Engineering drawing:

Engineering drawing:

(the activity) produces engineering drawings (the documents). More than merely the drawing of pictures, it is also a language—a graphical language that communicates ideas and information from one mind to another.

Purpose of an Engineering Drawing:

An engineering drawing is not an illustration. It is a specification of the size and shape of a part or assembly .The important information on a drawing is the dimension and tolerance of all of its features

Technical drawing tools:

include and are not limited to: pens, rulers, compasses, protractors and drawing utilities. Drafting tools may be used for measurement and layout of drawings, or to improve the consistency and speed of creation of standard drawing elements.

Pencils

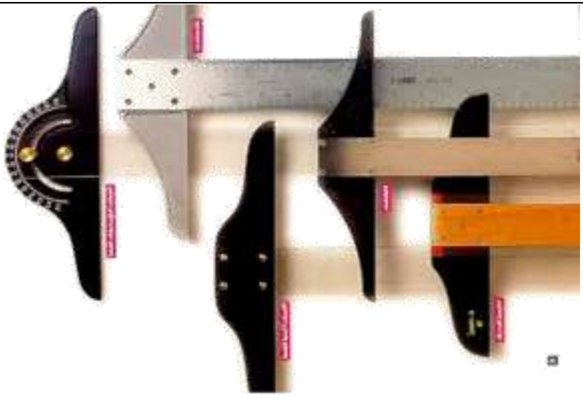
Traditional and typical styli used for technical drawing are pencils in use are usually mechanical pencils with a standard lead thickness. The usual line widths are 0.18 mm, 0.25 mm, 0.5 mm and 0.7 mm. Hardness varies usually from HB to 2H. Softer lead gives a better contrast, but harder lead gives a more accurate line. Bad contrast of the lead line in general is problematic when photocopying, but new scanning copy techniques have improved the final result. Paper or plastic surfaces require their own lead types.

The drawing board

is an essential tool. Paper will be attached and kept straight and still, so that the drawing can be done with accuracy. Generally, different kind of assistance rulers are used in drawing. The drawing board is usually mounted to a floor pedestal in which the board turns to a different position, and also its height can be adjustable. Smaller drawing boards are produced for table-top use. In the 18th and 19th centuries, drawing paper was dampened and then its edges glued to the drawing board. After drying the paper would be flat and smooth. The completed drawing was then cut free.[4] Paper could also be secured to the drawing board with drawing pins [5] or even C-clamps. More recent practice is to use self-adhesive tape to secure paper to the board, including the sophisticated use of individualized adhesive dots from a dispensing roll. Some drawing boards are magnetized, allowing paper to be held down by long steel strips. Boards used for overlay drafting or animation may include registration pins or peg bars to ensure alignment of multiple layers of drawing media.

T-square

A T-square is a straightedge which uses the edge of the drawing board as a support. It is used with the drafting board to draw horizontal lines and to align other drawing instruments. Wooden, metal, or plastic triangles with 30° and 60° angles or with two 45° angles are used to speed drawing of lines at these commonly used angles. A continuously adjustable 0–90° protractor is also in use. An alternative to the T-square is the parallel bar which is permanently attached to the drawing board. It has a set of cables and pulleys to allow it to be positioned anywhere on the drawing surface while still remaining parallel to the bottom of the board. The drafting machine replaces the T-square and triangles.



French Curves

French curves are made of wood, plastic or celluloid. Some set squares also have these curves cut in the middle. French curves are used for drawing curves which cannot be drawn with compasses. A faint freehand curve is first drawn through the known points; the longest possible curve that coincides exactly with the freehand curve is then found out from the French curves. Finally, a neat continuous curve is drawn with the aid of the French curves.[8]

Rulers

Rulers used in technical drawing are usually made of polystyrene. Rulers come in two types according to the design of their edge. A ruler with a straight edge can be used with lead pencils and felt pens, whereas when a technical pen is used the edge must be grooved to prevent the spread of the ink.

An architect's scale is a scaled, three-edged ruler which has six different scales marked to its sides. A typical combination for building details is 1:20, 1:50, 1:100, 1:25, 1:75 and 1:125. There are separate rulers for zoning work as well as for inch units. Today scale rulers are made of plastic, formerly they were made of hardwood. A pocket-sized version is also available, with scales printed on flexible plastic strips.

Compass

Compasses are used for drawing circles or arc segments of circles. One form has two straight legs joined by a hinge; one leg has a sharp pivot point and the other has a holder for a technical pen or pencil. Another form, the beam compass, has the pivot point and pen holder joined by a trammel bar, useful when drawing very large radius arcs. Often a circle template is used instead of a compass when predefined circle sizes are required.

Pencil Eraser 8.

Erasing Shield

Sharpener

Templates

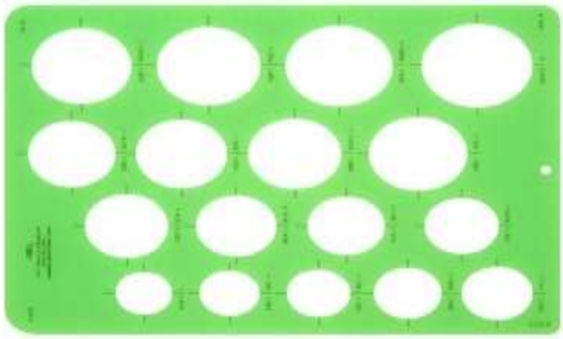
Templates contain pre-dimensioned holes in the right scale to accurately draw a symbol or sign.

Letter templates are used for drawing text, including digits and letter characters. Diagrams are usually of a standard letter shape and size to conform to standards of encodings (e.g. DIN or ANSI). For example, in Finland the series used is 1.8 mm, 2.5 mm, 3.5 mm, 5.0 mm and 7.0 mm. Except for the very biggest ones, the templates are only suitable for technical pen drawing.

For drawing circles and circle-arcs, circle templates which contain a set of suitably-sized holes are used. Templates are also available for other geometric shapes such as squares and for drawing ellipses, as well as many specialized varieties for other purposes.

There are also specific templates to provide user with the most common symbols in use in different branches of designing. For example, the architect templates can be used to draw different sized doors with their "opening arcs", building and equipment symbols and furniture. The templates also provide the symbols for thermal insulation.

Two methods of drawing smooth curves in manual drafting are the use of French curves and flat splines (flexible curves). A French curve is a drawing aid with many different smoothly-varying radiused curves on it; the manual drafter can fit the French curve to some known reference points and draw a smooth curved line between them. A spline is a flexible ruler, usually rubber or plastic coated with a metal "backbone", which can be smoothly shaped to follow a desired curve and allows drawing a smooth line between initial reference points. Sometimes a spline is temporarily held in position with small weights.

Conventional parts (areas) of an engineering drawing

Title block

The title block (T/B, TB) is an area of the drawing that conveys header-type information about the drawing, such as:

Drawing title (hence the name "title block")

Drawing number

Part number(s)

Name of the design activity (corporation, government agency, etc.)

Identifying code of the design activity (such as a CAGE code)

Address of the design activity (such as city, state/province, country)

Measurement units of the drawing (for example, inches, millimeters)

Default tolerances for dimension callouts where no tolerance is specified

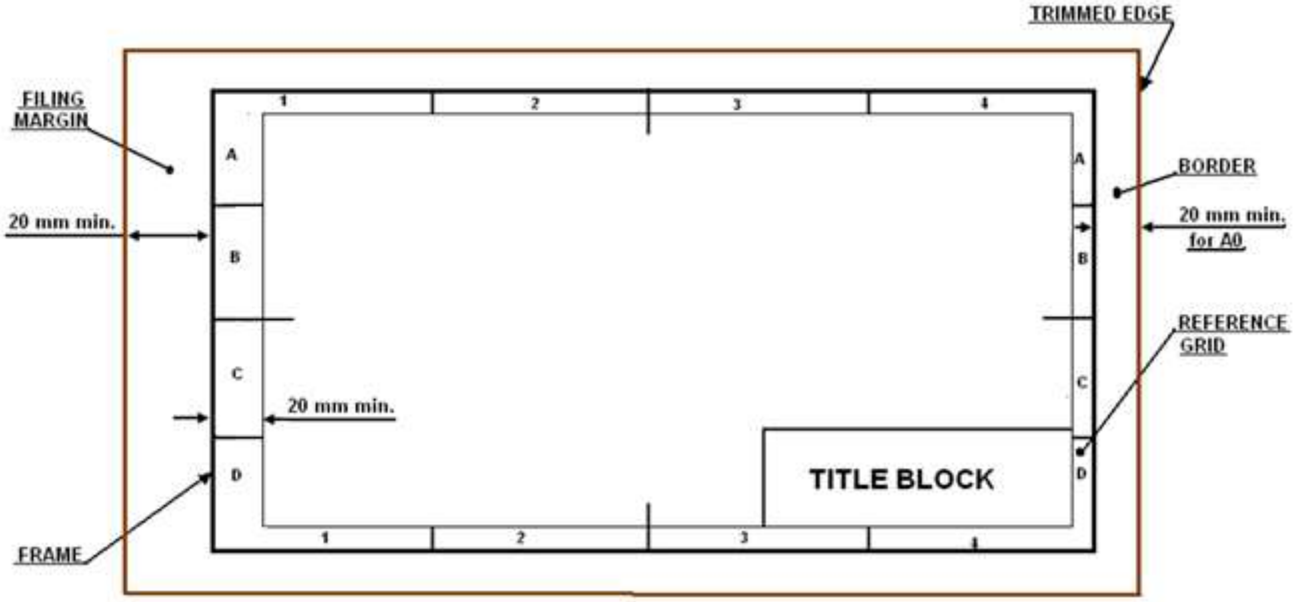
Boilerplate callouts of general specs

Intellectual property rights warning

Traditional locations for the title block are the bottom right (most commonly) or the top right or center.

Layout of a drawing sheet

Every drawing sheet is to follow a particular layout. As a standard practice sufficient margins are to be provided on all sides of the drawingsheet. The drawing sheet should have drawing space and title page. A typical layout of a drawing sheet is shown in the figure below:



A typical layout of a drawing sheet.

Borders – A minimum of 10 mm space left all around in between the trimmed edges of the sheet.

Filing margin – Minimum 20 mm space left on the left hand side with border included. This provided for taking perforations .

Grid reference system – This is provided on all sizes of industrial drawing sheets for easy location of drawing within the frame. The length and the width of the frames are divided into even number of divisions and labelled using numerals or capital letters. Number of divisions for a particular sheet depends on complexity of the drawing. The grids along the horizontal edges are labelled in numerals whereas grids along vertical edges are labelled using capital letters. The length of each grids can be between 25 mm and 75 mm. Numbering and lettering start from the corner of the sheet opposite to the title box and are repeated on the opposite sides. they are written upright. Repetition of letters or numbers like AA, BB, etc., if they exceed that of the alphabets. For first year engineering students grid references need not be followed.

Title box – An important feature on every drawing sheet. This is located at the bottom right hand corner of every sheet and provides the technical and administrative details of the drawing. The title box is divided into two zones

Identification zone : In this zone the details like the identification number or part number, Title of the drawing, legal owner of the drawing, etc. are to be mentioned.

Additional information zone : Here indicative items lime symbols indicting the system of projection, scale used, etc., the technical items lime method of surface texture, tolerances, etc., and other administrative items are to be mentioned.

Line styles and types

Lines

Lines is one important aspect of technical drawing. Lines are always used to construct meaningful drawings. Various types of lines are used to construct drawing, each line used in some specific sense. Lines are drawn following standard conventions mentioned in BIS (SP46:2003). A line may be curved, straight, continuous, segmented. It may be drawn as thin or thick. A few basic types of lines widely used in drawings.

Standard engineering drawing line types

A variety of line styles graphically represent physical objects. Types of lines include the following:

visible – are continuous lines used to depict edges directly visible from a particular angle.

hidden – are short-dashed lines that may be used to represent edges that are not directly visible.

center – are alternately long- and short-dashed lines that may be used to represent the axes of circular features.

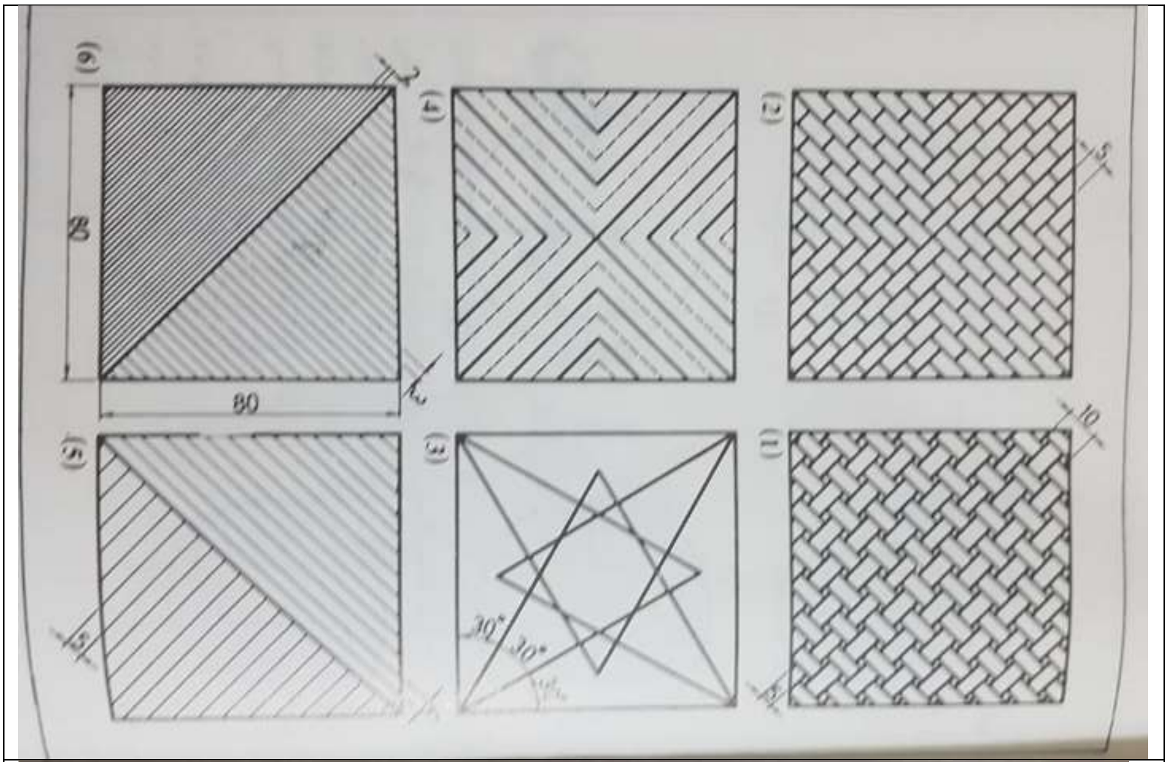
cutting plane – are thin, medium-dashed lines, or thick alternately long- and double short-dashed that may be used to define sections for section views.

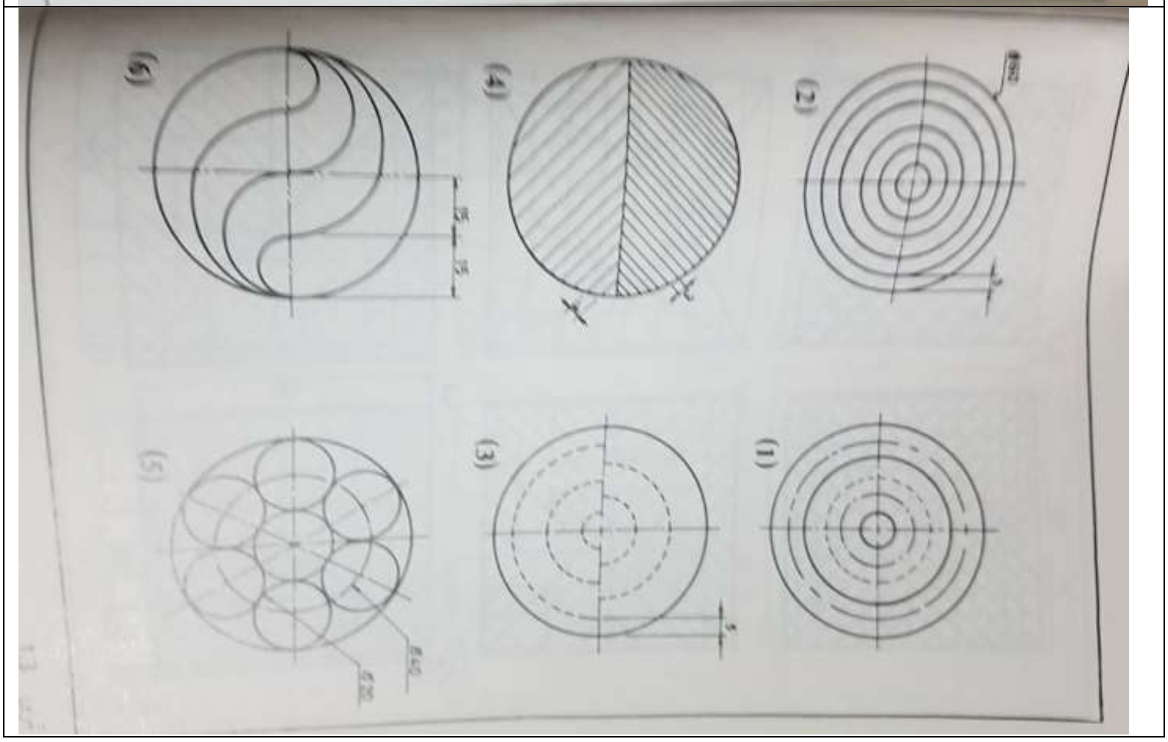
section – are thin lines in a pattern (pattern determined by the material being "cut" or "sectioned") used to indicate surfaces in section views resulting from "cutting." Section lines are commonly referred to as "cross-hatching."

phantom - (not shown) are alternately long- and double short-dashed thin lines used to represent a feature or component that is not part of the specified part or assembly. E.g. billet ends that may be used for testing, or the machined product that is the focus of a tooling drawing.

Illustration	Application
Thick	Outlines, visible edges, surface boundaries of objects, margin lines
Continuous thin	Dimension lines, extension lines, section lines leader or pointer lines, construction lines, boarder lines
Continuous thin wavy	Short break lines or irregular boundary lines – drawn freehand
Continuous thin with zig-zag	Long break lines
Short dashes, gap 1, length 3 mm	Invisible or interior surfaces
Short dashes	Center lines, locus lines Alternate long and short dashes in a proportion of 6:1,
Long chain thick at end and thin elsewhere	Cutting plane lines

Exsersises:





scales

There is a wide variation in sizes for engineering objects. Some are very large (eg. Aero planes, rockets, etc) Some are very small (wrist watch, MEMs components)
There is a need to reduce or enlarge while drawing the objects on paper. Some objects can be drawn to their actual size. The proportion by which the drawing of aan object is enlarged or reduced is called the scale of the drawing.

Definition
A scale is defined as the ratio of the linear dimensions of the object as represented in a drawing to the actual dimensions of the same.

Drawings drawn with the same size as the objects are called full sized drawing.

It is not convenient, always, to draw drawings of the object to its actual size. e.g. Buildings,

Heavy machines, Bridges, Watches, Electronic devices etc.

Hence scales are used to prepare drawing at

Full size

Reduced size

Enlarged size

BIS Recommended Scales are shown in table 1.

Table 1. The common scales recommended.

Reducing scales 1:Y (Y>1)	1:2 1:20 1:200 1:2000	1:5 1:50 1:500 1:5000	1:10 1:100 1:1000 1:10000
Enlarging scales X:1 (X>1)	50:1 5:1	20:1 2:1	10:1
Full size scales			1:1

Intermediate scales can be used in exceptional cases where recommended scales can not be applied for functional reasons.

Types of Scale :-
Engineers Scale : The relation between the dimension on the drawing and the actual dimension of the object is mentioned numerically (like 10 mm = 15 m).

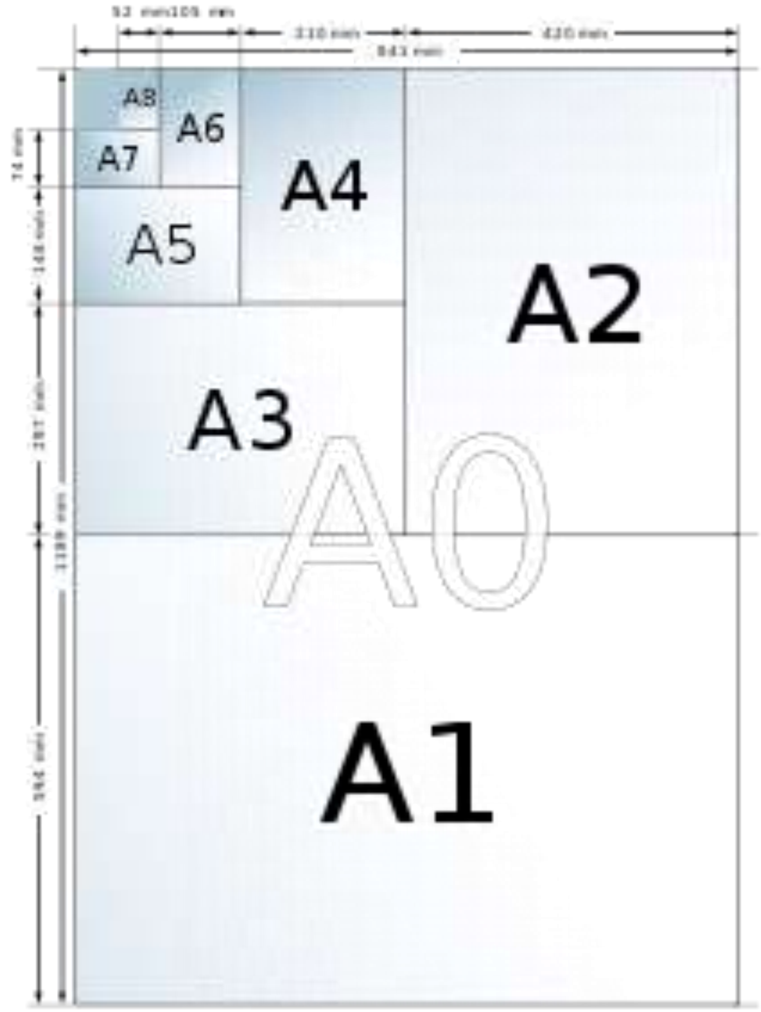
Graphical Scale: Scale is drawn on the drawing itself. This takes care of the shrinkage of the engineer's scale when the drawing becomes old.

Plans are usually "scale drawings", meaning that the plans are drawn at specific ratio relative to the actual size of the place or object. Various scales may be used for different drawings in a set. For example, a floor plan may be drawn at 1:50 (1:48 or ¼″ = 1′ 0″) whereas a detailed view may be drawn at 1:25 (1:24 or ½″ = 1′ 0″). Site plans are often drawn at 1:200 or 1:100.

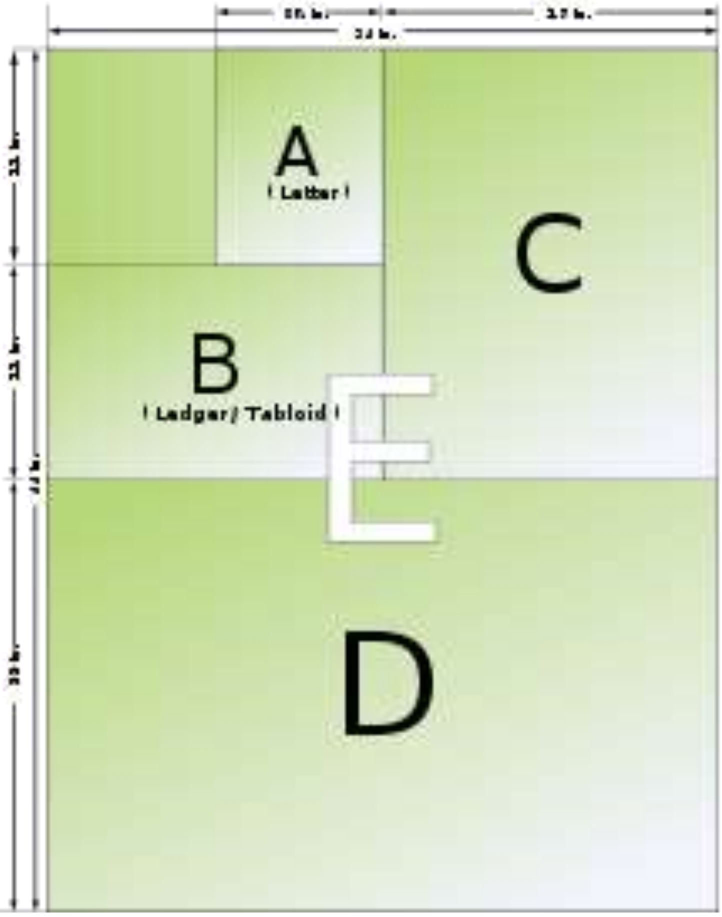
Scale is a nuanced subject in the use of engineering drawings. On one hand, it is a general principle of engineering drawings that they are projected using standardized, mathematically certain projection methods and rules. Thus, great effort is put into having an engineering drawing accurately depict size, shape, form, aspect ratios between features, and so on. And yet, on the other hand, there is another general principle of engineering drawing that nearly diametrically opposes all this effort and intent—that is, the principle that *users are not to scale the drawing to infer a dimension not labeled.* This stern admonition is often repeated on drawings, via a boilerplate note in the title block telling the user, "DO NOT SCALE DRAWING."

The explanation for why these two nearly opposite principles can coexist is as follows. The first principle—that drawings will be made so carefully and accurately—serves the prime goal of why engineering drawing even exists, which is successfully communicating part definition and acceptance criteria—including "what the part should look like if you've made it correctly." The service of this goal is what creates a drawing that one even *could* scale and get an accurate dimension thereby. And thus the great temptation to do so, when a dimension is wanted but was not labeled. The second principle—that even though scaling the drawing *will* usually work, one should nevertheless *never* do it—serves several goals, such as enforcing total clarity regarding who has authority to discern design intent, and preventing erroneous scaling of a drawing that was never drawn to scale to begin with (which is typically labeled "drawing not to scale" or "scale: NTS"). When a user is forbidden from scaling the drawing, s/he must turn instead to the engineer (for the answers that the scaling would seek), and s/he will never erroneously scale something that is inherently unable to be accurately scaled.

Paper size Drawing Sheet



ISO paper sizes



ANSI paper sizes

Sizes of drawings typically comply with either of two different standards, ISO (World Standard) or ANSI/ASME Y14.1 (American).

The metric drawing sizes correspond to international paper sizes. These developed further refinements in the second half of the twentieth century, when photocopying became cheap. Engineering drawings could be readily doubled (or halved) in size and put on the next larger (or, respectively, smaller) size of paper with no waste of space. And the metric technical pens were chosen in sizes so that one could add detail or drafting changes with a pen width changing by approximately a factor of the square root of 2. A full set of pens would have the following nib sizes: 0.13, 0.18, 0.25, 0.35, 0.5, 0.7, 1.0, 1.5, and 2.0 mm. However, the International Organization for Standardization (ISO) called for four pen widths and set a color code for each: 0.25 (white), 0.35 (yellow), 0.5 (brown), 0.7 (blue); these nibs produced lines that related to various text character heights and the ISO paper sizes.

All ISO paper sizes have the same aspect ratio, one to the square root of 2, meaning that a document designed for any given size can be enlarged or reduced to any other size and will fit perfectly. Given this ease of changing sizes, it is of course common to copy or print a given document on different sizes of paper, especially within a series, e.g. a drawing on A3 may be enlarged to A2 or reduced to A4.

The U.S. customary "A-size" corresponds to "letter" size, and "B-size" corresponds to "ledger" or "tabloid" size. There were also once British paper sizes, which went by names rather than alphanumeric designations.

Drawing Sheet

Trimmed paper of a size A0 ~ A4.

Standard sheet size (**JIS**)

A4 210 x 297

A3 297 x 420

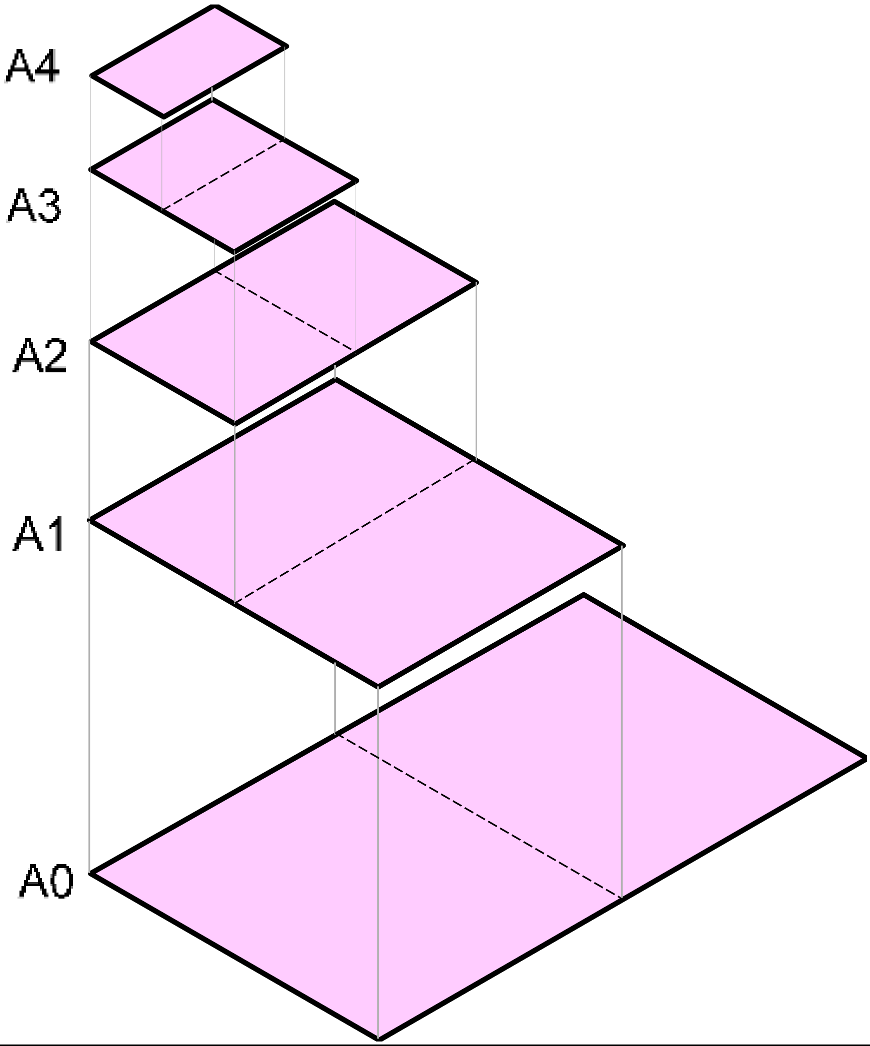
A2 420 x 594

A1 594 x 841 A0 841 x 1189

(Dimensions in millimeters)

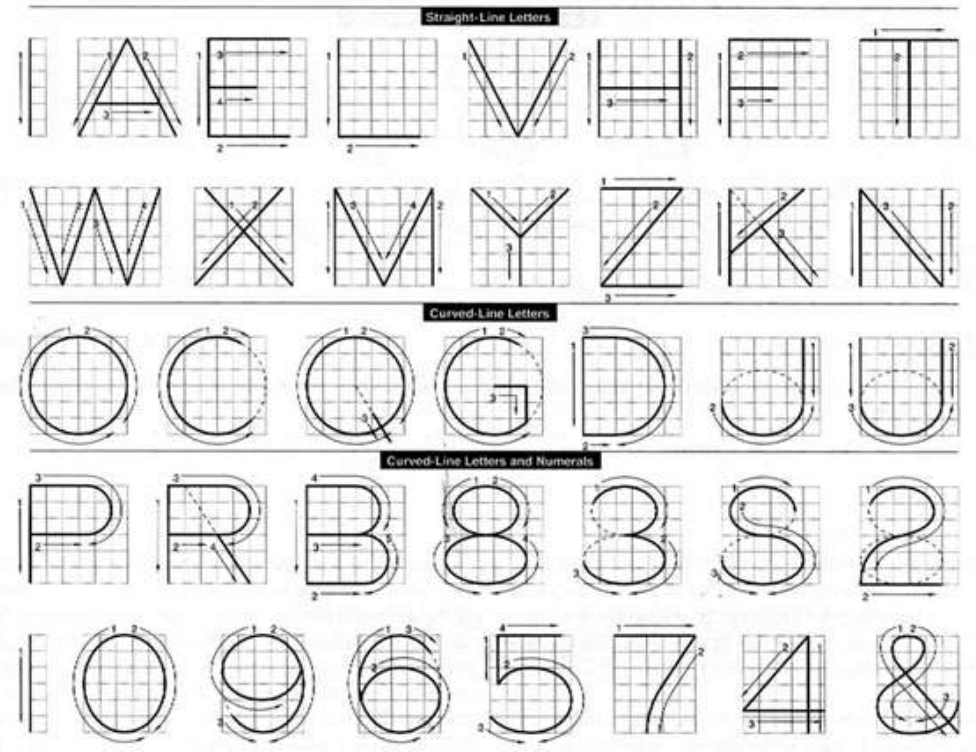
Orientation of drawing sheet

1. **Type X** (A0~A4)
2. **Type Y** (A4 only)

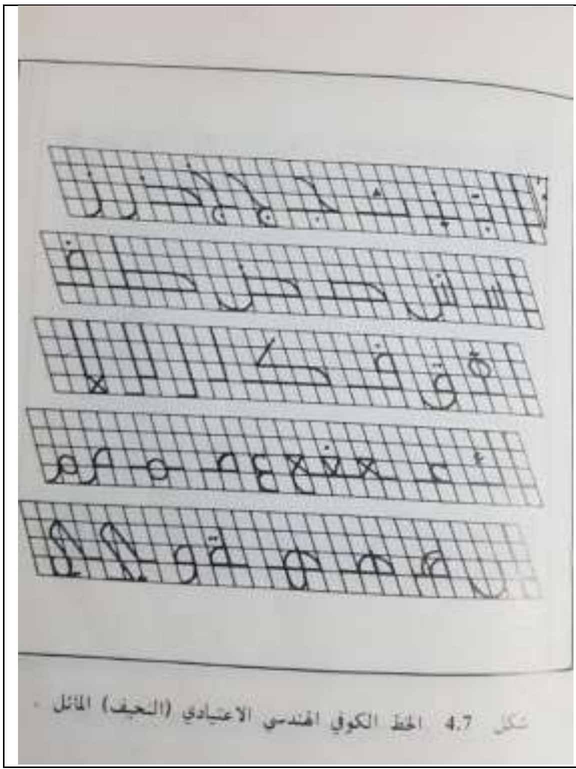


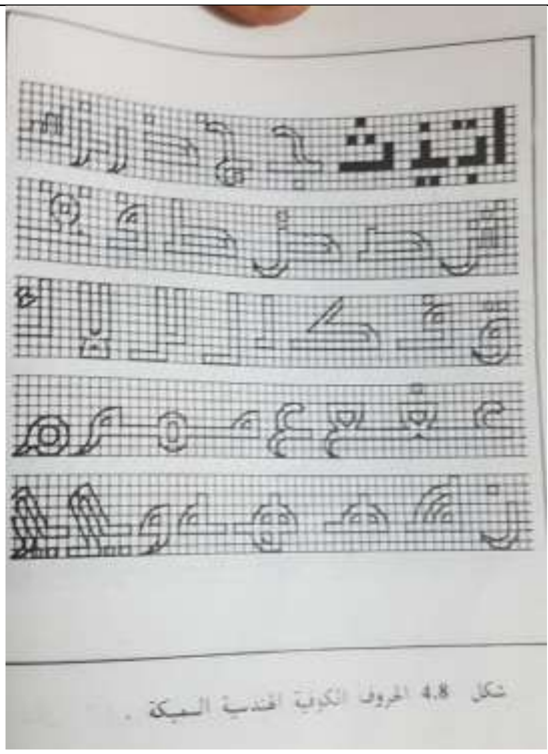
Technical lettering

Technical lettering is the process of forming letters, numerals, and other characters in technical drawing. It is used to describe, or provide detailed specifications for an object. With the goals of legibility and uniformity, styles are standardized and lettering ability has little relationship to normal writing ability. Engineering drawings use a Gothic sans-serif script, formed by a series of short strokes. Lower case letters are rare in most drawings of machines. ISO Lettering templates, designed for use with technical pens and pencils, and to suit ISO paper sizes, produce lettering characters to an international standard. The stroke thickness is related to the character height (for example, 2.5mm high characters would have a stroke thickness - pen nib size - of 0.25mm, 3.5 would use a 0.35mm pen and so forth). The ISO character set (font) has a serif fed one, a barred seven, an open four, six, and nine, and a round topped three, that improves legibility when, for example, an A0 drawing has been reduced to A1 or even A3 (and perhaps enlarged back or reproduced/faxed/ microfilmed &c). When CAD drawings became more popular, especially using US American software, such as AutoCAD, the nearest font to this ISO standard font was Romantic Simplex (Romans) - a proprietary six font) with a manually adjusted width factor (override) to make it look as near to the ISO lettering for the drawing board. However, with the closed four, and arced six and nine, romances typeface could be difficult to read in reductions. In more recent revisions of software packages, the TrueType font ISOCPEUR reliably reproduces the original drawing board lettering stencil style, however, many drawings have switched to the ubiquitous Arial.ttf.



Arabic lettering





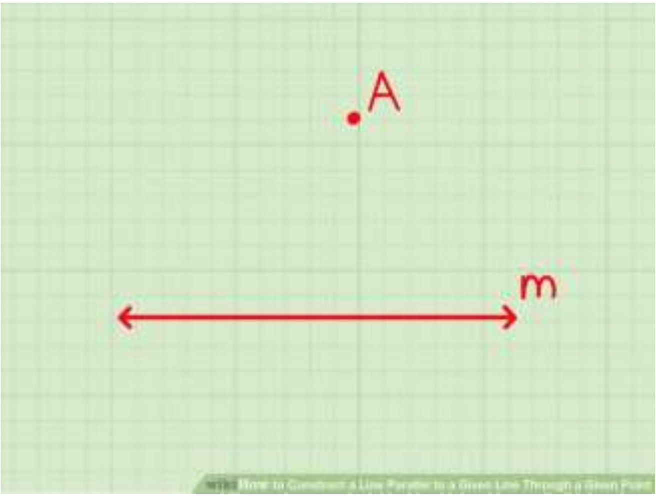
Engineering drawings construction:

Drawing a line through a given point, parallel to another line.

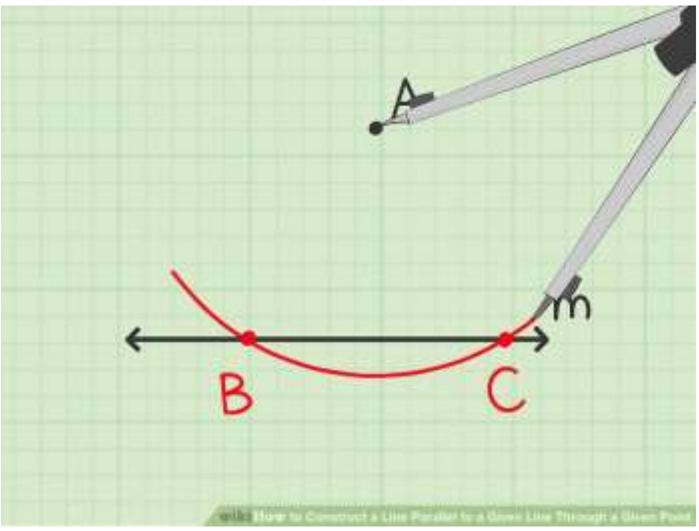
Parallel lines are lines that are equidistant at all points and would never touch if they went on forever.[1] Sometimes you may be presented with one line and need to create another line parallel to it through a given point. You might be tempted to simply take a straight edge and draw a line that seems right; however, you could not be sure that the line you constructed was technically parallel. Using geometry and a compass, you can plot additional points that will ensure the line you construct is truly parallel.

Method 1

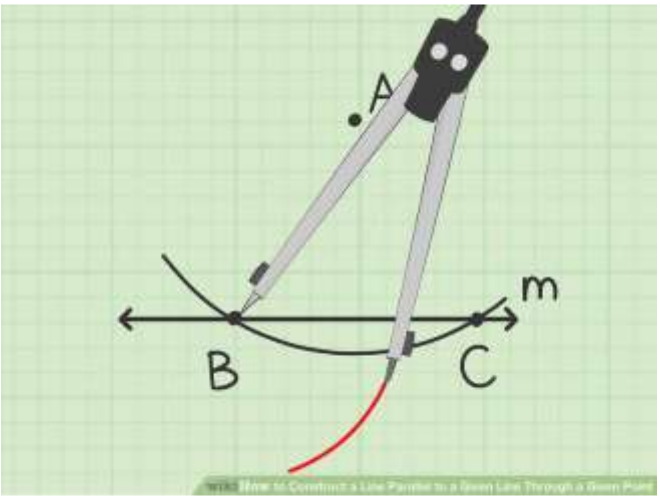
Drawing Perpendicular Lines



Locate the given line and the given point. The point will not be on the given line, and can be above or below it. Label the line m{\display style m} and the point A{\display style A}.

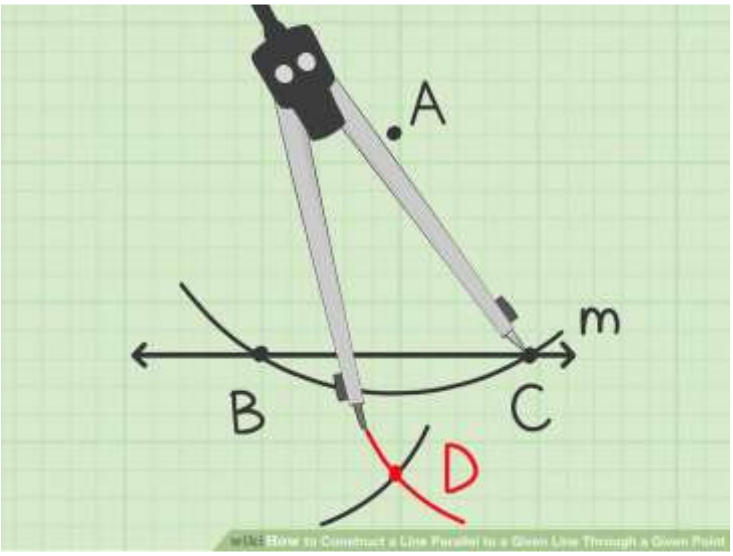


Draw an arc that intersects the given line at two different points. To do this, place the compass tip on point A{\display style A}. Open the compass so that it is wide enough to reach beyond line m{\display style m}, then draw an arc that sweeps across the line at points B{\display style B} and C{\display style C}.

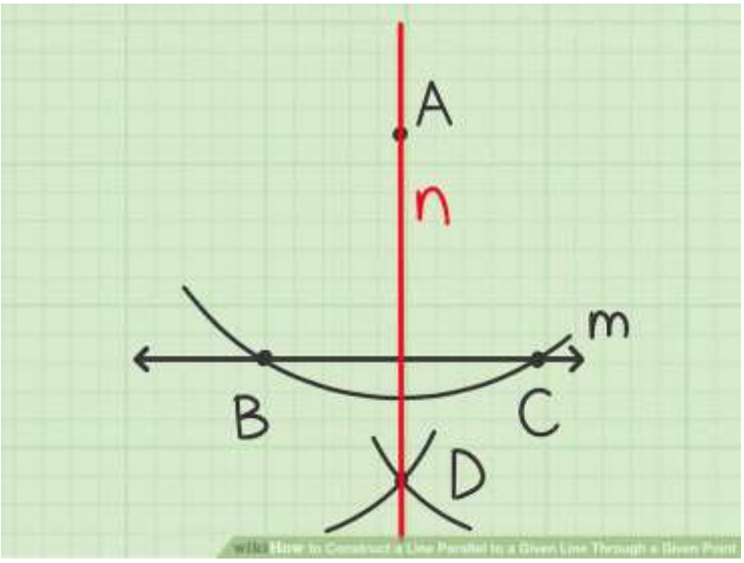


Draw a small arc opposite the given point. To do this, open the compass a little wider. Set the compass tip on point B{\display style B}, and draw an arc that sweeps directly across from point A{\display style A}.

- If the given point is above the line, you should draw this arc below the line. If the given point is below the line, you should draw this arc above the line.
- The arc does not have to be very long, as long as part of it falls directly under the given point.

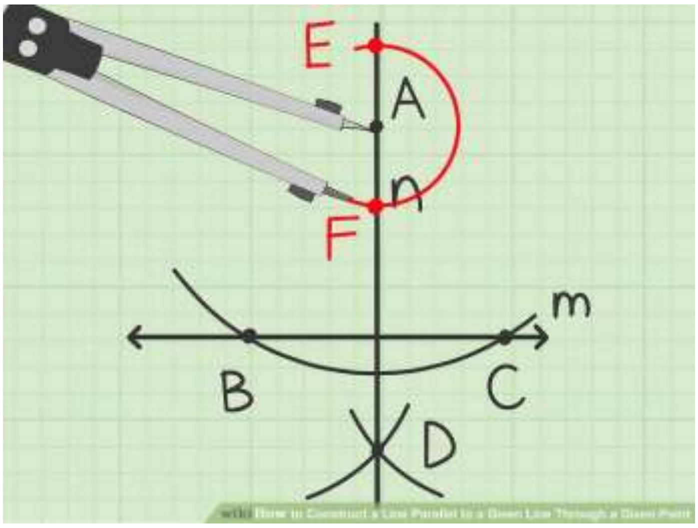


Draw a another small arc intersecting the previous one. To do this, keep the compass set to the same width. Set the compass tip on point C{\displaystyle C} and draw an arc that intersects the previous small arc. Label this point D{\displaystyle D}

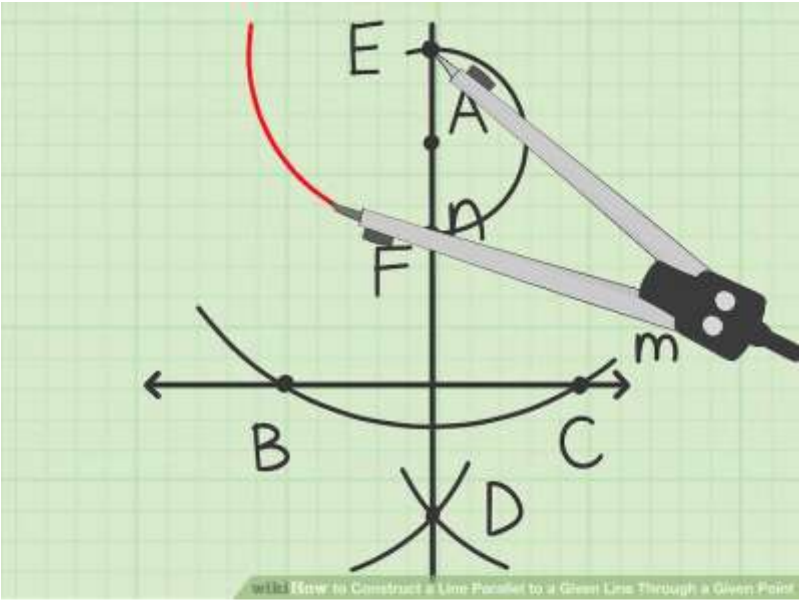


Draw a line that connects the given point and the intersection of the two small arcs. Label this line line n{\displaystyle n}. Line n{\displaystyle n} is perpendicular to line m{\displaystyle m} through points A{\displaystyle A} and D{\displaystyle D}.[2]

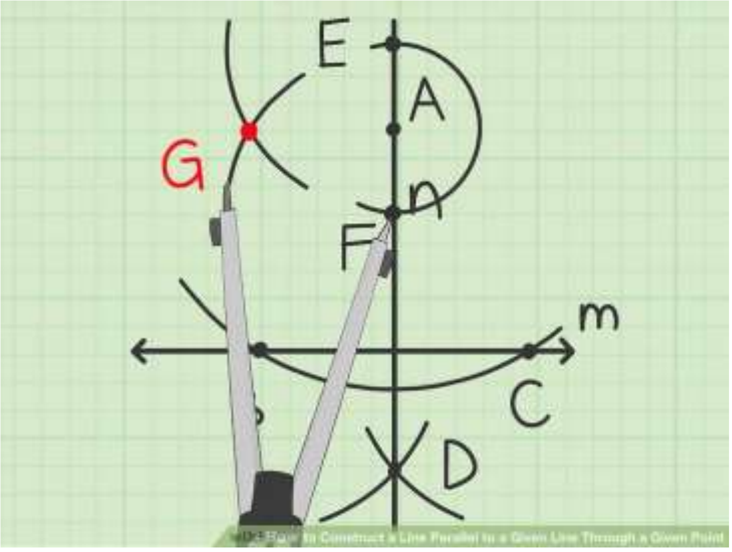
- Remember, a perpendicular line is a line that creates a 90 degree angle.



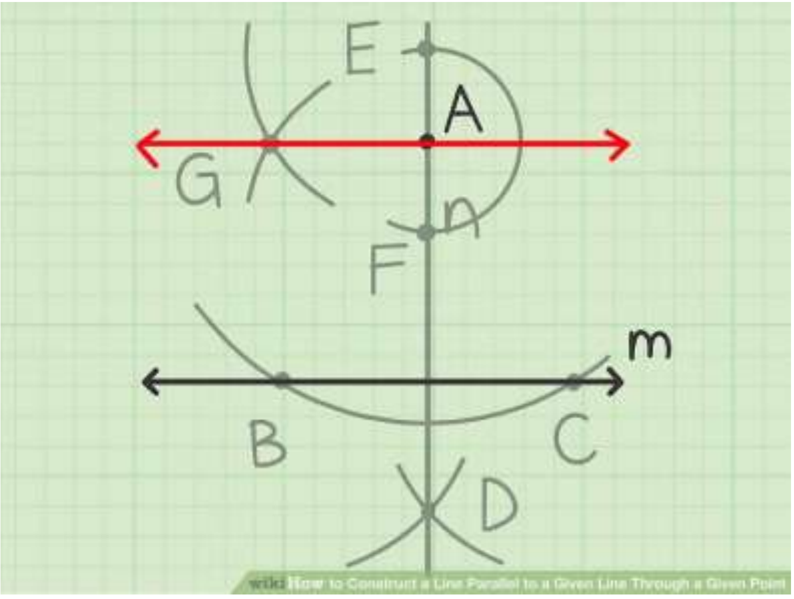
Draw an arc that intersects the perpendicular line at two different points. To do this, place the compass tip on point A{\displaystyle A}, then draw an arc that sweeps across line n{\displaystyle n} at points E{\displaystyle E} and F{\displaystyle F}.



Draw a small arc opposite the given point. To do this, open the compass a little wider. Set the compass tip on point E{\displaystyle E}, and draw an arc that sweeps directly across from point A{\displaystyle A}.

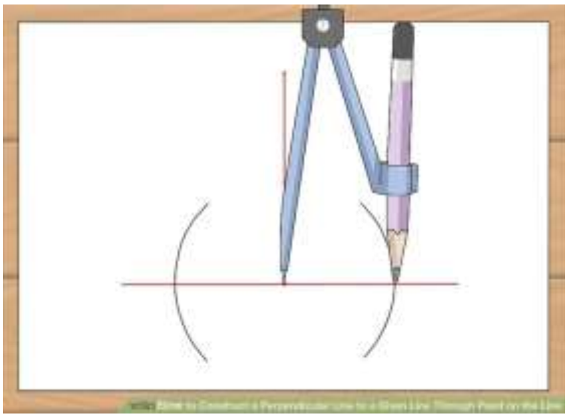


Draw a another small arc intersecting the previous one. To do this, keep the compass set to the same width. Place the compass tip on point F{\displaystyle F} and draw an arc that intersects the previous small arc. Label this point G{\displaystyle G}.



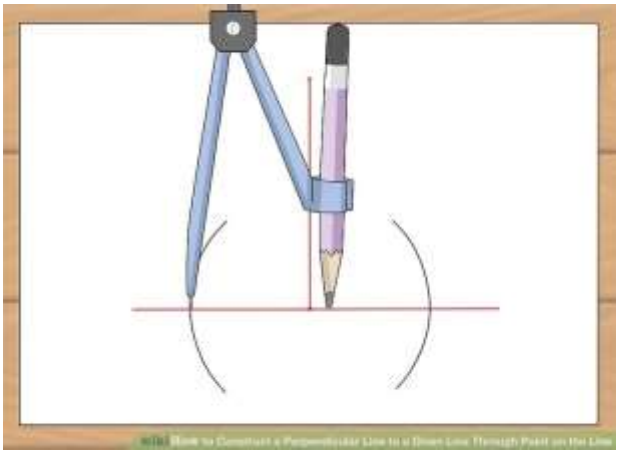
Draw a line connecting the given point to this new point. This line is perpendicular to line

Using a Compass and Straightedge



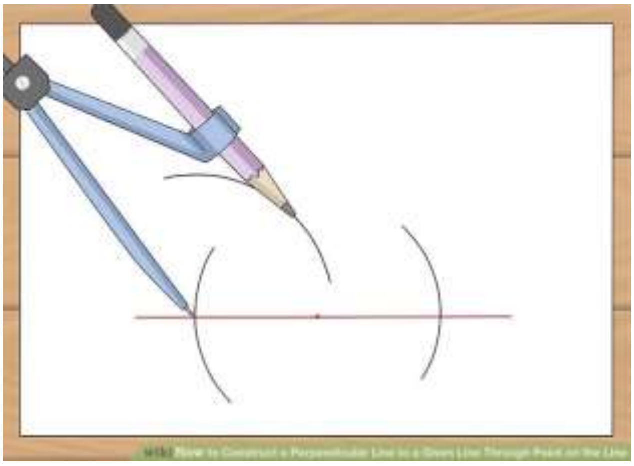
Draw an arc on either side of the given point. To do this, place the compass tip on the given point on the line. Then, swing the compass, drawing two arcs on both sides of the given point. The arcs should intersect the line.[2] Mark and label the points where the arcs intersect the line.

- You can set the compass to any width for this step.
- For example, you might be given point A on a line. Use the compass to draw point P to the left, and point Q to the right.



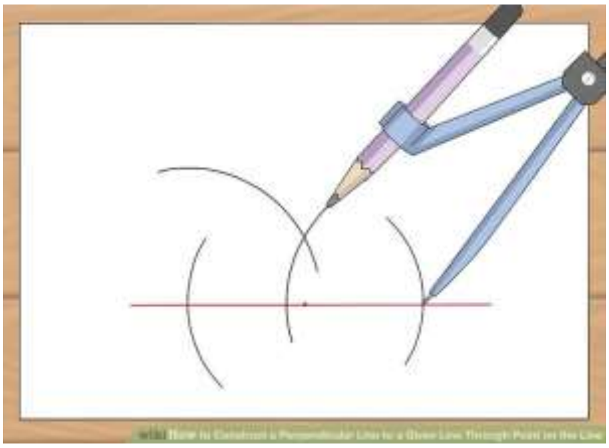
Increase the width of the compass. Place the compass tip on the new point to the left of the original point. Stretch the compass so that it reaches about halfway between the original point, and the new point on the right.[3]

- For example, place the compass tip on point P, and stretch the compass to a point about halfway between points A and Q.



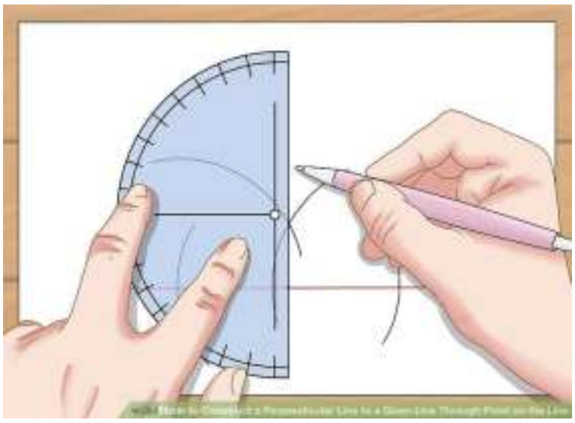
Draw an arc above the line. You could also draw the arc below the line. Keeping the compass tip on the left point, swing the compass, drawing an arc. Make sure the arc crosses over the original point.[4]

- For example, keep the compass tip on point P. Draw an arc above the line.



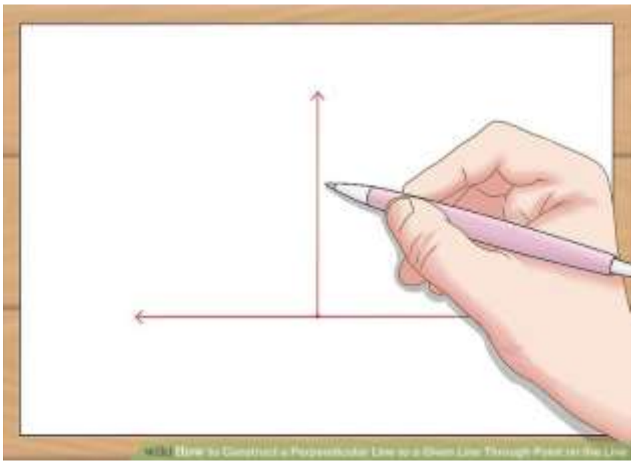
Draw a second arc, intersecting the first. Do not change the width of the compass. Set the compass tip on the right point. Swing the compass, drawing an arc above the line that intersects the first arc.[5] Mark this intersection with another point.

- For example, place the compass tip on point Q. Draw an arc that intersects the first arc at point T.



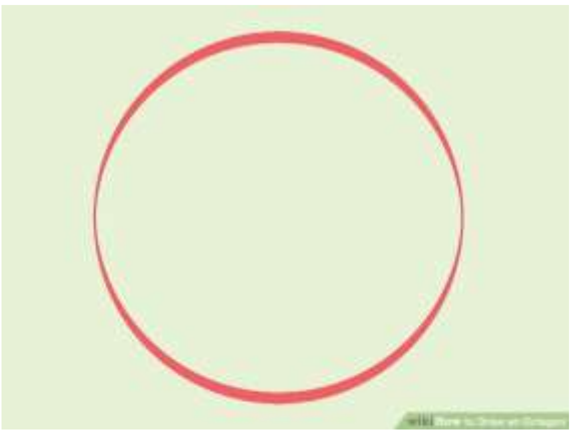
Connect the given point to the point where the arcs intersect. Use a straightedge to ensure the line is straight. The line you draw is perpendicular to the first line, through the given point on the line.[6]

- For example, draw a line connecting points A and T.

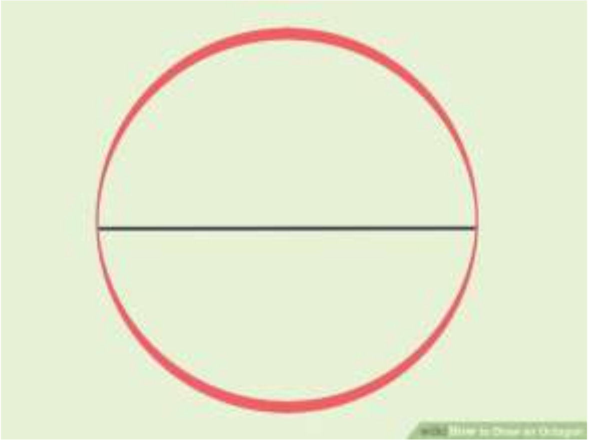


Finish up with the construction.

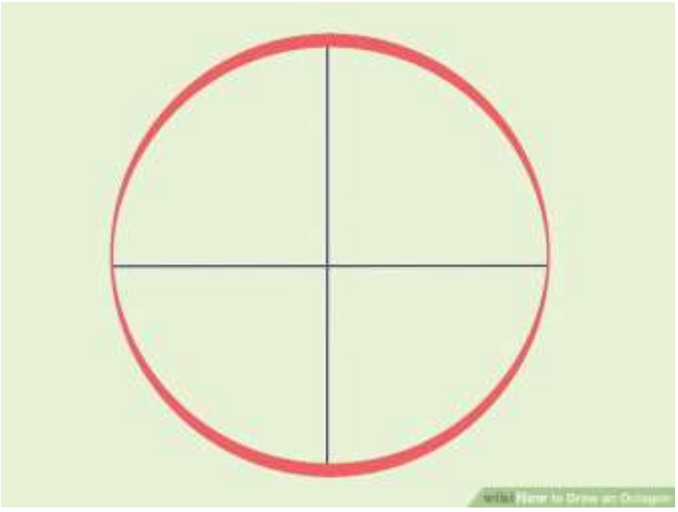
Regular Octagon



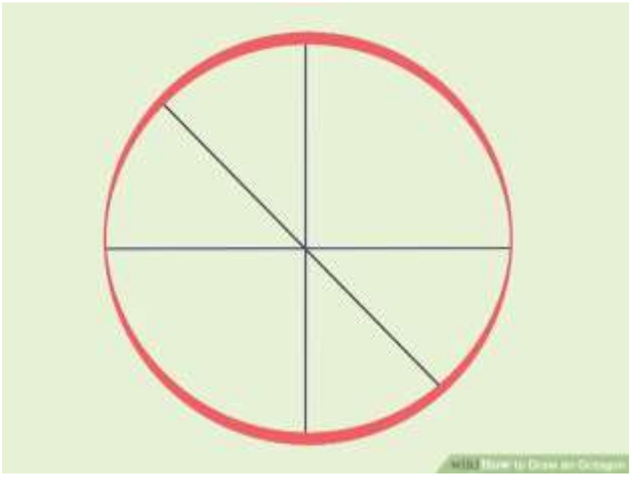
Draw a large circle at the center of the page.



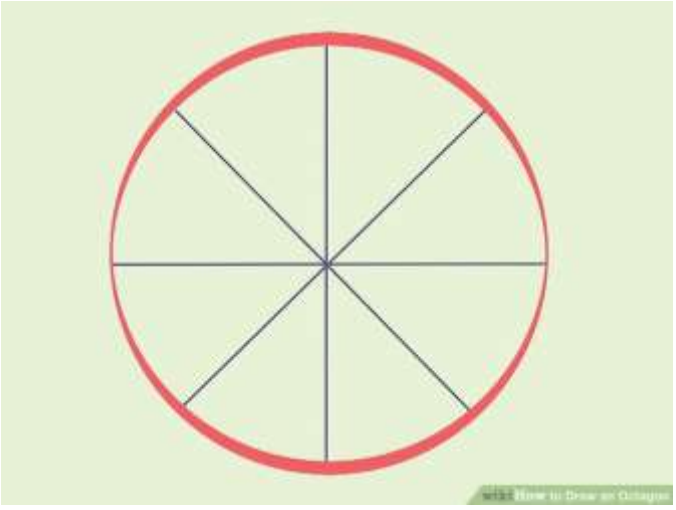
Draw a straight horizontal line splitting the circle to equal parts.



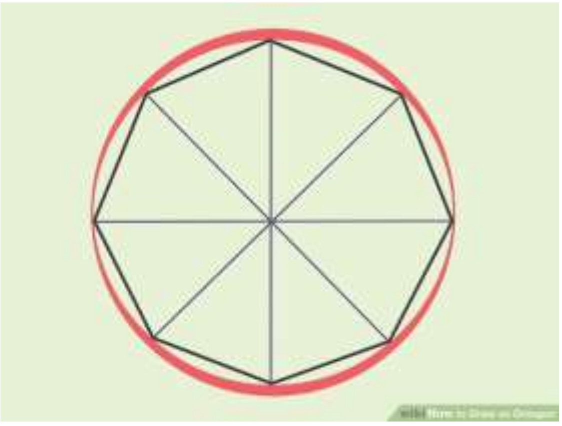
Draw a straight vertical line (also splitting the circle to equal parts) of which its center will intersect with that of the horizontal line.



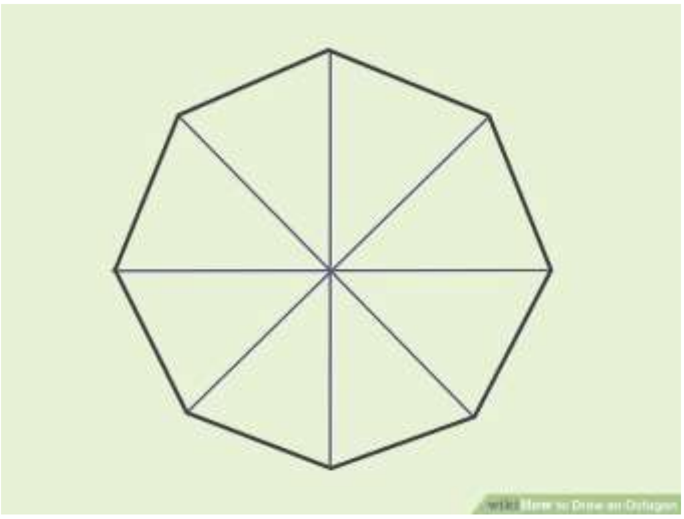
Draw a straight diagonal line (northwest to southeast) that will also intersect at the center, dividing equally the space between the horizontal and vertical lines.



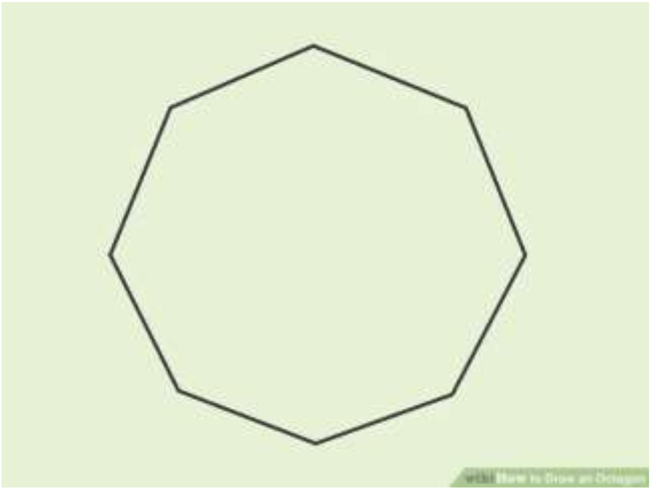
Draw another diagonal line (northeast to southwest) that will also intersect at the center, dividing equally the space between the horizontal and vertical lines. By now you will have an image resembling an eight-spoke wheel.



Connect the tips of these spokes with straight lines.



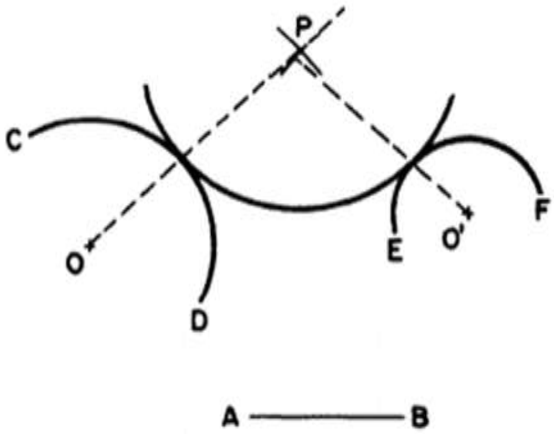
Erase the circle, leaving behind the newly formed octagon.



Erase the lines inside the octagon.

CIRCULAR ARC OF A GIVEN RADIUS TANGENT TO TWO OTHER CIRCULAR ARCS

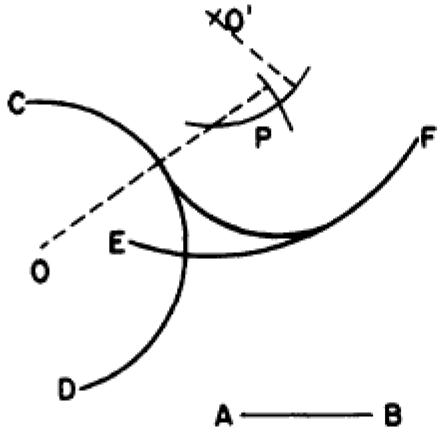
The problem   is to draw an arc with a radius equal to AB, tangent to the circular arcs CD and EF. Set a compass to a spread equal to the radius of arc CD plus AB (indicated by the left-hand dashed line), and, with O as a center, strike an arc. Set the compass to a spread equal to the radius of arc EF plus AB (indicated by the right-hand dashed line), and, with O´ as a center, strike an intersecting arc. The point of inter-section between the two arcs (P) is the center of the circle of which an arc of given radius is tangent to arcs CD and EF.   the circular arcs CD and EF curve in opposite directions.



the problem is to draw an arc with radius equal to AB, tangent to two circular arcs, CD and EF, that curve in the same direction.

Set a compass to a radius equal to the radius of EF less AB, and, with O´ as a center, strike an arc. Then, set a compass to a radius equal to the radius of arc CD plus line AB, and, with O as center, strike an intersecting arc at P. The point of intersection of these two arcs is the center of the circle of which an arc of the given radius is tangent to CD and EF.

When a circular arc is tangent to another, it is commonly the case that the two arcs curve in opposite directions. However, an arc may be drawn tangent to another with both curving in the same direction. In a case of this kind, the tangent arc is said to enclose the other.

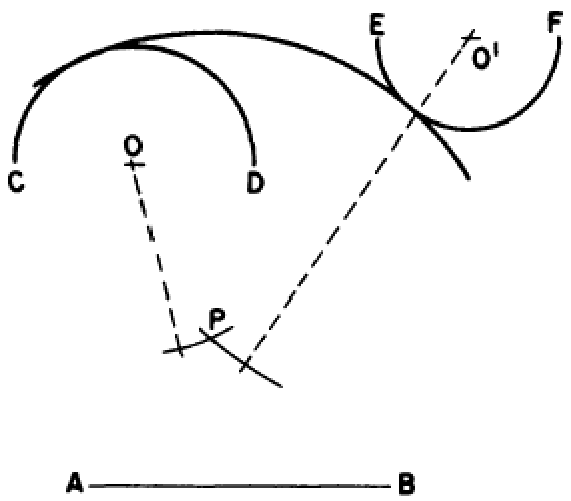


.-Circular arc tangent to arcs that curve in the same direction.

.-Circular arc tangent to and enclosing one arc and tangent to, but not enclosing, another.

the problem is to draw a circular arc with a radius equal to AB, tangent to, and enclosing, CD, and tangent to, but NOT enclosing, EF. Set a compass to a radius equal to AB less the radius of arc CD (indicated by the dashed line from 0), and, with O as a center, strike an arc, Set the compass to AB plus the radius of EF (as indicated by the dashed line from O´), and, with O´ as a center, strike an inter-secting arc at P. The point of intersection of the two arcs is the center of a circle of which an arc of the given radius is tangent to and encloses arc CD and also is tangent to, but does not enclose, arc EF.

Circular arc tangent to and enclosing two other circular arcs.



.-Circular arc tangent to and enclosing one arc and tangent to, but not enclosing, another.

Drawing an arc tangent to a right angle

It is impractical to draw small radii arcs by tangency construction. For small radii or radii up to 5/8ths inch, draw a 45° bisector of the angle and locate the arc by trial and error. You may also use a circle template so long as the diameter of the circle precisely equals twice the required radius.

To draw an arc tangent to two lines at right angles. follow this table:

Step

Action

1

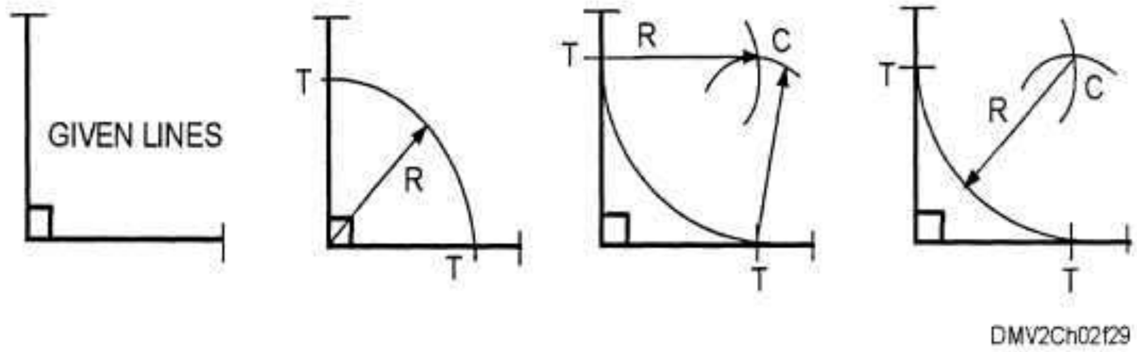
Given two lines at right angles to each other, strike an arc at a selected radius intersecting the lines at tangent points T.

2

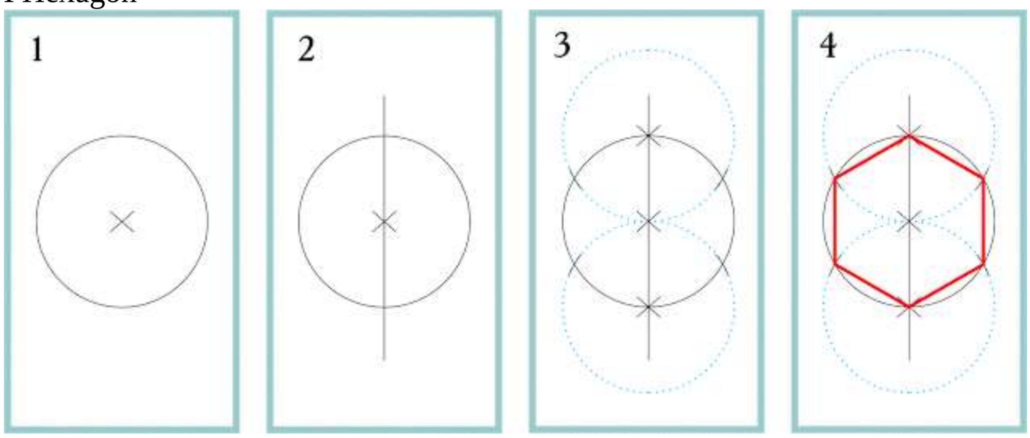
With the same selected radius and using points T as centers, strike another arc to intersect at a point C.

3

With C as a center, use the selected radius to draw the required tangent arc.



Draw A Hexagon

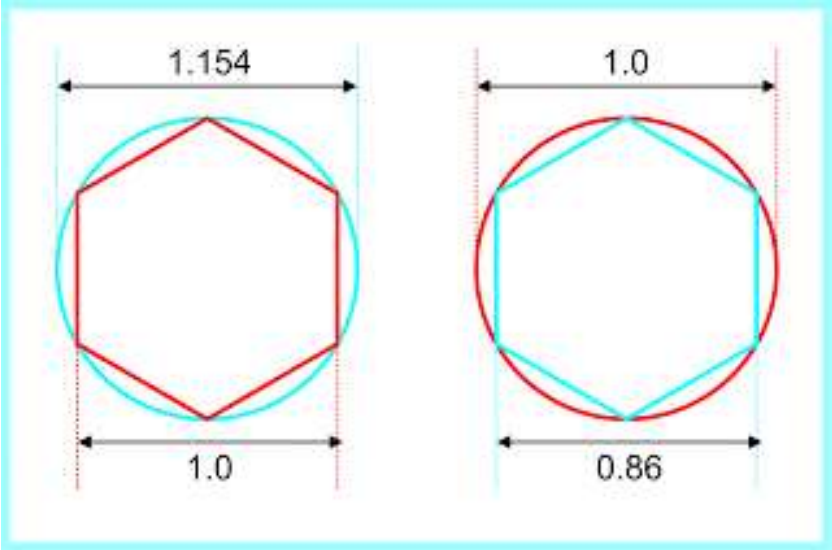


It's very, very easy. You will need a compass, a pen and/or pencil, and a ruler to make measurements and draw straight lines.

1. With the compass, draw a circle with the same radius as you want the length of the sides.
2. With the ruler, draw a line exactly bisecting the circle by going through the hole the compass made in the centre.
3. Draw two more circles with the compass, this time centring it at the points where the line bisects the circle.
4. With the ruler, connect the points where the three circles overlap.

And that's it. You have a perfect hexagon drawn to precise measurements.

If you need to draw a hexagon with measurements from side to side, you will need these ratios:



The circle will need to be 1.154 x the desired width of the hexagon, which means that the hexagon will be 0.86 x the diameter of the circle.

There you go. Easy-peasy.

PROJECTION METHOD

Auxiliary views

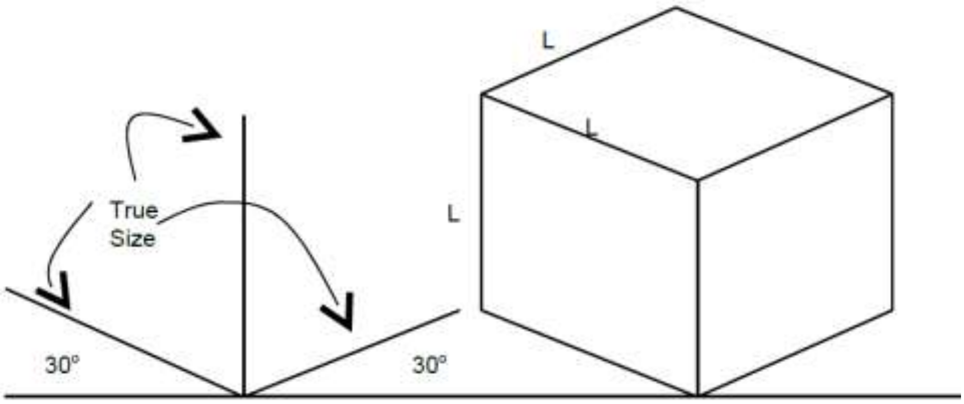
An *auxiliary view* is an orthographic view that is projected into any plane other than one of the six *primary views*.[8] These views are typically used when an object contains some sort of inclined plane. Using the auxiliary view allows for that inclined plane (and any other significant features) to be projected in their true size and shape. The true size and shape of any feature in an engineering drawing can only be known when the Line of Sight (LOS) is perpendicular to the plane being referenced. It is shown like a three-dimensional object. Auxiliary views tend to make use of axonometric projection. When existing all by themselves, auxiliary views are sometimes known as *pictorials*.

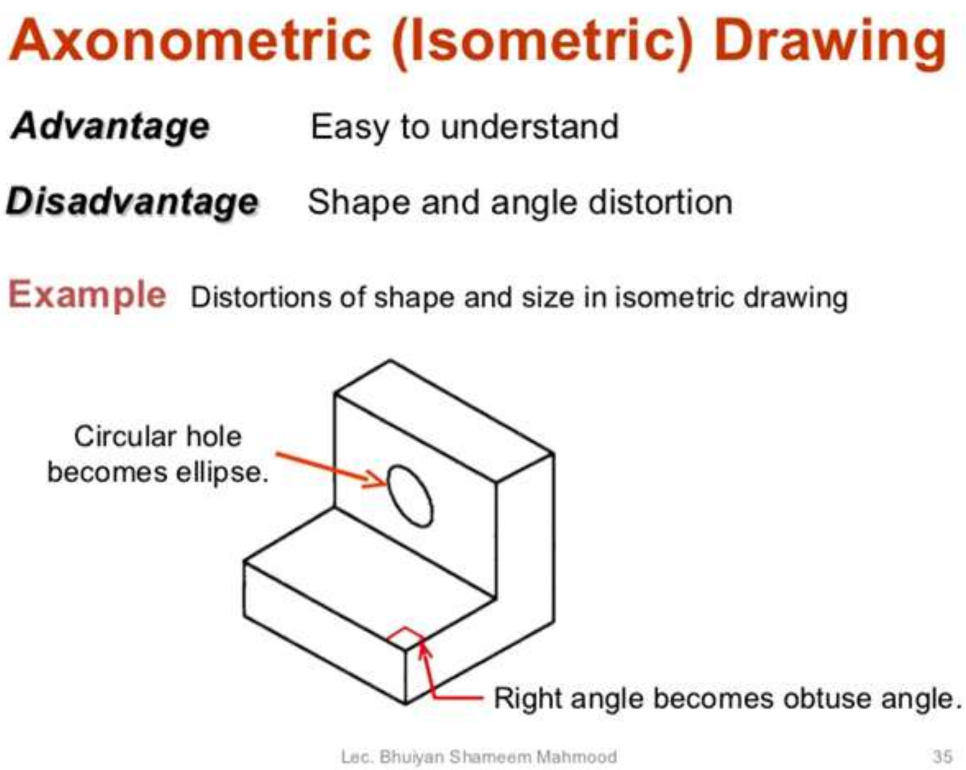
Isometric projection

An isometric projection shows the object from angles in which the scales along each axis of the object are equal. Isometric projection corresponds to rotation of the object by ± 45° about the vertical axis, followed by rotation of approximately ± 35.264° [= arcsin(tan(30°))] about the horizontal axis starting from an orthographic projection view. "Isometric" comes from the Greek for "same measure". One of the things that makes isometric drawings so attractive is the ease with which 60° angles can be constructed with only a compass and straightedge.

Isometric projection is a type of axonometric projection. The other two types of axonometric

projection are:





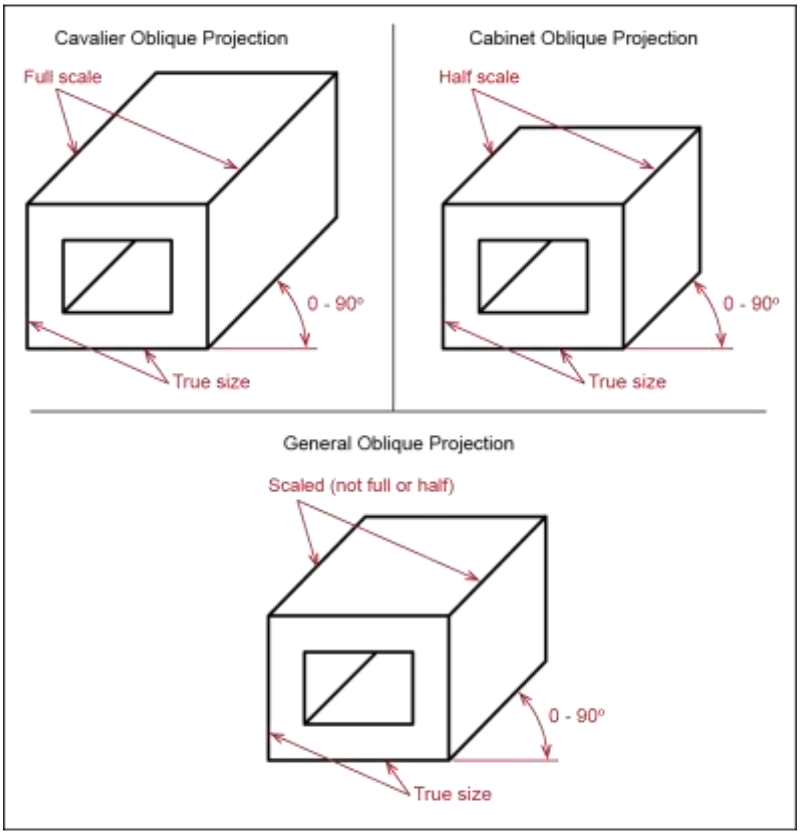
Dimetric projection

Trimetric projection

Oblique projection

An oblique projection is a simple type of graphical projection used for producing pictorial, two-dimensional images of three-dimensional objects: here are 3 types of oblique projections.

1. Cavalier
2. Cabinet
3. General



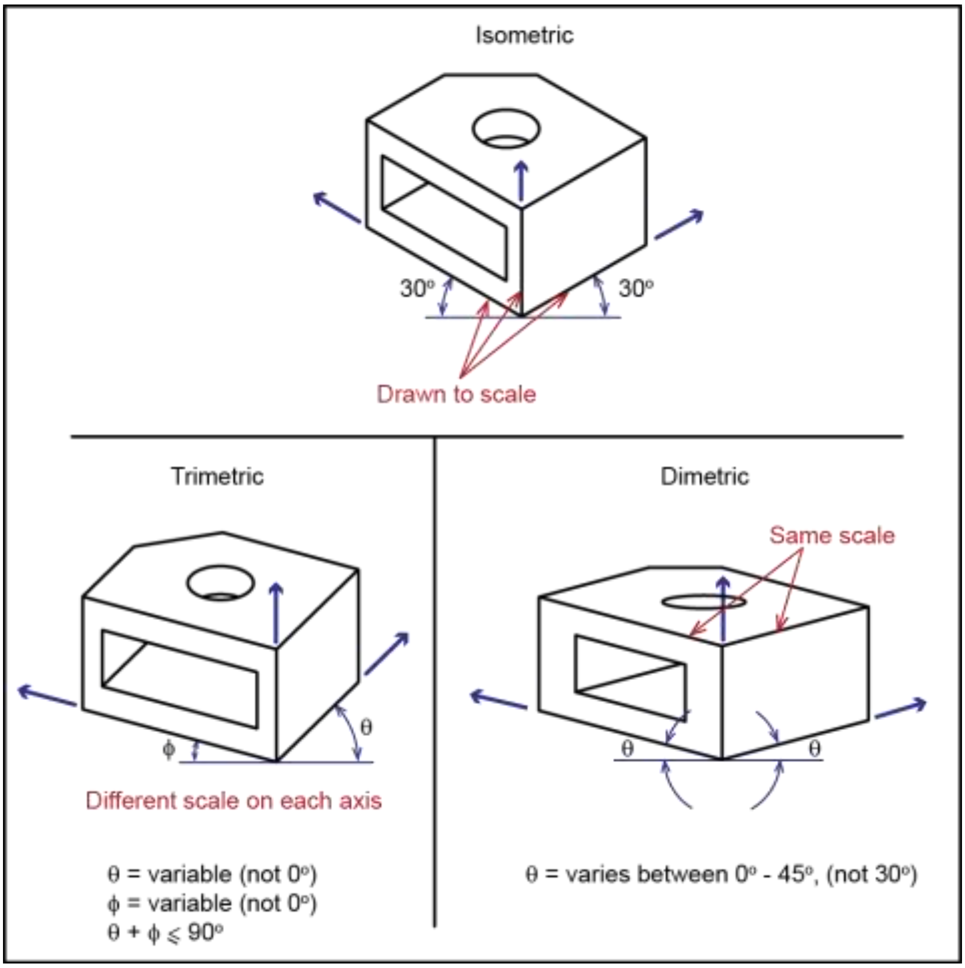
it projects an image by itersecting parallel rays (projectors)

from the three-dimensional source object with the drawing surface (projection plan).

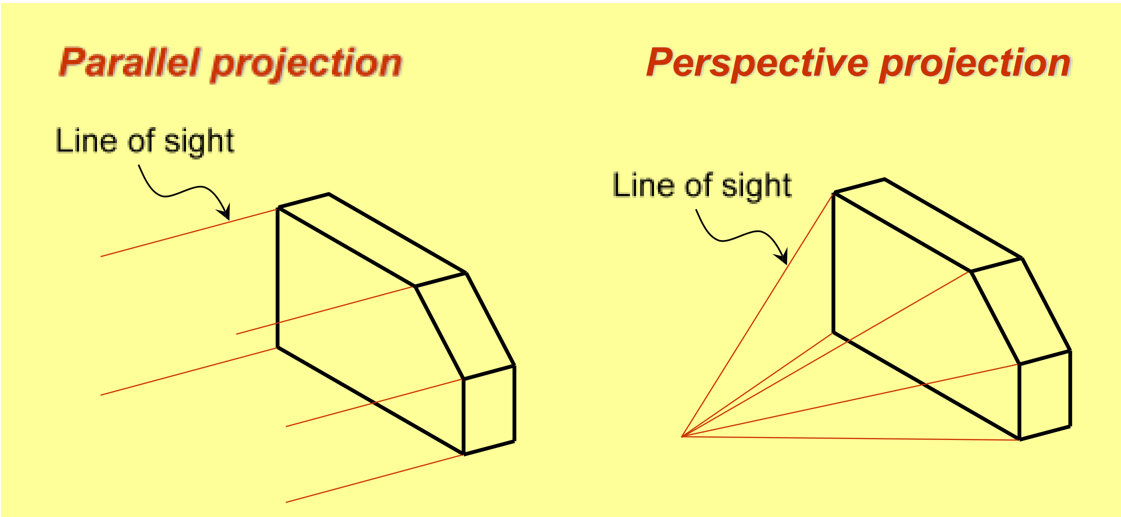
In both oblique projection and orthographic projection, parallel lines of the source object produce parallel lines in the projected image.

There are 3 types of axonometric projections.

1. Isometric
2. Dimetric
3. Trimetric



Parallel projection



Orthographic projection is a parallel projection technique in which the parallel lines of sight are perpendicular to the projection plane Lec. Bhuiyan Shameem Mahmood 5 Object views from top Projection plan

MEANING Orthographic projection is a parallel projection technique in which the parallel lines of sight are perpendicular to the projection plane Lec. Bhuiyan Shameem Mahmood 5 Object views from top Projection plan.

Multiple views and projections

: Graphical projection

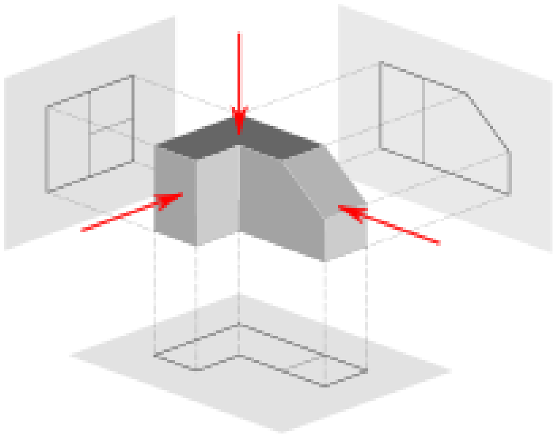
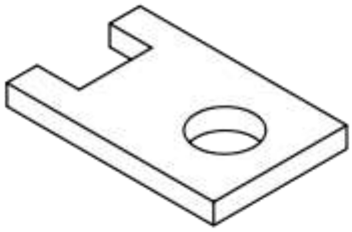


Image of a part represented in *first-angle projection*



Isometric view of the object shown in the engineering drawing below.

In most cases, a single view is not sufficient to show all necessary features, and several views are used. Types of *views* include the following:

Multiview projection

A *multiview projection* is a type of orthographic projection that shows the object as it looks from the front, right, left, top, bottom, or back (e.g. the *primary views*), and is typically positioned relative to each other according to the rules of either first-angle or third-angle projection. The origin and vector direction of the projectors (also called projection lines) differs, as explained below.

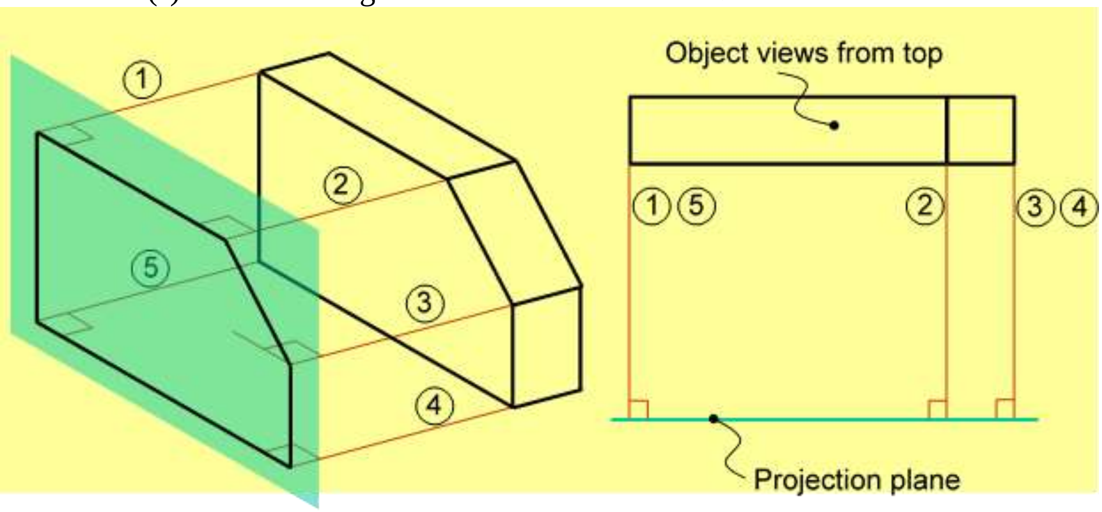
In *first-angle projection*, the parallel projectors originate as if radiated *from behind the viewer* and pass through the 3D object to project a 2D image onto the orthogonal plane *behind* it. The 3D object is projected into 2D "paper" space as if you were looking at a radiograph of the object: the top view is under the front view, the right view is at the left of the front view. First-angle projection is the ISO standard and is primarily used in Europe.

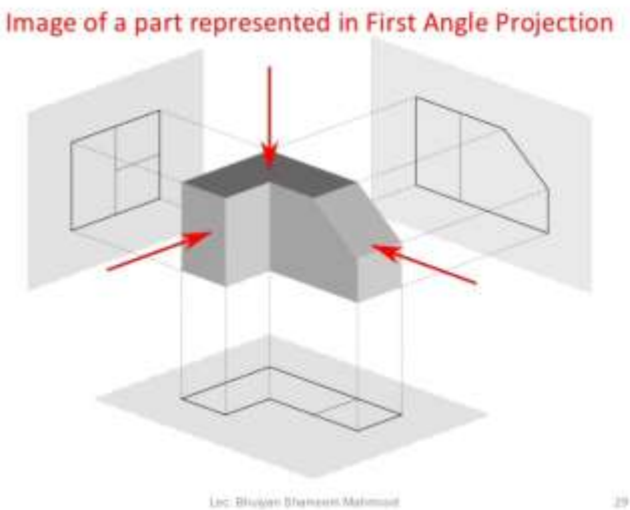
In *third-angle projection*, the parallel projectors originate as if radiated *from the far side of the object* and pass through the 3D object to project a 2D image onto the orthogonal plane *in front of* it. The views of the 3D object are like the panels of a box that envelopes the object, and the panels pivot as they open up flat into the plane of the drawing.[2] Thus the left view is placed on the left and the top view on the top; and the features closest to the front of the 3D object will appear closest to the front view in the drawing. Third-angle projection is primarily used in the United States and Canada, where it is the default projection system according to ASME standard ASME Y14.3M.

Until the late 19th century, first-angle projection was the norm in North America as well as Europe;[3][4] but circa the 1890s, third-angle projection spread throughout the North American engineering and manufacturing communities to the point of becoming a widely followed convention,[3][4] and it was an ASA standard by the 1950s.[4] Circa World War I, British practice was frequently mixing the use of both projection methods.[3]

As shown above, the determination of what surface constitutes the front, back, top, and bottom varies depending on the projection method used.

Not all views are necessarily used.[5] Generally only as many views are used as are necessary to convey all needed information clearly and economically.[6] The front, top, and right-side views are commonly considered the core group of views included by default,[7] but any combination of views may be used depending on the needs of the particular design. In addition to the six principal views (front, back, top, bottom, right side, left side), any auxiliary views or sections may be included as serve the purposes of part definition and its communication. View lines or section lines (lines with arrows marked "A-A", "B-B", etc.) define the direction and location of viewing or sectioning. Sometimes a note tells the reader in which zone(s) of the drawing to find the view or section.



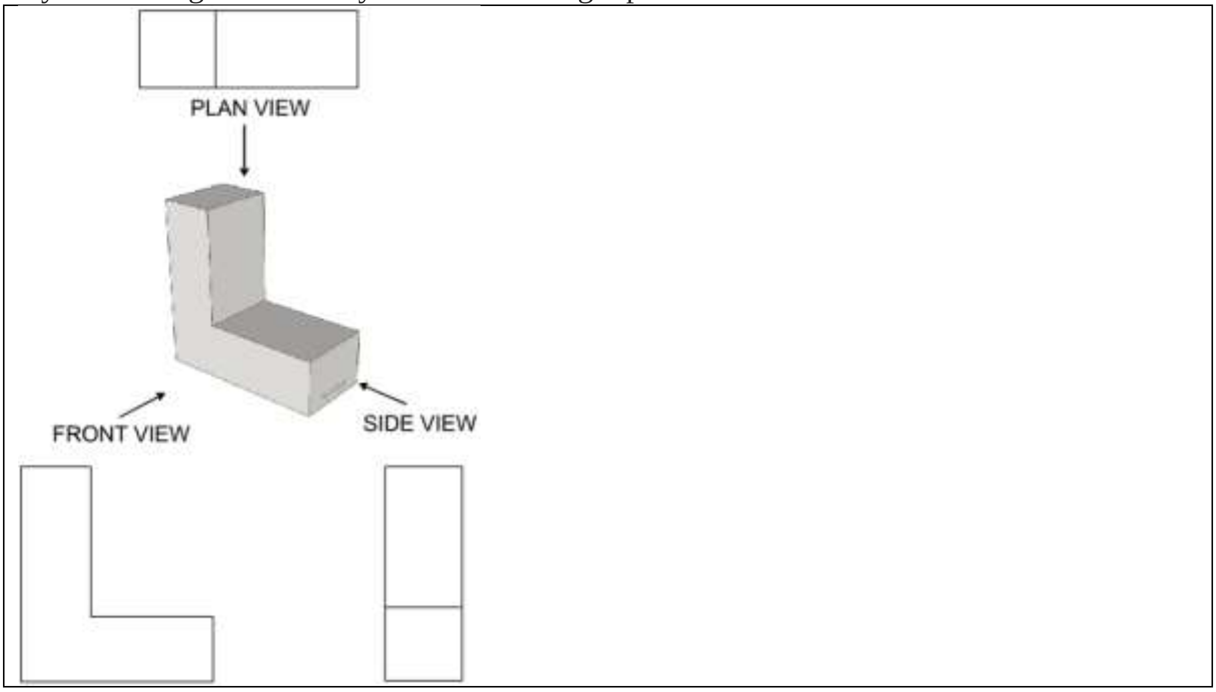


First-angle projection (European Standards)

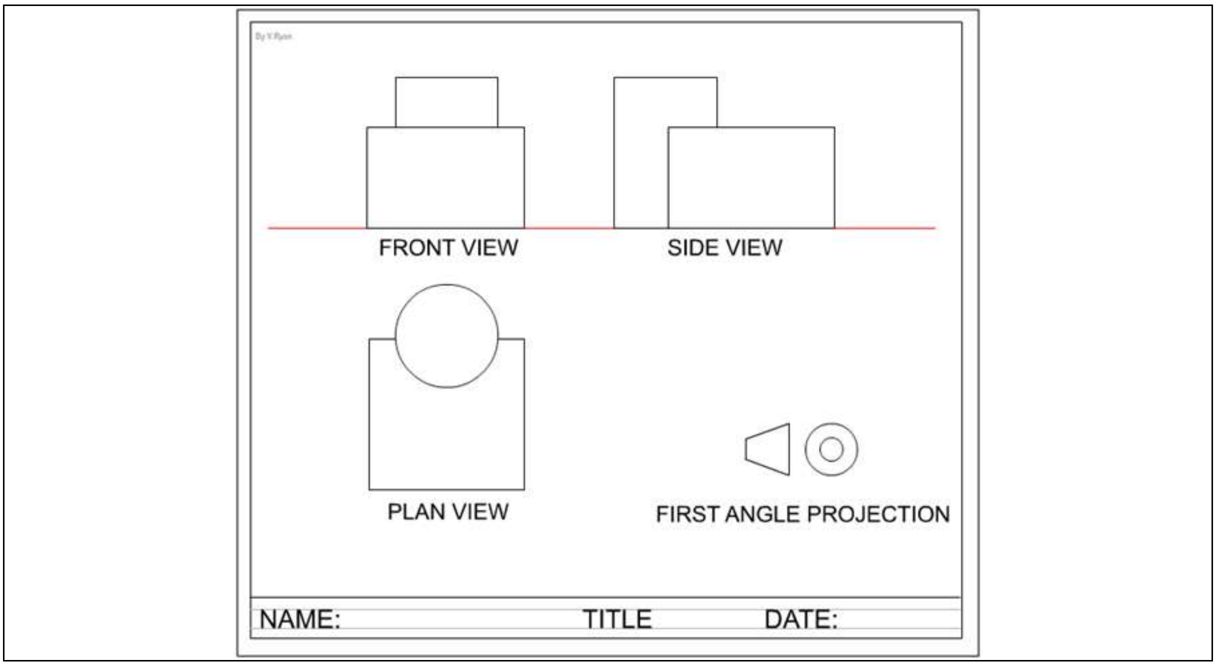
In first-angle projection, the object is conceptually located in quadrant I, i.e. it floats above and before the viewing planes, the planes are opaque, and each view is pushed through the object onto the plane furthest from it. (Mnemonic: an “actor on a stage”.) Extending to the 6-sided box, each view of the object is projected in the direction (sense) of sight of the object, onto the (opaque) interior walls of the box; that is, each view of the object is drawn on the opposite side of the box. A two-dimensional representation of the object is then created by “unfolding” the box, to view all of the interior walls. This produces two plans and four elevations. A simpler way to visualize this is to place the object on top of an upside-down bowl. Sliding the object down the right edge of the bowl reveals the right side view. Orthographic Projection is a way of drawing an 3D object from different directions. Usually a front, side and plan view are drawn so that a person looking at the drawing can see all the important sides. Orthographic drawings are useful especially when a design has been developed to a stage whereby it is almost ready to .manufacture

IMPORTANT: There are two ways of drawing in orthographic - First Angle and Third Angle. They differ only in the position of the plan, front and side views. Below is an example of First .Angle projection. Opposite is a simple L-shape, drawn in three dimensions

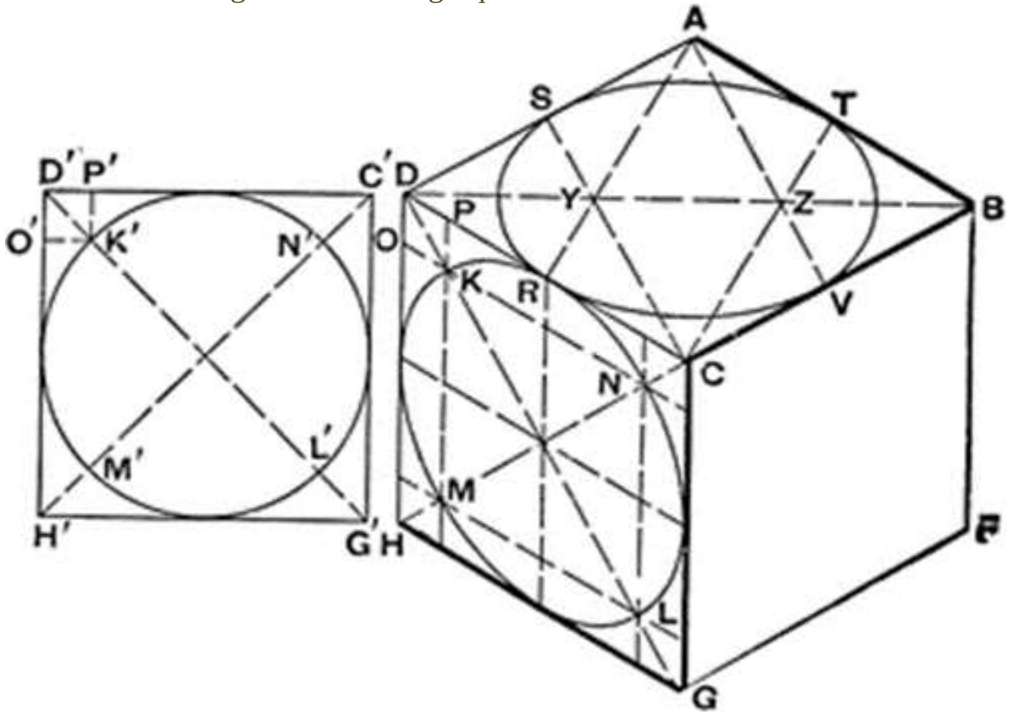
The front, side and plan views have drawn around the 3D shape. However this is not the correct way of drawing them as they are not in the right positions.

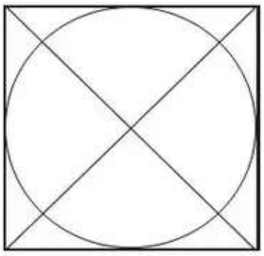


The correct method of presenting the three views, in first angle orthographic projection is shown below. The drawing is composed of a front, side and plan view of the L-shaped object. The first drawing is the front view (drawn looking straight at the front of the L-shape), the second is a drawing of the L-shape seen from the side (known as side view) and last of all a drawing from above known as a plan view. The red lines are faint guidelines and they are drawn to help keep each view in line, level and the same size.



Isometric Drawing of Circle using Square





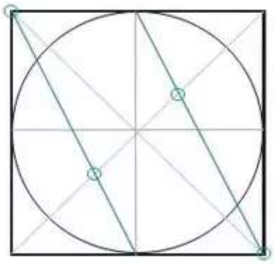


Fig 3

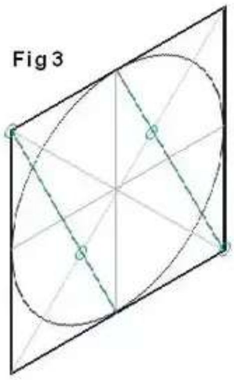


Fig. 4

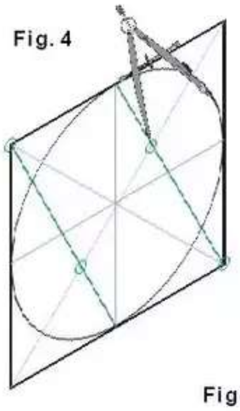


Fig. 5

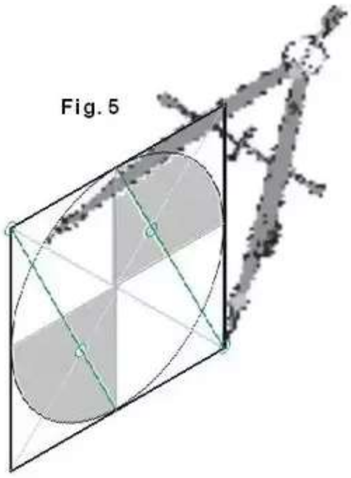
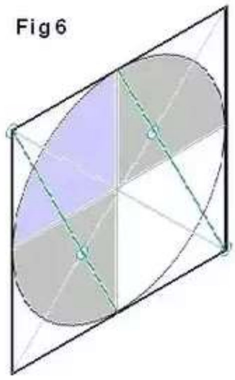


Fig 6



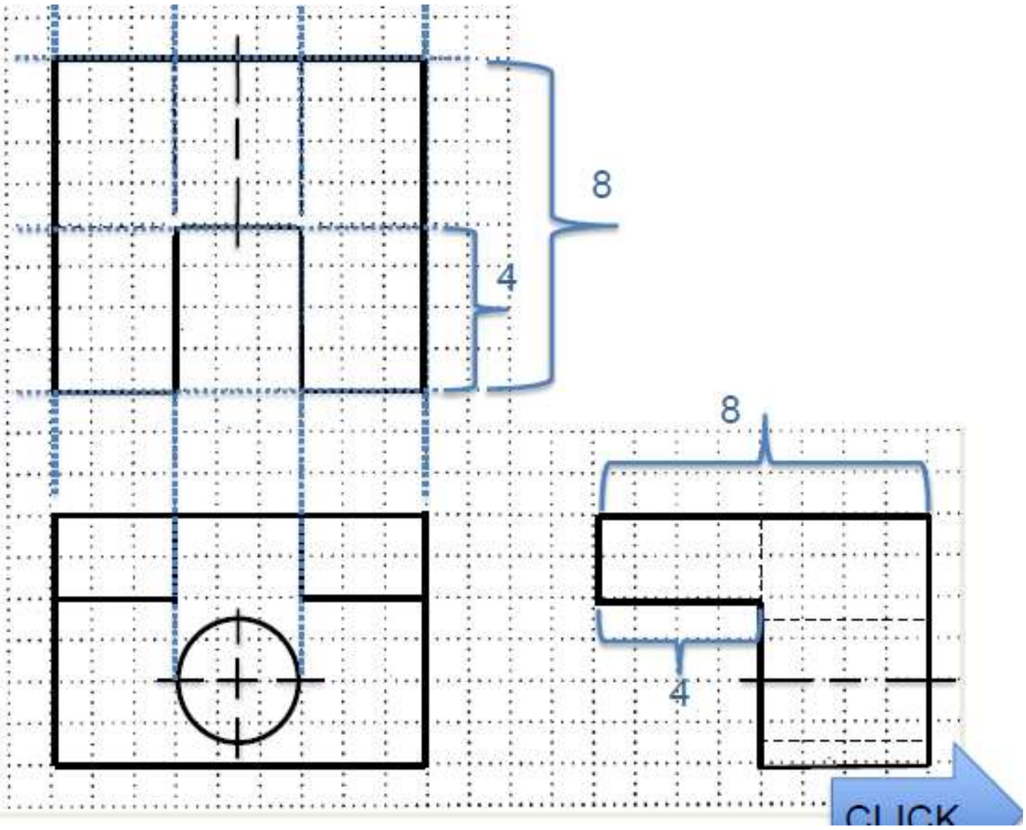
Missing Views

Objectives

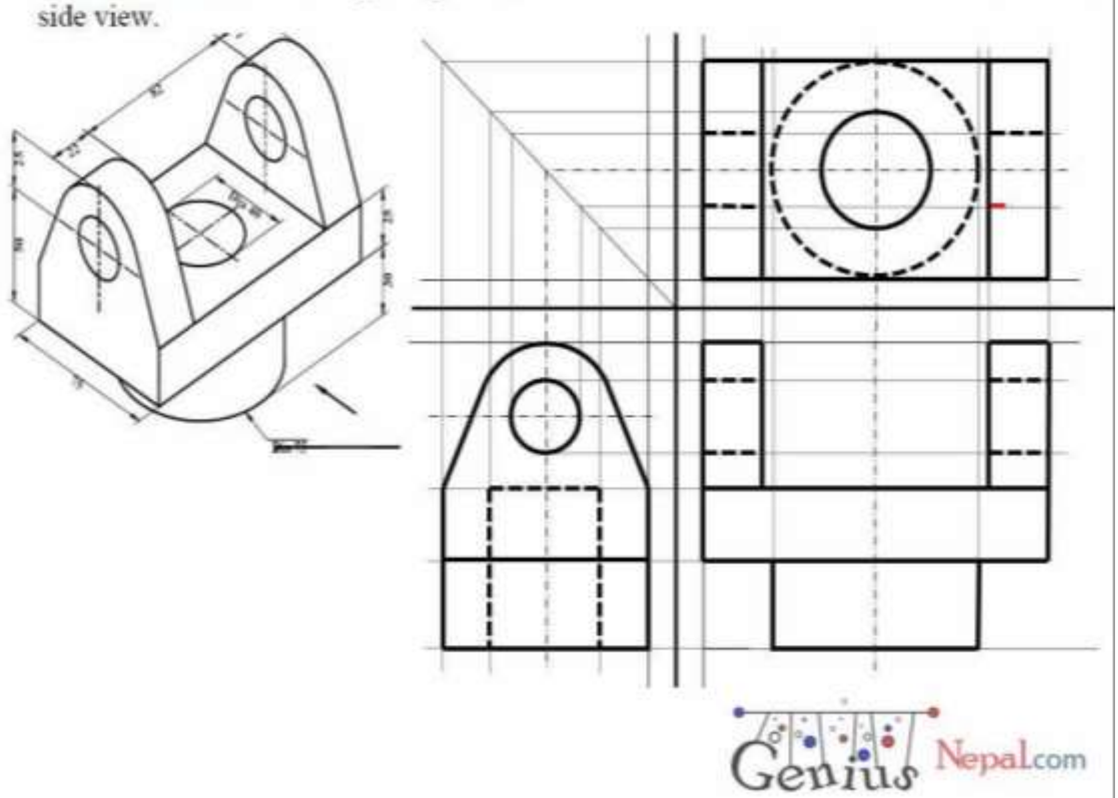
Construct a missing view of an object using 2 provided views.
Produce an isometric sketch from a set of orthographic projections

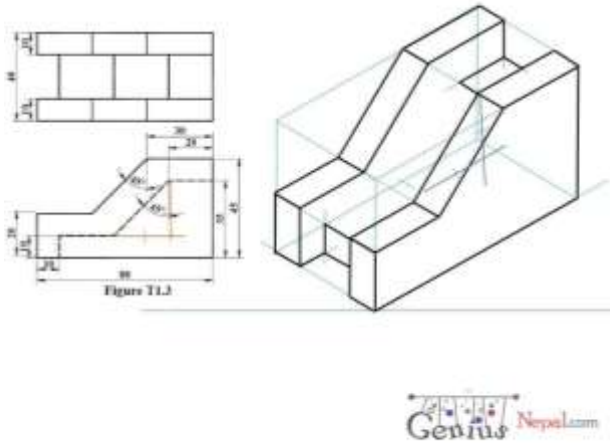
Missing Views – Draw the missing top view

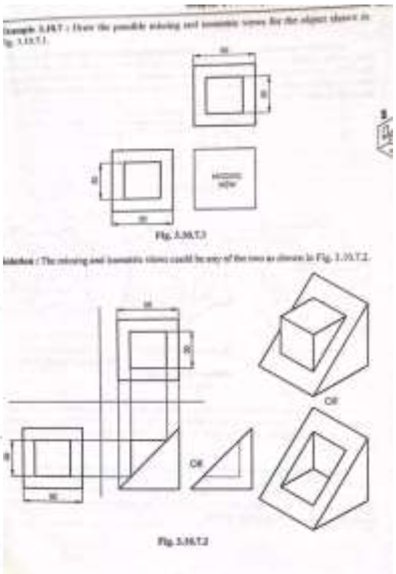
Step 1: Project vertices.
Step 2: Measure distances from Right Side View.
Step 3: Locate and connect corresponding vertices.
Step 4: Add hidden and center lines.



2. Draw the views of the objects given below with sectional front view and sectional side view.

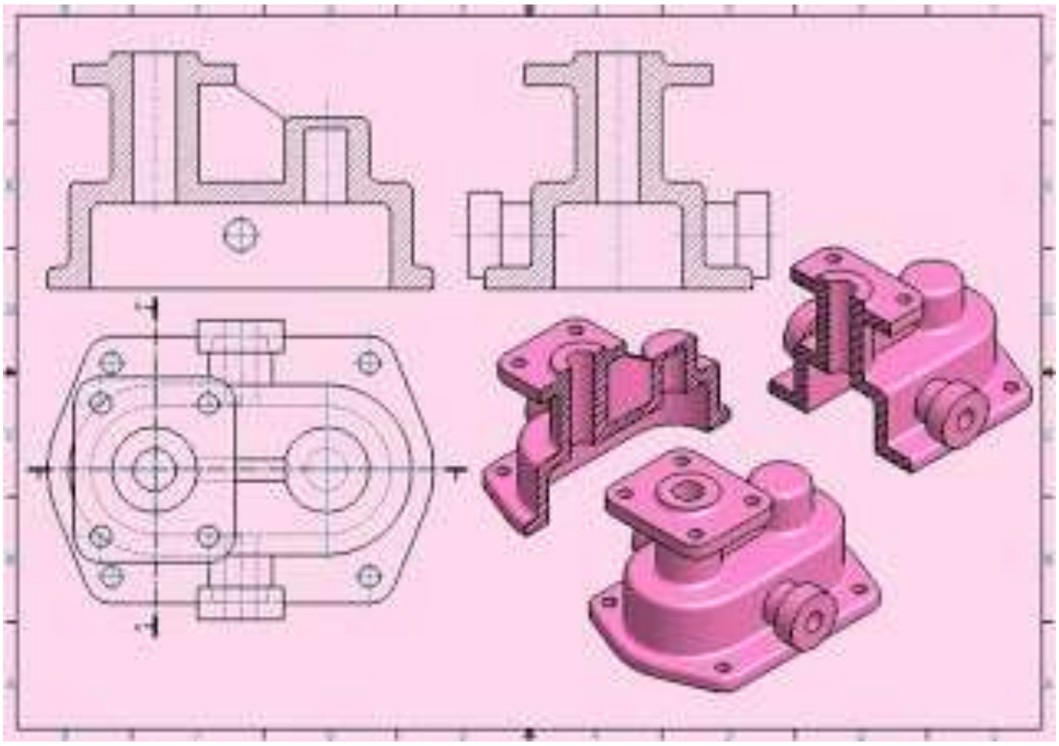






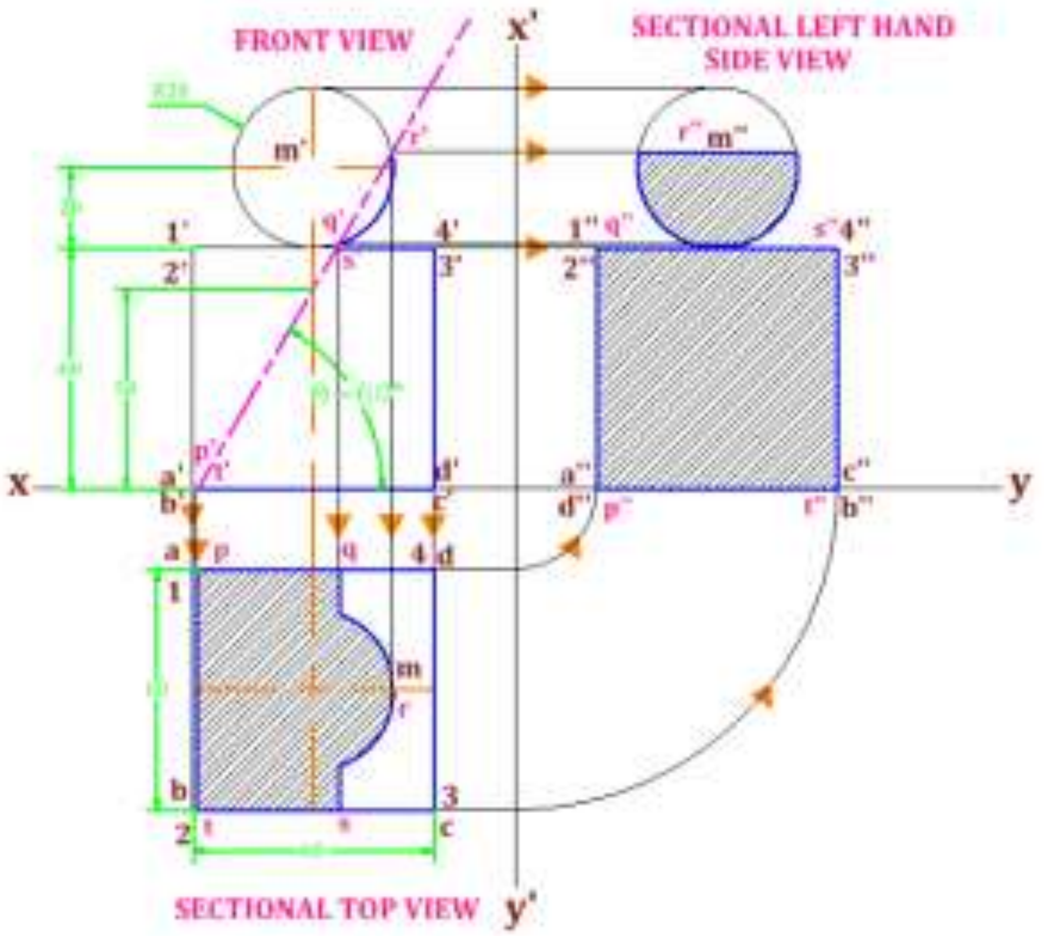
Section Views

Projected views (either Auxiliary or Multiview) which show a cross section of the source object along the specified cut plane. These views are commonly used to show internal features with more clarity than may be available using regular projections or hidden lines. In assembly drawings, hardware components (e.g. nuts, screws, washers) are typically not sectioned.



Exercise- Section of Solids

Problem 7.10 Section of Solids – A spheres of diameter 40 mm is resting on a cube of side 60 mm. The cube is resting on H.P. and the assembly is cut by a cutting plane which is perpendicular to V.P. inclined to H.P. by the angle 60° and bisecting the full axis of the assembly. Draw front view, sectional top view and sectional left hand side view.



Procedure:

Step-1 Draw a horizontal x-y line of some suitable length.

Step-2 Draw a square of side of base 60 mm below the x-y line at some suitable distance from it, such that two sides of the square should be parallel with x-y line. Give notations on it.

Step-3 From the center of the square, draw a vertical center line of length 60 mm from the x-y line as shown into the figure. And from all notations of the square draw vertical projectors of the length equal to its height i.e., 60 mm. It is a square shape & draw a circle of diameter 40 mm such that the vertical center line of the circle and the square should be same and it should rests on it, as shown in the figure. It is front view. And Give the notations on it.

Step-4 Draw a cutting plane line passing at the distance 50 mm from the base & on the center line of the square and circle in the front view, such that its inclination with the x-y line should be equal to 60°, as shown into the figure.

Step-5 Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the square & circumference of the circle in front view, i.e., p’, q’, r’ etc. as shown into the figure.

Step-6 Now from these cutting points on the cutting plane line, draw vertical downward projectors in the top view, such that these projectors will intersect at respective points in the top view, as shown in the figure. Then draw hatching lines in the region bounded by these projectors in the top view. It is the Sectional Top View.

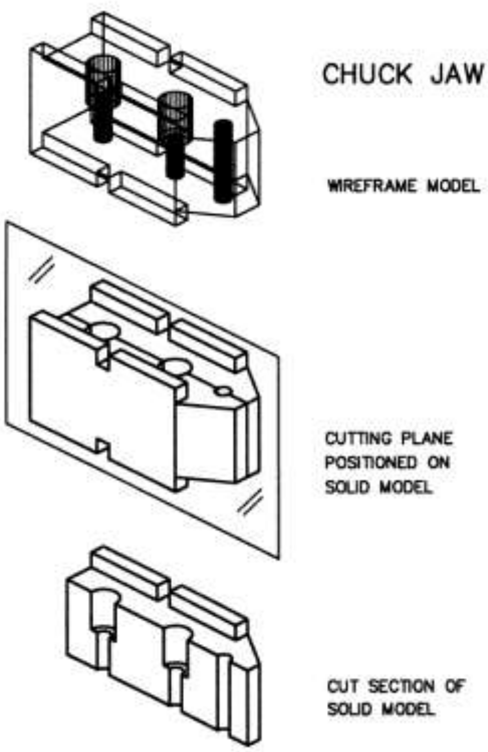
Step-7 Now draw an x’-y’ line perpendicular to the x-y line and on the right of the front view. Then draw horizontal projectors from the all notations and cutting points on the cutting plane line in right side of the x’-y’ line of some sufficient length as shown into the figure. And transfer the all notations form the sectional top view in the right side of the line x’-y’, such that these all the points will intersect with each other at respective points.

Step-8 Now Connects all the points in sequence with medium dark straight lines and smooth curve as per the shape of the cut section, as shown in the figure, and draw hatching lines in it. It is the Sectional Left Hand Side View.

Step-9 Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

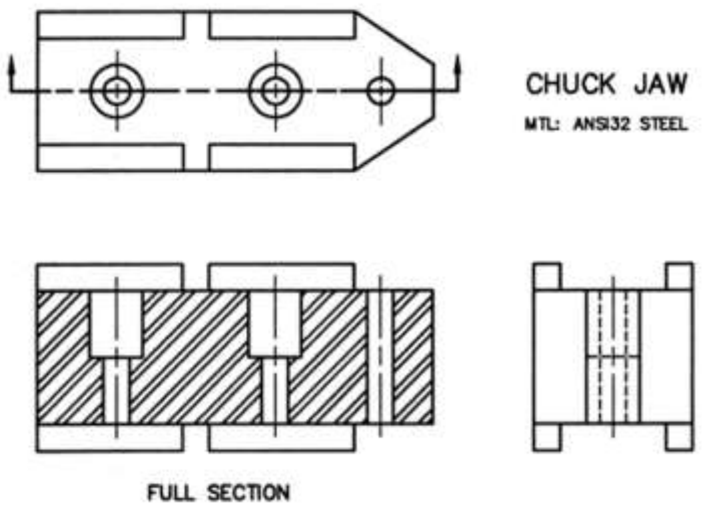
.Full Section of the Chuck Jaw Solid Model

The cutting plane is centered through the middle of the model, cutting exactly through the centers of the two counterbores and the small hole. The front part of the object is then .assumed to be removed, showing the remaining part as a full section



.Full Section Drawing of the Chuck Jaw

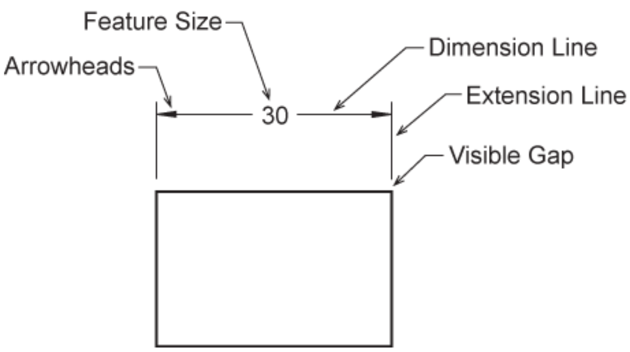
The cutting plane line is drawn on the top view indicating the position of the cutting plane. The full section is shown in the front view. The part of the object that is solid at the cutting plane is not crosshatched, but the visible background lines of these features are drawn. Hidden lines are not drawn for edges that are behind the full section of the front view.



Dimensioning technique

Features of a Dimension

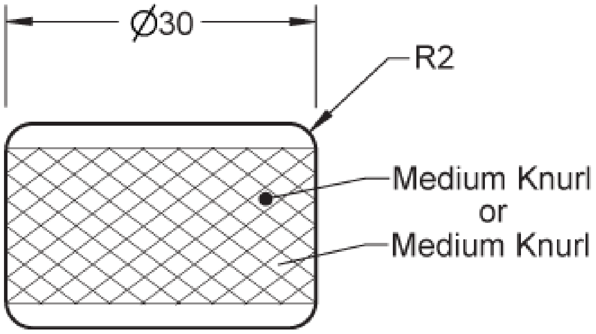
Dimensions use special lines, arrows, symbols and text. Dimensions make use of dimension lines, extension lines and leader lines. All three line types are drawn continuous and thin.



leader Lines

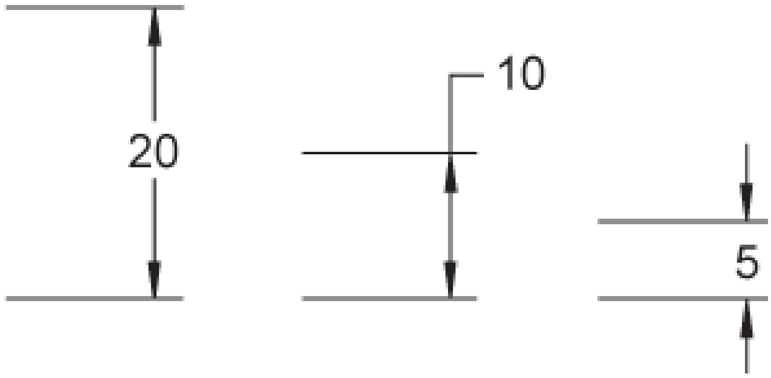
A leader line may be terminated in three different ways. Leader lines should be constructed such that there are ...

- no crossing leaders.
- no excessively long leaders.
- no leaders that are parallel to dimension or extension lines.
- no leaders that make a small angle with the surface to which it refers.



Arrowheads

Arrowheads are drawn between the extension lines if possible. If space is limited, they may be drawn on the outside.



Types of Dimensions

Dimensions are given in the form of linear distances, angles, and notes.

Linear distances: They are usually arranged horizontally or vertically, but may also be aligned with a particular feature of the part.

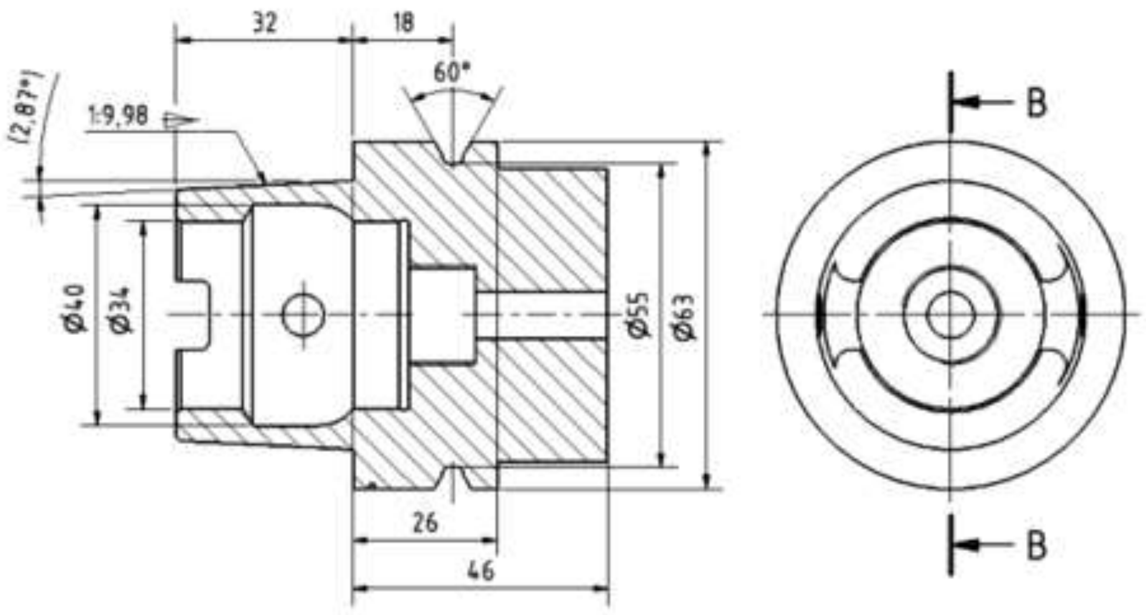
Angles: Used to give the angle between two surfaces or features of a part.

Notes: Used to dimension diameters, radii, chamfers, threads, and other features that can not be dimensioned by the other two methods.

Lettering should be legible, easy to read, and uniform throughout the drawing. Upper case letters should be used for all lettering unless a lower case is required. The minimum lettering height is 0.12 in (3 mm).

Dimension symbols

Dimensioning symbols replace text. The goal of using dimensioning symbols is to eliminate the need for language translation.



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