Manual Engineering Drawing

2016

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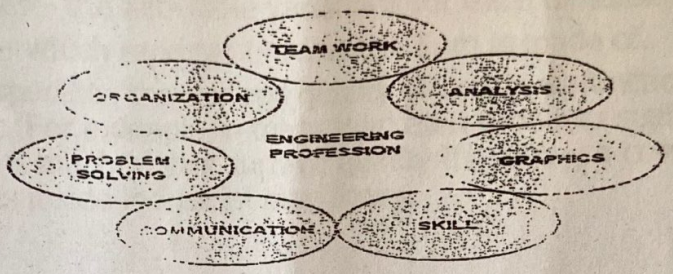
Introduction

Engineering Profession

the application of scientific knowledge about matter and energy for practical human uses such as construction, machinery, products, or systems.



Effectiveness of Graphics Language

1. Try to write a description of this object.

2. Test your written description by having someone attempt to make a sketch from your description.

You can easily understand that ...

The word languages are inadequate for describing the size, shape and features completely as well as concisely.

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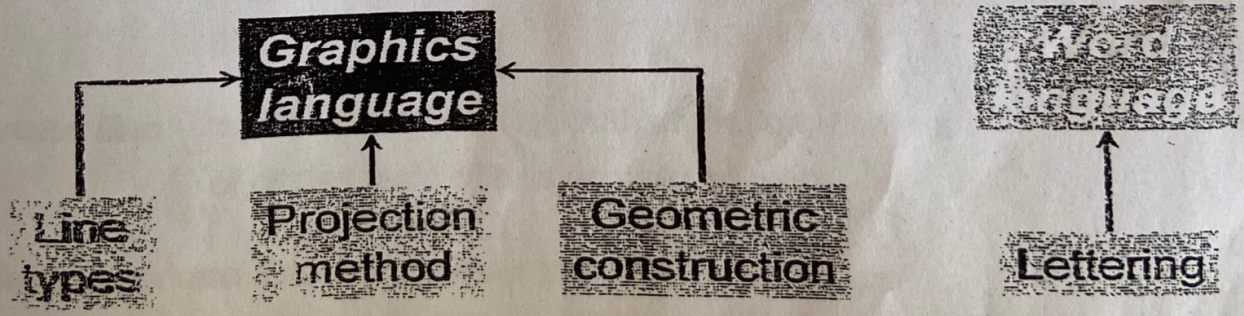
Common Features of Engineering Drawings

- **Geometry** - the shape of the object; represented as views, how the object will look when it is viewed from various standard directions, such as front, top, side, etc.
- **Dimensions** - the size of the object is captured in accepted units.
- **Tolerances** - the allowable variations for each dimensions.
- **Material** - which represents what the item is made of.
- **Finish** - specifies the surface quality of the item, functional or cosmetic. For example, a mass marketed product usually requires a much higher surface quality than, say, a component that goes inside industrial machinery.

Basic Knowledge for Drafting



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Line Styles

A variety of line styles are used to 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 parallel pattern used to indicate surfaces in section views resulting from "cutting." Section lines are commonly referred to as "cross-hatching."

Meaning of Lines

Visible lines represent features that can be seen in the current view

Hidden lines represent features that can not be seen in the current view

Center line represents symmetry, path of motion, centers of circles, axis of axisymmetrical parts

Dimension and Extension lines indicate the sizes and location of features on a drawing

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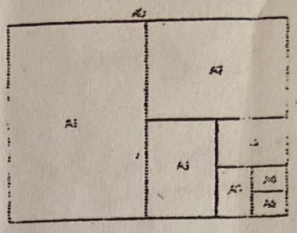
Sizes of Drawings

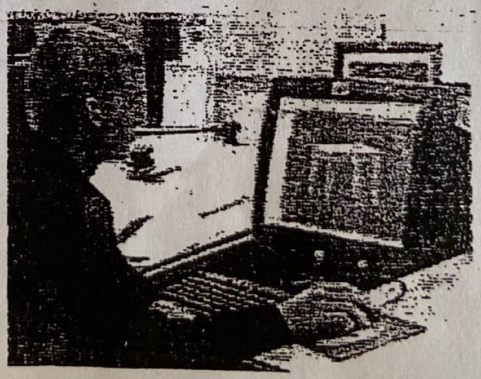
- **ISO A Drawing Sizes (mm)**
- **A4**210 X 297
- **A3**297 X 420
- **A2**420 X 594
- **A1**594 X 841
- **A0**841 X 1189



Drafting Instruments

A design is as good as its instruments

Conventional



CAD

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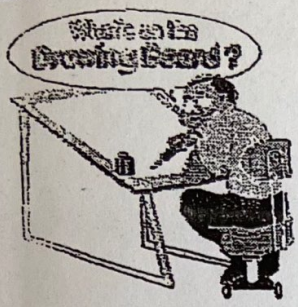
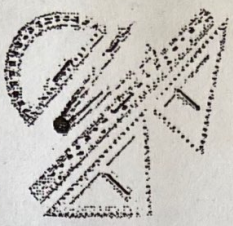
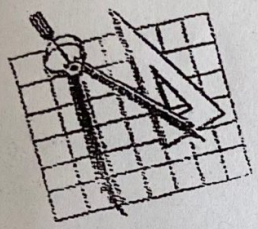
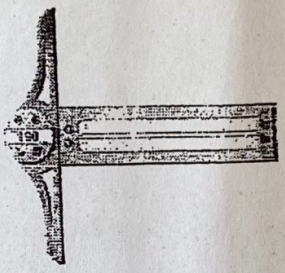
Conventional Drafting Tools

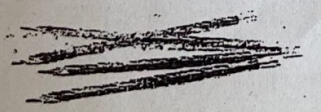


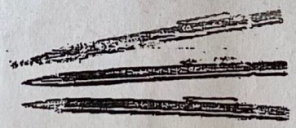


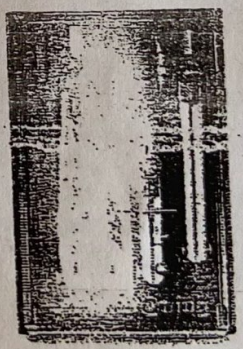


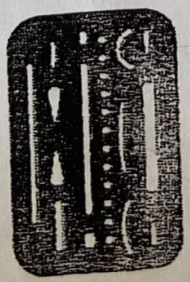


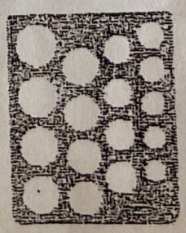
Conventional Drafting Tools











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لتنصيف الخط افتح الفرجار بفتحة أكبر من نصف طولها
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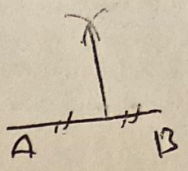
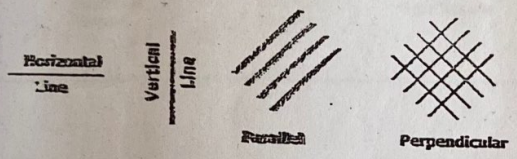


* Bisect aline *

Geometric Construction

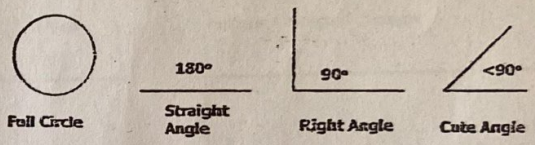
Basic Geometric Elements- Lines

- A straight line is the shortest distance between two points and is commonly referred to simply as a "line"
- Horizontal lines have constant distance from the lower edge of the drawing sheet, vertical lines have constant distance from the right side and left side edges of the sheet.
- Straight lines or curved lines are parallel if the shortest distance between them remains constant.



Basic Geometric Elements- Angles

- An angle is formed by two intersecting lines.
- There are 360° in a full circle.
- A degree is divided into 60 minutes, 60'. A minute is divided into 60 seconds, 60".

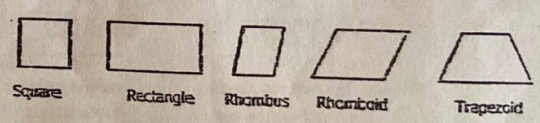


Basic Geometric Elements- Triangles

- A triangle is a plane figure bounded by three straight sides.
- The sum of the interior angles is always 180°

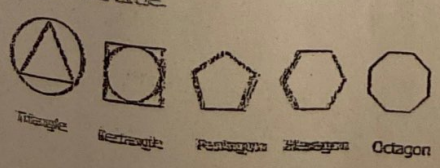
Basic Geometric Elements- Quadrilaterals

- A quadrilateral is a plane figure bounded by 4-straight sides.
- If the opposite sides are parallel, the quadrilateral is also called parallelogram



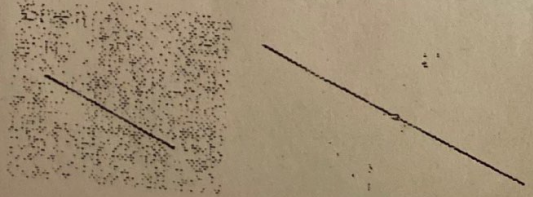
Basic Geometric Elements- Polygons

- A polygon is any plane figure bounded by straight lines.
- Regular Polygons have equal sides and angles
- Regular Polygons can be inscribed in or circumscribed around a circle.



Bisecting a line or Arc

1. Swing two arcs of any radius greater than half-length of the line with the centers at the ends of the line.
2. Join the intersection points of the arcs with a line.
3. Locate the midpoint.



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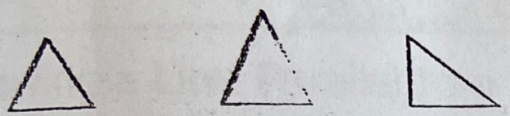
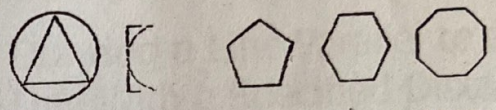


Equilateral Triangle | Isosceles Triangle | Right Triangle

Basic ometric Elements- Polyc

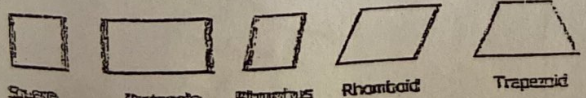
- A polygon plane figure bounded by straight lines.
- Regular P have equal sides and angles
- Regular P can be inscribed in or circumscribed around a



Triangle | Pentagon | Hexagon | Octagon

Basic Geometric Elements- Quadrilaterals

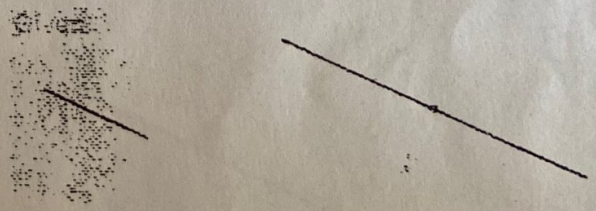
- A quadrilateral is a plane figure bounded by 4- straight sides.
- If the opposite sides are parallel, the quadrilateral is also called parallelogram



Square | Rectangle | Rhombus | Rhomboid | Trapezoid

Bisec a line or Arc

1. Swing two arc dius greater than half-length of the line with the ends of the line.
2. Join the inter s of the arcs with a line.
3. Locate the



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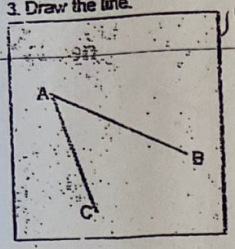
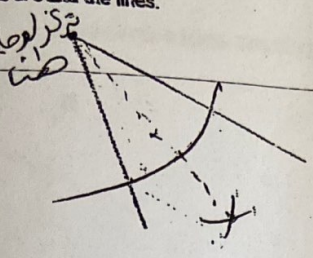
Bisecting an Angle

∠ CAB

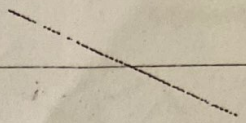
1. Swing an arc of any radius whose centers at the vertex.
2. Swing the arcs of any radius from the intersection points between the previous arc and the lines.
3. Draw the line.





Drawing a Line Parallel to a Given Line Through a Point

Given

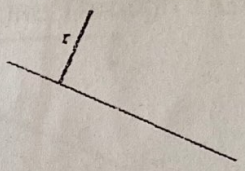


Drawing a Line Parallel to a Given Line Through a Point

Given

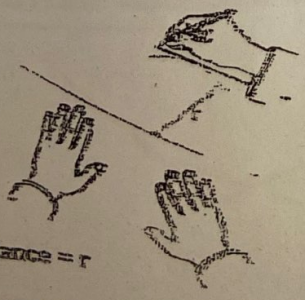
Repeat

Drawing a Line Parallel to a Given Line With a Specified Distance



Given distance = r

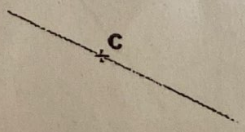
Drawing a Line Parallel to a Given Line With a Specified Distance



Given distance = r

Repeat

Drawing a Line Perpendicular to a Given Line at a Given Point



Revolve method

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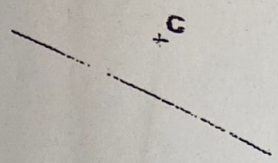
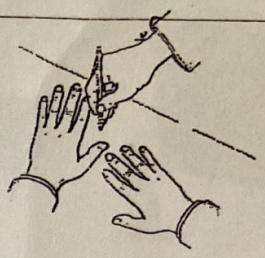
Drawing a Line Perpendicular to a Given Line at a Point not on the line

Adjacent-sides method



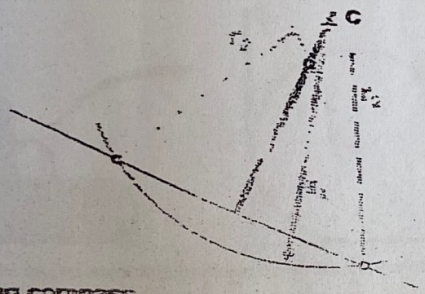
Drawing a Line Perpendicular to a Given Line at a Point not on the line

Adjacent-sides method



Repeat

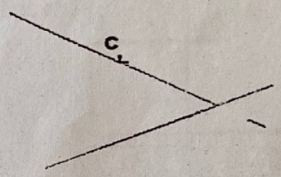
Drawing a Line Perpendicular to a Given Line at a Point not on the line



Using compass

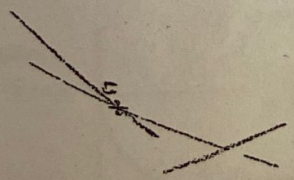
Drawing a Line making 15° With a Given Line Through a Given Point

Given



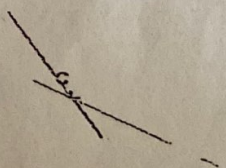
Drawing a Line making 15° With a Given Line Through a Given Point

Given



Drawing a Line making 30° With a Given Line Through a Given Point

Given



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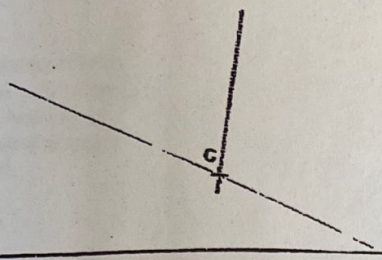
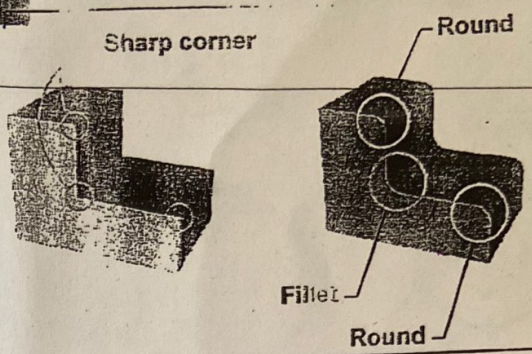
Drawing a Line making 75° With a Given Line Through a Given Point

Given



Fillet and Round



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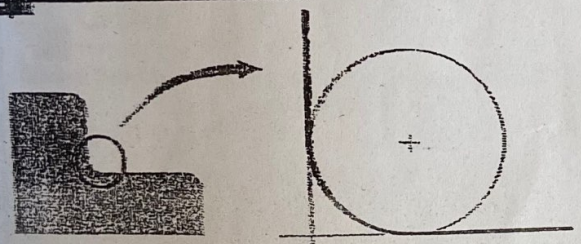
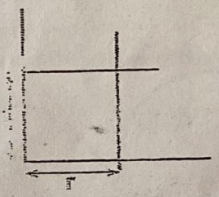


To draw the arc, we must find the location of the center of that arc.

How do we find the center of the arc?

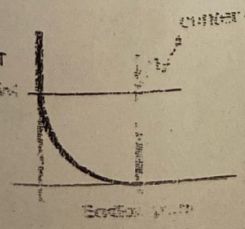
Drawing an Arc of Given Radius Tangent to Two Perpendicular Lines

Given arc radius r



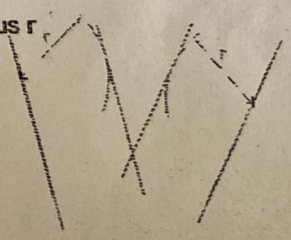
Drawing an Arc of Given Radius Tangent to Two Perpendicular Lines

Given arc radius r



Drawing an Arc of Given Radius Tangent to Two Lines

Given arc radius r



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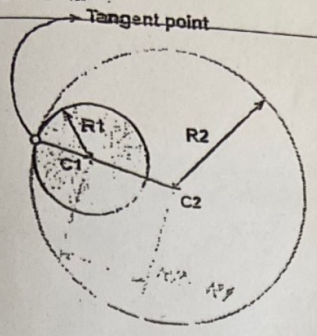
A Circle Tangent to Other Circle

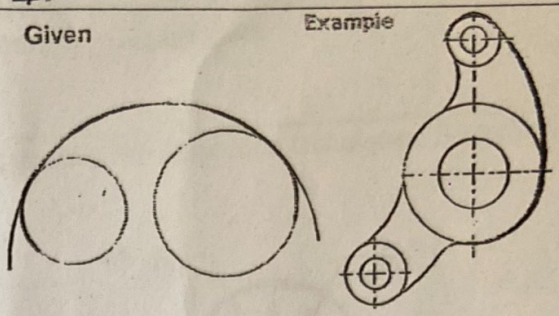


The center of two circles and tangent point must lie on the same straight line !!!

Drawing a Circle Tangent to Two Circles

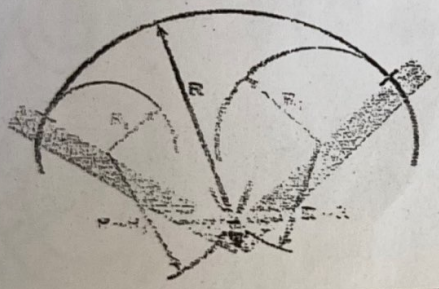
Given

Example



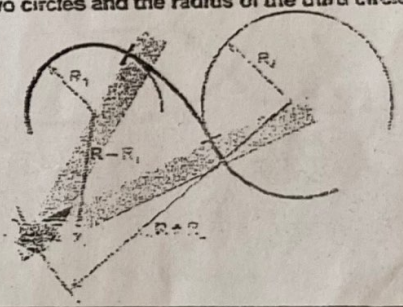
Drawing a Circle Tangent to Two Circles

Given Two circles and the radius of the third circle = R



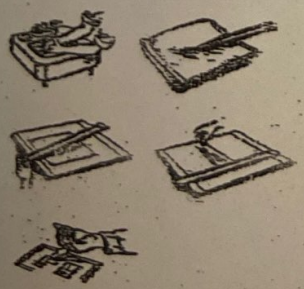
Drawing a Circle Tangent to Two Circles

Given Two circles and the radius of the third circle = R

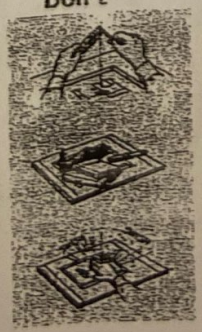


Keep Your Drawing Clean

Do



Don't



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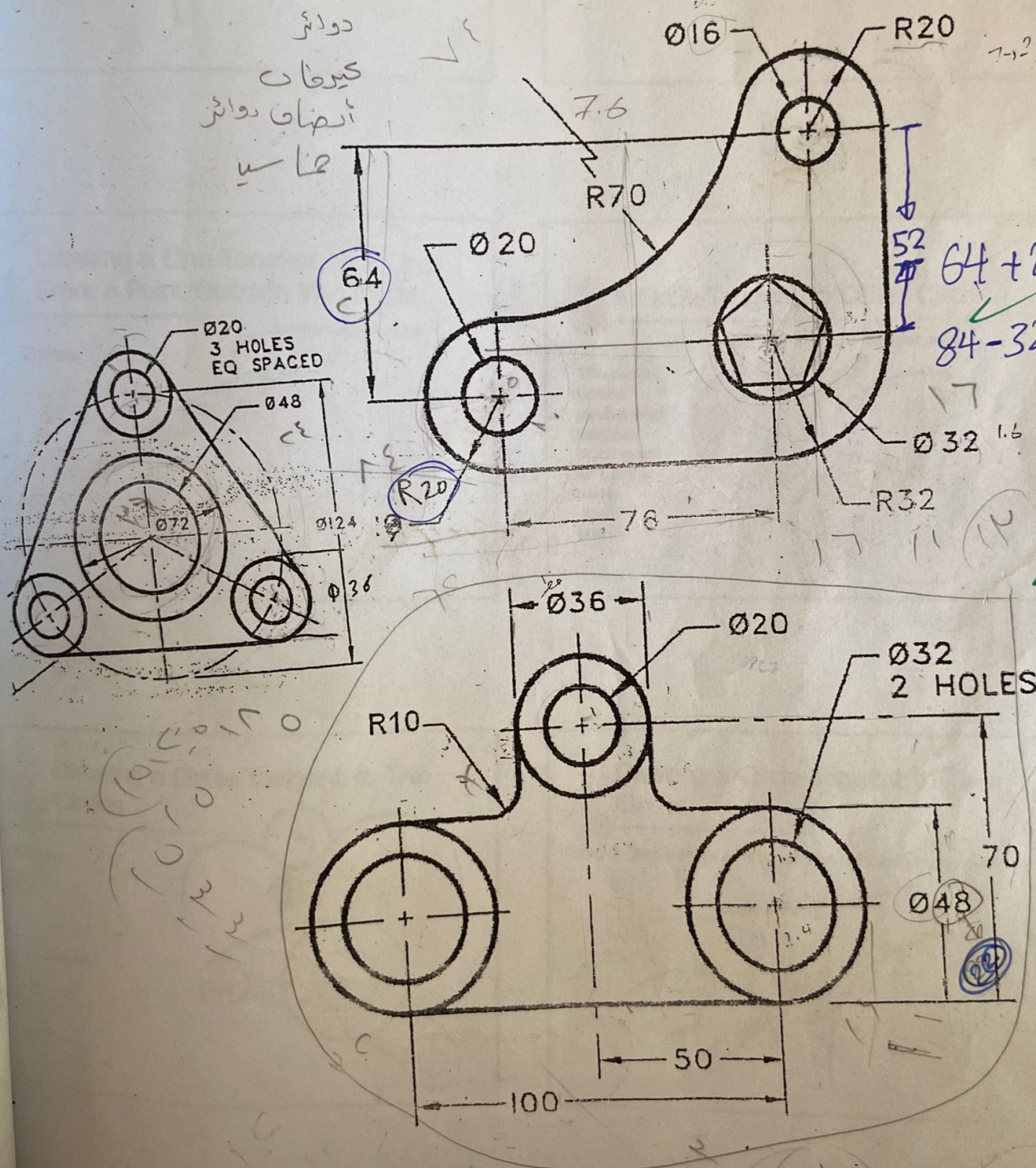
The Hashemite University
Civil Engineering Dept. - Engineering Drawing
EX # 2: Geometric Construction

Reconstruct the following objects using geometric construction techniques. Dimensions are in mm.



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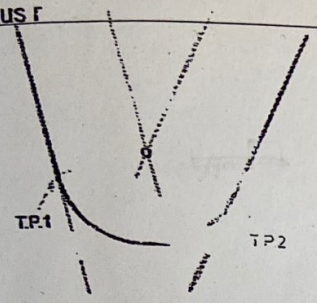
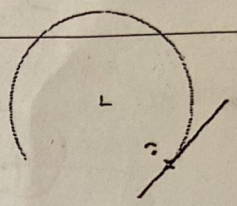
Drawing an Arc of Given Radius Tangent to Two Lines

Given arc radius r



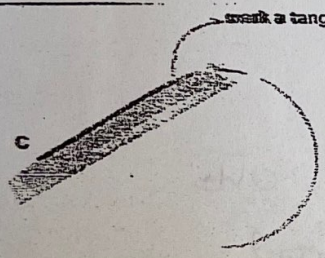
Drawing a Line Tangent to a Circle at a Point on The Circle

Given



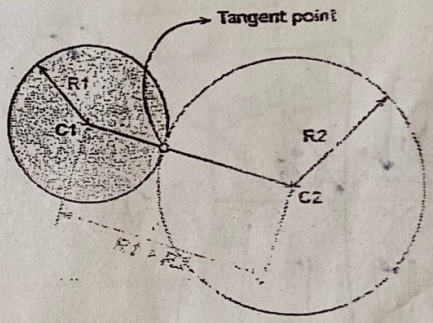
Drawing a Line Tangent to a Circle From a Point Outside The Circle

Given



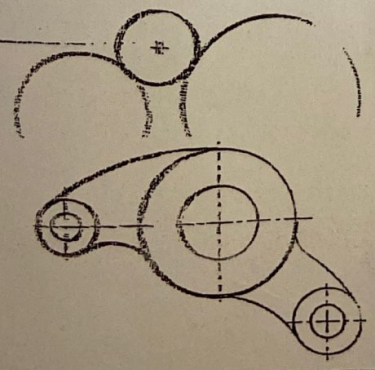
A Circle Tangent to Other Circle

The center of two circles and tangent point must lie on the same straight line !!!



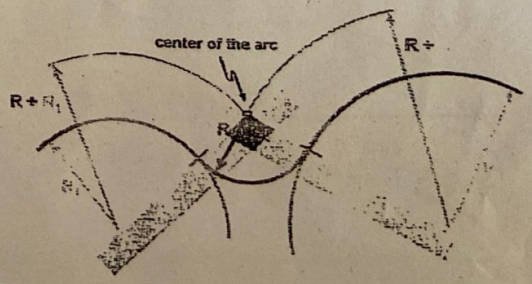
Drawing a Circle Tangent to Two Circles

Given



Drawing a Circle Tangent to Two Circles

Given Two circles and the radius of the third circle = R



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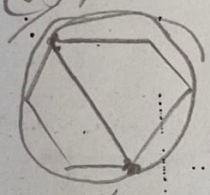
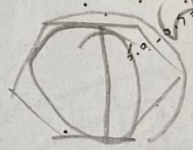
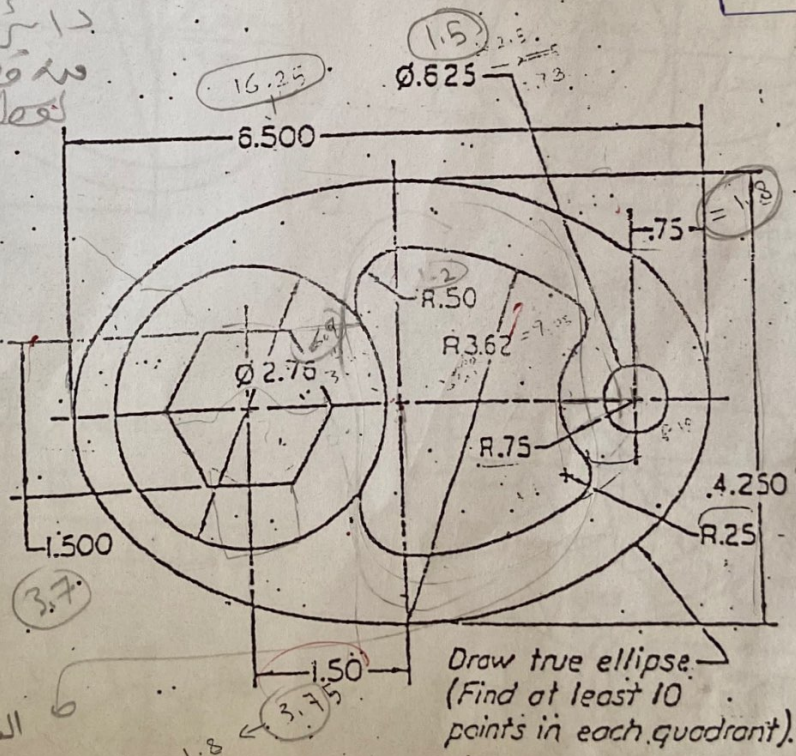
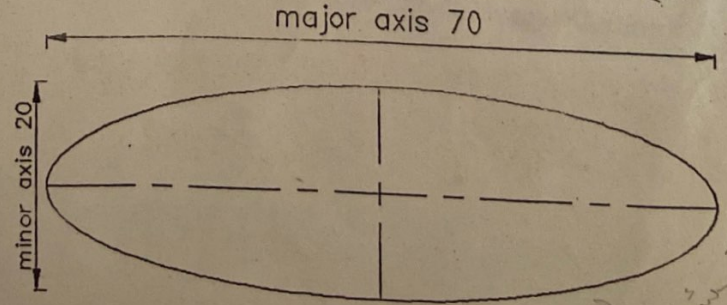
The Hashemite University
Civil Engineering Dept. - Engineering Drawing
EX # 3: Geometric Construction

Reconstruct the following objects using geometric construction techniques. Dimensions are in inch.









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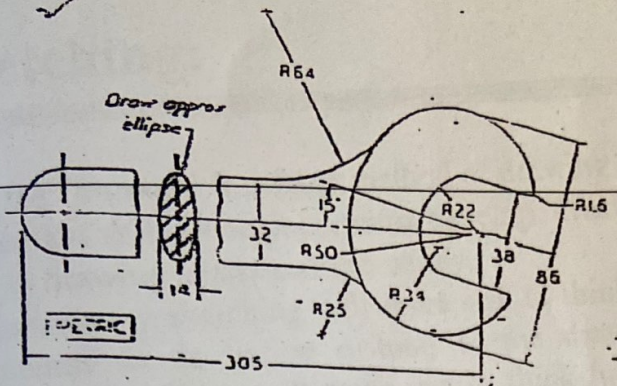

Fig. 5.69 Spanner.*

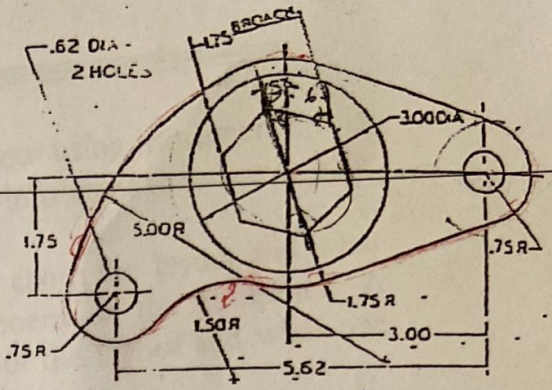

Fig. 5.70 Rocker Arm.*

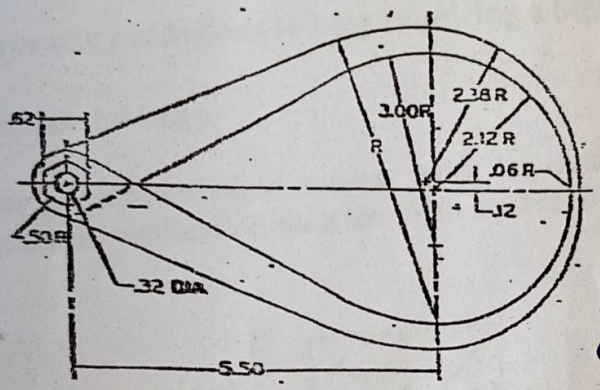

Fig. 5.71 Outside Caliper.*

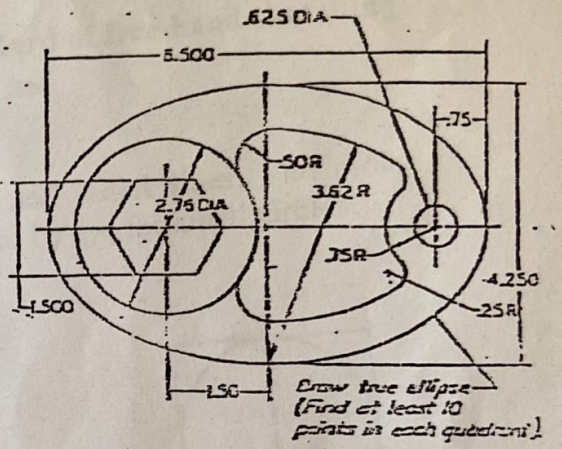

Fig. 5.72 Special Cam.*

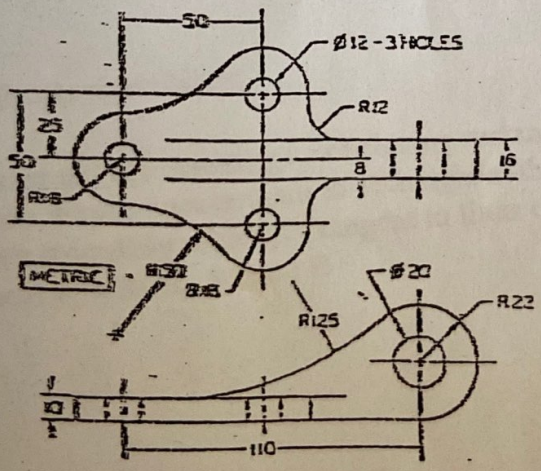

Fig. 5.73 Boiler Stay.*

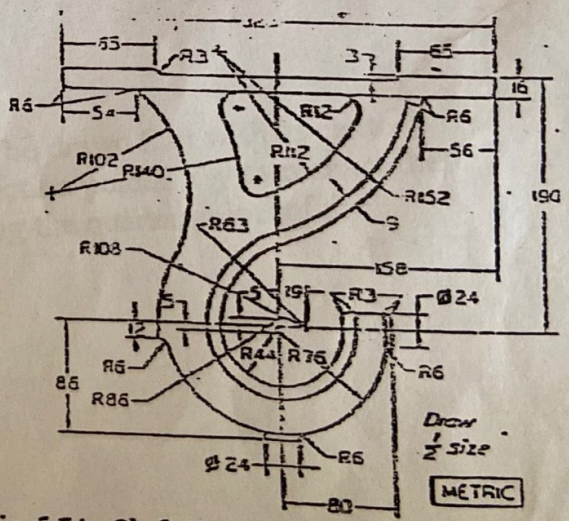

Fig. 5.74 Shaft Hanger Casting.*

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Sketching:

Sketching is a rapid free hand method of drawing (without using instruments. It is an important skill an engineer must develop. Practice is important to improve your ability in drawing neatly and accurately.

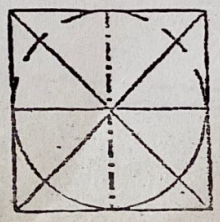
The preliminary sketching will force one to think first about the layout and what one intends to do before rushing to the drawing board or the computer. A preliminary sketching will force one to think first about the layout and what one intends to do before starting on drawing board or CAD screen.

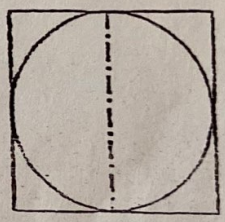
To start free hand drawing, what you need is just a sheet of paper, eraser, and a pencil

Always use guidelines to help acquiring a high standard of free hand sketching

Circle sketching :

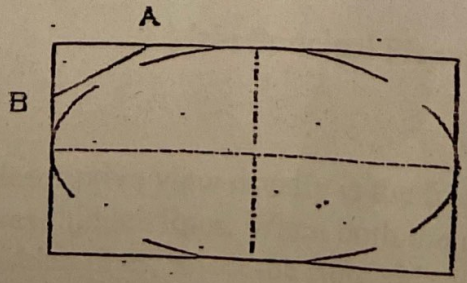
Draw a circumscribed square with its centerlines and radial lines. The radial distance is marked on each line with a piece of paper or by eye for small circles.





Ellipses sketching:

As an aid for drawing an enclosing rectangle may be drawn first with its center lines. Draw arcs tangent to rectangle at the intersection points. Try to connect these arcs smoothly with arcs tangent to lines connecting the quarter points of the rectangle sides. A and B



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Orthographic Projections

Orthographic projections: Is the system of drawing views of an object by projecting them perpendicularly onto projection planes with parallel projectors.

Projection planes: Image planes perpendicular to the lines of sight, placed between the object and the eye.

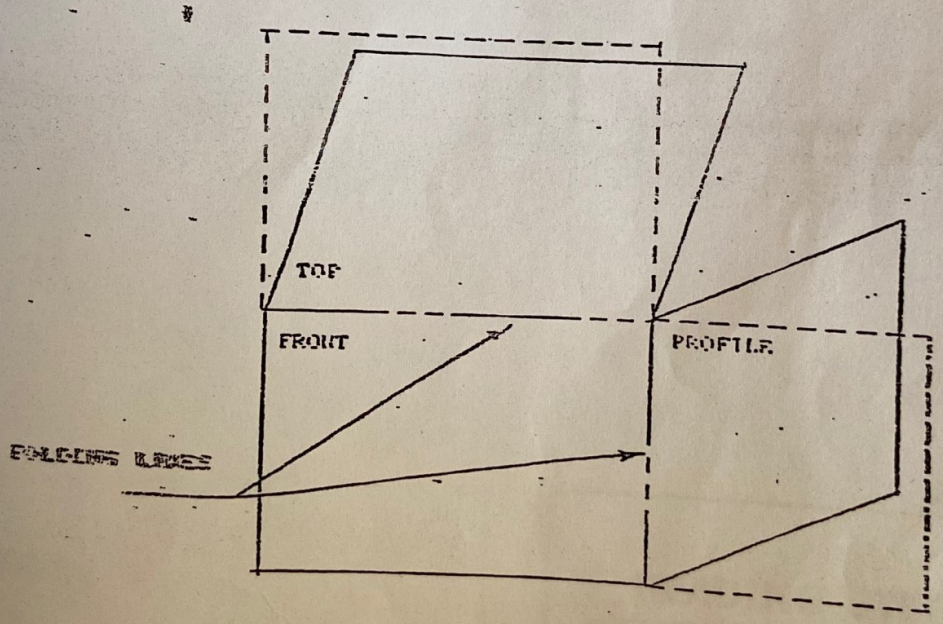
Lines of sight: The form the eye to a particular point on the object. These lines are parallel.

Horizontal plane: An image plane, all points on it are of the same elevation. (top or plane view)

Frontal plane: Plane perpendicular to the horizontal plane. All the points on it are of the same depth.

Profile Plane: Plane perpendicular to the horizontal and frontal planes.

Folding Line: The line made by the intersection of two image planes.



Main Principal Planes

Note:

The most descriptive view usually is the front view. Select the sequence of views with the fewest hidden lines. When both the right and left views have an equal number of hidden lines, select the right side view.

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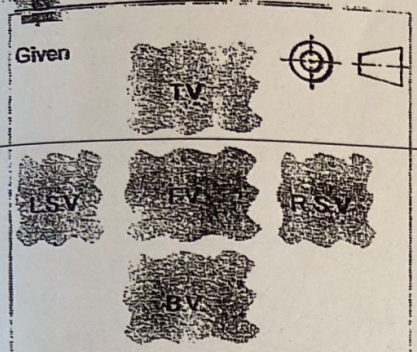
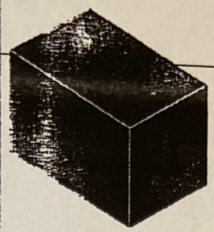
VIEWING DIRECTION

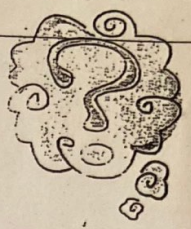
Given





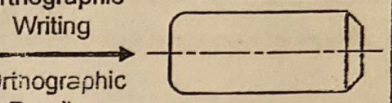
DEFINITION

Reading a drawing is the process of ***recognizing the shape of an object*** by interpreting the orthographic views.



Orthographic Writing

Orthographic Reading



BASIC IDEA - 2

Objects are decomposed into solid geometric primitives.

Some of familiar solid objects

- Cone
- Pyramid
- Sphere

Analysis by Solids

BASIC IDEA

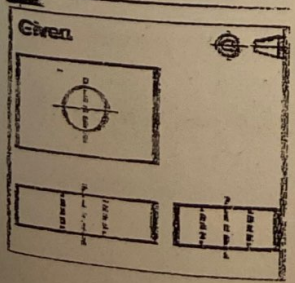
Objects are decomposed into solid geometric primitives.

Some of familiar solid objects

- Rectangular prism
- Cylinder
- Negative cylinder (Hole)

EXAMPLE A

Given



Composition

- Rectangular prism
- Hole

Front View

READING STEPS

1. Orient yourself with the views given. (Choose the viewing direction.)
2. Read the individual surfaces that appeared in each view and related to each other.
3. Create a proper solid geometric primitive from each reading.
4. Assembly all of solid geometric primitive according to orthographic views.

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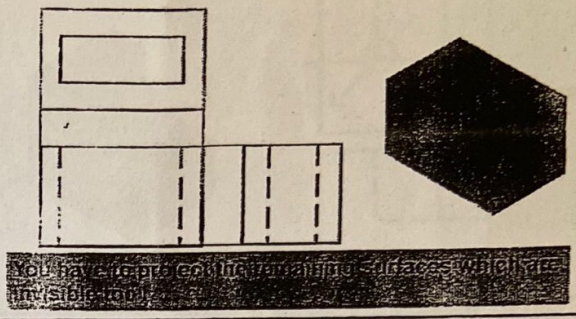
Object Features

are areas that are bounded by edges or limiting element.

is a line that represents the last visible part of the curve surface.

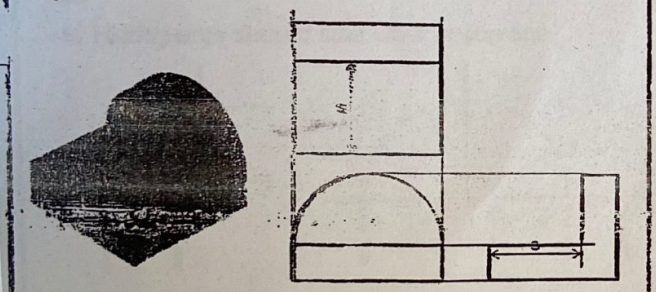
Projection of Object

The views are obtained by projecting all object features to the picture plane.

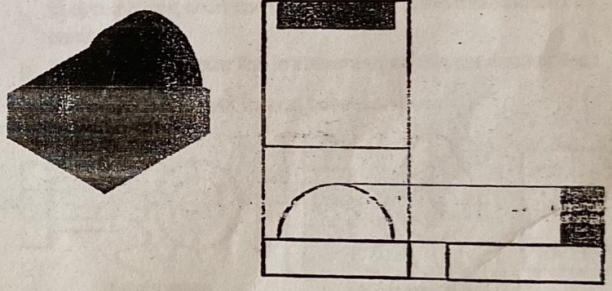


You have to omit the remaining surfaces which are invisible to you.

Projection of Object



Projection of Object

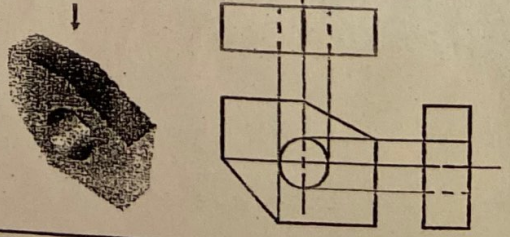


Line Convention

- Precedence of coincide lines.
- Hidden line drawing.
- Center line drawing.

Precedence of Line

Order of importance: Visible line → Center line



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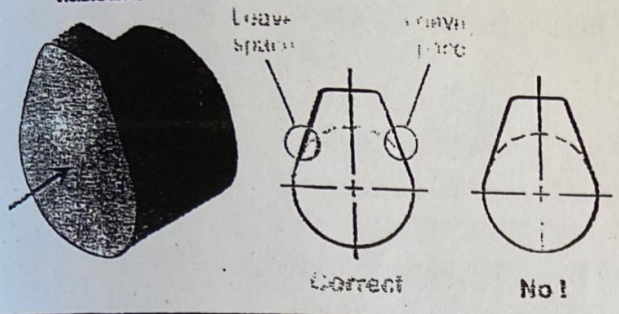
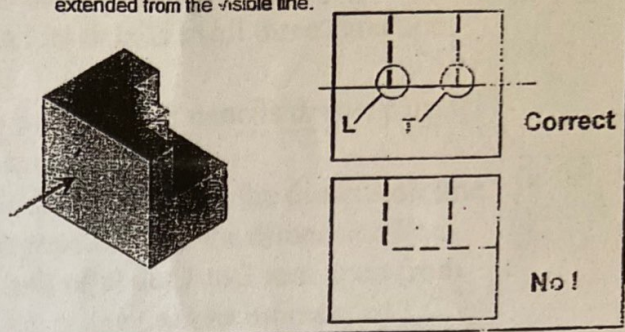
Hidden Line Practice

- Hidden line should join a visible line, except it extended from the visible line.



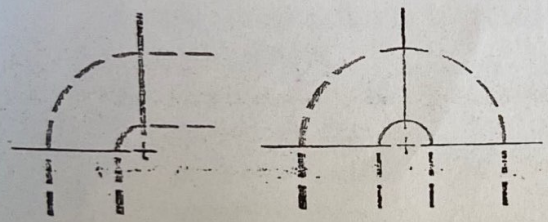
Hidden Line Practice

- Hidden line should join a visible line, except it extended from the visible line.



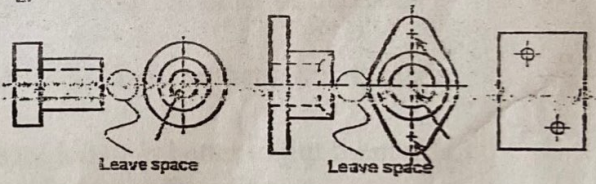
Hidden Line Practice

- Hidden arcs should start on a center line.



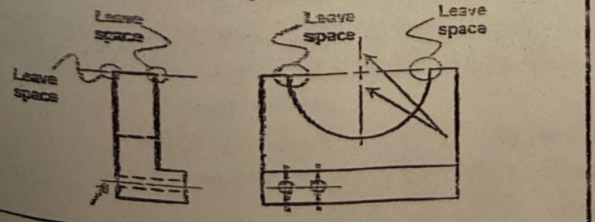
Center Line Practice

- In circular view, short dash should cross at the intersections of center line.
- For small hole, center line is presented as thin continuous line.
- Center line should not extend between views.



Center Line Practice

- Leave the gap when centerline forms a continuation with a visible or hidden line
- Center line should always start and end with long dash.



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Dimensioning

Drawings should be drawn to scale, but direct measurements from the drawing is not recommended, and instead all required dimensions must be exactly given. The dimensions for a geometric shape should identify all its details in all three directions. A dimension consists of:

5. Dimension line : Thin line drawn by 2H or 4H pencils drawn parallel to the line for which a dimension is required
6. Extension lines: Light lines of the same weight as the dimension line. Drawn at the ends, and usually perpendicular to the dimension line. They should not touch the shape, and of about 1 to 2 mm apart from the shape. For dimensions inside the shape (not recommended), extension lines are not required.
7. Arrow heads: Drawn freehand as neatly as possible at the ends of the dimension line. They have 15° head angle (dark, HB pencil)
8. Figures: Numerals written clearly with HB pencil. Written above or in space in the dimension line. They are commonly given in SI units, and they are unitless.

Important notes:

1. Dimension should be put outside the drawing unless it is necessary to add some inside
2. Dimensions that are not needed can be obtained from other dimensions should be discarded
3. A dimension should be shown in the view or direction that gives the true magnitude.
4. Scattering dimension lines should be avoided. It is better to put them all in one or two lines, with organized manner for ease of reading.
5. Dimensions are arranged such that inner dimensions are closest, and outer dimensions are farthest from the shape
6. A dimension line should not intersect with and extension line other than its own line
7. When it is necessary to put a dimension inside a hatched area, a blanked space must be left for the dimension figure.
8. In practical views, extension lines should be drawn in the same plane as the face for which the dimensions are given.
9. Place dimensions on the most descriptive views of an object.
10. Dimension visible features, not hidden features.
11. Don't repeat dimensions.
12. Angular dimensions may be specified in a coordinate form or as an angle and vertex.
13. Fillets and rounds should be dimensioned by specifying their radii with a leader pointing towards their centers.

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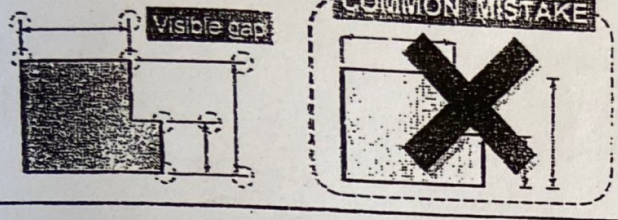
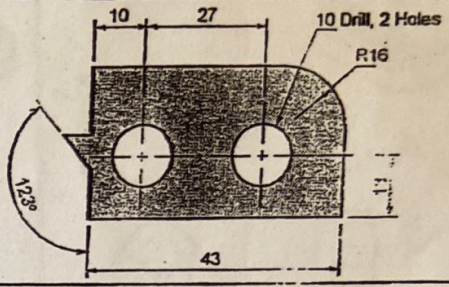
EXTENSION LINES

- Leave a visible gap (= 1 mm) from a view and start drawing an extension line.
- Extend the lines beyond the (last) dimension line 1-2 mm.



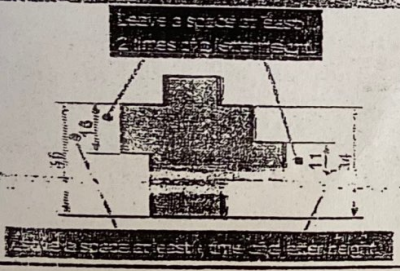
LEADER LINES

Indicate details of the feature with a ... note.



DIMENSION LINES

Dimension lines should not be spaced too close to ... each other and to the ...

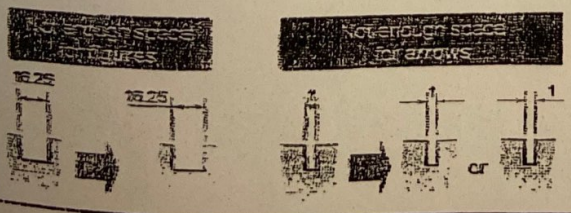


EXTENSION LINES

- Do not break the lines as they cross object lines.

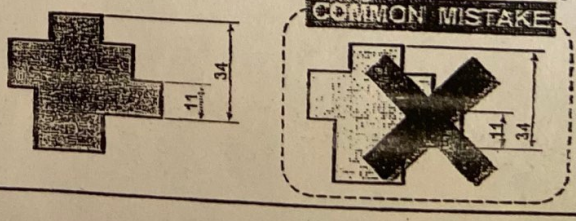
DIMENSION FIGURES

- When there is not enough space for figure or arrows, put it outside either of the extension lines.



DIMENSION FIGURES

- The height of figures is suggested to be 2.5–3 mm.
- Place the numbers at about 1 mm above dimension line and between extension lines.



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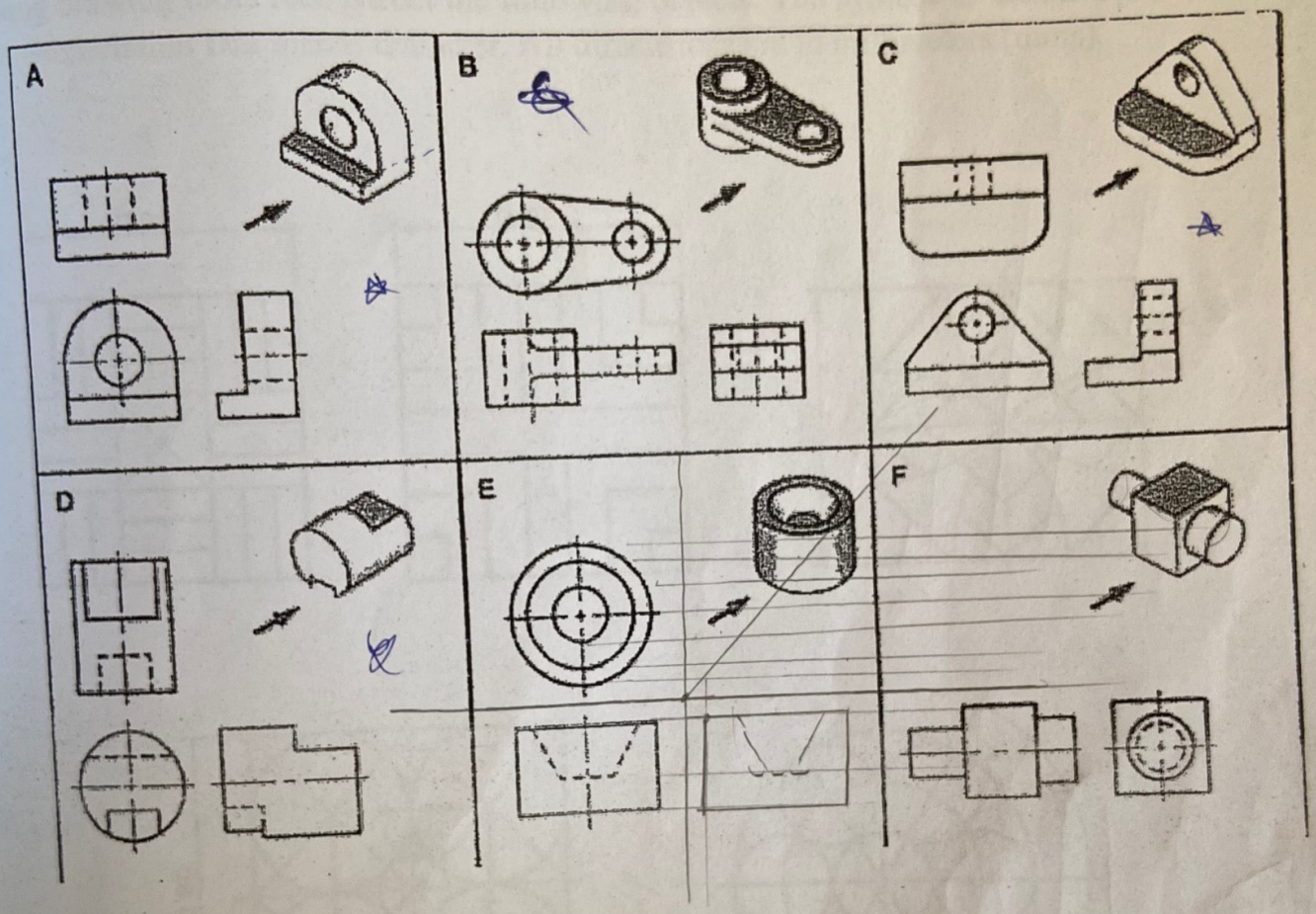
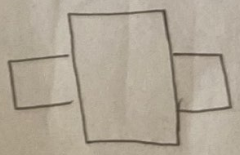
The Hashemite University
Civil Engineering Dept. - Engineering Drawing
Orthographic Projection

[redacted] 2010

Study the following objects and observe the given views (Front, Top, and Right-side).



Question: For objects **E** and **F** only two views are given, why?



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The Hashemite University
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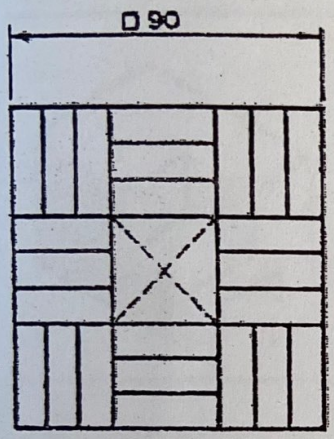
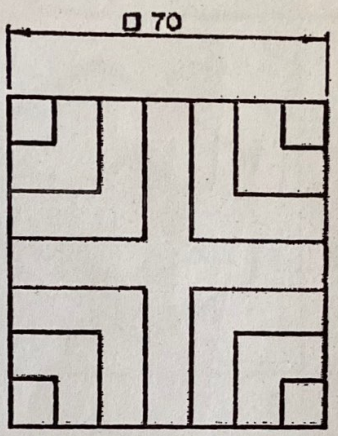
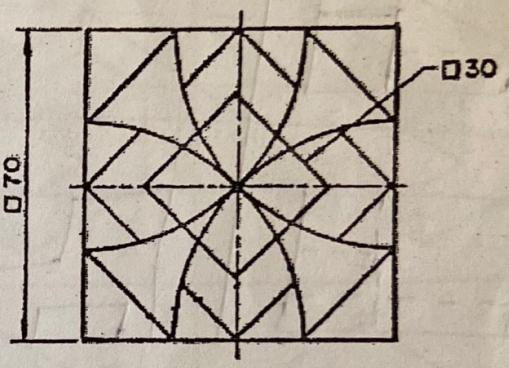
EX # 1: Practicing Tools

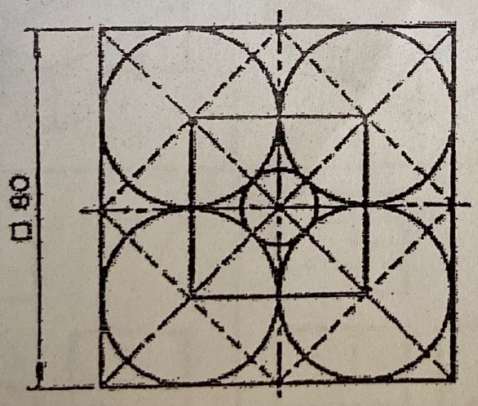
Spring 2010 **Dr. Zeyad Tarawneh**

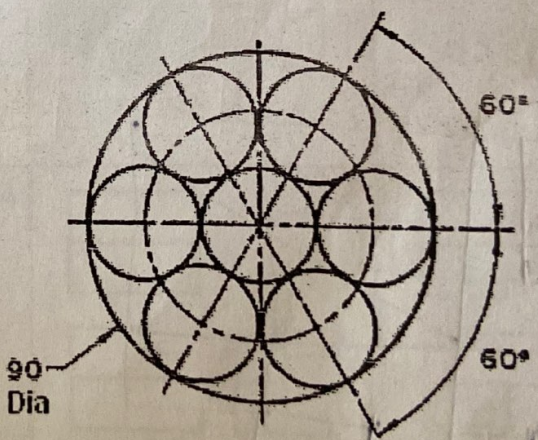
Using drawing tools reconstruct the following objects. The symbol □ means square, and the abbreviation **Dia** means diameter. All dimensions are in millimeters (mms).











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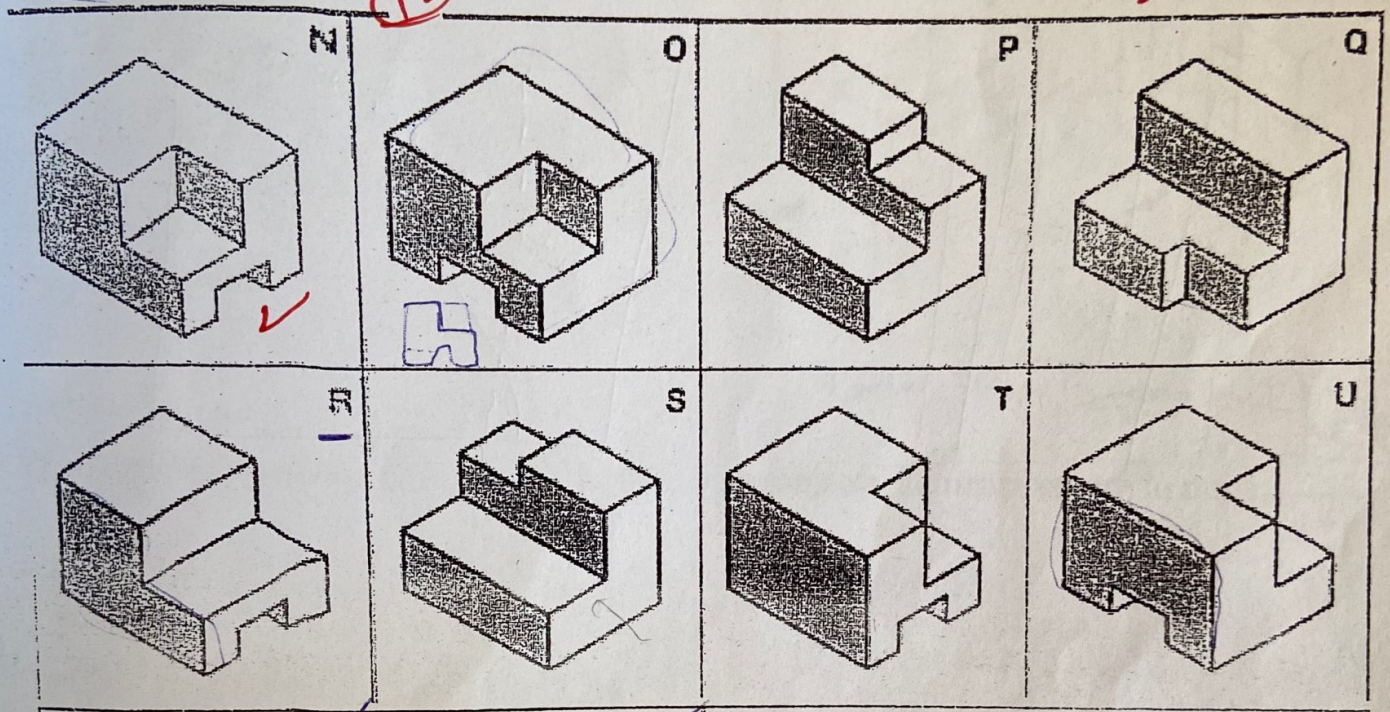
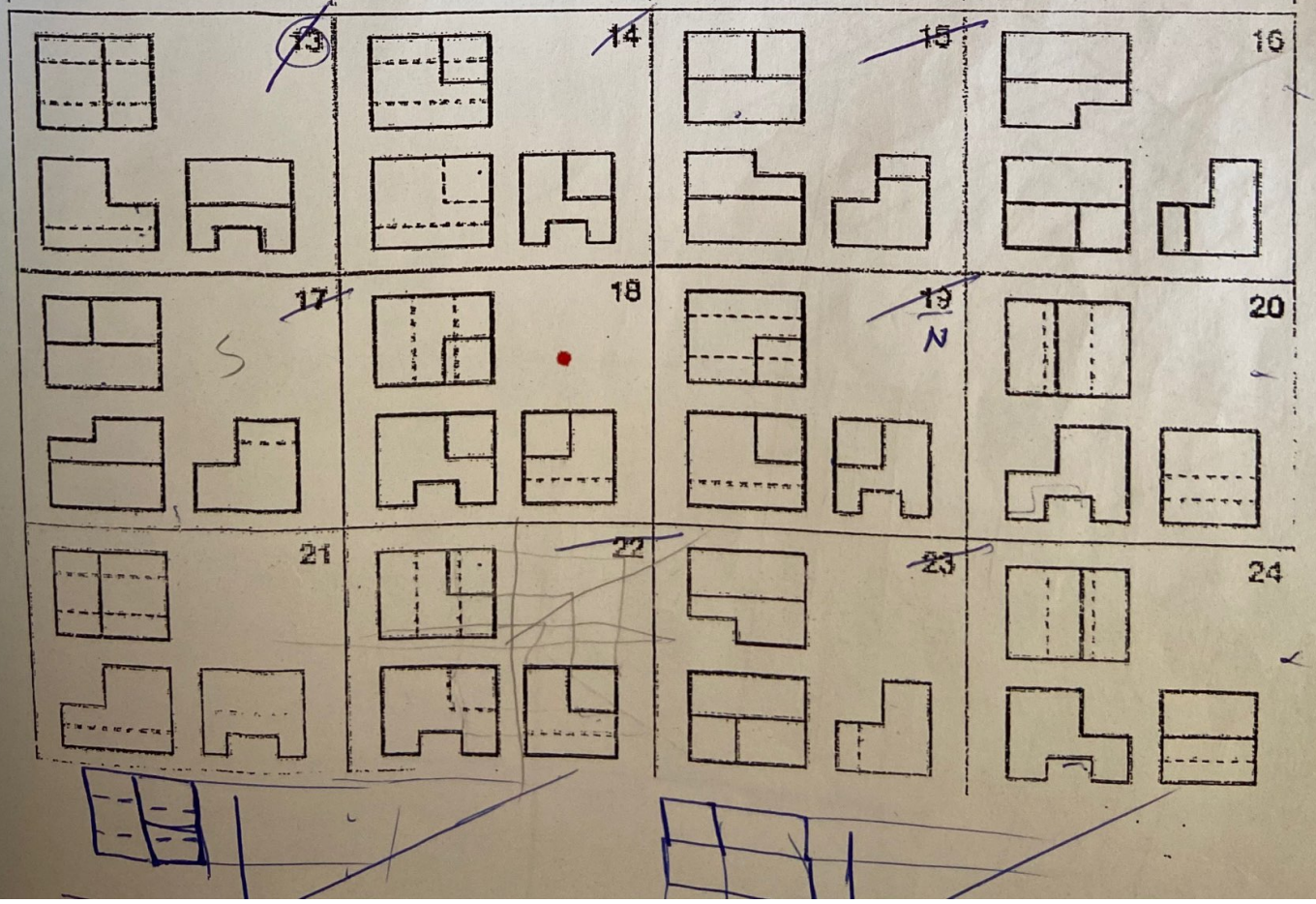
Study the objects (N – U) and match each object with its appropriate views given below (13 – 24). Fill your answer in the following Table.

Object	N	O	P	Q	R	S	T	U
Match #	19	13	15	23	21	17	14	22





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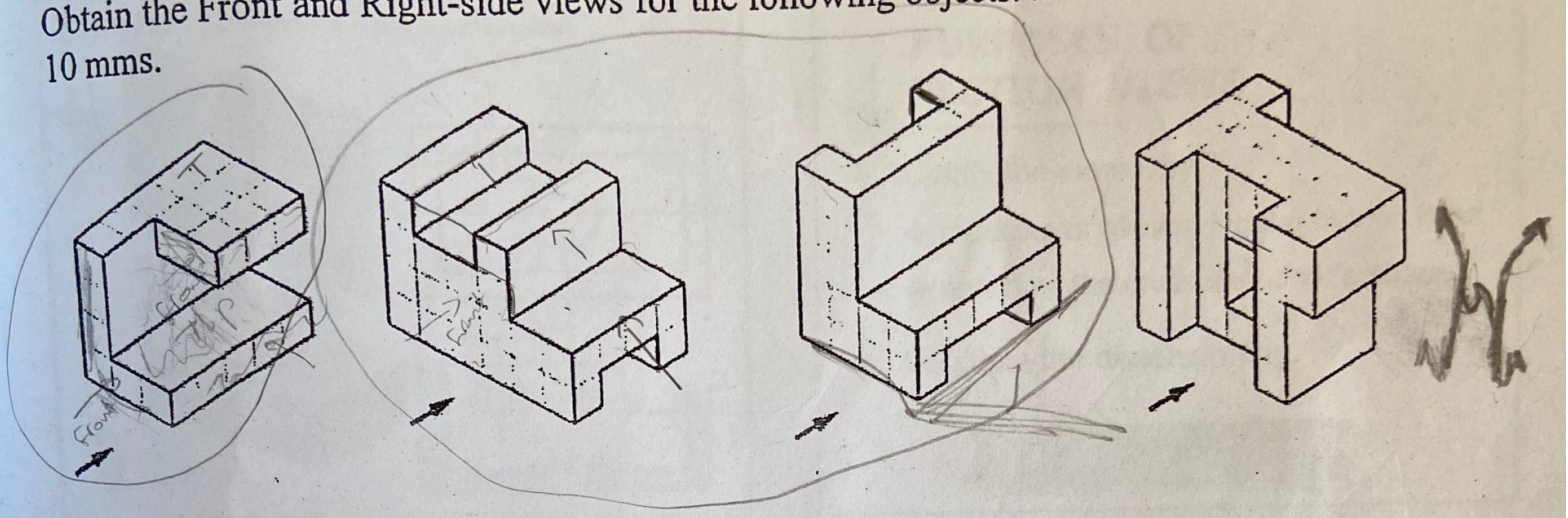
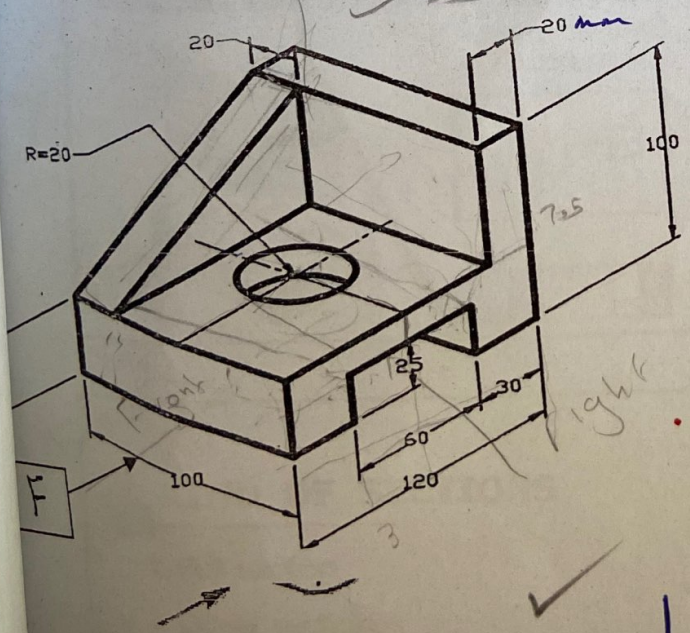
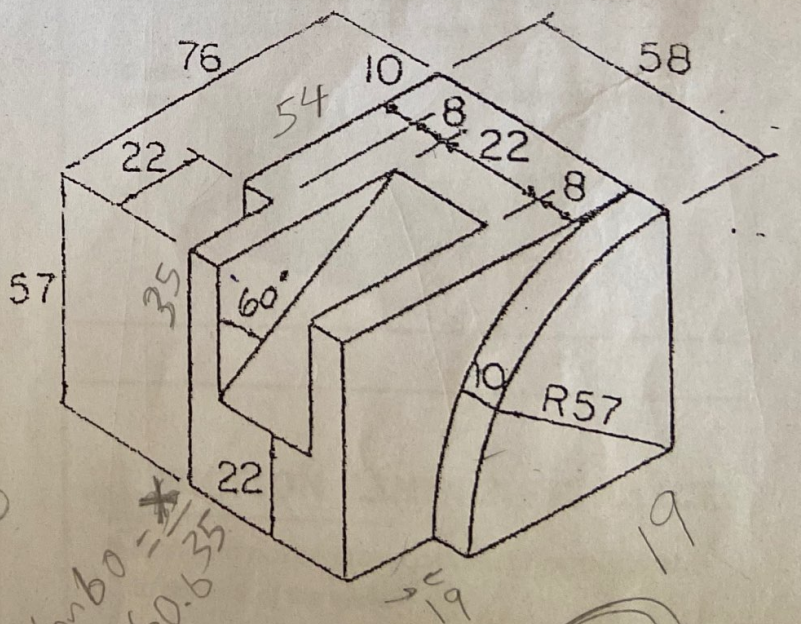
Obtain the Front and Right-side views for the following objects. Each division represents 10 mms.



Obtain the main views (F, R, T) for the following objects. Dimensions are in mms.





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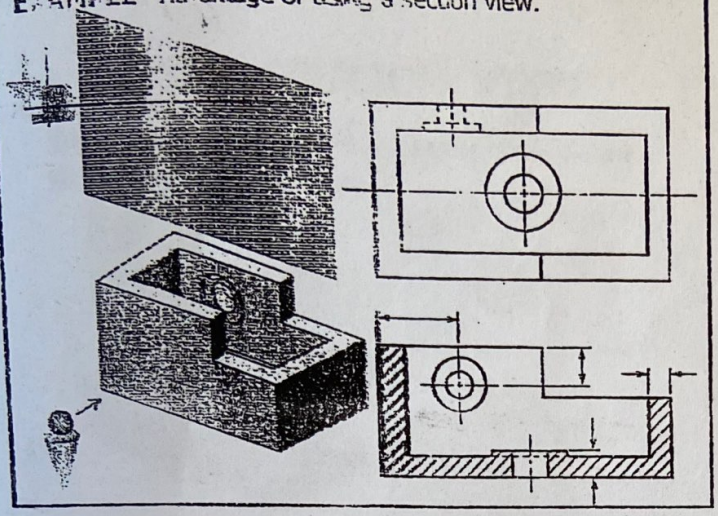
Sections

EXAMPLE : Advantage of using a section view.



PURPOSES OF SECTION VIEWS

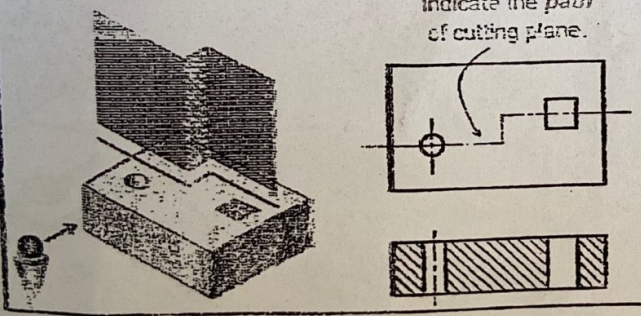
- Clarify the views by
  - reducing or eliminating the hidden lines.
  - revealing the cross sectional's shape.
- Facilitate the dimensioning.

Let See the example

CUTTING PLANE LINE

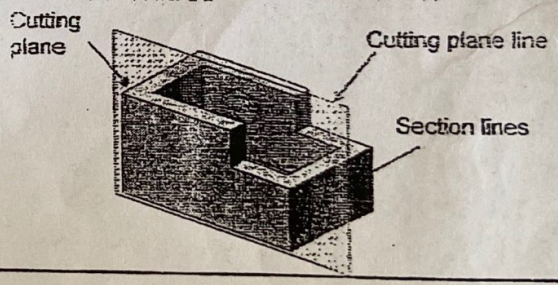
Cutting plane line is an edge view of the cutting plane.

Indicate the *path* of cutting plane.



CUTTING PLANE

Cutting plane is a plane that *imaginarily* cuts the object to reveal the internal features.

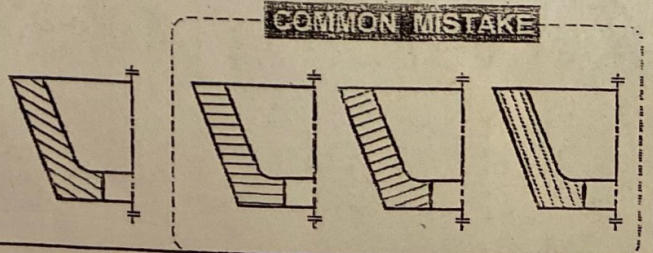


KIND OF SECTIONS

1. Full section
2. Offset section
3. Half section
4. Broken-out section
5. Revolved section (aligned section)
6. Removed section (detailed section)

SECTION LINING PRACTICE

- It *should not* be drawn *parallel* or *perpendicular* to contour of the view.



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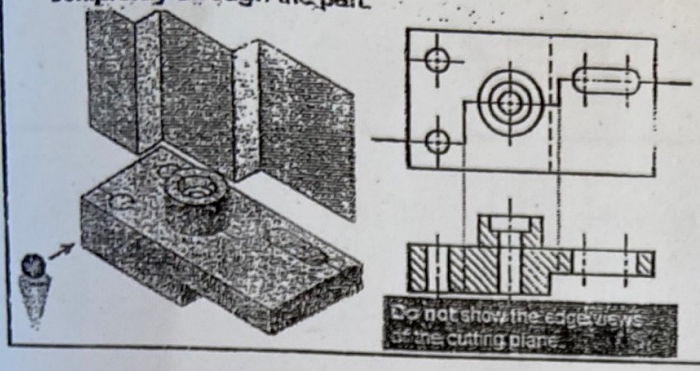
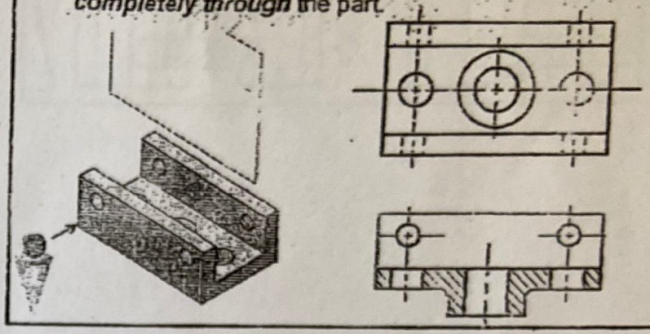
OFFSET SECTION VIEW

The view is made by passing the *bended* cutting plane *completely through* the part.



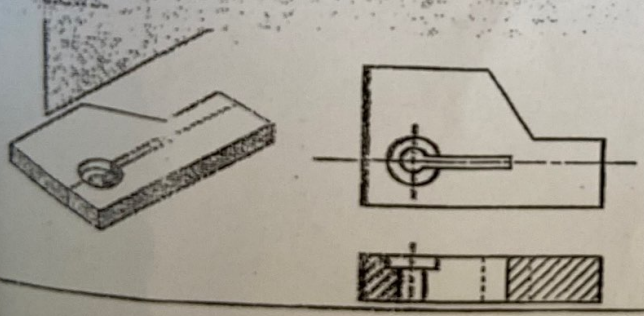
FULL SECTION VIEW

The view is made by passing the *straight* cutting plane *completely through* the part.



TREATMENT OF HIDDEN LINES

- Hidden lines are *normally omitted* from section



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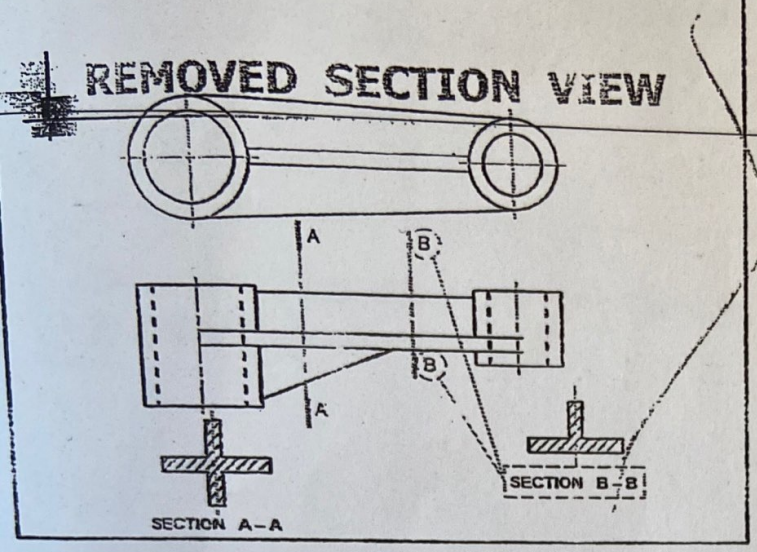
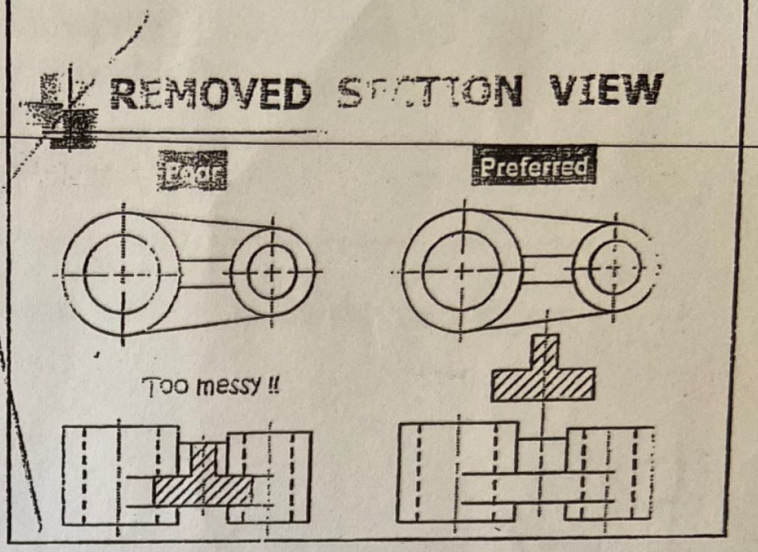
REMOVED SECTION VIEW



REMOVED SECTION VIEW



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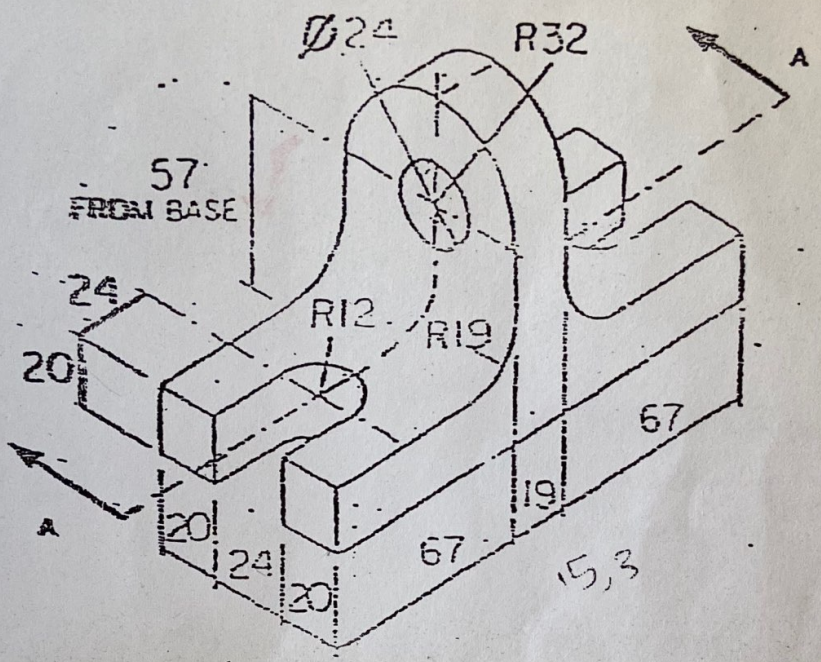
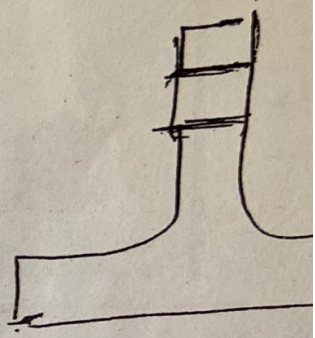
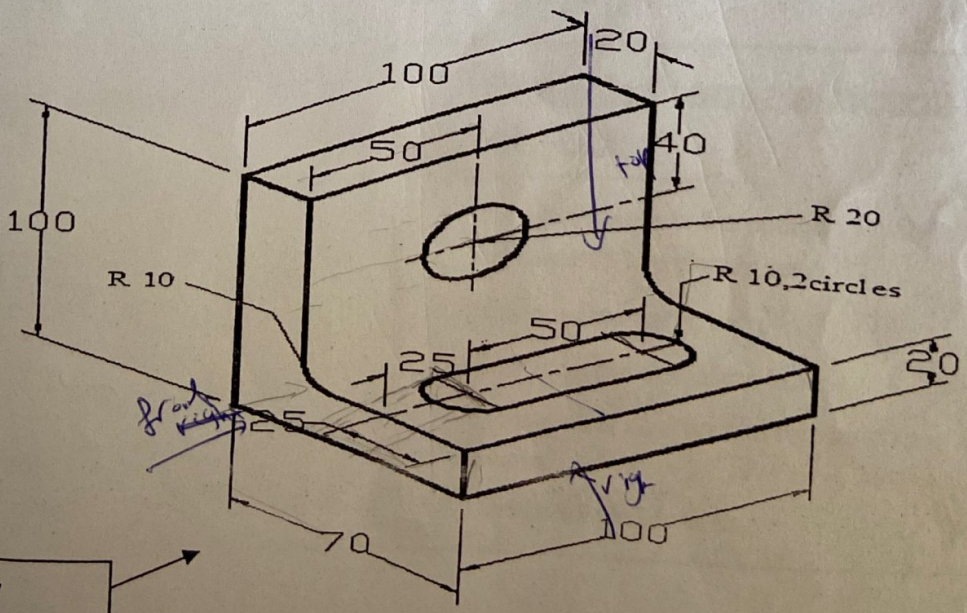
Ex # 6: Sections

Draw the Right-side view and the full sectional view A-A for the next object. Dimensions are in mms.





Draw the Front and the offset sectional view A-A for the next object. Dimensions are in mms.

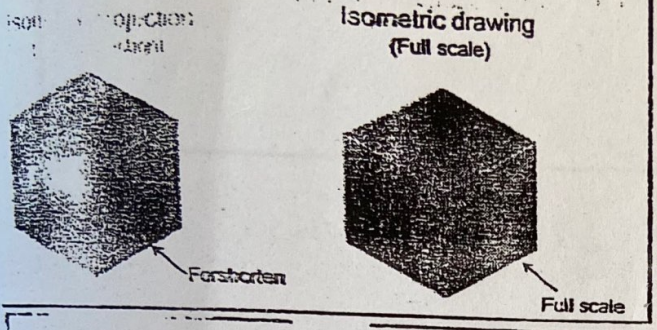


Front view

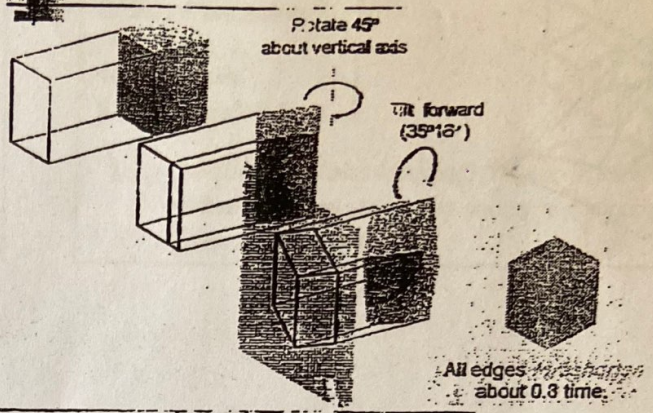
Isometric drawings

Isometric Drawing

Isometric drawing is a drawing drawn on an isometric axes using full scale.

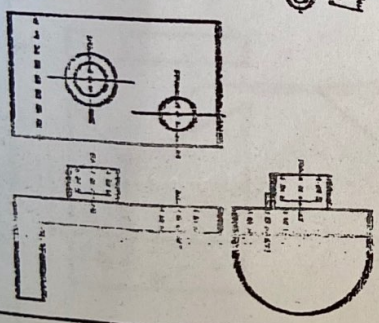


Isometric Projection



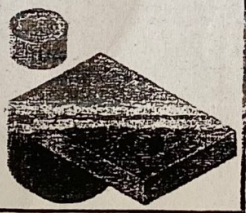
EXAMPLE

Given



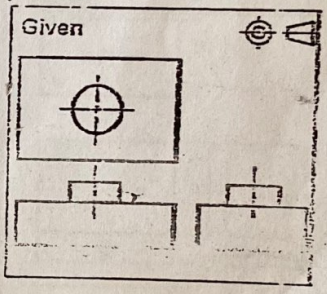
Composition

- Cylinder with a blind hole.
- L-shaped with round end
- Hole



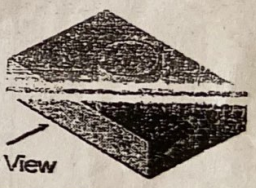
EXAMPLE

Given



Composition

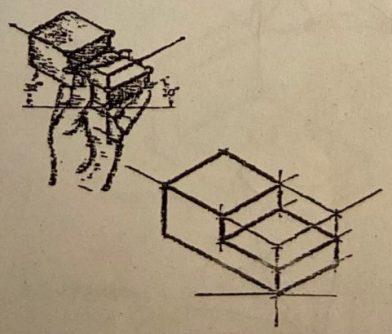
- Rectangular prism
- Cylinder



Sketch from an actual object

STEPS

1. Positioning object.
2. Select isometric axis.
3. Sketch enclosing box.
4. Add details.
5. Darken visible lines.



Sketch from an actual object

1. Place the object in the position which its shape and features are clearly seen.
2. Define an isometric axis.
3. Sketching the enclosing box.
4. Estimate the size an and relationship of each details.
5. Darken all visible lines.

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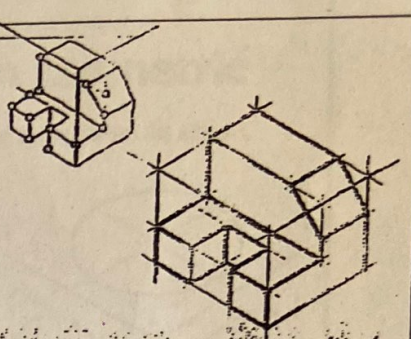
Sketch from multiview drawing

1. Interprete the ***meaning*** *of lines/areas* in multiview drawing.
2. Locate the lines or surfaces relative to isometric axis.

Sketch from an actual object

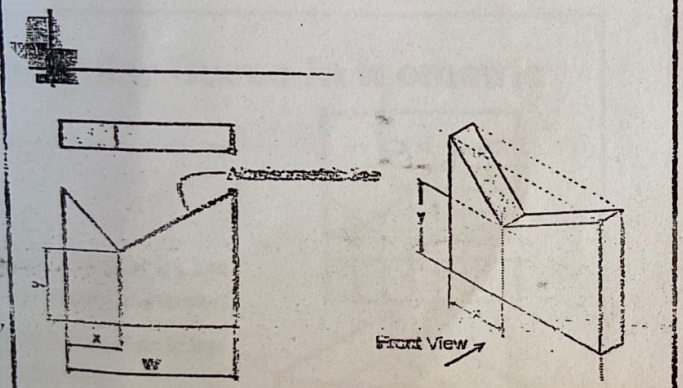
STEPS

1. Positioning object.
2. Select isometric axis.
3. Sketch enclosing box.
4. Add details.
5. Darken visible lines.

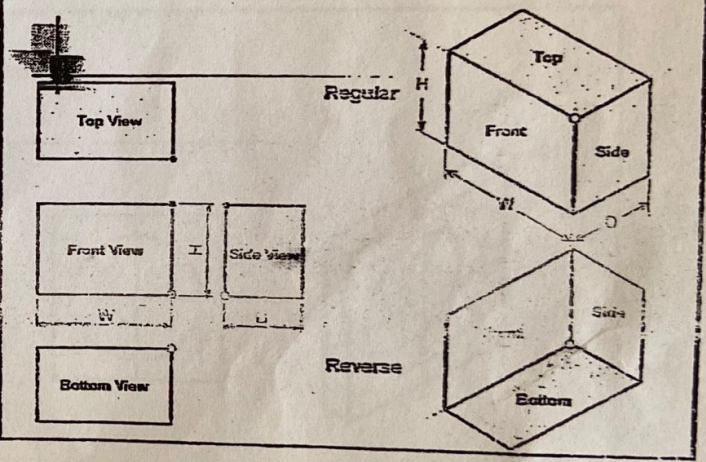


Note In isometric sketch/drawing), hidden lines are *omitted* unless they are absolutely necessary to completely describe the object.

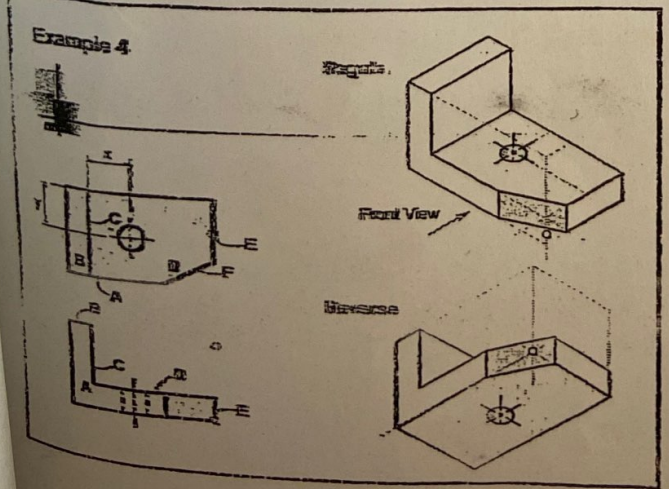
Example 2 : Object has inclined surfaces



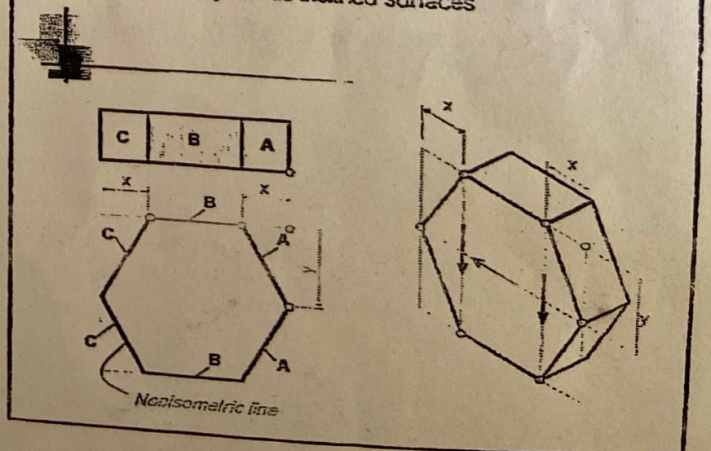
Example 1 : Object has only normal surfaces



Example 4



Example 3 : Object has inclined surfaces



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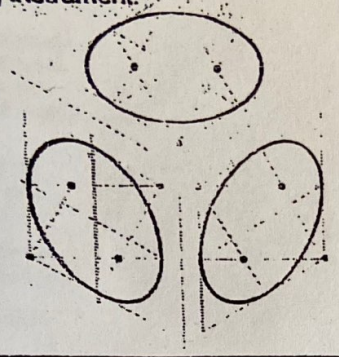
Circle & Arc in Isometric

Four-center method is usually used when drawn an isometric ellipse with drawing instrument.

Sketching Steps

1. Locate the center of an ellipse.
2. Construct an isometric square.
3. Construct a perpendicular bisector from each tangent point.
4. Locate the four centers.
5. Draw the arcs with these centers and tangent to isometric square.

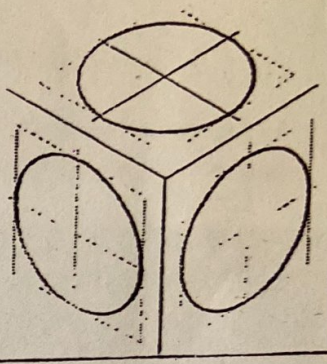


Circle & Arc in Isometric

In isometric drawing, a circle appears as an ellipse.

Sketching Steps

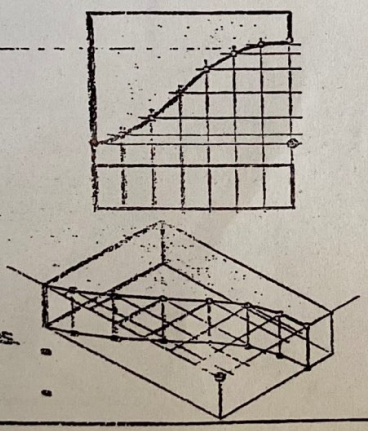
1. Locate the center of an ellipse.
2. Construct an isometric square.
3. Sketch arcs that connect the tangent points.



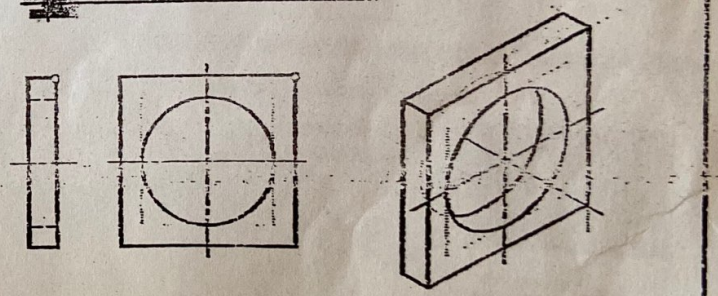
Irregular Curve in Isometric

ps

- Construct points along the curve in multiview drawing.
- Locate these points in the isometric view.
- Sketch the connecting lines.



Example 5



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Missing views

Object Representation

Back in the 18th century a French mathematician and engineer, Gaspard Monge (1746-1818), developed a system, using two planes of projection at right angles to each other, for graphical description of solid objects.

Monge's Descriptive Geometry forms the basis of what is now called Orthographic Projection

The word orthographic means to draw at right angles and is derived from the Greek words:
ORTHOS = right, rectangular, upright
GRAPHOS = written, drawn

Analysis by Surfaces

Reading Steps

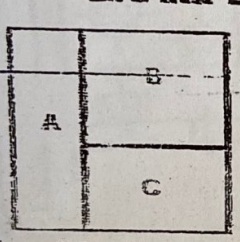
1. Orient yourself with the views given

2. Read the individual set of lines or surface that appeared in each view and related to each other.

An understanding in orthographic projection, i.e. **meaning of lines and surfaces** are almost important.

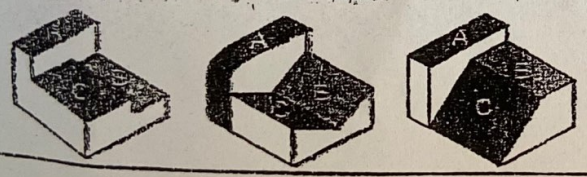
EXAMPLE

Top view



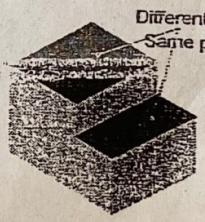
All surfaces A, B and C are **not** in the same plane

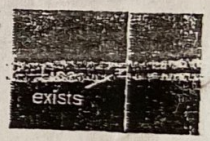
Some of possible objects' shape



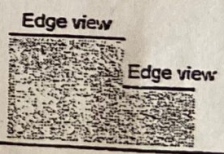
GUIDANCE 1

- Adjacent areas that are not in the same plane must be separated by lines.



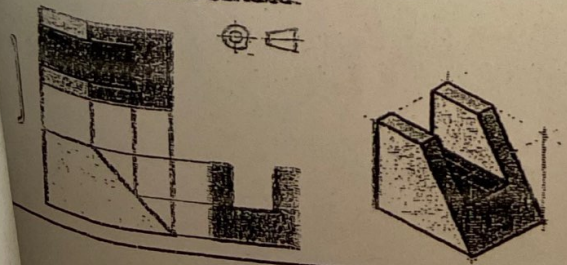


Edge view



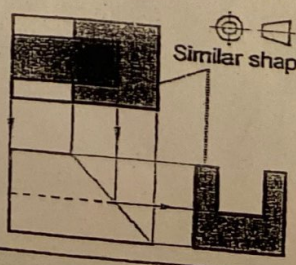
GUIDANCE 2

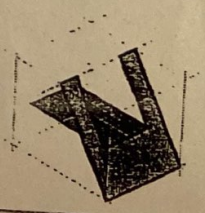
- Areas that show a similar shape in more than one view is the same surface.



GUIDANCE 2

- Areas that show a similar shape in more than one view is the same surface.





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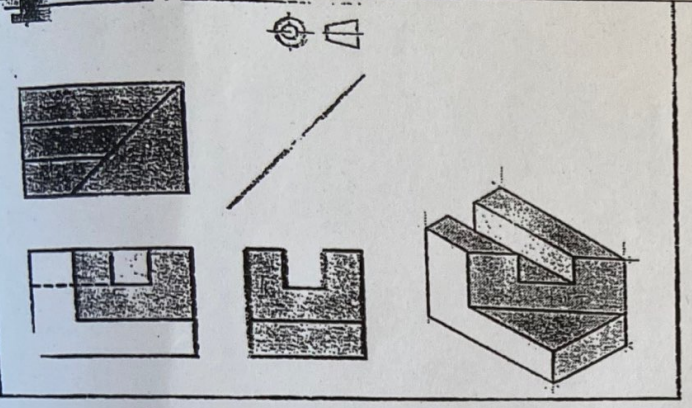
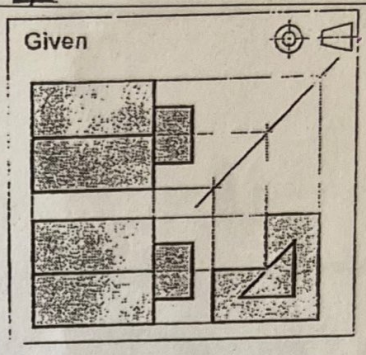
EXAMPLE



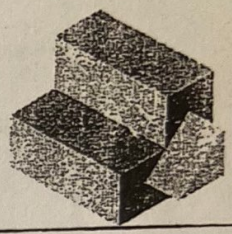
EXAMPLE

Given

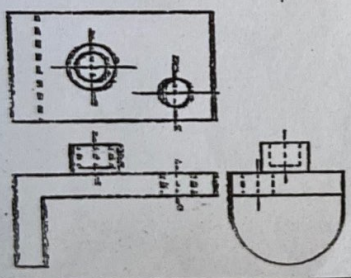


Composition

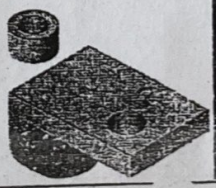
- Wedge
- L-shaped block



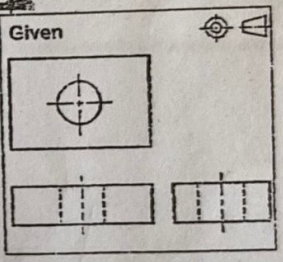
Given



- Cylinder with a blind hole.
- L-shaped with round end
- Hole

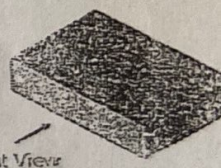


Given



Composition

- Rectangular prism
- Hole



Front View

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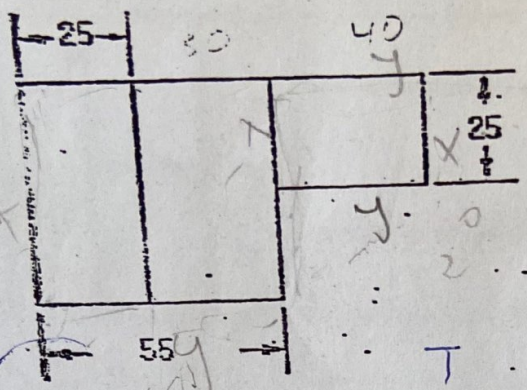
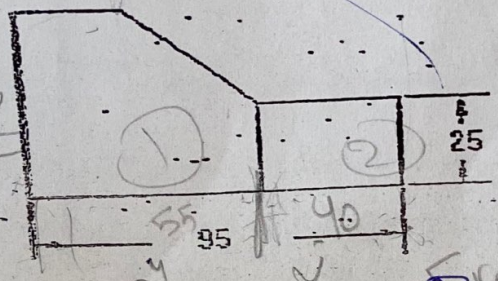
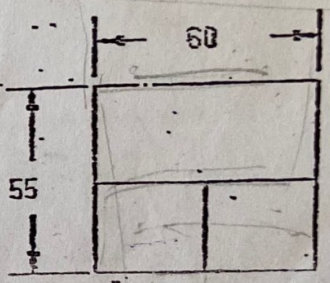
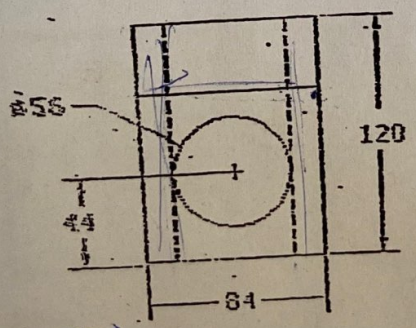
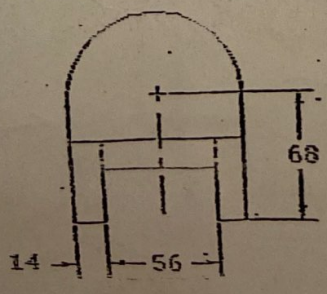
Given the f..lowing views, draw the 30° isometric objects. Dimensions are in mms.

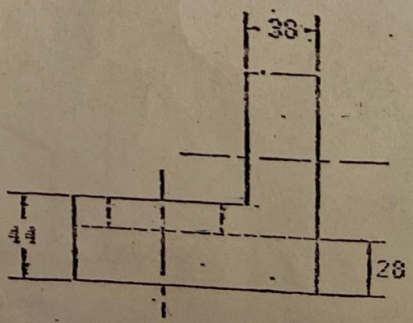












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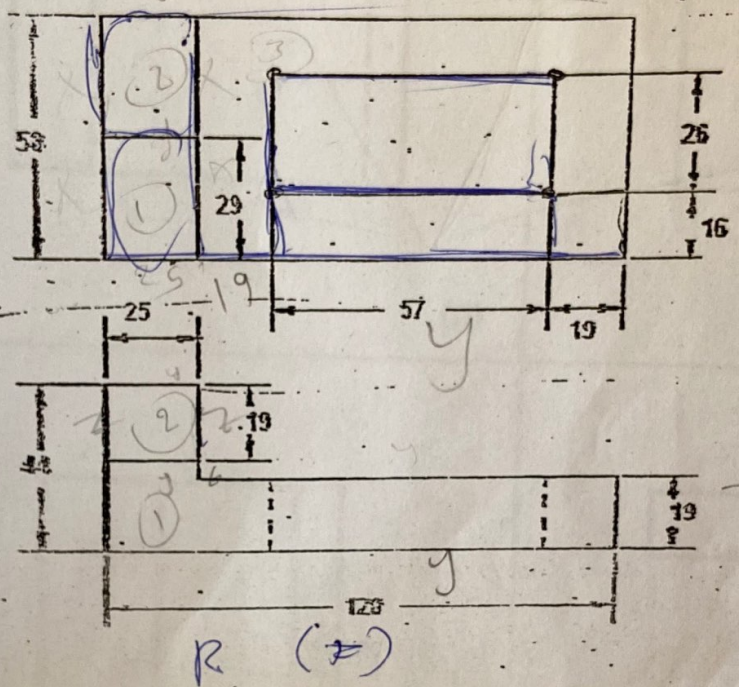
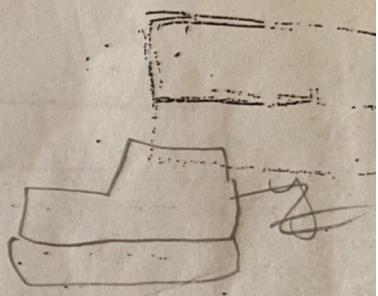
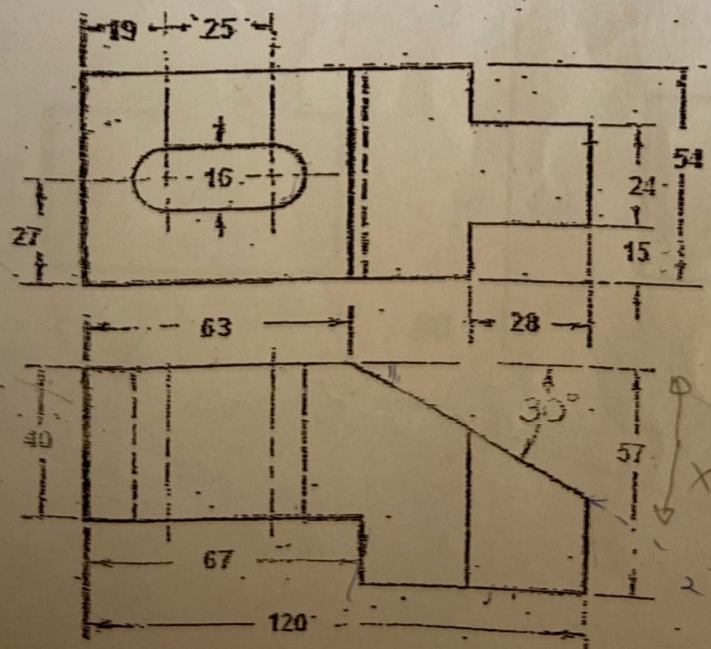
Civil Engineering Dept. - Engineering Drawing
Ex # 8: Missed View & Isometric Drawings

For the given views, obtain the missed view and place necessary dimensions. Dimensions are in mms.







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