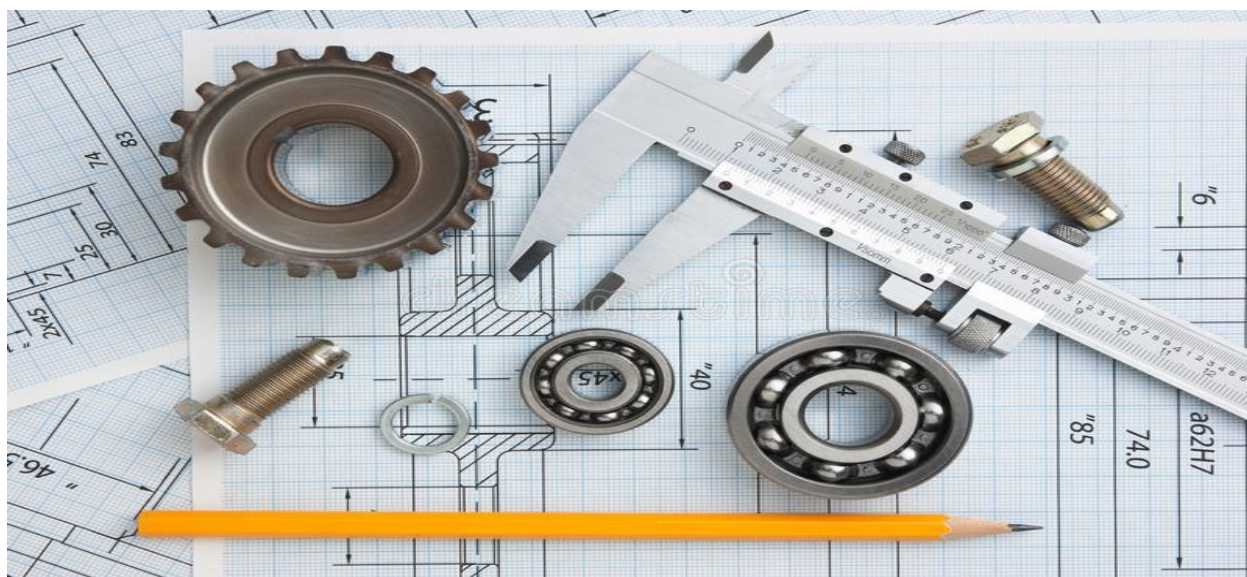


Biomedical Equipment Servicing

Level – II

Based on September 2021, curriculum Version-II



MODULE TITLE: Preparing and Interpreting Technical Drawing

MODULE CODE: HLT BES2 M03 0822

NOMINAL DURATION: 50 Hours

August, 2022

Addis Ababa, Ethiopia

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Table of Contents

Table of Contents	II
List of Figures	III
Acknowledgement	V
Acronyms	VI
Introduction	1
Unit one: Technical Drawing Workstation	3
1.1 kinds of technical drawings	3
1.1.1 Types of technical drawing projection	5
1.2 Selecting and segregating correct technical drawing	7
1.2.1 Technical drawing	7
1.2.2 Preparation of technical drawing	8
1.3 drawing tools and instruments	11
1.3.1 Types of drawing tools and equipment	11
1.4 Applying 3S procedures	17
1.4.1 3S	18
Self-check -1	18
Unit two: Construct and interpret technical drawing	20
2.1 components, assemblies and objects of Technical Drawing	20
2.2 Dimensions of objects	21
2.2.1. Dimension	21
2.2.2 Units of Measurement	23
2.3 symbols views and lines	27
2.3.1 Symbols	27
2.3.2 Views	38
2.3.3 Lines	40
2.4 Constructing basic drawings/schematics	42
2.4.1 Electrical schematics	42
2.4.2 Types of electrical/electronic diagrams	43
2.4.3 Types of Circuit	44
2.5 Interpreting diagrams and drawings	49
2.6 Checking and validating drawing	50
Self-check 2	51
Operation sheet-1	52
LAP Test	53
Unit three: Store technical drawings and equipment /instruments	54

3.1 Handling of drawing instruments.....	55
3.2 Recording.....	55
3.3 Storing drawing instruments	56
Self-check 3	57
Reference	58
Developers Profile	59

List of Figures

Figure 1.1 Artistic drawing	4
Figure 1.2: Technical drawing	5
Figure 1.3: parallel and prospective projection	6
Figure 1.4: plane of projection	6
Figure 1.5 : point projection.....	7
Figure 1.6: 3D geometric shape.....	9
Figure 1.7: block diagram	10
Figure 1.8: schematic diagram	10
Figure 1.8: T-square	12
Figure 1.9: Drawing board.....	13
Figure 1.10: Tracing paper	13
Figure 1.11: compass	13
Figure 1.14: Circle and Ellipse template.....	15
Figure 1.14: French curve	15
Figure 1.15: Compos	15
Figure 1.16: Drawing Pencils	16
Figure 1.17: Pencil sharpener	16
Figure 1.18: Erase	17
Figure: 1.19: Ruler.....	17
Figure: 1.20: Scales:	17
Figure 2.1 : dimension	22
Figure 2.2 Dimension.....	22
Figure 2.3 Dimension line.....	24
Figure 2.4 arrow dimension	25
Figure 2.5 dimension line	27
Figure 2.6 common electrical symbol.....	29
Figure 2.8 electrical sign.....	31
Figure 2.9 Symbols of Passive components	31
Figure 2.10 Symbols of active components (Digital electronic)	32
Figure 2.11 Instrumentation symbols	32
Figure 2.12 mechanical symbol	34
Figure 2.13 Position and Flow Boxes.....	35
Figure 2.13 flow box	35
Figure 2.14 port	36
Figure 2.15 Port Labeling.....	36
Figure 2.16 Valve and Actuator Symbols.....	37
Figure 2.17 pneumatic valve.....	38
Figure 2.18 views	39
Figure 2.19 perspective view	39
Figure 2.20 exploded view	40
Figure 2.22. Arrow heads	42
Figure 2.23 Pictorial diagram	43
Figure 2.23 AC/DC current.....	44
Figure 2.24 Series Circuit.....	45
Figure 2.25 parallel Circuit	45

III	Author/Copyright Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1
			August , 2022

Figure 2.25: Single line diagram	46
Figure 2.26: Schematic diagram	46
Figure 2.27: Installation assembly drawing	47
Figure 2.28: Schematic (elementary) of a pulsing third brake light	47
Figure 2.29 diagram of a pulsing third brake light	48
Figure 3.1 Suggested Technical Drawing Equipment Tidy box	57

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			August , 2022

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Acronyms

ANSI-----	American National Standards Institute
ASME-----	American Society Of Mechanical Engineers
CAD-----	Computer-Aided Design
HB-----	Hard Black
IEC-----	International Electro Mechanical
LED-----	Light Emitting Diode
NEMA-----	National Electrical Manufacturers Association

VI	<u>Author/Copyright</u> Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module
			Version -1
			August , 2022

Introduction

A technical drawing, also known as an engineering drawing, is a detailed, precise diagram or plan that conveys information about how an object functions or is constructed. Engineers, electricians, and contractors all use these drawings as guides when constructing or repairing objects and buildings.

Technical drawings bridge the communication between designers, the people who come up with ideas, and producers, the people who put those ideas into practice. They're designed as a universal language to be understood by engineers, contractors, and architects.

1	<u>Author/Copyright</u> Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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Module units:

- Technical Drawing Workstation
- Construct And Interpret Technical Drawing
- Store Technical Drawings And Equipment /Instruments

Learning objectives of the Module

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

- Plan and prepare drawing workstation
- Construct and Interpret technical drawing
- Store technical drawings and equipment /instruments

Module Learning Instructions:

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

2	<u>Author/Copyright</u> Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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Unit one: Technical Drawing Workstation

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

- Kinds Of Technical Drawings
- Selecting And Segregating Correct Technical Drawing
- Technical drawing tools and instruments
- 3S procedures

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

- Different Kinds Of Technical Drawings
- Select And Segregate Correct Technical Drawing
- Select Drawing Tools And Instruments
- Apply 3S procedures

1.1 kinds of technical drawings

Technical drawing, drafting or drawing, is the act and discipline of composing drawings that visually communicate how something functions or is constructed.

Different literatures define drawing in different terms while basically their core message remains the same. For instance, look the following definitions given for drawing on different literatures;

- **Drawing**:-Is graphic representation of a real thing, an idea, or a proposed design for later manufacture or construction.
- **A graphic** that represents an idea, a concept, or an entity which actually or potentially exists in life. A way of communicating all necessary information about an abstraction such as an idea or a concept.

There are two basic types of drawings:

Artistic and **Technical** drawings.

A. Artistic Drawings :

Artistic Drawings range in scope from the simplest line drawing to the most famous paintings. Regardless of their complexity, artistic drawings are used to express the feelings, beliefs, philosophies, and ideas of the artist. In order to understand an artistic drawing, it is

3	Author/Copyright Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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sometimes necessary to first understand the artist. Artists often take a subtle or abstract approach in communicating through their drawings, which in turn gives rise to various interpretations



Figure 1.1 Artistic drawing

B. Technical Drawings:

The technical drawing, on the other hand, is not subtle, or abstract. It does not require an understanding of its creator, only an understanding of technical drawings. A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes and specifications.

4	<u>Author/Copyright</u> Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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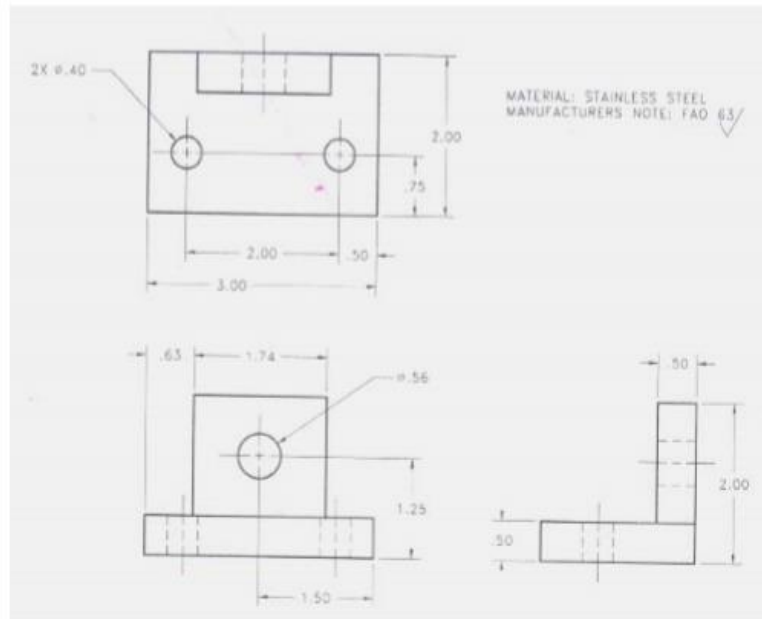


Figure 1.2: Technical drawing

1.1.1 Types of technical drawing projection

Technical drawings are constructed on the basis of the fundamental principles of projection. There are two main types of technical drawing or projection:

- Parallel projection
- Perspective projection.

(Note that each projection has various categories.)

A projection is any drawing, draft, or representation of an idea or object that is carried out after considering views from various imaginary planes. Projections, which are quite similar to the direct views that one can see on televisions, can be used to represent actual objects if the following are employed:

- The eye of the viewer looking at the object.
- An imaginary plane of projection as dictated by the direction of the eye(s) of the viewer.
- projectors or imaginary lines of sight

The theories behind projection have been widely used to draft 3-dimensional objects on 2-dimensional media such as papers and computer screens. The theory of projection is based on two variables:

- Line of sight.
- Plane of projection: plane from which images can be projected—depending on the axis.

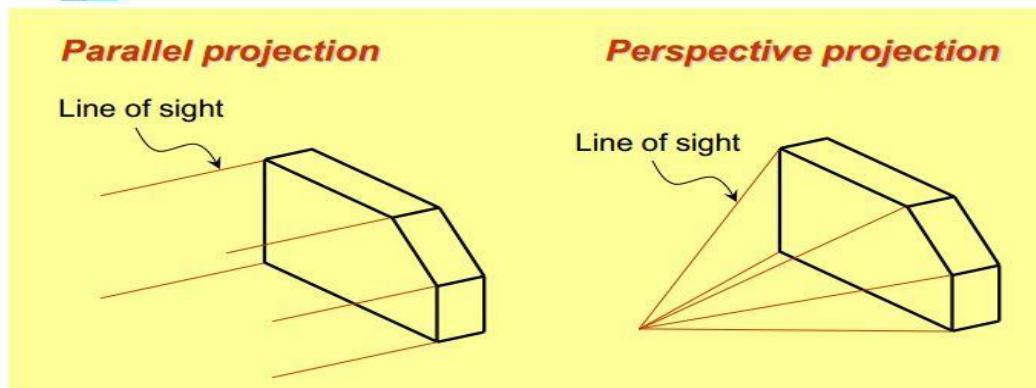


Figure 1.2: parallel and prospective projection

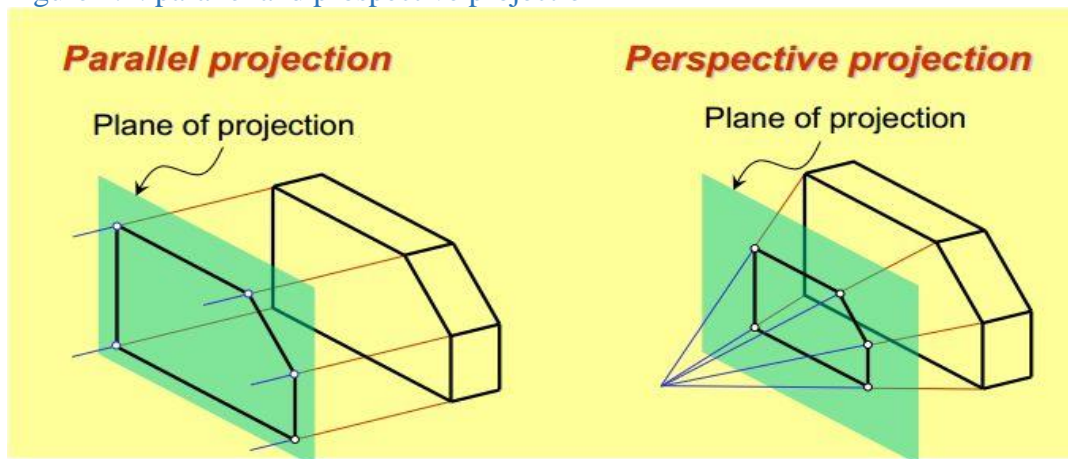


Figure 1.3: plane of projection

- **Parallel projection**

Parallel projection is the type of projection in which the lines of sight or projectors are parallel to each other, and also perpendicular to the planes of objects or images. Parallel projection can be categorized or divided into

- ✓ Orthographic,
- ✓ Oblique,
- ✓ Axonometric projections.

- **Perspective projection**

Perspective projection is the type of projection in which objects appear smaller as their distances from an observer increases: objects' dimensions along a line of sight appear shorter than they actually are.

There are 3 types of perspective projections:

- 1-point,
- 2-point,
- 3-point projections.

One-point perspective projections consist of 1 vanishing point, while 2-point and 3-point perspective projections consist of 2 and 3 vanishing points, respectively.

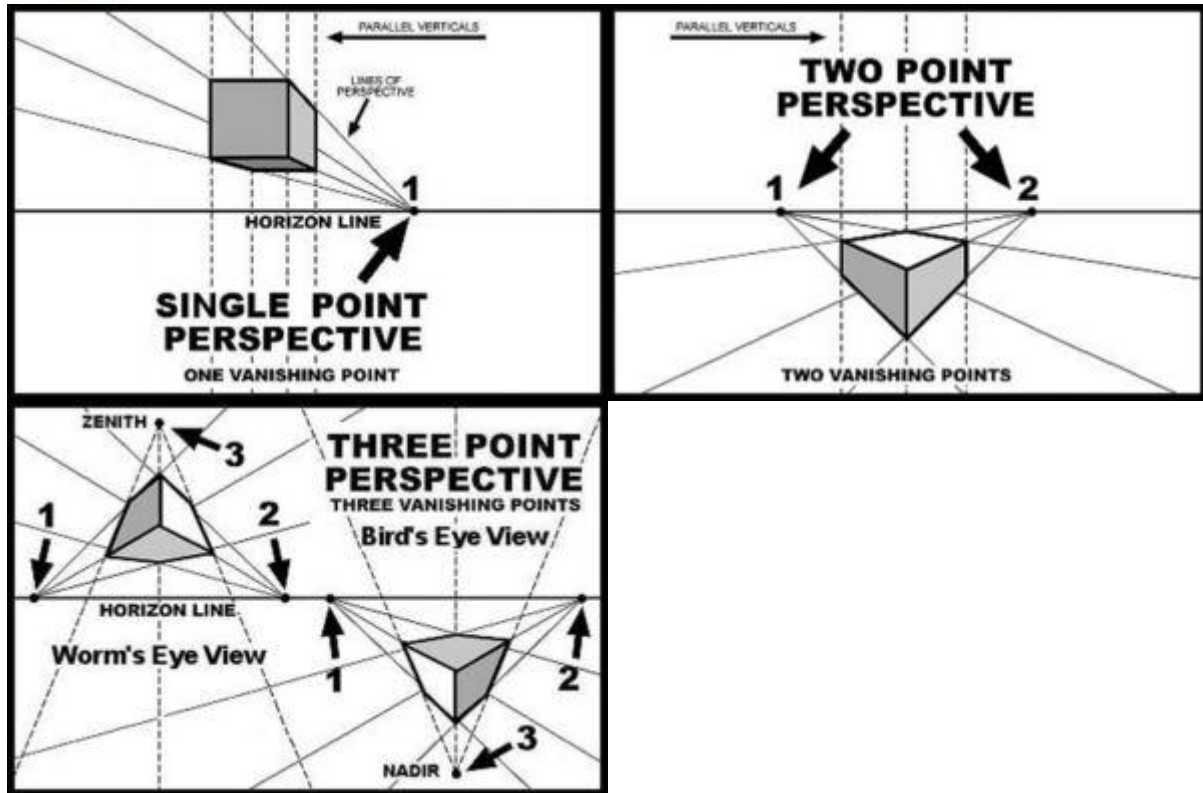


Figure 1.4 :point projection

- **Objectives of technical drawing**

- ✓ The general objectives of studying technical drawing include the following:
- ✓ To develop skills in using universally accepted tools, symbols, scales, and conventions to draw any visible object or invisible idea on paper, and computer.
- ✓ To understand orthographic and isometric projections and employ them in drafting/drawing ideas and objects using both projections, respectively.
- ✓ To understand and interpret technical drawings, sketches, and working drawings.
- ✓ To develop the ability to use imagination to observe, visualize and draft objects, ideas, or concepts.
- ✓ To develop the ability to produce clean, accurate, neat, and informative drawings in a moderate amount of time.
- ✓ To develop the ability to take on any projects and draw environmental health science, civil, and environmental engineering objects/structures.

1.2 Selecting and segregating correct technical drawing

1.2.1 Technical drawing

Technical drawings are the common language of those who work in technology. Engineers, architects, designers, technologists, technicians and specialized workers use them to communicate with each other.

This universal language varies little from one country to another. Unlike spoken languages, it ensures unequivocal understanding of the definition and construction of technical objects. This means that two engineers who do not speak the same language can understand most of a technical drawing, with the exception of annotations written in a specific language. There are many types of technical drawings, including:

- 3D drawings (isometric, perspective)
- Exploded-view 3D drawings
- Complete working drawings
- Detail drawings (2D orthogonal projections)

Diagrams are another form of technical drawing with looser, less universal standards. Technical drawing is an essential tool for young people learning about technology. They need to learn the basics through the tasks assigned to them

1.2.2 Preparation of technical drawing

The preparation of technical drawing is possible only through knowledge and skill in the use of a variety instruments. With the aid of knowledge and skill practice will bring perfection!

The following listed drawing instruments are the basic ones:

Technical drawings are segregated in accordance with the types and kinds of drawings. To produce a quality and marketable electronic diagram, you have to follow the Electronic Drafting Standards which is the process of illustrating various kinds of circuits and wiring systems. The most common graphical languages used in the illustration of components in circuits and wiring systems are

- Two dimensional
- Three dimensional
- Block diagrams
- Schematic diagrams
- Lay-out plans
- Location plans
- Process and instrumentation diagrams
- Loop diagrams
- System Control Diagrams

Most symbols that you will encounter in laying out electronic diagrams are accepted as standard, but in some cases some manufacturers modify symbols and practices to suit a particular industrial policy while others use their own symbols to represent unique or special component and devices

Three dimensional

In geometry, a three-dimensional shape can be defined as a solid figure or an object or shape that has three dimensions – length, width and height. Unlike two-dimensional shapes, three-dimensional shapes have thickness or depth.

The attributes of a three-dimensional figure are faces, edges and vertices. The three dimensions compose the edges of a 3D geometric shape.

8	<u>Author/Copyright</u> Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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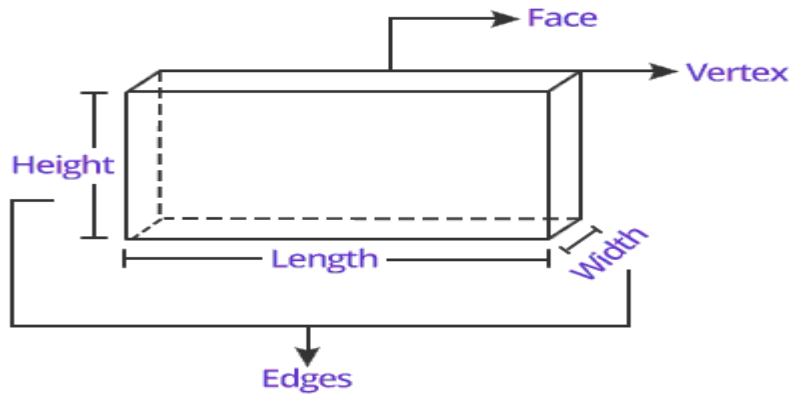


Figure 1.6: 3D geometric shape

- **Block diagrams**

A block diagram is a specialized, high-level flowchart used in engineering. It is used to design new systems or to describe and improve existing ones. Its structure provides a high-level overview of major system components, key process participants, and important working relationships

- **Types and Uses of Block Diagrams**

A block diagram provides a quick, high-level view of a system to rapidly identify points of interest or trouble spots. Because of its high-level perspective, it may not offer the level of detail required for more comprehensive planning or implementation. A block diagram will not show every wire and switch in detail, that's the job of a circuit diagram.

A block diagram is especially focused on the input and output of a system. It cares less about what happens getting from input to output. This principle is referred to as black box in engineering. Either the parts that get us from input to output are not known or they are not important.

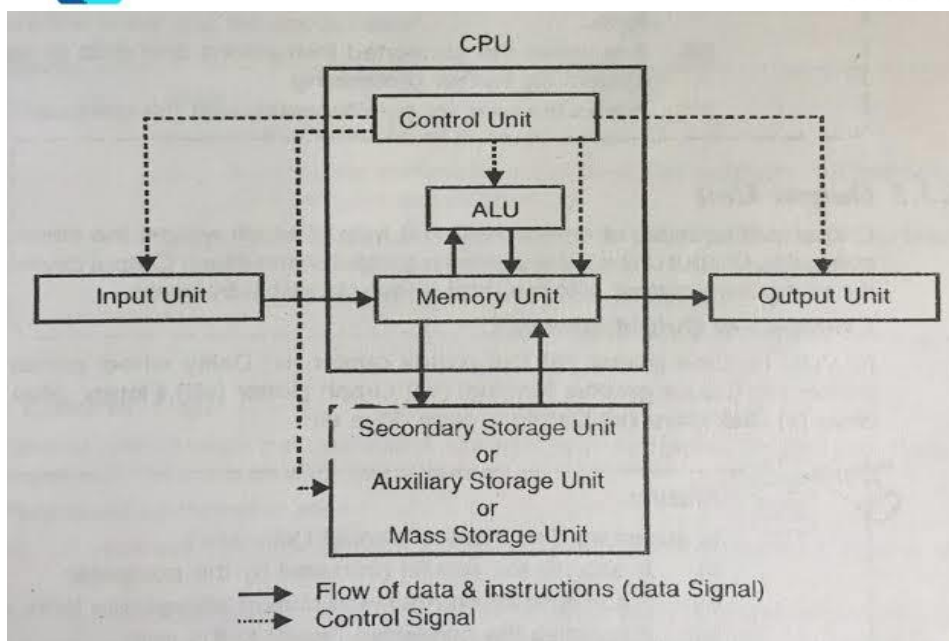


Figure 1.7: block diagram

- **Schematic diagrams**

A schematic diagram is a picture that represents the components of a process, device, or other object using abstract, often standardized symbols and lines.

Although schematic diagrams are commonly associated with electrical circuits, many examples can be found in other industries.

- **Schematic Diagrams in Electronics**

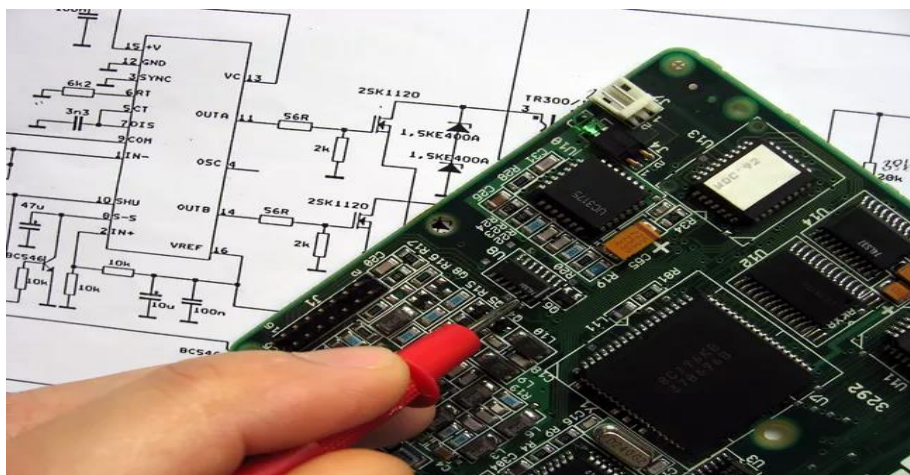


Figure 1.8: schematic diagram

Schematic diagrams are typically associated with electrical circuits. Also called wiring diagrams or circuit diagrams, these diagrams show how the different components of a circuit are connected. In these diagrams, lines represent connecting wires, while other elements like resistors, lamps, and switches are represented by standardized symbols called electrical schematic symbols.

In electronics, having a schematic diagram on hand may help a user design an entire circuit before building it, or troubleshoot an electronic that has stopped working.

Schematic diagrams may also be used to explain the general way that an electronic functions without detailing the hardware or software used in the actual electronic. For example, to explain how a computer projects the words you type on a screen, you might use a schematic diagram that shows how information passes from the keys you press to a word processing program, and finally to the computer screen.

- **Lay-out plans**

a plan of the entire site showing location of plots or building blocks, roads, open spaces, entry or exit, parking, landscaping etc.

- **Location plans**

A site plan is an architectural document that functions as a map of a building site. It provides all the details about how the structure will be oriented on the lot. The site notes contain valuable information that impacts your property

- **Process and instrumentation diagrams**

A Process and Instrumentation Diagram, known as a P&ID, shows how process equipment is connected and by the use of symbols, represents flow directions, safety and control systems, pressure ratings and other key piping and instrument details of a system. An understanding of P&IDs is essential when carrying out plant and process operations, such as tracing faults, isolating equipment and locating items for maintenance.

- **Loop diagrams**

Loop diagrams are the most detailed form of diagrams for a control system and thus it must contain all details omitted by PFDs and P&IDs alike. Loop drawings can be customized per customer taste although certain minimum standard information is required to be included in loop sheets.

- **System Control Diagrams**

A control system is a system, which provides the desired response by controlling the output. The following figure shows the simple block diagram of a control system.



Here, the control system is represented by a single block. Since, the output is controlled by varying input, the control system got this name. We will vary this input with some mechanism. In the next section on open loop and closed loop control systems, we will study in detail about the blocks inside the control system and how to vary this input in order to get the desired response.

1.3 drawing tools and instruments

1.3.1 Types of drawing tools and equipment

Drafting equipment like T-square, drawing board or binder, ruler, set squares, compasses, protractors, French curves, templates, eraser, dividers, ... etc

- **T-square**

T-square is provides a parallel straight edge for the beginning drawing drafter.

It is composed of two parts:

11	Author/Copyright Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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- The head and
- The blade.

The two parts are fastened together at an exact right angle. The blade must be straight and free of any necks and imperfections. Used to draw horizontal lines on the drawing sheet Used to draw vertical lines and slanted lines with the help of additional equipment basically 45° and 60° set- squares. Draw lines only against the upper edge of the blade. Make sure the head is held against the left edge of the drawing board to guarantee parallel lines. The uses of T-square are to align the drawing paper to the

drawing board, and to draw parallel horizontal lines on the paper.

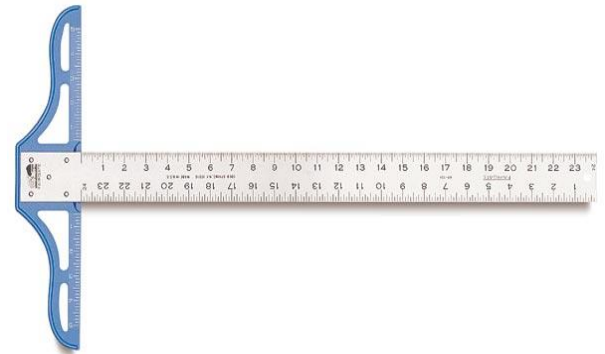
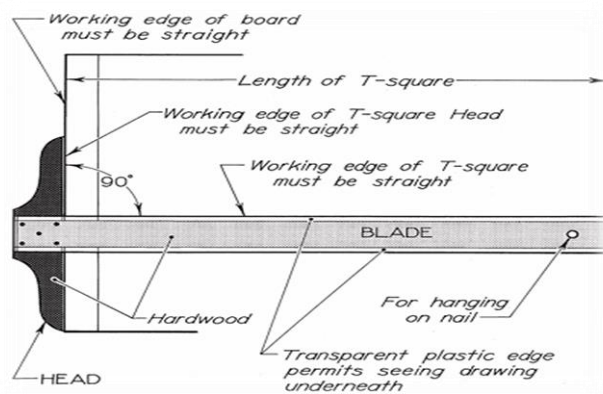


Figure 1.8: T-square

• Drawing Board

Drawing Board; is Available in a variety of styles and sizes. Most are adjustable up and down, and can tilt to almost any angle from vertical 90° to horizontal. The drawing surface must be clean, flat, smooth, and large enough to accommodate the drawing and some drafting equipment. If a T-square is to be used, at least one edge on the board must be absolutely true. Most quality boards have a metal edge to ensure against warping and to hold the T-square securely.



Figure 1.9: Drawing board

- **Tracing paper**

Is a thin white transparent paper for general use where one drawing is to be made over another? But if ink was applied then you cannot use again. This material is recommended to use in preparation of plans and specifications.



Figure 1.10: Tracing paper

- **Compass**

Drawing Compass History and Types of Compasses

A technical drawing tool named drawing compass is used to draw circles or arcs. This tool is also known as a pair of compasses, or simply as a compass. It can also be used for measuring distances or more precisely distances on the maps. Apart from that, drawing compasses are used in navigation, mathematic, drafting and any many other disciplines. Materials of which compasses are made are usually plastic or metal. Drawing compass has two parts connected by a hinge so the radius of the circle that is drawn can be adjusted and changed. Usually at the end of one part is a needle and at the end of another is a pencil.



Figure 1.11: compass

- **Divider**

Dividers are similar to compasses, except that both legs are provided with needle points. As with compasses, dividers are available in large and small sizes, Dividers are used to transfer measurements. To step off a series of equal

distances, and to divide lines into a number of equal parts A divider is similar to a compass, except that it has a metal point on each leg. It is used to lay off distances and to transfer measurements



Figure 1.12: Compass

- **Triangles (Set- square)**

Triangles (setsquares) they are used to construct the most common angles (i.e. 30° , 45° , 60°) in technical drawings. The $45^\circ \times 45^\circ$ and $30^\circ \times 60^\circ$ triangles are the most commonly used for ordinary work.

Triangles are used in combination with the T square or straightedge to draw vertical and inclined lines. They are usually made of transparent plastic, which allows you to see your work underneath the triangles

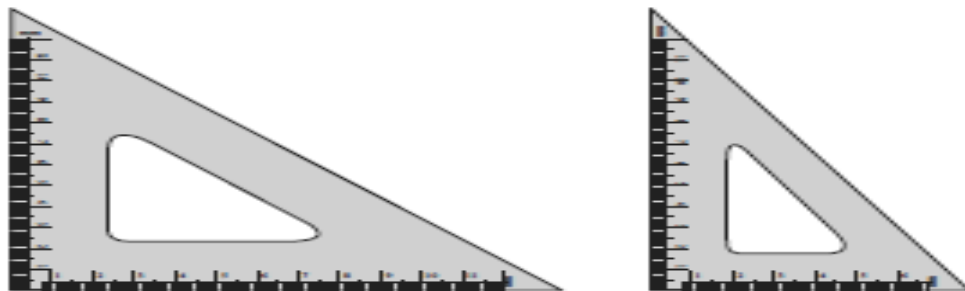


Figure 1.13: set square

- **Drawing Templates**

A template is a thin, flat piece of plastic containing various cutout shapes. It is designed to increase the speed and accuracy of the Drafter. Templates are available for drawing issee as following circles, ellipses

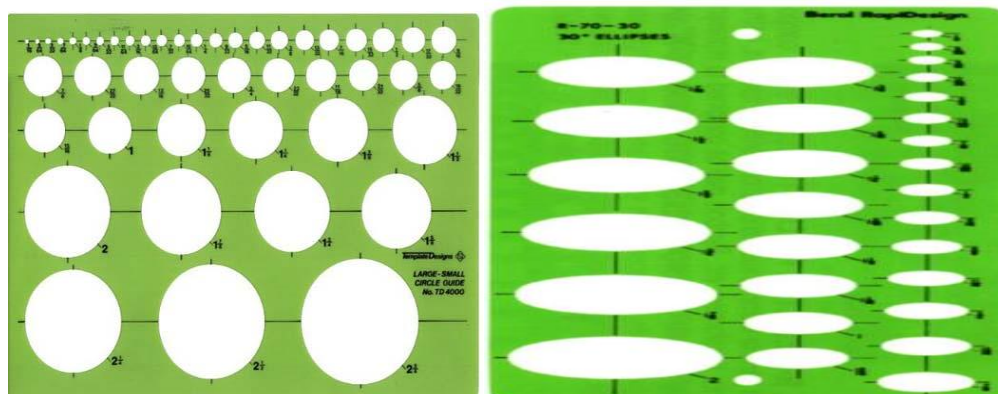


Figure 1.14: Circle and Ellipse template

- **French curves and flex curves**

French curves are thin plastic tools that come in assortment of curved surfaces. They are used to produce curved lines that cannot be made by a compass. Most common French curves are actually segments of ellipses, **parabolas** and **hyperbolas**.

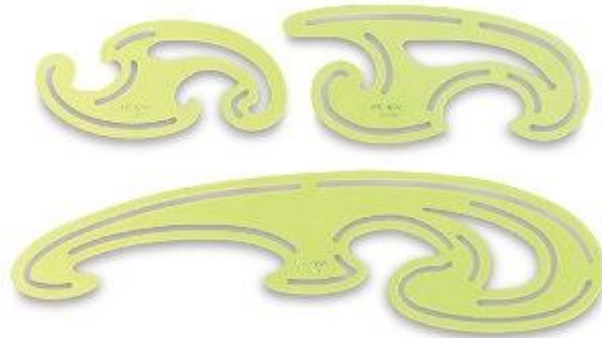


Figure 1.14: French curve

- **Protractor**

Protractors are used to mark or measure angles between 0 and 180°. They are semicircular in shape (of diameter 100mm) and are made of Plastic or celluloid which has more life. Protractors with circular shape capable of marking and measuring 0 to 360° are also available in the market.

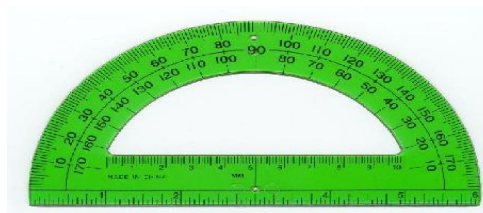


Figure 1.15: Compos

- **Drawing Paper**

They are available in many varieties and good quality paper with smooth surface should be selected for Drawings which are to be preserved for longer time. Recommended Standard *size of drawing sheet* Designation Size (mm) is.

15	Author/Copyright Ministry of Labor and Skills	Module title Test Basic Digital Electronic Components	Training module Version -1 August , 2022
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SIZE (MILLIMETERS)		LETTER SIZE
WIDTH	LENGTH	
210	x 297	A4
297	x 420	A3
420	x 594	A2
594	x 841	A1
841	x 1189	A0

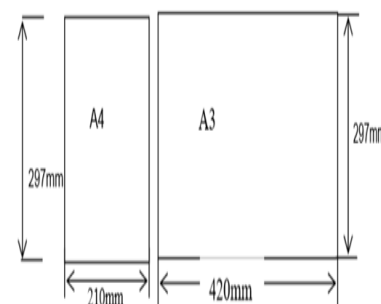


Table 1 :Drawing paper layout

• Drawing Pencils

The accuracy and appearance of a Drawing depends on the quality of Pencil used to make Drawing. The grade of a Pencil lead is marked on the Pencil. HB denotes medium grade. Increase in hardness is shown by value put in front of H such as 2H, 3H etc., Softer pencils are marked as 2B, 3B, and 4B etc. A Pencil marked 3B is softer than 2B and Pencil marked 4B is softer than 3B and so on. Beginning of a Drawing may be made with H or 2H. For lettering and dimensioning, H and HB Pencils are used.



Figure 1.16: Drawing Pencils

- **Pencil sharpener** is an essential for sharpening pencils. Accurate drawings cannot be produced unless they are sharp. However, when shading a blunt pencil is sometimes useful. This is an electrical pencil sharpener and it is a heavy duty. Very precise and sensitive pencil sharpener requires very careful in dealing with it so that it will not consume your pencil easily.



Figure 1.17: Pencil sharpener

- **Eraser:** Are a soft and a consumable material. There are two kinds of it, an eraser for pencil and an eraser for ink pen.



Figure 1.18: Erase

- **Ruler:** is possibly one of the most important pieces of drawing equipment. Be remembered that the edge of a ruler is not guaranteed to have a perfectly straight edge unlike a good T-Square or set square. The recommended material for a ruler is a plastic but for cutting purpose, it is advisable to use a metal ruler. Recommended maximum dimension of a ruler is 12 inches and it is commonly known as one foot ruler.

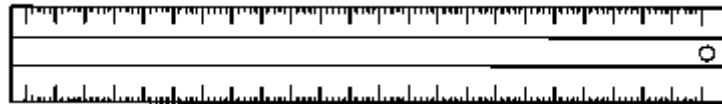


Figure: 1.19: Ruler

- **Scales:** The architectural draftsman's scale is made in various lengths, but 12 - inch triangular scale will be found best for student use. This has in one face the normal full size division of the foot. The scale at which the drawing is to be made may depend upon three things: first the size of the paper on which the draftsman wishes to work; second the size of the building or detail to be drawn; third, the amount of detail that is desirable to show in the drawing.

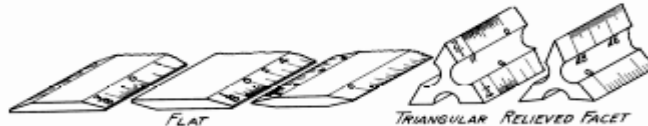


Figure: 1.20: Scales:

1.4 Applying 3S procedures



Figure 1.20: 3S

1.4.1 3S

Is a workplace organization and productivity tool with the primary purpose of finding and identifying problem. 3S is just three of these: Sort, Sweep, and Standardize.

- **Sort**

Sort means to get rid of all unnecessary items. Companies either sell them, recycle them, or throw them away. And the best companies do this on an ongoing basis. Once you've gotten rid of all the crap by sorting, the next relevant activity is to sweep.

- **Sweep**

Sweep means to keep your workplace clean and tidy. It removes dirt, debris, oil, and grime and anything else. But the real heart of Sweep is inspection. Cleaning the workplace regularly gives you an ongoing opportunity to find problems and to address the sources of mess generators in your workplace. For example, instead of vacuuming up shavings from a table saw every day you might find opportunity to install a vacuum permanently onto the table saw with automatic turn on and shut off. That way the wood shavings never create a mess on the floor in the first place. But observations like this only happen when inspecting while you sweep.

- **Standardize**

The last activity of 3S is to Standardize. Standardization comes in many formats and some depend on the nature of your business and industry. This could be a document standard or a physical standard. It could be a work instruction, visual aid, form, or other document. Or it could be a physical label, a color coding system, a method or best practice, training, a set number, location, or layout of tools, or any other number of things.

Self-check -1

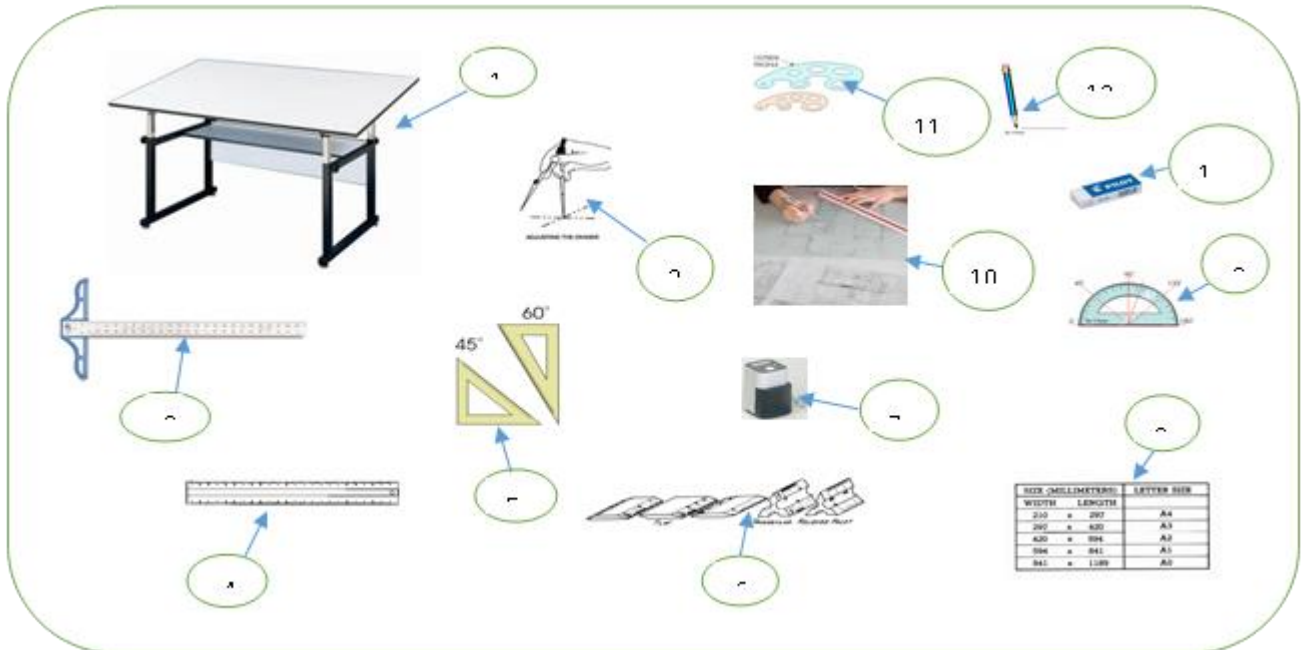
Directions: Answer all the questions listed below.

I. Say True if the statement is correct and Say False if the statement is incorrect

1. Drawing is a graphic representation of a real thing, an idea, or a proposed design for later manufacture.
2. Artists some time take a subtle or abstract approach in communicating through their drawings
- 3 .A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality

4. Artistic drawings are used to express the feelings, beliefs, philosophies, and ideas of the artist.

II. write the name of the following drawing instrument



Part III Matching

A

1. Sort
2. Sweep
3. Standardize

B

- A. work instruction
- B. clean and tidy
- C. get rid of all unnecessary items

Unit two: Construct and interpret technical drawing

This learning guide is developed to provide you the necessary information regarding the following topics:–

- components, assemblies and objects
- dimensions of the object
- symbols, views and lines
- Constructing basic drawings/schematics
- Interpreting diagrams and drawings
- Checking and validating drawing.

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 –**

- Identify components, assemblies and objects
- Identify dimensions of the object
- interpret symbols, views and lines
- Construct basic drawings/schematics
- Interpret diagrams and drawings
- Check and validate drawing

2.1 components, assemblies and objects of Technical Drawing

A detailed technical drawing consists of all the essential components of the object.

The essential components of technical drawing are:

- **Orthogonal views**

There are different views (front, side, top) in a technical drawing. In a detailed drawing, one can expect a combination of views that accurately describes the component.

- **Dimensions**

Dimensions are numerical values expressed in measurement units and are crucial in defining the size, location, orientation, or other features of an object or part.

- **Projection**

A pictorial representation of a design can't always show the details of complex shapes and structures that contain information helpful for manufacturing the part. A typical projection

method represents a 3D object in an easier way to be understood more readily by the manufacturer.

- **Drawing Standards**

There are specific conventions for uniformity in conveying detailed technical information related to a part's complexities or components. These conventions are known as drawing standards.

- **Name/ Title of the drawing**

In every drawing, there is a fixed place for name, title and drawing number. The name or title is based on the standard annotation that a part is usually referred to. The drawing number is unique and is used for identification purposes.

- **Tolerances**

Sometimes it is not possible to produce parts exactly according to specifications. There is always a variance between the intended dimensions and the delivered parts. According to the industrial standard, tolerance is “the total amount a specific dimension is permitted to vary. The variance between the maximum and the minimum limits is tolerance.

2.2 Dimensions of objects

2.2.1. Dimension

Dimension is a numerical value expressed in appropriate units of measurement and indicated graphically on technical drawings with lines, symbols and notes.

A drawing without dimensions is meaningless. Dimensions are necessary to show the exact size of an object. Dimensioning refers to the act of giving dimensions, i.e., length, width, height, diameter, etc., of the object. This information is provided by giving numeric values to various features of the object on the drawing. A feature is an individual characteristic such as a flat or cylindrical surface, a slot or a groove, a taper, a shoulder, a screw thread, etc.

- **Length**

Length is a measure of distance. In the International System of Quantities, length is a quantity with dimension distance. In most systems of measurement a base unit for length is chosen, from which all other units are derived. In the International System of Units (SI) system the base unit for length is the meter.

Length is commonly understood to mean the most extended dimension of a fixed object. However, this is not always the case and may depend on the position the object is in.

Various terms for the length of a fixed object are used, and these include height, which is vertical length or vertical extent, and width, breadth or depth. Height is used when there is a base from which vertical measurements can be taken. Width or breadth usually refer to a shorter dimension when length is the longest one. Depth is used for the third dimension of a three dimensional object.

Length is the measure of one spatial dimension, whereas area is a measure of two dimensions (length squared) and volume is a measure of three dimensions (length cubed).

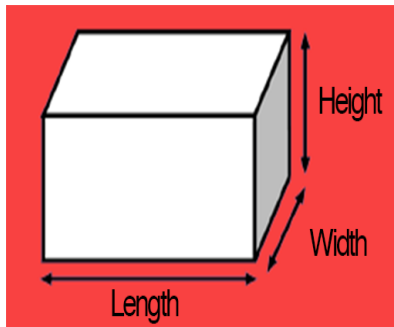


Figure 2.1 : dimension

Width

Width is commonly used to describe the measure of an object from side to side, or, particularly in shapes and geometry, width is the shorter side of an object.

Refer to the rectangles below. Both are the same rectangle, but one is rotated just to show that in both, the shorter side of the rectangle is called the width.

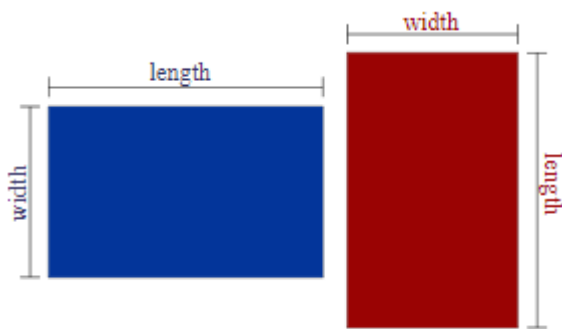


Figure 2.2 Dimension

- **Height**

Height is measure of vertical distance, either vertical extent (how "tall" something or someone is) or vertical position (how "high" a point is). For example, "The height of that building is 50 m" or "The height of an airplane in-flight is about 10,000 m".

- **Diameter**

In geometry, a **diameter** of a circle is any straight line segment that passes through the center of the circle and whose endpoints lie on the circle. It can also be defined as the longest chord of the circle. Both definitions are also valid for the diameter of a sphere.

In more modern usage, the length of a diameter is also called the diameter. In this sense one speaks of *the* diameter rather than *a* diameter (which refers to the line segment itself), because

all diameters of a circle or sphere have the same length, this being twice the radius

$$d = 2r \quad \text{or equivalently} \quad r = \frac{d}{2}.$$

- **Angles**

In geometry, an angle can be defined as the figure formed by two rays meeting at a common end point. An angle is represented by the symbol \angle . Here, the angle below is $\angle AOB$. Angles are measured in degrees, using a protractor.

Types of Angles

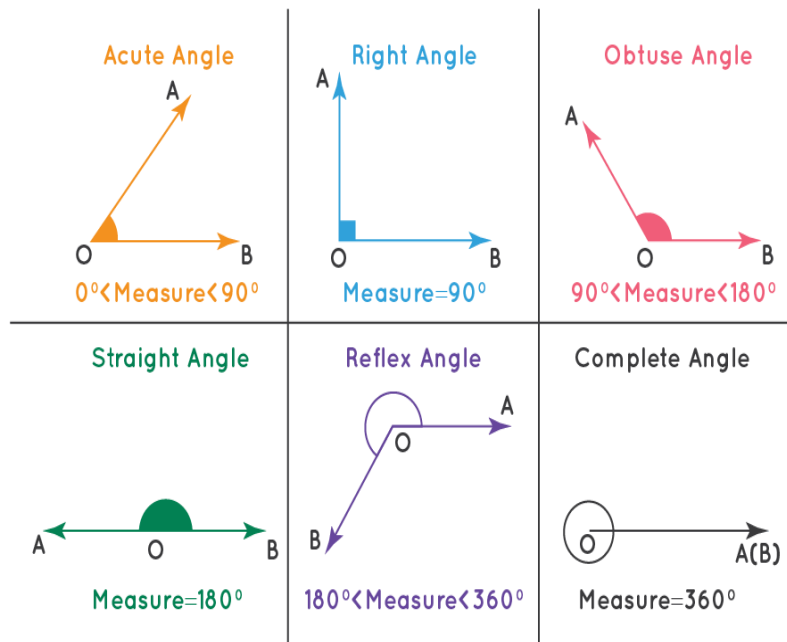


Figure 2.3 angle

2.2.2 Units of Measurement

On technical drawing we need to show lengths and angles. The most convenient unit for length is millimeter. In civil engineering and architectural drawing, inch or foot is often used as a unit of length. Angles are shown in degrees.

- **Symbols** : Symbols are incorporated to indicate specific geometry whenever necessary.

Notes: Notes are provided to give specification of a particular feature or to give specific information necessary during the manufacturing of the object.

1. Dimensions lines should not cross each other, Dimension lines should also not cross any other lines of the object. However, extension lines may cross each other or outlines of the object.

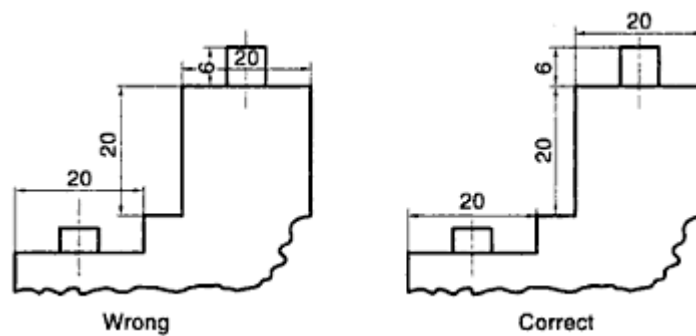


Figure 2.3 Dimension line

2. All dimensions must be given. As far as possible, there should not be need for calculation, assumption or direct measurement for any dimension.
3. Each dimension should be given only once. No dimension should be redundant, i.e., no dimension should be repeated directly or indirectly. If a particular dimension is mentioned, directly or indirectly, in one view, it should not be repeated in other views.
4. Do not use an outline or a centerline as a dimension line. A centerline may be extended serve as an extension line
5. When it is necessary to place a dimension within a sectioned area, leave a blank space for the dimension.
6. Avoid dimensioning hidden lines.
7. Keep dimensions 6 – 8 mm away from the object line and also from each other.
8. If the space between two extension lines is too narrow to mark arrowheads and the dimension then one of the following ways, depending on space availability, should be adopted.
 1. Draw arrowheads touching the outsides of the extension lines and pointing toward each other. Place the dimension above the dimension line.
 2. Draw arrowheads as in (i) above and place the dimension at one end of the dimension line outside of the extension line.

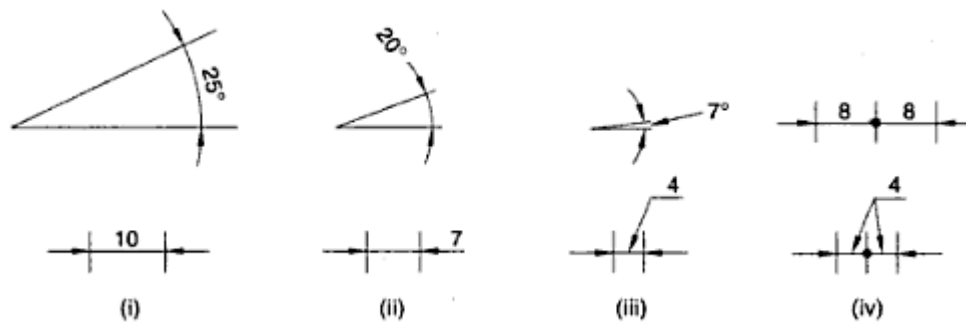
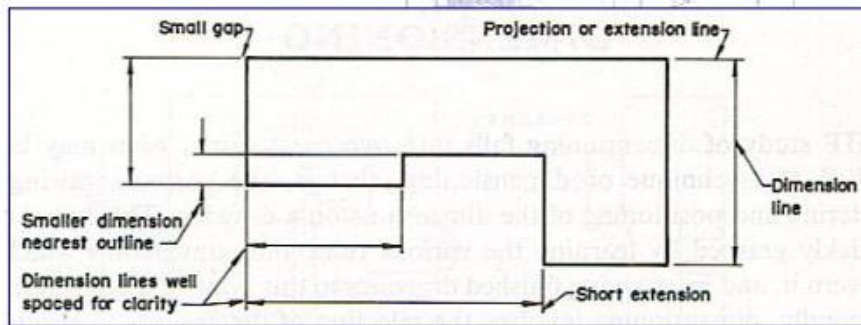


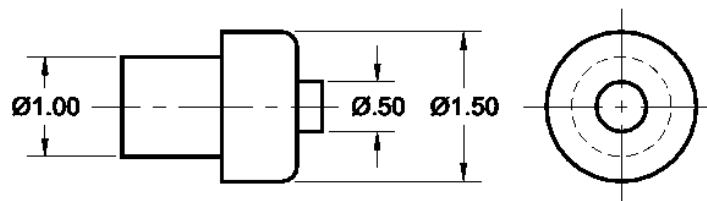
Figure 2.4 arrow dimension

3. Draw arrowheads as in (i) above and place the dimension at the end of the leader which terminates on the dimension line.
4. For two consecutive dimensions, replace two intermediate arrowheads by a dot and place the dimensions as in (i) or (iii) above, depending on the space availability.
9. For dimensions in series, adopt any one of the following ways :
 - (i) **Chain dimensioning (continuous dimensioning):** All the dimensions are aligned in such a way that an arrowhead of one dimension touches tip-to-tip the arrowhead of the adjacent dimension. The overall dimension is placed outside the other smaller dimensions.
 - (ii) **Parallel dimensioning (progressive dimensioning):** All the dimensions are shown from a common reference line. Obviously, all these dimensions share a common extension line. This method is adopted when dimensions have to be established from a particular datum surface.
 - (iii) **Combined dimensioning:** When both the methods, i.e., chain dimensioning and parallel dimensioning are used on the same drawing, the method of dimensioning is called combined dimensioning.
10. Smaller dimensions should always be placed nearer the view. The next dimension should be placed next and so on. The overall dimension should always be away from the view. This will avoid crossing of the extension lines and dimension lines.
11. All notes should be written horizontally

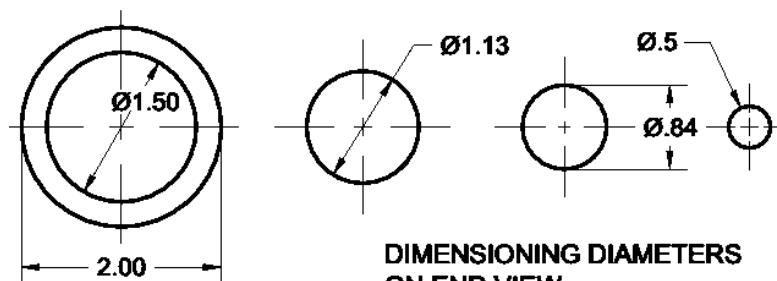
Below are samples figures on how to place dimensions in objects:



Dimension Lines (DL)

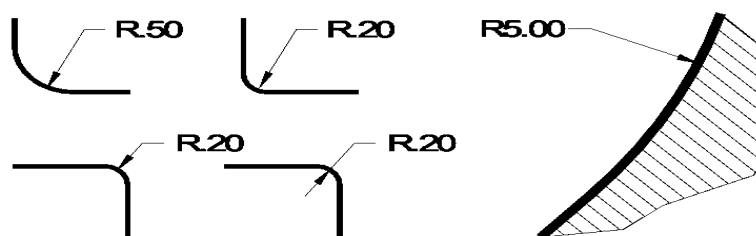


TWO VIEW DRAWING

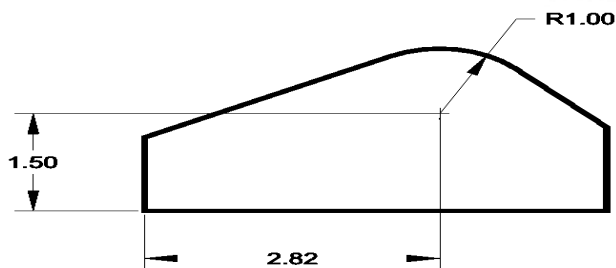


DIMENSIONING DIAMETERS
ON END VIEW

DIMENSIONING RADII



DIMENSIONING RADII
which do not need their centers located



DIMENSIONING RADII
when locating the radius center.

Metric

Decimal Inch

- Decimals are the ANSI standard.
- Decimals are easier to add, subtract, multiply and divide than fractions.
- Preferably, decimals should be rounded to two decimal places (Unless more precision is required).
- Where linear measurement are less than 10,000 millimeters, the millimeter is the standard unit of measure.
- The abbreviation for millimeters (mm) is usually omitted when all dimensions are in millimeters.
- The period is used as a decimal point only in English speaking countries, others use a comma.

Leading and Trailing Zeros

	Inches	Millimeters
Values less than one unit	Show trailing zeros Omit leading zeros .250 .500 .875	Show leading zeros Omit trailing zeros 0.25 0.5 0.875
Values greater than or equal to one unit	Show trailing zeros 1.000 1.500 1.875	Omit trailing zeros 1 1.5 15

Figure 2.5 different types of dimension line

2.3 symbols views and lines.

2.3.1 Symbols

A less common symbol is simply a series of peaks on one side of the line representing the conductor, rather than back-and-forth as shown here. Circuit diagrams are pictures with symbols that have differed from country to country and have changed over time, but are now to a large extent internationally standardized. Simple components often had symbols intended to represent some feature of the physical construction of the device. For example, the symbol for a resistor shown here dates back to the days when that component was made from a long piece of wire wrapped in such a manner as to not produce inductance, which would have made it a coil. These wire wound resistors are now used only in high-power applications, smaller resistors being cast from *carbon composition* (a mixture of carbon and filler) or fabricated as an insulating tube or chip coated with a metal film. The internationally standardized symbol for a resistor is therefore now simplified to an oblong, sometimes with the value in ohms written inside, instead of the zig-zag symbol.










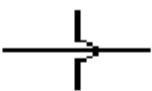


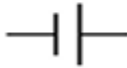

- Electrical Symbols**

The **American Society of Mechanical Engineers (ASME)** is a professional association that, in its own words, "promotes the art, science, and practice of multidisciplinary engineering and allied sciences around the globe" via "continuing education, training and professional development, codes and standards, research, conferences and publications, government relations, and other forms of outreach. ASME is thus an engineering society, a standards organization, a research and development organization, a lobbying organization, a provider of training and education, and a nonprofit organization. Founded as an engineering society focused on mechanical engineering in North America, ASME is today multidisciplinary and global.

- **common electrical symbols**

Electrical Symbols are small drawings or pictograms used to represent various electrical devices in a diagram or plan of an electrical circuit. These symbols are used in sketching schematic diagrams and electrical plans for numerous types of electrical works. Practically any electrical fixture found in a house has a symbol that coincides to said fixture on an electrical wiring diagram. These are very useful guide for an electrician or electrical contractor, thus, making the wiring easier to install as well.

The following are common electrical symbols used in sketching wiring plan and diagram.

Symbol	Description	Symbol	Description
	Conductor/Wire		Ammeter
	Terminal		Voltmeter
	Switch		Galvanometer
	Fuse		Wattmeter
	Connected Wires		Wires Not Connected
	Circuit Breaker		Push Button
	Cell		Bell

	Battery		Buzzer
	Resistor		Speaker
	Capacitor		Antenna
	Diode		Male plug
	Ground		Service Entrance (3 wires)
	Lightning Arrester		Duplex Convenience Outlet
	Kilowatt-Hour Meter		Range Outlet
	Power Panel Board		Special Purpose Outlet
	Lighting Panel Board		Weatherproof Outlet

Figure 2.6 common electrical symbol

- **Electrical signs**

Your power tool with its manual may contain "WARNING ICONS" (a picture symbol intended to alert you to, and/or to instruct you how to avoid a potentially hazardous condition). Knowing and understanding these symbols will help you operate your tool better and more safely.

Electrical signs and stickers alert students, workers, and visitors to electrical hazards in the area. Alerting workers to high voltage areas, electrical hazards, power lines and other electrical equipment in the area, can help prevent fires and injuries. Proper electrical signs can inform workers of the dangers in the area.

	<p>CAUTION indicates some precautionary measures against potential hazardous situation which, if not avoided, may result to a minor or moderate injury.</p>
	<p>SAFETY ALERT indicates that a person should observe extra awareness</p>
	<p>PROHIBITION means that any activity is not allowed as stated by the symbol.</p>
	<p>DANGER specifies hazardous situation which, if not avoided, will result to a serious injury or even death.</p>
	<p>WARNING specifies a potentially hazardous situation which, if not avoided, could result to serious injury or even death.</p>
	<p>READ AND UNDERSTAND INSTRUCTION MANUAL means that a person should make some reading before doing any activity.</p>
	<p>WEAR EYE PROTECTION indicates that a person should wear safety goggles or any related protection for the eyes.</p>



	ELECTRICAL HAZARD indicates that electrical hazard is present in the area.
	VOLTAGE DANGER indicates high voltage in the area and surrounding equipment.

Figure 2.8 electrical sign

• **Symbols Pass components**

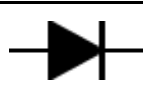

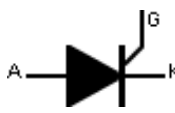

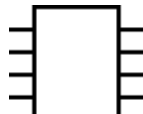
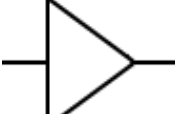
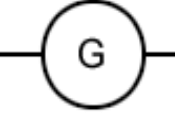
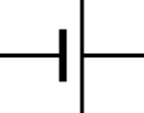
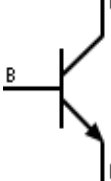
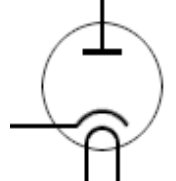


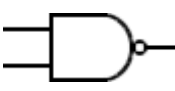

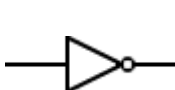
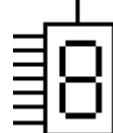
	Diode		Diac
	Thyristor		Triac
	IC / Chip		Amplifier
	Electric generator		Battery
	Transistor		Vacuum tube / Electron tube Example: Diode

Figure 2.9 Symbols of Passive components

✓ **Symbols of active components (Digital electronic)**

	AND gate ANSI system		OR gate ANSI system
	NAND gate ANSI system		NOR gate ANSI system
	Logic inverter		Display 7-segment LED

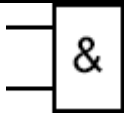
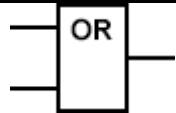
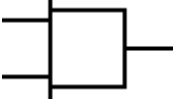

	AND gate British system		OR gate British system
	AND gate NEMA system		OR gate NEMA system

Figure 2.10 Symbols of active components (Digital electronic)

- **Instrumentation symbols**





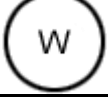
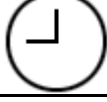
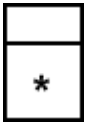

	Ammeter		Voltmeter
	Ohmmeter		Frequencymeter
	Wattmeter		Electric clock
	Electrical counter / Integrator The asterisk is replaced by the letter or symbol for the quantity count		Recording instrument The asterisk is replaced by the letter or symbol of the magnitude recorded

Figure 2.11 Instrumentation symbols

- **Mechanical symbols**









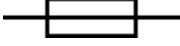
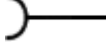




	Resistor IEC system		Resistor NEMA system
	Inductor / Coil		Capacitor
	Switch		Circuit switch
	Pushbutton		Plug IEC system
	Fuse		Female plug IEC system
	Electric line		Plug NEMA system
	Ground		Female plug NEMA system


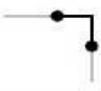
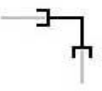
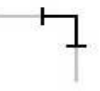


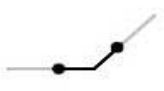
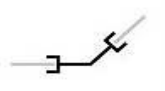
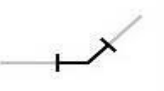


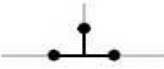
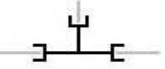
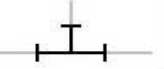



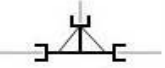
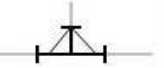


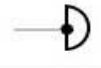




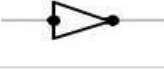


Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image
	Elbow 90°				Elbow 90°	
	Elbow 45°				Elbow 45°	
	Tee equal				Tee equal	
	Tee reducing				Tee reducing	
	Cap				Cap	
	Reducer concentric		---	---	Reducer concentric	---
	Reducer eccentric		---	---	Reducer eccentric	---
Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image

Figure 2.12 mechanical symbol

- **Pneumatic symbols**

Directional air control valves are the building blocks of pneumatic control. Pneumatic circuit symbols representing these valves provide detailed information about the valve they represent. Symbols show the methods of actuation, the number of positions, the flow paths and the number of ports. Here is a brief breakdown of how to read a symbol.

- **Pneumatic Circuit Valve Symbols**

Most valve symbols have three parts. The Actuators are the mechanisms which cause the valve to shift from one position to another. The Position and Flow Boxes indicate how the valve functions. Every valve has at least two positions and each position has one or more flow paths, thus every valve symbol has at least two Flow Boxes to describe those paths

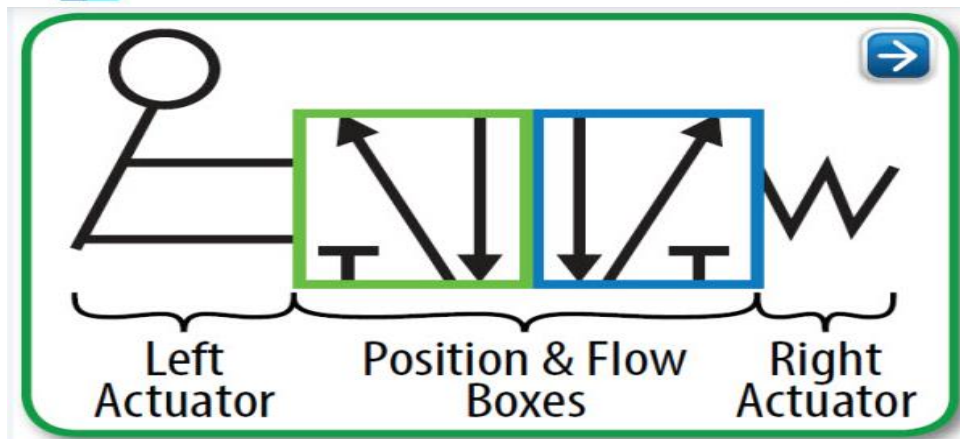


Figure 2.13 Position and Flow Boxes

- **Position and Flow Boxes**

The number of ‘position and flow boxes’ that make up a valve symbol indicate the number of valve positions. Flow direction is indicated by the arrows in each box. These arrows represent the flow paths the valve provides when it is in each position.

The Flow Box next to the ‘active’ actuator always shows the current flow path(s) of the valve. In the example above, when the lever is NOT being activated, the spring return actuator (right side) is controlling the valve, and the box adjacent to the spring shows the flow path. When the lever IS actuated, the box next to the lever shows the flow path of the valve. A valve can only be in one position at a given time.

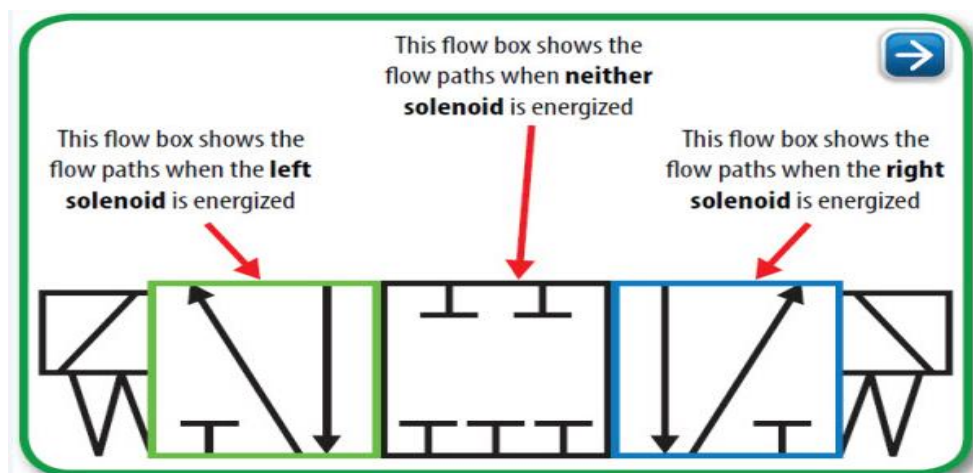


Figure 2.13 flow box

With this 3-position valve, the center flow box shows the flow path when neither actuator is active and the springs are holding the valve in the center position. In this fairly common example, the center box indicates that there will be no air flow (and the associated cylinder won’t move) unless one of the two actuators is active. This type of valve can thus be used to “bump” or “inch” a cylinder incrementally along its extension or retraction stroke for various purposes.

- **Ports**

The number of ports is shown by the number of end points in a given box. Count only the ports in one flow box per symbol (For example there are three boxes in the Figure 2B valve symbol showing each of the three different positions possible for the valve). In Figure 2C, there are a total of 5 ports. Sometimes a port (usually an exhaust port) goes directly to atmosphere and there is no mechanical means for attachment of silencers, flow control valves, or any other accessories. To indicate this (in some flow diagrams), ports with attachment capability will have a short line extending beyond the box (as shown on ports 1, 2, & 4), while the ports you cannot attach to will not have the external line segment (ports 3 & 5 in this example).

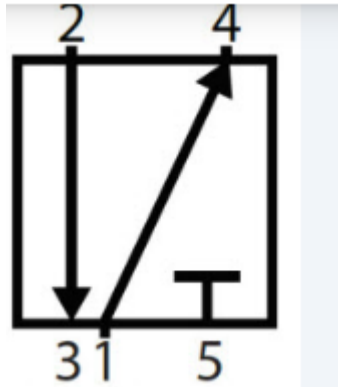


Figure 2.14 port

Port labels are typically shown on a single flow box per symbol. Different manufacturers label valve ports with different letters, but the labels at right are fairly standard. “P” represents the pressure inlet port, “A” and “B” are outlets (generally plumbed to the ‘extend’ and ‘retract’ ports on a cylinder), and “R” and “S” indicate the exhaust ports.

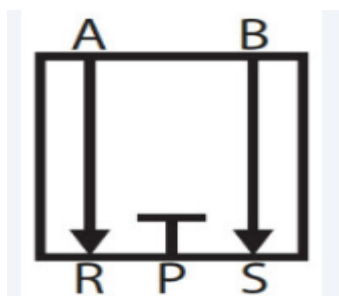


Figure 2.15 Port Labeling

• Ports vs “Ways”

Valves are often referred to by their number of ports, and also by the number of “ways” that air can enter or exit the valve. In most situations the number of ports and ways are the same for a given valve, but take a look at Figure 2C above.

It has five ports, but it is considered a 4-way valve because two of the ports share the same exhaust function. This is a holdover from hydraulics – where the two exhaust paths are joined (internally to the valve), so that only one return port is required, and only one return line is required to get the hydraulic oil back to the storage tank for re-use. In other words, in a pneumatic system the two exhaust ports (R and S in Figure 2D) are only counted as a single “way” since they both connect the valve to the same place (atmosphere). In the case of our pneumatic valve with similar functionality, the separate exhaust ports are created for mechanical simplicity (and as a cost saving measure), but they are not considered distinct “ways”.

The symbols on the next page detail many of the ports, ways, and positions of common pneumatic valves. The specification for “ways” can be somewhat tricky; analyzing the circuit symbols is a better method for verifying that a given valve offers the required functionality.

- **Common Valve and Actuator Symbols**

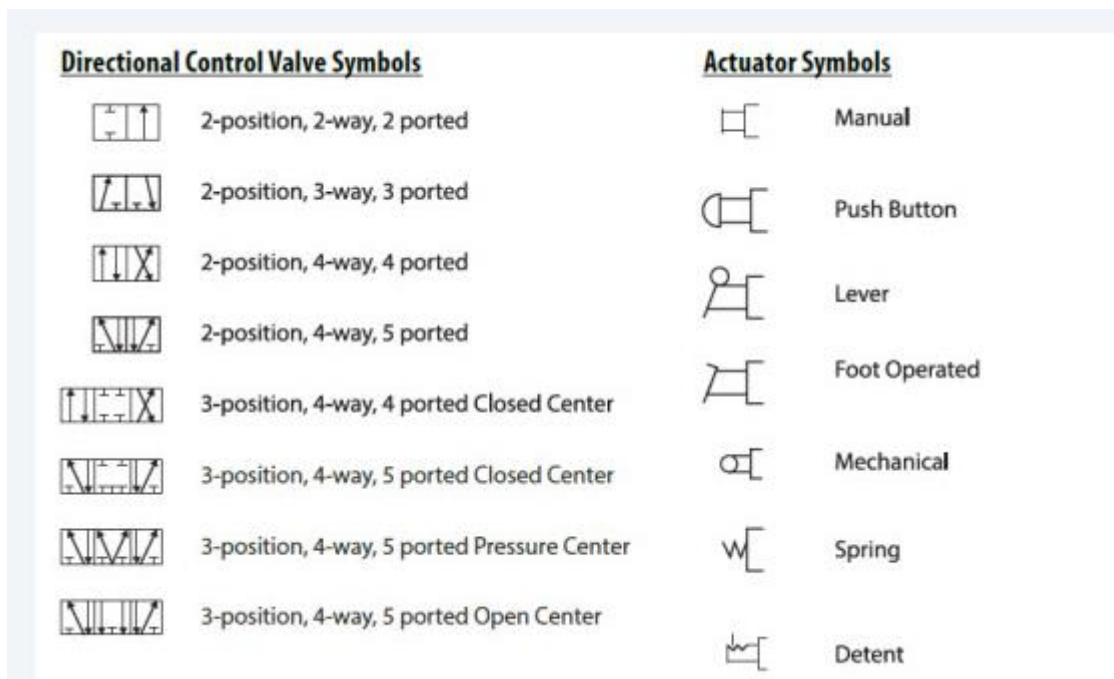


Figure 2.16 Valve and Actuator Symbols

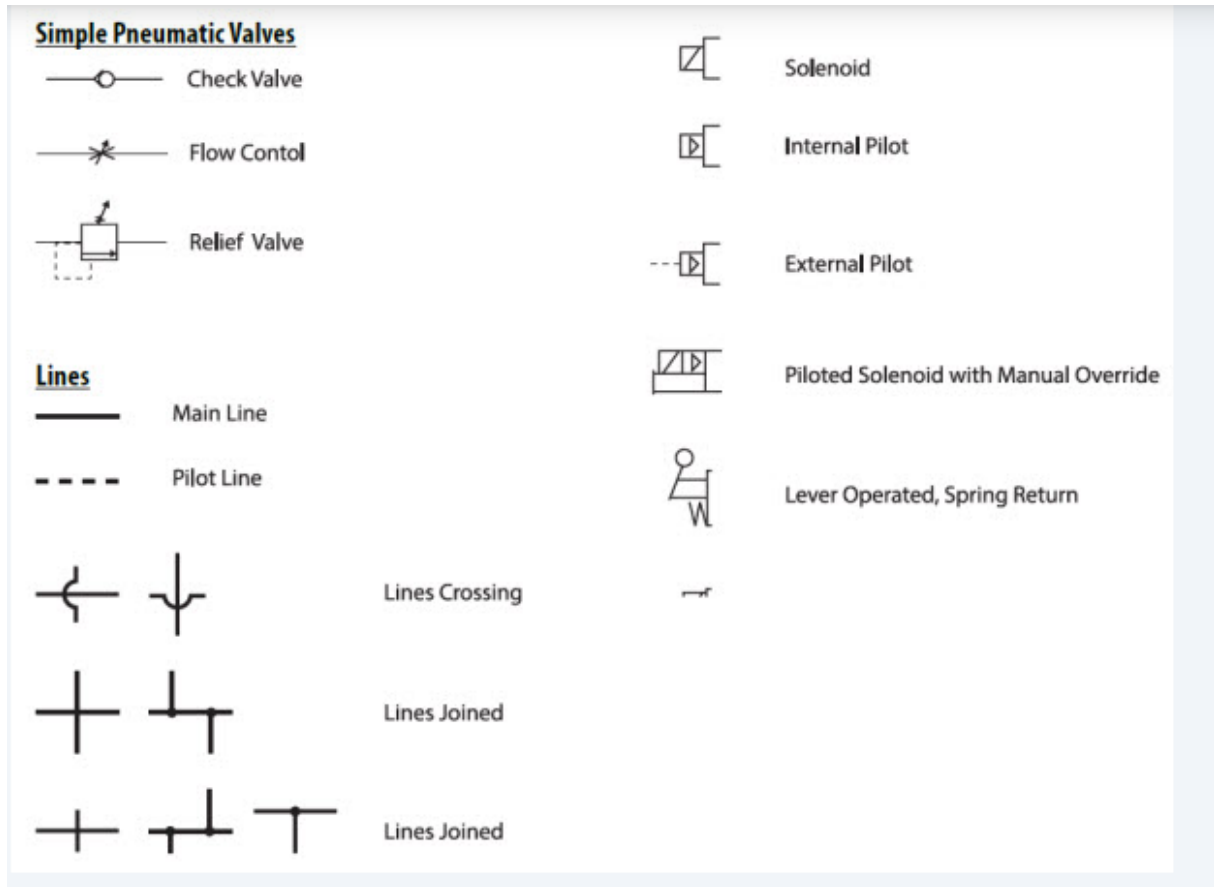


Figure 2.17 pneumatic valve

2.3.2 Views

The two main types of views (or “projections”) used in drawings are:

A. Pictorial views

Describes the angle in which a three-dimensional object is depicted on a drawing surface.

Pictorial views show a 3-D view of how something should look when completed. There are three types of pictorial views:

- Perspective
- Isometric
- Oblique

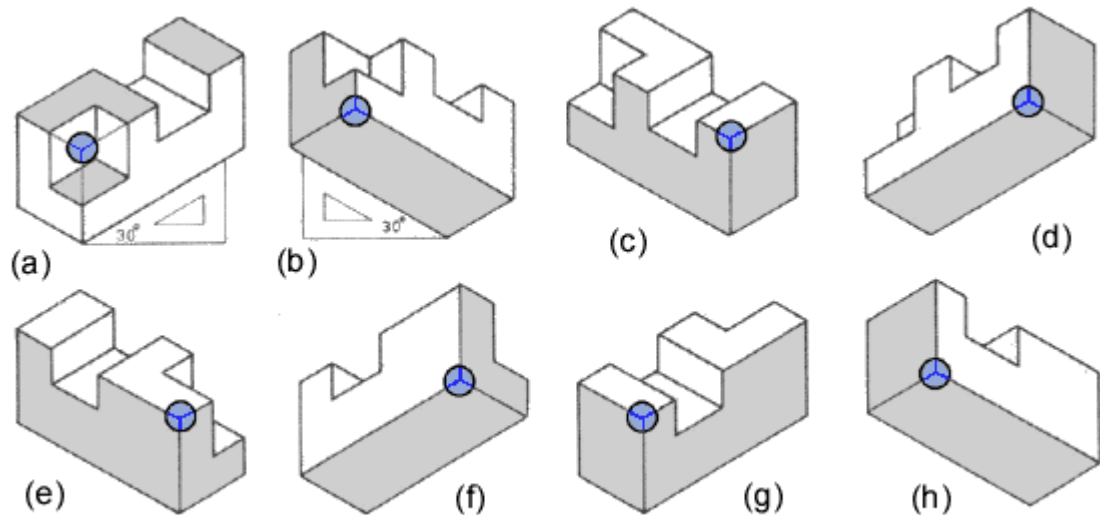


Figure 2.18 views

B. Perspective view

Two-dimensional representation of a three-dimensional space, where the apparent size of an object decreases as its distance from the viewer.

A perspective view presents a building or an object just as it would look to you. A perspective view has a vanishing point; that is, lines that move away from you come together in the distance

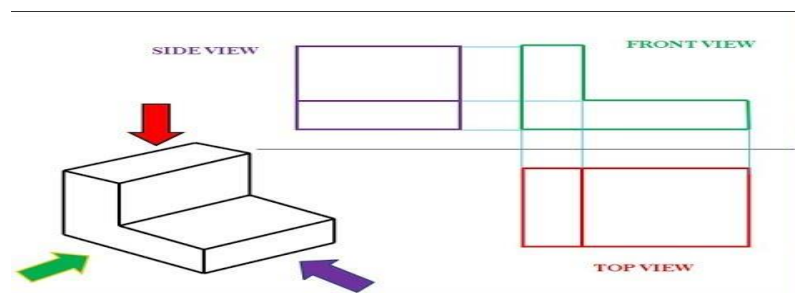


Figure 2.19 perspective view

- **Front view**

A front view is a projection view obtained by drawing perpendiculars from all points on the edges of the part to the plane of projection. The plane of projection upon which the front view is projected is called the *frontal plane*.

- **Top view**

Top view of an object shows the width and depth dimensions. In multi-view drawings, the right side view is the standard side view used. The right side view of an object shows the depth and the height dimensions

- **Side view**

In multi-view drawings, the right side view is the standard side view used. The right side view of an object shows the depth and the height dimensions. The right side view is projected onto the profile plane of projection, which is a plane that is parallel to the right side of the object.

- **Rear view**

The back view can also be referred to as the rear view. To produce an accurate drawing of an object, it is seldom necessary to show all six views. A working drawing typically shows three views of an object, which is sufficient to describe its shape and give all the required dimensions.

- **Exploded view**

An exploded view drawing is a diagram, picture, schematic or technical drawing of an object, that shows the relationship or order of assembly of various parts.

It shows the components of an object slightly separated by distance, or suspended in surrounding space in the case of a three-dimensional exploded diagram. An object is represented as if there had been a small controlled explosion emanating from the middle of the object, causing the object's parts to be separated an equal distance away from their original locations.

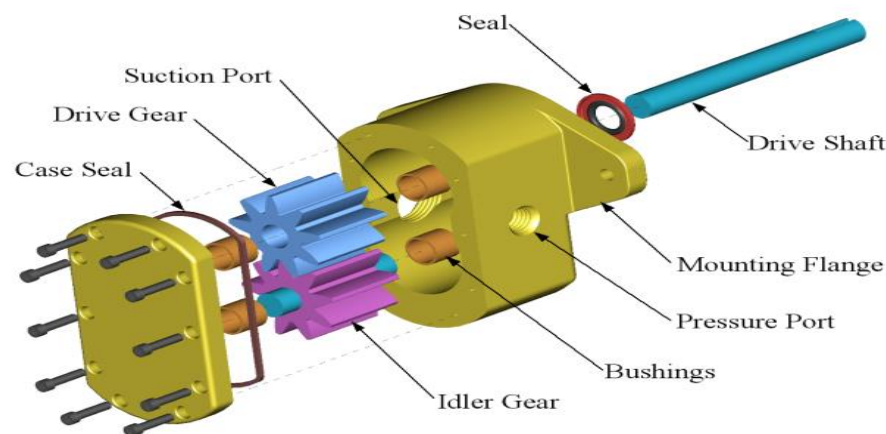


Figure 2.20 exploded view

2.3.3 Lines

A line on the drawing whose length is to be shown is called an *object line*. The object line is essentially an outline representing the feature(s) of the object. While showing an angle, the two lines forming the angle will be the object lines.

- **Extension line** – is a short line drawn perpendicular to an object line. These line start immediately or a few millimeters from the ends of object lines and extend a few

millimeters beyond a dimension line. Extension lines may be used to show an angle due to space constraint. In such case, extension lines are drawn parallel to and at the ends of object lines.

- **Hidden lines:** consisting of short, evenly-spaced dashes outline invisible or hidden surfaces. They are thin lines, about half as heavy as visible lines. They always begin with a dash in contact with the line from which they start, except when a dash would form a continuation of a solid line.
- **Visible line** the outline or visible line is used for all lines on the drawing representing visible lines on the object. This is a medium-towide line that represents edges and surfaces that can be seen when the object is viewed directly.
- **Centerlines**
Centerlines are made up of alternate long and short dashes. They indicate the center of an object or part of an object. Where centerlines cross, the short dashes intersect symmetrically. In the case of very small circles, the centerlines may be shown unbroken.
- **Break Lines**
Break lines indicate that a portion of the object is not shown on the drawing. Short breaks are made by solid, freehand lines. For long breaks, solid ruled lines with zigzags are used. Shafts, rods, tubes, and other such parts that have a portion of their length broken out have the ends of the break drawn
- **Dimension line** – is drawn between two extension lines parallel to the object line. As a rule, there must be one and only one dimension line between any two extension lines. One dimension line represents one dimension. While dimensioning an angle, a curved dimension line is drawn by drawing a suitable arc having its center at the vertex of the angle.
- **Leader line** – is a line which connects a note or a dimension with the feature to which it applies. Leaders are drawn at suitable angles, preferably 30°, 45° or 60°, and are never drawn horizontal or vertical. One end of the leader carries an arrowhead which connects it to the outline of the object. A dot is used instead of an arrowhead, if the leader ends inside the object, figure 3.2(b). The other end of the leader is made horizontal. A note or dimension is placed above the horizontal portion of the leader. Leaders are frequently used to indicate the diameter or radius of a circular feature.

- **Arrowheads** – an arrowhead is drawn at each end of a dimension line. The tip of an arrowhead touches the extension line. An arrowhead is also drawn at the end of a leader, which points out the feature of an object. The various styles of drawing an arrowhead are shown in the figure below. The arrowheads may be open, closed, or closed and filled. The angle formed the barbs of the arrowhead usually varies from 15° to 90° . Sometimes, an oblique stroke drawn at 45° to the extension line is used instead of an arrowhead

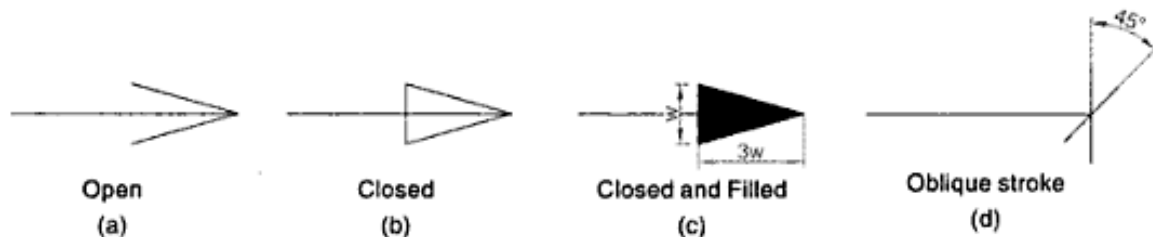


Figure 2.22. Arrow heads

The closed and filled arrowhead is most commonly adopted. It is the form of an isosceles triangle having a height three (3) times of its base. The space inside the triangle is uniformly filled in. The size of an arrowhead should be proportionate to the length of the dimension line. Too small or too large arrowheads should be avoided.

2.4 Constructing basic drawings/schematics

2.4.1 Electrical schematics

A schematic diagram is a fundamental two-dimensional circuit representation showing the functionality and connectivity between different electrical components. It is vital for a PCB designer to get familiarized with the schematic symbols that represent the components on a schematic diagram.

A schematic diagram is a fundamental two-dimensional circuit representation showing the functionality and connectivity between different electrical components. It is vital for a PCB designer to get familiarized with the schematic symbols that represent the components on a schematic diagram.

- **Standards for schematic symbols**

Schematic symbols are regulated around the globe using two standards:

- ✓ **IEC 60617:** International Electro technical Commission (IEC) has issued this standard. It is based on the older standard, British Standard (BS 3939). This database includes over 1750 schematic symbols.
- ✓ **ANSI standard Y32:** American National Standard Institute (ANSI). This provides a variety of specialized symbols originally used for aircraft applications. A series of minor changes performed on this standard has made the existing document aligned with IEC.

How to Draw Electrical Diagrams

1. Start with a collection of electrical symbols appropriate for your diagram
2. Draw circuits represented by lines
3. Drag and drop symbols to the circuits and connect them
4. Use line hops if any lines need to cross

2.4.2 Types of electrical/electronic diagrams

There are many kinds of electrical/electronic diagrams. Each kind of diagram suits its purpose.

- **Electrical wiring diagram**

The flow of current in a conductor or wire can be represented by diagram. There are two types of diagram: pictorial diagram and schematic diagram.

- ✓ **Pictorial diagram** is a sketch of electrical circuit that shows the external appearance of each component. It is much like a photograph of the circuit and uses simple images of parts.

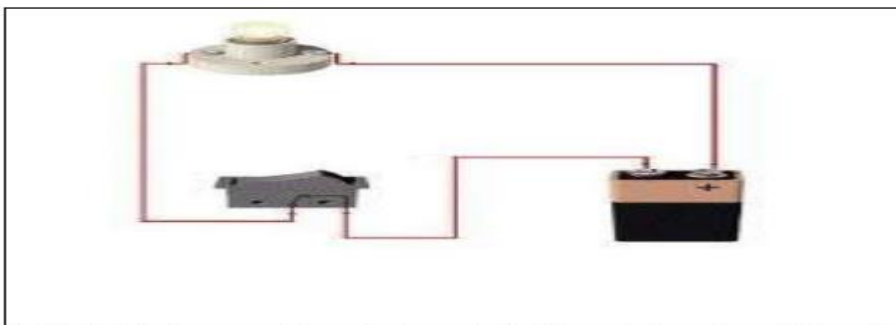
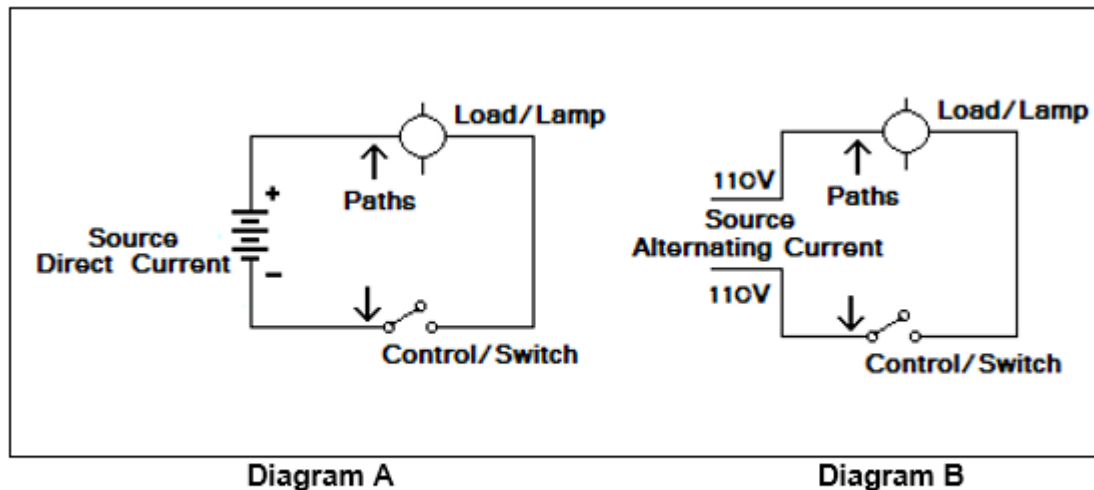


Figure 2.23 Pictorial diagram

Sample Pictorial diagram of one bulb controlled by single pole switch using 9 volt battery source.

- ✓ **Schematic diagram** is a sketch showing the components of the circuit using standard electrical symbols. It shows the actual number of components and how the wiring is routed but not the actual location



Sample schematic diagrams of one bulb controlled by single pole switch using *direct current* (Diagram A) and *alternating current* (Diagram B) source.

Figure 2.23 AC/DC current

2.4.3 Types of Circuit

A. Series Circuit

is a circuit in which lamps are arranged in a chain, so that the current has only one path to take. The current is the same through each load. Example of this is the Christmas lights. It consists of a number of bulbs that are connected side by side to meet the voltage requirement which is 220 volts for alternating current.

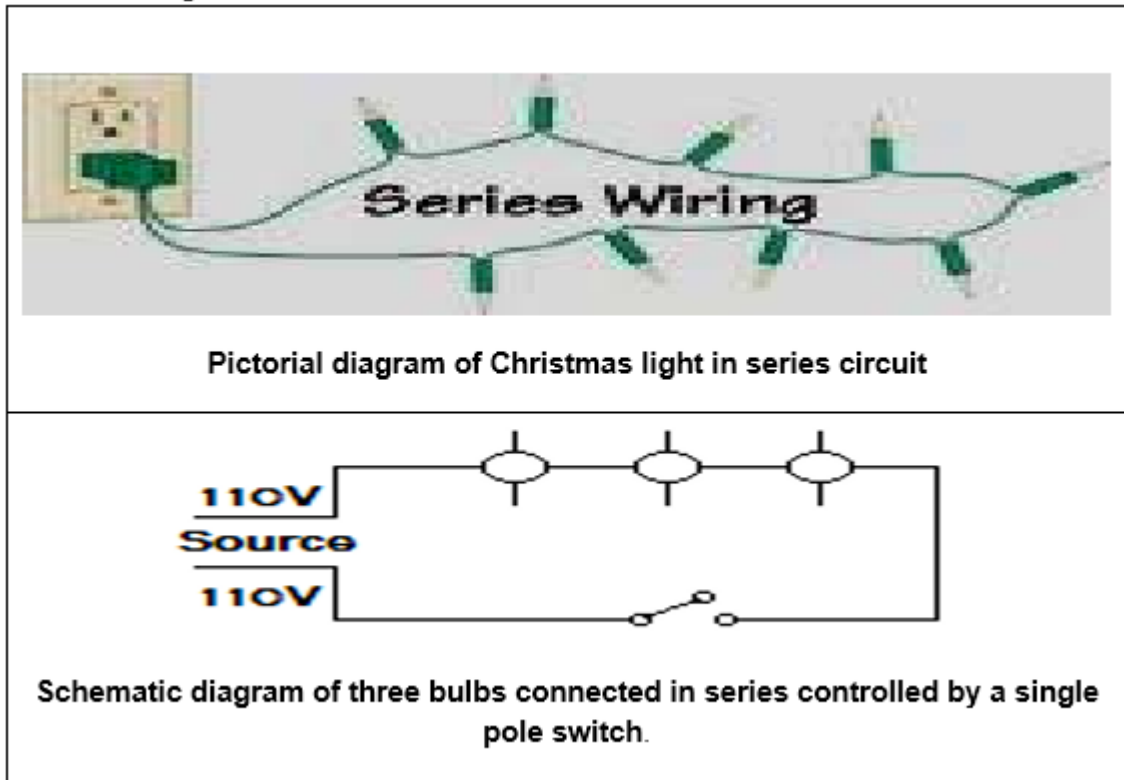


Figure 2.24 Series Circuit

B.Parallel Circuit

is a circuit in which lamps are connected across the wires. The voltage across each load on parallel circuit is the same. The advantage of using parallel circuit is that even if one of the lamps fails, still the remaining lamps will function.

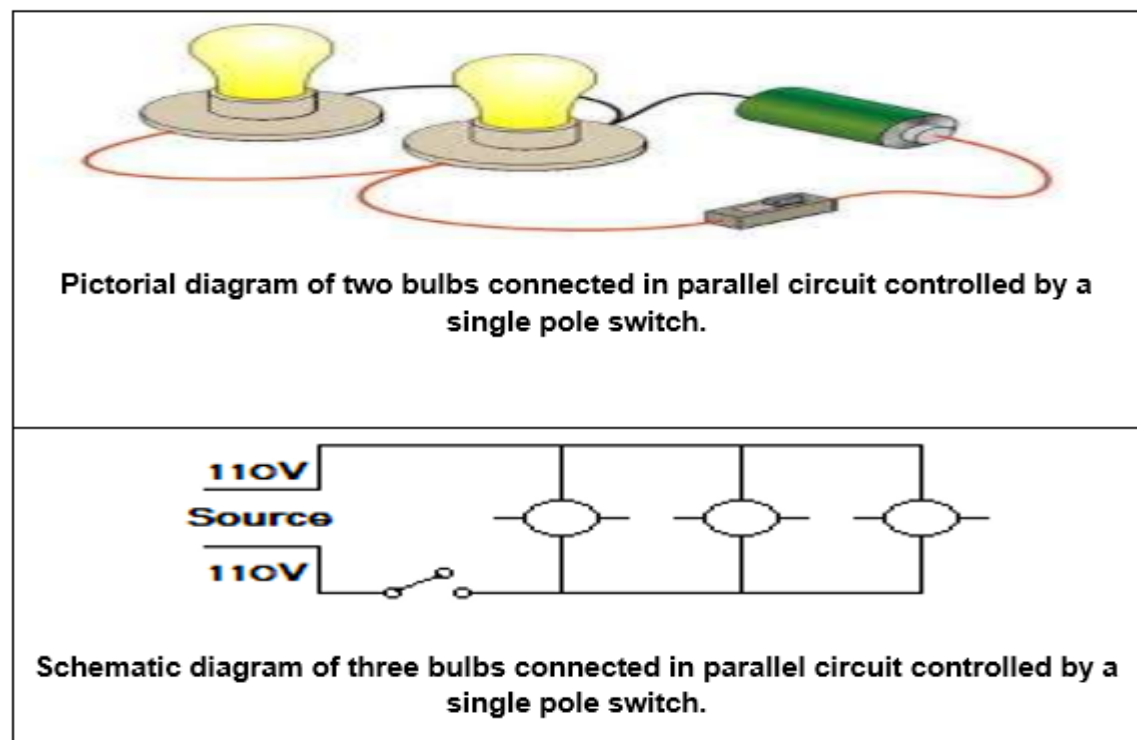


Figure 2.25 parallel Circuit

• SINGLE-LINE DIAGRAM

The single-line diagram is used basically for the same purpose as the block diagram. When used with text material, it gives you a basic understanding of the functions of the components of a system.

There are two major differences between the single-line diagram and the block diagram. The first difference is that the single-line diagram uses symbols, rather than labeled blocks, to represent components. Second, the single-line diagram shows all components in a single line. There are no interconnections shown for selected components as were shown on the block diagram (for example, alternator to voltage regulator and back to the battery). The single-line diagram is very simplified and should be used primarily to learn (in very broad terms) the function of each of the various components as a part of the total system.

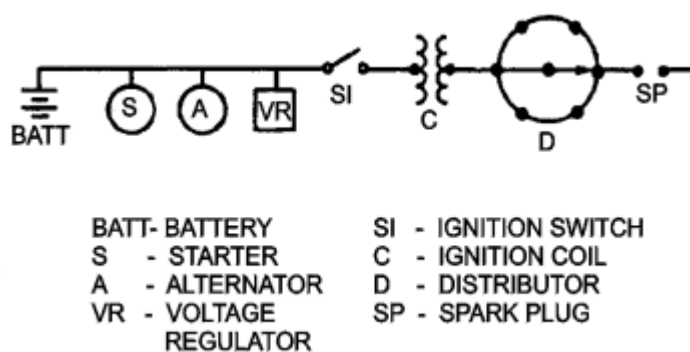


Figure 2.25: Single line diagram

- **SCHEMATIC (ELEMENTARY) DIAGRAM:** Shows the ways a circuit is connected and what the circuit does using graphic symbols. The schematic does not have to show the size or shape of the parts of the circuit. It does not have to show where the parts of the circuit actually are.

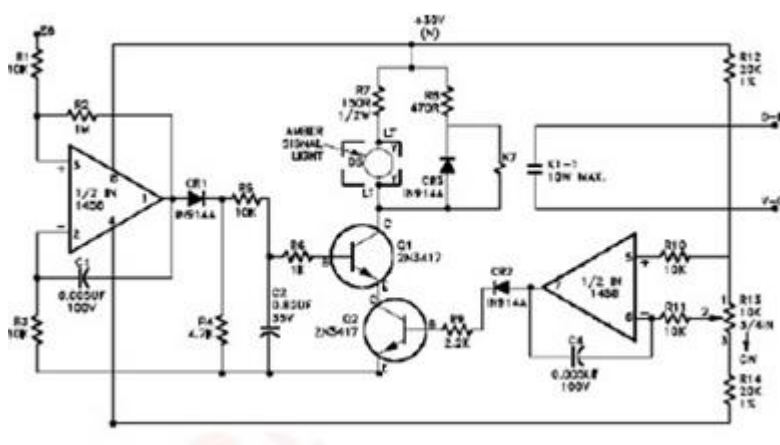


Figure 2.26: Schematic diagram

- **Connection or Wiring Diagram:**

Shows how the components of a circuit are connected. It may cover connections inside or outside the components. It has as much detail as is needed to make or trace connections. The connection diagram usually shows how a component looks and where it is placed.

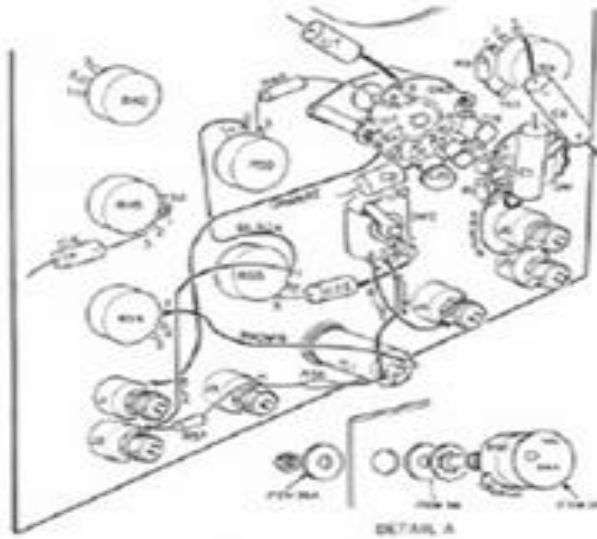


Figure 2.27: Installation assembly drawing

- **LAY OUT DIAGRAM:** Is a pictorial representation of how the electronic circuit actually looks. These drawings show the actual lay out of the components on the circuit board. This provides a two dimensional drawing, usually looking down from the top, detailing the components in their location. Figure below shows the schematic for the circuit and the same circuit drawn in pictorial or lay out format for comparison. Normally the pictorial layout would be accompanied by a parts list.

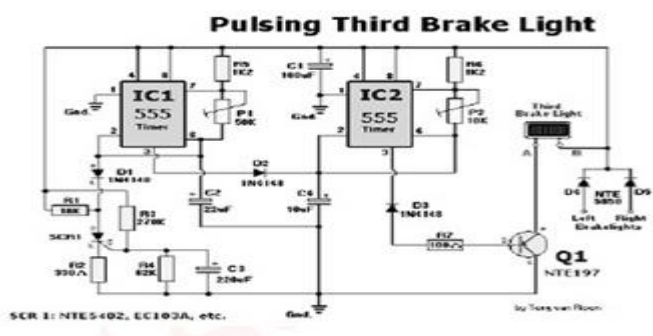
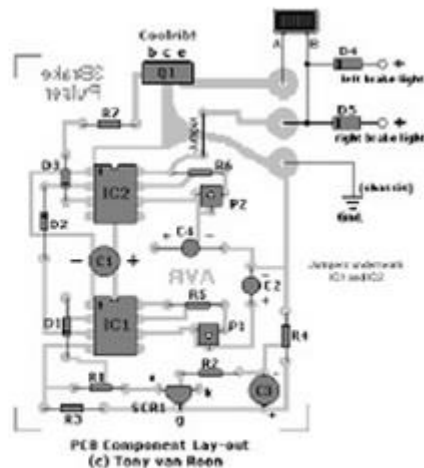


Figure 2.28: Schematic (elementary) of a pulsing third brake light diagram



C. Layout, component side

- **BLOCK DIAGRAM**

A block diagram is used primarily to present a general description of a system and its functions. This type of diagram is generally used in conjunction with text material. A block diagram shows the major components of a system and the interconnections of these components. All components are shown in block form, and each block is labeled for identification purposes.

- **CHART**

A chart, also called a graph, is a graphical representation of data, in which "the data is represented by symbols, such as bars in a bar chart, lines in a line chart, or slices in a pie chart". A chart can represent tabular numeric data, functions or some kinds of qualitative structure and provides different info.

The term "chart" as a graphical representation of data has multiple meanings:

A data chart is a type of diagram or graph that organizes and represents a set of numerical or qualitative data.

Maps that are adorned with extra information (map surround) for a specific purpose are often known as charts, such as a nautical chart or aeronautical chart, typically spread over several map sheets.

Other domain specific constructs are sometimes called charts, such as the chord chart in music notation or a record chart for album popularity.

- **LOCATION PLAN**

- ✓ A location plan shows the proposed development in relation to its surrounding properties
- ✓ It must be based on an up-to-date map and at an identified standard metric scale (typically 1:1250 or 1:2500)
- ✓ The site of the proposed development needs to be outlined in red and any other land owned by the applicant that is close to or adjoining the site needs to be outlined in blue

2.5 Interpreting diagrams and drawings

Technical drawings are used to visualize just about anything that is manufactured, built or assembled. From idea to drawing to factory, mill or construction firm, a technical drawing describes shape, dimensions, materials, construction and overall look of the object being created. With a few tips and some insight about terms and meaning, anyone can visualize the final product from looking at a technical drawing

• Understanding Projections and Views

Step 1: Start by looking at the Title Block on each drawing. Located in the lower right of the drawing, the Title Block contains the architect or designer's name, the drawing number, project name, part number or building address and the scale of the drawing. This will help you understand what you're looking at.

Step 2: Drawings generally include the front, side and top of the object being designed. These are labeled "front view," "top view" and "side view." These drawings are drawn in either parallel or perspective projections.

Step 3: Parallel projections include orthographic drawings: flat, multi-view drawings of the subject. These consist of a front view with the top of the object drawn on the paper below the front view and a drawing of the side view placed to the side.

Step 4: The drawing of the front of the object shows dimensions of width and height. The drawing of the top shows width and depth, and the side shows height and width.

Step 5: Perspective projections are drawings in which an object is drawn using one-, two- or three-point perspective. These drawings present the subject as a three-dimensional object.

Step 6: Section views show the hidden features of an object so that a craftsman or builder can completely understand how the piece is shaped inside and out.

Step 7: Exploded views show the pieces that make up a given object outside of the object. Connector lines indicate where the pieces go and how the unit is assembled.

Projection and Dimension Lines

Step 1: Projection and dimension lines are drawn in or around the outline of the subject and are used to indicate measurements and instructions.

Step 2: A projection line is drawn in alignment with edges of the subject or with a section such as the edges of a window or chimney. These are used to indicate the width of the indicated section.

Step 3: A dimension line is drawn from one projection line to another with arrowheads touching each projection line. Measurements are notated on dimension lines to describe what size materials should be.

Reading Symbols

Step 1: Architectural symbols are used for doors and the way they open, windows, stairs, appliances, fixtures and furniture. These symbols are generally notated.

Step 2: Other types of symbols used in architecture, landscaping and manufacturing denote the types of materials being used in the construction of a unit, part or section (i.e., marble, brick, wood, plastic, steel) and are notated.

Step 3: Electrical outlets, cables and wiring, along with duct work, are also included in a plan. Oftentimes a separate drawing (such as detailed electrical drawings) can be on lighter paper that is overlaid on the main drawing. Some notation might be included in other views of the subject.

2.6 Checking and validating drawing

Drafting standard and drawing management system has been established, a drawing validation process must exist to ensure compliance with corporate standards.

Oftentimes this consists of one or more drafters or checkers performing drawing audits from within AutoCAD software using various tools like Check Standards,

This process can be time-consuming and costly especially when a large amount of drawings must be processed within a short time period.

Several third-party applications exist to assist with this process but most require an extensive setup and an external database.

Validation should take place from the early to the final stages of our product lifecycle and even after the release of the final solution.

The most commonly used methods are surveys/questionnaires, usability tests, card sorting, eye-tracking, A/B tests and a continuous monitoring of how users are responding and interacting with your product even after every release.

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Self-check 2

I. Direction :say true if the stament is true otherwise false

1. Distance is measure of vertical distance, either vertical extent
2. Angle is figure formed by two rays meeting at a common end point
3. the most convenient unit for length is centimeter
4. Dimensions lines should cross each other, Dimension lines should also not cross any other lines of the object.
5. Width is commonly used to describe the measure of an object from side to side,

II. Write Short Answer for the Following Questions.

1. Draw symbols of the following electronic components.

- Resistor
- Inductor
- Push button
- Fuse

III. choose the best answer

1----- Is a fundamental two-dimensional circuit representation showing the functionality and connectivity between different electrical components?

A. block diagram C. schematic diagram

B. wiring diagram D. pictorial diagram

2. ----- is used primarily to present a general description of a system and its functions

A. block diagram C. schematic diagram

B. wiring diagram D. pictorial diagram

3. ----- Is a pictorial representation of how the electronic circuit actually looks.

A. lay out diagram C. schematic diagram

B. wiring diagram D. pictorial diagram

4. -----shows the proposed development in relation to its surrounding properties

A. lay out diagram C. schematic diagram

B. location plan D. pictorial diagram

5. ----- is a graphical representation of data

- A. lay out diagram C. schematic diagram
B. location plan D. chart

Operation sheet-1

Operation Title: free hand sketching

Instruction: Using freehand sketching, you are required to do draw given diagram

Purpose: drawing diagram with free hand sketching

Required tools and equipment:

- ✓ HB drawing pencil lead
- ✓ 4H drawing pencil lead
- ✓ 45° x 90° triangle
- ✓ 30° x 60° triangle
- ✓ Eraser
- ✓ T-square
- ✓ Drawing table
- ✓ Drawing papers

Precautions:

- Never erase the line with your hand
- Choose wet free flat table
- Never use transparent paper

Procedures:

1. Set up the drawing paper on top of the drawing board.
2. Check to see that the paper edges are parallel to the left and bottom edges of the board respectively.
3. Properly secure the paper on top of the table by using masking tape or tacks or the likes.
4. Using the set of triangles and T-square, draw the border line around the drawing paper, leaving area for the title block at the bottom part.

5. Divide the effective drawing area into nine (9) equal parts as shown in the figure template below.
6. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.
7. For normal drafting or lettering use the soft lead pencil (**HB**) for final results. Use the harder lead pencil (**4H**) for guidelines drawing only.
8. Fill the each box with alphabet of lines according to each respectively examples. Observe approximately uniform spacing of your work.
9. This is not a work of speed but a work of accuracy and aesthetics, so do your work with quality.
10. You may submit your finish work once you are true but should be within the time specified for submission.

Quality criteria:

- Proper component selection
- correct sequence of the operation
- Proper sharpening of pencil
- Neatness of drawing paper

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

Name: _____

Date: _____

Time started: _____

Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Task 1: sketch the given diagram with your free hand

Unit three: Store technical drawings and equipment /instruments

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

- Handling and maintaining of drawing instruments
- Recording technical drawings and preparing inventory
- Storing drawing instruments.

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

- Handle and maintain of drawing instruments
- Record technical drawings and preparing inventory
- Store drawing instruments

3.1 Handling of drawing instruments

Drawing tools are often delicate and have many intricate and small pieces that need to be well maintained to continue working properly. Organizing and storing these items has a great deal to do with keeping them in pristine shape and working correctly. With a little patience and developing a routine, your tools will be well taken care of and working for a long time

- Lay out all the drawing tools that you use and separate them into piles of like items. Place all pencils together, markers, erasers, rulers, stencils, paper and miscellaneous.
- Using the cleaner, spray the cloth and wipe down supplies that have residue on them. Pencils, markers, stencils and rulers often retain oils on them from fingers.
- Take the erasers and rub out any black marks. Do this by rubbing the eraser against a clean piece of paper until the black smudge has disappeared. For kneaded erasers, these can simply be stretched and remodeled into a ball, similar to bread dough, to get the black smudge marks out.
- Run your hands through your drafting brush to remove any loose debris. Then, wipe it down with the cleaning cloth to remove any residue from the handle.
- Roll up your drafting papers into a tight roll. Secure them with a rubber band at each end. Place the roll into a drafting tube for storage
- Place the pens and markers into the long slots of the organizer tray. Place the erasers in the smaller cube slots. Fill in with any other drafting materials, such as lead refills, push pins, paper clips, small rulers and mounting stickers.
- Take your compass and wipe it off with the cleaning cloth. If it is going to be stored in the organizer tray, wind the compass down until it is straight (versus at an angle, making a triangle shape). If it has its own case, then wind it to the size the case has set for it to be stored, and place it into the box.
- Make a folder to hold all your stencils. Create holding flaps in an ascending order so the stencils can be layered and easy to see and access when needed. To make these flaps, simply use card stock paper and cut it into 3- or 4-inch sections. Glue each section onto a large main piece of card stock, starting towards the top for the smallest stencil and working your way down to the bottom. Glue three of the four edges, leaving the top edge open for the stencil to slide into.
- Place this newly made stencil holder into a large plastic or mesh pouch. Put a dry cleaning cloth in the pouch, placed over the stencils, to help keep them clean.
- Place the drafting brush and rulers into the pouch. Then place the organizer tray into the pouch. If the compass had its own storage box, then place this in the pouch. All the major tools should now be in this portable carrying pouch with your paper in the separate portable carrying drafting tube.

3.2 Recording

Record is a thing constituting piece of evidence about the past .specially an account of occurrence kept in writing on some other permanent form.

Inventory is complete list of items such as property, goods, in the stock or the content of the building. It makes complete list of all the things that are in place.

Item name	Quantity	Description	Remark
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Procedure in filling up inventory template

1. Specify the instrument and fill in in the first column of the table
2. Provide how many items are available and fill in the second column of the table
3. Describe the usage and function of each item based on its usage and function and label it in the third column
4. Mark functional if the equipment is still usable or damage if not usable and fill it in the fourth column of the table

3.3 Storing drawing instruments

When a session of drawing is finished, it is important that the equipment, which has been in use, is stored neatly in clean and dry conditions. Dirty and damaged equipment does not help in the production of good, neat and clean drawings. Drawing boards can be either placed in purpose-made racks or stacked one on top of the other. Tee squares should be placed in properly made racks, which make sure that the drawing edges are not damaged and that their two parts do not become separate. Set squares must be kept in a clean condition. They may pick up dust and erasing particles and if they are stored in such a condition other equipment becomes dirty. Pencils can be placed in racks made from blocks of wood with appropriately sized holes. Compasses are easily damaged if not stored properly.

The best method of storing drawings is for each pupil or student to have a folder in which his or her drawings can be placed without their being folded. Other drawings, such as those used to demonstrate the principles of working should be stored flat in drawers large enough to take them unfolded. Take care when placing drawings in folders or drawers. Careless handling can easily cause them to become damaged, even to be torn. Drawings must be kept clean if they are to be read easily.

• A SUGGESTED EQUIPMENT TIDY BOX

Figure below shows a box, made from wood and hardboard and designed to hold a set of technical drawing equipment. The main dimensions of the box are:

- Overall length: 330 mm
- Overall depth: 270 mm
- Height: 25 mm
- Thickness of sides: 10 mm

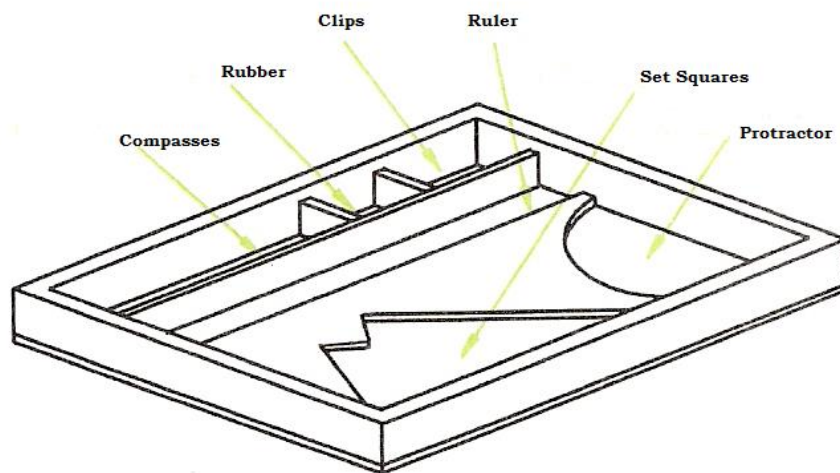


Figure 3.1 Suggested Technical Drawing Equipment Tidy box

Self-check 3

Direction I. Give short answer to the following questions.

1. List Procedure in filling up inventory template
2. What is the need of storing drawing equipment safely?
3. State the best method of storing drawings.
4. Explain how T-square is stored.

Direction I. matching

A

1. Sweep

2. Sort

3. Standardize

B

A. get rid of all unnecessary items

B. clean and tidy

C. label

Part III True /False

1. Drawing tools are often delicate and have many intricate and small pieces that need to be well maintained to continue working properly.
2. The best method of storing drawings is for each pupil or student to have a folder

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