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Edition 1 – October 2014

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Unit Resource Manual

Manufacturing Skills Australia Courses

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Aims of the Competency Unit:

This unit covers identifying the drawing requirements, preparing or making changes to engineering drawings, preparing an engineering parts list and issuing the drawings

Unit Hours:

72 Hours

Prerequisites:

MEM09002B Interpret technical drawing.

Elements and Performance Criteria

- | | | |
|---|-----|--|
| 1. Identify drawing requirements | 1.1 | Requirements and purpose of drawing are determined from customer and/or work specification and associated documents. |
| | 1.2 | All data necessary to produce the drawing is identified and collected. |
| | 1.3 | Drawing requirements are confirmed with relevant personnel and timeframes for completion are established. |
| 2. Comply with environmental regulations. | 2.1 | Drafting equipment is selected appropriate to the drawing method chosen. |
| | 2.2 | Drafting principles are applied to produce a drawing that is consistent with standard operating procedures within the enterprise. |
| | 2.3 | All work is undertaken safely and to prescribed procedure. |
| | 2.4 | Completed drawing is approved in accordance with standard operating procedures. |
| 3. Prepare engineering parts list | 3.1 | Components parts are identified and organised by component type and/or in accordance with organisation/customer requirements. |
| 4. Issue drawing | 4.1 | Drawings and or parts lists records are completed in accordance with standard operating procedures. |
| | 4.2 | Approved drawings and or parts lists are copied and issued to relevant personnel in accordance with standard operating procedures. |
| | 4.3 | Approved drawings and or parts lists are stored and catalogued in accordance with standard operating procedures. |

Required Skills and Knowledge

Required skills include:

- obtaining all relevant job requirements, data/information and specifications necessary to produce the drawing in accordance with workplace procedures
- using drafting equipment appropriate to the drawing method chosen
- producing/changing the drawing to conform with the relevant standard
- undertaking all work safely and in accordance with workplace procedures
- checking the completed drawing in accordance with standard operating procedures
- producing the component parts list with part name, description of part, material specification or part number, quantities and all other details specified by the customer and/or organisational procedures
- recording completed drawings and or parts lists in accordance with standard operating procedures
- where appropriate, copying and issuing approved drawings and or parts lists in accordance with standard operating procedures
- handling and storing the approved drawings and or parts lists in accordance with standard operating procedures
- reading, interpreting and following information on written job instructions, specifications, standard operating procedures, charts, lists, drawings and other applicable reference documents
- planning and sequencing operations
- checking and clarifying task related information
- undertaking numerical operations, geometry and calculations/formulae within the scope of this unit

Required knowledge includes:

- requirements and purpose of the drawing to be produced
- requirements and purpose of the engineering parts list
- sources of relevant data/ information
- timeframe for completion of the drawing(s)
- person(s) who can confirm drawing requirements
- method of drawing preparation
- the reasons for selecting the chosen drawing method
- procedures for producing an initial drawing
- procedures for changing an existing drawing
- drafting principles to be applied to the production/changing of a drawing
- standards to which the drawing is to be produced
- procedures for checking drawings
- the persons responsible for checking and approving drawings
- consequences of inappropriate/incomplete components parts lists
- procedures and reasons for recording completed drawings and or parts lists
- procedures for copying approved drawings and or parts lists
- procedures for issuing approved drawings and or parts lists
- the personnel to whom copies of approved drawings and or parts lists can be issued
- procedures for filing approved drawings and or parts lists
- procedures for safe handling and storage of drawings and or parts lists
- consequences of inappropriate handling and storage of approved drawings and or parts lists

Lesson Program:

Unit hour unit and is divided into the following program.

Topic	Skill Practice Exercise
Topic 1 – Drafting Basics:	MEM09003-SP-0101 to MEM09003-SP-0108
Topic 2 – Arrangement of Views:	MEM09003-SP-0201 to MEM09003-SP-0207
Topic 3 – Standard Drawing Sheets:	MEM09003-SP-0301
Topic 4 – Dimensioning Techniques:	MEM09003-SP-0401 to MEM09003-SP-0405
Topic 5 – Sections & Conventions:	MEM09003-SP-0501 to MEM09003-SP-0510
Topic 6 – Auxiliary Views:	MEM09003-SP-0601 to MEM09003-SP-0603
Topic 7 – Technical Lettering:	MEM09003-SP-0701 to MEM09003-SP-0703
Topic 8 – Engineering Scales:	MEM09003-SP-0801 to MEM09003-SP-0802
Practice Competency Test:	MEM09003-PT-01
Answers:	

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Topic 1 – Drafting Basics:

Required Skills:

- Use different line constructions to identify features on an orthogonal view
- Produce a simple drawing without notations and dimensions in Orthogonal Projection.

Required Knowledge:

- The Australian Standard controlling the preparation and presentation of all drawings in Australia.
- The difference between First and Third Angle Projection.
- Types of drawings used in engineering and manufacturing.
- Items of manual drafting equipment.
- Types of line construction and line widths used in preparing a drawing.

1.1 Introduction to Drawings:

The preparation of plans for the construction of ships, buildings and machines is as old as written history. Original drawings were carved on rock or sketched onto papyrus. One of the oldest drawings of an engineering component is a cave painting of a bow in Castellon, France in about 8000BC. As civilisation grew and the skills became more advanced, plans were produced on other mediums such as bark and paper using a variety of instruments to assist in creating better quality drawings.

The image shown in **Error! Reference source not found.** shows a portion of the clay plans of a six-room building, a sanctuary or a private house and are part of the Gudea cylinders dating about 4200 years ago, on which is written in cuneiform a Sumerian myth called the Building of Ningursu's temple.

A new material, papyrus, was developed for storing written history, documents and plans. **Error! Reference source not found.** shows the remains of a papyrus documenting mathematical formula dating from about 3500 years past.

As technology improved, so did the media on which the documents and plans were recorded. About 2500 years ago, parchment or vellum was created using dried hides and skins of goats and lambs. Figure 1.1 shows the plans drawn on parchment for the monastery at Saint Gall, Switzerland, which are now about 1200 years old.

In China, the origins for the use of silk and the development of paper can be traced back 2200 years but by the 1600's paper and canvas was being used extensively for art and the recording of engineering plans. Leonardo De Vinci was a major innovator in designs and while many did not work at the time, it has been proven that with modern light-weight materials, the inventions did work. Figure 1.2 shows the drawing for an Armoured Tank drawn in about 1500.

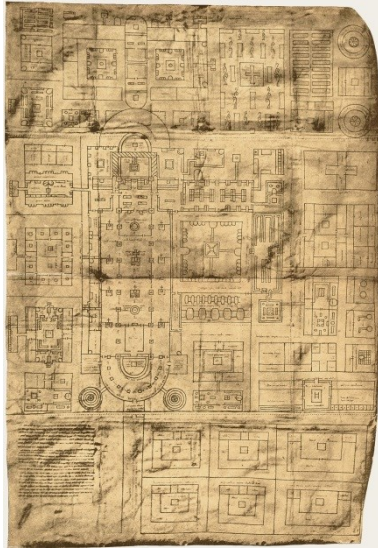


Figure 1.1



Figure 1.2

During the Industrial Age drawings became elaborate and were prepared by qualified architects, engineers and draughtsmen. By 1833 Stephenson produced a drawing of his steam engine named the "Rocket" and shown in **Error! Reference source not found.** while **Error! Reference source not found.** shows Robinson's New York Utility plan complete with the sewer, gas, water services and ventilation.

Modern drawings may consist of one or more views and include all general and toleranced dimensions, notations, welding symbols, machining symbols, surface finish and geometric tolerancing symbols to produce accurate components, assemblies and constructions. The methods of drafting have also changed, seldom are drawings created using manual drafting equipment on drawing boards; modern detail, assembly and construction drawings are produced using complex Computer Aided Drafting (CAD) programs which produce both 2D plotted/printed drawings and 3D models.

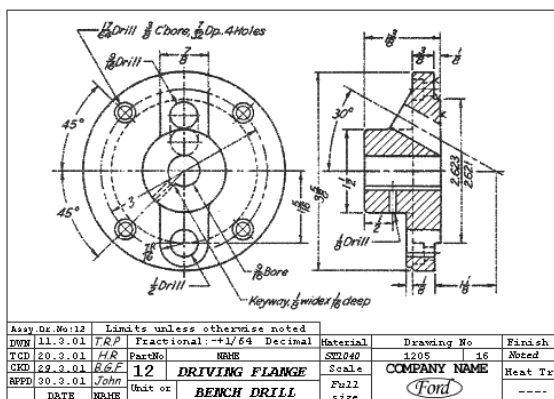


Figure 1.3

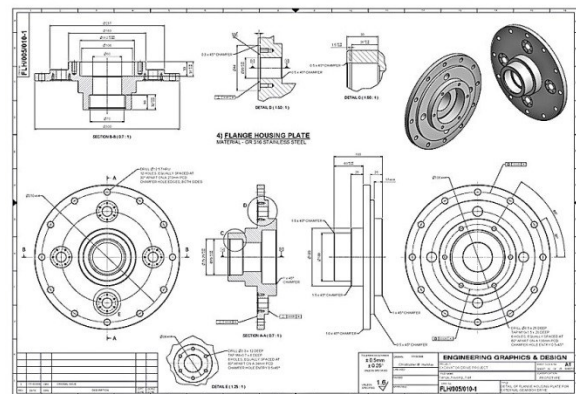


Figure 1.4

Drawings were once created by the designer with little thought to conformity or any standard; some drawings had some dimensions or sizes however many drawings showed the basic shape or overall sizes and the actual details were left up to the engineer and supervisor on the job.

1.2 Standards - General Information:

Standards have existed since the beginning of recorded history. The ancient Egyptians developed the 365 day calendar in 4236 BC based on the rising of the “Dog Star” or Sirius every 365 days. In Ancient times, the cubit was a standard measurement and based on the length of the forearm from the elbow to the tip of the middle finger; in 1120 AD, King Henry I of England instituted the “ell” which was the equivalent to the length of his arm.

The earliest standards were the physical standards for weights and measures which provided a single reference point and against which all other weights and measures in the society could be standardised. As trade and commerce developed, written documents developed which set down mutually agreed standards for products and services such as shipbuilding, housing, electrical/electronic goods, clothing and nearly any object that has to be manufactured. Initially, the standards were unique documents and formed part of a single contract between the supplier and the purchaser. Later the concept of common standards evolved where the same standard could be used across a range of transactions; this portability offering a uniform set of criteria, is the basis of modern standardisation.

After the rapid industrialisation of the early 19th century, the general absence of national standardisation caused high inefficiencies. Lack of conformity was a major cost as evidenced with the different railway gauges between the different states; each carriage had to be unloaded from one carriage in New South Wales and loaded onto another carriage in Victoria when transporting goods between the states. The Albury Railway Station has the longest platform in Australia and it was only in 1962 the railway gauge was standardised.

It wasn't until the end of the 19th century that the value of standardisation in sizes, specifications, materials, testing and conformance was recognised as a national priority. By 1900, standardisation was flourishing and has continued to where it has now become intrinsic to modern society and has extended far beyond the initial focus to include consumer safety, occupational health and a myriad of other topics, all of which serve to improve the quality and comfort of everyday life.

Standards are the tools we use to organise our technical world and measures we employ to establish norms for management procedures; they underpin consumer expectations that products purchased will be safe, reliable and fit-for-purpose. Standards have become such integral components of our economic, social and legal systems that they are often taken for granted and their crucial role in modern society is often not recognised.

1.3 Australian Drawing Standard:

A Standard is a published document which sets out specifications and procedures designed to ensure that a material, product, method or service is fit for its purpose and consistently perform in the way it is intended. Standards establish a common language which defines quality and establishes safe criteria. Standards and conformance are the keys to ensuring the quality and consistency of physical, chemical and biological measurement throughout Australian society and the economy.

The benefit of standards to both the Public and National Interest are:

- Standards protect Australians.
- Standards support Australian innovation.
- Standards boost Australian production and productivity.
- Standards make Australian business more competitive.
- Standards link Australia to the world.
- Standards complement Australian regulation and make markets work better.
- Working on Australian Standards rewards participants.

The Australian Standards applying to the preparation and presentation of drawings in Australia is AS1100 and sets the standard for linework, lettering, dimensioning, symbols, borders, sheet sizes etc. The standards are divided into 5 parts:

- Part 101: General principles (1992)
- Part 201: Mechanical engineering drawing (1992)
- Part 301: Architectural drawing (1985)
- Part 401: Engineering survey and engineering survey design drawing (1984)
- Part 501: Structural engineering drawing (2002)

1.4 Manual Drafting Equipment:

Manual drafting has largely disappeared from modern drawing offices in favour of CAD, however, the basic drafting skills should be developed for use when:

- Operating at a remote site where power or computers are not available.
- Revising old manually produced drawings.

The equipment used to produce a drawing depends on the method of drafting being used; i.e. computer, drawing board, photographic etc. Drawings prepared electronically (computers) require little more than a computer, keyboard, monitor, software and a printer/plotter. A drawing being prepared manually varies depending on the medium and methods used. The equipment usually consists of:

1.4.1 Drawing Board:

A drawing board is the surface upon which a drawing is prepared. A drawing board can be a simple sheet of plywood with a layer of thick paper or vinyl to allow a good quality line to be drawn or an elaborate drafting machine with movable arms and rules which can be rotated. Most drawing boards are used on a flat table and may be slightly inclined for an easier working position. Drafting machines can be raised or lowered, positioned vertically or horizontally, and some can rotate to allow the draftsman to work upside down at the top of the drawing without having to remove and reposition the drawing.

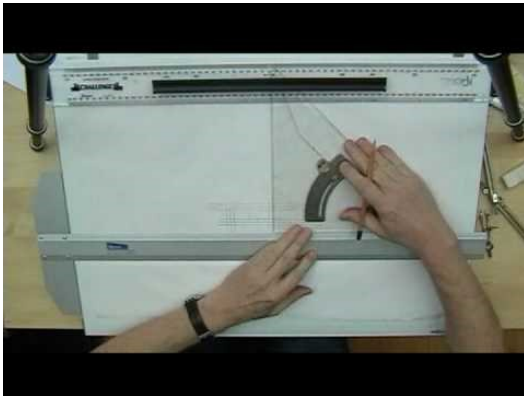


Figure 1.5 – Drawing Board



Figure 1.6 – Drafting Machine

Drawing boards and machines have been largely replaced by the computer.

1.4.2 T-square, Set Squares and Protractor:

The T-square has a long horizontal arm called the Blade, fastened to a shorter vertical arm called the Head. The upper edge of the blade and the inner edge of the head are the working edges. The working edge of the blade must be straight or the drawn lines will be drawn curved; the head must not be convex or the head will rock and the drawn lines will not be parallel; a concave edge will also draw unsquared lines towards the top and bottom of the drawing board.

Set squares are available in 45° and 30°/60° styles; they are made from transparent plastic with a bevelled edge, which allows lines on the drawing below the set-square to be seen.

Protractors are used for measuring and setting out angles other than those obtainable with the set-squares. Protractors are normally made from transparent plastic similar to set-squares.



Figure 1.7
T-Square

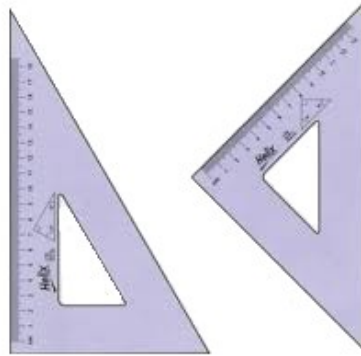


Figure 1.8
Set Square

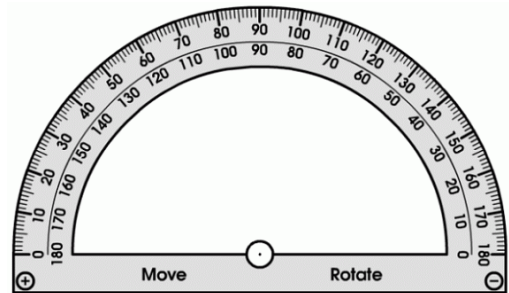


Figure 1.9
Protractor

T-Square Set Squares Protractor

1.4.3 Compass Set:

A compass has one leg which carries a pencil; the legs are connected by a bow-shaped spring instead of a joint. An adaptor can be inserted into the pencil leg and an ink pen used in place of the pencil. Compasses are used to draw arcs or circles.



Figure 1.10 – Compass Set



Figure 1.11 – Bow Compass

When using the pencil attachment with the compass, the pencil graphite is placed with the bevelled edge on the outside. The pin on the leg is placed at the point where the circle centre is required, the radius is set and the compass rotated about the pin by rotating the handle between the thumb and forefinger.

1.4.4 Technical Pens:

Technical pens consist of a cone which is a tube with a needle point; inside the pen's body is a reservoir that supplies ink to the cone. Technical pens are available in a large range of standard widths. For optimum line work quality, the cones are manufactured in a variety of materials (mild steel, tungsten tip, ceramic tip) depending on the drawing material being used.



Figure 1.12 – Compass Set



Figure 1.13 – Bow Compass

1.4.5 Scale Rule:

The Scale Rule is similar to a normal rule but is graduated in the metric (or imperial) system to set scales; with practice, using a scale rule is as easy as reading a normal rule. Standard scales used in the scale rule are 1:1, 1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500 and larger.

Scale rules can be “flat” or “triangular”; the flat rule has bevelled edges for when using ink.



Figure 1.14 – Flat Scale Rule



Figure 1.15 – Triangular Scale Rule

1.4.6 Pencils:

High quality pencils should always be used when drawing. Pencils are available in the old style timber pencil or modern technical pencils. The older style timber pencils have a thin rod of graphite in the centre and require constant sharpening to maintain a good sharp point for drawing. Mechanical pens have the graphite inside a tube and as the point wears down or breaks, more lead can be exposed as required. Mechanical pens are also available in a range of standard widths (0.25mm, 0.35mm, 0.5mm, 0.7mm, 1mm) which give a constant line width.



Figure 1.16 – Timber Pencil



Figure 1.17 – Mechanical Pencil

When using timber pencils, the pencil should be revolved between the thumb and forefinger to assist in retaining a sharp point; revolving a mechanical pencil is not as important but can assist with maintaining a constant line width.

Pencils are available in a range of grades (or hardness) ranging from 9H to 7B. The 9H pencil has a very hard lead and leaves a very narrow and light line; if the draftsman is not careful, the pencil can act as a knife and cut through the medium. At the opposite end of grades the 7B is very soft and leaves a wide and dark line; lines drawn using softer pencils are easily smudged. The middle range of pencils includes the F and HB

grades. The pencils normally used by draftspersons are 3H, 2H, H, F, HB, and B with the H and 2H being the most commonly used.

When using a compass, it is generally accepted to use a lead about 2 grades softer than used when drawing because less pressure is used when drawing a circle using a compass than when drawing a straight line with a pencil.

1.4.8 Eraser and Erasing Shield:

Erasers are available in a range of materials, hardness and abrasiveness depending on the type of pencil/ink and the drawing medium. Care must be taken to retain the drawing surface in as good condition as possible – intense erasing will damage the surface and make it unsuitable for drawing or even create a hole.

The erasing shield is made from thin metal sheeting which has a series of different sized holes and slots. The shield is placed over a line to be erased thus protecting most of the other adjoining lines and text.



Figure 1.18 – Eraser

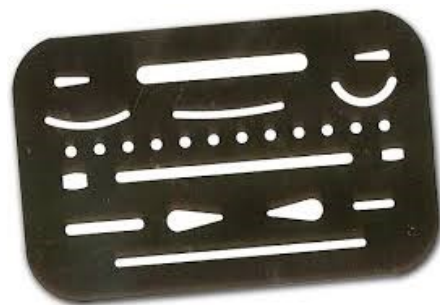


Figure 1.19 – Erasing Shield

1.4.9 Stencils:

Stencils are made from transparent plastic sheets which have letters, numbers, or shapes cut out so a pencil or pen can quickly and accurately reproduce the shape. Lettering guides are available in a range of sizes and are specifically suited to pen sizes (0.25 pen for 2.5mm text, 0.35 pan for 3.5mm text, 0.5 pen for 5mm high text etc). Other stencils are available for symbols and appliances in most drafting disciplines, circles, ellipses and squares for mechanical/basic drawing, and electrical, electronic, architectural and structural to name but a few.

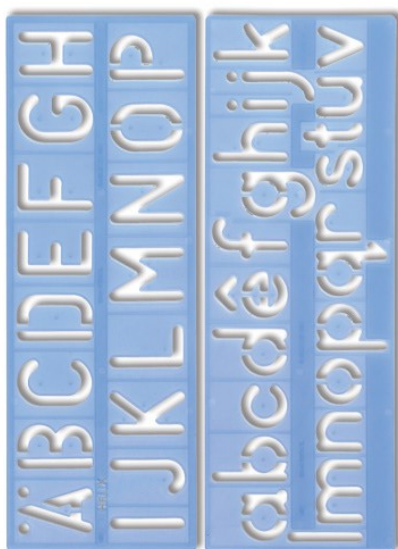


Figure 1.20
Lettering Template

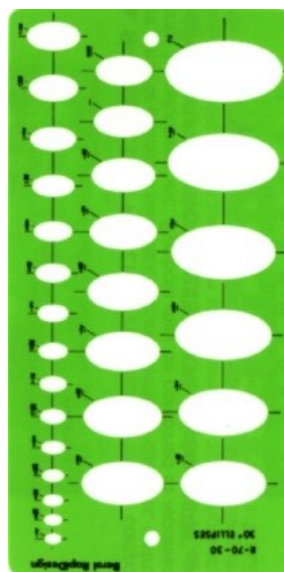


Figure 1.21
Ellipse Template

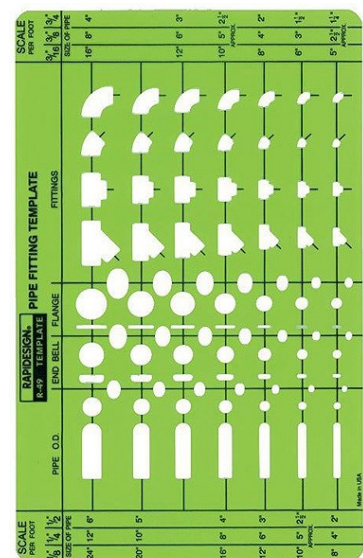


Figure 1.22
Pipework Template

1.5 Drawing Media:

A large variety of drawing mediums are available for producing drawings including Bond Paper, Cartridge Paper, Tracing Paper, Tracing Linen, and Polyester Films and Coated Sheets. Better quality papers are more resilient and stable than the cheaper varieties. As humidity changes, the paper absorbs the moisture in the air and the sheet changes shape and size resulting in inaccurate drawings.

The International Organization for Standardization (ISO) paper industry standard, which measures weight in grams per square meter (gsm), is deemed the most consistent paper weight system for comparisons between paper types.

1.5.1 Bond Paper:

It is a certainty that bond paper has probably been used in the preparation of this learning material.

Bond paper is a strong, high quality, durable paper consisting of up to 100% rag pulp. Probably best known for its important role in offices as the paper of choice for letterhead, envelopes, and other papers for official business; it is also used for memos, announcements, manuals, flyers, newsletters, reports, personalized stationery, brochures, and postings. ATM, cash registers use bond paper for receipts while engineering and architectural drawings are normally plotted on paper.

This type of paper got its name from its use in printing bonds and legal documents, but now it is used in a wide variety of arts and crafts. It can be used to create model airplanes, for example. Bond paper is also used to make drawing pads and easel paper for use with a variety of media including crayons, pencils, coloured markers, and paint. It is available in white, as well as pastel and bright colours such as blue, buff, canary, lemon yellow, red, salmon, and watermelon, giving it added versatility for cutting and pasting projects, such as Christmas ornaments and cut-out snowflake decorations.

Office bond is available in 500-sheet reams in letter or legal size and in a variety of weights and brightness. It is available in environmentally friendly versions, including partially recycled or 100% recycled options. Components of 100% recycled bond may be, for example, 25% cotton, 30% post-consumer waste, and 45% pre-consumer waste. Partially recycled paper may contain, for example, 50% virgin fibre and 50% recycled material in the form of 25% cotton, 15% post-consumer waste, and 10% recovered waste fibres.

Where Does It Fit in With Other Papers? Paper weight is described in various ways. One system uses point sizes that measure the thickness of a single sheet in thousandths of an inch. Basis weight takes a measurement in pounds of the weight of 500 sheets of the standard size of the paper, but because the size of different types of paper is not consistent, comparing basis weights is complicated. Bond paper is in the medium text weight range. A typical weight for bond paper is 80 gsm.

1.5.2 Cartridge Paper:

Cartridge paper is a high quality type of heavy paper used for illustration and drawing and was originally used for making weaponry cartridges. Cartridge paper used in drawing is slightly more course than bond paper. A typical weight for cartridge paper is 120 gsm

1.5.3 Tracing Paper:

Tracing paper is a type of paper that can be used to transfer an image to another surface, as well as part of an established system whereby artists improve an image, an oft-used overlay, and a surface for sketches and finished artwork. Draftspersons are among those who can produce finished drawings on tracing paper, and they also use tracings from their large, often full-size, épure drawings that focus on particular building elements. The recommended media for this paper are generally listed as pencil, pen, markers, and charcoal.

Tracing paper is described in several ways: by point sizes that measure the thickness of a single sheet in thousandths of an inch, and by basis weight, a measurement in kilograms of the weight of 500 sheets of the standard size of the paper, whatever that may be. Because the size of different types of paper is not consistent, comparing basis weights is complicated. Tracing paper is available in grades from the lightweight 42gsm to the heavyweight 280gsm.

1.5.4 Vellum:

Vellum can be manufactured from wood pulp or cotton pulp and is used for high quality paper. Vellum is available in a wide range of colours and sizes and can be embossed or plain and is available from 60 to 110gm/ m². Vellum is a good drawing material and is more stable than bond, cartridge and tracing paper.

Vellum is a type of paper-like writing surface that has been used for centuries in various forms. Ancient vellum was made from the skin of mammals such as calves or goats. Modern forms are made from wood pulp cotton fibers that have been treated. It generally is more durable than paper and is most often used for special documents or other manuscripts that are meant to be preserved.

Preparation in Ancient Times:

Originally, "vellum" referred to a translucent white writing surface made by the Hebrews before 1000 BC. It was prepared from untanned calfskin by drying it under tension after it was cleaned, de-haired and scraped. After it was stretched, it was polished with pumice, which is an abrasive, and talc, which is a filler, as a final preparation for writing. In the Middle Ages, illuminated manuscripts were prepared on vellum, as were other documents.

Later, vellum was prepared from the skins of stillborn animals. Sometimes, goatskin or sheepskin was used to make parchment referred to by this name. The names "parchment" and "vellum" are sometimes used interchangeably. Besides being used for writing, it has been used to make drumheads and lampshades.

Modern Preparation:

In the late 19th century, a paper product with properties similar to vellum was created by treating and embossing wood pulp and/or cotton fibre. The paper is thick, ivory-coloured and semi-translucent with a low gloss. It also might be called vellum paper, imitation vellum, vegetable vellum, or Japanese vellum.

Modern vellum paper is available in a variety of colours for documents, diplomas and projects such as making cards, announcements or programs; tracing; and scrapbooking. Vellum comes in white and cream varieties as well as pastels, bright colours and pinstripes. Marbled paper is another option, and metallic and speckled designs also can be found. Embossed variations can also be purchased, and the embossing is often gold.

1.5.5 Drafting Linen:

Drafting linen is made from undyed muslin (finely woven) fabric, normally cotton and is an alternative to timber pulp; the cloth was then highly starched and calendered (paper is passed between sever pairs of rollers to give a shiny surface) to create a smooth surface for precise ink and graphite lines. Linen provided an excellent surface for drawing but is highly unstable in humid conditions.

1.5.6 Polyester Drafting Film:

Polyester drafting film is a highly stable drawing media. The film has a matte finish on the drawing side which provides a good surface for drawing in ink and pencil, and good erasability when using an eraser with little damage to the surface. Film has excellent tensile strength and tear resistance although can be easily ripped if the edge is first nicked. Although the surface feels smooth, film is very abrasive so harder graphite pencils or special plastic pencils, and tungsten or ceramic pens should be used when drawing.

1.6 Types of Lines:

A standard system of linetype construction is used on drawings and drawn in 2 line widths or thicknesses, thick and thin. Thick lines include visible outlines, cutting planes and break lines; thin lines include hidden, hatching, extension, centre lines, dimension, break, phantom and existing or adjacent lines. The correct use of linetype allows the tradesperson, architect, engineer or “lay” person to correctly read and interpret the drawing.

1.6.1 Visible Outline:

Visible outlines are 0.5 mm wide continuous lines and are used to show all edges that are seen by the eye when looking at the object. The lines appear only when two flat surfaces meet at any angle; tangents are curves that form a smooth transition and as such cannot be seen.

1.6.2 Hidden Outline:

A hidden line is comprised of 0.25 mm wide dashed lines and show surfaces that cannot be seen. The dashes are the same length and are approximately 3 mm long while the gaps are all equal lengths approximately 1 mm long. The distances are estimated only and are never measured. The dashes must start and end on a visible outline.

1.6.3 Dimension Line:

Dimension lines are 0.25 mm wide continuous lines and used to show the extent of a dimension. The dimension text appears above the dimension line while a leader is another form of dimension line and used to connect dimensions (radius or diameter) and notes to a drawing feature.

1.6.4 Projection Line:

Projection lines are 0.25 mm wide continuous lines and used in conjunction with dimension lines. Projection lines extend from the dimension to the points which the dimension line refers to on the object within the view.

1.6.5 Centreline:

Centrelines are 0.25 mm wide and used to locate the centres of holes or circular parts of an object. The line consists of a series of long and short dashes, separated by a gap. The long dashes are approximately 25 mm long while the short dashes and gaps are approximately 3 mm long each. Like hidden outlines, the distances are estimated only and are never measured. The long dashes start and end approximately 15 mm to 20 mm outside the visible outline.

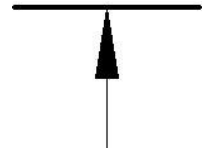
Centrelines can also be curved to show the centres of holes around a centre point and are referred to on a drawing as PCD meaning Pitch Circle Diameter.

1.6.6 Hatching Line:

Section lines are used to show that a surface has been cut in a sectional view. Section lines are drawn 0.25 mm wide, parallel, and spaced approximately 3 mm apart with the spacing varying according to the material and area to be hatched. Lines are usually drawn at 45° but can also be 30° or 60° depending on the shape of the object.

1.6.7 Cutting Plane:

The cutting plane shows where a section has been taken through an object (where it has been theoretically cut in half to view the inside shape clearly). The line is drawn using a 0.5 mm wide continuous line 10mm long and parallel to the cutting plane, and then another 0.5mm wide line 10 mm long at right angle to the cutting plane; arrows are placed at the end of this line to identify the direction of viewing the section.



1.6.8 Break Line:

Break lines are used to show that a part of the object has been removed or broken away to show the internal area clearly. Break lines are drawn with 0.25 mm continuous lines; the lines may be straight with a "Z" shape in the middle or curved lines.



1.6.9 Phantom Line:

A phantom line shows the position of an object that moves or the extents of the original shape. Phantom lines are 0.25 mm wide and drawn using a long dashed line approximately 20 mm long, followed by 2 short dashes approximately 3 mm long, all separated by 3mm wide gaps.



1.6.10 Existing or Adjacent Part:

Existing or adjacent parts are continuous lines 0.25 mm wide and represent any structure or part immediately in the vicinity of the object.

1.7 Orthogonal Projection:

Orthographic projection is a technique used in drafting or engineering drawings to depict a three-dimensional object in two dimensions. Typically, an orthographic projection will show the top, side, and front views of an object. In cartography, or map-making, an orthographic projection refers to a two-dimensional map with a perspective of infinity. A map using this technique appears similar to a view from space, but land mass shapes and distances are distorted.

In engineering drafting, one way to visualize an orthographic projection is to picture the object inside a cube. When viewed from the front, side or top, the object projects an image onto that face of the cube. Opening the cube, the front view can be positioned on the paper/monitor with the left and right side views being horizontally aligned with the front view, while the top and bottom views are vertically aligned with the front view. The rear view can be placed outside the left, right, top or bottom views.

An advantage of an orthographic projection is that dimensions of sides or common edges only have to be shown once. The projection shows the relationship of the common edge dimension from front to side or from side to top views. Once an orthographic projection is created, an artist or draftsman can create dimensional drawings showing the part from different perspectives or angles.

When planning an orthographic projection, the viewer can examine the object from different directions. The front and top views are common to most projections, but the designer can choose to view the left or right side view.

First Angle Projection was the preferred method for drawing for many years however Third Angle Projection proved to be more logical and became the preferred method of projection. In Australia, the method of projection used according to AS1100 is Third Angle Projection.

The rules for Orthogonal Projection are:

- The Top and Bottom Views must be positioned vertically above or below the Front View.
- The Left and Right Side Views must be positioned horizontally in line with the Front View.
- The height of the Side Views must be the same as the Front View.
- The width of the Side Views must be the same as the Top and/or Bottom Views.
- The views should be evenly spaced over the drawing.

1.7.1 Third Angle Projection:

In Third Angle Projection, the object is fully located in front of the viewing plane; any visible feature is drawn using a continuous outline while any hidden feature is drawn using dashed lines.

N.B. The view are drawn from where the object is being viewed. View from the Left, drawn on the Left; view from on top, draw the view on the top.

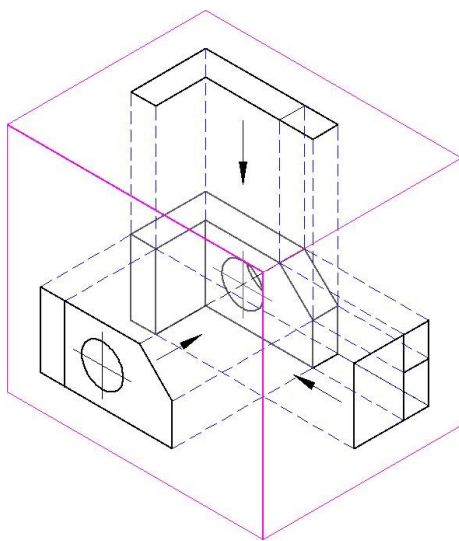


Figure 1.23

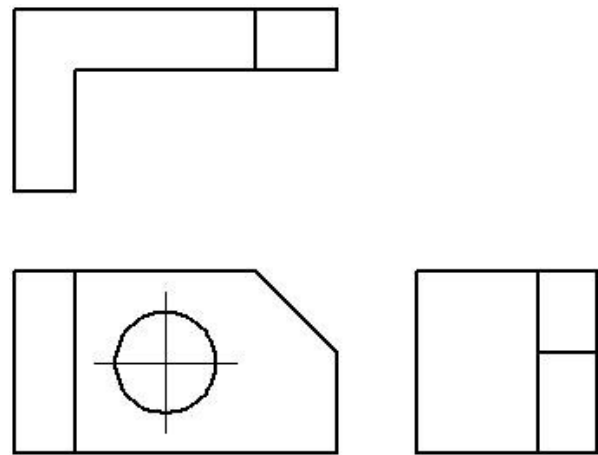


Figure 1.24

In Figure 1.23, the orthogonal planes are represented by the boundary box. The faces of the 3 visible sides have been projected along the dashed lines and drawn as seen from the viewing direction; the hinged faces are indicated by the heavier box outlines. Figure 1.24, the views are shown with the planes opened flat to leave the Front, Right and Top views.

A drawing produced in Third Angle Projection can be identified with the following symbol as shown in Figure 1.25 and drawn to the dimensions shown Figure 1.26.

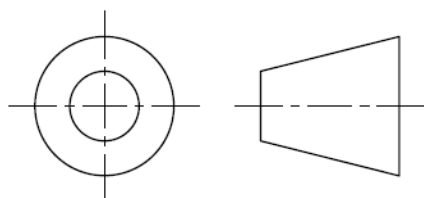


Figure 1.25

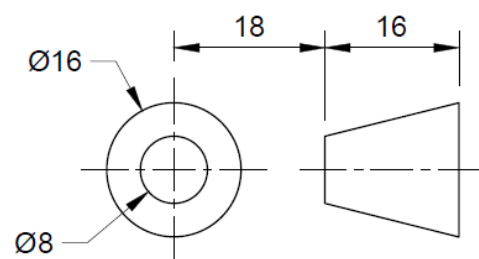


Figure 1.26

1.7.2 First Angle Projection:

In First Angle Projection, the object is fully located behind of the viewing plane; any visible feature is drawn using a continuous outline while any hidden feature is drawn using dashed lines. The shape of the view and the details shown are exactly the same as the view drawn in third angle projection – only the position of the view changes. The

view when viewed from the left is drawn on the right while the view from above is drawn below.

In **Error! Reference source not found.**, the orthogonal planes are represented by the boundary box (magenta lines). The faces of the 3 visible sides have been projected along the dashed lines (blue) and drawn on the other side of the object and the viewing direction; the hinged faces are indicated by the heavier box outlines. In **Error! Reference source not found.**, the views are shown with the planes opened flat to leave the Front, Right and Top views but are the direct opposite to that shown in Figure 1.26. The right side view is drawn on the left of the front view while the top view is drawn below the front view.

A drawing produced in First Angle Projection can be identified with the symbol shown in Figure 1.27 and drawn to the dimensions shown Figure 1.28.

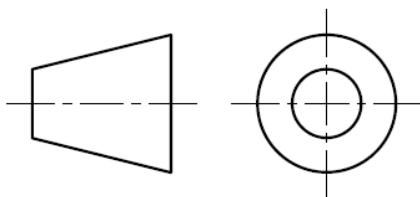


Figure 1.27

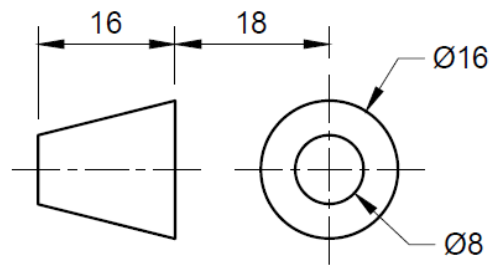


Figure 1.28

1.7.2 Number of Views:

The number of views required depends on the complexity of the component; some drawings may require only one view with the width of the material shown under the Title while other components may require 5 or 6-views to fully describe the object. Figure 1.29 shows a complex cam that requires only 1-view to fully show all the features and dimensions; the thickness is constant and Side View would only show a rectangle so the thickness can be placed below the Title.

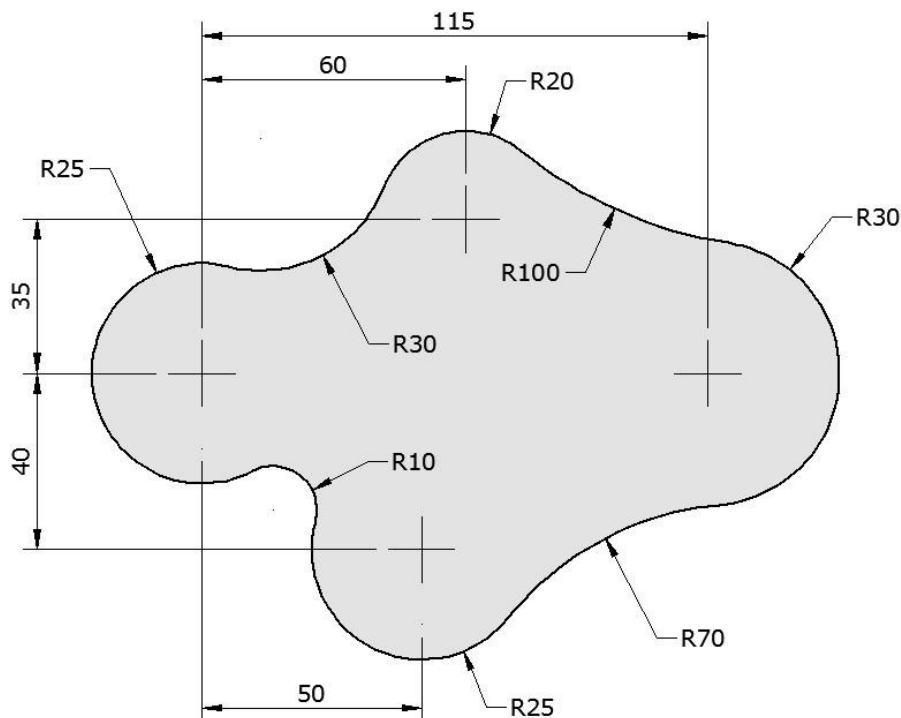


Figure 1.29

Figure 1.30 shows a simple hypothetical block with a series of different shape holes; however 5-views are required to fully describe the shape. The front view shows a rectangular shape however as there is no additional lines to help in defining the shape, the end view could be circular (although a centreline should then be included to define a circular shape). The dashed lines can also represent a variety of shapes which would not require a centreline.

Most detail drawing require 3-views to fully display the shape of the component and its dimensions however some components could only require 2-views, especially if it is symmetrical.

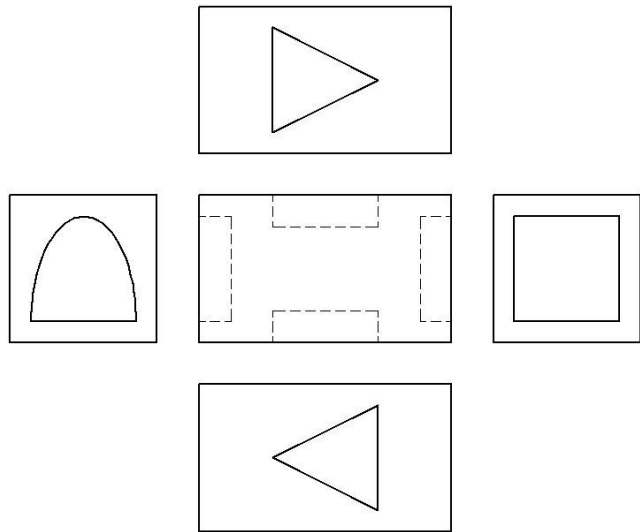


Figure 1.30

N.B. The number of views depends on the complexity of the object being drawn.

1.7.3 Determining the Front View:

The Front View is usually defined as showing the most detail, or, it is the largest view. Most draftspersons use the largest view because it requires less drawing room to layout the views. To use an example, a detail drawing of a 50 mm x 50 mm x 8 mm thick angle bar, 200 long has to be prepared. If the view selected for the Front View is based on the most detail, then the 3 views will not fit onto an A4 sheet as can be seen in Figure 1.31 as the Top View extends past the outside of the sheet; in fact the views will only just fit onto a standard A3 sheet.

If the criteria used to select the view is based on the largest view, then the 3 views will fit onto an A4 sheet as can be seen in Figure 1.32 which results in reduced printing expenses; and smaller sheets are easier to handle on job sites especially when in working in exposed elevated and windy sites.

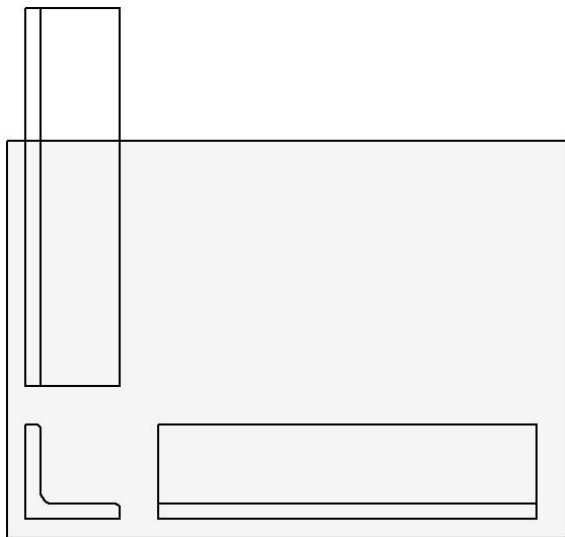


Figure 1.31

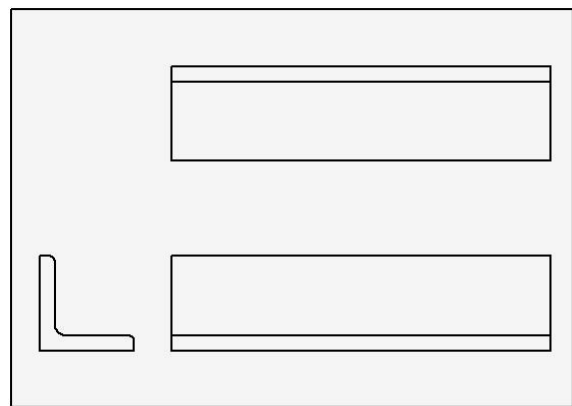


Figure 1.32

When selecting the Front View, the following should also be considered:

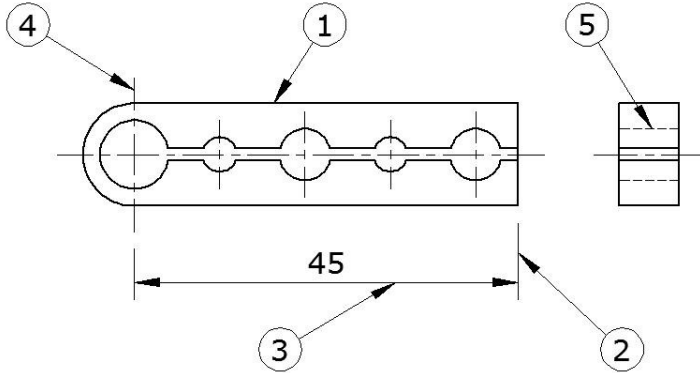
- Reduce the number of views required to fully describe the information to be specified.
- Avoid the need for hidden outlines.
- Avoid the unnecessary repetition of detail.

Skill Practice Exercises:

Skill Practice Exercise MEM09003-SP-0101

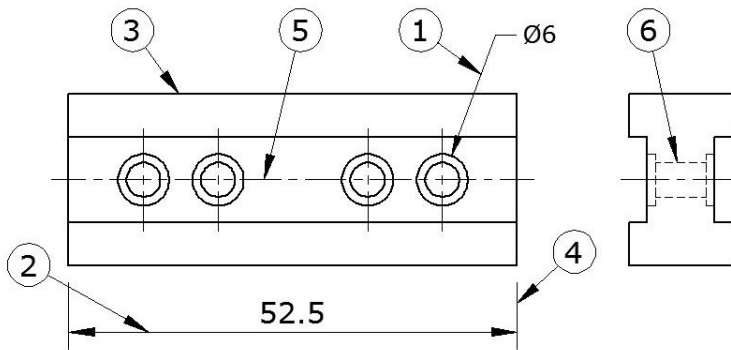
In the space provided, name the type of line indicated.

Drilled Block:



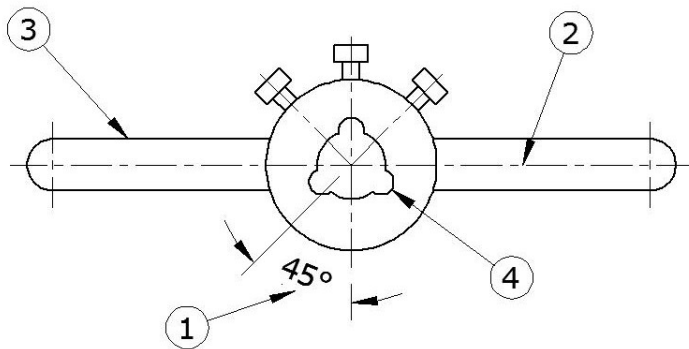
- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____

Spacer Bar



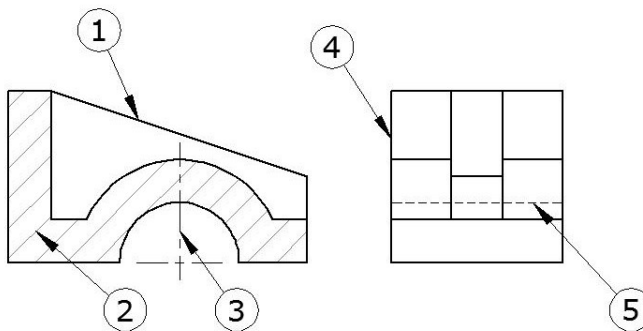
- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____
- 6 _____

Tap Wrench



- 1 _____
- 2 _____
- 3 _____
- 4 _____

Block

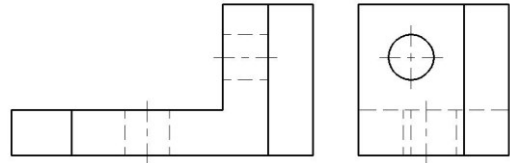
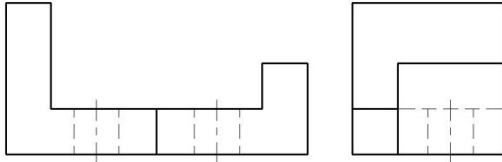
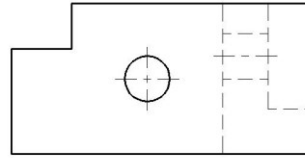
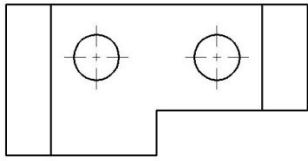


- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____

Name: _____

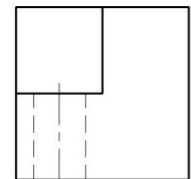
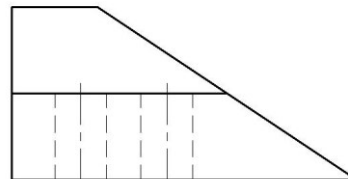
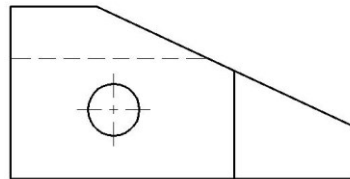
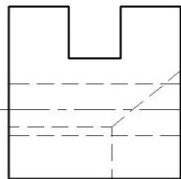
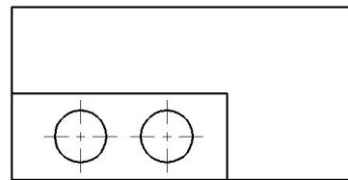
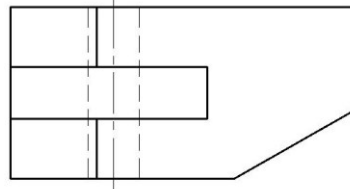
Skill Practice Exercise MEM09003-SP-0103

Identify the method of projection used for the following objects:



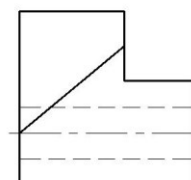
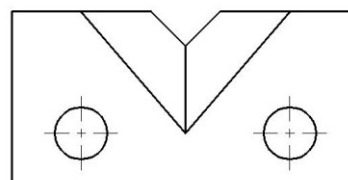
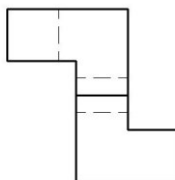
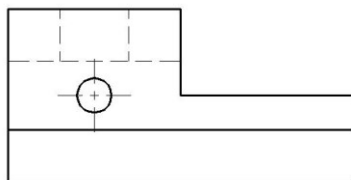
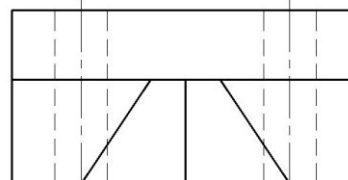
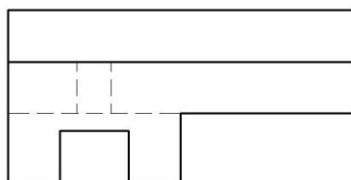
A. _____

B. _____



C. _____

D. _____



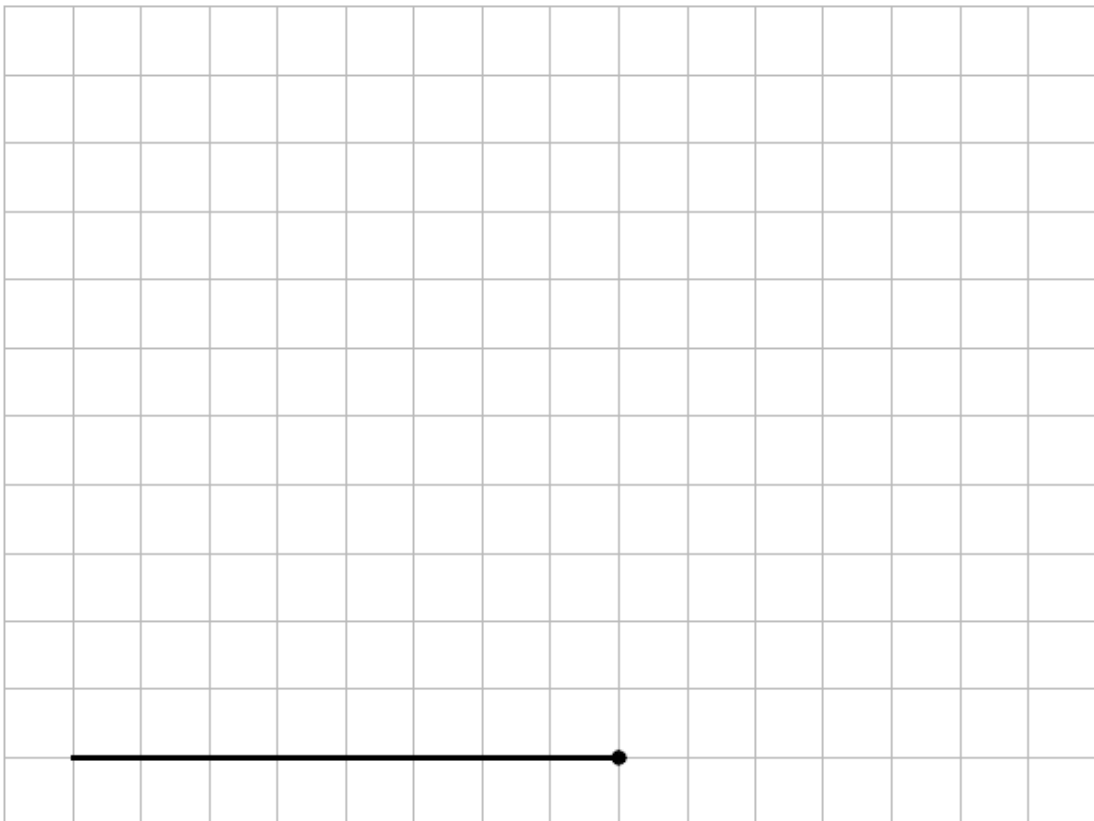
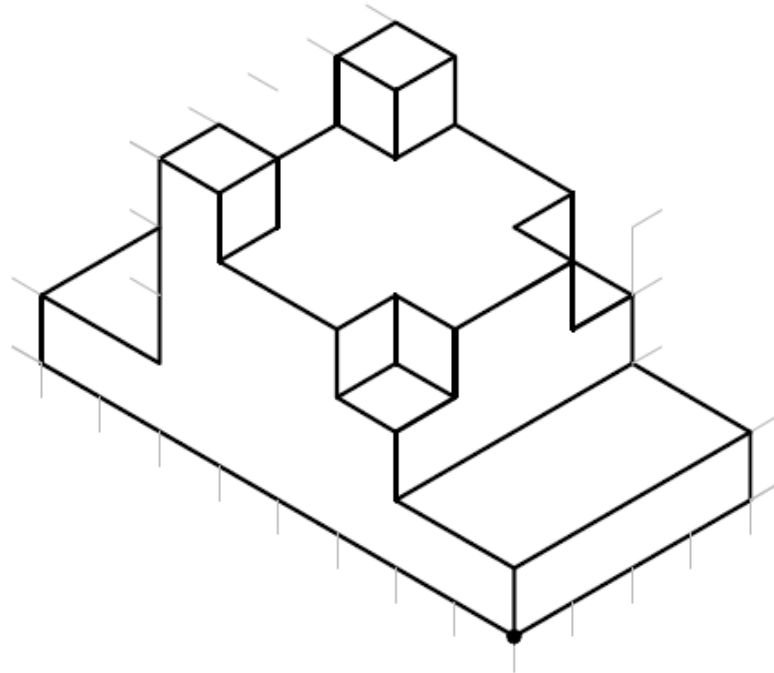
E. _____

F. _____

Name: _____

Skill Practice Exercise MEM09003-SP-0105

Add any missing lines in the following image in the grid paper below.



Name: _____