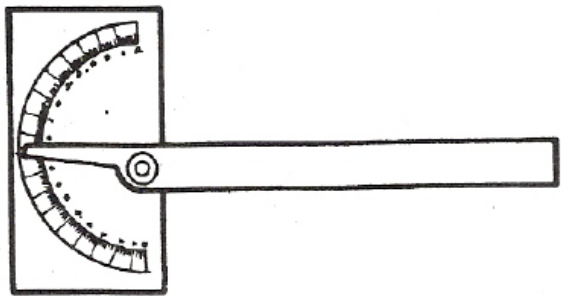


Fig.2.11: Protractor

Trammel Points(sometimes called a beam compass)

These are used for scribing large arcs and circles. They are manufactured in various types with two straight, removable legs tapered to needle points and attached to separated heads or holders. The heads or holders slide on wood or steel beams and are held in place by thumb screws. Either of the points can be removed and often one point has adjustment for fine settings. A special clamp for a pencil can be attached to one of the points.

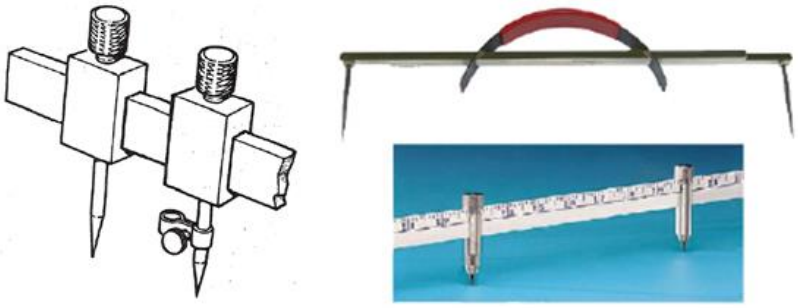


Fig.2.12: Trammel Points

Prick Punches

Prick Punches are made of tool steel and having a tapered point ground to approximately 30° included angle. These punches are used for making small dents or indentations and/or establishing points for dividers and trammel points.

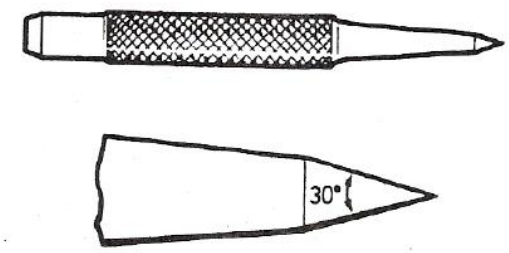


Fig.2.13: Prick punch

Centre Punch

Similar in design to the prick punch except that the tapered point is ground to an angle of 90° included. They are used primarily for marking the location of points and the centers of holes to be drilled. Such punches are manufactured in various sizes and may be purchased in sets. Neither prick punches nor center punches should be used to punch holes. These are both intended for establishing points only.

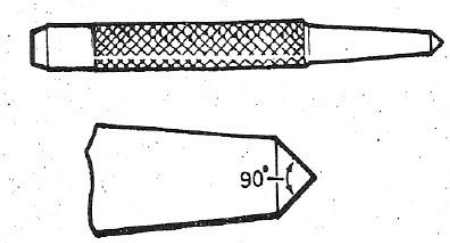


Fig. 2.14: Center Punch

Tape Rule

It is very popular for measuring and laying out large jobs. Available in various lengths,

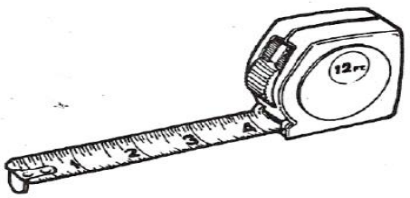


Fig.2.15: Tape Rule

B. Cutting Tools and equipment

Hand Snips

Various types of hand snips and hand shears are used for cutting and notching sheet metal. All of the snips, shears, and nibblers are either manual or power operated. Hand snips are necessary because the shape, construction, location, and position of the work to be cut frequently prevent the use of machine-cutting tools.

Hand snips are divided into two groups. Those for straight cuts are straight snips, combination snips, bulldog snips, and compound lever shears. Those for circular cuts are circle, hawk's bill, aviation, and Trojan snips. These snips are shown in *Figure bellows.* The following is a brief description of each type of snip.

Straight snips have straight jaws for straight-line cutting. To ensure strength, they are not pointed. These snips are available for right- or left-hand use.

Combination snips have straight jaws for straight cutting, but the inner faces of the jaws are sloped for cutting curves as well as irregular shapes. These snips are available in the same sizes and capacities as straight snips.

Bulldog snips are a combination type. They have short cutting blades with long handles for leverage. The blades are inlaid with special alloy steel for cutting stainless steel.

Compound lever shears have levers designed to give additional leverage to ease the cutting of heavy material. The lower blade is bent to allow the shears to be inserted in a hole in the bench or bench plate. This will hold the shear in an upright position and make the cutting easier. The cutting blades are removable and can be replaced.

Circle snips have curved blades and are used for making circular cuts, as the name implies. They come in the same sizes and capacities as straight snips and either right- or left-hand types are available.

Hawk's bill snips are used to cut a small radius inside and outside a circle. The narrow, curved blades are beveled to allow sharp turns without buckling the sheet metal. These snips are useful for cutting holes in pipe, in furnace hoods, and in close quarters work.

Aviation snips have compound levers, enabling them to cut with less effort. These snips have hardened blades that enable them to cut hard material. They are also useful for cutting circles, squares, compound curves, and intricate designs in sheet metal. Aviation snips come in three types: right hand, left hand, and straight. On right-hand snips, the blade is on the left and they cut to the left. Left-hand snips are the opposite. They are usually color-coded in keeping with industry standards-green cuts right, red cuts left, yellow cuts straight. Both snips can be used with the right hand.

Trojan snips are slim-bladed snips that are used for straight or curved cutting. The blades are small enough to allow sharp turning cuts without buckling the metal. These snips can be used to cut outside curves and can also be used in place of circle snips, hawk's bill snips, or aviation snips when cutting inside curves. The blades are forged high-grade steel.

Pipe & Duct snips (Double Cut) have a straight cut blade pattern. This style of aviation snip cuts a narrow section equal to the width of the center blade as it cuts. The material on either side of the cut tends to stay flat, as only the narrow section takes a curl as it is cut. This style can be used in stovepipe and downspout work where distortion on either side of the cut is not desirable.

Nibbler is for cutting sheet metal with minimal distortion. One type operates much like a punch and die, with a blade that moves in a linear fashion against a fixed die, removing small bits of metal and leaving a kerf approximately 6 mm wide.

Another type operates similar to tin snips, but shears the sheet along two parallel tracks 3–6 mm apart, rolling up the waste in a tight spiral as it cuts. Nibblers may be manual (hand operated) or powered.

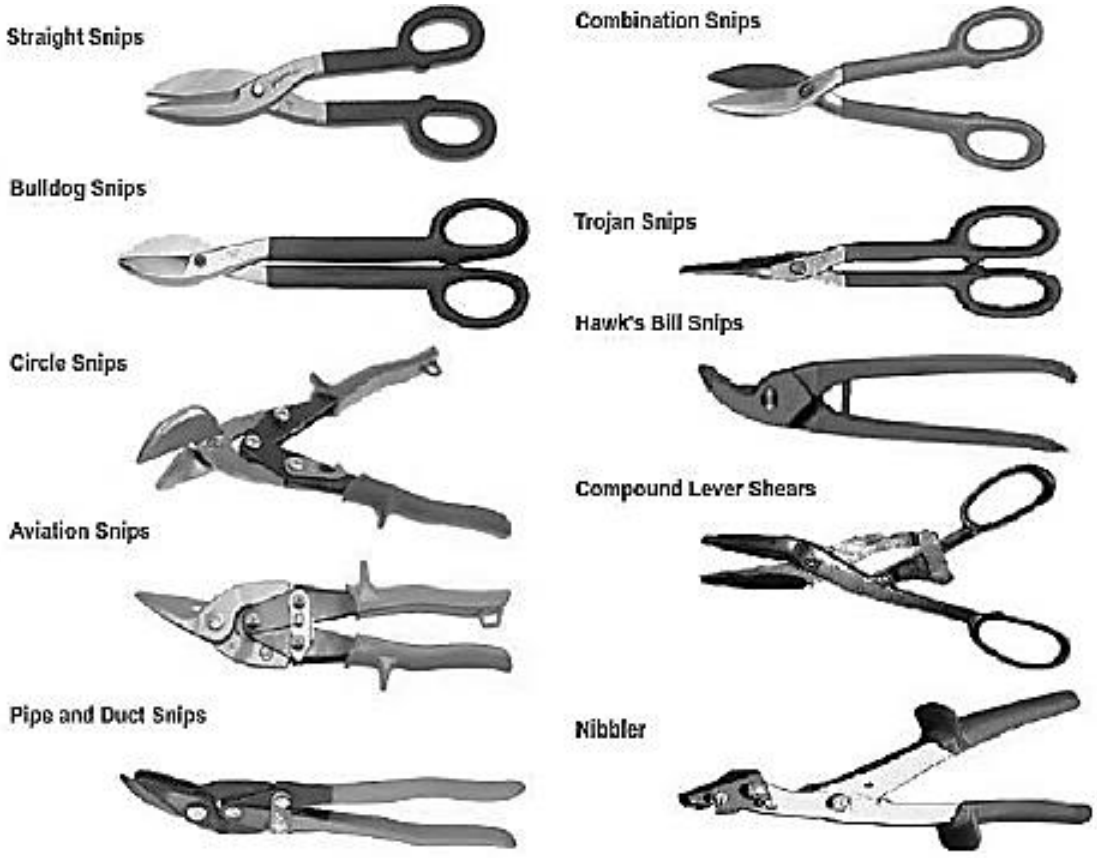


Fig.2.16: Types of hand snips

Bench shear

Bench shear sand hand shears have blades tha rotate about a pivot and it is this pivoting action that creates the shear angle. For more information observe this videos: https://www.youtube.com/watch?v=izInJffsnpQ

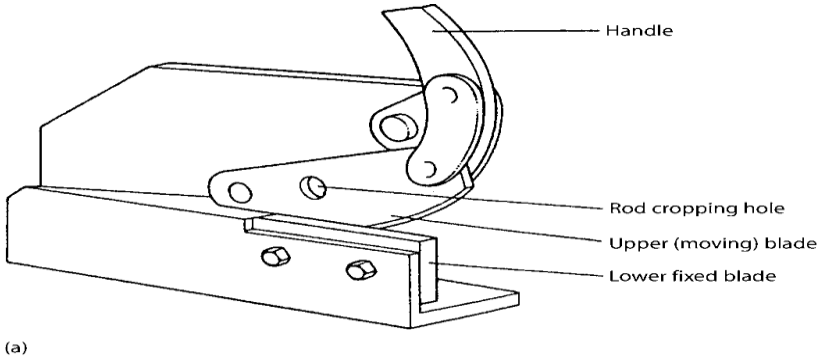


Fig. 2.17: Bench shear

Chisels

They are generally used in sheet metal work for cutting sheets, rivets, bolts and chipping operations. A good number of cold chisels are used.

The flat chisel and round nose chisel are most widely used in sheet metal work.

The various types of chisels are used for cutting metal.

- **Flat cold Chisel**. Sheet metal workers generally use this chisel more than the other types since it is used for cutting sheet metal, rivets, bolts, and in chipping operations.
- **Cape Chisel**. Cape chisels are used for cutting grooves and keyways.
- **Diamond Point Chisel**. These chisels are used for cutting V shaped grooves, for chipping corners, and sometimes for removing bolts whose heads have broken off.
- **Round Nose Chisel**. Round nose chisels are used for roughing out the concave surfaces of corners arid also for cutting grooves.

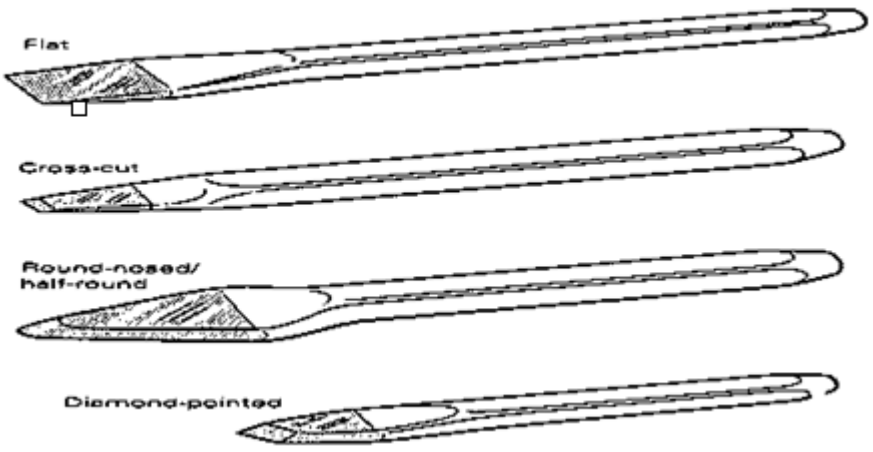


Fig.2.18: Types of Chisels

Files

There are many shapes and sizes of files available with various grades of cut. Files are used to remove burrs from sheets of metal, to straighten uneven edges and for various other operations that require a small amount of metal to be removed. They should always be used with a handle. Common types used by the industrial insulator are: flat, square, round, half-round.

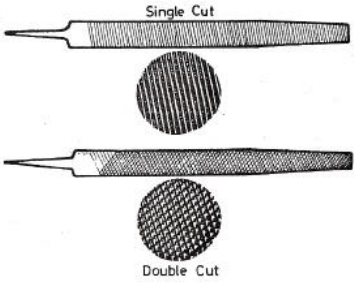


Fig.2.19: Single cut and Double cut files

Guillotine machine

The principle of shearing is similar to punching except that the area being sheared is a relatively small continuous section, starting at one end of the sheet and ending at the other. A hold-down clamping stop holds the sheet rigid while the blade of the guillotine shears through the sheet. For more see: https://www.youtube.com/watch?v=kF-EULAbKZQ

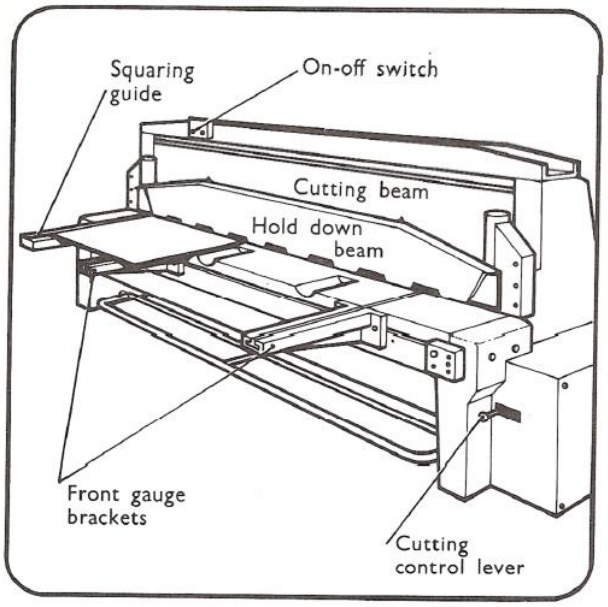


Fig.2.20: Guillotine

An important factor in the production of a good cut edge is the clearance between the blades as well as the sharpness of the blade edges. Some machines have provision for altering the blade clearance to suit the thickness of sheet being cut out, usually the clearance is set at manufacture and checked periodically. A reasonable guide is 0.1 mm

increase in clearance for every 1 mm of sheet thickness. The shearing capacity of the guillotine should be more than the shearing strength of the material being cut.

Safety Issues

- Ensure all guards are in place before starting machine.
- Ensure prescribed personal protection is worn - Overalls, safety boots and gloves.
- Before using the guillotine its maximum shearing capacity must be understood.
- Gloves must be worn if there are sharp edges on metal.
- Scrap behind machine to be cleared up daily and properly disposed of.

Compound lever shears

Compound lever shears; view have levers designed that give additional to ease the cutting of heavy material. The lower blade is bent to allow the shears to be inserted in a hole in the bench or bench plate. View have levers designed that give additional leverage to ease the cutting of heavy material. The lower blade is bent to allow the shears to be inserted in a hole in the bench or bench plate. Video: https://www.youtube.com/watch?v=mSlCW3WHaOQ

- portable power shear
- Actuated squaring shears
- Ring and circular shear

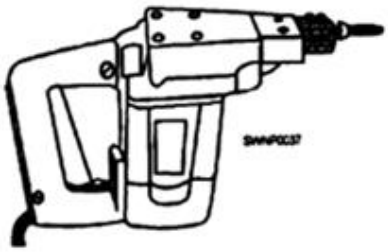


Figure 2-20.—Portable power shears

fig.2.21: Solid punch.

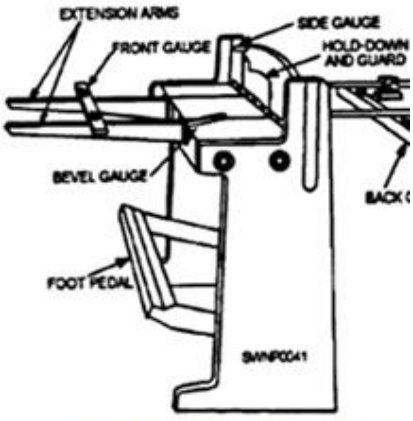


fig.2.22: Foot-actuated squaring shear

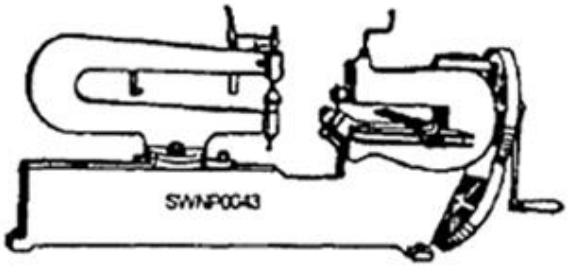


fig.2.23: Ring and circular shears

Side Cutting Pliers

These pliers have flat jaws grooved to hold the work, and are sharpened to cut light wire.

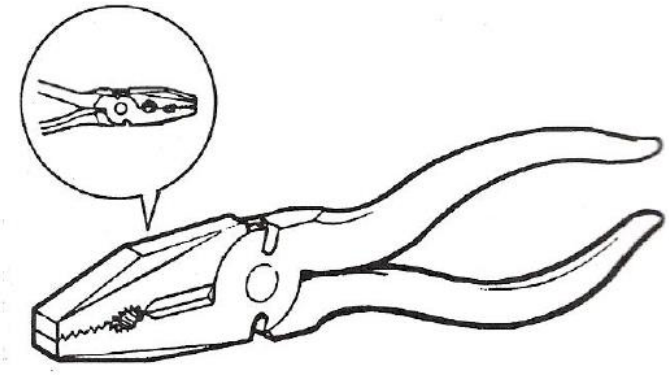


Fig.2.24: **Side Cutting Pliers**

C. Bending and forming tools and equipment

Hammers and Mallets

There are various types and sizes of hammer use in metal working.

- **Stretching Hammer:-** This is used for stretching edges and flanges on curved work. It is normally used in conjunction with a stake.
- **Planishing Hammer:-** The principal purpose of the Planishing Hammer is for smoothing and finalizing a surface after it has been roughed out to the required shape.

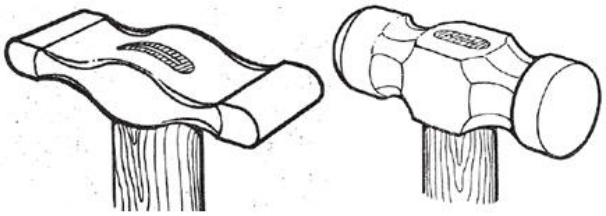


Fig.2.25: Stretching Hammer and Planishing Hammer

- **Engineers Ball Pein hammers:-** This is used for striking chisels, punches, rivets etc. The ball peen or machinist's hammer has a round, slightly curved face and round head. It is a general purpose hammer for general engineering use.

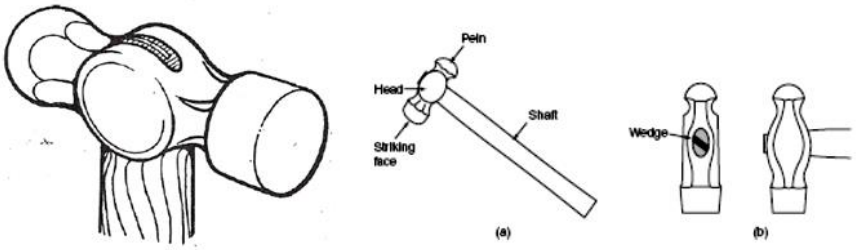


Fig.2.26: **Ball Pein hammers**

- **Boxwood and Rubber Mallets:-** It is Plastic-headed hammer of round or rectangular cross section. The striking face is made flat to the work. A mallet is used to give light

blows to the Sheet metal in bending and finishing. Mallets are properly used where steel hammers would deface the work. These mallets can be used on mild steel, copper or aluminum to prevent marring the metal.

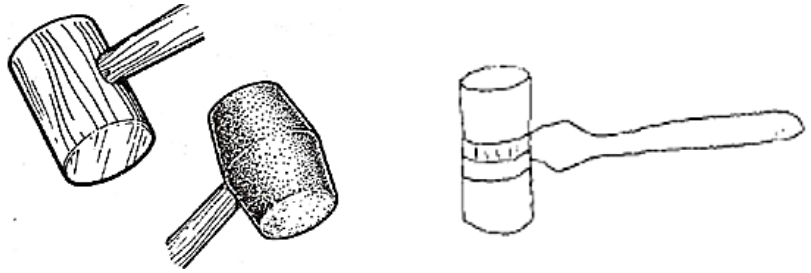


Fig.2.27: **Boxwood and Rubber/plastic mallet**

Sheet metal is given three-dimensional shape and rigidity by bending. Sheet metal can be formed by hand or with various special tools and machines. Several techniques are described in the following sections.

Bench vice

The most commonly used vice is parallel jaw vice. It is often fitted with a quick-release device that frees the screw from the nut so that the vice can be opened and closed quickly when changing between components of different widths in order to save time.

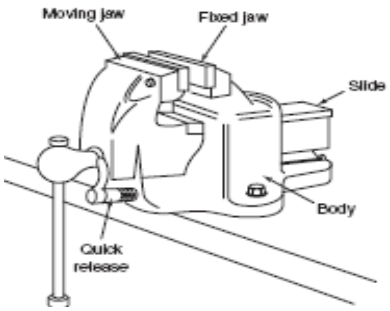


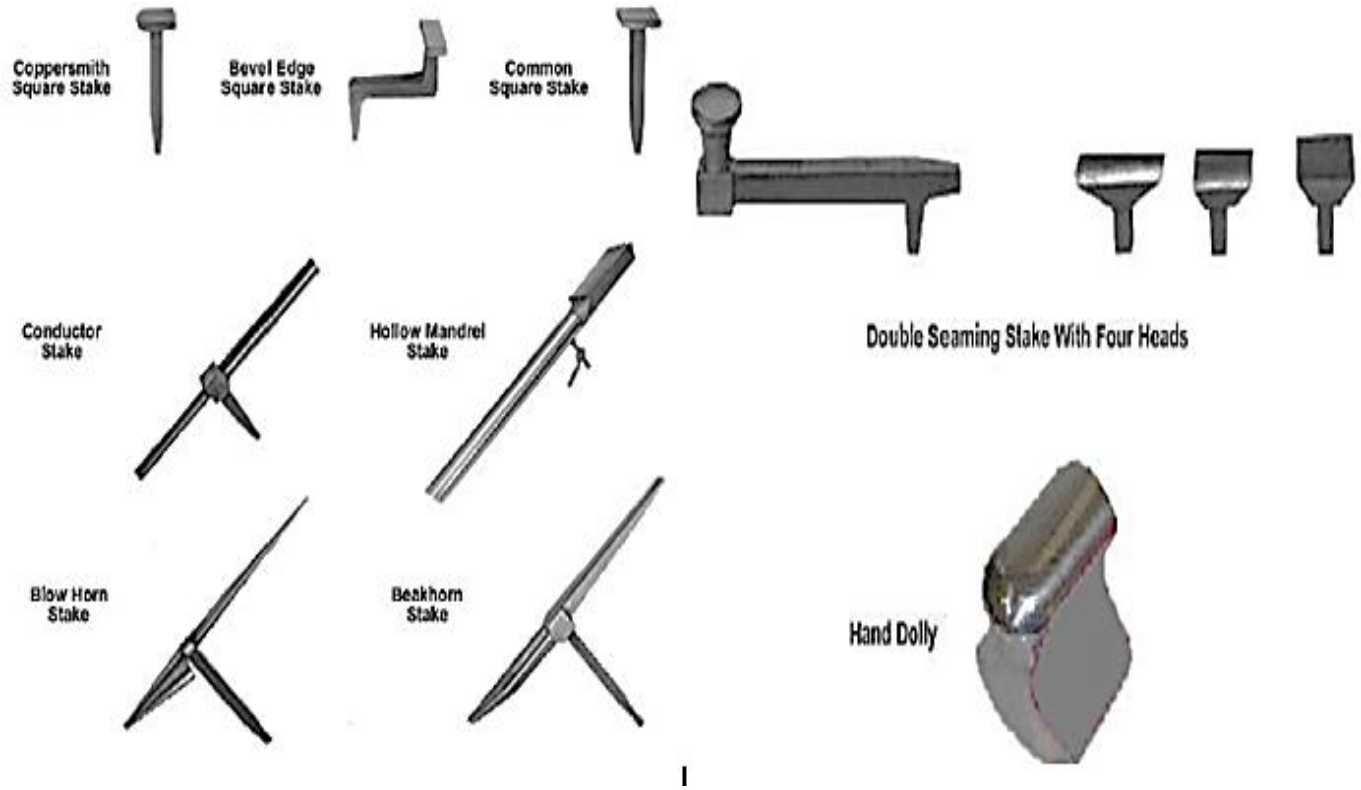
Fig.2.28: Bench Vice

Bench stakes

Stakes are the sheet metal workers evils used for bending, seaming or forming, using a hammer or mallet. They actually work as supporting tools as well as forming tools. They also help in bending operation. They are made in different shape and sizes to suit the requirements of the work.

- ✓ **Bevel-Edge Stake**: this stake has a flat, square head *with a* bevel edge on the outside of the head for double seaming. It also has an offset shank which permits the work to clear the bench.
- ✓ **Common Square Stake**: the common, square stake has a flat square- shaped head with a long shank, and is used for general operations.

- ✓ **Coppersmith Stake**: The coppersmith stake has a rounded edge on one side of the head and a sharp rectangular edge on the other. The stake is used for general operations.
- ✓ **Bottom Stake**: this stake has a fan- shaped, beveled edge, slightly rounded. It is used for dressing burred edges on a disk, for special double seaming, and for turning small flanges.
- ✓ **Hand Dolly Stake**. The hand dolly stake is designed with a fiat face, two straight edges, one convex edge, and one concave edge. It is a handy stake for all general **purposes** such as bucking rivets and double seaming. Hand dolly stakes come in various shapes and sizes.
- ✓ **Care of Stakes**: the condition of the stake has much to do with the workmanship of the finished job. If a stake has been roughened by punch marks or is chisel marked, the completed job will look rough and lacking in craftsmanship. Therefore, a stake should not be used to back up the work directly when prick punching or cutting with a cold chisel.
- ✓ **Stake Holder:-** it is used in sheet metal shop is a rectangular bench plate .



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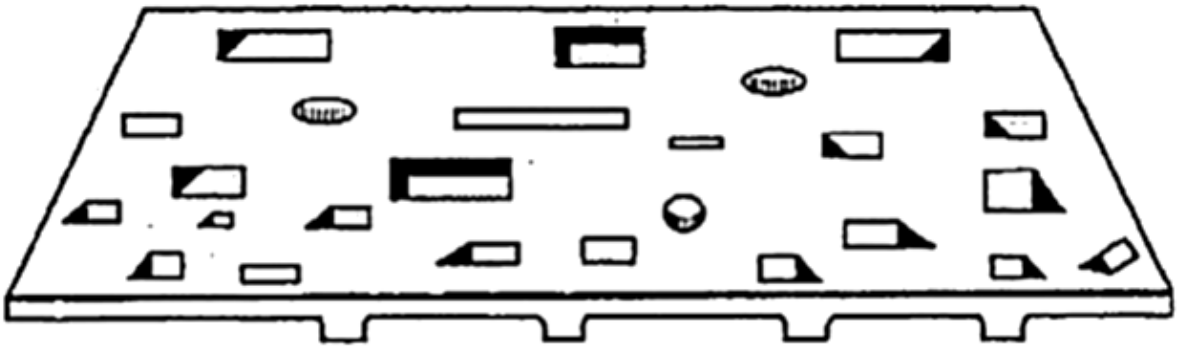


Stake Holder.

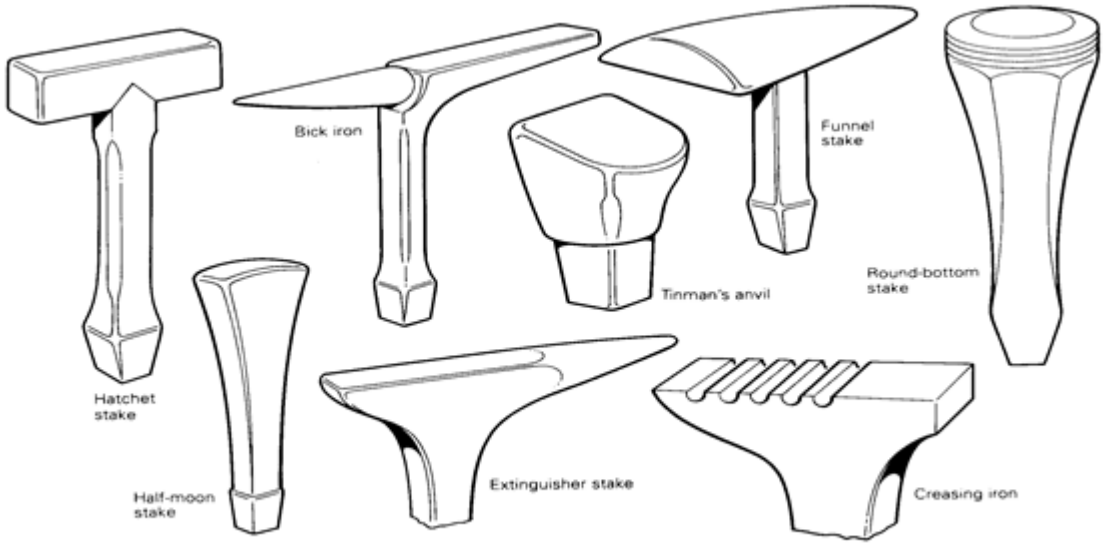


Figure 6.2 Stakes.

Fig.2.29: Bench stakes and stake holder

Sheet metal Folding Machine

This type of machine, while suitable for all types of bending operations, has special provision for folding pans, trays or boxes. No rods, wires or metal beyond the capacity of the machine should be bent on this machine.

- The most important points when using this machine is to set the machine to suit the metal thickness being folded.
- Never bend beyond the capacity of the machine. This strains the machine and will shorten the life-span and quality of the folders.
- Never bend round bar etc. in the machine.
- When removing or inserting the fingers (of machine) take care not to get your own hand or fingers squashed.

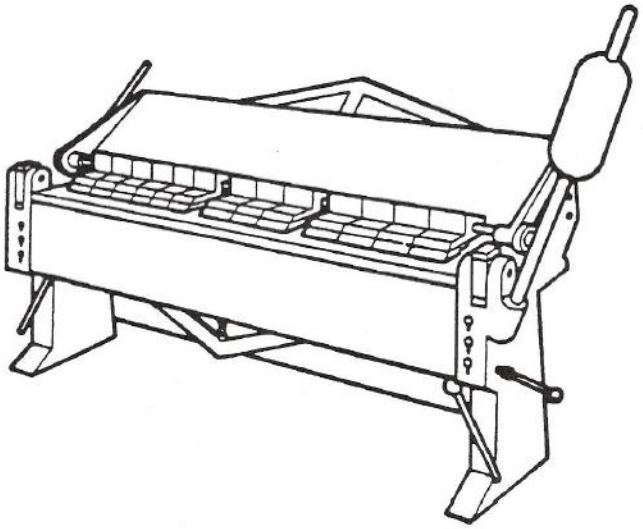


Fig.2.30: Folding Machine

Hazards:

- Beware of swinging counter-balance weights and bottom leaf (bed) of machine.
- Use the proper manual handling techniques when using this machine or moving metal in or out of benders. This machine can put great strain on your back.
- Refer to module 1-unit 2-manual handling.
- Beware of crushing of fingers when using machine and especially when changing the blades.

The Bending Rolls

The two types of bending rolls used in sheet metal are the plain bending and slip bending rolls. These machines are for curving sheet metal. On the slip bending rolls the upper roll can be released and this facilitates the removal of the work piece. This can't be done on plain rolls. There are power and manually operated types available.

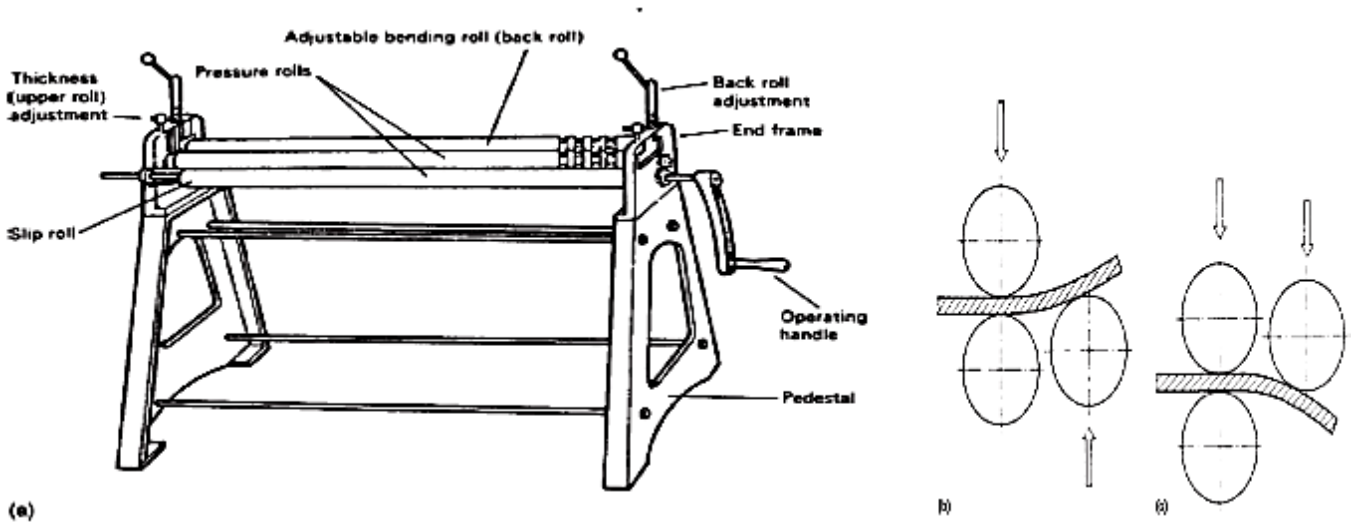


Fig.2.31: Bending Rolls

Hazards:

- Loose clothing e.g. cuffs may get caught up in machine. Always wear tightfitting overall.
- Exercise caution as fingers may also get caught in the machine.

Combination Rotary Machine

Preparing sheet metal for a wired edge, turning a burr, beading, and crimping are probably the most difficult of sheet metal forming operations to perform. Combination rotary machine with a selection of rolls will prove acceptable for most shop uses. The wire edge must be applied to tapered shapes after they are formed. This is accomplished by turning the edge on the rotary machine. Gradually, lower the upper roll until the groove is large enough for the wire. The edge is pressed around the wire with the rotary machine. The wire edge can be finished by hand if a rotary machine is not available. The edge is formed on the bar folder and forced into place around the wire with a setting hammer or pliers.

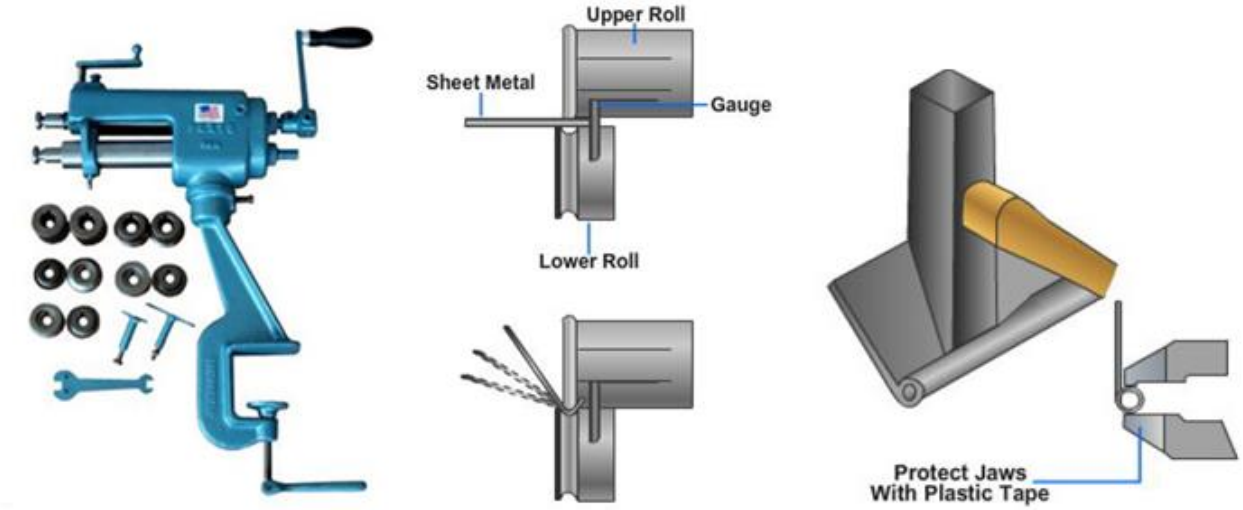


Fig.2.32: Combination Rotary Machine

Lubricating Machines

It is vitally important to lubricate all machines on a regular basis. A lubricant is used for a number of different reasons:

- To reduce friction.
- To prevent wear.
- To prevent adhesion.
- To aid in distributing the load.
- To cool moving parts.
- To prevent corrosion.

The range of materials used as lubricants has greatly broadened over the years so that in addition to oils and greases many plastics and solids and even gases are now being applied in this role. Because of the wide selection of lubricating materials available, great care is advisable in choosing the right material and the correct method of application. Always refer to the manufacturer's manuals regarding the type of lubricant to use, the correct method of application and the frequency of application.

Pop Riveting Guns

"Pop" Riveting Guns are used extensively with "pop" rivets for the assembly of light fabrications and are particularly useful for the assembly of metal cladding where access is restricted to one side of the work only. There are three different types available: hand "pop" gun, lazy tongs and pneumatic (air).

Hand "Pop" Gun

Riveting in confined spaces requires the use of a hand "pop" gun. These are unsuitable for larger dimensions of rivets, due to the reduced amount of leverage available.

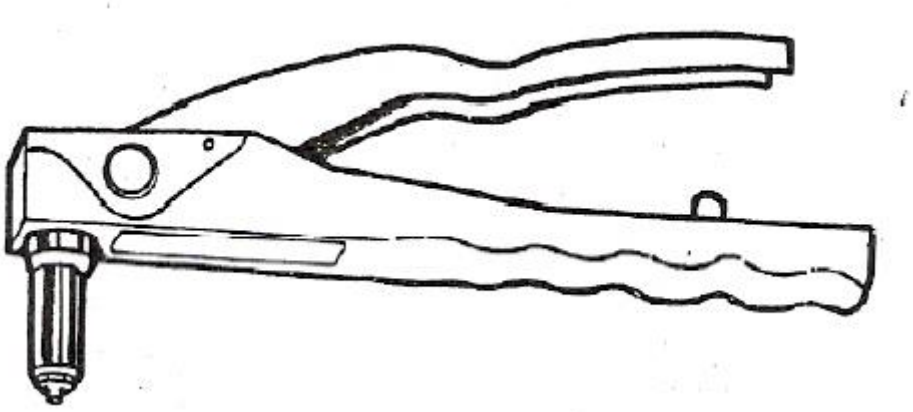


Fig.2.33: **Hand "Pop" Rivet Gun**

Lazy Tongs

Lazy Tongs are used for the larger diameters of rivets, where sufficient working space is available to permit operation of the tool. The construction of the tool permits a moderate pressure on the handle to provide a strong pulling force on the rivet mandrel.

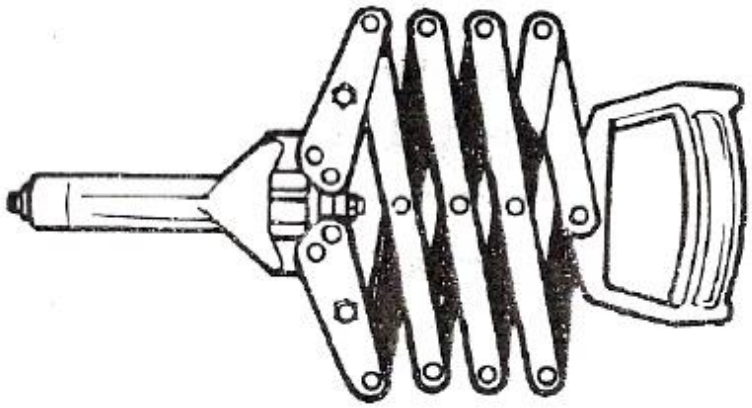


Fig.2.34: **Lazy Tongs**

2.3. Type of sheet metal Materials

There are many types of sheet metal. If an alloy can be stretched out into a sheet, that is all it takes to be sheet metal. Sheet metal is categorized by their alloy, thickness, and then further categorized by its hardness, method of manufacturing, tensile strength, and quality. With all these different variables, the types are endless. There are many varieties of sheet metal types, but here are the most common:

Steels Sheet

Steel is the most commonly used material in the sheet metal shop. This is because it is relatively cheap and is available in alloys and with special coatings for various uses. The most commonly used types of sheet steels are **mild steel, galvanized and stainless**.

Mild steel comes in two forms: hot-rolled commonly known as black iron, and cold-rolled commonly referred to as mild steel. Black iron is a cheaper variety and tends to be softer than mild steel. Any sheet metal can be obtained in 2000 x 1000 mm sheets and also available in roll form.

Galvanized Sheet Metal

It is a sheet steel coated with zinc. In the most common one, the steel is dipped in an acid both for cleaning and then is dipped into the zinc. Galvanized sheets are identified by their even grey color and are mainly used for their ability to resist corrosion.

Zinc is highly resistant to corrosion and, as long as it remains intact on the sheet, galvanized mild steel will have high corrosion resistance.

Stainless Steel

Stainless steel is one of the most important materials within industry. As the name indicates, stainless steel has high resistance to foreign or corrosive elements. It is also very easily cleaned. For these reasons, it is widely used in residential kitchens, institutional and restaurant kitchens, for hoods, sinks, splash backs etc. It is also widely used in the dairy

industry for milk storage tanks and containers. It is also used for metal cladding where appearance and fire resistance are very important.

Copper

This is a solid sheet easily recognized by its reddish color. The great advantage of copper is its high resistance to corrosion. Copper sheet is very expensive. The greatest use of copper today is in architectural sheet metal work. It is used extensively for high quality roofing, gutter, downpipes, roof flashings and hoods. Copper sheeting is available in both hot and cold rolled.

Aluminum

The main properties of aluminum are its light weight, corrosion resistance and appearance. Sheet aluminum weighs approximately one-third as much as sheet steel and is just as strong. Pure aluminum is too soft to hold a permanent shape in sheet form so the sheets are manufactured as an alloy.

Lead

In sheet form it has a number of uses, shower pans, flashings, tanks for highly corrosive materials and radiation shields are some of the major applications. The chemical and physical characteristics of lead sheet make it very useful for industry. For example, it is durable and has high resistance to corrosion from most acids and from exposure to air. It is very soft and easy to work. Lead is therefore commonly used on roof flashings on both corrugated and tiled roofs where it can be adapted by hand to contours of the roof.

Zinc

Sheet zinc is highly resistant to corrosion and is used in some instances where galvanized steel cannot provide adequate resistance. Compared to other metals, zinc is rather brittle so care must be taken while bending it. Zinc sheets are usually ordered by specifying decimal parts of an inch for thickness.

Tin

Steel sheets are coated with pure tin and have bright silvery appearance. This is used for nearly all solder work as it is easiest metal to join by soldering. The thicknesses of the tin plates are denoted by special marks not by gauge numbers. It is used for making buckets, pans, cans, etc.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. One of the following is not measuring tool.
   A. Steel rule B. Tape rule C. Folding rule D. All
2. Which one of the following sheet metal marking / layout tools.
   A. chisel B. snip C. Scriber
3. Among the listed which one is common material of sheet metal?
   A. Mild steel B. stainless C. Galvanized sheet metal D. All
4. From the given choose which one is cutting tool and equipment.
   A. Aviation snip B. Chisel C. Arm leaver shear D. guillotine E. All
5. One of the following is forming tool and equipment.
   A. Hand groover B. Different profiles of stakes C. Crimping and beading E. All
6. From the given choose which one is personal protective equipment.
   A. Safety goggles B. Safety shoes C. Clothes D. gloves
   E. ear protection F. all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Preparing work area

4.1. Preparing work area

In the work area safety precaution should be observed i.e. safety equipment, protective equipment and others should be observed. Each person should pay attention to own work area. A neat work area reflects a worker's approach to his work and equipment. Good housekeeping begins with panning ahead. Materials should be neatly stacked and any spillages of oil or grease should be cleaned up immediately.

Safe work practices can reduce the numbers of injuries on the job while lowering liability-related costs. Before instituting a safety program, evaluate current procedures and protocols to determine which are effective and which need improvement. It's important to take the time to plan a comprehensive program that thoroughly addresses current and potential safety risks. How to Plan and Prepare for Safe Work Practices stated as follows:

Hazards assessment

The first step in preparing a safe work practices plan involves completing a safety hazard assessment. Visit every department and note dangers such as machinery without safety guards, employees working without eye protection or piles of supplies blocking walkways. Observe the way employees perform their jobs to determine if they follow safety protocols or perform actions that put them at risk of injury. The U.S. Department of Labor suggests asking for employee input during the assessment and encouraging staff to identify safety issues and provide possible solutions.

Repair, Replace, Upgrade

Repair or replace defective or broken equipment, clean cluttered or dirty areas and replace worn carpeting or flooring. Inadequate lighting and uncomfortable work stations might make it difficult for employees to be productive, so consider replacing older furniture or cubicles. Don't limit this phase of the process to noticeable hazards only. Inspect machinery to ensure that it's in good working order and service and upgrade equipment as needed.

Safety First

Write a safe work practices plan after the hazard assessment is competed. It should include specific information for each department or job function. Safety for an office position might include keeping aisles and walkways free of boxes, using glare-free computer monitors and opening one file cabinet drawer at a time to prevent tipping. Manufacturing positions might follow policies including wearing protective gear, storing chemicals in labeled containers, and using safety guards on machinery and promptly reporting hazards to supervisors.

Spread the Word

Let employees know about the new safe work practices plan. Give each a copy of the section covering his job or work area. Post copies of the plan in areas where employees congregate, such as break rooms or time clocks. Employees might have questions, particularly if new practices differ from previous methods. Schedule a meeting to discuss the plan and answer any questions. Emphasize the plan's importance by recognizing departments that have no injuries for a given period and offering training programs on preventing injuries.

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. In the work area _____ should be observed.

A. Safety precaution B. safety equipment

C. Protective equipment D. All are answers

2. Good housekeeping is one of handling method in____.

A, work area B. Safety prevention C. A & B

3. The first step in preparing a safe work practices plan involves _____.

A. Repair, Replace, Upgrade C. Hazards assessment

B. Safety First D. Spread the Word

Note: **Satisfactory rating - 2 points** **Unsatisfactory – below 2 points**

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 4	Checking sealants, fixing and sheet metal materials

4.1. Introduction for sealants

Sealant is a type of mechanical seal that is widely used in domestic and industrial applications in order to fill up unwanted gaps and openings that may cause the seepage of water, gases or any particulate matter. Mating of two or more parts together results in gaps, which adversely affect the integrity and the performance of the object. Sealants are effectively used to fill up gaps between the surfaces and close off any spaces that may occur. However, sealants are not an alternative to adhesives while some sealants do have adhesive properties.

4.2. Types of sealants

Currently, there are more than forty types of sealants available in the market, out of these the most common industrially used sealants are as follows:

a. Silicone

Silicone sealants are one of the most commonly used sealants. Silicone sealants exist in either neutral cure or acetoxy. The production of silicone sealants involves an extensive polymerization and hydrolysis process of siloxanes and silanes. Both the neutral and acetoxy silicone sealants cure at the room temperature and are compatible with a variety of materials. Acetoxy silicone sealants are cheaper than its counterpart and offers quicker cure time. Acetoxy silicones are however, incompatible to perform a seal between subtracts that might react with acids. Neutral cure silicon sealants have a slower cure time and a bit more expensive to produce as compared to acetoxy. Silicone sealants have a life expectancy to around 10-20 years after application.

b. Epoxy

Epoxy sealants are usually supplied in a two-pack configurations consisting of a resin and a hardener. They are mixed together in pre-set ratio for the epoxy to perform its joint sealing. Epoxy sealants are well known for their high strengths, exceptional cure toughness and the ability to resist the environmental or chemical damage to the sealing. Epoxy sealants are one of the few sealants that also hold great strength to act as an adhesive. Epoxy sealants cure at room temperature whereas; in some case they might be required to be cured thermally.

c. Phenolic Sealant

Phenolic sealants are types of resins that provide effective bonding and have a good endurance rating against high temperature. Phenolic sealant is the only sealant that is

available in powder, liquid and film form. The phenolic sealant is usually composed of phenol and formaldehyde chemicals.

d. Acrylic sealant

Acrylic sealants are processed from acrylic acid (hence acrylic sealant) via catalytic reaction. Acrylic sealants are highly resistant to degradation caused by environment. Acrylic sealants however, are prone to chemical damage. Acrylic sealant is curable via many different ways however, if thermally cured; the curing time is lowered significantly. Acrylic sealants have a high holding power and avoid any infiltration by foreign particles.

e. Polymers

The group of polymers that makes up this category of sealant includes polyesters, polyamide, polysulfide and vinyl. The polymers form a permanent flexible seal at the joint and use the moisture in the air to cure. Polymer sealants are ideal to be applied on joints that encounter repetitive movements or are subjected to a varying temperature. One of the drawbacks to polymer sealant is that it requires the most curing time as compared to the rest of the sealants. Therefore, polymer sealants once applied to a joint are kept untouched for a long duration of time.

4.3. Material compatibility of sealant

To decide which sealant to use of all the available sealants, it must be made sure before application that whether the joining material is compatible or not. Having a sealant being applied on an incompatible material may result in the degradation of the material and failure to seal off the joint.

- **Porous surfaces:** Porous surfaces have the best compatibility with sealants having a high viscosity or gel like texture. Silicone, polymers and epoxies are the best-suited sealants for porous materials.
- **Concrete:** Concrete is the constructing material that is used for construction of buildings, walls and other structures. Polymer sealants are usually used to seal concrete joints.
- **Metal:** Metal joints are usually sealed together using silicone and polymer based sealants. Silicone is highly compatible with iron, aluminum, steel and iron compounds.
- **Ceramics:** Ceramics are the oxides and nitrides that are non-metal and have a high melting and boiling point. Ceramics can be sealed off using epoxy, silicone and acrylic sealants.
- **Textiles:** Textiles are most compatible with silicone-based sealants.
- **Plastics:** Plastics are the organic, process or synthetic materials obtained from polymer. Silicone and polymer acts as the most suitable sealants.

Sealant type	Cure procedure	Material Compatibility						
		Concrete	Plastic	Ceramic	Textile	Porous	Metal	Rubber
Silicone	Room temperature		X	X	X	X	X	X
Epoxy	Room temperature			X		X		X
Phenolic Sealant	Various				X			
Acrylic sealant	Various			X				
Polymers	Thermoplastic	X	X			X	X	X

4.4. Metal Bonding Adhesive

Metals are readily bonded with a variety of adhesives. It can be challenging to choose the best metal adhesive given the vast number of options. Each chemistry has its own unique benefits.

Structural adhesives, such as structural acrylic adhesives and epoxies are ideal metal adhesives for forming strong bonds that resist stress, temperature, chemicals.

Anaerobic adhesives are used as a thread locker, pipe thread sealant, retaining compound or FIP gasket. Anaerobic adhesives are only used as metal adhesive and sealants. They do not cure on other substrates such as glass and plastic.

Cyanoacrylate adhesive develop strength very quickly. Consider the methyl cyanoacrylate, these bonds perform well in shear and resist non polar solvents. If you require and adhesive for metal that provides impact resistance or resistance to polar solvents consider structural acrylics.

UV Curable adhesives are ideal for invisible bonds between glass and metal. These are used extensively to bond metal hinges, knobs, and fixtures to glass doors.

MS Polymer adhesive are ideal metal adhesives for thin sheets of metal – such as truck panel bonding, where the low shrinkage provides no read through (you can't see where the adhesive is placed through the panel) providing a good aesthetic finish.

Permabond adhesives are supported by a team of sales, customer service, and technical professionals. This team will assist you in selecting the proper adhesive for metal for your application or develop a product to meet your application's requirements.

4.5. Fixing materials

Fasteners join two thin materials together and must be purpose-designed for the application. These are generally either self –drilling stitcher screws with bonded sealing washers and integral laps, blind sealed rivet. Uses of fixing material on the building like, doors, windows,

wall sheet metal part and roofs to prevent water, dust and air linking. Diffirent types of fixing materials are explained bellow:

- **Rivets**

Rivets are used to make permanent joints in metal, to join metal to soft materials and for joining soft materials to each other.

Solid rivets

Snap or round head rivets are used for general purposes where a flush finish is not important and countersinking would weaken the job.

Countersunk head rivets are used for general purposes where a flush surface is needed. They are the most commonly used type.

Flat head rivets are used for joining thin plates which cannot be countersunk.

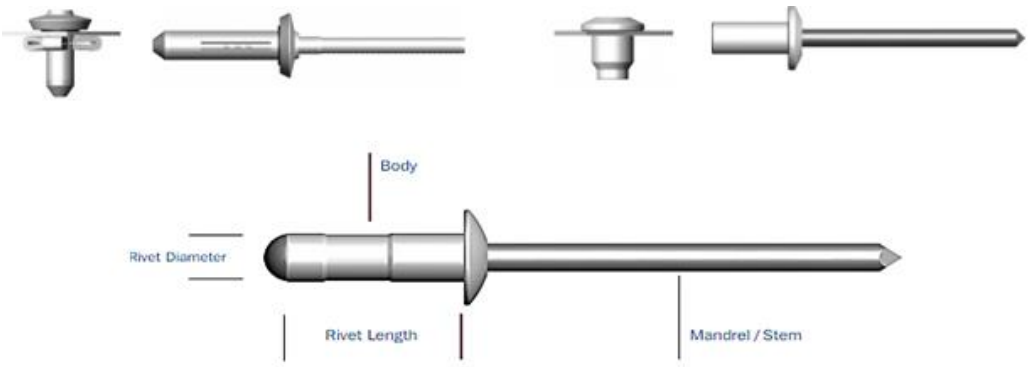


Fig.4.1: Rivets

- **Nuts, bolts and machine screws**

All these fixings are usually made of steel or brass and can be coated either to rustproof the steel or to improve their appearance.

Bolts usually have either a square or a hexagonal head. They are ordered by the diameter of the thread and the length to the underside of the head. Bolts may be threaded for all or part of their length.

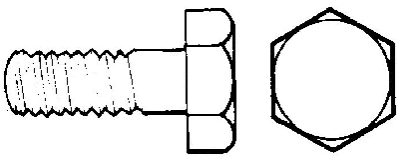


Fig.4.2: Bolts

Coach bolts are used to join wood to wood or wood to other materials. They have a domed head with a square collar underneath which is pressed into the wood to prevent the bolt turning. They are usually used for strong structural woodwork.

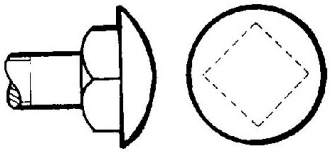


Fig.4.3: Coach bolts

Machine screws are available in a wide range of thread diameters, lengths and head shapes.

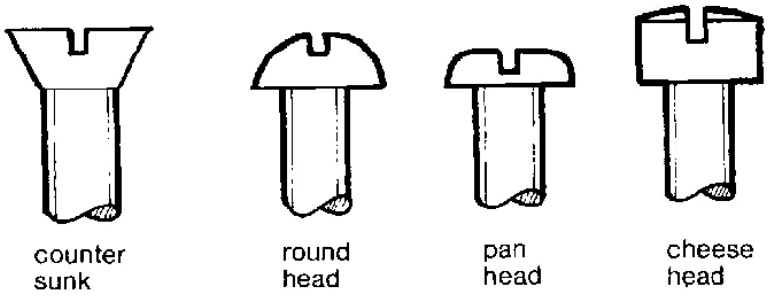


Fig.4.4: Machine screws

Nuts are either Plain Square, plain hexagonal, wing nuts for easy removal, or special locking nuts to prevent vibration loosening them.

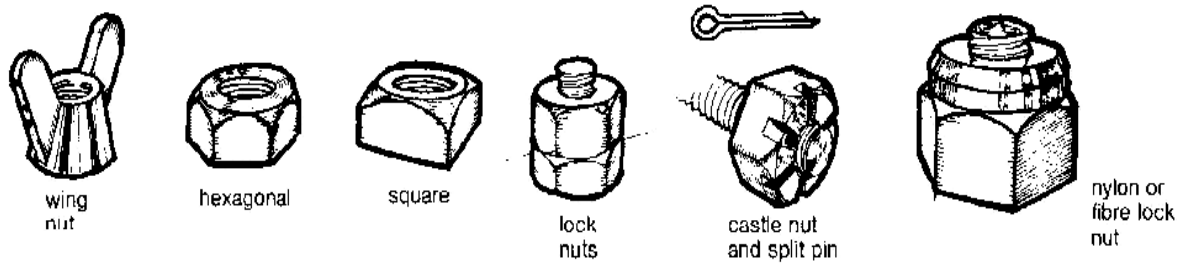


Fig. 4.5: different types of nuts

Washers are used to protect the surface when the nut is tightened, to spread the load or to prevent vibration loosening the joint.

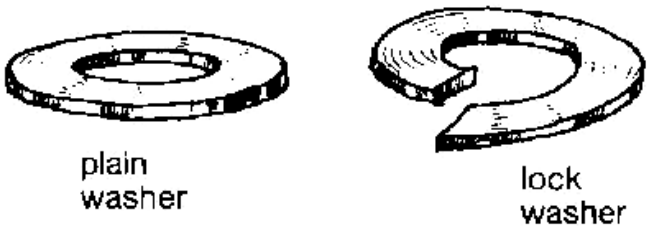
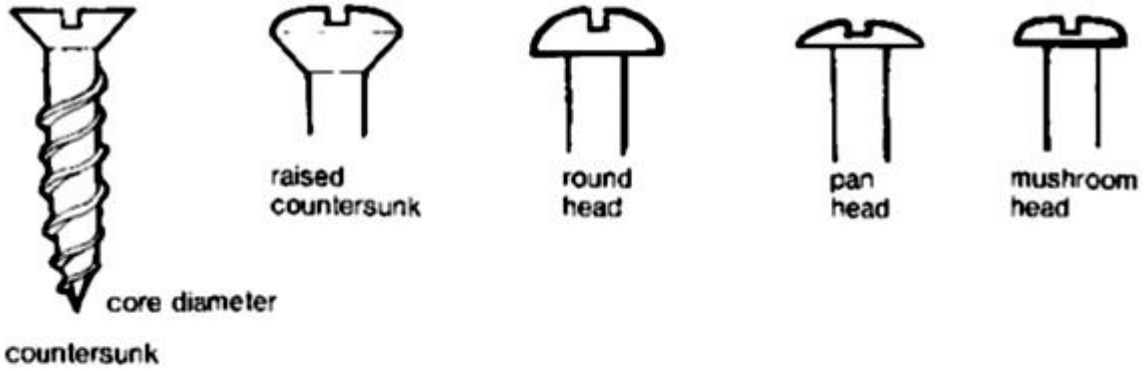


Fig.4.6: Washers

Self-tapping screws are used to join thin sheets of metal and plastics and as chipboard screws where ordinary woodscrews would cause the chipboard to crumble. They are made of hardened steel so that they can cut their own thread as they are screwed in. Common sizes are 6 mm to 50 mm with Phillips, Pozidriv and straight slots. Drill a tapping size hole equal to the core diameter of the screw.



Screw Joint / Fasteners

Fig.4.7: self-tapping screws

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

1. It is used to make permanent joints in metal, to join metal to soft materials to each other.

   1. Bolts B. Rivets C. Self-tapping screws D. All

2. Which one is used to join wood to wood or wood to other materials?

   A. Machine screws B. Nuts C. Coach bolts D. All

3. Which sealant the most commonly used sealants?

   A. Silicone B. Polymers C. Epoxy D. Phenolic Sealant

4. Which sealant is more compatible for metals?

   A. Silicone B. Polymers C. Epoxy D. Phenolic Sealant E. A &B

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1	Methods of selecting PPE, Tools and Equipment for sheet metal work

Methods of selecting PPE, Tools and Equipment are;

Steps1- Read the PPE user instructions carefully before every use, and seek assistance if needed or to ensure that the PPE meets the specifications

Step 2- If in doubt about what PPE to use, call the your teacher/instructor

Step 3- check labels, PPE instructions, and safety equipment catalogs detailed information.

Step 4- Make Sure PPE is Working Properly

Step 4- select the PPE required by the label

Step 4- Before and after every use, check for any type of deterioration of or damage to all the components, seams, etc. of the specific reusable PPE and, if necessary, dispose of properly.

Operation Sheet 2	Methods of preparing workplace for cutting and joining sheet metal

Methods of preparing workplace for cutting and joining sheet metal are:

Step 1- Do not block exits

Step 2- Change burned-out light fixtures in work areas, walkways, and exits

Step 3- Keep floors and work areas clean, dry, and grease-free

Step 4- Keep steps and ladders in serviceable condition

Step 5- Keep emergency equipment clean and unobstructed

Step 6- Ensure that all signs and caution labels are in good condition and visible

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00-2:30 hours.

Task 1: Select PPE, Tools and Equipment used for sheet metal work

Task 2: prepare workplace for cutting and joining sheet metal

List of Reference Materials

1. “Layout and Fabrication of sheet metal and fiberglass duct”, NAVEDTRA 14250A, Chapter 13.
2. “student safety guidelines”: Technology,
3. Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”, PHASE 2, Module 1, Michael Kelly, © SOLAS 2014
4. https://www.castleheadhigh.renfrewshire.sch.uk/images/C_D_Joining_Materials.pdf
5. http://library.stic.et/documents/30479/2624587/english-1.pdf/9ae2c577-91d0-c9fc-6fac-a6e135ba22cf?version=1.0&download=true
6. http://www.bvrit.ac.in/Freshman_Lab_Manuals/Engineering%20Workshop/Engineering%20Workshop.pdf

Basic Metal Works

Level-I

Learning Guide-38

Unit of Competence: Cut and Join Sheet Metal

Module Title: Cutting and Joining Sheet Metal

LG Code: IND BMW1 M11 LO3-LG-38

TTLM Code: IND BMW1 M11 TTLM 1019v1

LO 3: Cut and join sheet metal

Instruction Sheet	Learning Guide: 38

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

- Preparing and cleaning surface
- Marking out sheet metal
- Cutting sheet metal to pattern
- Joining sheet metal

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

- mark out sheet metal in accordance with plans/specifications
- Measure and cut sheet metal to pattern using appropriate cutting tools and according to specifications
- Prepare and clean surface of grease and other contaminants
- Join sheet metal to comply with plans/specifications, avoiding damage to all surrounding surfaces

Learning Instructions:

11. Read the specific objectives of this Learning Guide.
12. Follow the instructions described below 3 to 6.
13. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4 in page 56, 59, 63 and 68 respectively”.
14. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self-check 4” in page -58, 62, 67 and 81 respectively.
15. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2, Operation Sheet 4, Operation Sheet 5, Operation Sheet 6, Operation Sheet 7 and Operation Sheet 8” in page -82,84,85, 86,88,and 89
16. Do the “LAP test” in page – 90 if you are ready).

Information Sheet- 1	Preparing and cleaning surface

1.1. Cleaning surface of sheet metal

Identifying the sheet metal required for work. Before starting to perform your work, you should have to clean the surface of work pieces from sheet metal (foreign materials) like, grease, dust, rust, oil and others. Commonly there are two ways of cleaning surface of sheet metals. They are by mechanically and chemical. Mechanically by using abrasive paper, sand blasting, wire brush, and rage/ stracho, etc. and chemical by using solvents.

Adequate surface preparation is a vital prerequisite for ensuring the quality and durability of metal coatings. Without proper preparation, even the most advanced metal coating technologies will fail. To turn your first metal paint job into a successful experience, we invite you to check the next five steps to preparing metal for paint.

1.1.1. Five Important Steps Preparing Metal for Paint

1. **Clean the surface.**

To properly prepare new metal surfaces, use mineral spirits to remove grease and apply a rust-inhibitive primer before painting. For painted surfaces that are in sound condition, remove dust with a clean, dry cloth, de-gloss the surface with light sanding, and wipe with mineral spirits to ensure good adhesion. To remove persistent dirt, wash surfaces with a mild detergent solution or with a commercial product recommended for cleaning painted surfaces.

2. **Remove loose and peeling paint.**

If the old paint is in poor condition, you can remove it by hand wire brushing, sanding, or scraping. Since these methods are labor intensive and usually fail to deliver the results expected, many professionals opt for power tool cleaning, which can help remove paint quickly and easily. However, one drawback of using power tools is that they can polish metal surfaces, potentially causing paint-adhesion problems.

3. **Remove rust.**

When preparing metal for paint, checking for rust is important to make sure that the paint will adhere properly to the surface. To restore lightly rusted metal surfaces to their original state, use a brush to clean off loose rust, sand the area, and apply a high-quality rust-inhibitive primer (e.g. Rust-Oleum Rust Reformer). Also known as rust converters, rust-inhibitive primers can be used to cover rusted spots and turn them into non-rusting, paintable surfaces.

4. Repair small holes and dents.

To repair holes and dents, sand the area until you reach bare metal and wipe with a degreaser mixed with mineral spirits. For small holes and dents, inject an appropriate epoxy-based composite directly into the hole and/or dent. For larger holes, apply epoxy filler to the edge of the hole, cut a piece of fiberglass mesh approximately one inch larger than the hole, and press it into the filler. Then, cover the mesh with epoxy, working your way from the edge toward the center of the hole.

5. Prime the surface

Priming is a very important step in preparing metal for paint, especially if the surface will be exposed to moisture. To select the right primer, the type of metal to be coated along with the desired appearance, performance requirements, and environmental conditions should be considered. To begin with, water-based (latex) primers shouldn't be used on metal surfaces, as moisture can seep through and cause paint to fail within weeks or months.

Professionals recommend two types of metal primers: the rust converters mentioned above and galvanized metal primers. While a rust converter is ideal for preventing rust from recurring and making a rusted surface easier to paint, a galvanized primer is appropriate for metals (e.g. aluminum) that prevent paint from adhering to the surface. You can also find iron oxide and zinc chromate primers, which can be used on most metal surfaces, including interior and exterior iron and steel.

Priming immediately after cleaning the surface is imperative to prevent dust or dirt from accumulating and flash rust (rust that occurs within hours) from forming.

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. The common method of clean foreign materials from sheet metal
   A. Mechanically C. A & B
   B. Chemically
2. The common removing of grease from sheet metal.
   A. Rage B. Abrasive paper C. wire brush D. chemical
3. Chemically to remove foreign material from sheet metal
   A. By water B. By solvent C. By Abrasive paper D. By wire brush
4. Which one is true about surface preparation and cleaning?
   A. It is the prerequisite for ensuring the quality and durability of metal coatings
   B. Metal coating technologies will fail
   C. Old paint is in not removed before paint
   D. Small holes and dents not repaired

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet- 2	Marking out sheet metal as plan

2.1. Measuring sheet metal as pattern

Measurement is the process of associating numbers with physical quantities and phenomena. Measurement is fundamental to the sciences; to engineering, construction, and other technical fields; and to almost all everyday activities. “Measurement” is the act of determining a target's size, length, weight, capacity, or other aspect.

2.1.1. Measurement methods

Direct measurement is measurement done by bringing the target into contact with the measurement system to read the length, height, or other aspect directly. Although direct measurement allows measurement results to be known as they are, errors may occur depending on the skill of the person doing the measurement.

Indirect measurement is done, for example, by using a dial gauge to measure the height difference between a measurement target and a gauge block and using that height to indirectly determine the target's height. Because this type of measurement is based on a reference, indirect measurement is also referred to as “comparative measurement.”

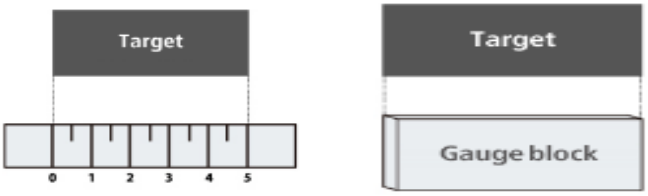


Fig.2.1: Measurement methods

Metric and English Systems

2.1.2. Metric (SI) systems

The metric system is an internationally agreed decimal system of measurement created in France in 1799. The International System of Units (SI), the official system of measurement in almost every country in the world, is based upon the metric system. In the metric system, each basic type of measurement (length, weight, capacity) has one basic unit of measure (meter, gram, and liter).

10 millimeters (mm) =	1 centimeter (cm)	
10 centimeters =	1 decimeter (dm)	= 100 millimeters
10 decimeters =	1 meter (m)	= 1,000 millimeters
10 meters =	1 dekameter (dam)	
10 dekameters =	1 hectometer (hm)	= 100 meters
10 hectometers =	1 kilometer (km)	= 1,000 meters

2.1.3. English System

While the metric system was lawfully accepted for use in the United States in 1866, the US has not adopted the metric system as its "official" system of measurement. The US English System of measurement grew out of the manner in which people secured measurements using body parts and familiar objects. For example, shorter ground distances were measured with the human foot and longer distances were measured by paces, with one mile being 1,000 paces. Capacities were measured with household items such as cups, pails (formerly called gallons) and baskets.

Obviously this system allowed for discrepancies between measurements obtained by different individuals. A standard was eventually set to ensure that all measurements represented the same amount for everyone.

Length:	Weight:	Capacity:
1 foot (ft) = 12 inches (in) 1 yard (yd) = 3 feet 1 mile (mi) = 5280 feet 1 mile = 1760 yards	1 pound (lb) = 16 ounces (oz) 1 ton = 2000 pounds	1 tablespoon (tbsp) = 3 teasponns (tsp) 1 cup (c) = 16 tablespoons 1 cup = 8 fluid ounces (oz) 1 pint (pt) = 2 cups 1 quart (qt) = 2 pints 1 gallon (gal) = 4 quarts

For more follow: https://mathbitsnotebook.com/Algebra1/Units/UNMetricEnglish.html

2.2. Marking out sheet metal

Marking out is the process of transferring measurements from a project drawing to the material or work piece. The resulting flat pattern made directly on the metal drawing on sheet metal is called the layout. It shows the shape and size of the object, the location of all holes or openings, and the areas to be machined or otherwise removed. A layout I similar to a working drawing laid out on a metal work piece. Accuracy is very important, if you make an error, your job can be ruined before you ever start it.

See video: https://youtu.be/IObgZ5gYWIE

To make a good lay-out, you must be able to

- Read and understand drawings and prints,
- Use lay-out tools correctly, and
- Transfer measurements accurately from a drawing to the material itself.

The following (fig.2.2.), shows you the pattern what look likes. it shows full information/ data about box , shown also by pictorial drawing.

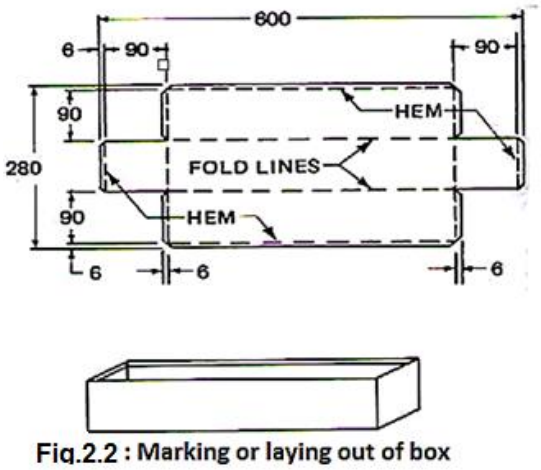


Fig.2.2 : Marking or laying out of box

2.3. Pattern Development

Layout or development refers to the methods of developing the lines which form the patterns.

The common layout methods are: - Parallel line development

- Radial line development, etc.

1. Parallel line development

- Parallel line development is based upon the fact that a line that is parallel to another line is an equal distance from that line at all points.

2. Radial line development

- The radial line method of pattern development is used to develop patterns of objects that have a tapering form with lines converging at a common center. Example cone shape objects

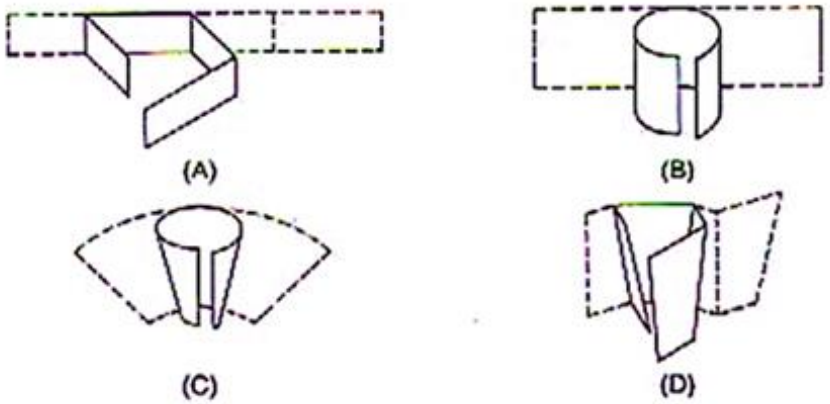


Fig.2.4: Three kinds of pattern developments: (A and B) parallel-line development to make a box or a cylinder, (C) radial-line development to make a cone, and (D) triangulation to make a two-transition piece.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. _____ is the act of determining a target's size, length, weight, capacity, or other aspect.
   A. Marking out
   B. measurement
   C. Method of layout
   D. Development
2. English (US) is an internationally agreed decimal system of measurement.
   A. True B. False
3. The process of transferring measurements from a project drawing to the material from which the project is to be made.
   A. Marking out
   B. Drawing
   C. Sketching
   D. Pattern
4. A kind of pattern which is used in making cone-shaped objects such as funnels, buckets or tapered lamp shades.
   A. Triangulation
   B. Parallel line
   C. Radial line
   D. Square
5. The resulting flat pattern made directly on the metal.
   A. Drawing
   B. Sketching
   C. Triangulation
   D. Lay-out

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet- 3	Cutting sheet metal to pattern

4.2. Cutting sheet metal

Cutting processes are those in which a piece of sheet metal is separated by applying a great enough force to cause the material to fail. The most common cutting processes are performed by applying a shearing force, and are therefore sometimes referred to as shearing processes. See: https://www.youtube.com/watch?v=LTZ4K3NoIr0

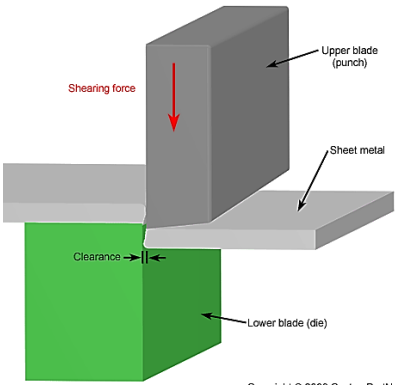


Fig.3.1: shearing of sheet metal

Sheet metal cutting processes include the following:

- **Shearing:** Shearing is a sheet metal cutting operation along a straight line between two cut-ting edges by means of a power shear.
- **Cutting off:**- is the operation of shearing the piece from sheet metal with a cut along a single line.
- **Parting:** This means that the strip is removed between the two pieces to part them.
- **Piercing:-**is the operation of making a hole of any shape in a sheet metal by punch or die.
- **Blanking** - sheet metal cutting to separate piece from surrounding stock
  - Cut piece is the desired part, called a *blank*

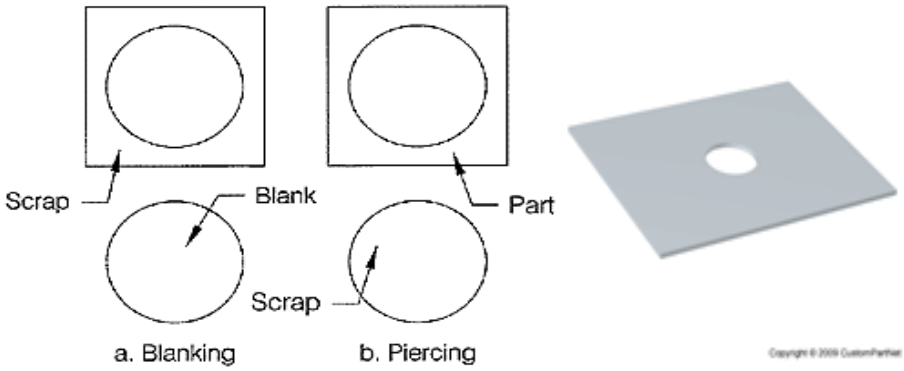


Figure:3.2: Blanking and piercing differentiation.

- **Notched corners:-**the term notching is used to describe the removal of metal from the edges and or corners of sheet metal blanks or patterns prior to carrying out any forming operations.

- ✓ Good notching is of prime important where the finished article is to have a neat appearance.
- ✓ Bad notching result to overlaps bulges and gaps.
- ✓ **Notching** - Punching the edge of a sheet, forming a notch in the shape of a portion of the punch.

Fig.3.3: Notching operation

- **Punching** - sheet metal cutting similar to blanking except cut piece is scrap, called a *slug*
  - ➢ Remaining stock is the desired part

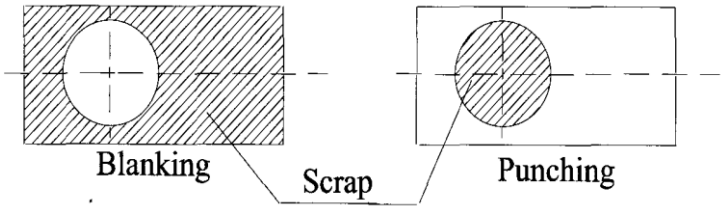


Fig.3.4: Punching

- **Bending**: Bending is defined as the straining of the sheet metal around a straight edge

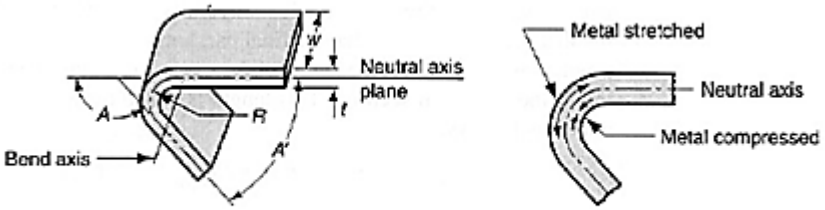


Fig. 3.4: Bending of sheet metal

- **Slitting:** It is the operation of cutting the sheet metal in a line along the length.
- **Slotting** - A punching operation that forms rectangular holes in the sheet. Sometimes described as piercing despite the different shape.

Fig.3.5: Slotting

- **Trimming:** It is the operation of finishing the edges of a part by removing excess metal around it.
- **Drawing:** Drawing is a sheet-metal operation to make hollow-shaped parts from a sheet blank.

- Sheet metal forming to make cup-shaped, box-shaped, or other complex-curved, hollow-shaped parts.
- Products: beverage cans, ammunition shells, automobile body panels

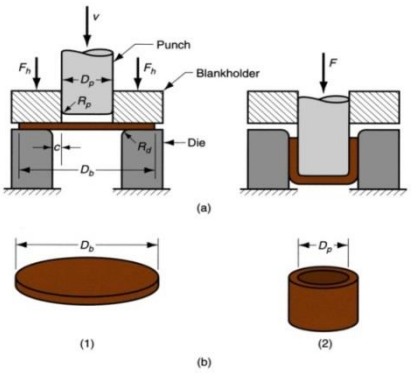


Fig. 3.6: Drawing

- **Nibbling** - Punching a series of small overlapping slits or holes along a path to cutout a larger contoured shape. This eliminates the need for a custom punch and die but will require secondary operations to improve the accuracy and finish of the feature

Fig.3.7: Nibbling

- **Lancing** - Creating a partial cut in the sheet, so that no material is removed. The material is left attached to be bent and form a shape, such as a tab, vent, or louver.

Fig.3.8.Lancing

4.3. Bend allowance for sheet metal

When sheet metals bend through an angle outside of the metal becomes **stretched** and inside of the metal becomes **compressed**. Thus it is necessary to make allowance for this effect, when making a blank sheet prior to bending. Because there is slight difference between the amount of compressive and extension, the neutral line (imaginary curved line) lie nearer to the inside of the bend. See this Video: https://youtu.be/HemwD3NpKXk

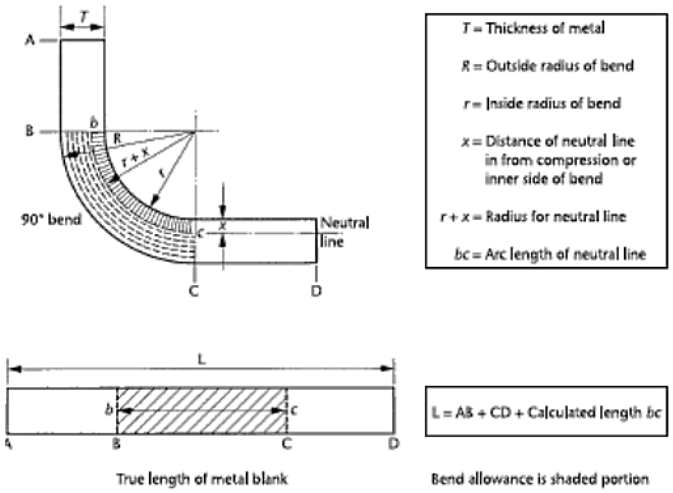


Figure 3.9: Bend allowances for sheet metal

The neutral line curve is regarded as the arc of a circle whose radius is equal to the sum of the inside bends radius plus the distance of neutral line from the inside of bend. This radius is equal to 0.4 times thickness of the sheet.**1**

4.4. Calculation – center line bend allowance

Calculate the length of the blank required to form the ‘U ’ clip shown in Fig.3.6 . The position of the neutral line is 0.5 *T* (center line), where *T* =2 mm.

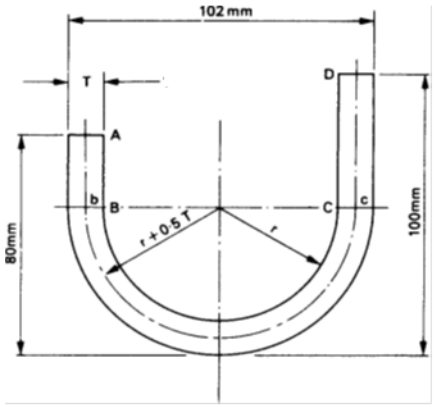


Figure 3.9: Calculation – center line bend allowance

Solution

The length (*L*) of the blank is equal to the sum of the straight arm lengths ‘ AB ’ and ‘ CD ’ plus the mean line (radius) length ‘*bc* . Thus, L = AB + CD + BC

Where *bc* represents a semi-circular arc whose mean radius *R* is equal to the inside radius *r* plus half the metal thickness *T*.

Where r =102/2-T =49mm

Then R =r + 0.5T = 49+1=50mm

bc = ½ * 2πR = πR = 3.14 * 50mm =157mm

Therefore L= AB + CD + bc = 29 + 49 + 157 =235mm size of blank to be cut.

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. The process of cutting sheet metal
   A. Shearing
   B. Welding
   C. Tearing
   D. Riveting
2. A kind of sheet metal cutting that makes hole on the metal
   A. Tearing
   B. Drilling
   C. Holing
   D. Punching
3. A tool which used to cut sheet metals
   A. Vise grip
   B. Diagonal cutting plier
   C. Hand snip
   D. Drill bit
4. After marking out and measuring what is the next to be done?
   A. Cutting
   B. Forming
   C. Bending
   D. Joining
5. In shearing machine used for straight line cutting
   A. The lower blade is fixed
   B. The upper blade is movable
   C. The upper blade is inclined to the lower blade
   D. All
6. A punching operation that forms rectangular holes in the sheet is:
   A. Slitting
   B. Drawing
   C. Slotting
   D. Lancing

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet- 4	Joining sheet metal

4.1. Fabrication of Edges, Joints, Seams, and Notches

There are numerous types of edges, joints, seams, and notches used to join sheet metal work. We will discuss those that are most often used.

- **Fabricating Edges or Hem**

Edges are formed to enhance the appearance of the work, to strengthen the piece, and to eliminate the cutting hazard of the raw edge. The kind of edge that you use on any job will be determined by the purpose, by the sire, and by the strength of the edge needed.

The **single hem edge** is shown in *Figure below*. This edge can be made in any width. In general, the heavier the metal, the wider the hem is made. The allowance for the hem is equal to its width (W).

The **double hem edge** is used when added strength is needed and when a smooth edge is required inside as well as outside. The allowance for the double-hem edge is twice the width of the hem.

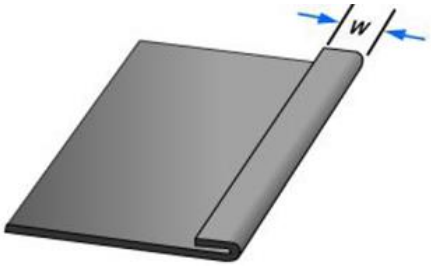


Fig. 4.1: **Single hem edge**

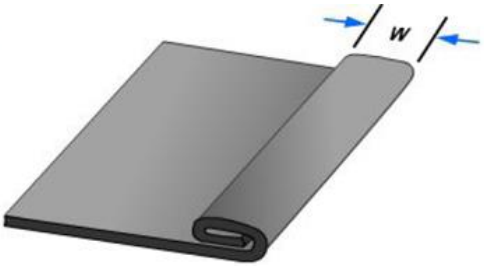


Fig.4.2: Double hem edge.

A **wire edge** is often specified in the plans. Objects such as funnels, water troughs, and garbage pails are fabricated with wire edges to strengthen and stiffen the jobs and to eliminate sharp edges. The allowance for a wire edge is 2 1/2 times the diameter of the wire used. As an example, you are using wire that has a diameter of 4mm. multiply 4 by 2 1/2 and your answer will be 10mm, which you will allow when laying out sheet metal for making the wire edge.

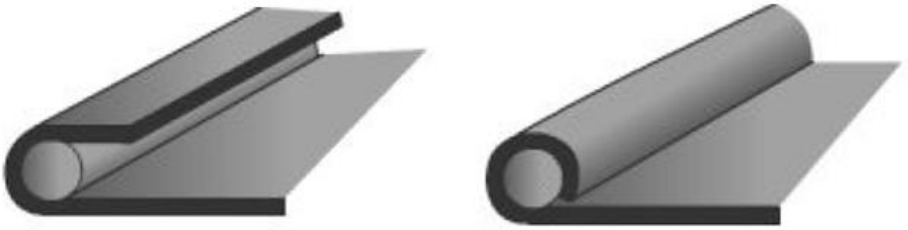


Fig.4.3: Development of a wire edge on a cylinder

- **Fabrication of Joints**

The **grooved seamed joint** is one of the most widely used methods for joining light- and medium-gauge sheet metal. It consists of two folded edges that are locked together with a hand groover. When making a grooved seam on a cylinder, you fit the piece over a stake and lock it with the hand groover. The hand groover should be approximately 1/16 inch wider than the seam. Lock the seam by making prick punch indentions about ½ inches in from each end of the seam.

Fig .4.4: Development of a grooved seam joint

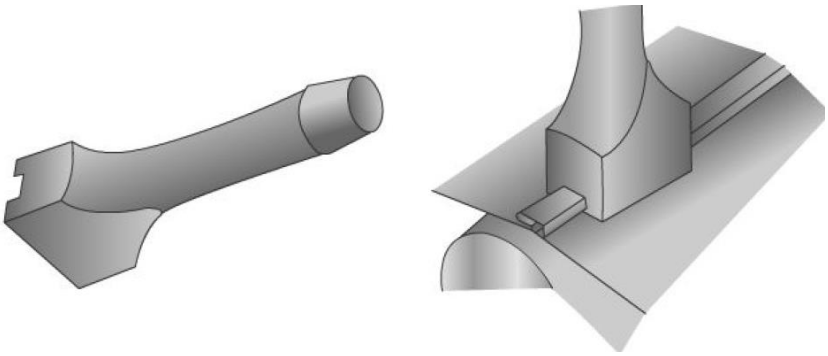


Fig.4.5: Hand groover and locking a grooved seam.

The **cap strip seam** (fig A) is often used to assemble air-conditioning and heating ducts. A variation of the joint, the locked corner seam (*Figure B*), is widely accepted for the assembly of rectangular shapes.

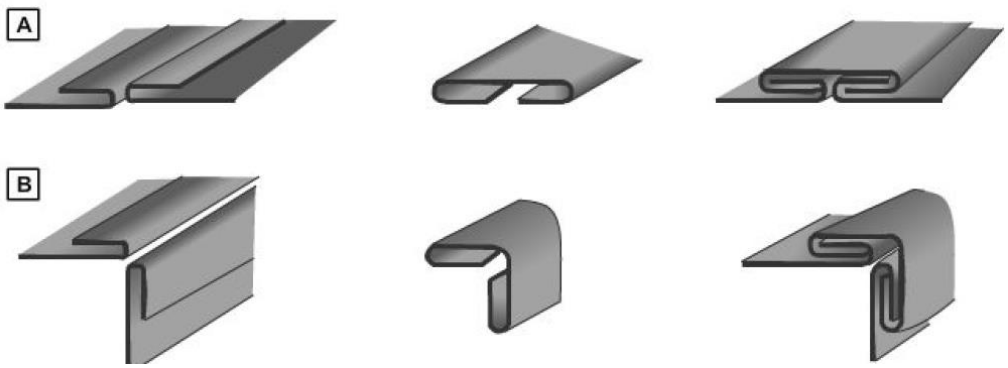


Fig.4.6: (A) cap strip seam, (B) locked corner seam

- **Fabricating Seams joints**

Many kinds of seams are used to join sheet metal sections. Several of the commonly used seams are shown in *Figure bellow*. When developing the pattern, ensure you add adequate material to the basic dimensions to make the seams. The folds can be made by hand;

however, they are made much more easily on a bar folder or brake. The joints can be finished by soldering and/or riveting.

When developing sheet metal patterns, ensure you add sufficient material to the base dimensions to make the seams. Several types of seams used to join sheet metal sections are discussed in this section.

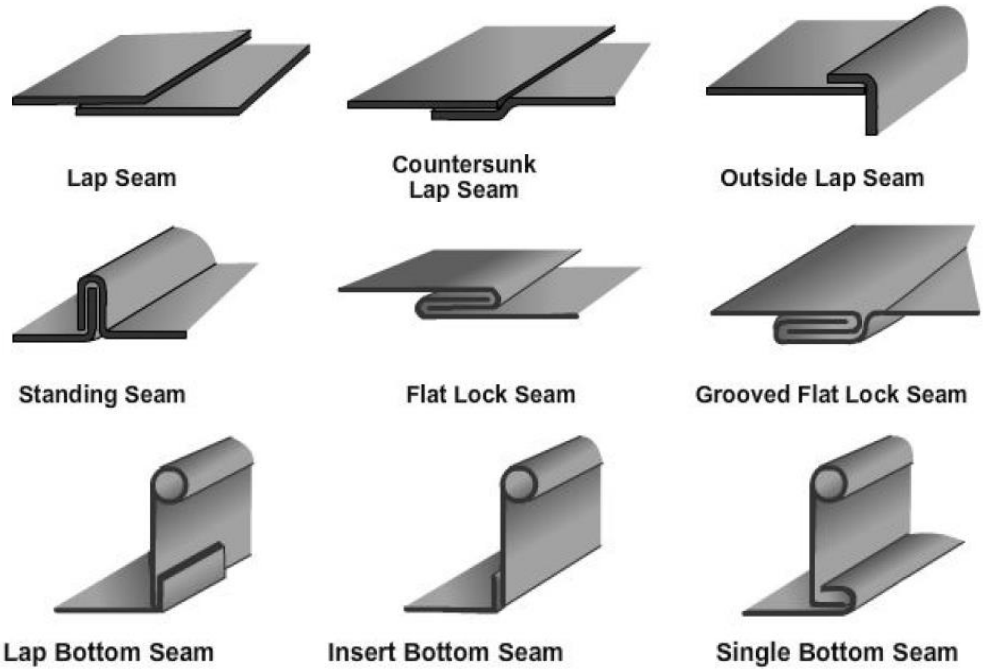


Fig.4.7: Common sheet-metal seams

There are three types of lap seams: the *plain lap seam*, the *offset lap seam*, and *the corner lap seam*. Lap seams can be joined by drilling and riveting, by soldering, or by both riveting and soldering. To figure the allowance for a lap seam, you must first know the diameter of the rivet that you plan to use. The center of the rivet must be set in from the edge a distance of 2 1/2 times its diameter; therefore, the allowance must be five times the diameter of the rivet that you are using.

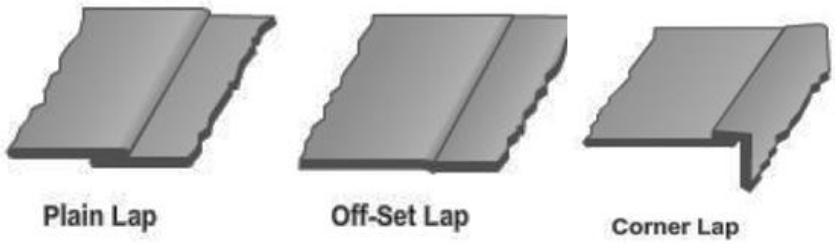


Fig.4.8:Types of Lap seam

The **Pittsburgh lock seam** is a comer lock seam. Figure below shows a cross section of the two pieces of metal to be joined and a cross section of the finished seam. This seam is used as a lengthwise seam at comers of square and rectangular pipes and elbows as well as fittings and ducts.

This seam can be made in a brake but it has proved to be so universal in use that special forming machines have been designed and is available. It appears to be quite complicated, but like lap and grooved seams, it consists of only two pieces. The two parts are the flanged, or single, edge and the pocket that forms the lock. The pocket is formed when the flanged edge is inserted into the pocket, and the extended edge is turned over the inserted edge to complete the lock.

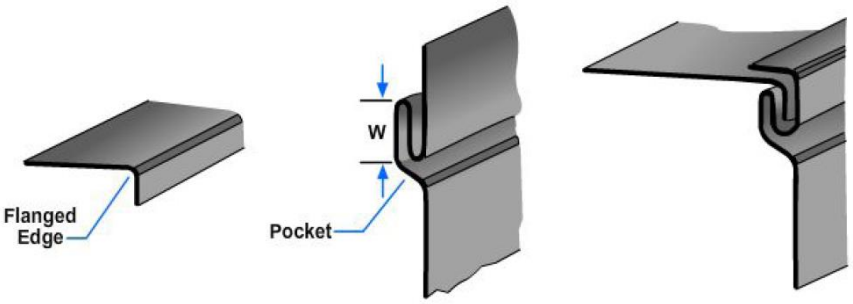


Fig.4.9: **Pittsburgh lock seam.**

The **dovetail seam** is used mainly to join a round pipe/fitting to a flat sheet or duct. This seam can be made watertight by soldering. *Figure bellows* shows the pattern for forming a dovetail seam and an example of its use.

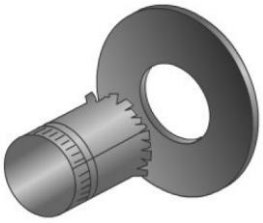
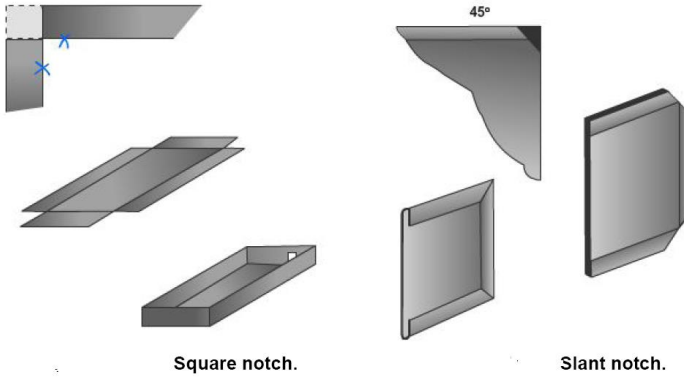


Fig.4.10: Dovetail lock seam.

Notching is the last step to be considered when you are getting ready to layout a job. Before you can mark a notch, you will have to lay out the pattern and add the seams, the laps, or the stiffening edges. If the patterns are not properly notched, you will have trouble when you start forming, assembling, and finishing the job.

No definite rule for selecting a notch for a job can be given. But as soon as you can visualize the assembly of the job, you will be able to determine the shape and size of the notch required for the job. If the notch is made too large, a hole will be left in the finished job. If the notch is too small or not the proper shape the metal will overlap and bulge at the seam or edge.

A **square notch** is likely the first you will make. It is the kind you make in your layout of a box or drip pan and is used to eliminate surplus material. This type of notch will result in butt comers. **Slant notches** are cut at a 45-degree angle across the comer when a single hem is to meet at a 90-degree angle.



A **V notch** is used for seaming ends of boxes. You will also use a full V-notch when you have to construct a bracket with a toed-in flange or for similar construction. When you are making an inside flange on an angle of less than 90 degrees, you will have to use a modification of the full V-notch to get flush joints. The angle of the notch will depend upon the bend angle.

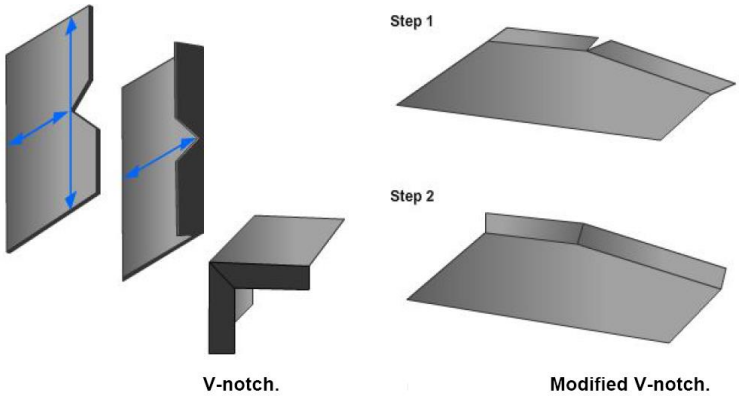


Fig. 4.11: types of notching

4.2. Permanent Fastening methods

There are several types of fasteners used to join pieces of sheet metal and to attach sheet metal to other materials. When sheet metal is fabricated, holes must often be drilled or punched in it for bolts, rivets, or other attachments of some type. The following fastening methods are widely adopted in sheet metal work.

(a) Riveting (b) Soldering (c) Brazing (d) Welding

1. Riveting

Riveting is a method of making permanent joints. The process consists of drilling or punching the sheets to be riveted, inserting the rivet, and then closing it by an applied compression force so that it completely fills the hole and forms a rigid joint. Rivet consists of head; shank and tail are generally made of same metal as the parts that are being joined.

- **Rivets**

Rivets are metal pins that look like bolts without threads. It may be solid or hollow. It is made of soft malleable metals which will not crack while the head is being formed. Rivets are

commonly made of Aluminum, Brass, Copper, magnesium and Mild steel. The most kinds of rivet heads are round, counter sunk and flat.

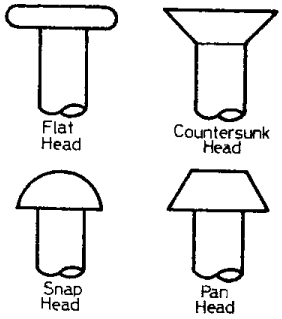


Fig.4.12: Types of rivets

- **Size of rivet**

The size of a rivet is measured by the diameter and length of the body. The head is not included in the length except on those designed to be countersunk. Rivets are available in size ranging from 3to 10mm in diameter in 0.75mm steps and from 6 to 76mm in length

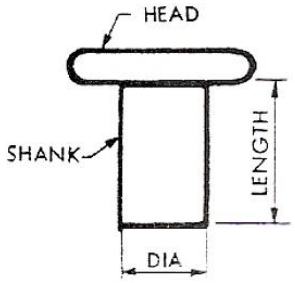


Fig. 4.13: Sizes of rivets

- **How to select rivet size**

Choose rivets that are 0.08mm to 0.4mm smaller in diameter than the holes in the pieces which you are going to rivet. Each rivet must be long enough to 90 through the pieces, with enough metal for forming a head, which is about 1.5 times the diameter of the rivet. The rivet selected generally should be made of the same material as the metal being riveted.

Example

1. If the diameter of the rivet is 3mm, the extended length will be:-

   1.5x diameter of rivet

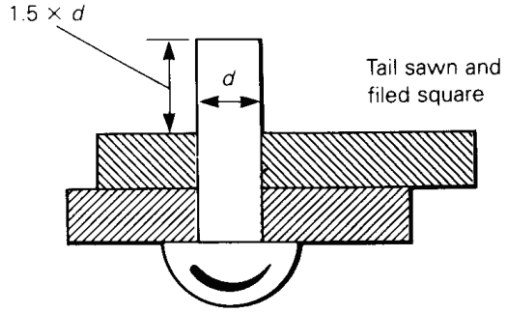
   1.5x 3= 4.5mm, the extended length will be 4.5mm

2. Find the length of a rivet, to rivet together a 0.4mm sheet metal and 0.3mm sheet metal thick and 3.6mm diameter rivet.

Solution

Sheet metal1 = 0.4 mm and sheet metal2 = 0.3 mm

1½ x3.6 mm= 5.40 mm, then 5.40mm +0.70mm 6.10 mm length of rivet



- **Rivet set**

A rivet set is made of a hardened steel tool 96 to 144mm long. The large end has a deep hole and a shallow cup- shaped hole. The deep hole fits over the rivet and is used to draw the sheets and the rivet together. The cup-shaped hole is used to form the head on the rivet. A rivet set can be used to force rivets directly through thin metal without previously punching a hole. An outlet is at the end of the drawing hole to allow the burrs to drop out. Rivet sets are made in a variety of sizes, with the numbers **00, 0, 1, 2… up to 8**. The number 8 is the smallest size and the number 00 is the largest.

Fig.4.14: rivet set

Faults in riveting;-

	CAUSE	RESULT
1	Hole too large for the diameter of rivet.	Rivet bends
2	Tool little of rivet length projecting	sinking partially filled Round head partially formed
3	Too much of rivet length projecting	Rivet bends Head miss-shaped
4	Rivet head badly position in a rivet set	Miss- shaped head.
5	Inefficient hammer blows.	Badly marked plates Partially formed round head
6	Drilling or punching burrs not removed	Gap left between plates
7	Neglecting to use rivet set	Gap left between plates and rivet forced between the gaps.
8	Rivets not spaced correctly	Plates split

- **Hollow rivets (blind rivet)**

It is a technique which enables a mechanical fastening to be made when access is limited to only one side of the parts to be assembled. You can use also it where access is available to both sides of an assembly. The blind rivet is a two part mechanical fastener

- Headed tubular body mounted on a mandrel
- Mandrel which is set in the setting tool

Operation of the setting tool pulls the mandrel head in to the rivet body causing it ot expand on the blind side of the assembly. When the blind side head is fully formed, continued operation of the setting tool causes the mandrel to break

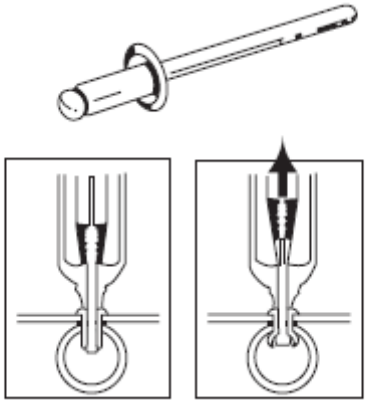


Fig. 4.15: operating principle of hollow rivet

- **Good fastening practice**

Blind riveting is a highly reliable and proven method of fixing material together permanently. To achieve a superior fastening, the following principles should be considered.

- **Work piece materials**

When materials of different thickness or strengths are being joined, the stronger material – if possible – should be on the blind side.

- **Hole size and preparation**

Achieving a good joint depends on good hole preparation, preferably punched and, if necessary, de-burred to the sizes recommended.

- **Rivet diameter**

As a guide for load-bearing joints, the rivet diameter should be at least equal to the thickness of the thickest sheet and not more than three times the thickness of the sheet immediately under the rivet head.

- **Edge distance**

Rivet holes should be drilled or punched at least two diameters away from an edge but no more than 24 diameters from that edge.

- **Rivet pitch**

As a guide to the distance between the rivets in load-carrying joint situations, this distance should never exceed three rivet diameters. In butt construction it is advisable to include a reinforcing cover strip, fastening it to the underlying sheet by staggered rivets.

- **Rivet material**

Choosing rivets of the correct material normally depends on the strength needed in the riveted joint.

- **Setting and safety**

The type of setting tool is usually selected to suit the production environment. The tool must be cleared of spent materials before setting the next rivet and, in the case of power operated tools, **must not** be operated without the mandrel deflector or mandrel collection system being in position. Safety glasses or goggles should always be worn.

1. **Soldering**

It is the process of joining two or more metal pieces by means of an alloy called solder. This alloy or solder made of lead and tin. The melting point of solder is less than the metal to be joined. For soldering, the base metal is heated by soldering iron which also melts solders and flux. The flux (zinc chloride paste) is used to dissolve the oxide film on the surface and also prevents oxidation during soldering. The molten solder fills the space between mating surfaces. It solidifies and forms a strong joint.

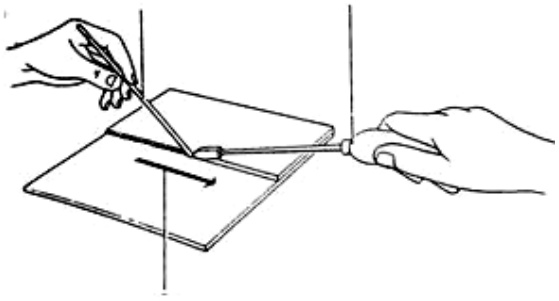


Fig.4.16: Solder

- **Soft soldering**

Soft soldering always tin/lead as joining medium. It is a low temperature thermal process in which the metals being joined are not themselves melted. For a successful joint, the molten solder must adhere to the surface of the parent metal being joined. It does this by reacting with surface layers of the parent metal to form an inter metallic compound called tinning.

The stages in making a soft-soldered joint are

1. Tinning the joint surface
2. Additional molten solder flows between the metal surfaces
3. The molten solder completely fill the space between the surfaces and fussing between the tinned surfaces
4. Solidification of the solder

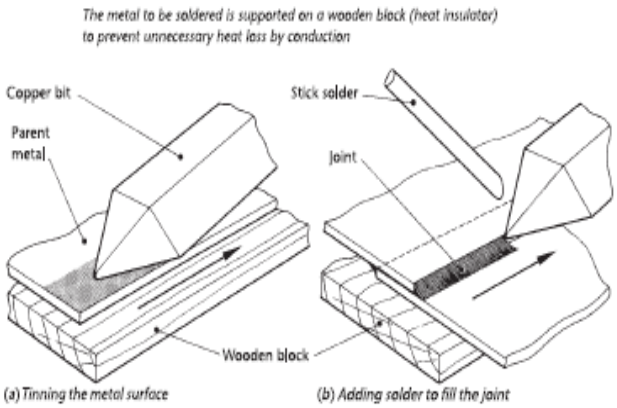


Figure 4.17: Basic stages in soft soldering

Soldering Joints

Soft soldered joints are useful in light sheet metal work. These joints are made on articles which will not be subjected to high temperature and vibrations. The strength of the joints depends much on the:-

- Type of joint
- Type of solder used, and
- Procedures used when soldering

2. Brazing

It is similar to soldering, but it gives much stronger joint. The major difference is that use of a harder filler material called **filler wire** and its melting point is higher than solder, but lower than the metal being joined. In brazing operation the two metal pieces are to be joined must be cleaned. Flux (Borax) is applied on the joint and heated to a temperature just above the melting point of the filler wire. The liquid filler (molten) is distributed between the surfaces by capillary action. After solidification it forms strong joint.

3. Sport Welding

The spot welding is used for joining the sheets by application of heat and pressure at specific locations called spots. In this, the sheets to be joined together are held between two electrodes at required located sports. Normally a high amperage current and low voltage is passed through electrodes causing local heating at that spots. The pressure applied on the

electrodes squeezes the sheet metal at various locations thus joining the two sheets together to form a joint.

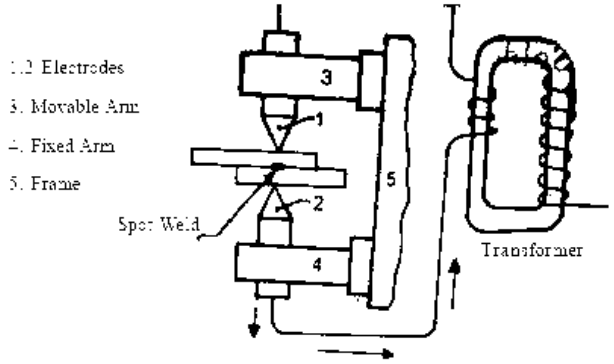


Fig. 4.18: Spot welding

4.4. Electrolysis and problems of joining dissimilar metals

When two different metals are in contact in a corrosive environment, one of the metals experiences accelerated galvanic corrosion while the other metal remains galvanicaly protected. Galvanic corrosion will occur when cathodic and anodic metals are in contact in humid, salty, or outside environments, or in and around water systems

When a metal is immersed in a conducting liquid it takes up an electrode potential (also known as the corrosion potential). This is determined by the equilibrium between the anodic and cathodic reactions occurring on the surface and it is usually measured with reference to a standard electrode such as the saturated calomel electrode (SCE). Bimetallic corrosion occurs when two metals, with different potentials, are in electrical contact while immersed in an electrically conducting corrosive liquid, Because the metals have different natural potentials in the liquid, a current will flow from the anode (more electronegative) metal to the cathode (more electropositive), which will increase the corrosion on the anode, see Figure below.

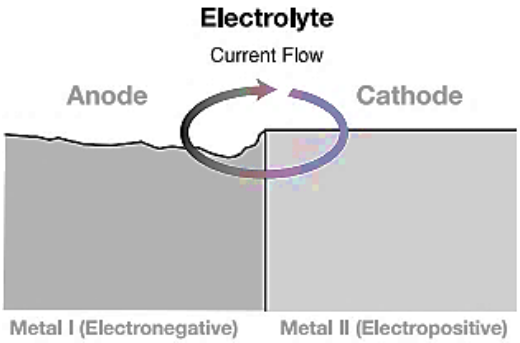


Fig.4.19: Method of bimetallic corrosion

This additional corrosion is bimetallic corrosion. It is also referred to as a galvanic corrosion, dissimilar metal corrosion or contact corrosion.

In general, the reactions which occur are similar to those that would occur on single, uncoupled metal, but the rate of attack is increased, sometimes dramatically. With some metal combinations the change in the electrode potential in the couple potential can induce corrosion which would not have occurred in the uncoupled state (e.g. pitting). In some environments the change in potential of the cathode in the couple can also introduce problems (e.g. hydrogen embrittlement)

The effect of coupling the two metals together increases the corrosion rate of the anode and reduces or even suppresses corrosion of the cathode. Hence, coupling a component to a sacrificial anode can prevent corrosion, and this is the principle of cathodic protection, which is discussed in a separate publication in this series.

- **Electrolyte**

Electrolyte factors that have a major influence on bimetallic corrosion are composition, pH value and, in particular, electrical conductivity, which affects both the intensity and distribution of corrosion. The severity of corrosion often increases with increasing electrical conductivity of the electrolyte because, in practice, high conductivity is often caused by the presence of aggressive ions such as chloride, or by acid or alkali.

Table: Fastener Effects

The following chart can be used to guide the selection of fasteners based on galvanic action:

Base Metal	Fastener Metal					
	Zinc & Galvanized Steel	Aluminum & Aluminum Alloys	Steel & Cast Iron	Brasses, Copper, Bronzes, Monel	Martensitic Stainless (Type 410)	Austenitic Stainless Steel (Type 302/304, 303, 305)
Zinc & Galvanized Steel	A	B	B	C	C	C
Aluminum & Aluminum Alloys	A	A	B	C	Not Recommended	B
Steel & Cast Iron	AD	A	A	C	C	B
Terne (Lead Tin) Plated Steel Sheets	ADE	AE	AE	C	C	B
Brasses, Copper, Bronzes, Monel	ADE	AE	AE	A	A	B
Ferritic Stainless Steel (Type 430)	ADE	AE	AE	A	A	A
Austenitic Stainless Steel (Type 302/304)	ADE	AE	AE	AE	A	A

Key:

A. Corrosion of the base metal is not increased by the fastener.

B. Corrosion of the base metal is slightly increased by the fastener.

C. Corrosion of the base metal is significantly increased by the fastener material.

D. Plating on the fasteners is rapidly consumed, leaving the bare fastener metal.

E. Corrosion of the fastener is increased by the base metal.

- **Joining dissimilar metal by brazing**

Brazing is ideally suited for joining of dissimilar metals and is performed at relatively low temperature. We've said that a brazed joint "makes itself" or that **capillary action**, more than operator skill, insures the distribution of the filler metal into the joint. But even a properly-designed joint can turn out imperfectly if the correct brazing process steps are not followed. For more information about capillary action during brazing see this video: https://www.youtube.com/watch?v=3zUA6Pet_ok

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

I. Choose the best answer.

1. One of the following joining technique is not permanent
   A. Riveting
   B. Soldering
   C. Seaming
   D. Welding
2. _____is a process of inserting metal pin in to a hole and clinching it so there is a head at each end
   A. Soldering
   B. Seaming
   C. Riveting
   D. Joining
3. During riveting, if rivet bends it is effect of
   A. Rivet too short
   B. Hole too large
   C. Rivet too long
   D. Rivet close together
4. When you want to assemble/join component to be water tight, you use
   A. Soft soldering
   B. Riveting
   C. Seaming
5. A single seam bent over against the body of the job is
   A. Single seam
   B. Double seam
   C. Grooved seam

II. Match part A to part B

A	B
____1. Notching	A. Metal pins like bolt without threads
____2. Spring back	B. A low temperature thermal process
____3. Rivets	C. The removal of metal from edge/corner of sheet metal
____4. Seaming	D. Self-secured joint
____5. Soldering	E. Slight recovery of shape after bending

Operation Sheet 1	Techniques of Laying out and cutting on a given sheet metal

Techniques of Laying out and cutting on a given sheet metal procedures are:

Step 1- Observed safety precautions, use appropriate PPEs

Step 2- Clean the surface of sheet metal by cleaning materials

Step 3- Copy the given drawing on the drawing papers.

Step 4- Collect the necessary tools and sheet metal.

Step 5- Draw the layout on the work material by using measuring tools and laying out tools.

Step 6- Cut the Sheet along the marked out line by using cutting tools or equipment.

Step 7- Check the edges of sheet for straightness and perpendicularity with the help of try square.

Step 8- Mark the necessary lines to practice straight line cutting.

Step 9- Cut the sheet along the marked lines using straight snips and straighten the sheet by the mallet.

Step 10- Check the dimensions and finish the model.

Operation Sheet 2	Technique of cutting sheet metal by snips

The procedures of cutting sheet metal by snips are:

Step 1- Observed safety precautions, use appropriate PPEs

Step 2- Depending on your project, select types of snip (straight, left, right) angle.

Step 3- Align the tin snips with the sheet metal, if necessary clamp the sheet metal in place on your work table to hold it in place while you work.

Step 4- Make your first cut in the sheet metal, once your tin snips make contact with the sheet metal, squeeze the handles with your fingers to make the first cut.

Step 5- Continue cutting through the sheet metal as needed.

https://www.wonkeedonkeetools.co.uk/tin-snips-and-aviation-snips/how-to-use-tin-snips/

https://makezine.com/2015/06/24/skill-builder-working-with-sheet-metal/

Operation Sheet 3	Techniques of Joining the given dimension of material using seam

Procedures of joining the given dimension of material using hem, single seam, double seam, lap seam and wired edge are:

Step 1-Use the proper personal protective equipment, and sheet metal work shop should be comfortable to work.

Step 2-Cut the two pieces of sheet metals with the required size.

Step 3-Place the metal on a flat stack and flatten the seam slightly with mallet be sure to keep the two piece tightly hooked.

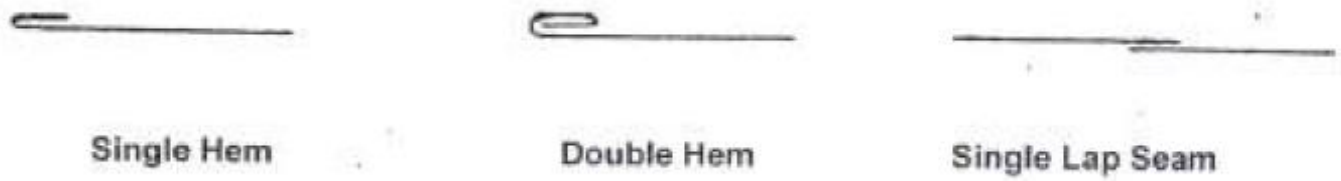
Step 4-Select the proper size of hand groovier.

Step 5-Place the groovier the seam at one end and strike lightly, but firmly with a hammer making a single seam.

Step 6-Make the balance of seam by moving the groovier along the seam.

Step 7-Flatten the seam with mallet to make it smooth completing the single seam.

Step 8-Measure the metal and determined how much metal was used to form the seam.



Single Hem Double Hem Single Lap Seam

Making a Wired Edge

Operation Sheet 4	To make a locked grooved joint as the given dimension

Making a locked grooved joint as the given dimension follows these procedures:

Step 1-Observed safety precautions and wear appropriate PPEs

Step 2-Copy the given drawing.

Step 3-Collect the tools and sheet metal.

Step 4-Draw the layout on the work material.

Step 4-Cut the Sheet along the marked out line.

Step 5-Check the edges of sheet for straightness and perpendicularity with the help of try square.

Step 6-Mark all the necessary lines to make the required model of size132 X 90mm.

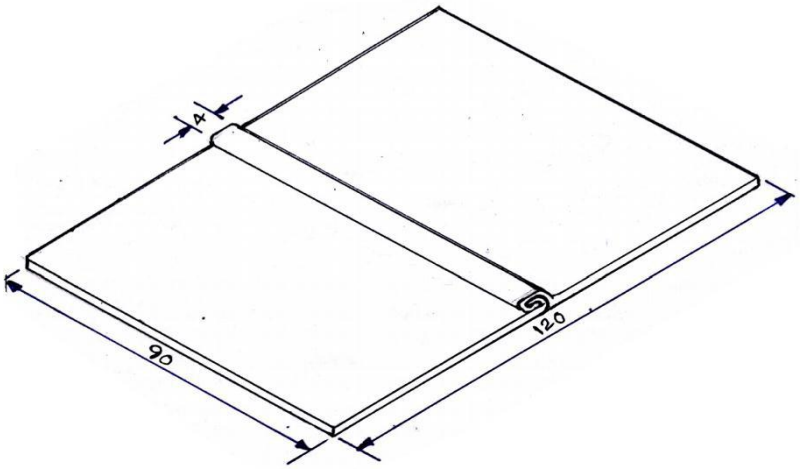
Step 7-Cut the sheet into two of size 66 X 90mm.

Step 8-Mark the necessary line to form the hook on each, need for bending.

Step 9-The hooks were fold together to form the joint by striking with mallet.

Step 10-Locked the joint with the help of hand groover and finished the model.

Step 11-Finish the model and check all the dimensions



Making a Grooved Seam

Operation Sheet 5	Techniques of making book rake store using mild steel sheet

Techniques of making book rake store using mild steel sheet Procedure are as follows:

Step 1-Mark and shear a piece of 18x14cms mild sheet with the help of lever shearing machine, check for square ness with try square.

Step 2-Mark two corner edges at diagonals of 20cm and at base mark a line 50mm from the edge with scriber and steel rule

Step 3-Mark lines on all the three sides of 40cm distance with scriber and an arc of 30cm with divider as shown in diagram

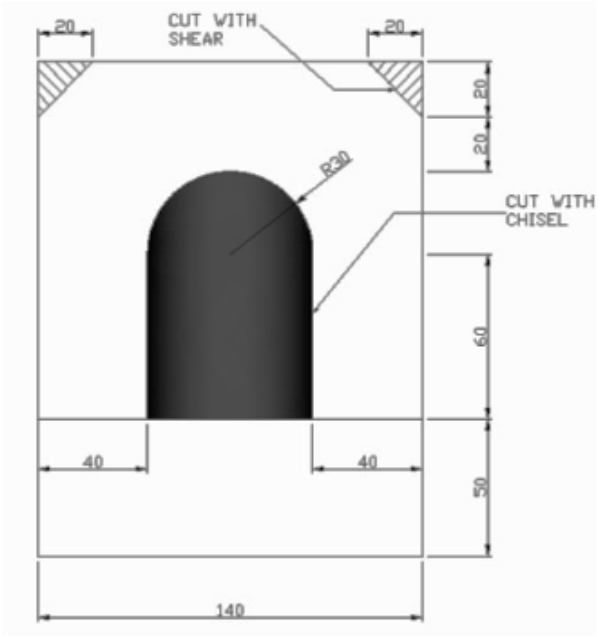
Step 4-Shear the 20cm diagonal edges and cut the inner marking piece with the help of chisel hammer

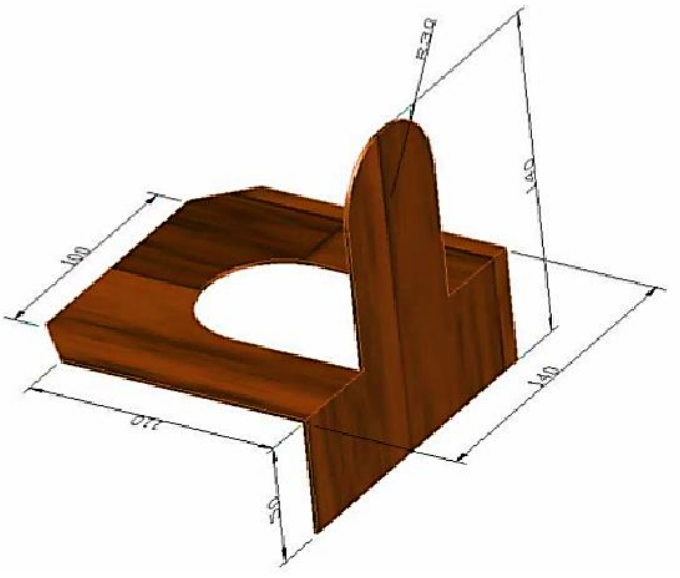
Step 5-Clam the sheet in bench vice and bend the inner cut portion by hammer at 90^0

Step 6-File the inner cut and portion and the blanking with half round and steel file

Step 7-Bend the 50 cm mark portion to opposite side at 90^0 as shown in diagram

Step 8-Finish the job from sharp edge with smooth file



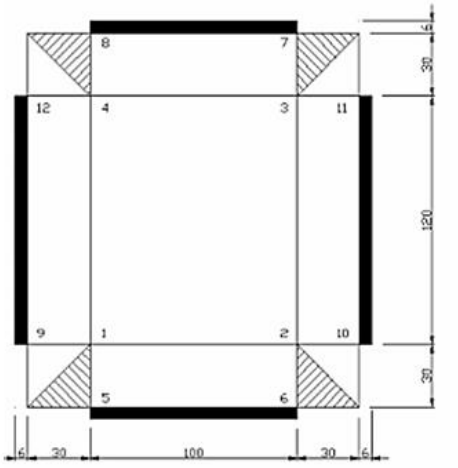


Operation Sheet 6	Sequence of operation to prepare tray and dustpan in sheet metal

Sequence of operation to prepare tray and dustpan in sheet metal are:

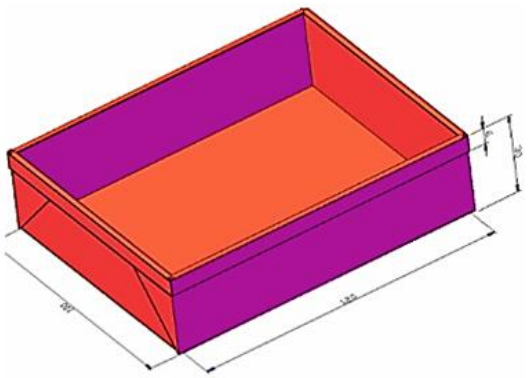
1. Draw 2D/3D sketch as per scale.
2. Draw the development considering all lines must be “TRUE LENGTH”.
3. Construct the base of the Tray/Dust pan.
4. Construct the two sides of the Tray /Dust pan.
5. Construct the two ends of the Tray or Dust pan.
6. Set 5mm extra allowance on side face for joining the corners by seaming.
7. Notch the point to prevent bulging in seaming.
8. Cut the development shape on lines by using scissor.
9. Place and fix the development on given G.P sheet by using Sticker.
10. Punch two thin points on each bending line.
11. Mark the boundary lines and bending lines with scriber and again mark with marking pen for visible.
12. Shear the boundary line with hand snip or shearing machine.
13. Flatten the sheet by using the mallet on flatter.
14. Always bend seaming line first then the remaining lines to get the desired shape.
15. Perform the forming operation with using suitable stake.
16. Solder the joints.
17. Finish the surface finishing and complete the Tray or Dustpan.

Development of Surfaces (Tray)



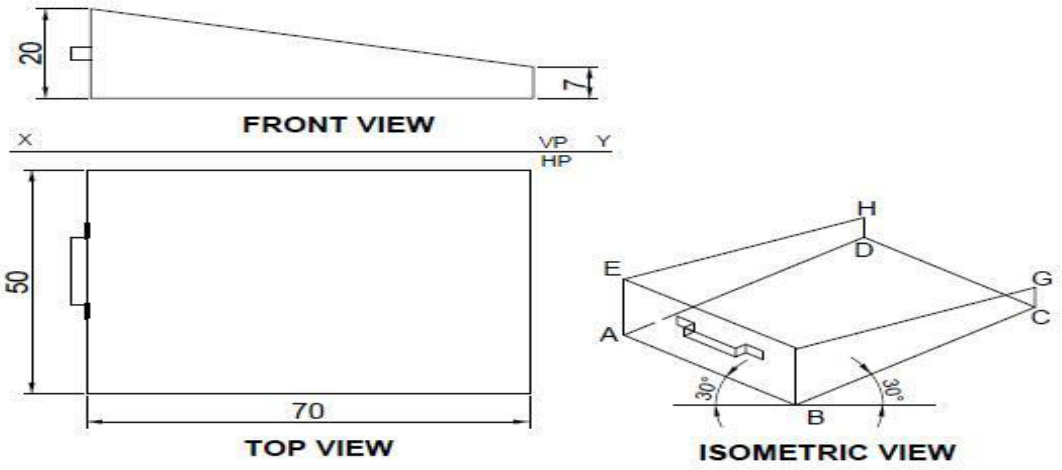
Black portion is to be bend (hem).
Hatched portion is to be cut out.
All Dimensions are in mm

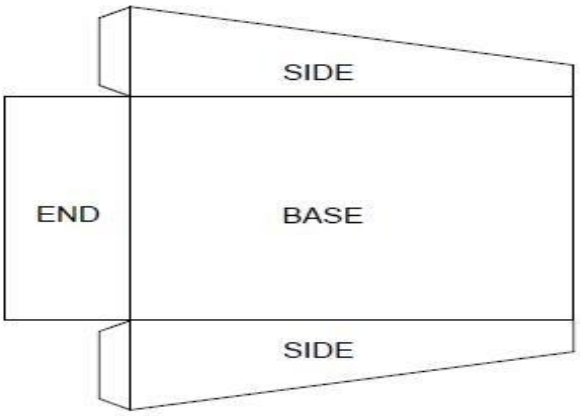
To make a rectangular tray.



MATERIAL: GI SHEET 28 SWG
ALL DIMENSIONS ARE IN mm.

DUST PAN





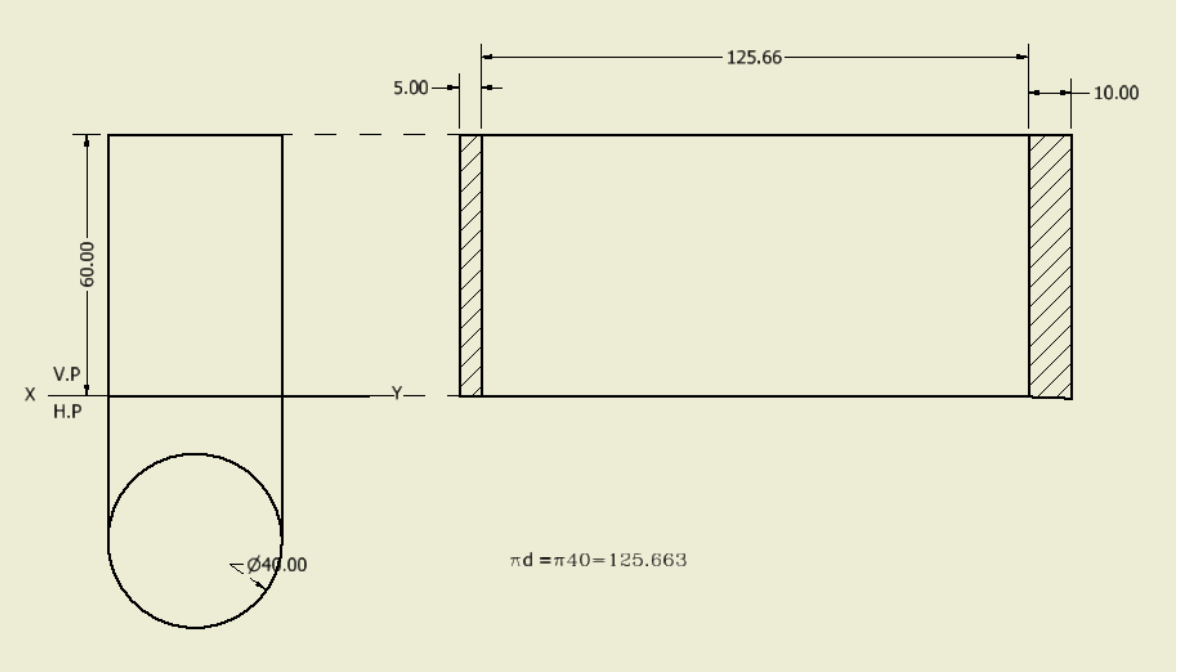
DEVELOPMENT OF DUST PAN

All Dimension are in mm

Operation Sheet 7	Making a Cylinder using the given G.I. Sheet or mild steel sheet

To make a Cylinder using the given G.I. Sheet or mild steel sheet you can follow these procedures:

1. Clean the given sheet with cotton waste.
2. Draw the orthographic view as shown in above figure and check with steel rule the size of the given sheet.
3. Mark the measurement and make the development surface sketch diagram.
4. The layout of the cylindrical shape pipe is marked on the given sheet
5. Set 5mm and10mm extra allowance for joining at the ends.
6. Trace the development on given G.P.sheet (galvanized plain sheet 28 gauge) and mark all bending lines
7. Cut the sheet along the line according to the development shape
8. Bend the seam line using bending dies or to the required shape using stakes and mallet.
9. Fold extra allowances in clockwise and anticlockwise directions by keeping hacksaw blade thickness and pressed
10. Remove hacksaw blade, and bend main body using rectangular stake and lock end joint and lock
11. Now the edges are slightly bent to one is one side and the other is opposite side, using stakes and mallet.
12. Join both the ends with in a cylindrical shape.
13. Finish all rectangular faces and longer edges using rectangular faced stakes

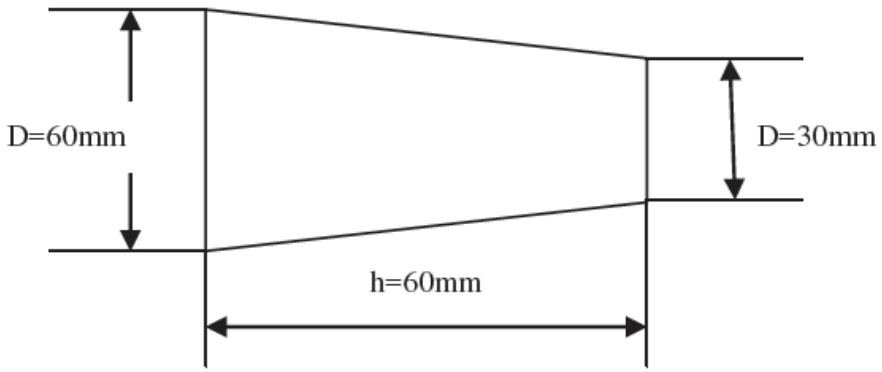


Operation Sheet 8	To make the pattern of sheet metal frustum of cone, cut the development, bend and form to final frustum of cone shape and solder the joint.

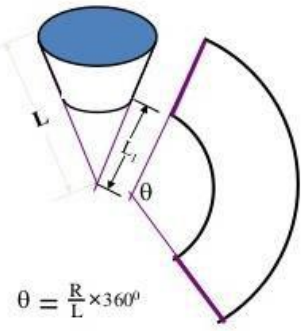
The procedures to draw the development of sheet metal frustum of cone, cut the development, bend and form to final frustum of cone shape and solder the joint are:

Procedure:

1. The development including calculations of the model is done and drawn on a sheet and sketch book.
2. Using the development sketch the same is redrawn on the sheet metal to be formed by using scale, scriber, divider etc.
3. Using stakes, form blocks bends are made by mallet on all bend lines.
4. Using a final shaped form block, hammer, the exact shape is formed by hammering on all the bend lines by trial and error.
5. Each joint is held tightly by pliers and soldering is done by a soldering gun, flux and solder by heating suitably and also by seaming joints
6. The soldered joint is then cleared of flux, slag etc and the model is complete.



DEVELOPMENT OF
FRUSTUM OF CONE



R= Base circle radius of cone
L= Slant height of cone
L_1 = Slant height of cut part.

LAP Test	Practical Demonstration

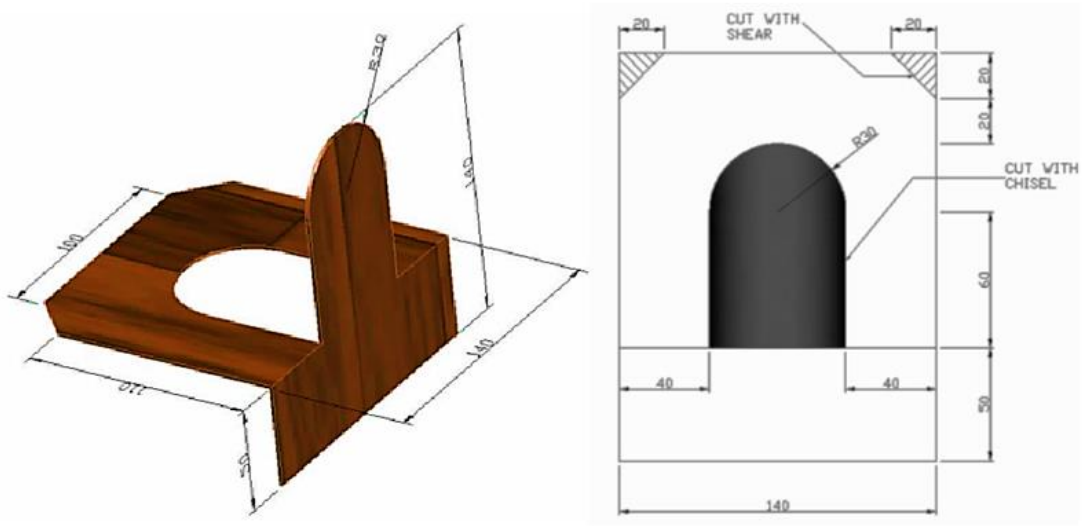
Name: _____ Date: _____

Time started: _____ Time finished: _____

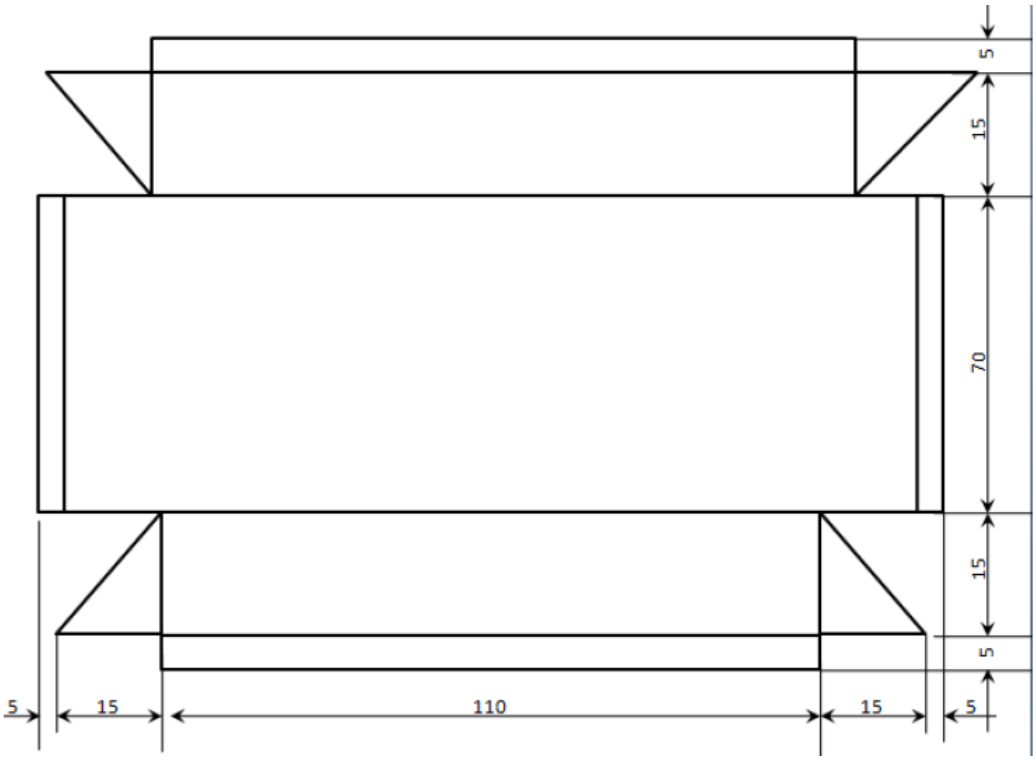
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

Task 1: perform Laying out and cutting operations

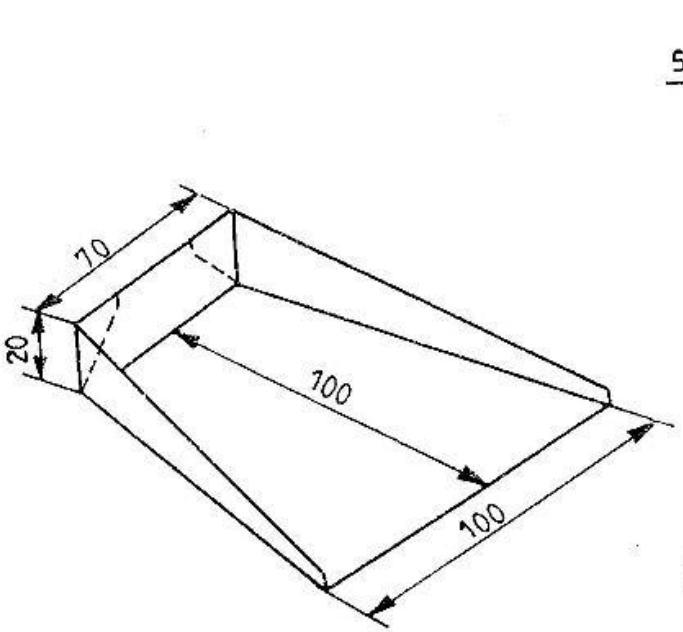
Task 2: making book rake store using mild steel sheet



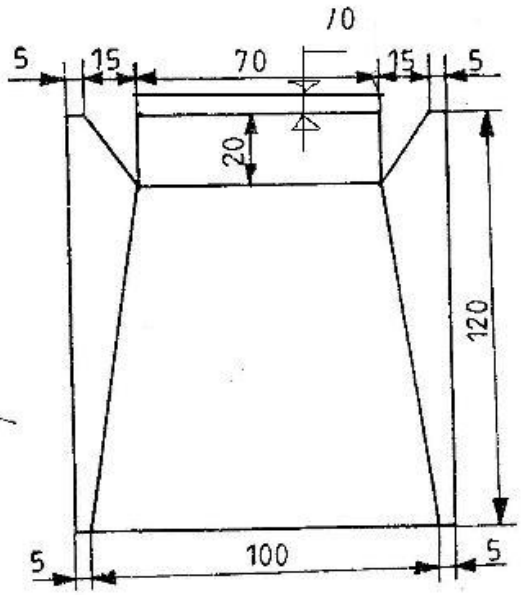
Task 3: prepare tray (rectangular dish) in mild steel sheet metal



Task 4: Make an open scoop as per the given dimensions by using mild steel sheet metal

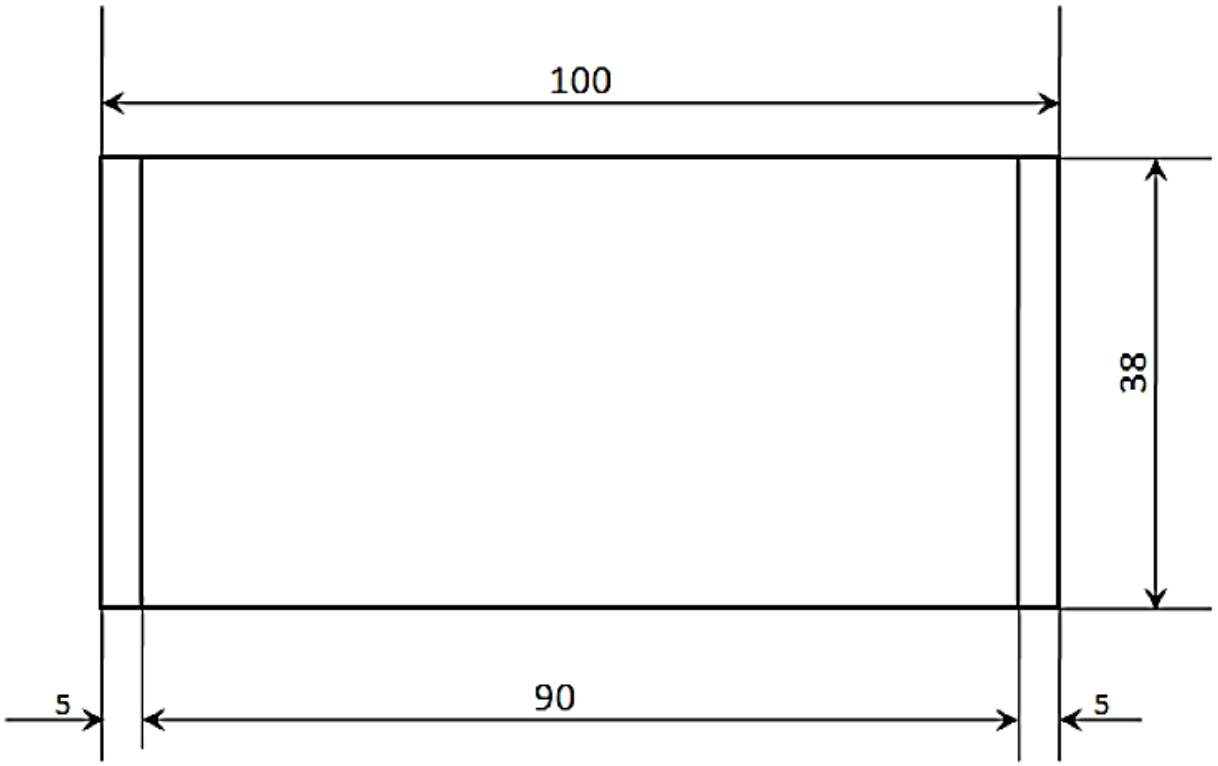


Open scoop

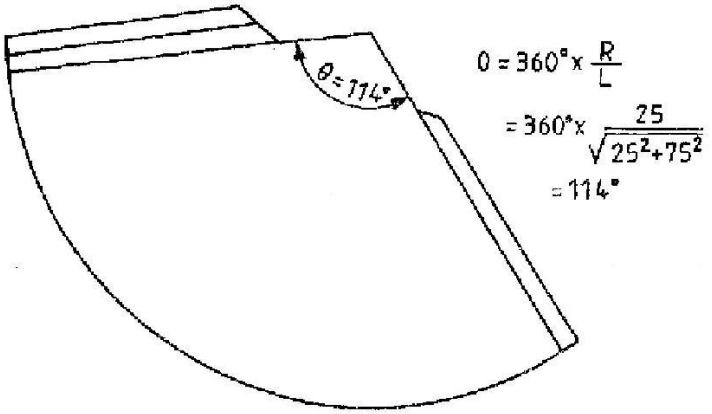


Development

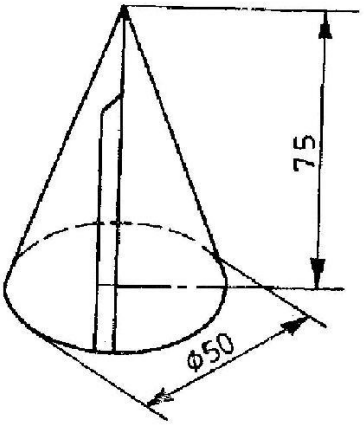
Task 5: Make a Cylinder using the given G.I. Sheet or mild steel sheet



Task 6: Make **frustum of cone** using the given G.I. Sheet or mild steel sheet



b
Development



a
Cone

List of Reference Materials

1. “Layout and Fabrication of sheet metal and fiberglass duct”, NAVEDTRA 14250A, Chapter 13.
2. “student safety guidelines”: Technology,
3. Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”, PHASE 2, Module 1, Michael Kelly, © SOLAS 2014
4. http://www.bing.com/videos/search?q=how+to+use+a+box+and+pan+brake&&view=detail&mid=0B5F895025F7C74515AE0B5F895025F7C74515AE&&FORM=VRDGAR
5. https://www.bitswgl.ac.in/ME/233814041-Engineering-Workshop-i-Lab-Manual_1st%20year.pdf
6. http://cittumkur.org/manuals/mech/workshop_manual_2016.pdf
7. https://sjce.ac.in/wp-content/uploads/2018/04/Workshop-Laboratory-Manual.pdf
8. https://dsceme.files.wordpress.com/2016/08/workshop-practice-manual-2016-17-1.pdf
9. https://youtu.be/IObgZ5gYWIE

Basic Metal Works

Level-I

Learning Guide-39

Unit of Competence: Cut and Join Sheet Metal

Module Title: Cutting and Joining Sheet Metal

LG Code: IND BMW1 M11 LO4-LG-37

TTLM Code: IND BMW1 M11 TTLM 1019v1

LO4: Quality assures work and clean up

Instruction Sheet	Learning Guide: 39

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

- Inspecting and measuring aligned, joined and sealed components
- Cleaning, checking, maintaining and storing work area, tools and equipment
- Completing documentation

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

- Inspect and measure aligned, joined and sealed components visually according to specifications
- Clean work area and check, maintain and store tools and equipment in accordance with regulations and procedures
- Complete documentation in accordance with workplace requirements

Learning Instructions:

17. Read the specific objectives of this Learning Guide.
18. Follow the instructions described below 3 to 6.
19. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3 in page 96,101 and 105 respectively”.
20. Accomplish the “Self-check 1, Self-check 2 and Self-check 3 in page -100, 104, and 107 respectively.

Information Sheet-1	Inspecting and measuring aligned, joined and sealed components

1.1. Inspection

Inspection is an organized examination or formal evaluation exercise. In engineering, inspection involves the measurements, tests, and gages applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

1.2. Visual inspection of double seam defects

There are numerous double seam defects that can arise during the fabrication process. There is a list of the most common double seam defects that are detected by the product of double seam. We have several seam analysis products that can inspect double seams and provide easy-to-use information to ensure your double seam quality.

- **Seam Impression**

As the rollers push the cover and body hook materials together, and against the seaming chuck, an impression is left on the inside of the can body. Too much pressure can cause this impression to damage the can liner.

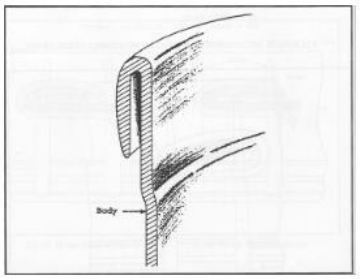


Fig.1.1: Seam impression

- **Seam bumps**

A seam bump is a short area of the double seam where the seam thickness suddenly increases by .004″ or more.

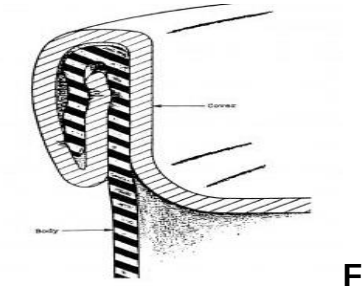


Fig. 1.2: Seam bups

- **Sprung seam**

A sprung seam is a condition where the seam is pulled away from the body wall. In some extreme cases, the seam is pulled away from the body wall the entire way around the can.

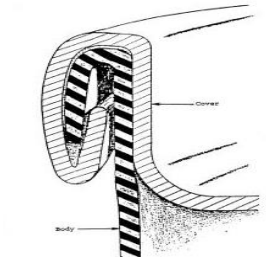


Fig.1.3: Sprung seam

- **Sharp seam**

A sharp seam is a condition where the seam has a sharp edge or radius on the upper inside edge of the countersink wall.

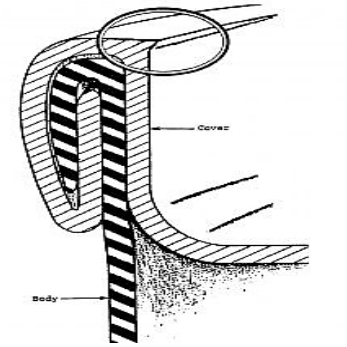


Fig.1.4:Sharp seam

- **Cut over**

A cut over is a critical defect where the metal is fractured at the top of the seaming chuck wall.

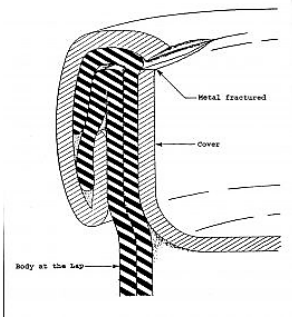


Fig.1.4: Cut over

- **False seam**

A false seam is a critical defect which occurs when the cover and the body hooks do not interlock around the can seam's circumference.

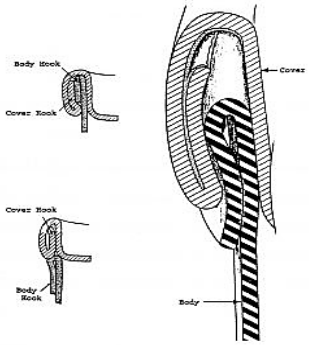


Fig.1.5: False seam

- **Loose first operation seam**

A loose first operation seam may not allow sufficient tuck up of cover curl to form a sufficient amount of cover hook and overlap.

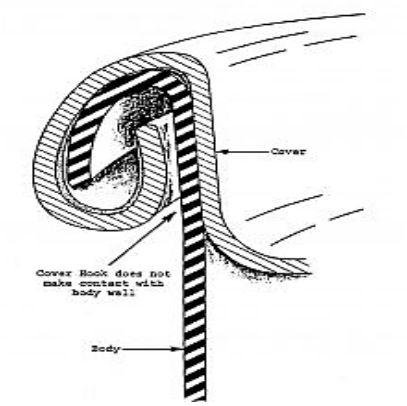


Fig.1.6: loose first operation seam

- **Tight first operation seam**

A tight first operation seam can create flatness on the bottom of the first operation seam throughout its length. The cover hook may also be turned back into the body hook.

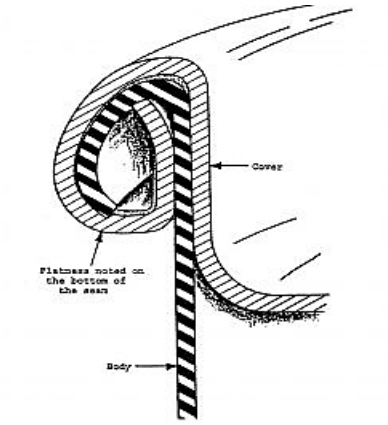


Fig.1.7.Tight first operation seam

1.3. Types of Resistance Welding Defects

When resistance welds are done incorrectly, it can lead to a few different defects—ones that manufacturer should look out for:

- **Spattering**

While weld spatter is common for processes that rely on a separate substance to act as a bonding agent, in resistance welding, it's a sign of a defective weld. Splatter is often caused by the use of too strong a current to form the weld.

Here, the spattered material is loose metal that was accidentally burned away by intense heat. The loss of material at the weld site can weaken the overall strength of the finished product.

- **Indented Surfaces**

Creating consistent spot welds requires incredibly precise control over the pressure applied to the metal surfaces to be joined. When too much pressure is applied resistance to electrical current decreases, keeping the metal from reaching proper welding temperature.

When inspecting a resistance-welded object, heavy indentations can be an indication that parts were pressed too tightly together. This may indicate a weak weld that wasn't properly executed.

- **Cracks in the Weld Area**

Too much pressure may reduce weld heat, but too little pressure also creates problems. When there isn't enough pressure from the weld electrodes at the weld site, the welded joint may become porous or even show signs of cracking.

Cracks at the site of a spot weld may indicate a low tensile strength for the weld, as the two pieces of metal weren't properly joined.

- **Asymmetrical Spot Weld Marks**

The vast majority of the time, a well-executed resistance spot weld mark should have a perfectly round shape, or at least conform to the shape of the welding heads used to join the two pieces of metal.

Shapes that are asymmetrical indicate imperfections in the weld, such as misaligned electrodes or the presence of foreign contaminants at the weld site. This creates a weaker weld that will be more likely to break under pressure.

- **Expulsion of Metal near Weld Site**

Molten metal seeping from the area where two pieces of metal are joined can indicate any number of problems with the weld, such as:

- Insufficient weld pressure;
- Mistiming of the weld;
- Excessive current used; and
- Surface contamination

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

Match part A to part B

Column A	**Column B**
____1. Seam Impression	A. Surface contamination
____2. Expulsion of Metal Near Weld Site	B. Defect where the metal is fractured at the top of the seaming chuck wall
____3. Crack at weld area	C. Too much pressure causes it to damage the can liner.
____4. False seam	D. Created by too little pressure
____5. Cut over	E. A defect which occurs when hooks do not interlock

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet- 2	Cleaning, checking, maintaining and storing work area, tools and equipment

2.1. Cleaning, checking, maintaining and storing work area, tools and equipment

Identify work areas to be cleaned and maintained, work equipment to be cleaned and maintained, Identify and locate instructions in relation to cleaning and maintenance, Assess area to be cleaned. Select appropriate cleaning equipment and chemicals. Select the protective clothing and equipment to be used. Dispose of waste, Return area to operational condition, Clean, check and store cleaning equipment and chemicals.

2.1.1. Cleaning your work area

Cleaning your work area makes it a safe and pleasant environment for your customers to shop. The cleaning of your work area must be carried out on a regular basis. The quick and easy jobs can be carried out during the day, while other larger tasks such as vacuuming might be done before the shop opens, or at the end of the day's trading. In some larger retail stores, professional cleaners may be used for the larger tasks, but it is still your responsibility to keep your own work area clean and tidy.

In this activity you will learn about cleaning procedures and how to dispose of waste correctly. You will also learn how to handle spills or other potential hazards efficiently to protect customers and your workmates from potential injury.

Poor housekeeping can be a cause of incidents, such as:

A. tripping over loose objects on floors, stairs and platforms
B. being hit by falling objects
C. slipping on greasy, wet or dirty surfaces
D. striking against projecting, poorly stacked items or misplaced material
E. cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

Effective housekeeping results in:

F. reduced handling to ease the flow of materials
G. fewer tripping and slipping incidents in clutter-free and spill-free work areas
H. decreased fire hazards
I. lower worker exposures to hazardous products (e.g. dusts, vapours)
J. better control of tools and materials, including inventory and supplies

K. more efficient equipment cleanup and maintenance
L. better hygienic conditions leading to improved health
M. more effective use of space
N. reduced property damage by improving preventive maintenance
O. less janitorial work
P. improved morale
Q. improved productivity (tools and materials will be easy to find)

2.1.2. Checking and cleaning tools and equipment

Keeping tools properly storing, cleaning, and maintaining will save time and money. In order to keep tools in good working condition during storage, there are some basic preparatory steps that should be taken. It is important to follow the cleaning and storage instructions, especially for larger power tools such as power saws or plate compactor.

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide an orderly arrangement. Returning tools promptly after use reduces the chance of it being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

2.1.3. Maintaining of tools and equipment

The maintenance of tools and equipment may be the most important element of good housekeeping. Maintenance involves keeping tools, equipment and machinery in safe, efficient working order and in good repair. It includes maintaining sanitary facilities and regularly painting and cleaning walls. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause incidents and affect work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes.

Maintenance of equipment's: Maintenance of sheet metals machines

- ✓ Changing worn blade
- ✓ Changing deformed gasket
- ✓ Operating frequently
- ✓ Changing oil monthly
- ✓ Greasing rotating or vibratory parts
- ✓ Regular Lubrication
- ✓ replacement of worn parts

Maintenance of Grinder

- ✓ lubricating with cleaned oil
- ✓ Replacing of worn parts of grinding machine.
- ✓ Cleaning dusts and other materials
- ✓ Changing worn blade

2.1.4. Storing tools and equipment's

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual material handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one metre (or about three feet) of clear space under sprinkler heads.

Stacking cartons and drums on a firm foundation and cross tying them where necessary, reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction. https://www.ccohs.ca/oshanswers/hsprograms/house.html

2.1.5. How to Prepare and Store Tools

1. To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.
2. After cleaning, damage or defects should be checked. If the tool cannot be repaired, it should be thrown to away.
3. Any soil and dirt should be scraped away from the metal surfaces with an approved solution. Before placing in storage it should be dried with a towel or rag.
4. The metal parts of the tools should be coated with a lubricant protector spray.
5. Tools is does not directly stored on the ground both small hand and power tools should be Placed on shelving.
6. Short-handled tools should be stored in a plastic bin or box. All surfaces of Power tools should be cleaned and completely dry before storage and Spraying lubricants

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

14. Which one is not the result of poor housekeeping?
    A. Tripping over loose objects on floors, stairs and platforms
    B. Being hit by falling objects
    C. Slipping on greasy, wet or dirty surfaces
    D. Decreased fire hazards

15. Keeping tools properly storing, cleaning, and maintaining will:
    A. Increase the cost
    B. Save time and money
    C. Reduces the chance of it being misplaced or lost.
    D. B&C
    E. All

16. The maintenance of tools and equipment involves:
    A. Keeping tools
    B. Equipment and machinery in safe
    C. Efficient working order and in good repair.
    D. All of the above

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet- 3	Completing documentation

3.1. Completing documentation

A **document** is a material that provides official information as evidence. It is Information used to support effective and efficient manufacturing operations. Like design, process and finished products.

Design is the process of defining, visualizing and documenting fabrication requirements for sheet metal prior to the manufacturing process.

Fabrication is the process of taking the completed fabricated product or pieces to make a complete product and then fitting them into their required location off-site.

Installation is the process of taking the completed fabricated product or pieces to make a complete product and then fitting them into their required location off-site.

3.2. Product Instructions (directions, or requirements)

Specifications:- Describe in detail the requirements with which the products or materials used or obtained during manufacture have to conform. They serve as a basis for quality evaluation.

Manufacturing Formulae, Processing, Packaging and Testing Instructions: Provide detail all the starting materials, equipment and computerized systems (if any) to be used and specify all processing, packaging, sampling and testing instructions. In process controls and process analytical technologies to be employed should be specified where relevant, together with acceptance criteria.

Procedures: (Otherwise known as Standard Operating Procedures, or SOPs), give directions for performing certain operations.

Manufacturing Formula and Processing Instructions

Approved, written Manufacturing Formula and Processing Instructions should exist for each product and batch size to be manufactured.

The Manufacturing Formula should include:

- The name of the product, with a product reference code relating to its specification;
- A description of the fabrication form, strength of the product and batch size;
- A list of all starting materials to be used, with the amount of each, described; mention should be made of any substance that may disappear in the course of processing;
- A statement of the expected final yield with the acceptable limits, and of relevant intermediate yields, where applicable

The Processing Instructions should include:

- A statement of the processing location and the principal equipment to be used;

- The methods, or reference to the methods, to be used for preparing the critical equipment (e.g. cleaning, assembling, calibrating, sterilising);
- Checks that the equipment and work station are clear of previous products, documents or materials not required for the planned process, and that equipment is clean and suitable for use;
- Detailed stepwise processing instructions [e.g. checks on materials, pre-treatments, sequence for adding materials, critical process parameters (time, temp etc)];
- The instructions for any in-process controls with their limits;
- Where necessary, the requirements for bulk storage of the products; including the container, labeling and special storage conditions where applicable;
- Any special precautions to be observed.

3.3. Packaging Instructions

Approved Packaging Instructions for each product, pack size and type should exist. It should include, Name of the product; including the batch number of bulk and finished product and a complete list of all the packaging materials required, including quantities, sizes and types, with the code or reference number relating to the specifications of each packaging material.

Testing

There should be written procedures for testing materials and products at different stages of manufacture, describing the methods and equipment to be used. The tests performed should be recorded.

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. It is the process of defining, visualizing and documenting fabrication requirements for sheet metal prior to the manufacturing process.

A. Fabrication B. Design C. installation D. None

2. Which one is used to give directions for performing certain operations?

A. Manufacturing formulae B Manufacturing testing C. procedures

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

List of Reference Materials

1. “Layout and Fabrication of sheet metal and fiberglass duct”, NAVEDTRA 14250A, Chapter 13.
2. “student safety guidelines”: Technology,
3. Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”, PHASE 2, Module 1, Michael Kelly, © SOLAS 2014
4. http://www.bing.com/videos/search?q=how+to+use+a+box+and+pan+brake&&view=detail&mid=0B5F895025F7C74515AE0B5F895025F7C74515AE&&FORM=VRDGAR
5. https://www.ccohs.ca/oshanswers/hsprograms/house.html

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