ENGINEERING DRAWING

LECTURE 3

GEOMETRIC CONSTRUCTION:
POLYGONS AND TANGENCY

TOPICS/SCHEDULE

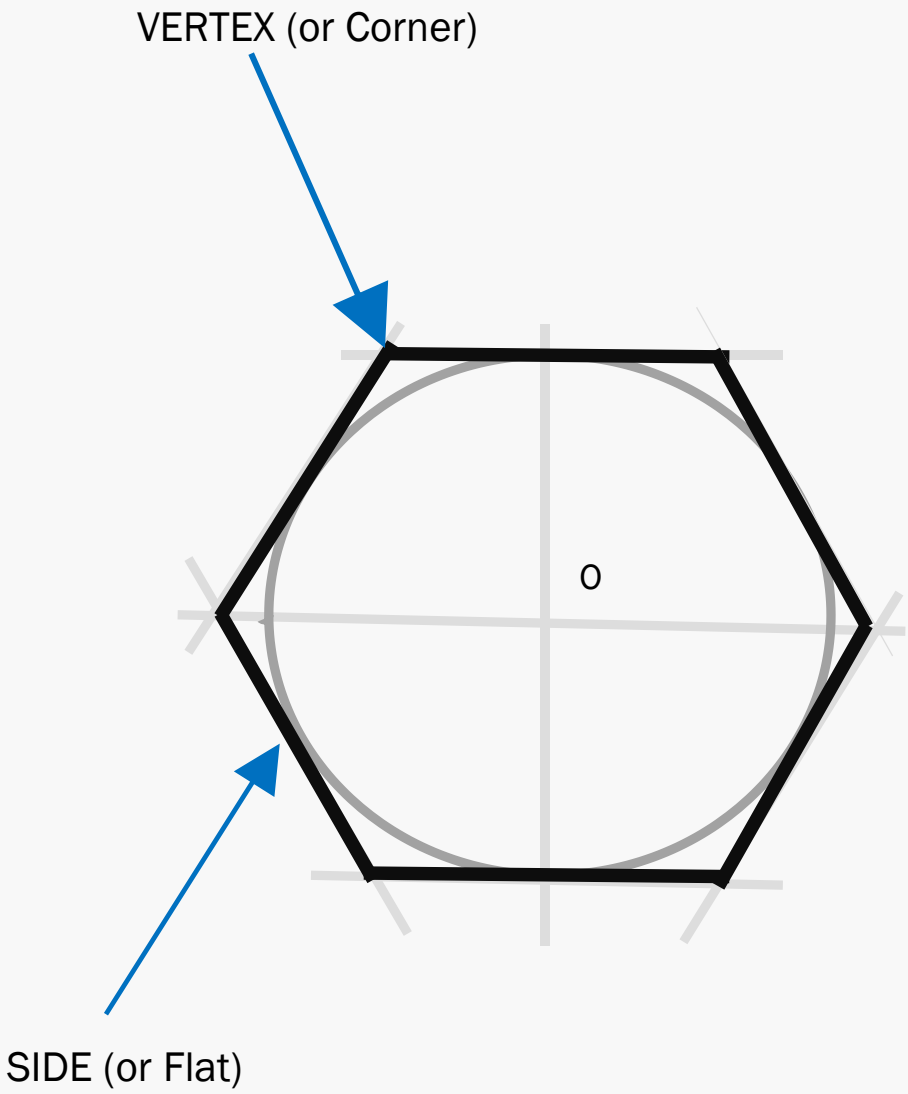
Introduction
Introduction to drawing instruments and their proper use
Use of scales, line work, lettering
Dimensioning
Polygons, Tangency, Loci: paths of points of simple mechanism
Loci: Cam profile, ellipse, hyperbola, parabola, involute, cycloids
Orthographic projection in 1st and 3rd Angle
Isometric projection and oblique projection
Isometric projections from orthographic projection

Polygons

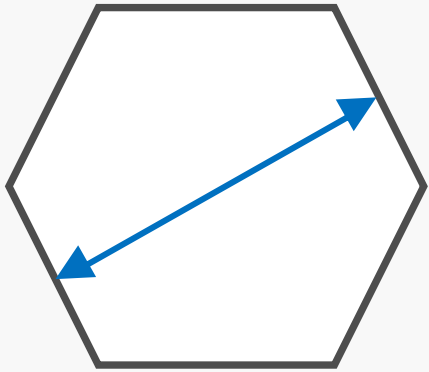
1. Plane figures bounded by a finite chain of straight line segments closing in a loop to form a closed chain or circuit.

2. Segments are called its **edges or sides**.

3. Points where two edges meet are the polygon's **vertices or corners**.



REGULAR HEXAGON:
Given The Distance Across Flats



1. Draw a circle of diameter equal to the given distance.

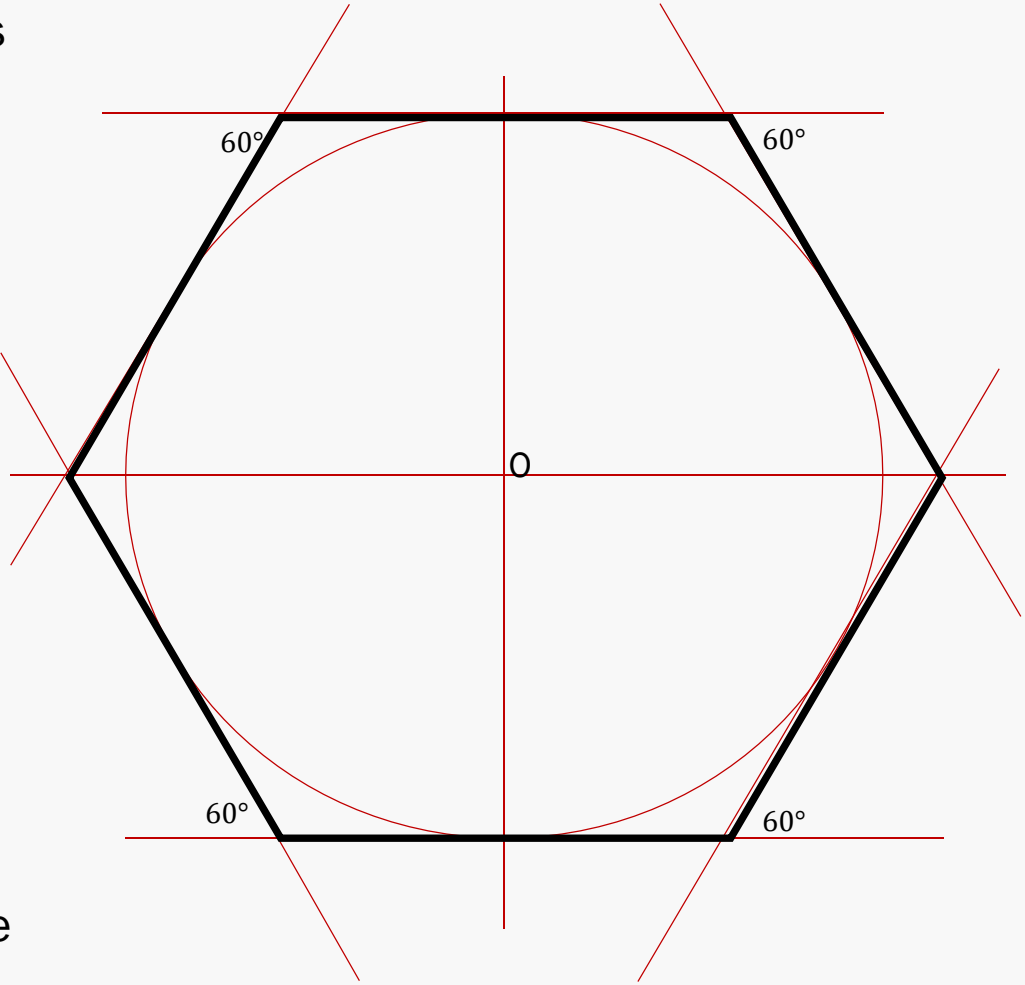
2. Draw vertical and horizontal lines across the diameter.

3. With the Tee-square, draw tangents to the circle at the top and below the circle.

4. With the 60^0 set square correctly placed on the Tee-square draw tangents to the circles.

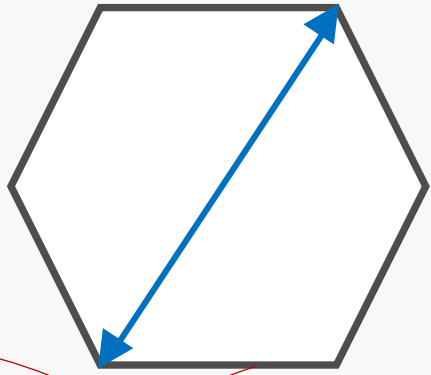
5. Join the tangents, as required, to produce the given hexagon

Note: A regular octagon can be produced with the procedures above using 45^0 set squares.

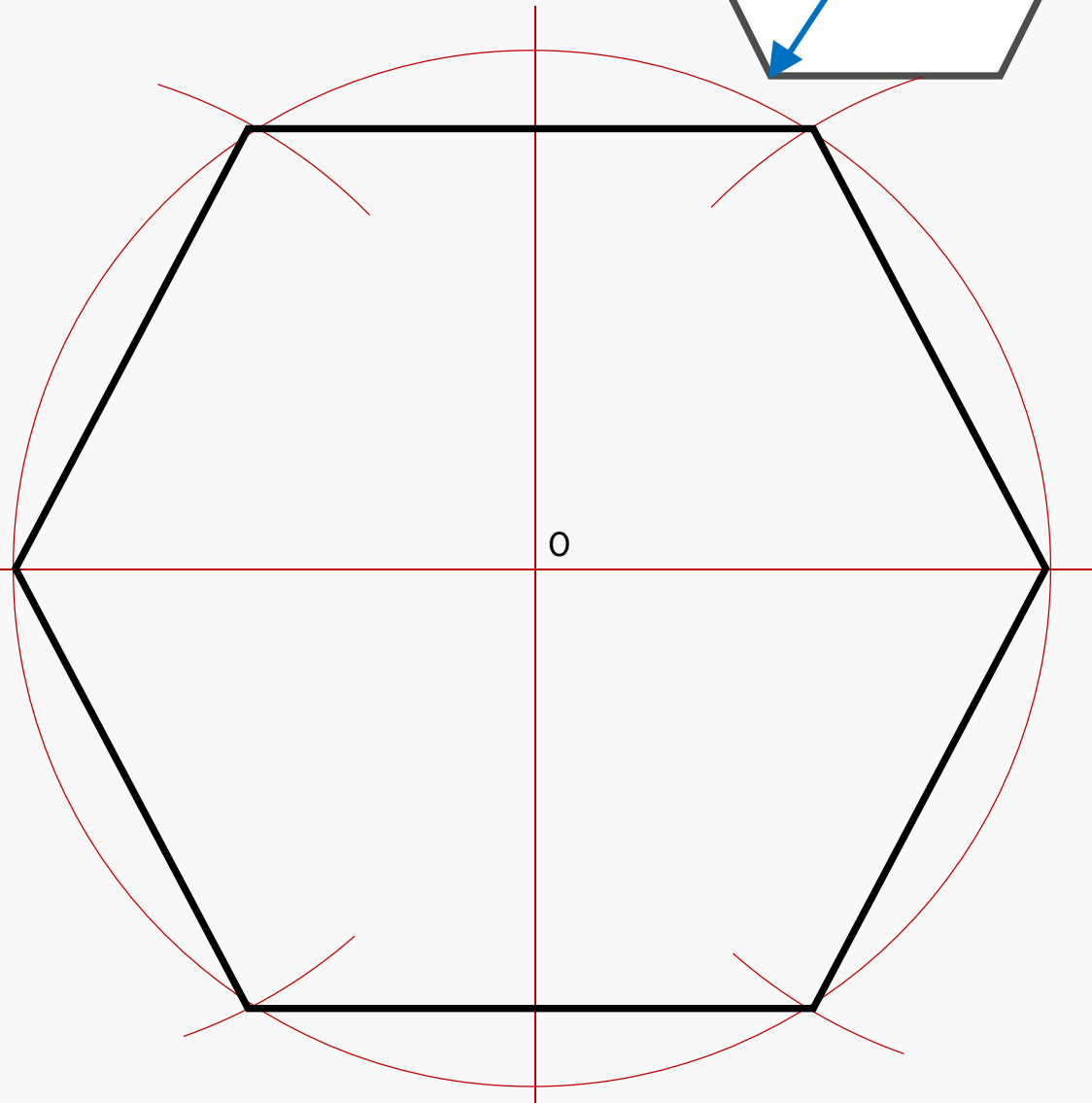


REGULAR HEXAGON:

Given the Distance Across Corners

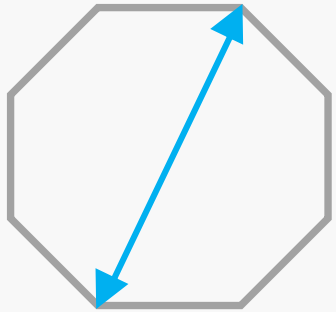


1. Draw a circle of diameter equal to the given distance.
2. Draw vertical and horizontal lines across the diameter to intercept at ***O.***
3. Using the ends of the horizontal line as starting point step off the radius of the circle round it.
4. Join the points to produce the hexagon.

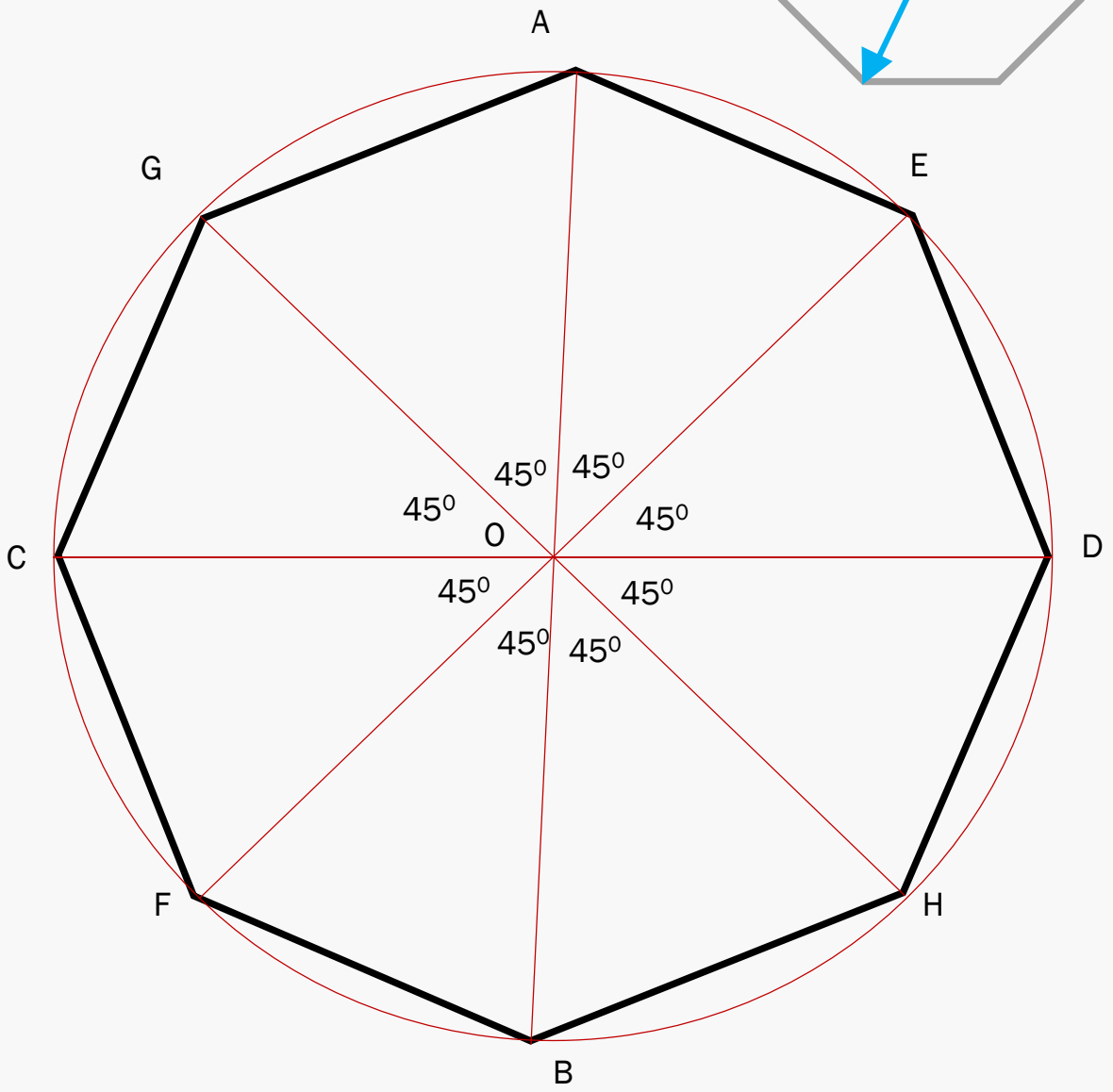


REGULAR OCTAGON:

Given the Distance Across Corners

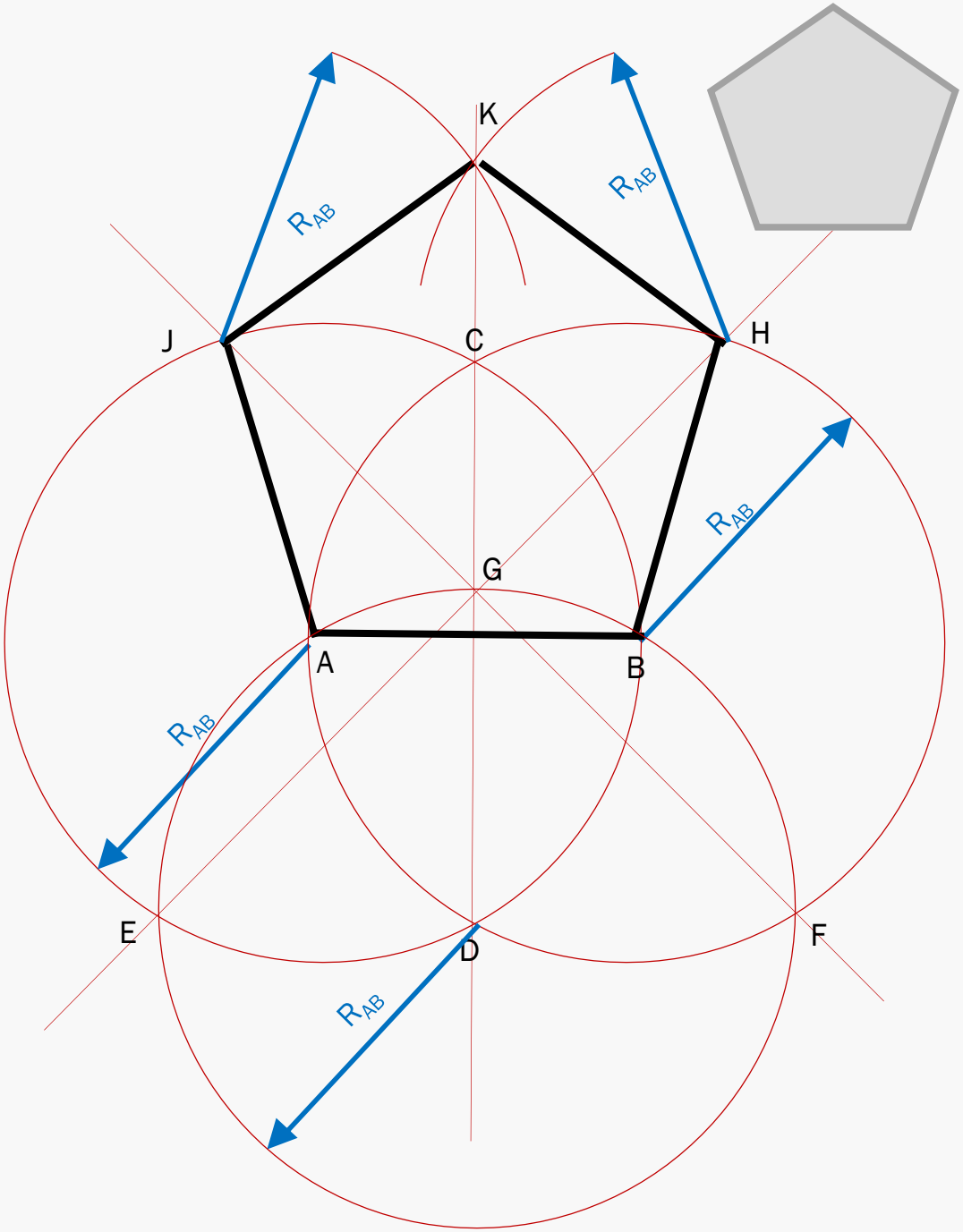


1. Draw a circle of diameter equal to the given distance
2. Draw vertical and horizontal lines through centre O to intercept the circle at A, B, C & D.
3. With the ***45⁰*** set square, draw two cross lines through centre O to intersect the circle at E, F, G & H.
4. Join all the interceptions to obtain the octagon (**A-E-D-H-B-F-C-G-A**)



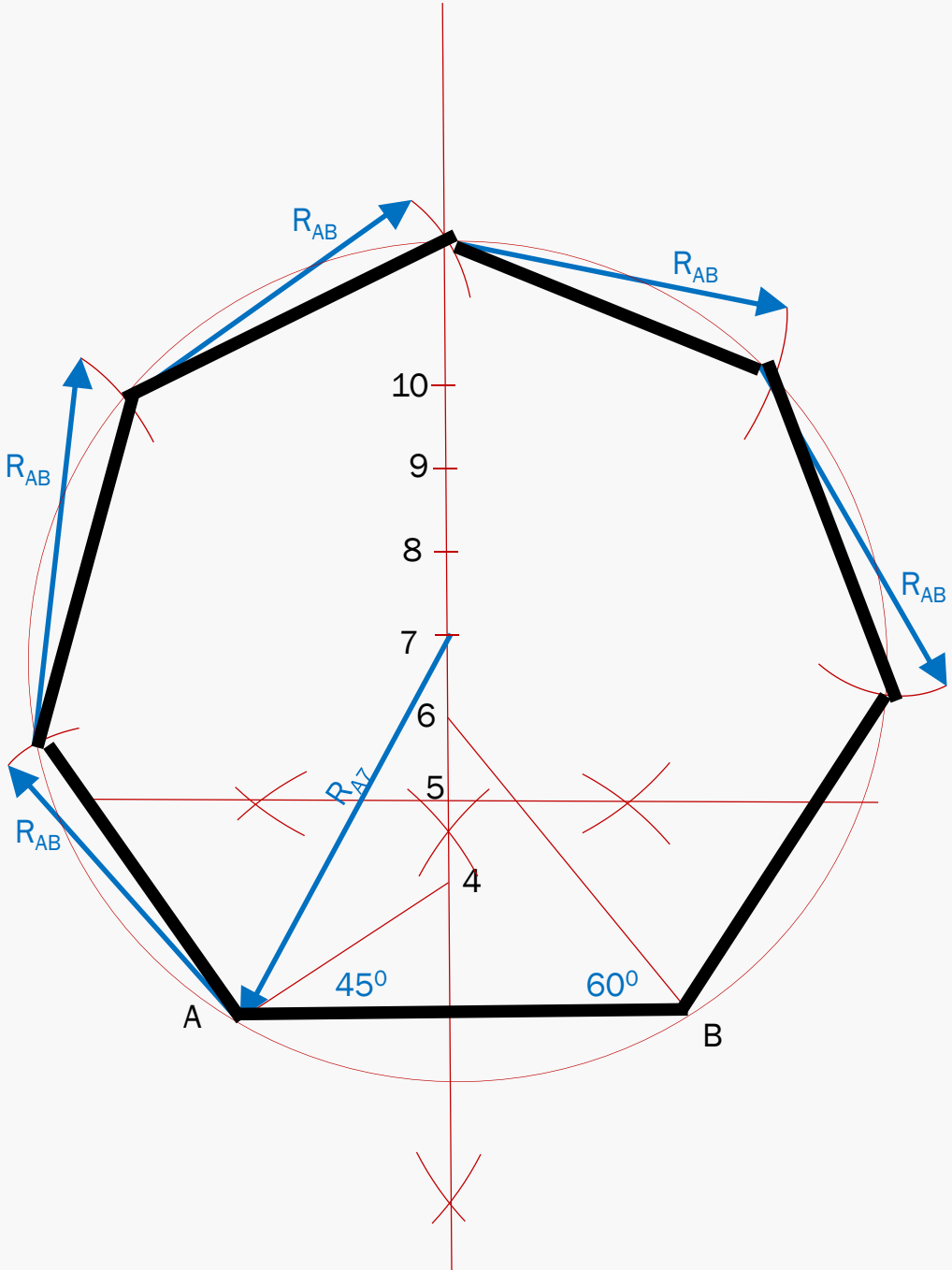
REGULAR PENTAGON

1. Draw the given line ***AB***
2. With A as centre draw a circle of radius ***AB***
3. With B as centre draw a circle of radius ***AB*** to intersect the previous circle at ***C*** and ***D***
4. Draw a line through ***C*** and ***D***
5. With centre ***D*** draw a circle of radius ***AB*** to intersect the previous circles at ***E*** and ***F*** and line ***CD*** at ***G***
6. Draw a line through ***E*** and ***G*** to intersect the second circle at ***H***
7. Draw a line through ***F*** and ***G*** to intersect the first circle at ***J***
8. With centres ***H*** and ***J*** and radius ***AB***, draw arcs to meet at ***K***
9. Join points ***AJKHB*** to complete the pentagon



REGULAR POLYGONS

1. Draw the given side ***AB*** and bisect
2. Draw a line through ***A*** inclined at ***45⁰*** using ***45⁰*** set square to intersect the bisection line at *4*
3. Draw a line through ***B*** inclined at ***60⁰*** using ***60⁰*** set square to intersect the bisection line at ***6***
4. Bisect ***4*** and ***6*** to obtain ***5***
5. Step off arcs ***4-5*** starting from ***6*** to produce ***7, 8, 9, …, n***
6. To draw a **heptagon**, use point ***7*** as centre to draw a circle passing through ***A*** and ***B***
7. Starting from ***A***, step off arcs on the circle with radius ***AB***
8. Join the intersections together to complete a regular heptagon



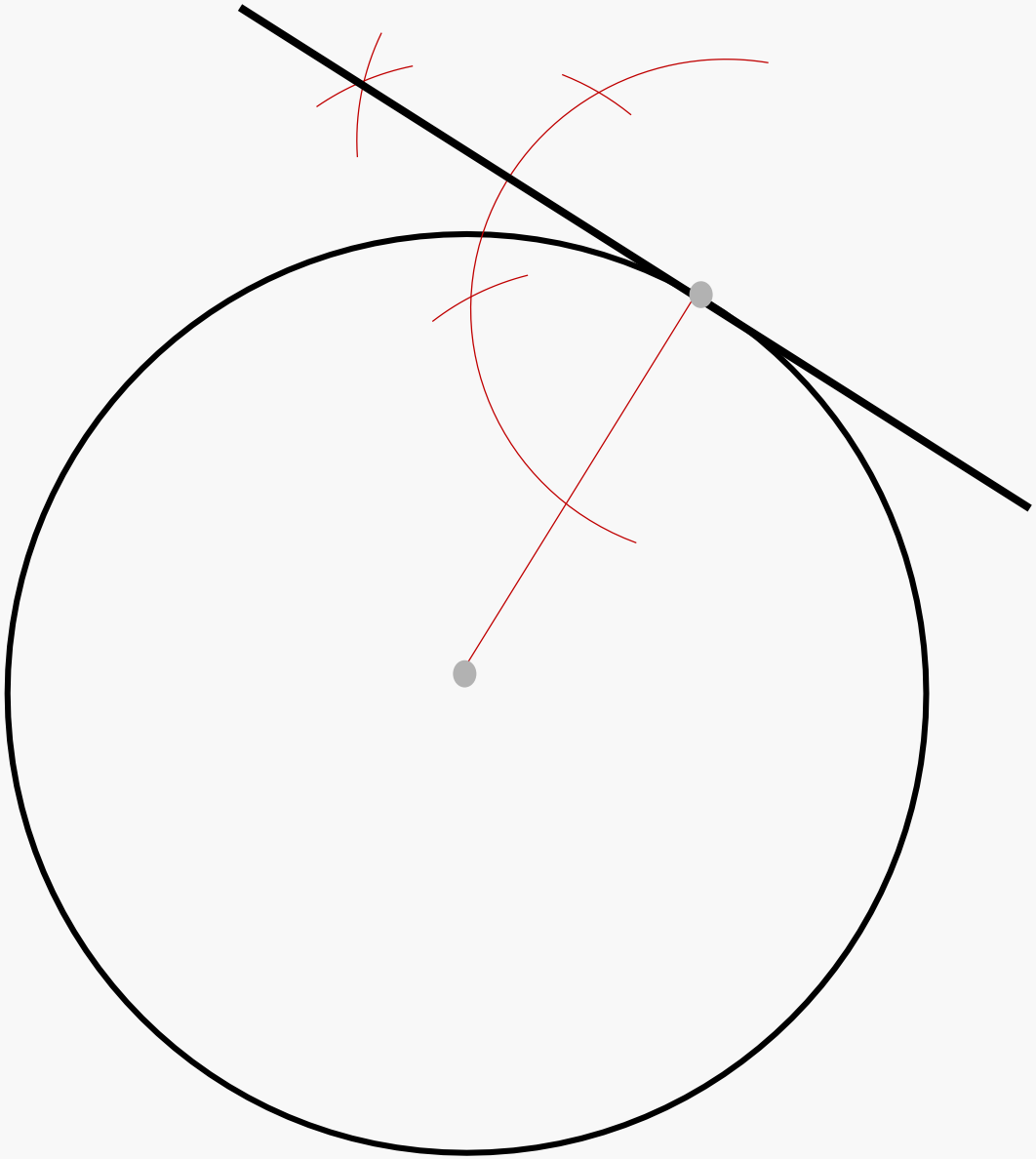
PRINCIPLES OF TANGENCY

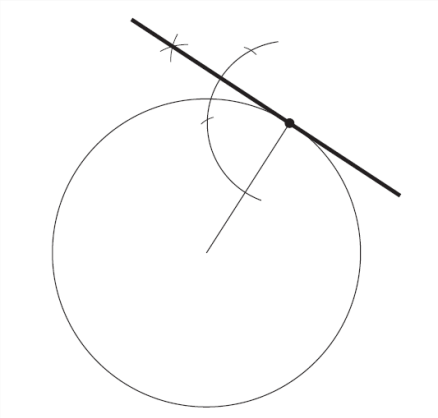
WHAT IS A TANGENT?

- A tangent to a curve is a straight line that touches the circle at only one point.
- A tangent is perpendicular to the radius of a circle drawn at the point where the tangent meets the circle.
- Tangents can be drawn to meet any curve *(recall when you found slope/gradient of quadratic/polynomial curve at a given point).*
- Tangents are common in engineering drawing.

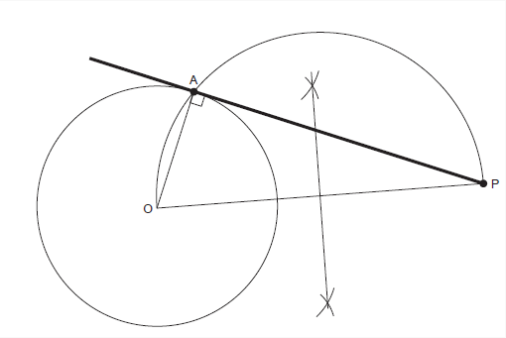
To Draw Tangent to a Circle from any Point on the Circumference

1. Draw the radius of the circle.
2. Construct an angle 90° from the point where the radius crosses the circumference.

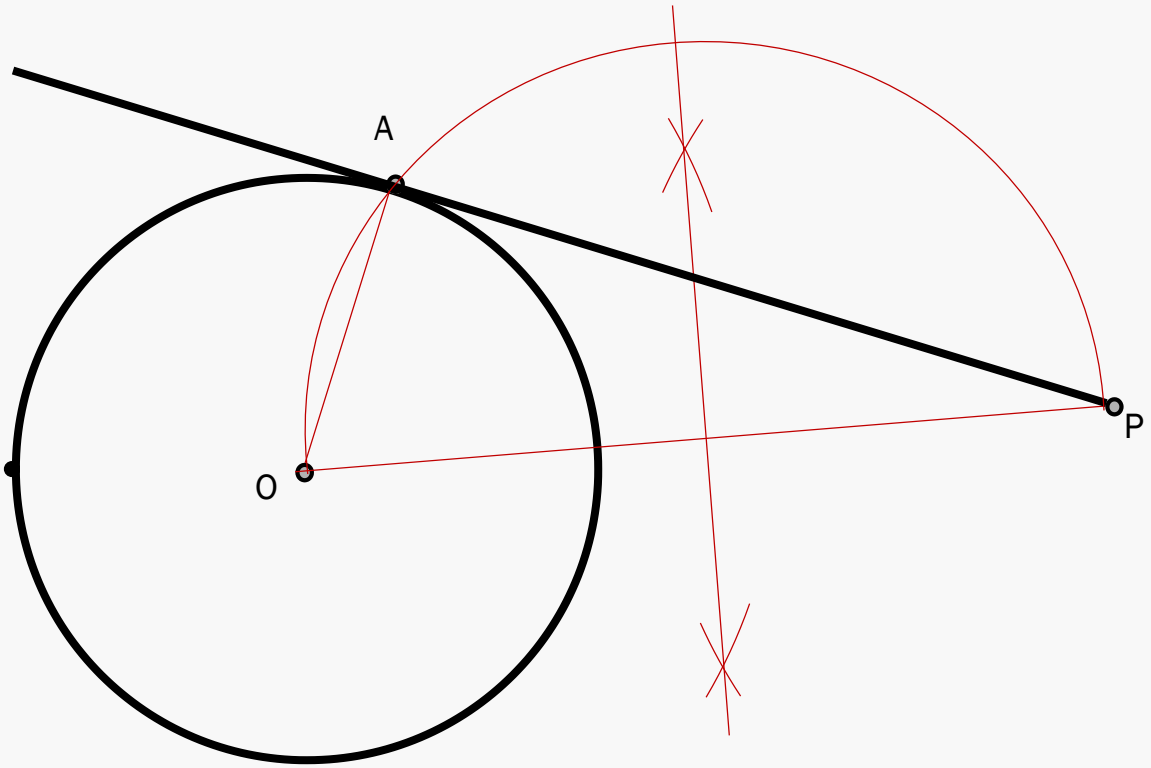




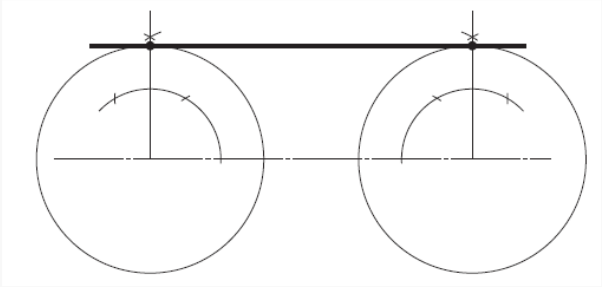
To Draw a Tangent from Any Point P to a Circle



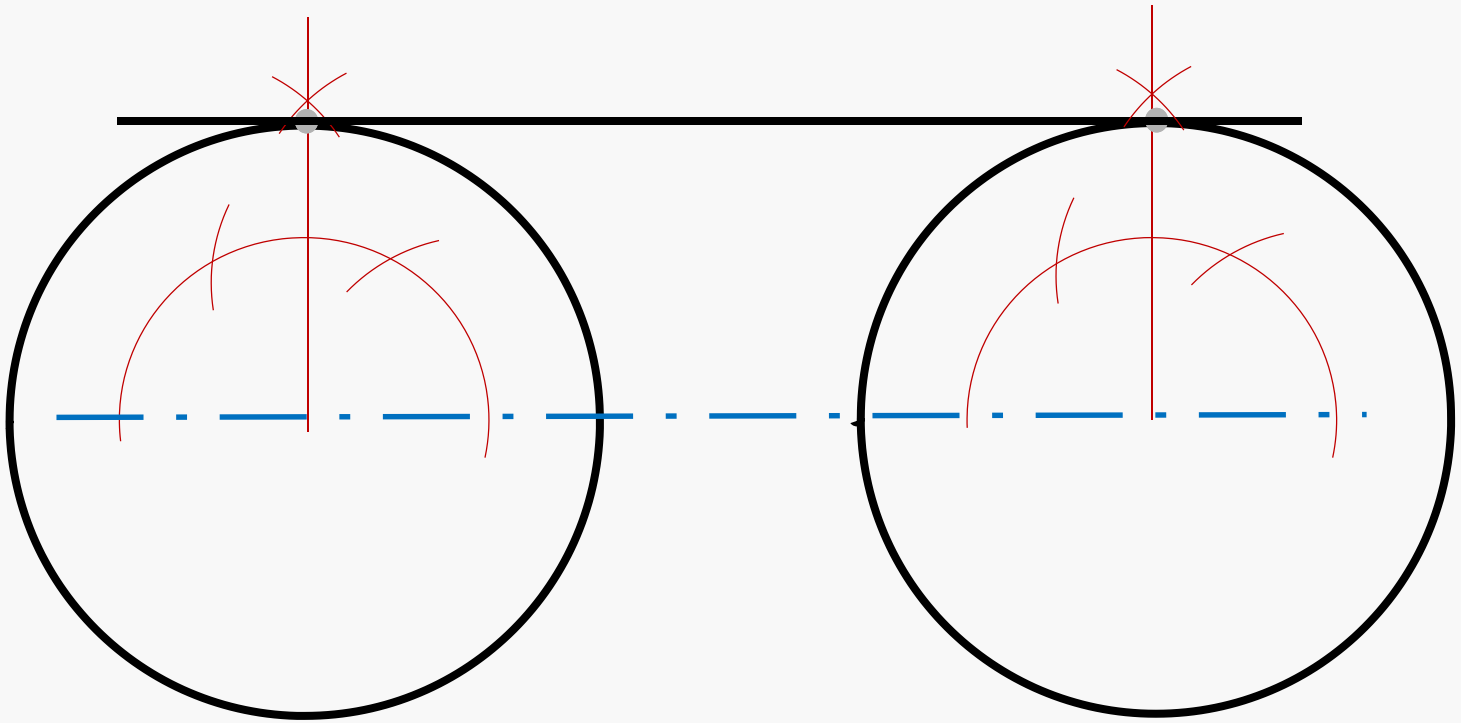
1. Draw the given circle and locate point ***P***
2. Join ***OP***
3. Bisect ***OP***
4. Draw a Semi circle from ***O*** to cut circle at ***A***.
5. Join ***AP***
6. ***AP*** is the required tangent



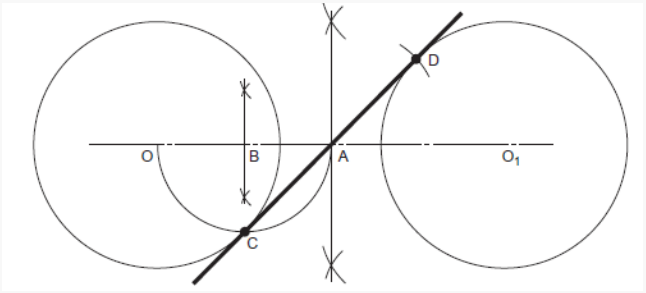
To Construct a Common Tangent to Two Equal Circles



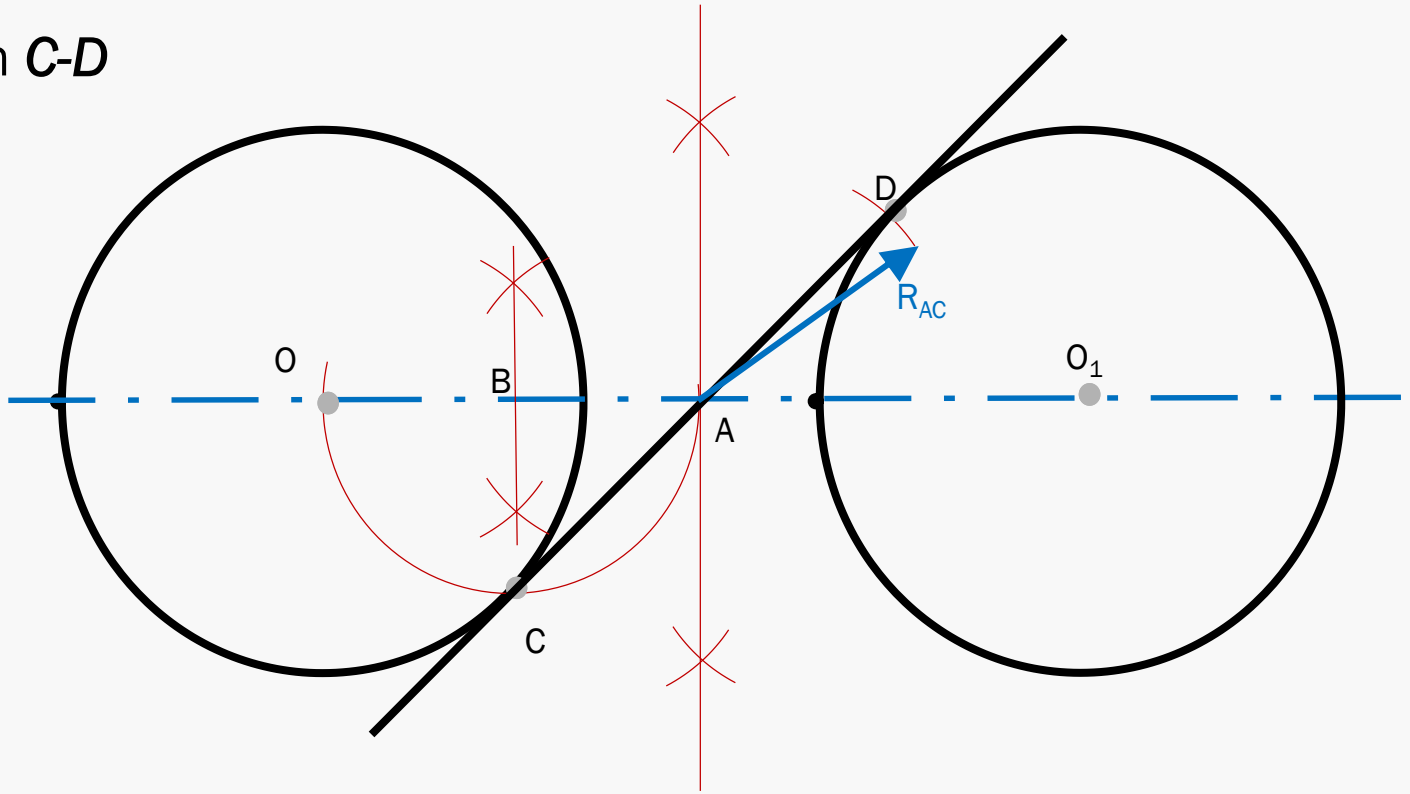
1. Join the centres of the two circles.
2. From each centre, construct lines at *90*° to the centre line.
3. Join the points of intersection to give the tangents.



To Construct a Common Cross Tangent to Two Equal Circles

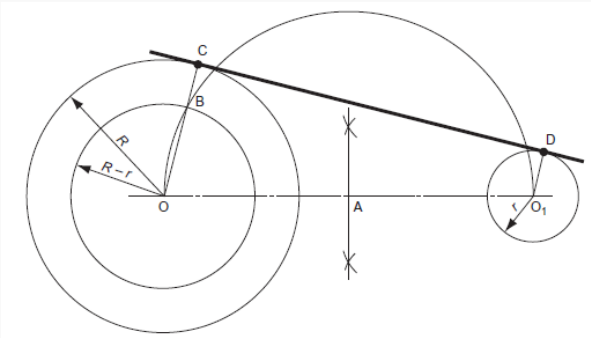


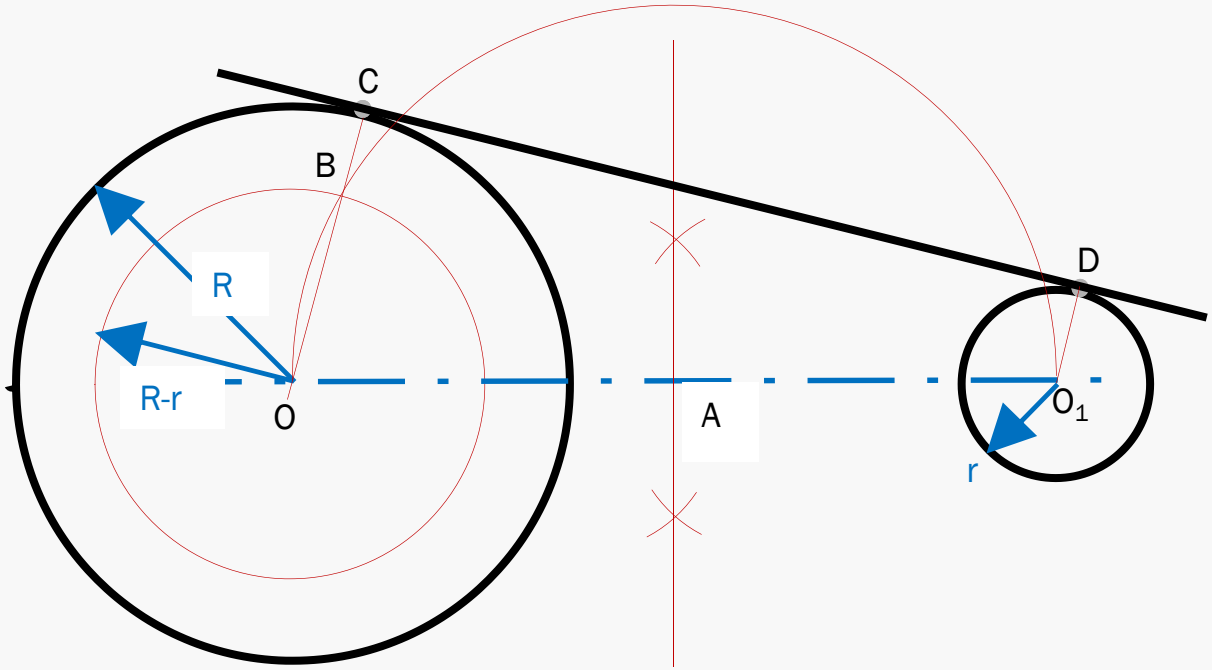
1. Join centres of circle.
2. Bisect ***O-O$_1$*** to give ***A***.
3. Bisect ***OA*** to give ***B***.
4. Draw a semi-circle with radius ***OB*** and centre ***B*** to cut circle at ***C***.
5. Locate ***D*** on second circle with ***AC=AD***.
6. Join ***C-D***



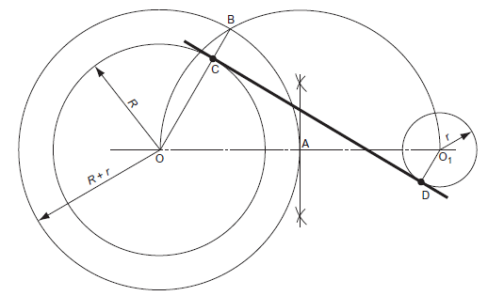
To Construct a Common Tangent to Two UNEqual Circles

1. Join centres of circle.
2. Bisect ***O-O$_1$*** to give ***A***.
3. Draw a semi-circle with radius ***OA*** and centre ***A***
4. Draw a circle centre ***O*** with radius ***R-r*** to cut semi-circle at ***B***.
5. Draw a line through ***OB*** to cut the first circle at ***C***
6. Draw line ***O$_1$D //OC***.
7. Join ***CD***.

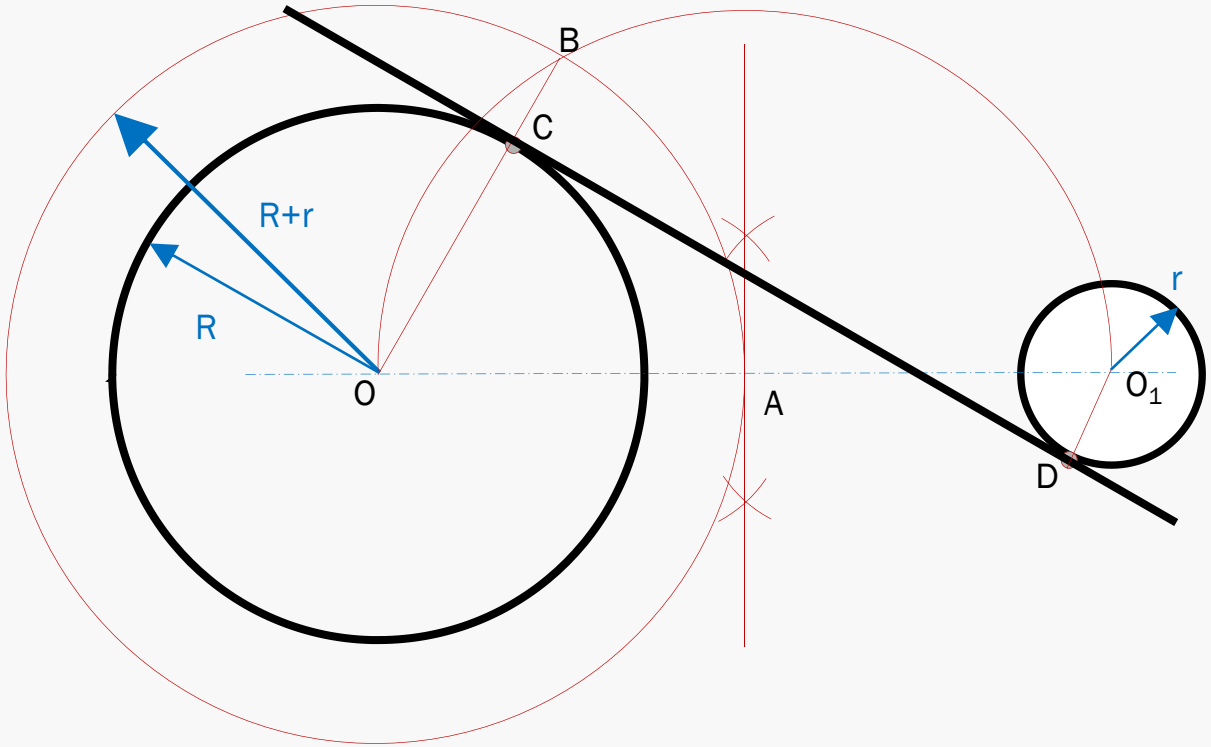




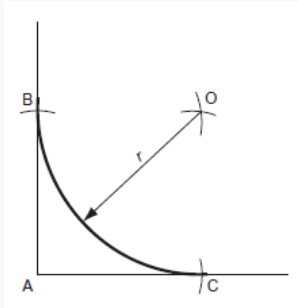
To Construct a Cross Tangent to Two UNEqual Circles



1. Join centres of circle.
2. Bisect *O*-O_1 to give *A*.
3. Draw a semi-circle with radius *OA*.
4. Draw a circle centre *O* with radius *(R+r)* to cut semi-circle at *B*.
5. Draw *OB* to cut lager circle at *C*.
6. Draw O_1D parallel to *OB*.
7. Join *CD*

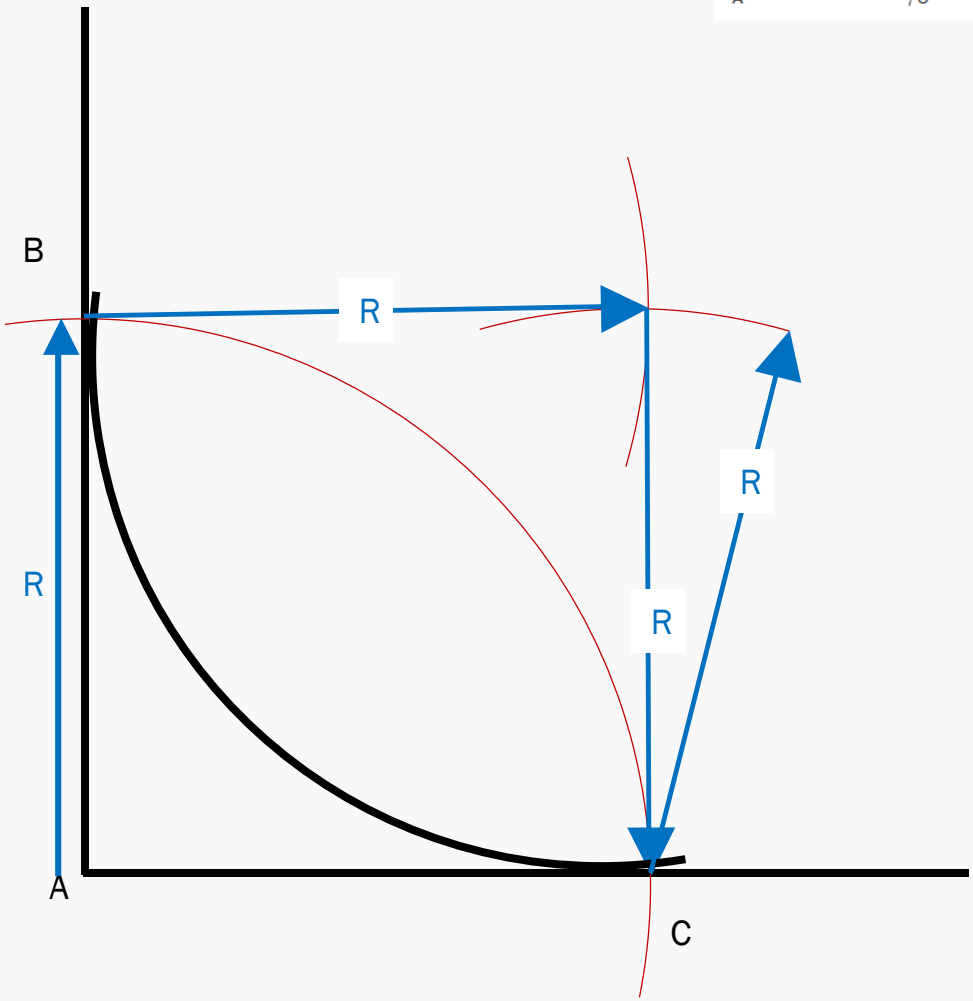


To Construct a Curve Tangential to two Perpendicular lines



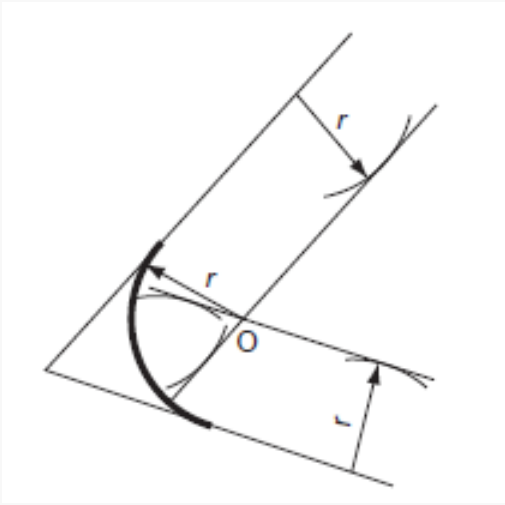
Radius of the curve is ***R***

1. With centre A and radius ***R***, draw arcs to cut lines at ***B*** and ***C***.
2. With centres ***B*** and ***C***, radius ***R***, draw arcs to intersect at ***O***.
3. With ***O*** as centre draw the required curve.

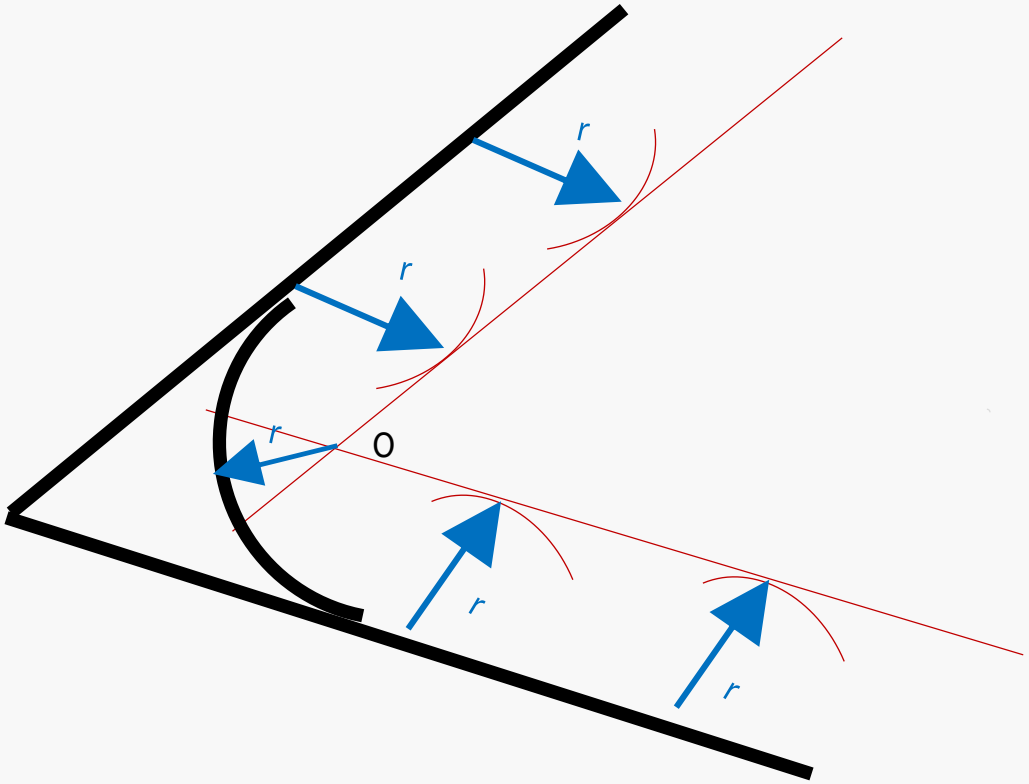


To Construct a Curve Tangential to two Lines

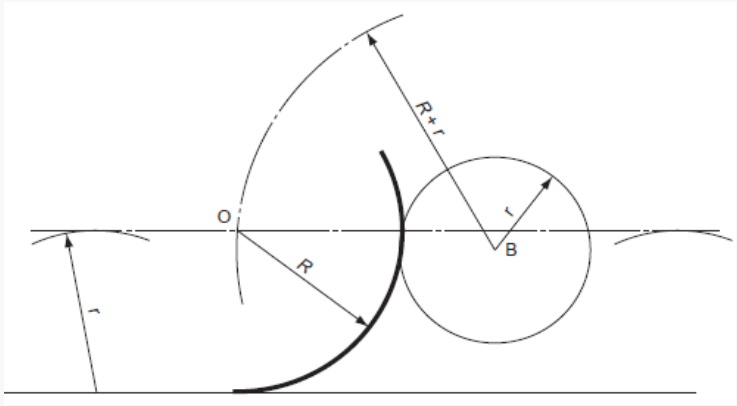
1. Construct lines parallel to the lines at a distance ***r*** away to intersect at ***O***.



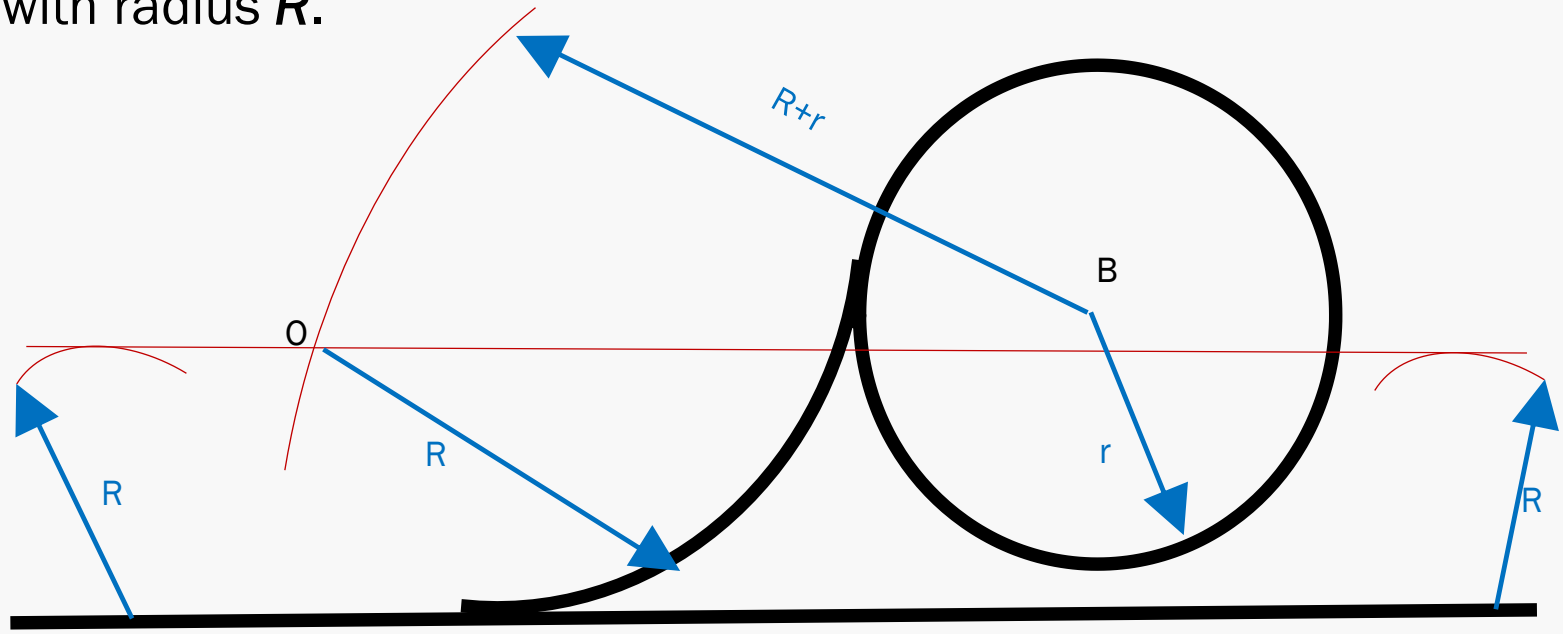
2. Draw the required curve with centre ***O*** and radius ***r***.



To Construct a Curve OF radius R Tangential to a Line and a Circle of radius r



1. Construct a line parallel to the given line
2. From centre of circle, draw an arc, radius ***R+r*** to intersect the parallel line at ***O***.
3. Draw the required curve from ***O*** with radius ***R***.



To Construct a Curve Tangential to Two Circles

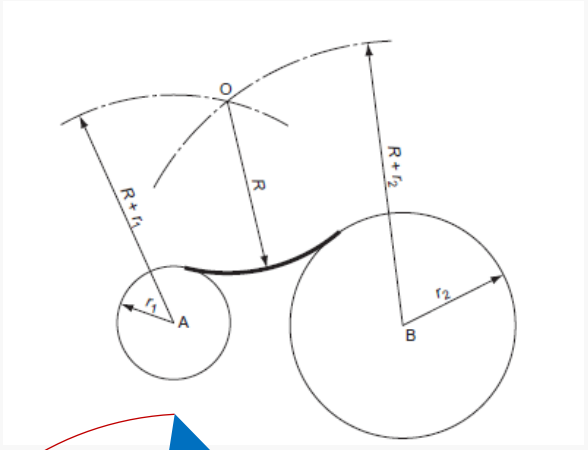
To construct tangential curve of radius ***R*** externally to two circles of radius r_1 and r_2

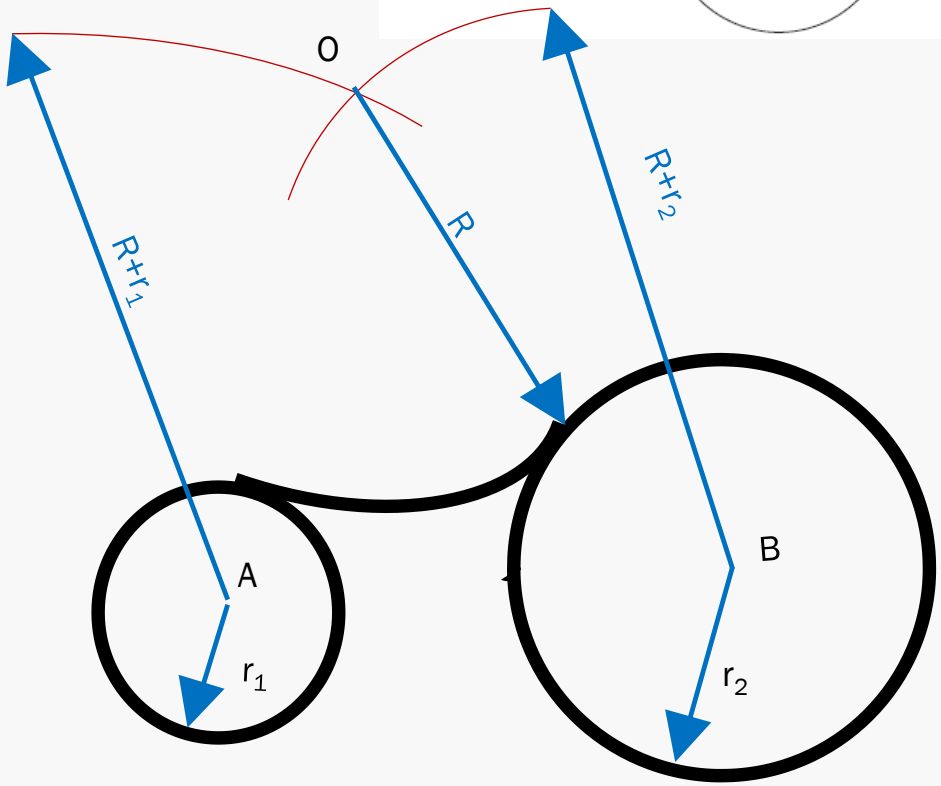
1. Draw the two given circles of radius r_1 and r_2, with centres ***A*** and ***B*** respectively

2. With centre ***A*** and radius $R+r_1$, draw an arc

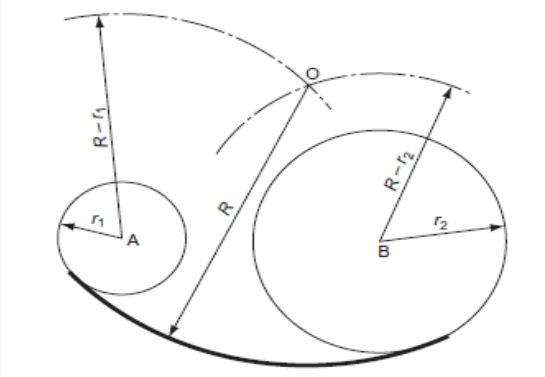
3. With centre ***B*** and radius $R+r_2$, draw an arc to intersect the first arc at ***O***

4. With centre ***O*** and radius ***R*** draw the required tangent





To Construct a Curve Tangential to Two Circles



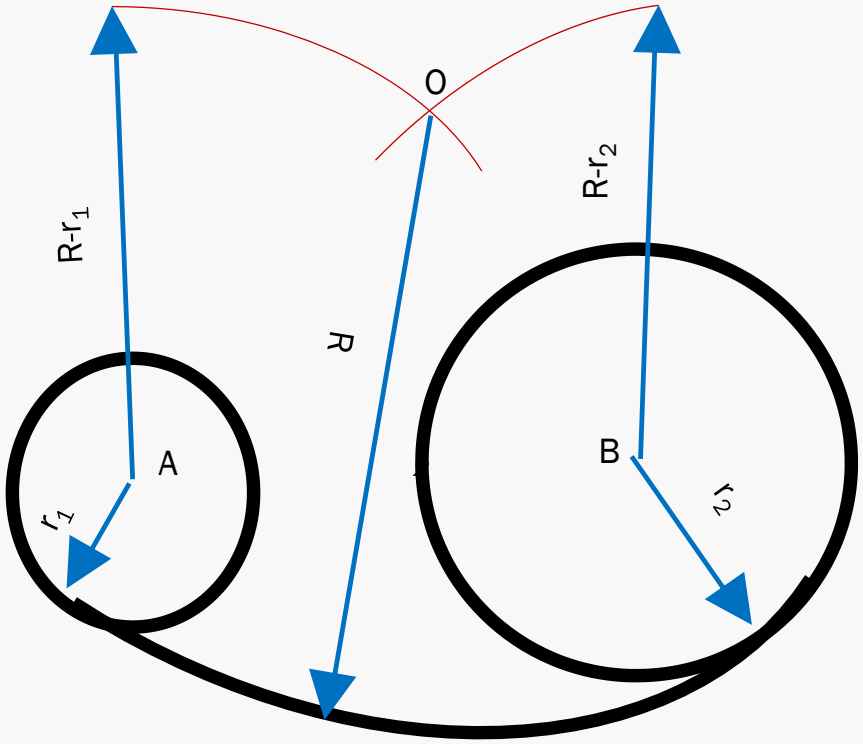
1. To construct tangential curve of radius ***R*** internally to two circles of radius r_1 and r_2

2. Draw the two given circles of radius r_1 and r_2, with centres ***A*** and ***B*** respectively

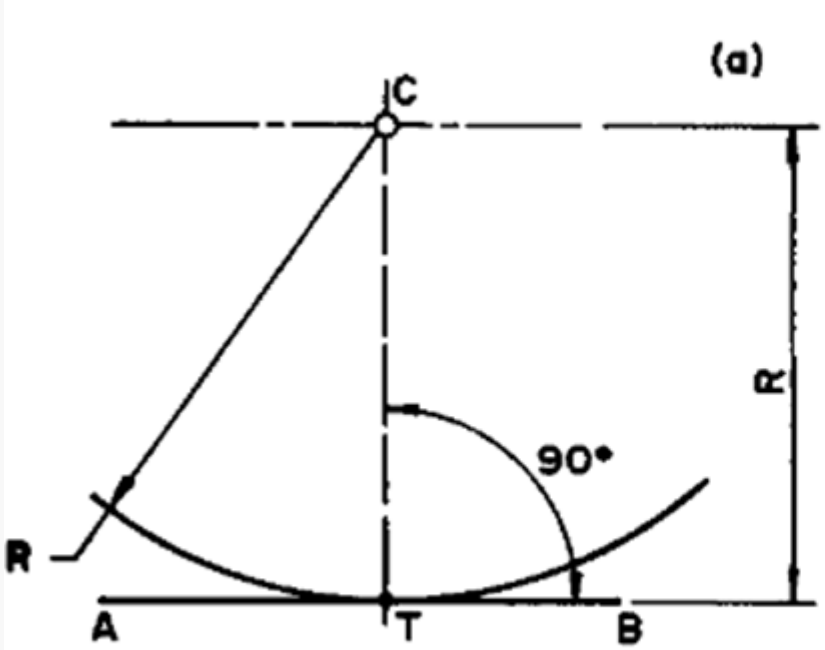
3. With centre ***A*** and radius $R-r_1$, draw an arc

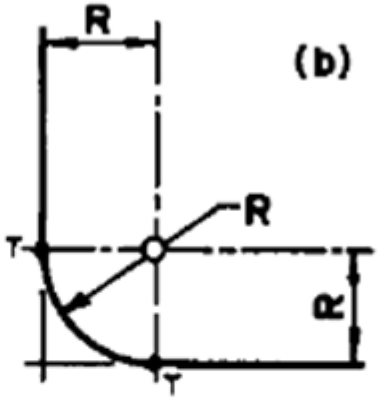
4. With centre ***B*** and radius $R-r_2$, draw an arc to intersect the first arc at ***O.***

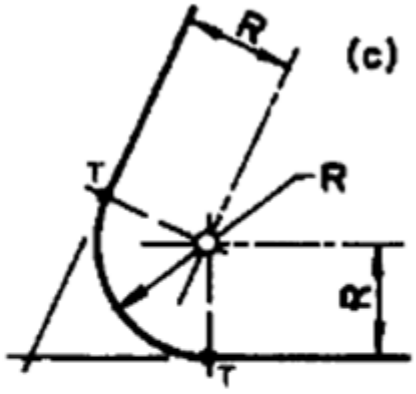
5. With centre ***O*** and radius ***R*** draw the required tangent



PRINCIPLES OF TANGENCY







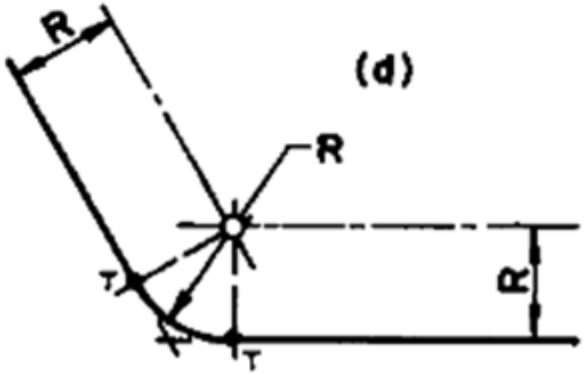


FIG. I TO DRAW AN ARC OF GIVEN RADIUS TO TOUCH A GIVEN STRAIGHT LINE

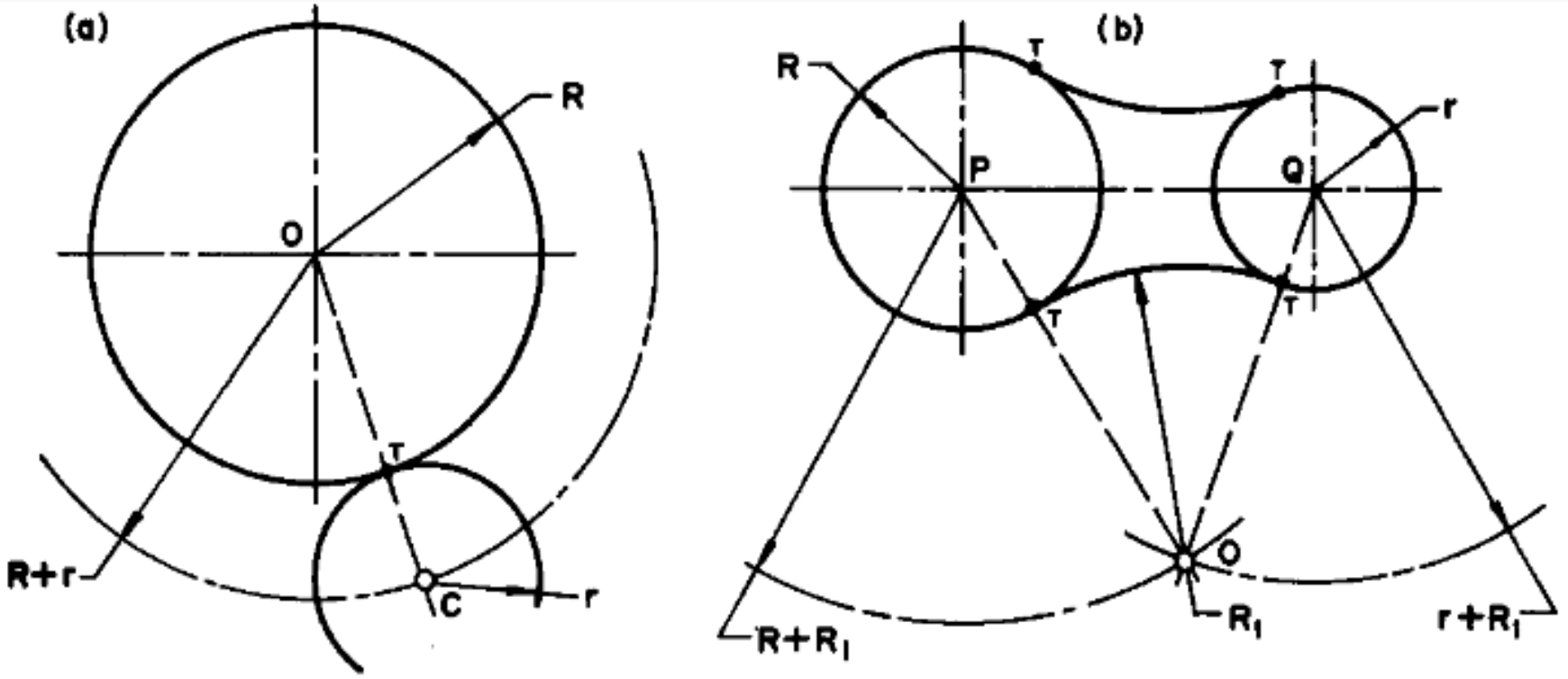


FIG.2 TO DRAW AN ARC OF GIVEN RADIUS TO TOUCH A GIVEN ARC EXTERNALLY

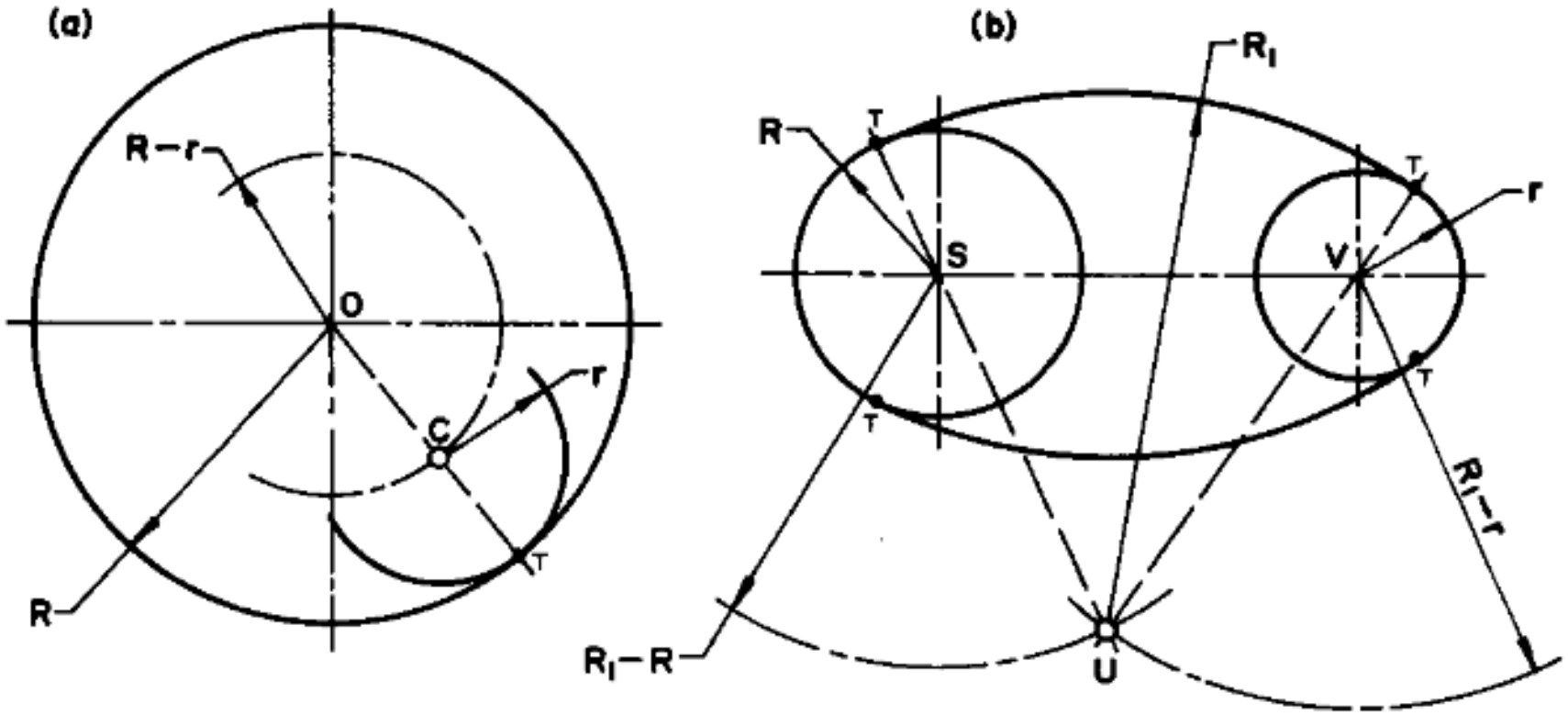
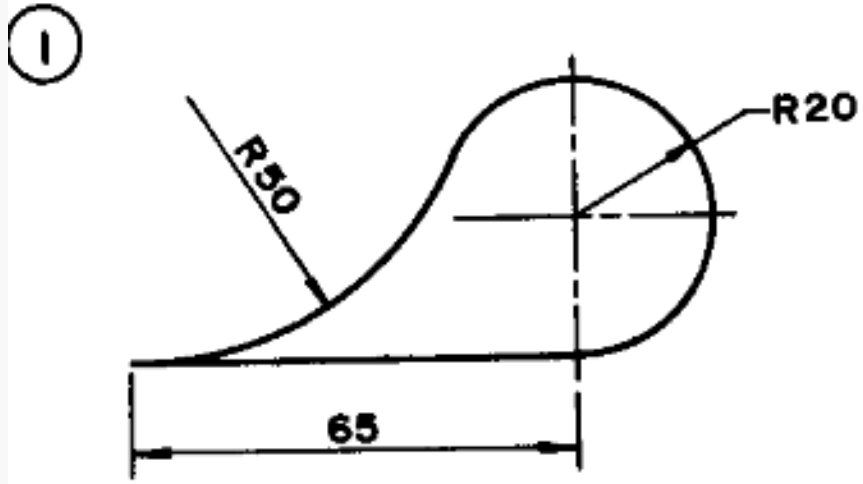
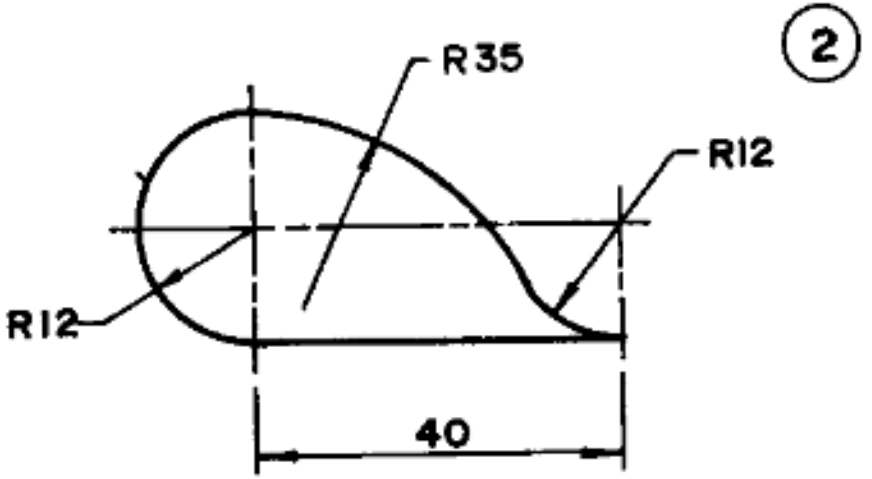
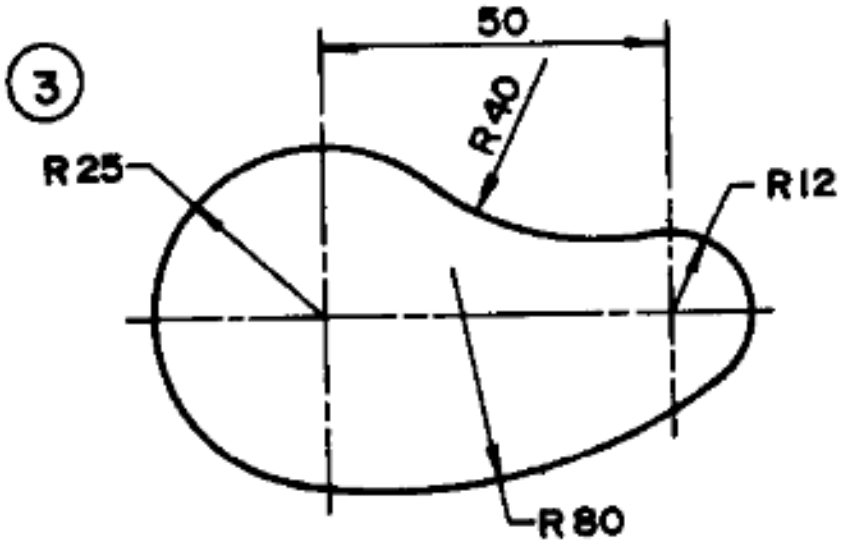


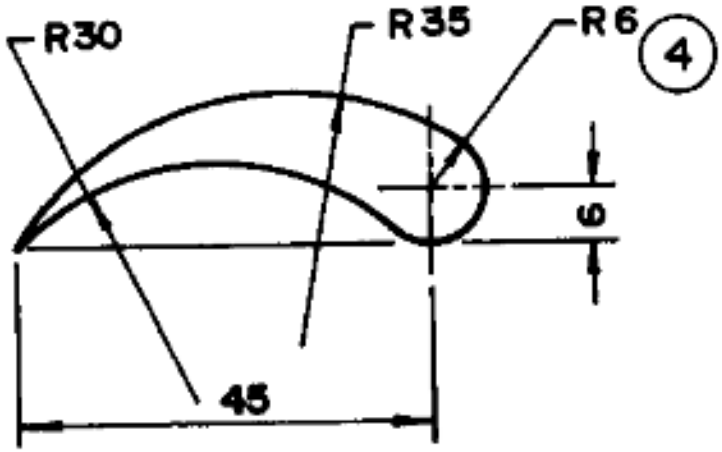
FIG.3 TO DRAW AN ARC OF GIVEN RADIUS TO TOUCH A GIVEN ARC INTERNALLY

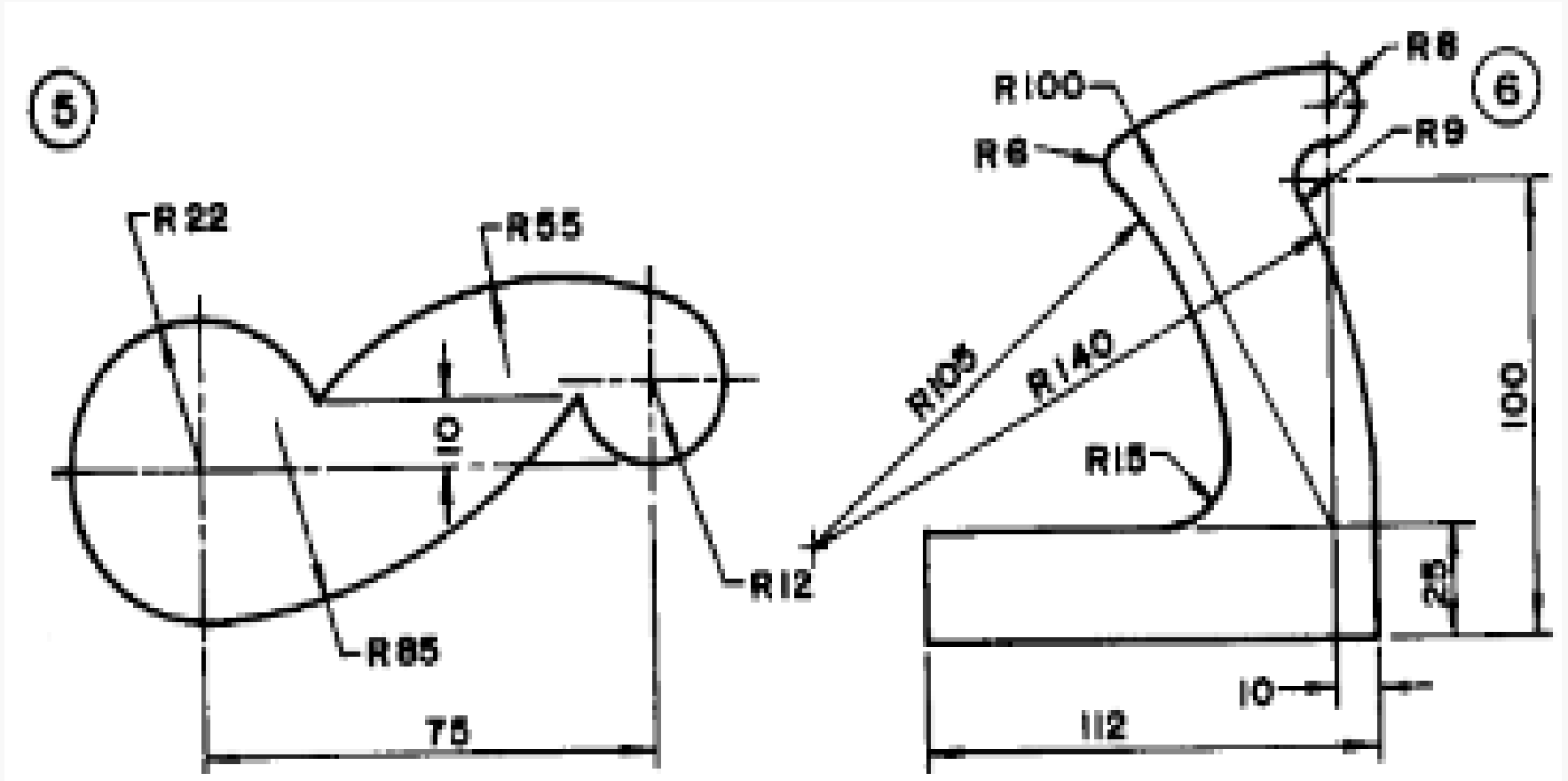
TANGENCY PROBLEMS

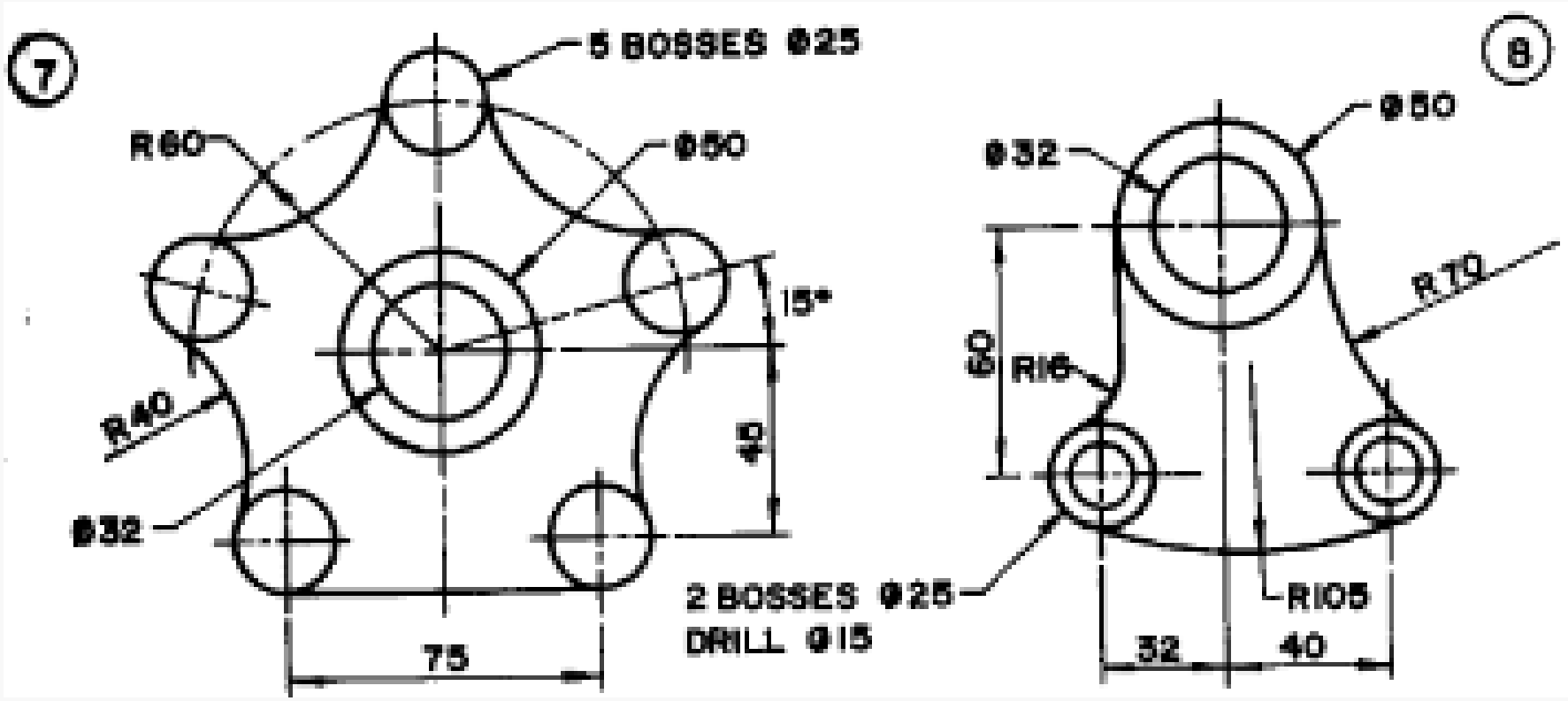




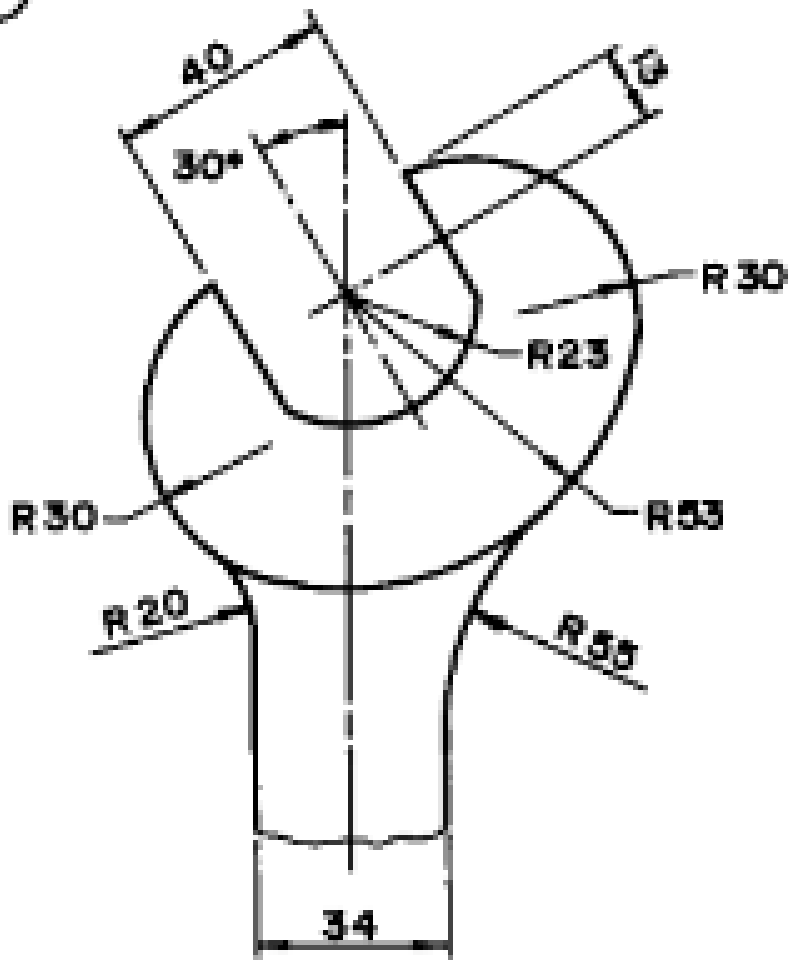


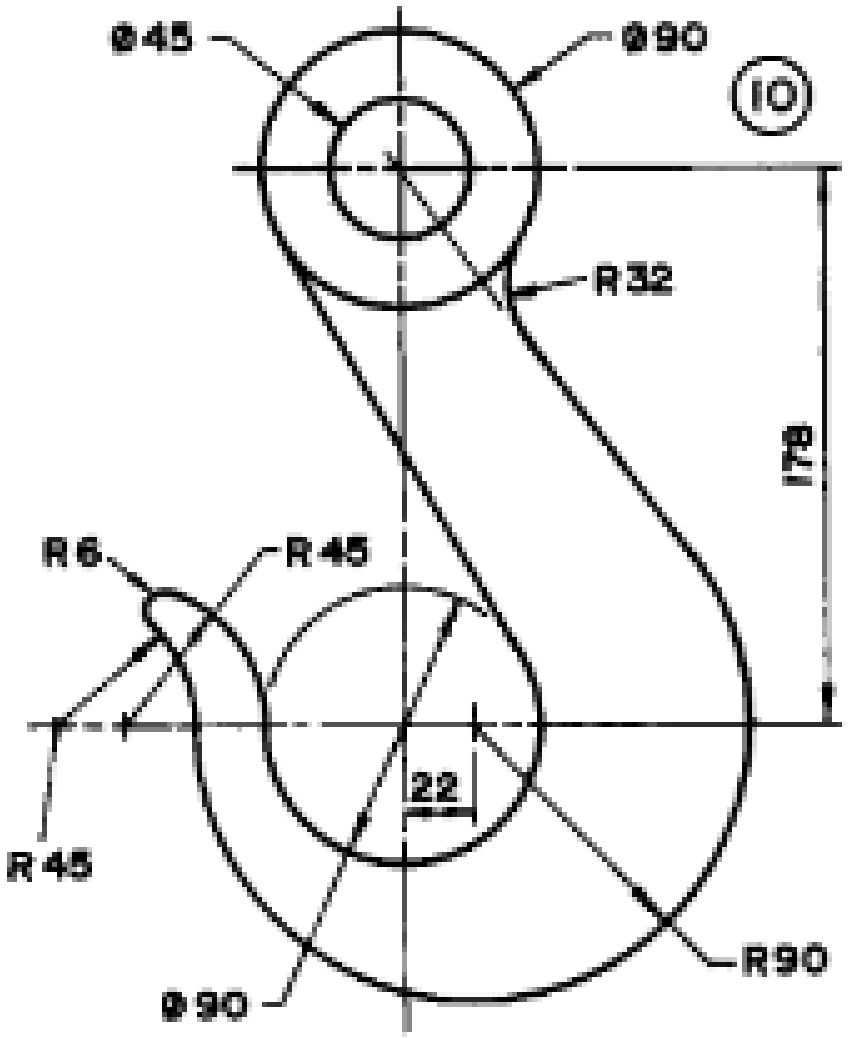


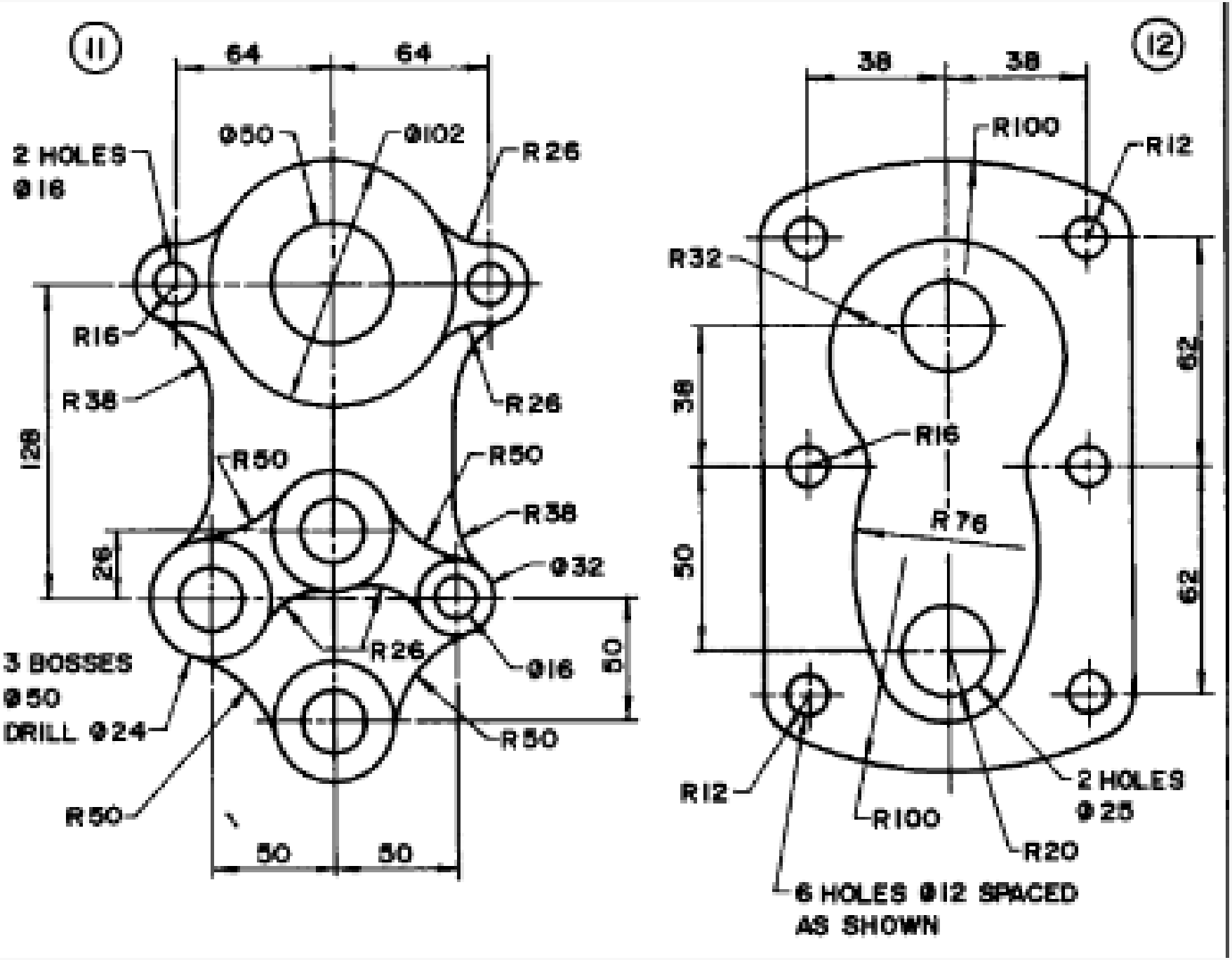

5
R22
R55
R85
R12
75
6
R100
R6
R8
R9
R105
R140
R15
100
20
10
112


7
5 BOSSES Ø25
R60
Ø50
15°
40
R40
Ø32
75
2 BOSSES Ø25
DRILL Ø15
8
Ø50
Ø32
R70
60
R16
R105
32
40

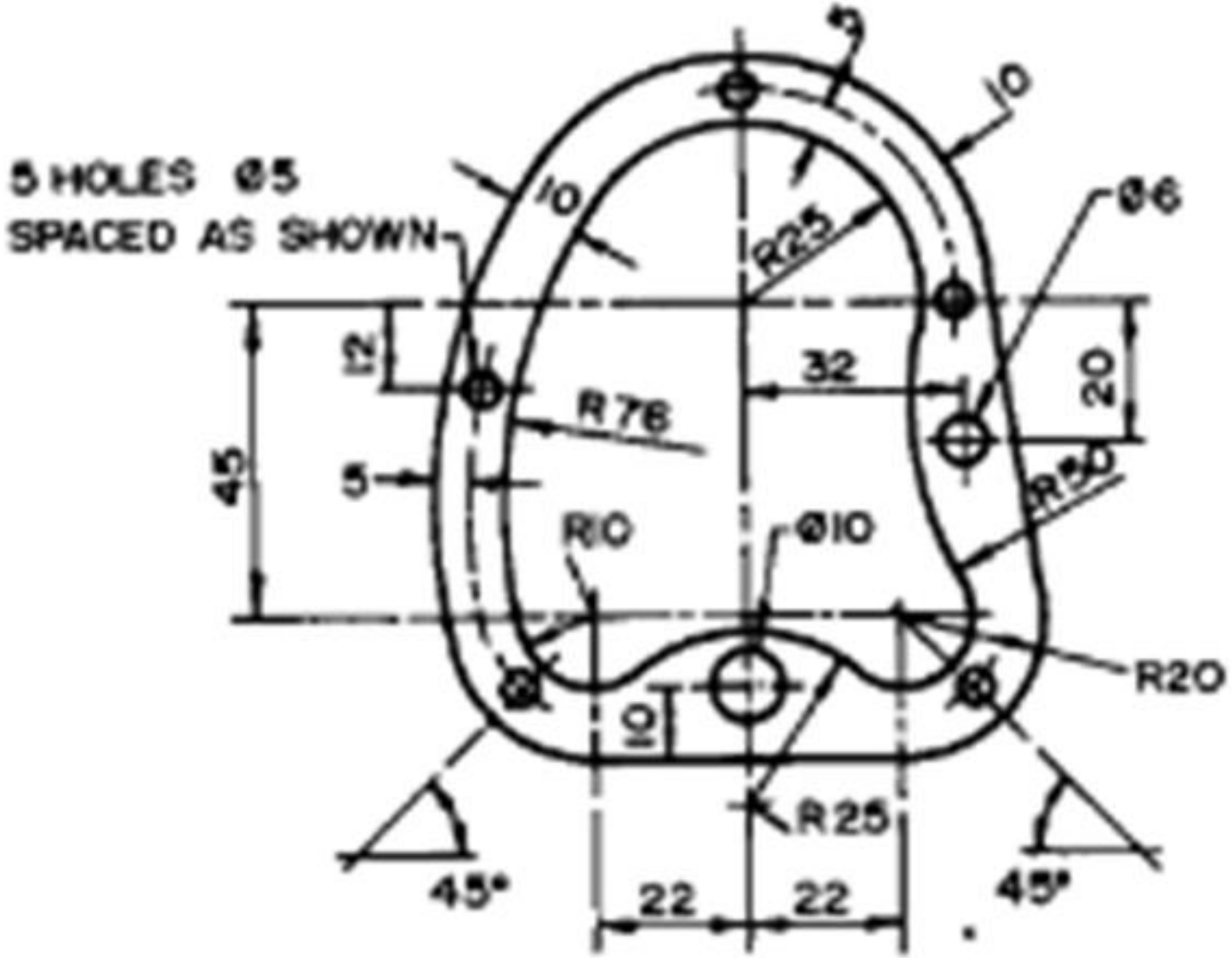
TANGENCY PROBLEMS



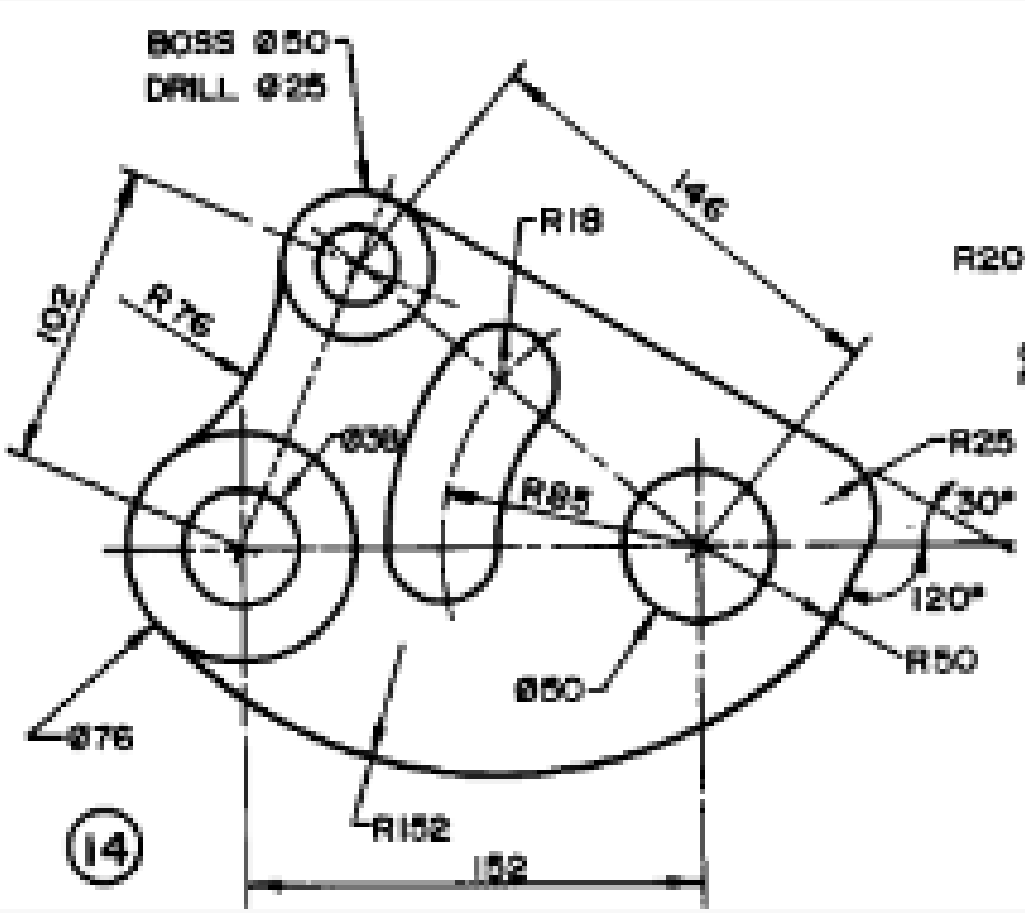


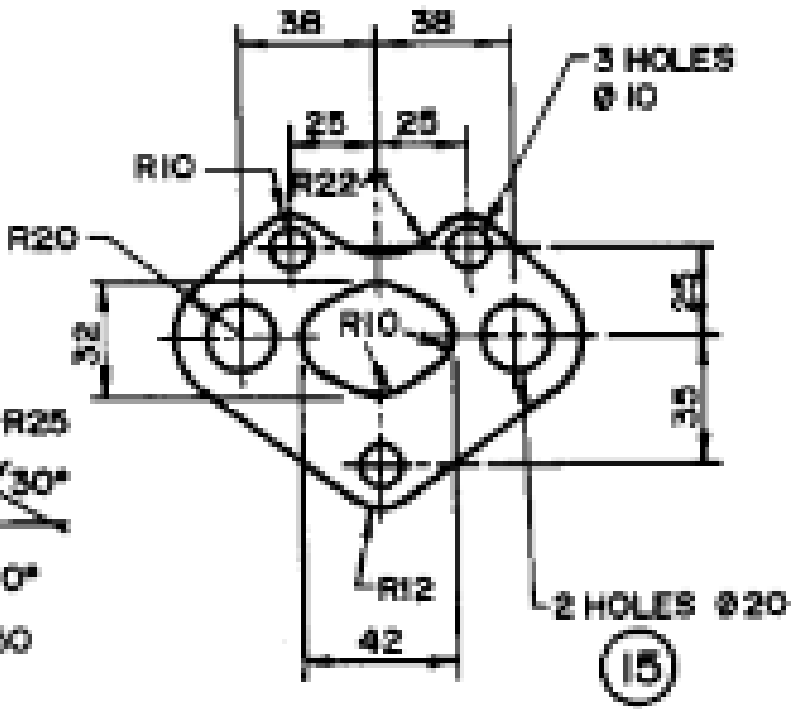

11
64
64
Ø50
Ø102
R26
2 HOLES
Ø16
R16
R38
128
R50
R50
R38
26
Ø32
R26
Ø16
60
3 BOSSES
Ø50
DRILL Ø24
R50
R50
50
50
12
38
38
R100
R12
R32
38
62
R16
R76
50
62
R12
R100
2 HOLES
Ø25
R20
6 HOLES Ø12 SPACED
AS SHOWN

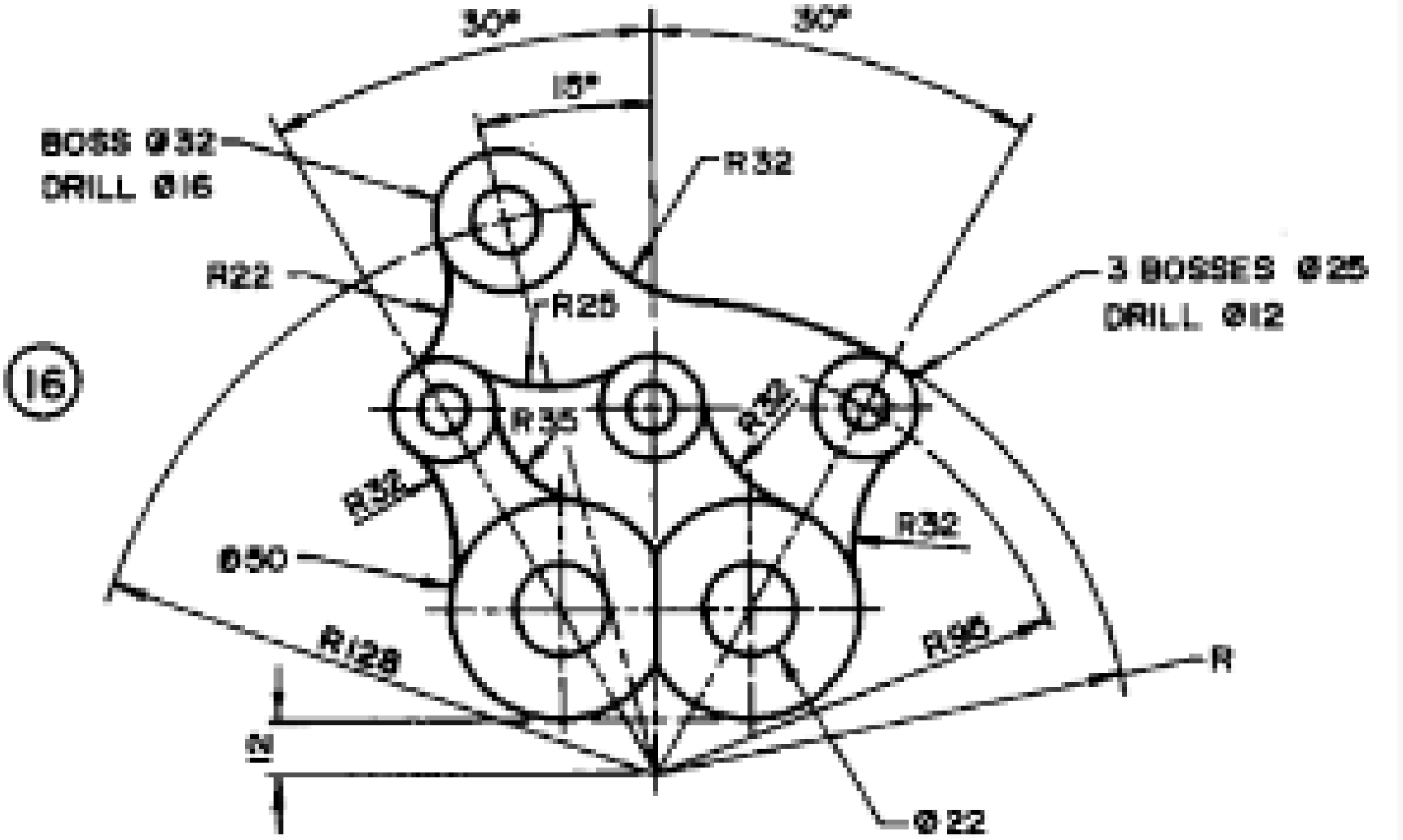
TANGENCY PROBLEMS



13


BOSS Ø50
DRILL Ø25
R18
146
102
R76
Ø38
R85
R25
30°
120°
R50
Ø80
Ø76
R152
152
14


38
38
3 HOLES
Ø 10
25
25
R10
R22
R20
32
R10
R12
42
2 HOLES Ø20
15


16
30°
30°
15°
BOSS Ø32
DRILL Ø16
R32
R22
R28
3 BOSSES Ø25
DRILL Ø12
R35
R36
R32
Ø50
R128
R96
R
N
Ø22

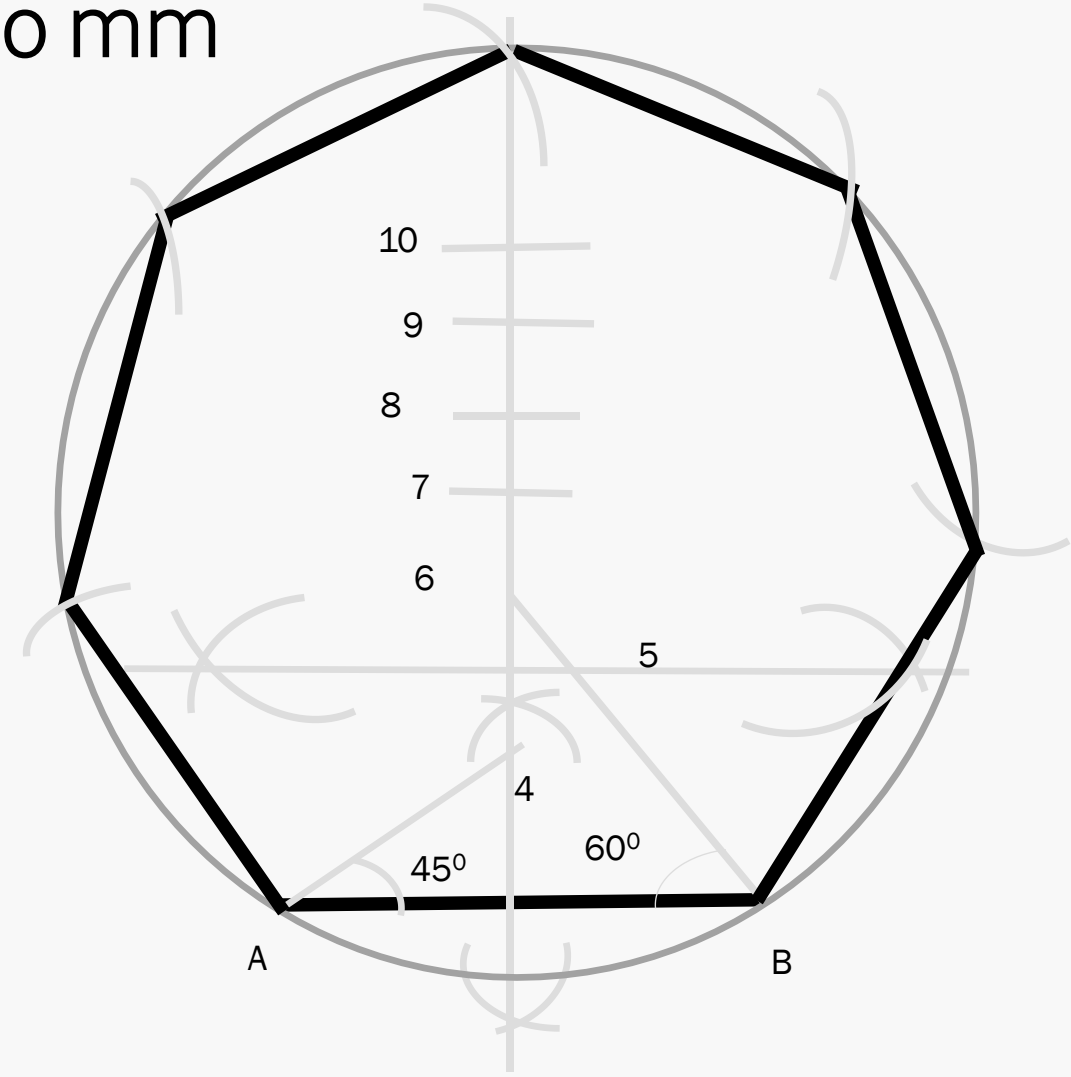
END OF LECTURE 3

SELF PRACTICE

SP 002

TO BE SUBMITTED ON TUESDAY 19th MARCH BY 12.00 NOON

Q1(a): Construct a nonagon of sides AB = 50 mm



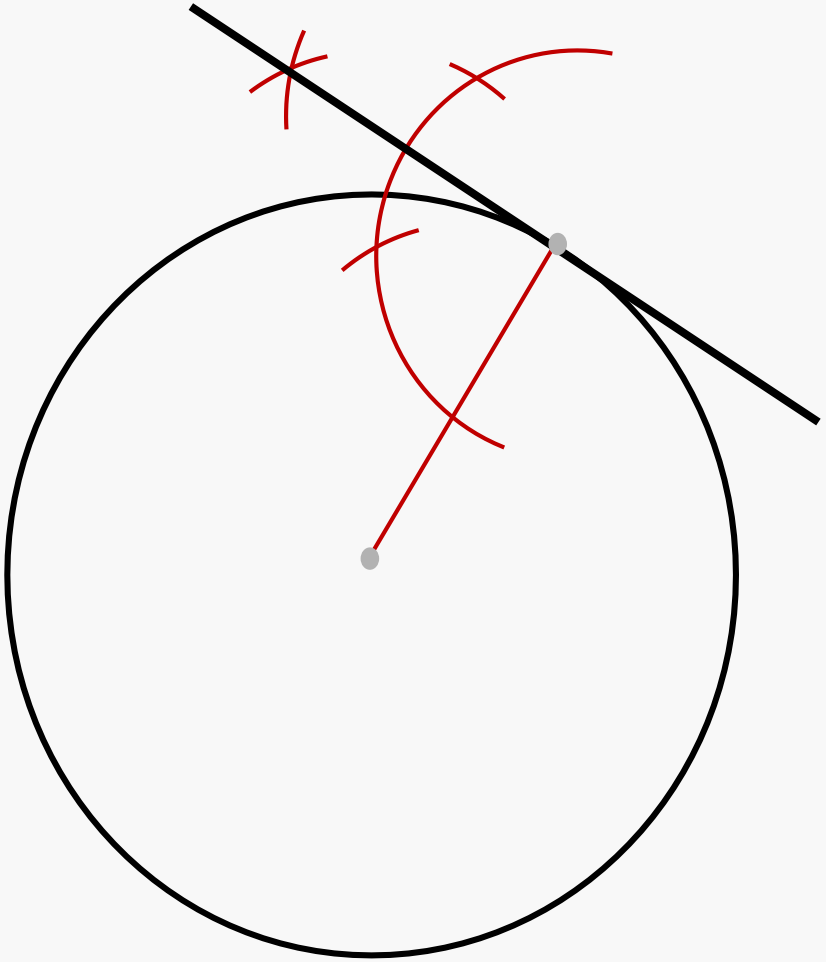
Q1(b):

- CONSTRUCT A PENTAGON OF SIDES 50 mm
- CONSTRUCT AN HEXAGON A/C OF DIAMETER 60 mm
- CONSTRUCT AN HEXAGON A/F OF DIAMETER 60 mm

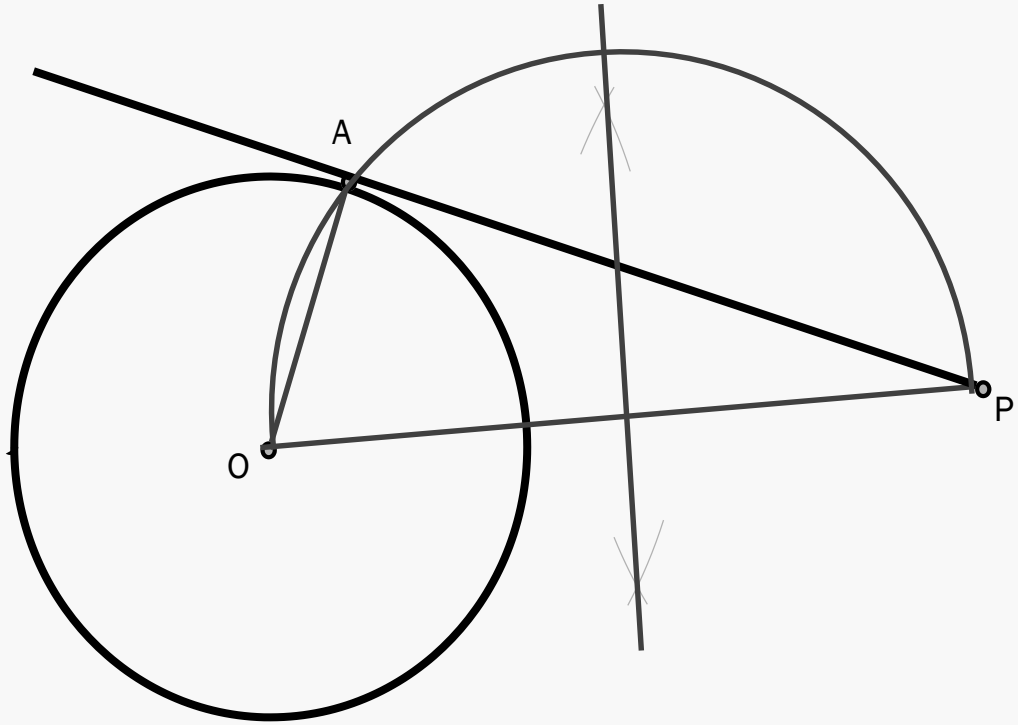
Q1(C):

- CONSTRUCT A SCALENE TRIANGLE OF ANY CONVENIENT SIDES AND INSCRIBE A CIRCLE IN IT.
- CONSTRUCT A SCALENE TRIANGLE OF ANY CONVENIENT SIDES AND CIRCUMSCRIBE A CIRCLE IN IT.
- DRAW A LINE OF ANY CONVENIENT LENGTH AND BISECT IT.
- DRAW A LINE OF ANY CONVENIENT LENGTH AND DIVIDE IT IN THE RATIO 3:5.
- DRAW AN ACUTE ANGLE AND BISECT INTO TWO.

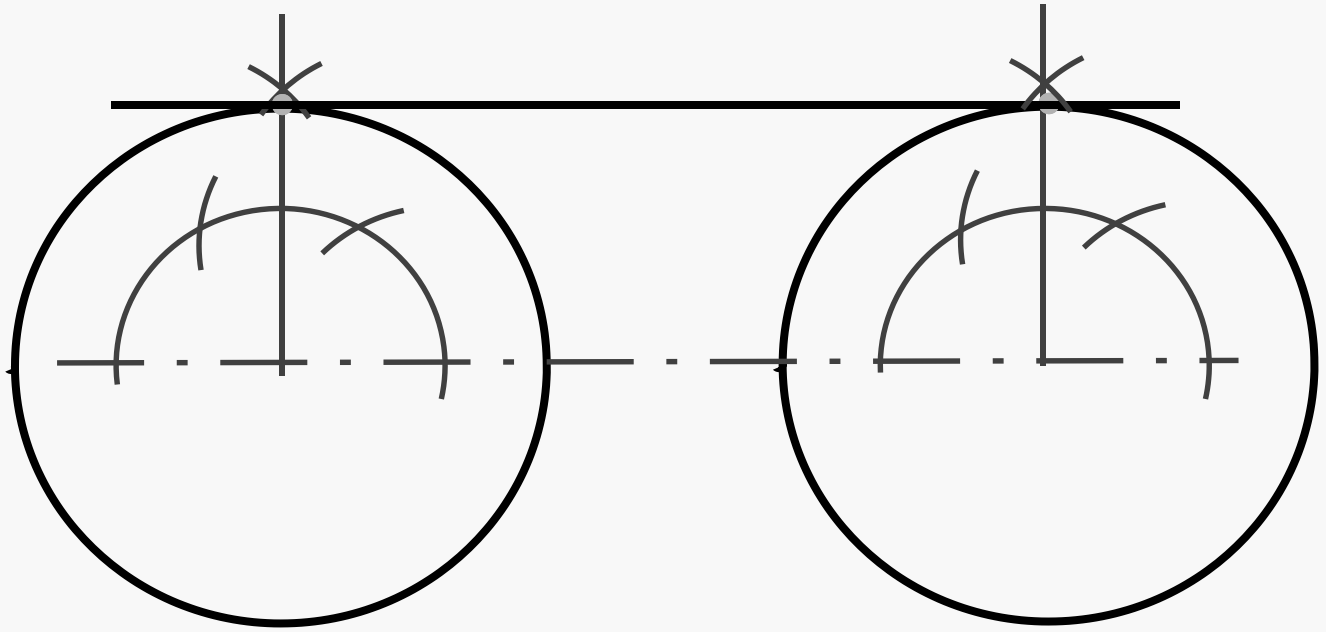
Q2: Draw A Tangent to a Circle OF RADIUS 30 mm from any Point on the Circumference



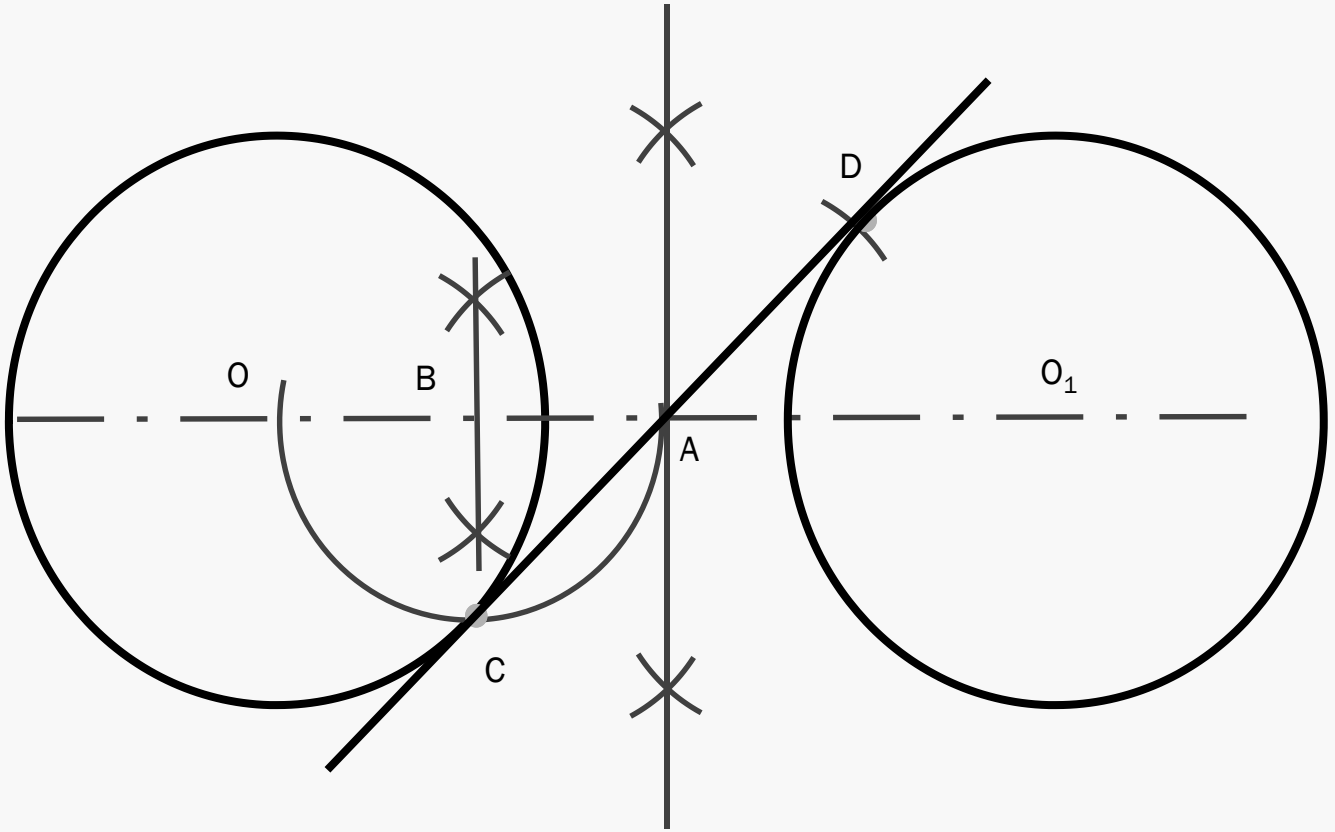
Q3: Draw a Tangent from Any Point P to a Circle of radius 50 mm. P IS OUTSIDE THE CIRCLE.



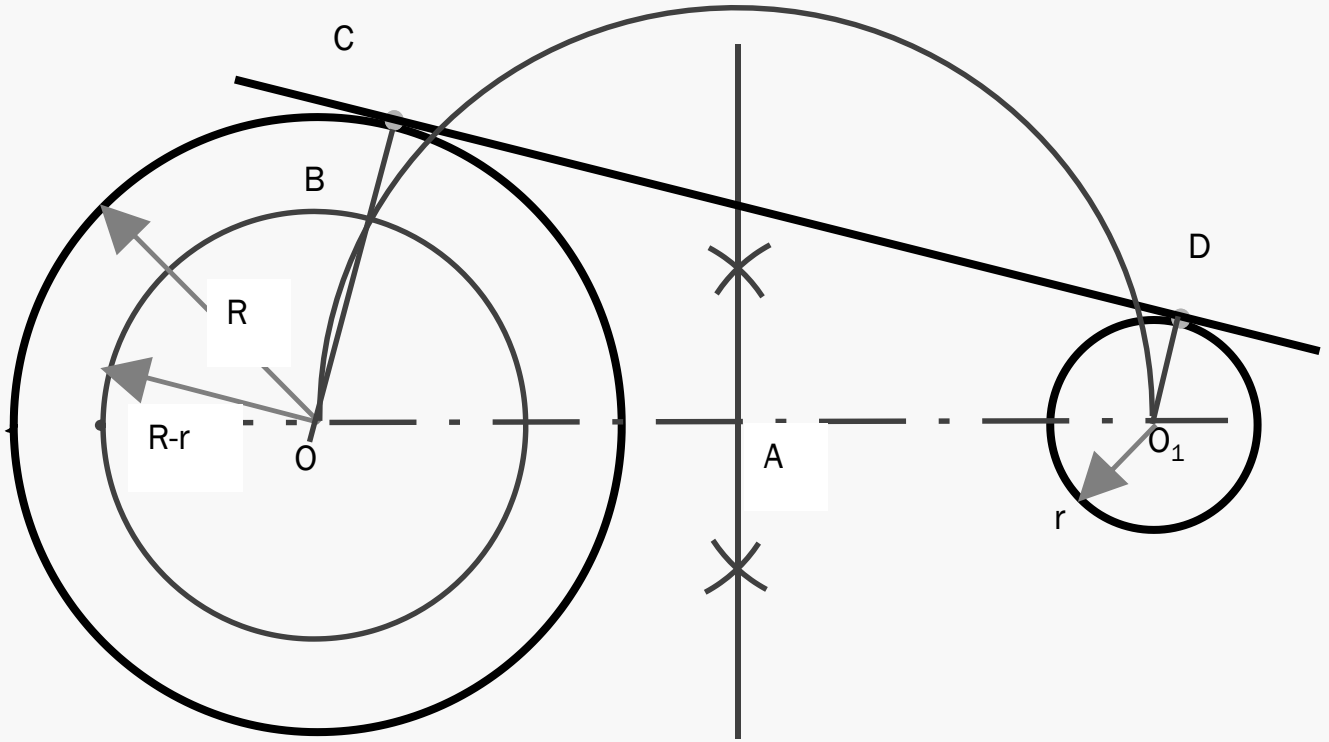
Q4: Construct a Common Tangent to Two Equal Circles OF RADIUS 40 mm AND 110 mm APART.



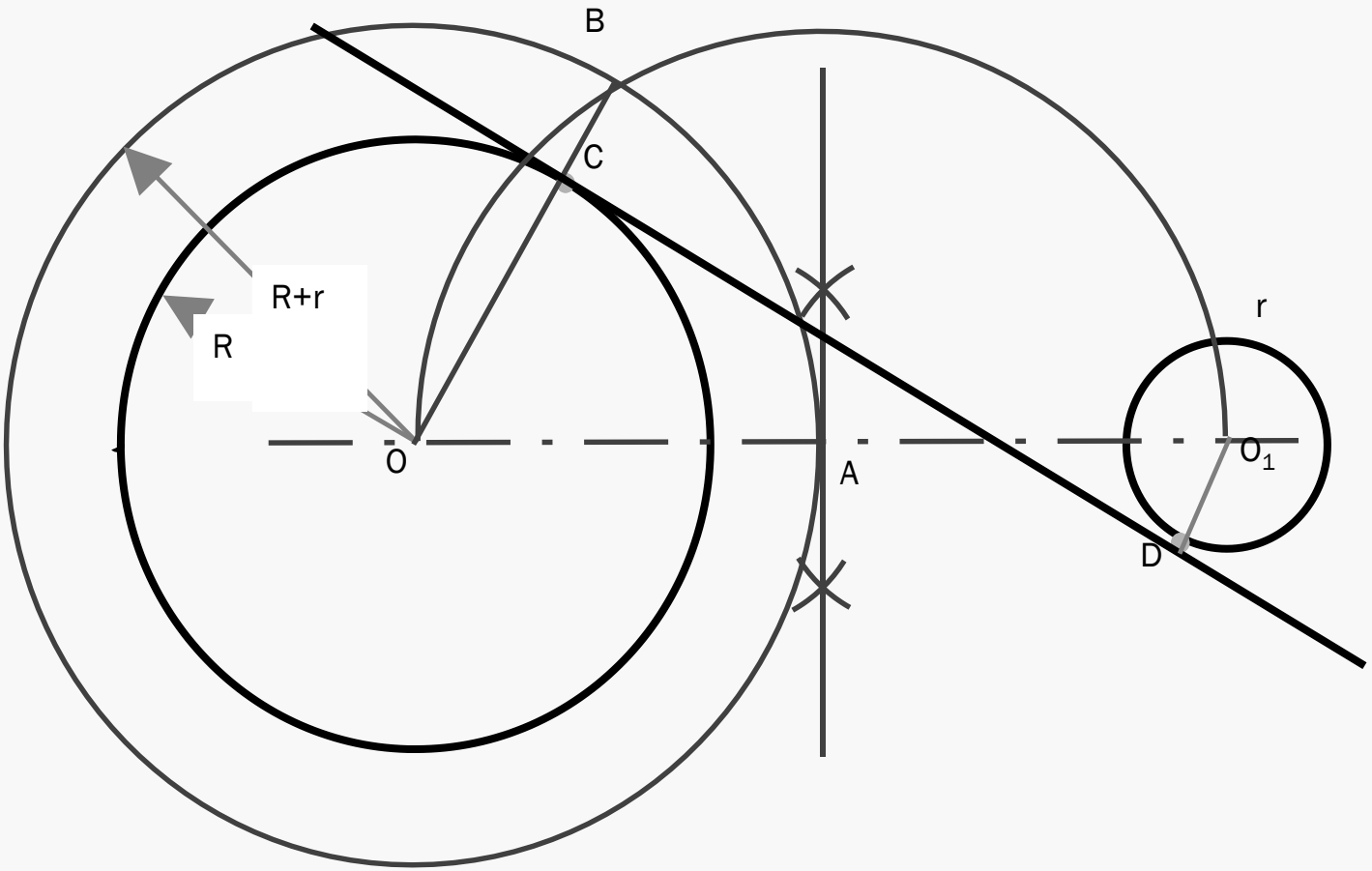
Q5: Construct a Common Cross Tangent to Two Equal Circles OF RADIUS 40 mm AND 110 mm APART.



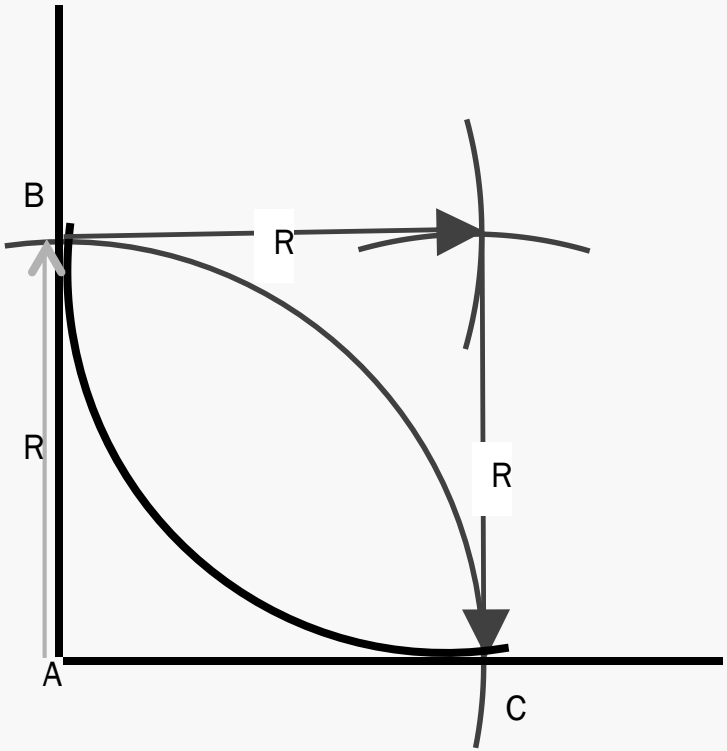
Q6: Construct a Common Tangent to Two Unequal Circles OF RADIUS 50 mm & 30 mm RESPECTIVELY & 120 mm APART.

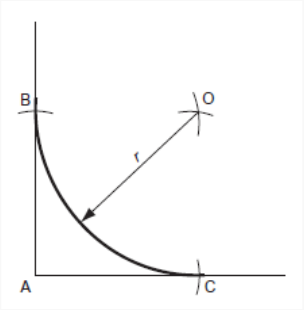


Q7: Construct a Cross Tangent to Two UNEqual Circles OF 50 mm & 30 mm RESPECTIVELY & 120 mm APART.

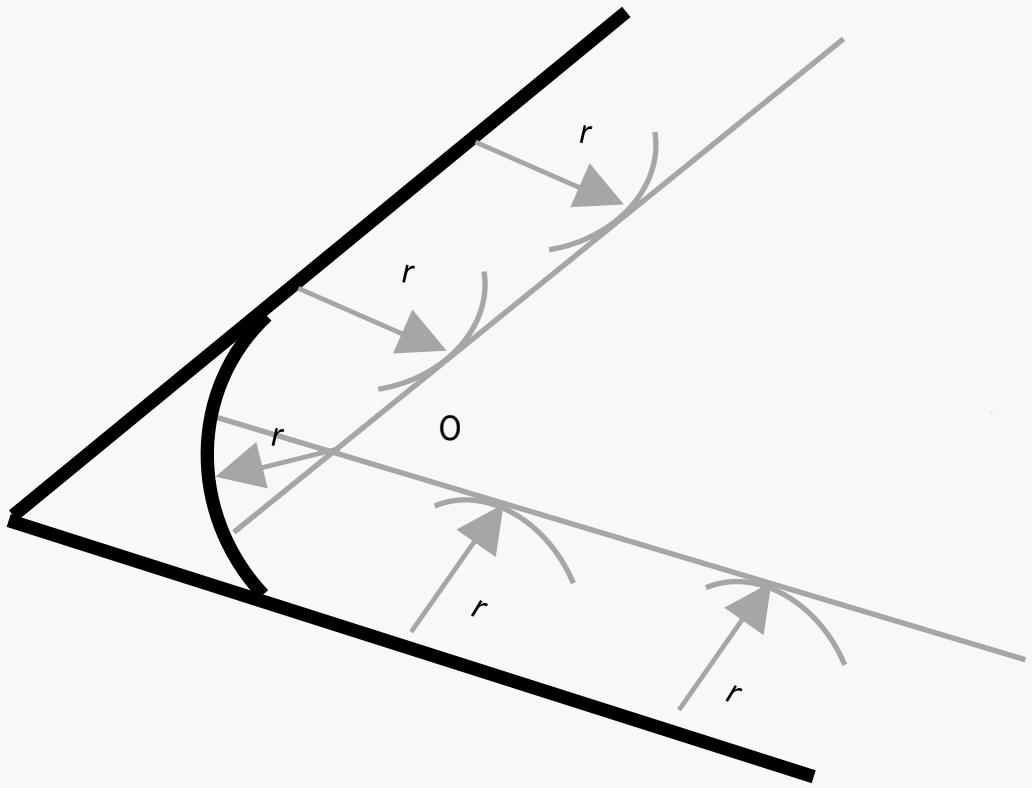


Q8: Construct a Curve OF RADIUS 30 mm Tangential to two Perpendicular lines

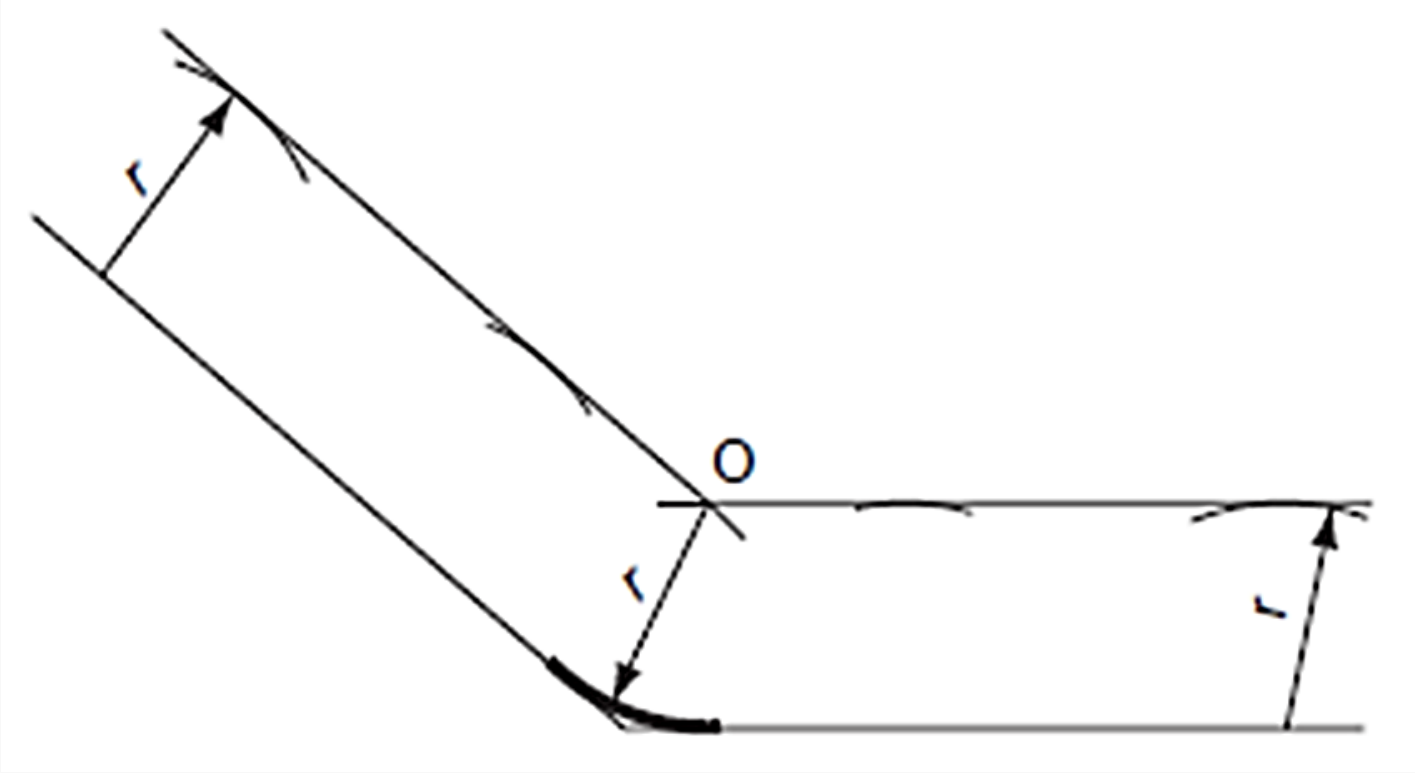




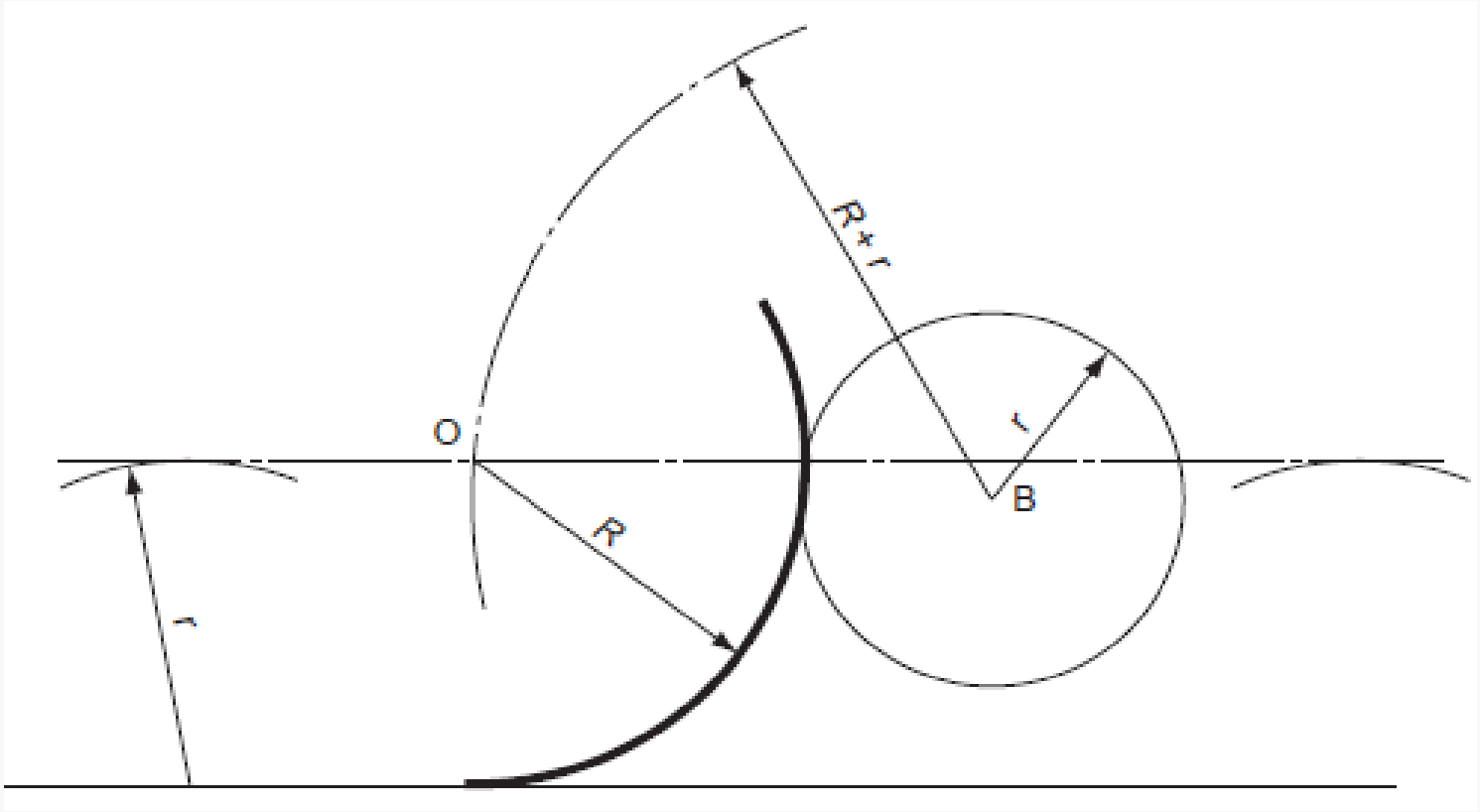
Q9: Construct a Curve OF RADIUS 20 mm Tangential to two Lines WHICH SUBTENDS ANGLE 30° WITH EACH OTHER.



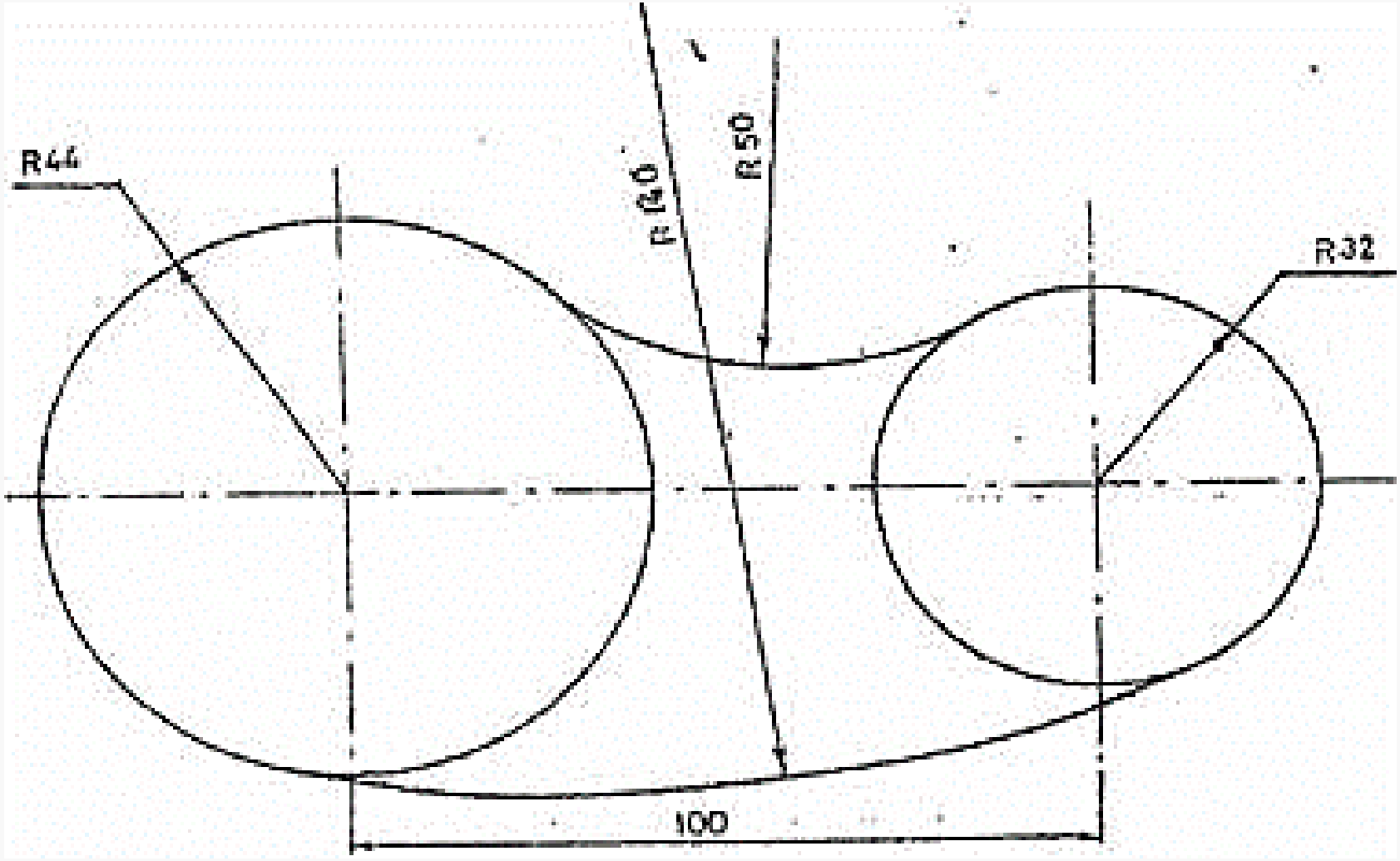
Q10: Construct a Curve OF RADIUS 30 mm Tangential to two Lines WHICH SUBTENDS ANGLE 120 WITH EACH OTHER.



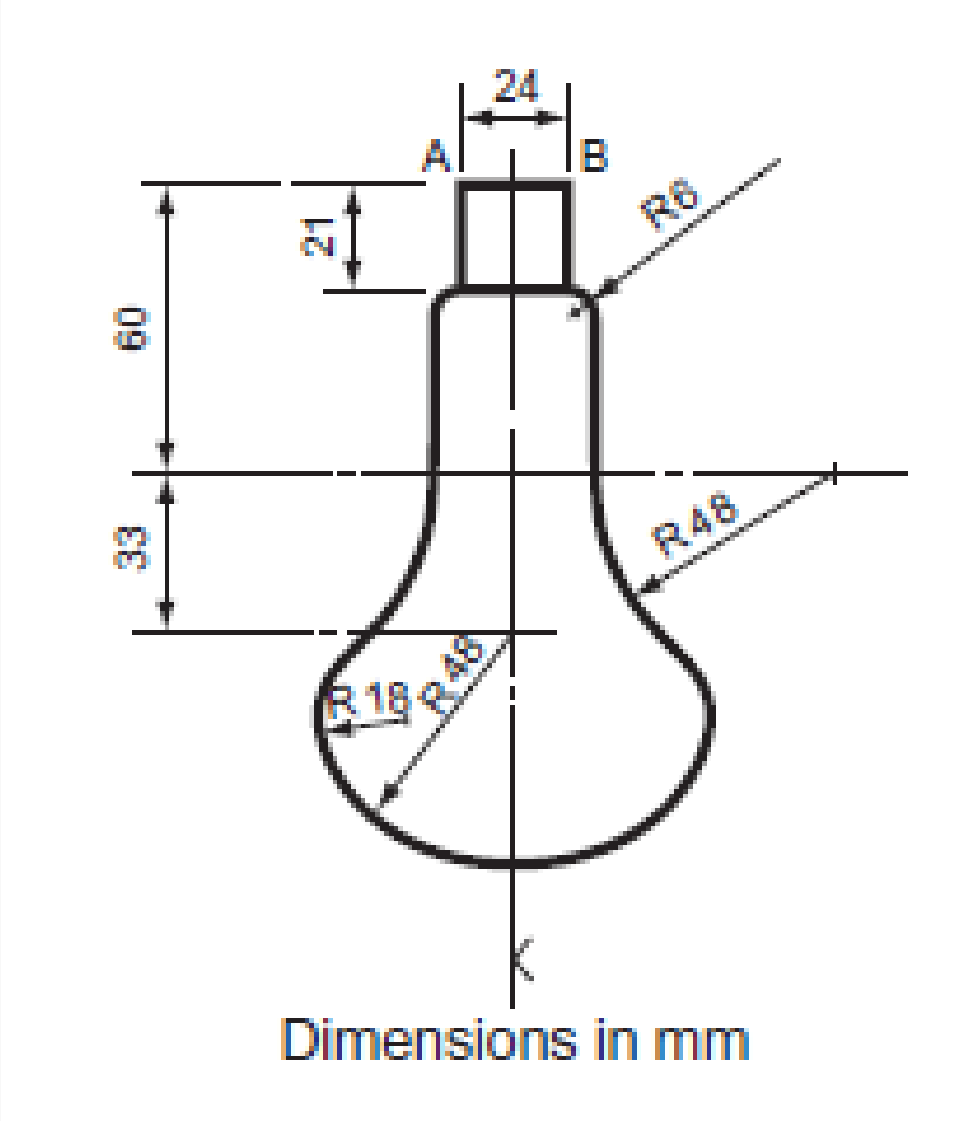
Q11: Construct a Curve OF radius R= 50 mm Tangential to a Line and a Circle of radius r = 30 mm. THE LINE IS 50 mm AWAY FROM THE CENTRE OF THE CIRCLE



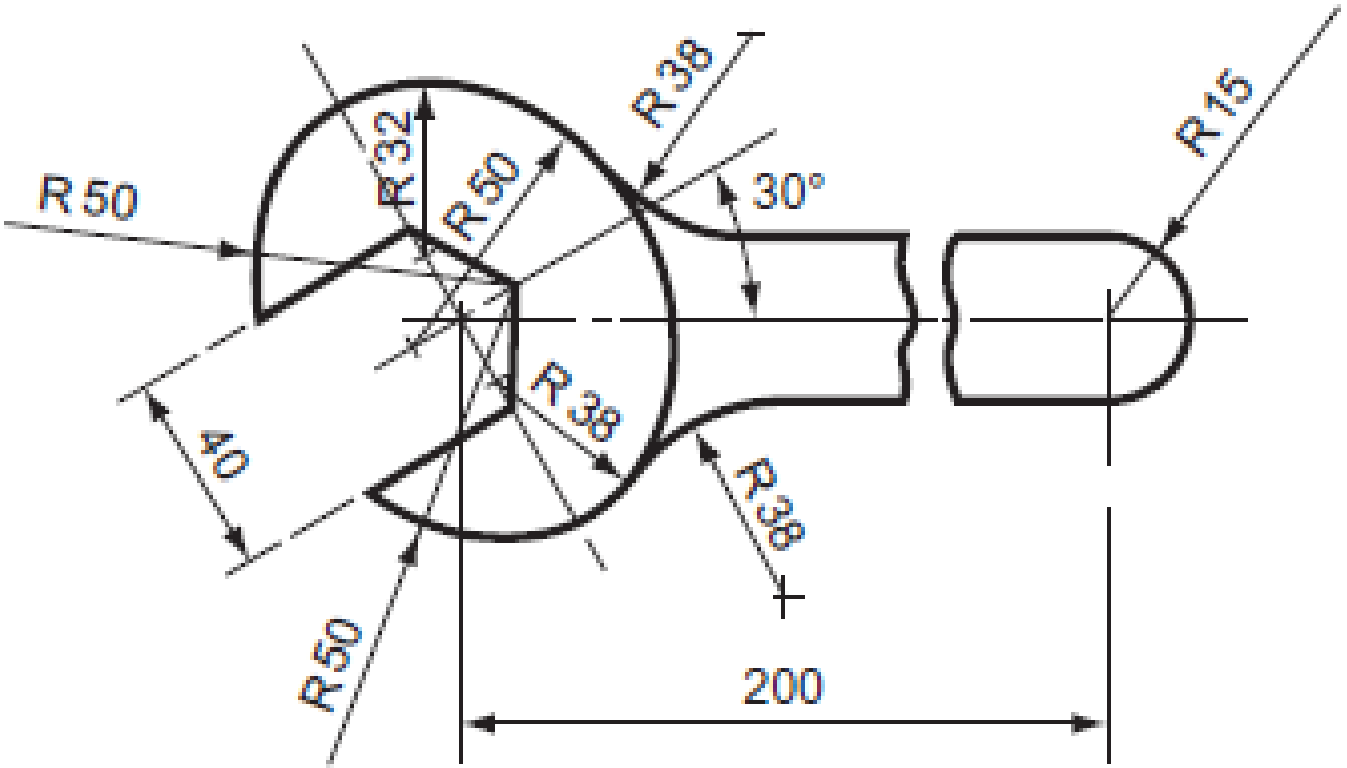
Q12: REPRODUCE THE FIGURE BELOW



Q13: REPRODUCE THE FIGURE BELOW



Q14: REPRODUCE THE FIGURE BELOW



Dimensions in mm

Q15: REPRODUCE THE FIGURE BELOW