# VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

- **Subject –** Mathematics
- **Chapter –** Lines and Angles

# Today's Targets

1 Complete Chapter

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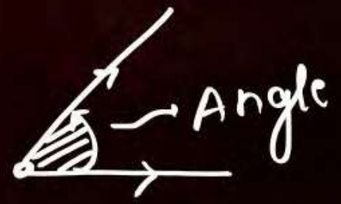
# Introduction

- In our daily life we see different types of angles formed between the edges of plane surfaces.
- Suppose you want to make the hut to keep in the school exhibition using bamboo sticks! Imagine how would you make it?

- Architect → multistoried building
- In science reflection and refraction diagrams are drawn using the knowledge of angles.

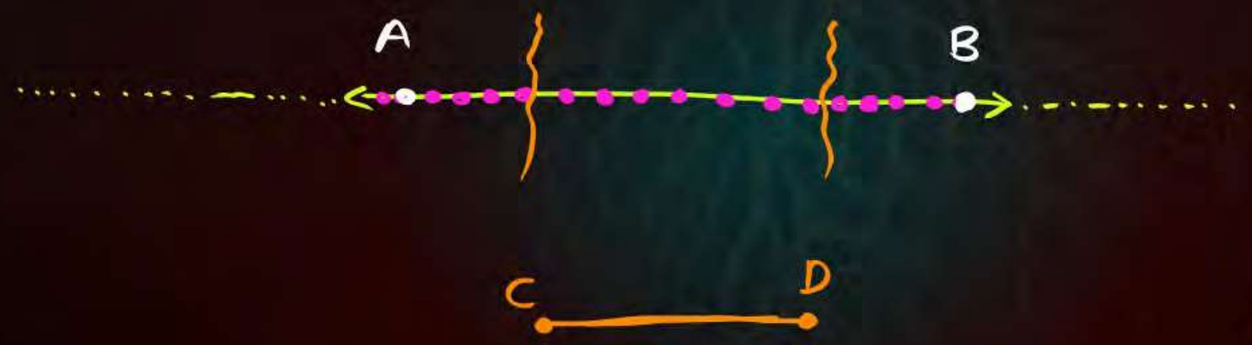



- Class 10th height and distances.

# Basic Definitions: Line and Line Segment

A line is a straight path with no end points and extends infinitely on opposite direction. A line segment is a straight path with two end points.

**Denoted by :**




$\overleftrightarrow{AB}$ → line AB

$\overline{CD}$ → line segment CD

Note: (1) We can't measure length of line and infinite many points can lie on line.
(2) We can measure the length of line segment.

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## Some important Notes

The line segment AB is denoted by $\overline{AB}$, and its length is denoted by AB. The ray AB is denoted by $\overrightarrow{AB}$, and a line is denoted by $\overleftrightarrow{AB}$. However, we will not use these symbols, and will denote the line segment AB, ray AB, length AB and line AB by the same symbol, AB. The meaning will be clear from the context. Sometimes small letters l, m, n etc. will be used to denote lines.

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# Basic Definitions: Ray

A ray is a part of a line which has only one end point.

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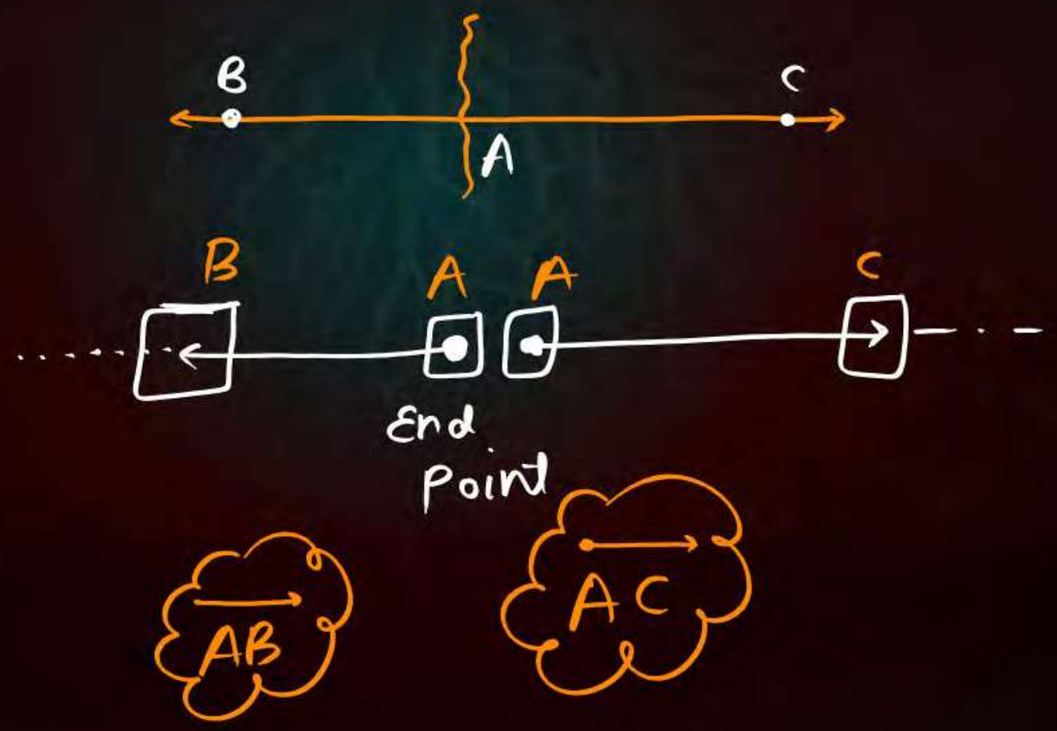


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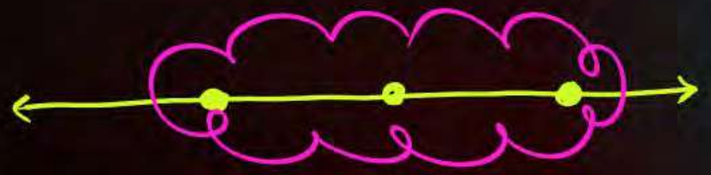
# Collinear points and Non- collinear points

If three or more points lie on the same line then these points are known as collinear points and the points which do not lie on the same line are known as non-collinear points.



Collinear Point

Non-collinear Points

Key point: Sare Ke sare Points line ke upar Hone chahiye!!!

Agar ek bhi point line se bahar hua to vo Non-collinear Hogal!

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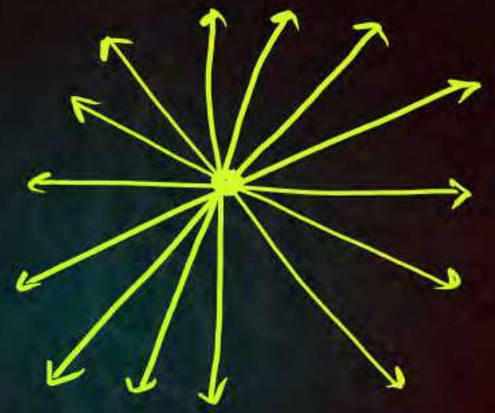
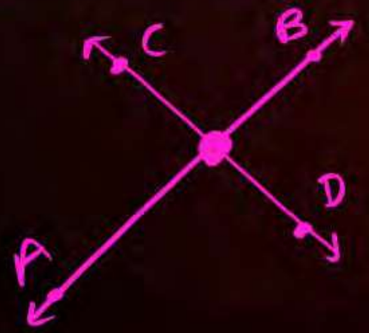
# Concurrent lines

Three or more lines are said to be concurrent if all of them intersect at the same point



**Intersecting lines :-**




→ AB and CD are intersecting line

conc urrent lines

Sare lines ek hi Points se pass kar rhe Hai !!

More than 2 lines

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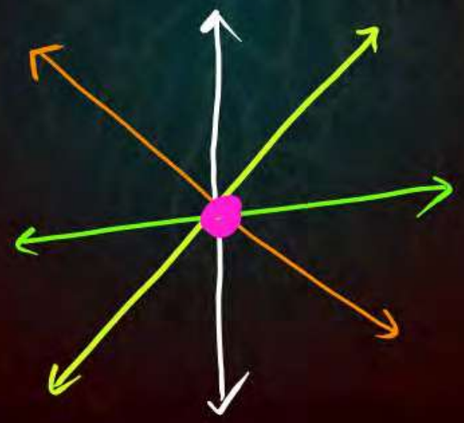
# Important Points

(1) A line segment has a definite length but a ray and a line have indefinite length.

(2) If there are two points given, then only a single line passes through them.

(3) There can be infinite number of lines passing through a single point.



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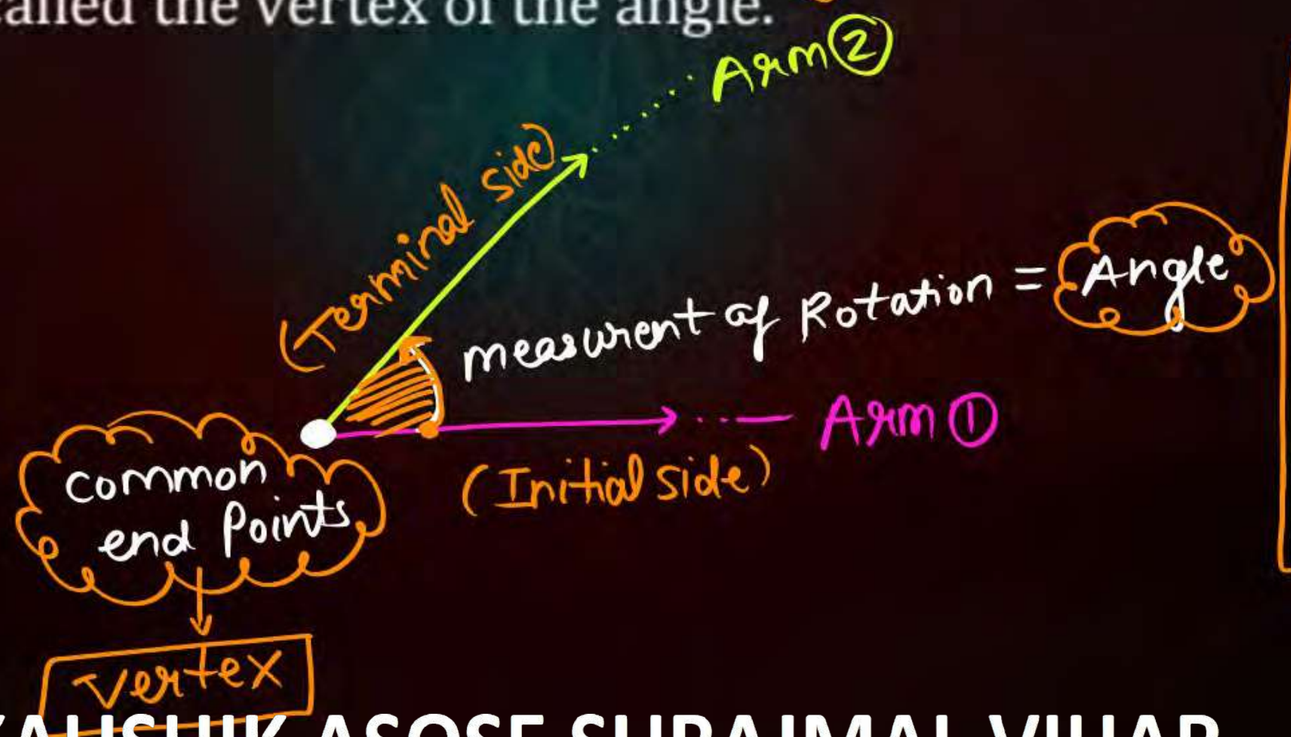
# Angles ki Baatein: Initial side, Terminal Side (Arms) and Vertex

- An angle is formed when two rays have same end point.
- The rays making an angle are called the arms of the angle
- The end point is called the vertex of the angle.




- vertex
- Initial side } ARM
- Terminal side
- Angle

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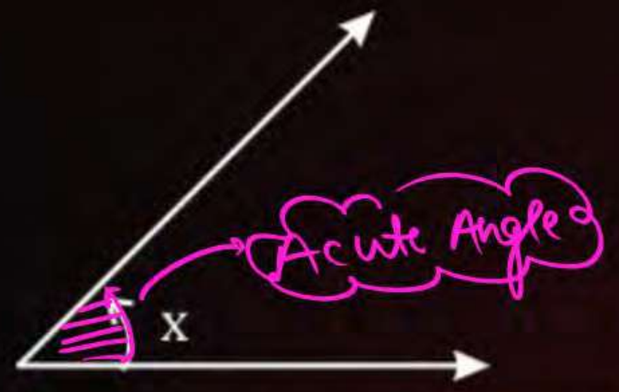
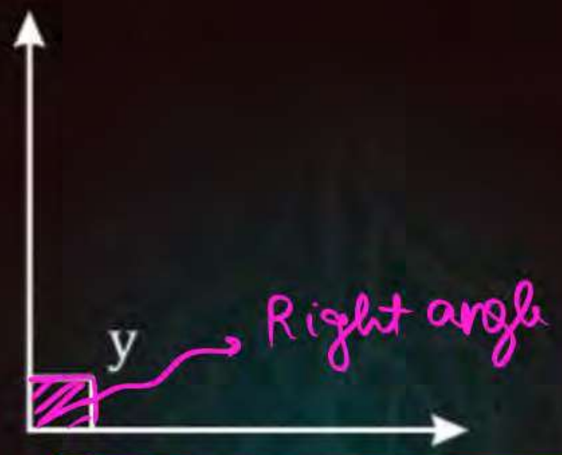
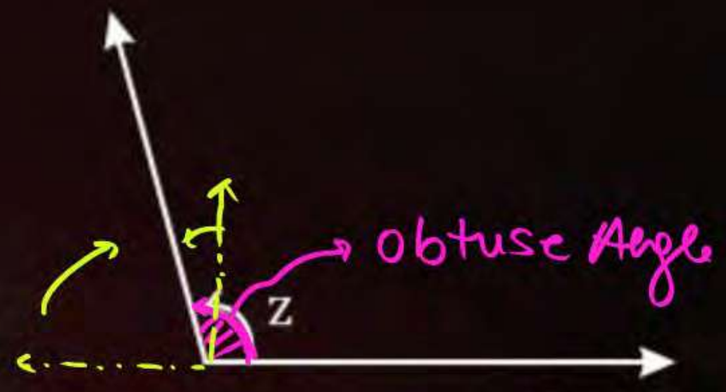
# Types of Angles




(i) Acute angle : $0° < x < 90°$

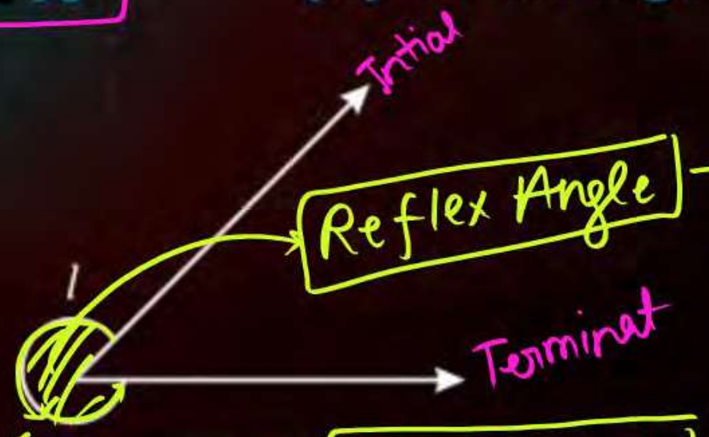



(ii) Right angle : $y = 90°$




(iii) Obtuse angle : $90° < z < 180°$

(iv) Straight angle : $s = 180°$




Acute angle ke pichhe vala part

(v) Reflex angle : $180° < l < 360°$

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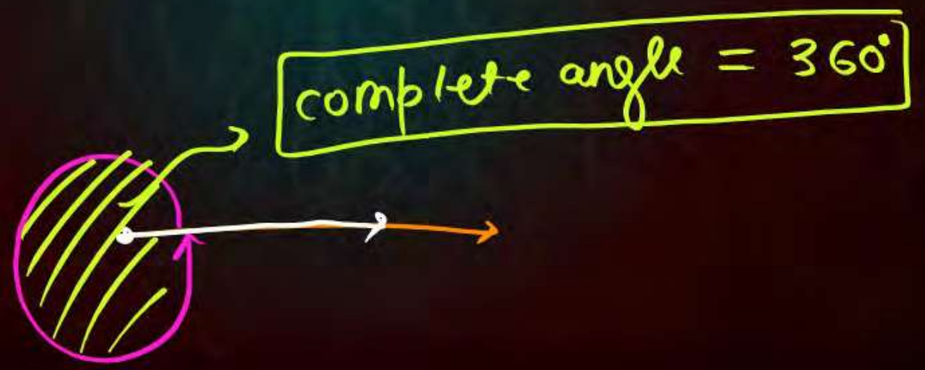
# Types of Angles

**(vi) Zero angle :**

**(vii) Complete angle :**

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# Complementary angles and Supplementary angles

## Complementary angles & Supplementary angles

Two angles are said to be complementary if their sum is equal to $\boxed{90°}$

Ex:- (a) 30°, 60°
(b) 45°, 45°
(c) 20°, 70°

$\boxed{\theta}$, $\boxed{90° - \theta}$

Two angles are said to be supplementary if their sum is equal to $\boxed{180°}$

Ex:- (a) 60°, 120°
(b) 30°, 150°
(c) 20°, 160°

$\boxed{\theta}$, $\boxed{180° - \theta}$

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# Points to Remember!

- Complementary and supplementary angles need not be adjacent.

- If $\angle a$ and $\angle b$ are complementary angles, then → $\angle a$ is a complement of $\angle b$ and $\angle b$ is a complement of $\angle a$.

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## Question

(1) Find the complement and supplement of angle 40°.

(2) The ratio of two complementary angles is 2 : 3. Find the angles.

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**Question**

(1) Find the complement and supplement of angle 40°.

given angle $\theta = 40^\circ$

complement $= 90^\circ - \theta = 90^\circ - 40^\circ = \boxed{50^\circ}$

supplement $= 180^\circ - \theta = 180^\circ - 40^\circ = \boxed{140^\circ}$

(2) The ratio of two complementary angles is 2 : 3. Find the angles.

Let those complementary are $\boxed{\theta}$ and $\boxed{90^\circ - \theta}$

$$\frac{\theta}{90^\circ - \theta} = \frac{2}{3}$$

$3\theta = 180^\circ - 2\theta \Rightarrow 5\theta = 180^\circ$

$\boxed{\theta = 36^\circ}$

complement $= 90^\circ - 36^\circ = \boxed{54^\circ}$

$$\frac{90^\circ - \theta}{\theta} = \frac{2}{3} \Rightarrow 270^\circ - 3\theta = 2\theta$$

$\Rightarrow 270^\circ = 5\theta$

$$\boxed{\theta = \frac{270^\circ}{5} = 54^\circ}$$

complement $= 90^\circ - 54^\circ = \boxed{36^\circ}$

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## Question

Find the complement of the following angles.

(i) $38°$

(ii) 4/5 of a right angles

(iii) $45° + x$

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## Question

Find the complement of the following angles.

(i) 38°

(ii) 4/5 of a right angles $= \frac{4}{5}$ of $90^\circ = \frac{4}{5} \times 90^\circ = \frac{360^\circ}{5} = \boxed{72^\circ} \rightarrow$ complement

$= 90^\circ - 72^\circ = \boxed{18^\circ}$

Ans

(iii) $\boxed{45^\circ + x} \longrightarrow$ complement $= 90^\circ - (45^\circ + x)$

$= 90^\circ - 45^\circ - x$

$= \boxed{45^\circ - x}$

**Question**

Find the supplement of the following angles.

(i) $118°$

(ii) $(100 + x)°$

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**Question**

Find the supplement of the following angles.

(i) $118°$ $\longrightarrow$ supplement $= 180° - 118° = \boxed{62°}$ Ans.

(ii) $(100 + x)°$ $\longrightarrow$ supplement $= 180° - (100° + x)$

$= 180° - 100° - x$

$= \boxed{80° - x}$ Ans

## Question

Find the angle which is

(i) $20°$ more than its complement.

(ii) $36°$ less than its supplement

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## Question

Find the angle which is

(i) 20° more than its complement.

(ii) 36° less than its supplement

(i) Let Required angle is $\theta$

A/c $\theta = (90^\circ - \theta) + 20^\circ$

$\theta = 90^\circ - \theta + 20^\circ$

$2\theta = 110^\circ$

$\boxed{\theta = 55^\circ}$

(ii) Let required angle is $\alpha$.

$\alpha = (180^\circ - \alpha) - 36^\circ$

$\alpha = 180^\circ - \alpha - 36^\circ$

$2\alpha = 144^\circ$

$\boxed{\alpha = 72^\circ}$ ✓

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**Question**

Find the angle whose

(i) Complement is one-sixth of its supplement

(ii) Supplement is four-times its complement

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**Question**

Find the angle whose

(i) Complement is one-sixth of its supplement → Let required angle is '$\theta$'.

$$(90^\circ - \theta) = \frac{1}{6} \times (180^\circ - \theta)$$

$$540^\circ - 6\theta = 180^\circ - \theta \Rightarrow 540^\circ - 180^\circ = 6\theta - \theta \Rightarrow 360^\circ = 5\theta \Rightarrow \theta = \frac{360^\circ}{5} = \boxed{72^\circ}$$

(ii) Supplement is four-times its complement

$$\boxed{(180^\circ - \theta) = \frac{1}{4} \times (90^\circ - \theta)}$$

**Question**

The difference in the measure of two complementary angles is 12°. Find the measures of angles.

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**Question**

The difference in the measure of two complementary angles is 12°. Find the measures of angles.

Let complementary are '$\theta$' and $(90^\circ - \theta)$.

$\theta - (90^\circ - \theta) = 12^\circ$

$\theta - 90^\circ + \theta = 12^\circ$

$2\theta = 90^\circ + 12^\circ$

$2\theta = 102^\circ$

$\boxed{\theta = 51^\circ} \longrightarrow$ complement $= 90^\circ - 51^\circ = \boxed{39^\circ}$

$(90^\circ - \theta) - \theta = 12^\circ$

$90^\circ - \theta - \theta = 12^\circ$

$90^\circ - 2\theta = 12^\circ$

$90^\circ - 12^\circ = 2\theta$

$78^\circ = 2\theta \Rightarrow \theta = \frac{78^\circ}{2} = \boxed{39^\circ}$

complement $= 90^\circ - 39^\circ$

$= \boxed{51^\circ}$

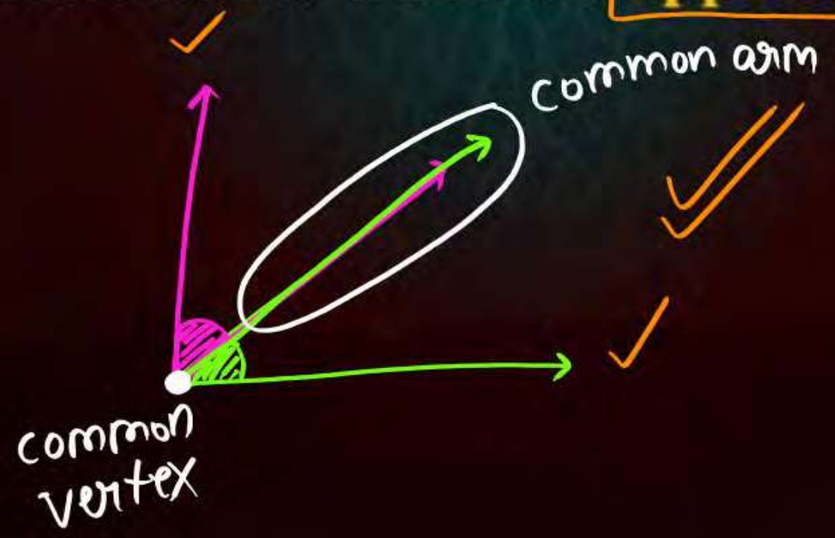
# Adjacent Angles

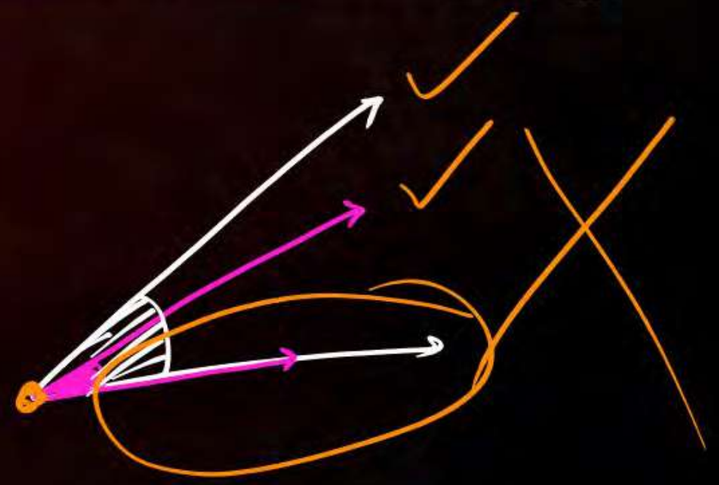
Two angles are said to be adjacent if they have

(1) a common vertex,

(2) a common arm

(3) and their non common arms are on the **opposite sides** of the common arm.



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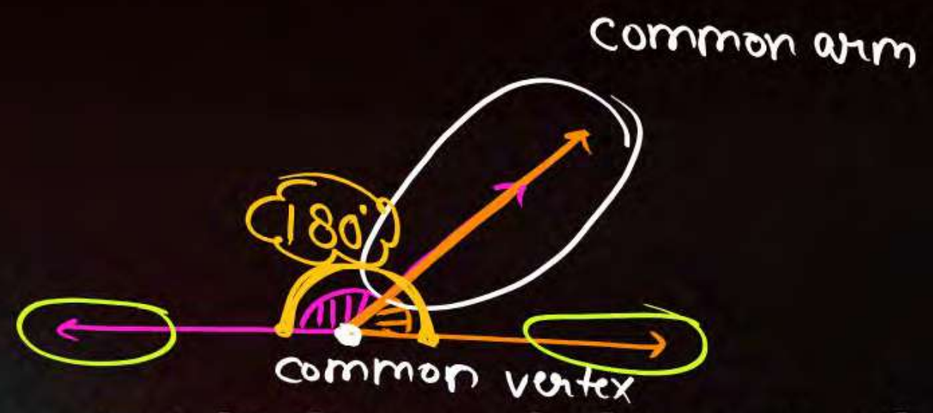
# Linear Pair




In a linear pair, if the two adjacent angles have

(1) a common vertex,

(2) a common arm,

(3) and then the non-common side makes a straight line and the sum of the measure of angles is 180°.

The linear pair of angles are always supplementary as they form on a straight line. In other words, the sum of two angles in a linear pair is always 180°.

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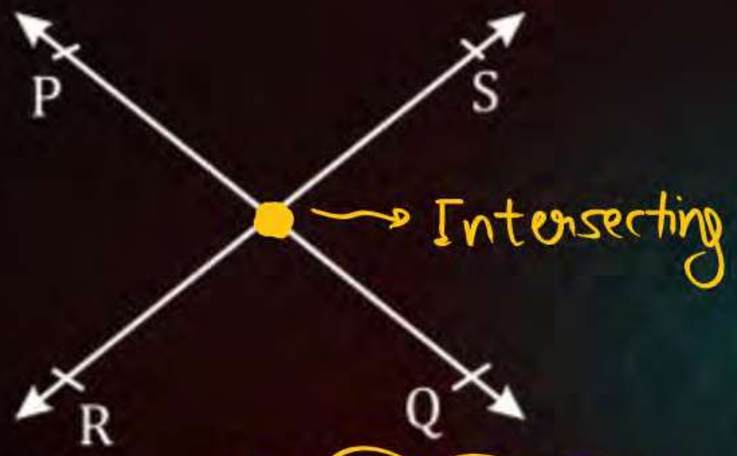
# Intersecting Lines and Non-intersecting Lines




These two lines meet at a single points

Two lines which never meets each other

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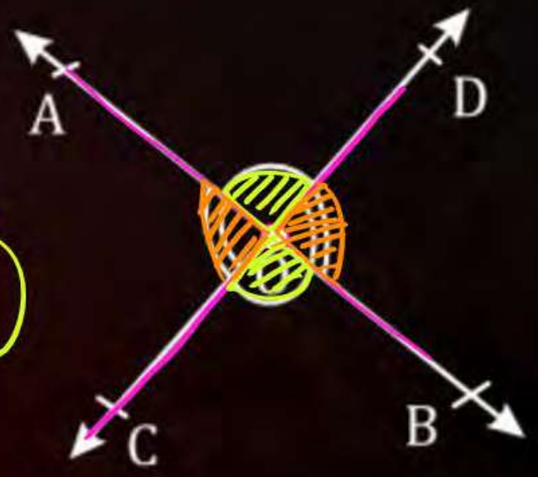
# Vertically opposite angles

When two straight lines intersect each other, each pair of opposite angles so formed are called vertically opposite angles.

Ek vertex ke along Jo 2 angles ek dusare ke opposite Ho!!!

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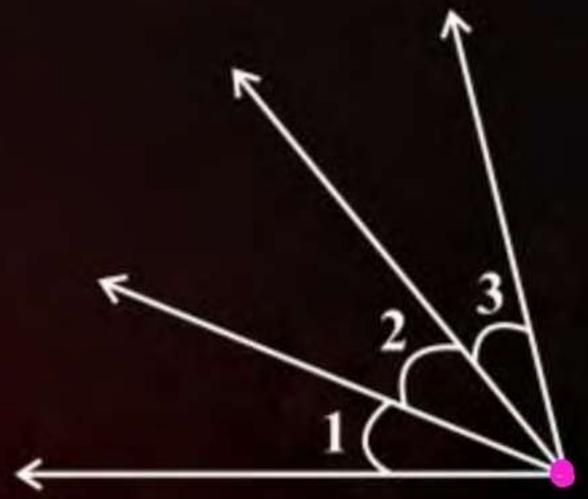
**Question**

In the following figure, is $\angle 1$ adjacent to $\angle 3$?

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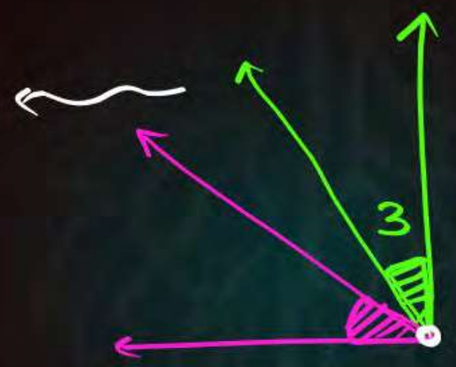
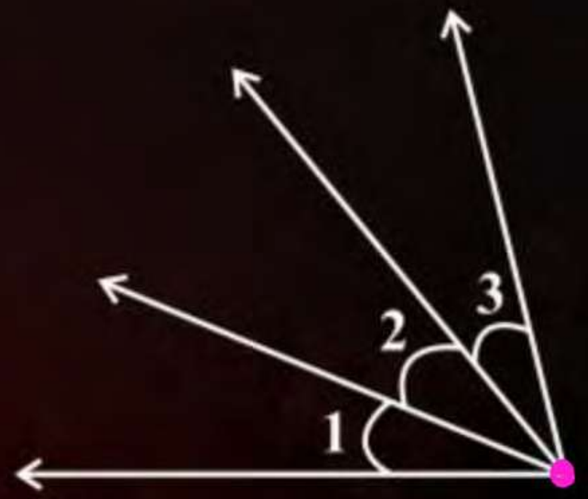
**Question**

In the following figure, is $\angle 1$ adjacent to $\angle 3$? → No

No common Arm

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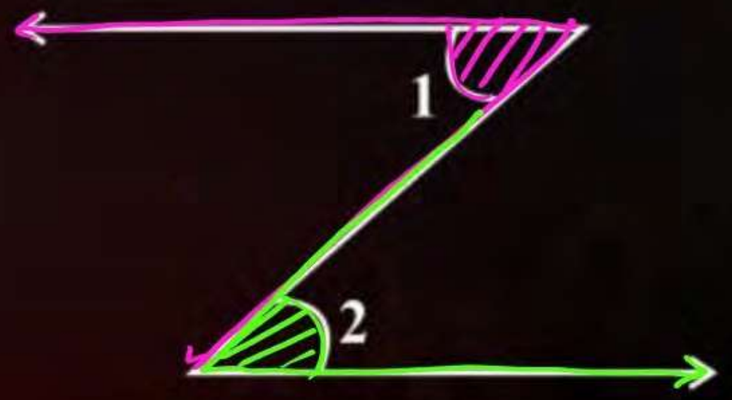
**Question**

Is $\angle 1$ adjacent to $\angle 2$?

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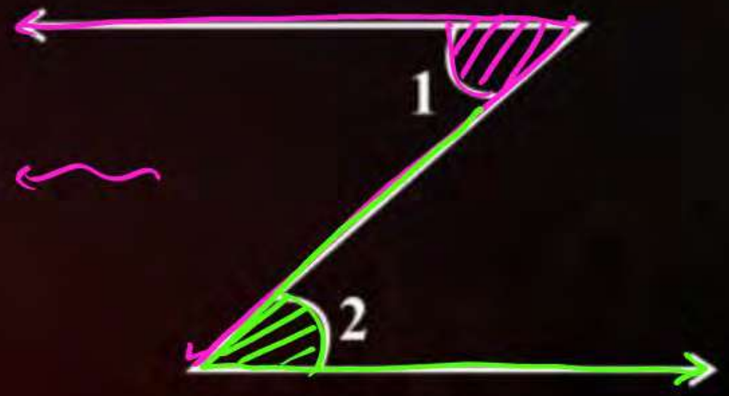
**Question**

Is $\angle 1$ adjacent to $\angle 2$? → No

No common vertex

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**Question**

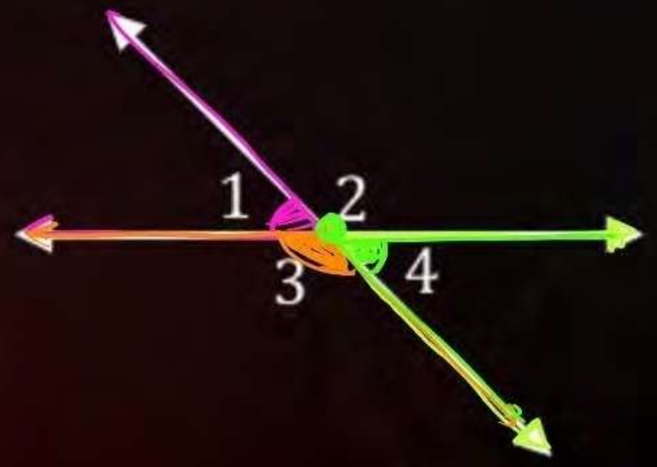
Which of the following statement is/are true?

$\angle 1$ and $\angle 4$ are adjacent

$\angle 3$ and $\angle 4$ are adjacent

$\angle 1$ and $\angle 3$ are adjacent

$\angle 2$ and $\angle 3$ are adjacent

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## Question

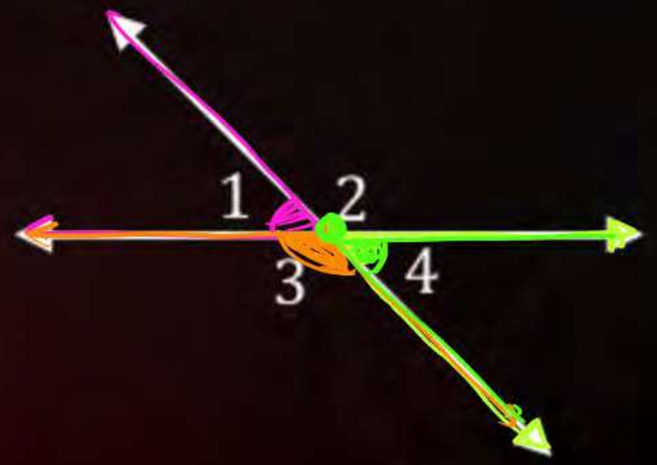
Which of the following statement is/are true?

**A** $\angle 1$ and $\angle 4$ are adjacent → False

**B** $\angle 3$ and $\angle 4$ are adjacent → True

**C** $\angle 1$ and $\angle 3$ are adjacent → True

**D** $\angle 2$ and $\angle 3$ are adjacent → False

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## Question

Given $\angle POR = 3x$ and $\angle QOR = 2x + 20°$, If POQ is a straight line, then the value of x is

32°

34°

36°

42°

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## Question

Given $\angle POR = 3x$ and $\angle QOR = 2x + 20°$, If POQ is a straight line, then the value of x is

A. 32°

B. 34°

C. 36°

D. 42°

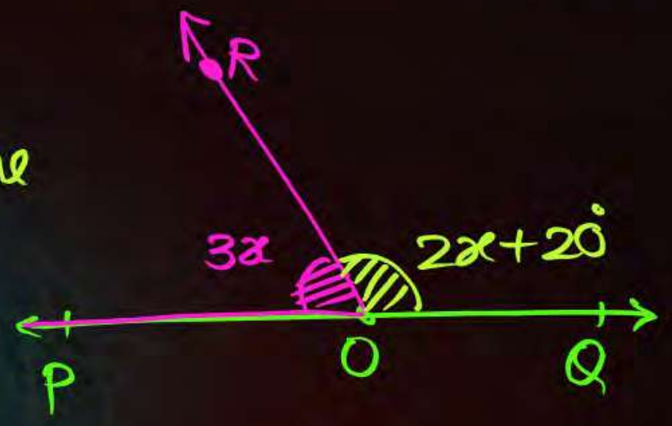
since POQ is a straight line

$(3x) + (2x + 20°) = 180°$

$5x + 20° = 180$

$5x = 160°$

$x = \frac{160°}{5} = \boxed{32°}$

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## Question

If the supplement of an angle is three times its complement, then the angle is

$40°$

$35°$

$50°$

$45°$

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## Question

If the supplement of an angle is three times its complement, then the angle is

A. 40°

B. 35°

C. 50°

D. 45°

Required Angle $= \boxed{\theta}$

$$\boxed{(180^\circ - \theta) = 3(90^\circ - \theta)}$$

$$180^\circ - \theta = 270^\circ - 3\theta$$

$$3\theta - \theta = 270^\circ - 180^\circ$$

$$2\theta = 90^\circ$$

$$\boxed{\theta = 45^\circ}$$

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## Question

Line AB and CD intersect at O. If $\angle AOC = (3x - 10°)$ and $\angle BOD = (20° - 2x)$, then the value of x is

10°

6°

30°

4°

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## Question

Line AB and CD intersect at O. If $\angle AOC = (3x - 10°)$ and $\angle BOD = (20° - 2x)$, then the value of x is

A. 10°

B. 6°

C. 30°

D. 4°

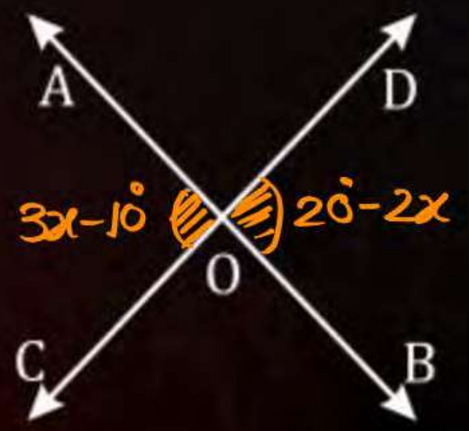
We know, vertically opposite angles are equal.

$3x - 10° = 20° - 2x$

$3x + 2x = 20° + 10°$

$5x = 30°$

$x = \frac{30°}{5} \Rightarrow \boxed{x = 6°}$

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# Boggle the Mind

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**Question**

Find the complement of $38°16'$ is

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**Question**

Find the complement of $\boxed{38°16'}$ is

compliment of $38°16' = 90° - 38°16'$

$= (89° + 1°) - 38°16'$

$= \boxed{89°}\,60' - \boxed{38°}\,16'$

$= \boxed{51°44'}$ Ans.

Key point:

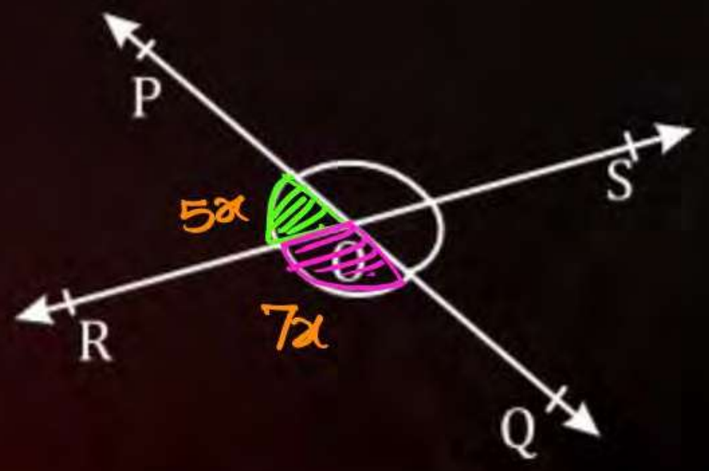
$1° = 60'$ ← Minute

$1' = 60''$ ← seconds

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In given figure, lines PQ & RS intersect each other at point O. If $\angle POR : \angle ROQ = 5 : 7$, find all the angles.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

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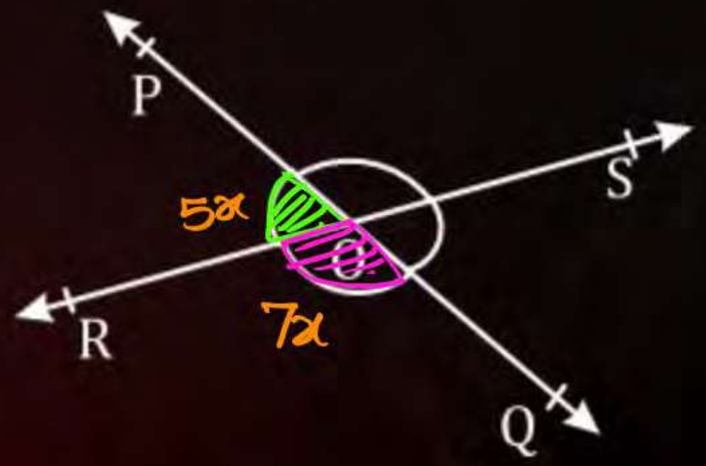


since PQ is a straight line.

$5x + 7x = 180^\circ$

$12x = 180^\circ$

$x = \frac{180^\circ}{12} = \boxed{15^\circ}$ Ans

$\angle POR = \angle SOQ = 5 \times 15^\circ = 75^\circ$

$\angle ROQ = \angle POS = 7 \times 15^\circ = 105^\circ$

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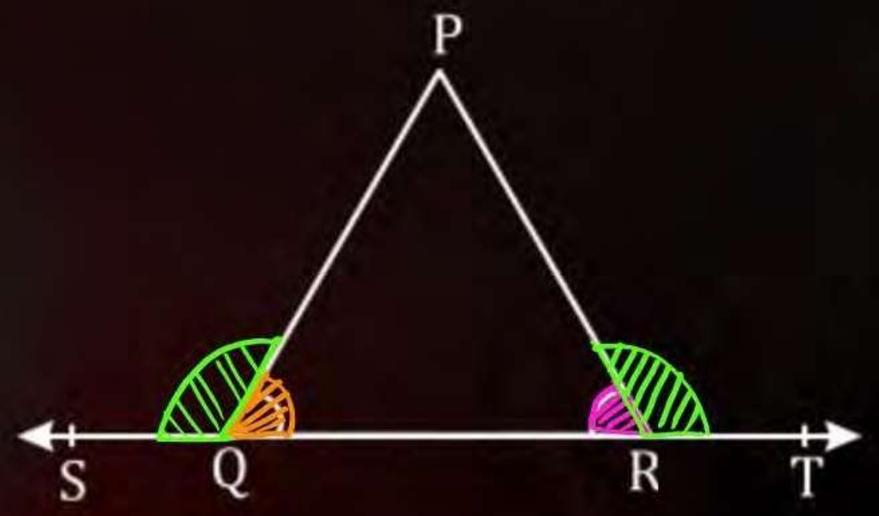
**Question**

In the given figure, $\angle PQR = \angle PRQ$, then prove that $\angle PQS = \angle PRT$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In the given figure, $\angle PQR = \angle PRQ$, then prove that $\angle PQS = \angle PRT$

Given, $\boxed{\angle PQR = \angle PRQ}$

We have a line ST.

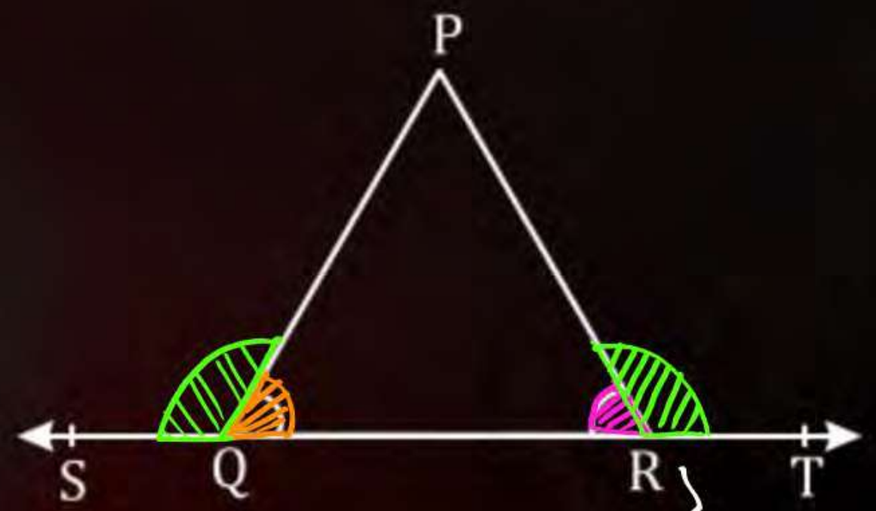
$\angle PQR + \angle PQS = 180^\circ$

$\angle PQS = 180^\circ - \angle PQR$

$\angle PQS = 180^\circ - \angle PRQ$

$\boxed{\angle PQS = \angle PRT}$

Hence, proved!!




$\angle PRQ + \angle PRT = 180^\circ$

$\boxed{\angle PRT = 180^\circ - \angle PRQ}$

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## Question

It is given that $\angle XYZ = 64°$ and XY is produced to point P. Draw a figure from the given information. If ray YQ bisects $\angle ZYP$, find $\angle XYQ$ and reflex $\angle QYP$.

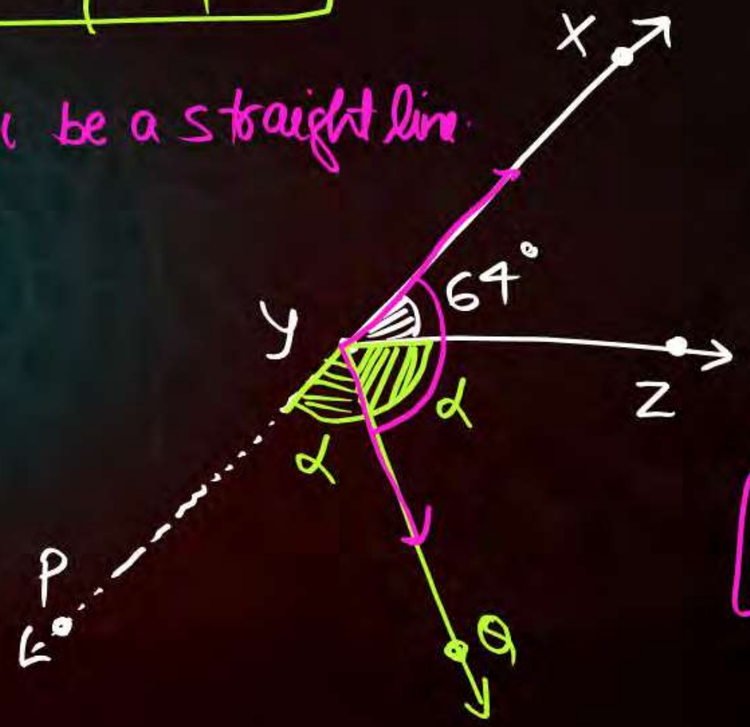
VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

It is given that $\angle XYZ = 64°$ and XY is produced to point P. Draw a figure from the given information. If ray YQ bisects $\angle ZYP$, find $\angle XYQ$ and reflex $\angle QYP$.

divide / distribute / break in two equal part

XY is extended till P, therefore, XP will be a straight line.




$\alpha + \alpha + 64° = 180°$

$2\alpha + 64° = 180°$

$2\alpha = 180° - 64°$

$2\alpha = 116°$

$\alpha = 58°$

$\angle XYQ = 64° + \alpha$

$= 64° + 58°$

$= 122°$

$\angle QYP = \alpha = 58°$

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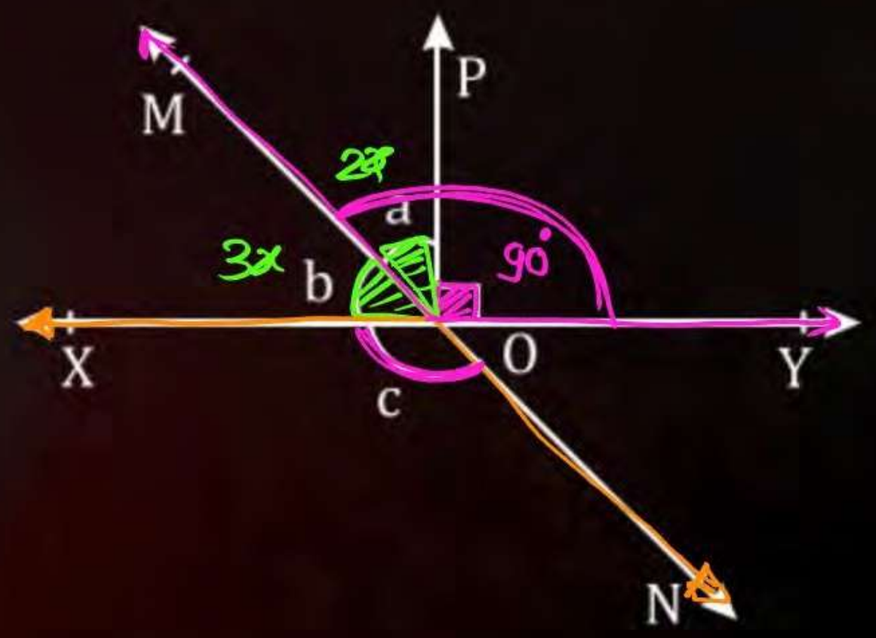
## Question

In the given figure, lines XY and MN intersect at O. If ∠POY = 90° and a : b = 2 : 3, find c.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

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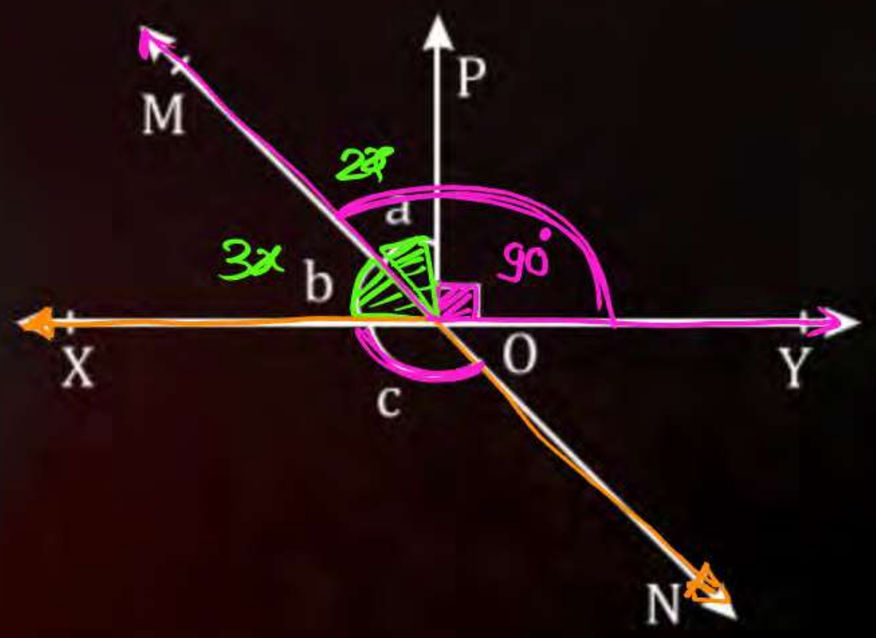


since XY is a straight line.

$2x + 3x + 90° = 180°$

$5x = 90°$

$x = \frac{90°}{5} = 18° \Rightarrow \boxed{x = 18°}$

Now, $\angle XON = \angle MOY$

$c = a + 90°$

$c = 36° + 90° = \boxed{126°}$ Ans

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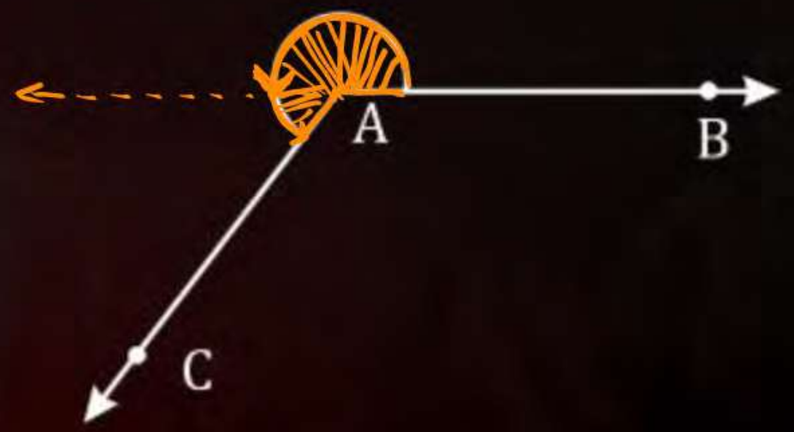
# Reflex Angle

Reflex Angle: $\boxed{180^\circ < \theta < 360^\circ}$

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# Axiom and Theorems

- An axiom is a statement that is considered to be true, based on logic; however, it cannot be proven or demonstrated because it is simply considered as self-evident.

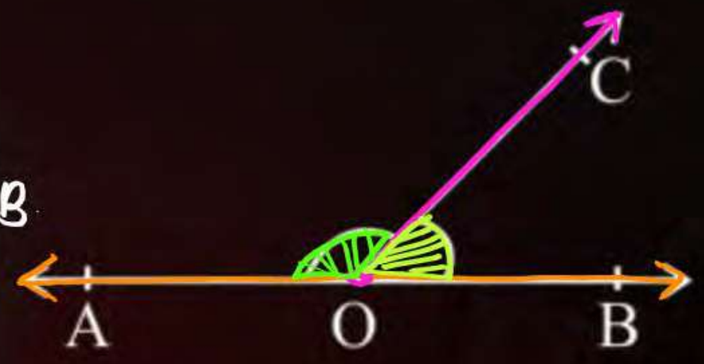
- A theorem is a mathematical statement whose truth has been logically established and has been proved.

We have learnt the definitions of some of the pairs of angles such as complementary angles, supplementary angles, adjacent angles, linear pair of angles, etc. Now, let us find out the relation between the angles formed when a ray stands on a line.

# Thoda Todte Hai Iss Concept Ko Bhi....

$\boxed{\angle AOC + \angle BOC = 180^\circ}$

Because of $\angle AOB = 180^\circ$ over the line AB



## From the above discussion, we can state the following axiom!

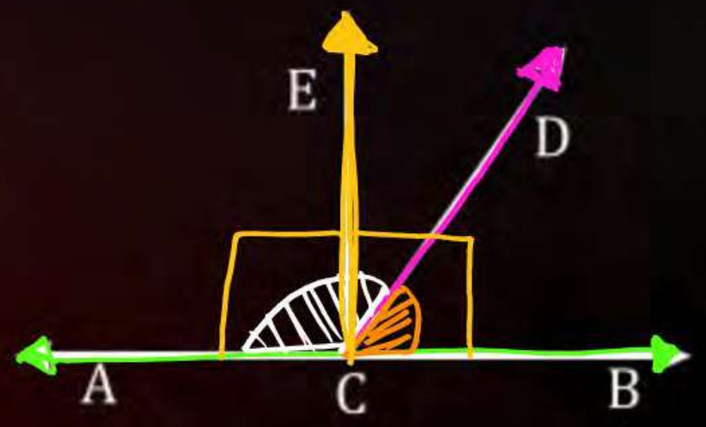
**Axiom 6.1 :** If a ray stands on a line, then the sum of the two adjacent angles so formed is 180°.

$\angle ACD = 90^\circ + \angle ECD$ ---- Eqn ①

$\angle BCD = 90^\circ - \angle ECD$ ---- Eqn ②

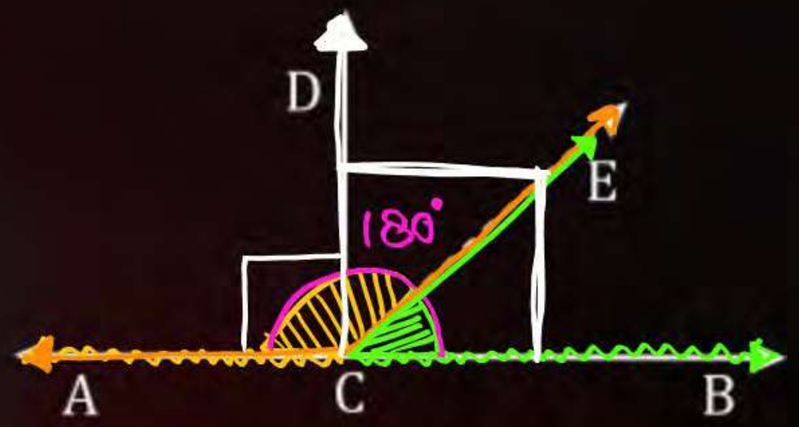
Add

$\boxed{\angle ACD + \angle BCD = 180^\circ}$ ✓



## From the above discussion, we can state the following axiom!

**Axiom 6.2 :** If the sum of two adjacent angles is 180°, then the non-common arms form a line.




$\angle ACE$ & $\angle BCE$ are adjacent angle

$\angle ACE + \angle BCE = 180^\circ$

$90^\circ + \angle ECD + \angle BCE = 180^\circ$

$\angle ECD + \angle BCE = 90^\circ$

$\boxed{\angle BCE = 90^\circ - \angle ECD}$ → Hence, proved !!

Note: The two axioms above together is called the Linear Pair Axiom.

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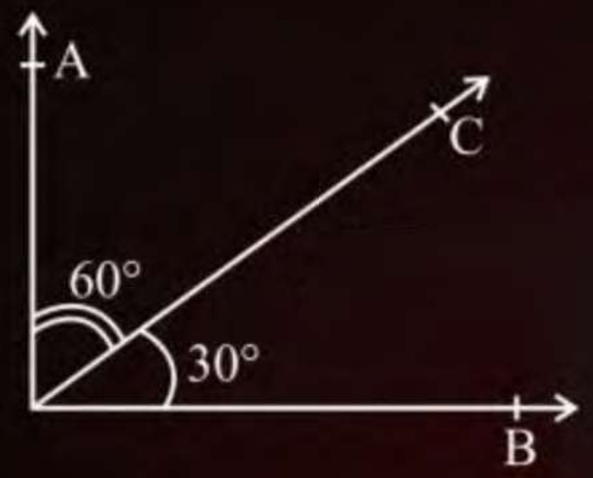
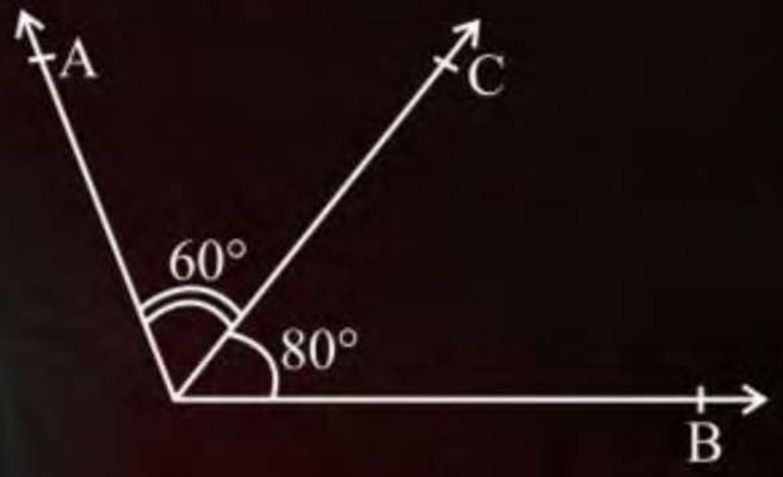
**Question**

Which of the following pair of adjacent angles make Linear Pair?

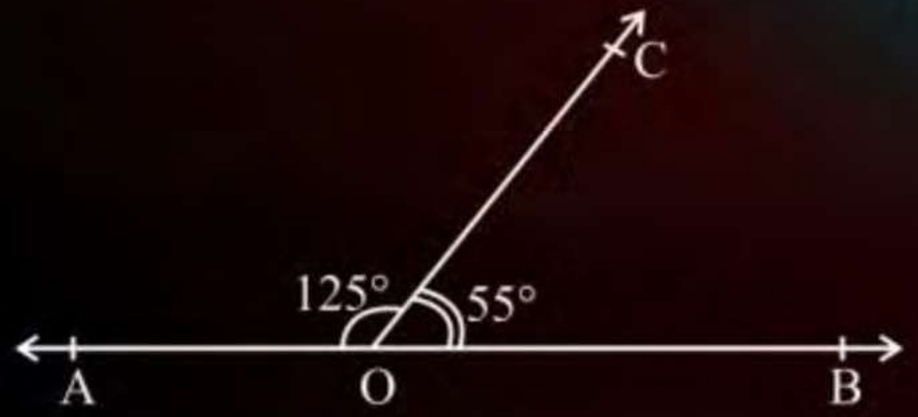
(A)



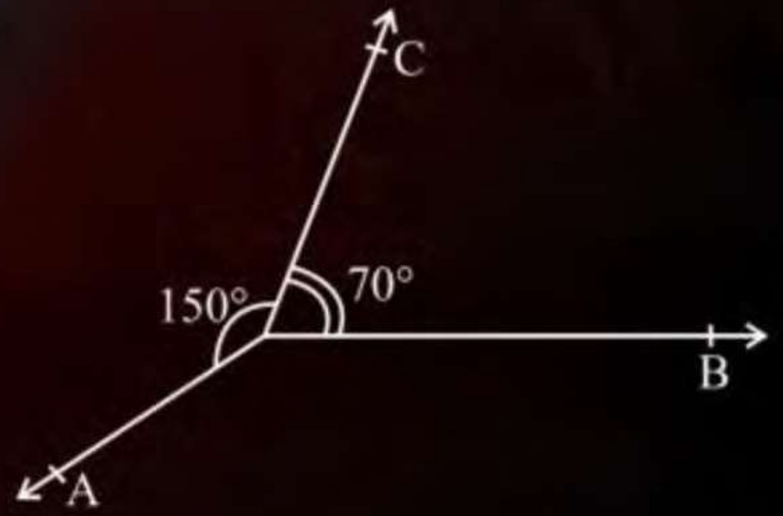

(B)




(C)




(D)

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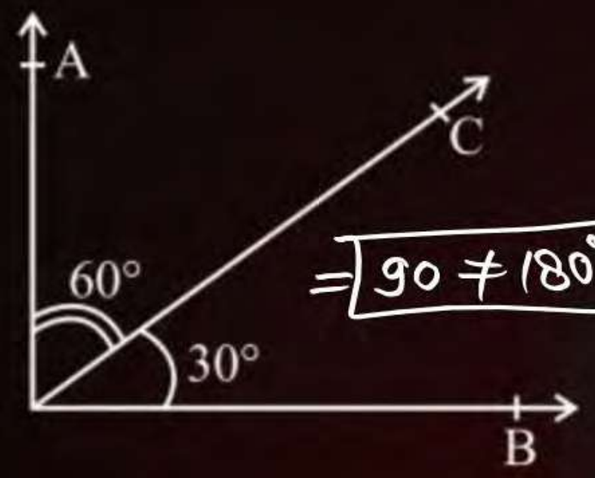
**Question**

Which of the following pair of adjacent angles make Linear Pair?

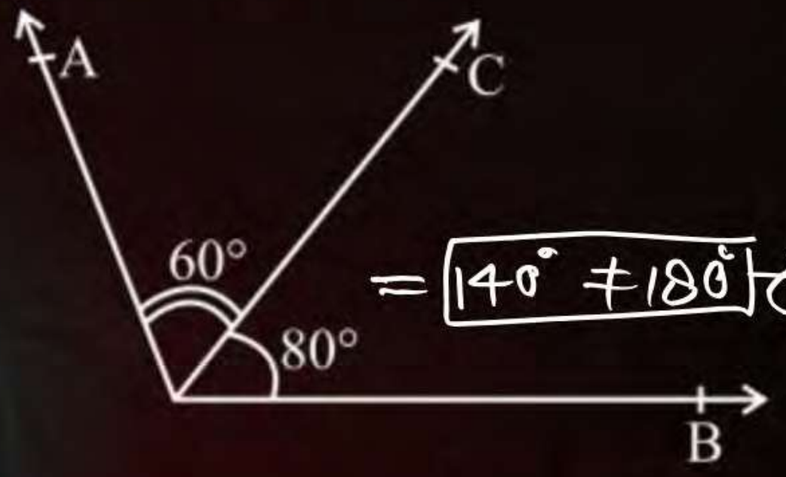
$= 180^\circ$

(A)



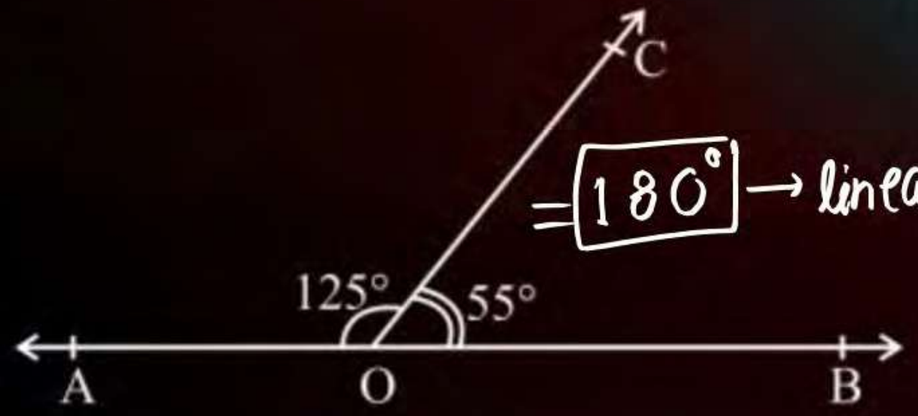

$= \boxed{90 \neq 180^\circ} \rightarrow$ No

(B)



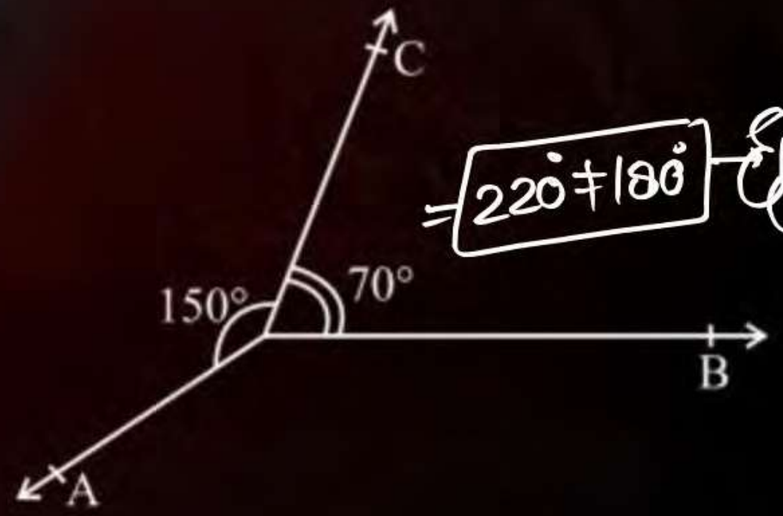

$= \boxed{140^\circ \neq 180^\circ} \rightarrow$ No

(C) ✓




$= \boxed{180^\circ} \rightarrow$ linear Pair

(D)




$= \boxed{220^\circ \neq 180^\circ} \rightarrow$ No

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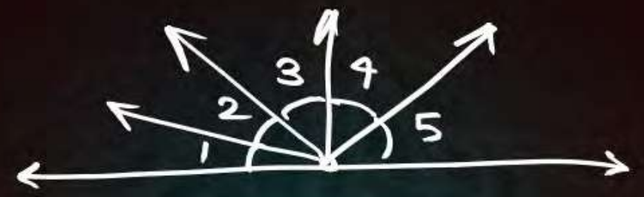
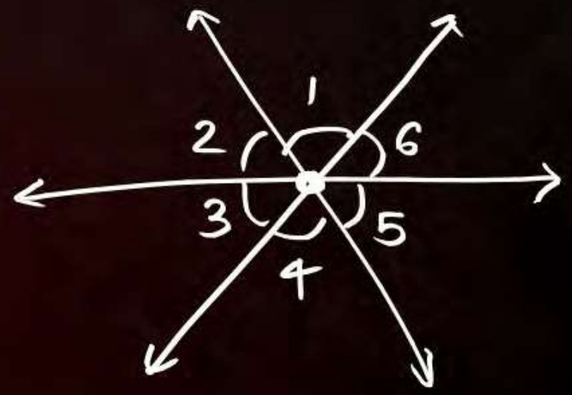
# Bate Thode Basic Level Ki.....

The sum of all the angles over a straight line is equal to 180°




$$\boxed{\angle 1+\angle 2+\angle 3+\angle 4+\angle 5=180^\circ}$$

The sum of all the angles round a point is equal to 360°




$$\boxed{\angle 1+\angle 2+\angle 3+\angle 4+\angle 5+\angle 6=360^\circ}$$

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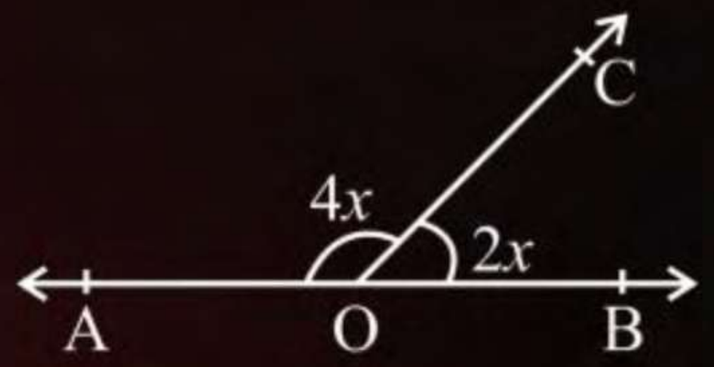
**Question**

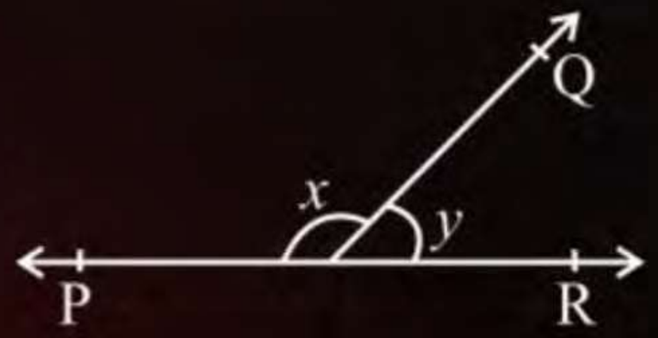
In fig., $\angle AOC$ and $\angle BOC$ form a linear pair. Determine the value of x.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In the given, figure, x is greater than y by 1/3 of a right, angle. Find the value of x and y.

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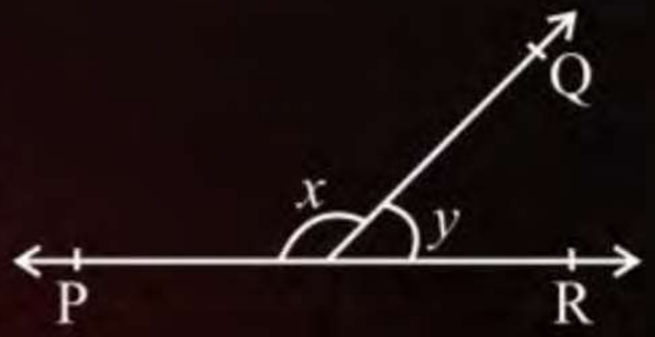



Ac $x = y + \frac{1}{3}$ of $90^\circ$

$x = y + \frac{1}{3} \times 90^\circ \Rightarrow \boxed{x = y + 30^\circ}$ --- eqn (1)

since, PR is a straight line, using linear pair Axiom

$x + y = 180^\circ$

$y + 30^\circ + y = 180^\circ$

$2y = 150^\circ \Rightarrow \boxed{y = 75^\circ} \rightsquigarrow \boxed{x = 105^\circ}$

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

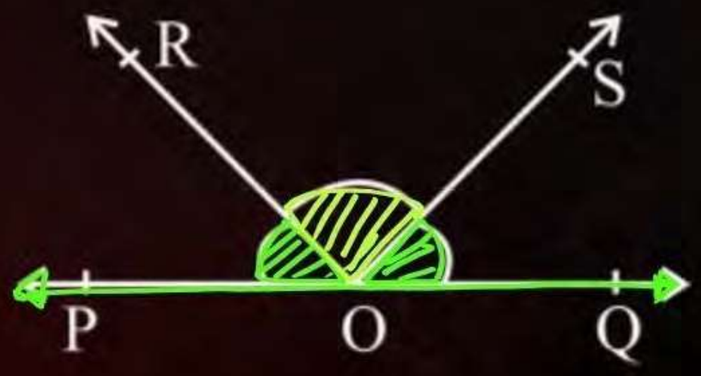
In the figure, If POQ is a straight line and $\angle POR + \angle QOS = 110°$. Find $\angle ROS$.

90°

70°

180°

None of these




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

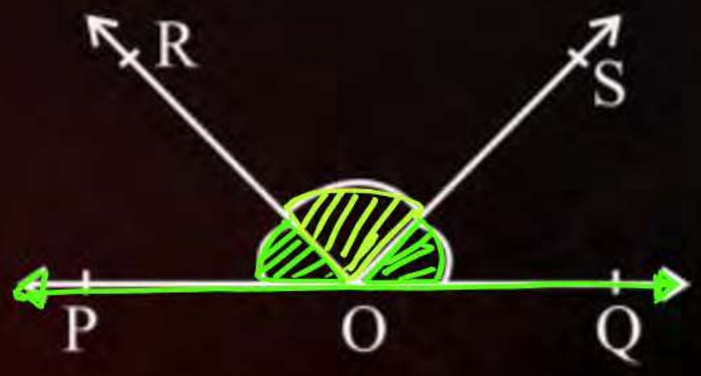
In the figure, If POQ is a straight line and $\angle POR + \angle QOS = 110°$. Find $\angle ROS$.

A. 90°

B. 70°

C. 180°

D. None of these




PQ is a straight line

$\angle POR + \angle ROS + \angle QOS = 180°$

$(\angle POR + \angle QOS) + \angle ROS = 180°$

$110° + \angle ROS = 180°$

$\angle ROS = 180° - 110°$

$= 70°$ Ans

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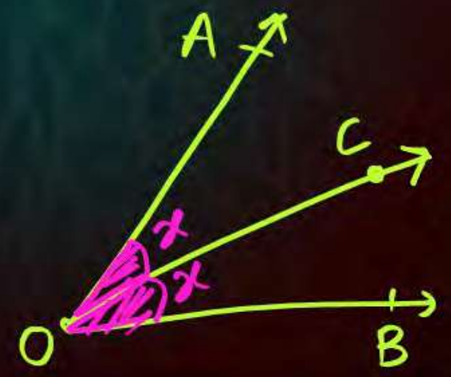
# Ab Ye Angles bisector Kya Hai ???

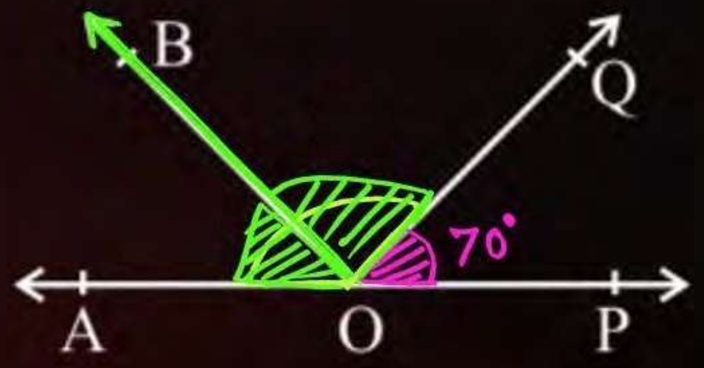
Bisector ka matlab hota hai, two equals parts me divide kar dena!!




OC will be bisector of ∠AOB

**Question**

In the figure, it is given that $\angle POQ = 70°$ and the ray OB bisector $\angle AOQ$. Find $\angle BOP$ and reflex $\angle AOB$.

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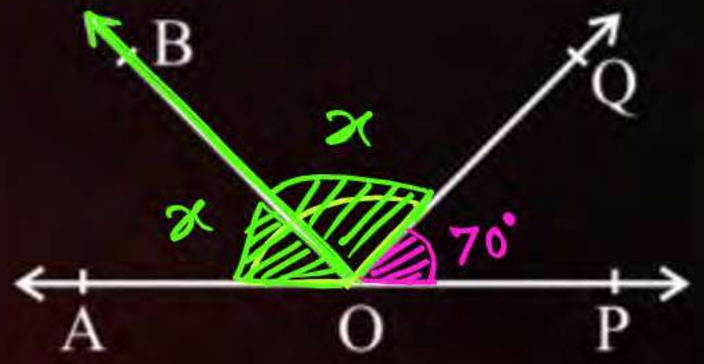
**Question**

In the figure, it is given that ∠POQ = 70° and the ray OB bisector ∠AOQ. Find ∠BOP and reflex ∠AOB.




since OB is bisector of ∠AOQ.

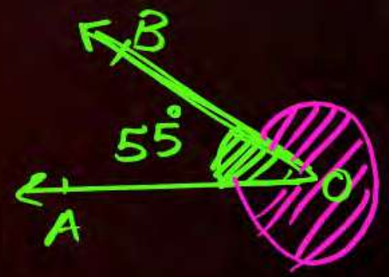
$\angle AOB = \angle BOQ = x$ (let say)

since AOP is a straight line,

$x + x + 70° = 180° \Rightarrow 2x + 70° = 180°$

$\Rightarrow 2x = 110°$

$\Rightarrow \boxed{x = 55°}$




$\boxed{i}$ $\angle BOP = \angle BOQ + \angle POQ$

$= 55° + 70° = \boxed{125°}$ ✓

$\boxed{ii}$

$55° + \text{Reflex } \angle AOB = 360°$

Reflex of $\angle AOB = \boxed{305°}$ ✓ Ans.

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## Question

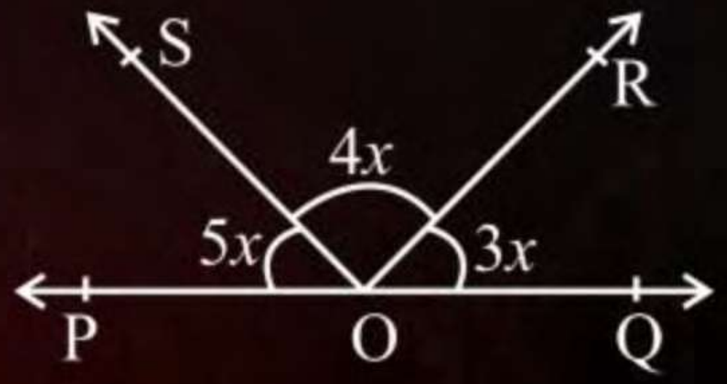
In the given figure, POQ is a straight line and the angle are as shows, the value of $\angle SOR$ is.....

A. $75°$

B. $60°$

C. $45°$

D. $15°$

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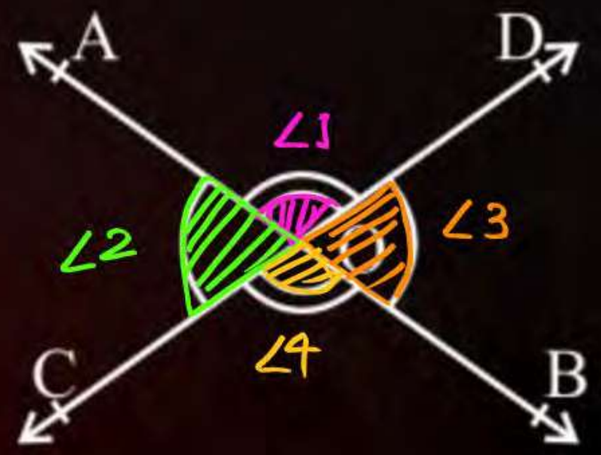
# Theorem – 1

If two lines intersect each other, them the vertically, opposite angles are equal.




AOB is a straight line, therefore ∠1 & ∠3 will be linear pair.

$\angle 1 + \angle 3 = 180^\circ \Rightarrow \boxed{\angle 3 = 180^\circ - \angle 1}$ ---- Eq^n ①

COD is a straight line, therefore ∠2 & ∠1 will be linear pair

$\angle 2 + \angle 1 = 180^\circ \Rightarrow \boxed{\angle 2 = 180^\circ - \angle 1}$ ---- Eq^n ①

From eq^n ① & ②

$\boxed{\angle 3 = \angle 2}$ ✓ → vertically opposite angles are equal. similarily, $\boxed{\angle 1 = \angle 4}$ ✓

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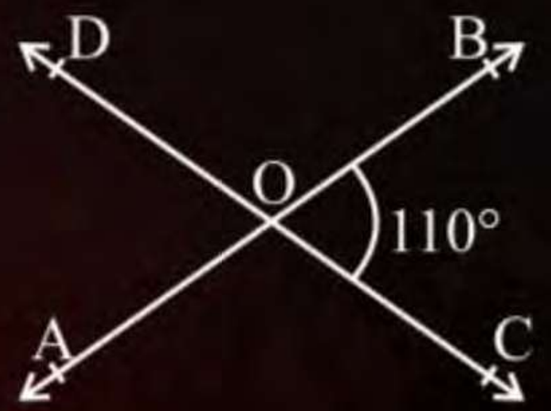
## Question

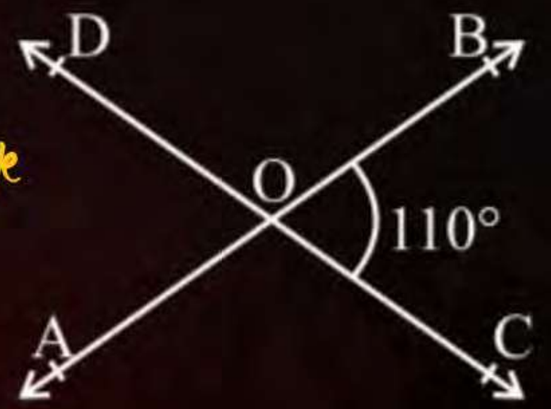
In the given figure, AB and CD are two straight lines intersecting at, O. If $\angle BOC = 110°$, then find all the other angles.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In the given figure, AB and CD are two straight lines intersecting at, O. If $\angle BOC = 110°$, then find all the other angles.




given: $\angle BOC = 110°$

$\angle AOD = \angle BOC = 110°$ (Because of vertically opposite Angles)

Now, CD is a straight line

$\angle DOB + \angle COB = 180°$

$\angle DOB + 110° = 180° \Rightarrow \boxed{\angle DOB = 70° = \angle AOC}$ → Because of vertically opposite angles.

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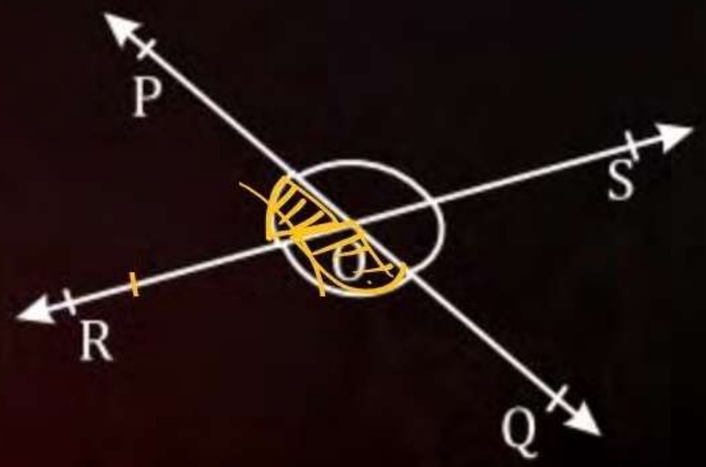
## Question

In given figure, lines PQ and RS intersect each other at point O. If $\angle POR : \angle ROQ = 5 : 7$, find the $\angle SOQ$.




**A** 75°

**B** 105°

**C** 90°

**D** None of these

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## Question

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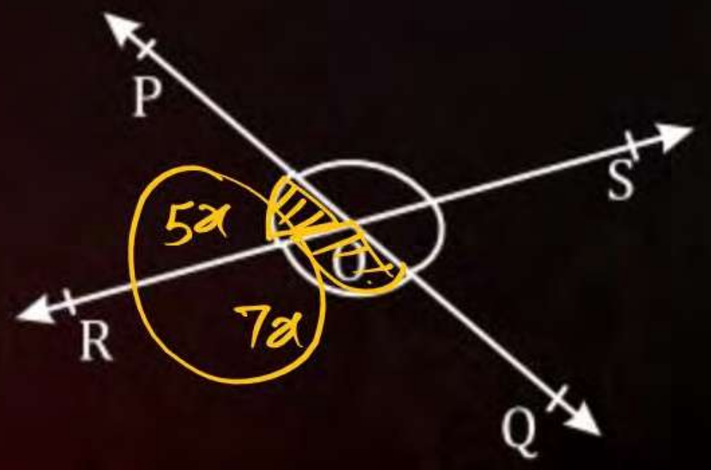


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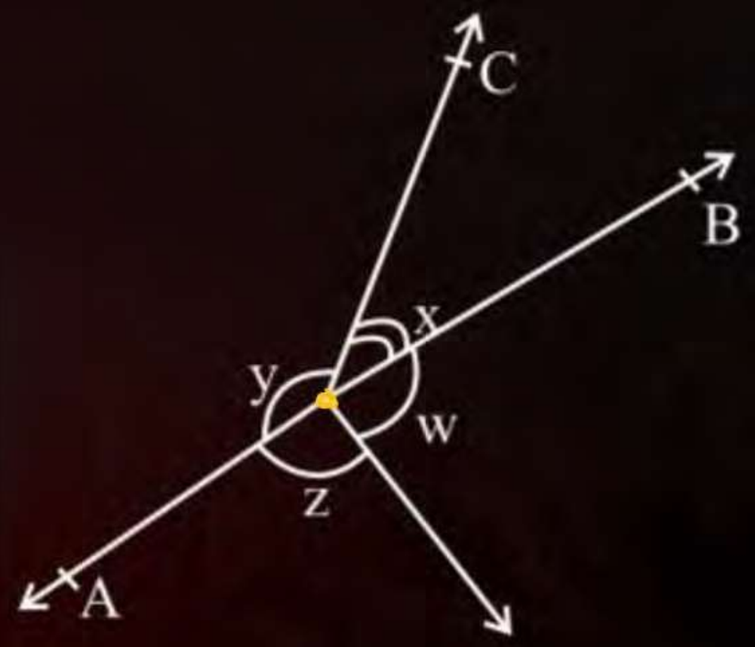
**Question**

In figure, if x + y = w + z, then prove that AOB is a line.

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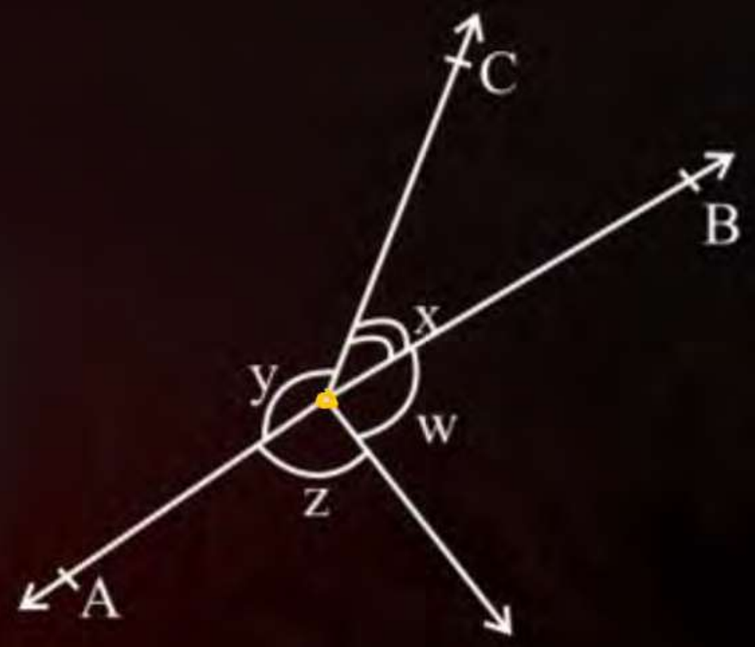



Given, $\boxed{x+y=w+z}$

Now, $\boxed{x+y}+\boxed{w+z}=360^\circ$

(Angle around a point $=360^\circ$)

$(x+y)+\boxed{x+y}=360^\circ$

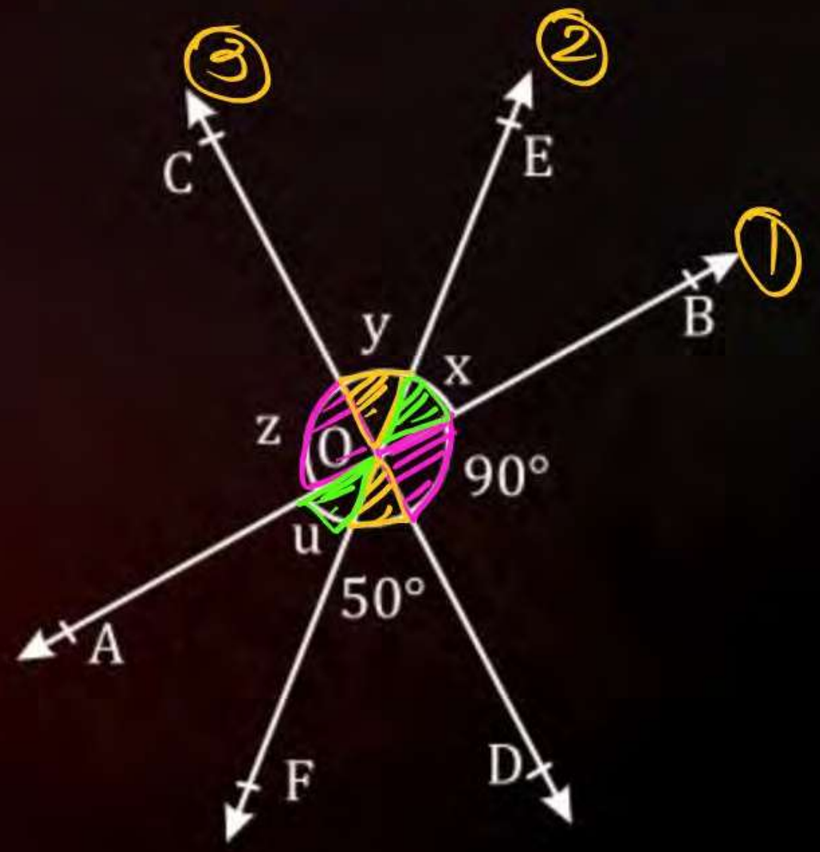
$2(x+y)=360^\circ$

$x+y=\frac{360^\circ}{2} \Rightarrow \boxed{x+y=180^\circ}$

↳ x & y are linear pair → $\boxed{\text{AOB is a straight line}}$

## Question

In the given figure three coplanar lines intersect at a point O forming angles as shown in the figure. Find the values of x, y, z and u

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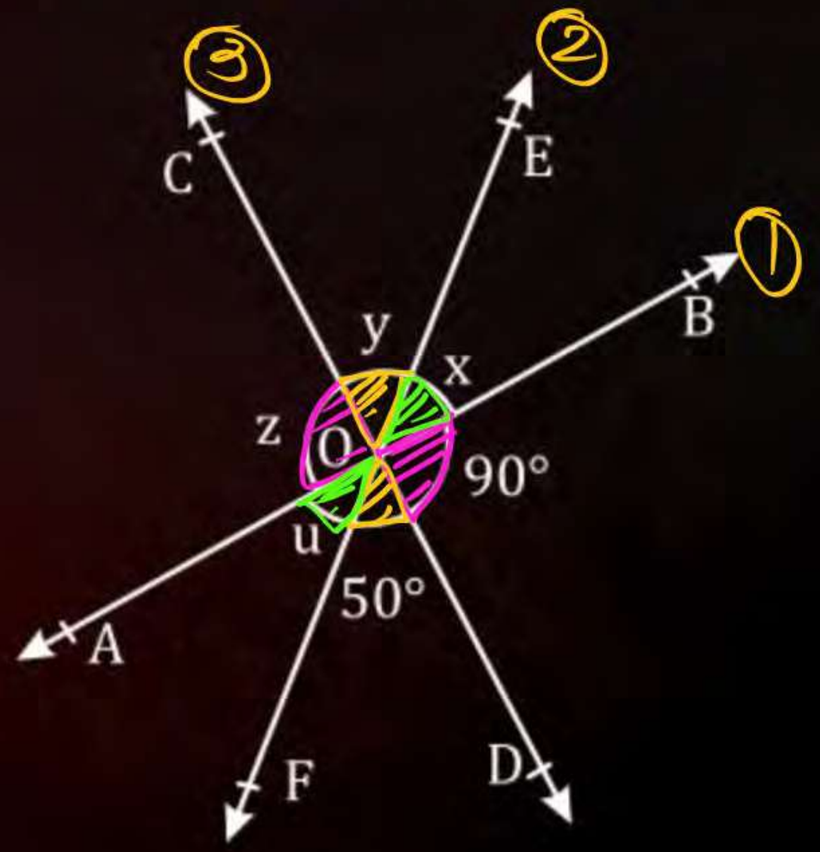


$z = 90^\circ$ (Because of V.O.A)

$y = 50^\circ$ (Because of V.O.A)

since, AOB is a straight line,

$u + 50^\circ + 90^\circ = 180^\circ$

$u = 180^\circ - 140^\circ$

$\boxed{u = 40^\circ = x}$ → Because of V.O.A)

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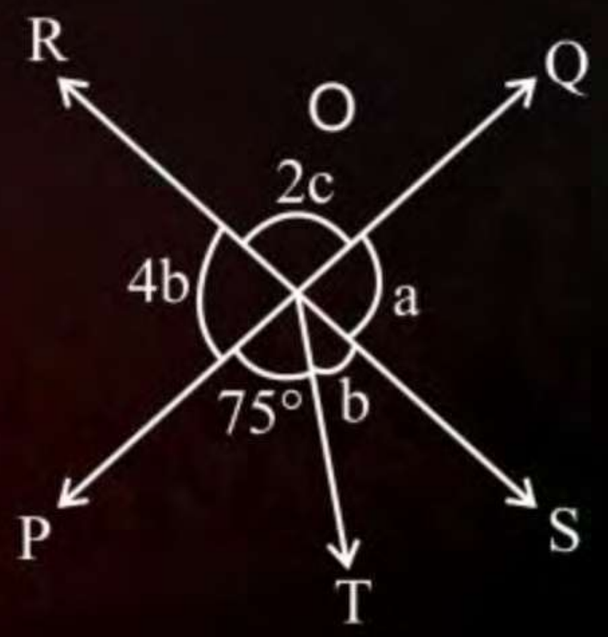
## Question

In fig., two straight lines PQ and RS intersect each other at O. If ∠POT = 75°, find the values of a, b and c.

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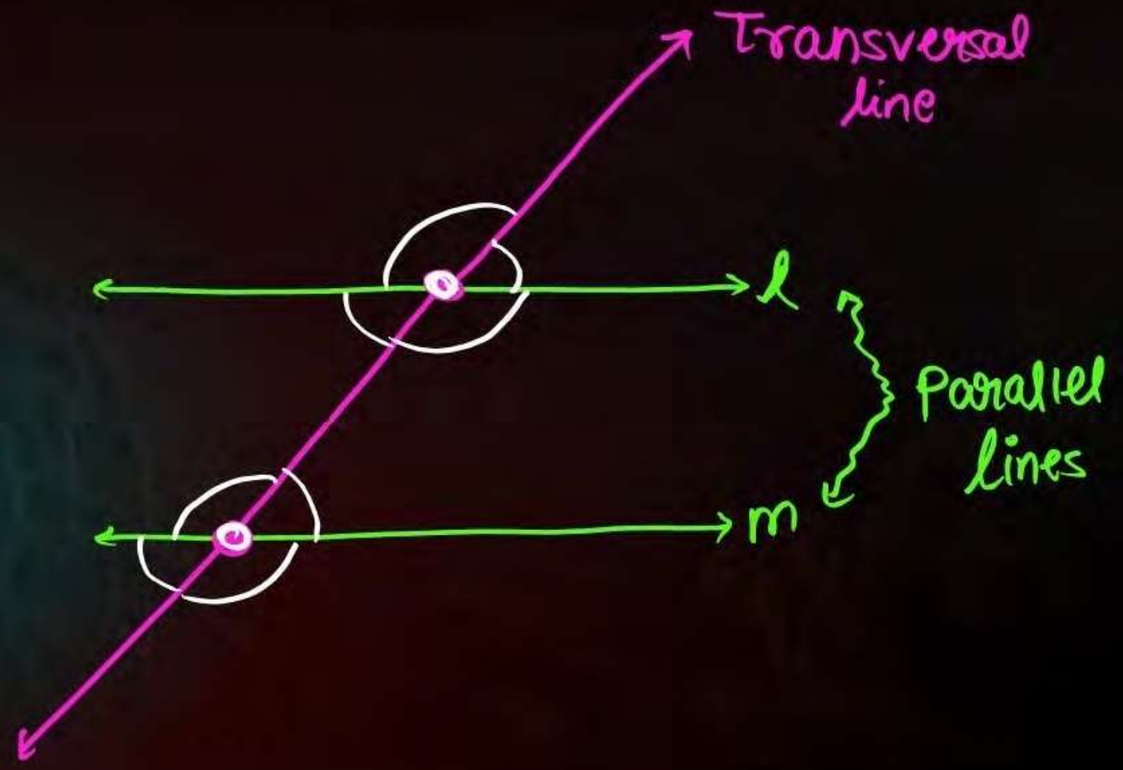


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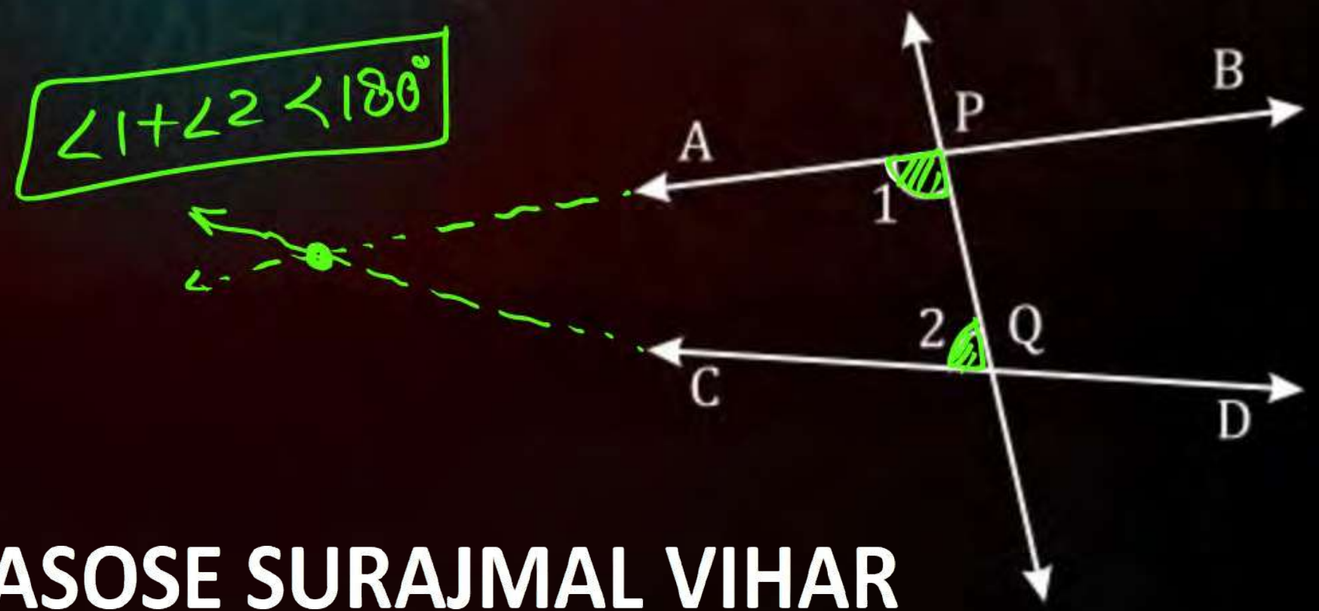
# Euclid's Postulate (5)

**Postulate 5 :** If a straight line falling on two straight lines makes the interior angles on the same side of it taken together less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.

The line PQ falls on lines AB and CD such that the sum of the interior angles 1 and 2 is less than 180° on the left side of PQ. Therefore, the lines AB and CD will eventually intersect on the left side of PQ.

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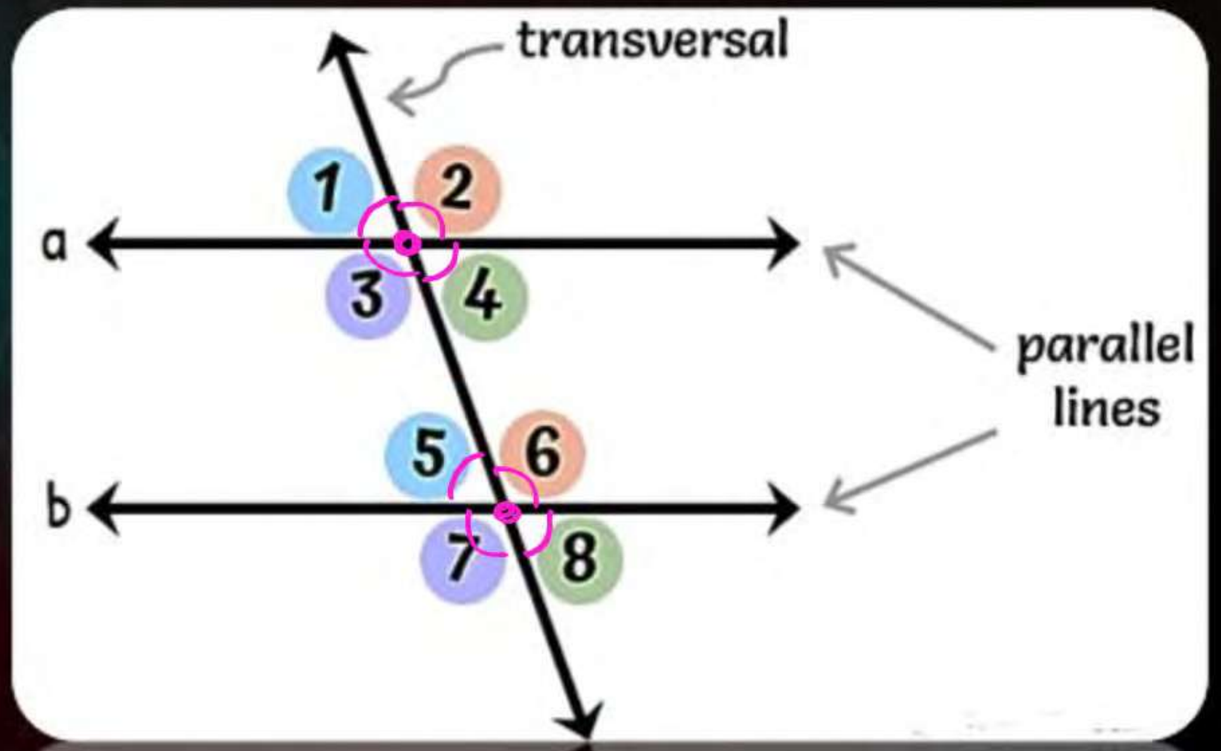
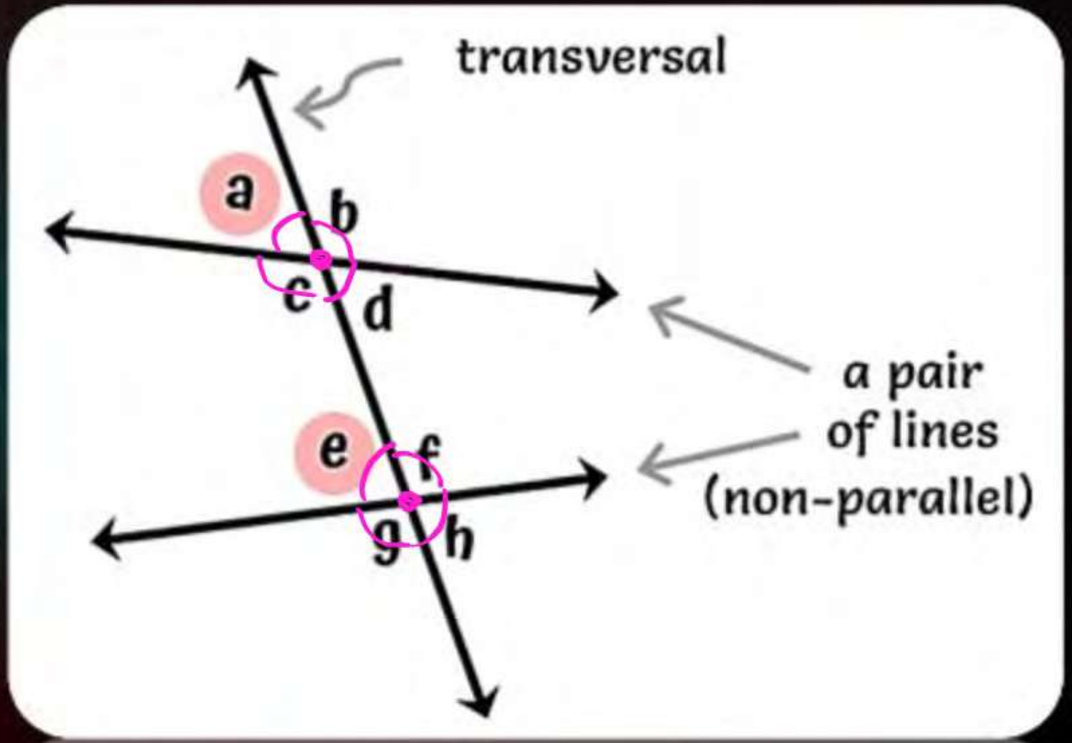
# Parallel lines and transversal

**Transversal :** A line which intersects two or more given lines at distinct points, is a transversal of the given lines.



# Angles made by transversal with two lines

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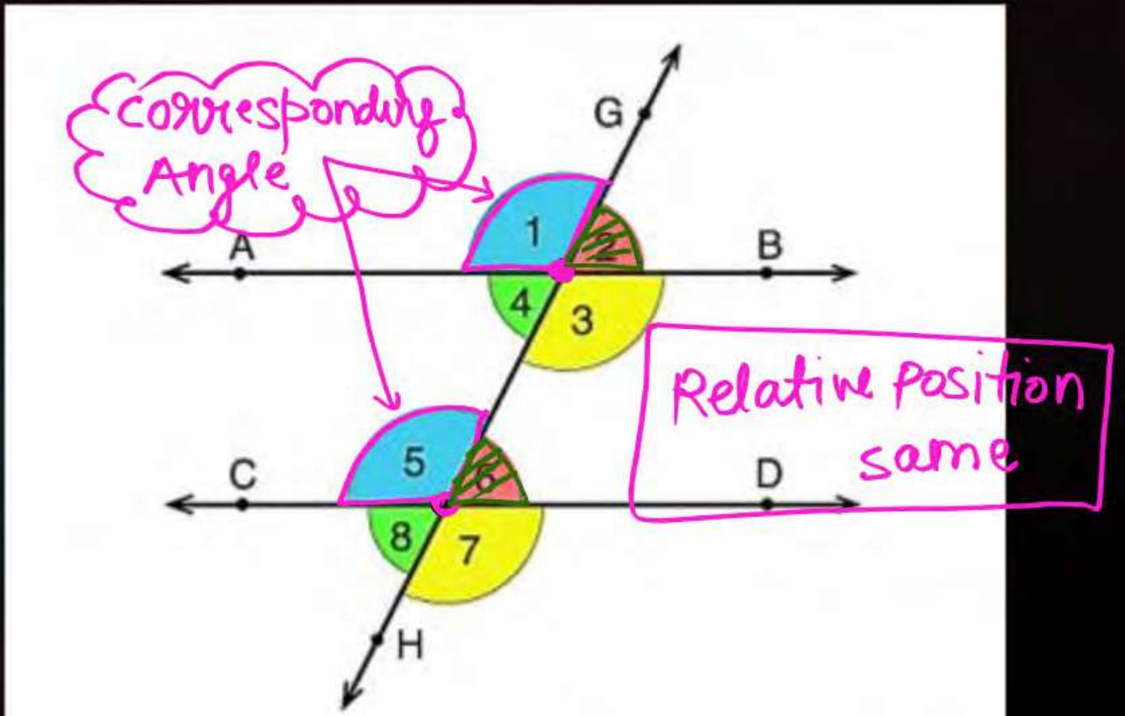
# Different Types of Pair of Angles

**Corresponding angles:-** Two angles on the same side of a transversal are known as the corresponding angles if both lie above the two lines or below the two lines.

Corresponding angles are two angles that lie in similar relative positions on the same side of a transversal or at each intersection.

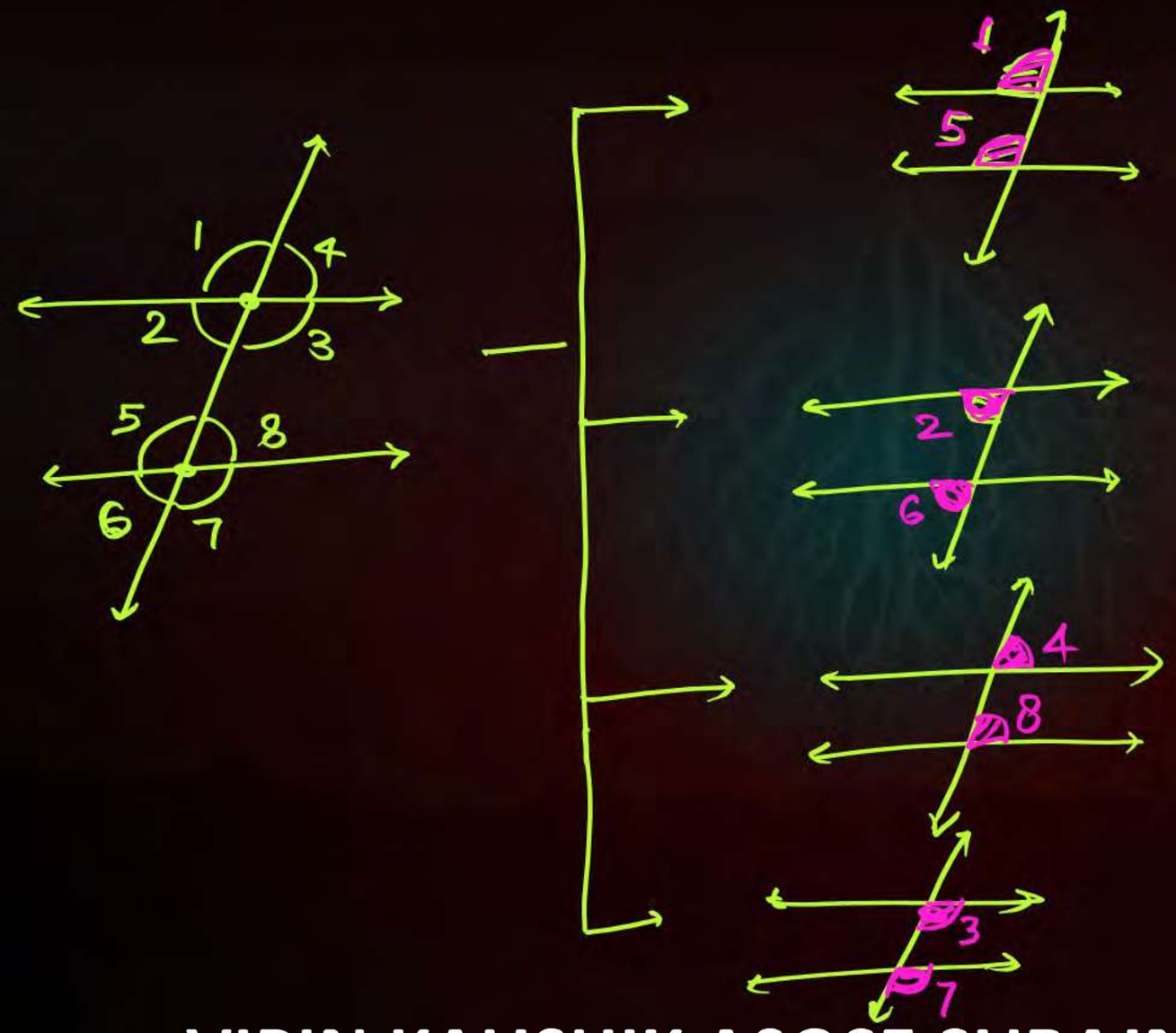



∠1 corresponds to ∠5

∠2 corresponds to ∠6

∠3 corresponds to ∠7

∠4 corresponds to ∠8




Ek hi side upar ki taraf

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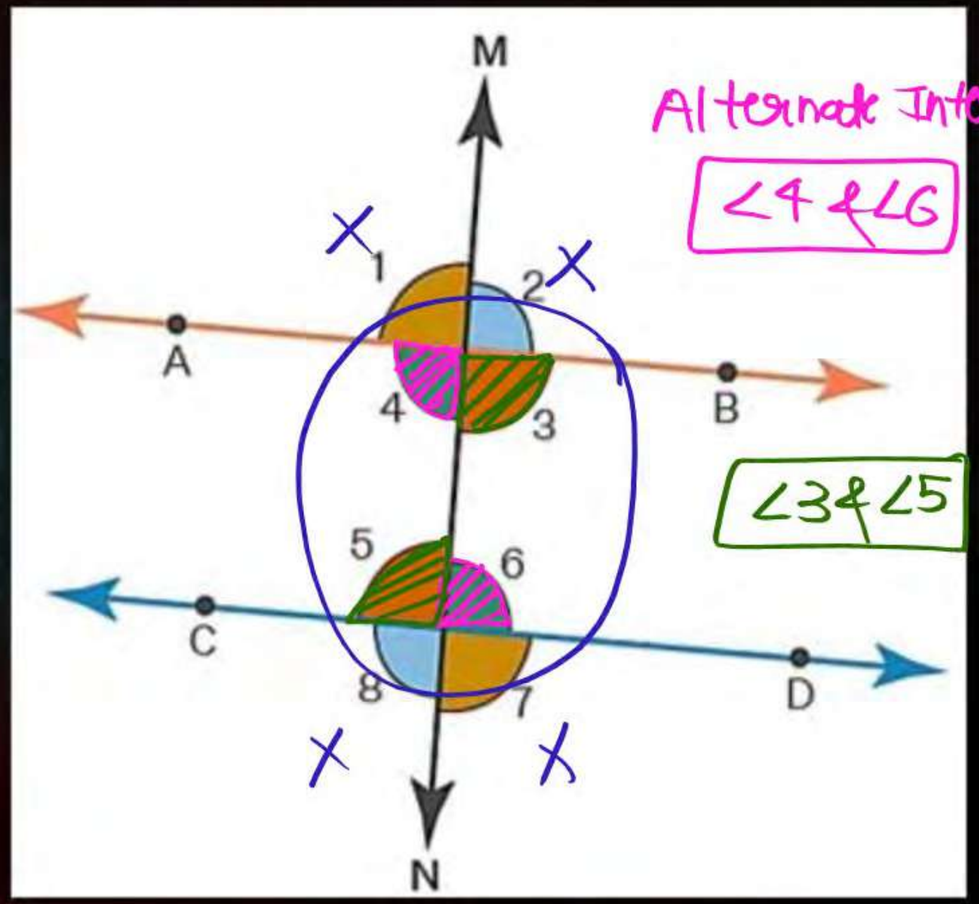
# Different Types of Pair of Angles

**Alternate interior angles :-** The pair of non-adjacent angles that lie between the two lines but are on opposite sides of the transversal are called alternate interior angle.

**Alternate exterior angles :-** Alternate exterior angles are angles that are on opposite sides of the transversal and outside the two lines.

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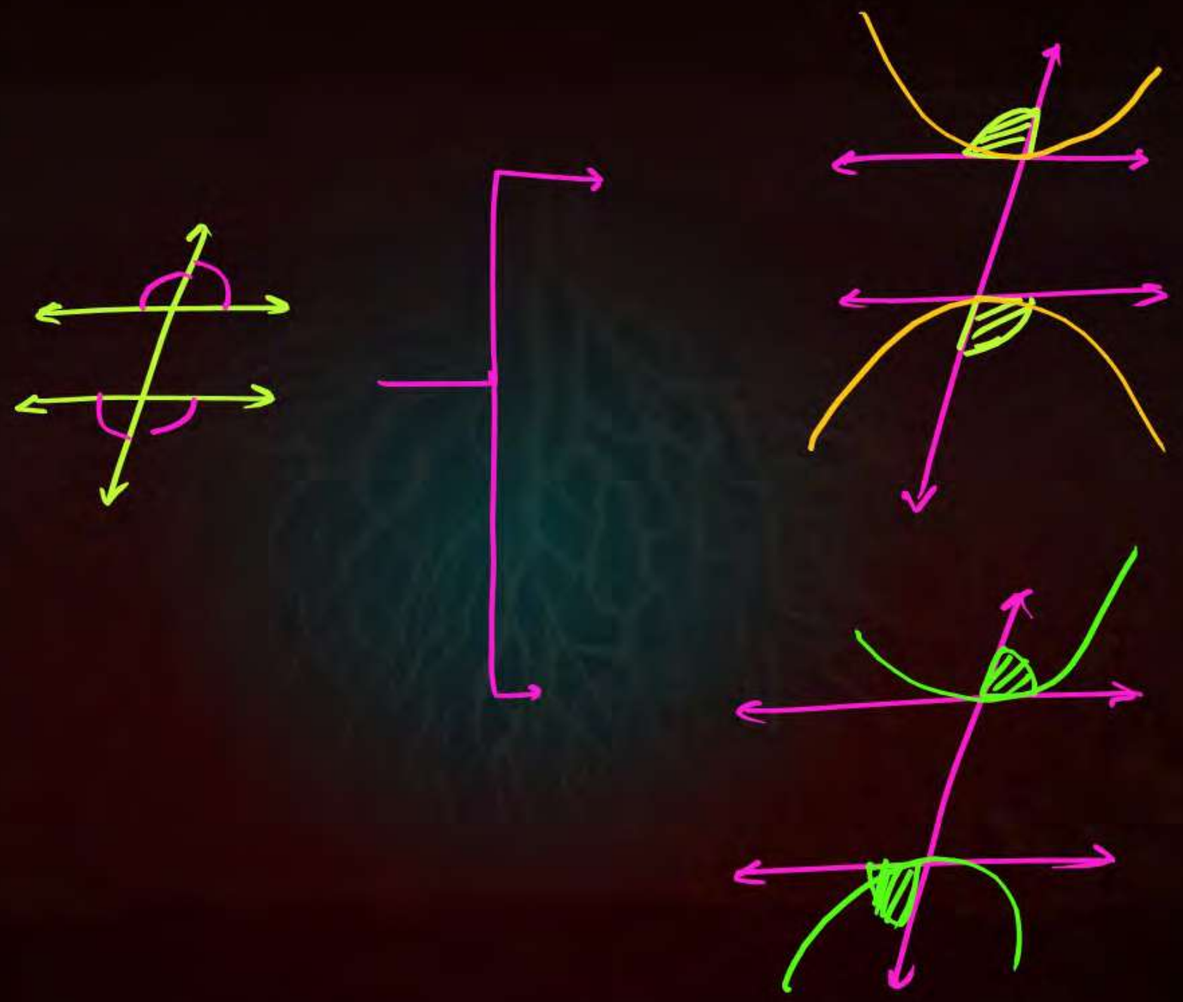
Alternate Exterior Angle



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# Axiom 6.3 & 6.4 (Corresponding angles axiom)

(i) Corresponding angles axiom: If a transversal intersects two parallel lines, then each pair of corresponding angles are equal.

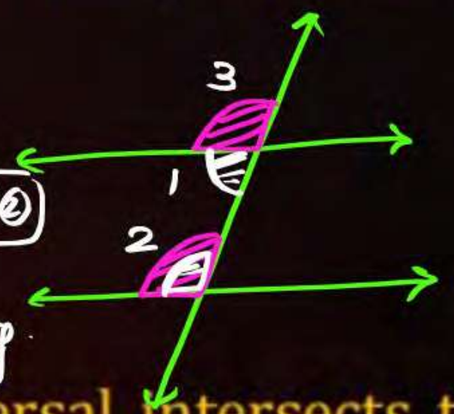
$\angle 1 + \angle 2 = 180^\circ$

$\boxed{\angle 2 = 180^\circ - \angle 1 \cdots eq^n (1)}$

$\angle 1 + \angle 3 = 180^\circ$

$\boxed{\angle 3 = 180^\circ - \angle 1 \cdots eq^n (2)}$

$\angle 2 = \angle 3 \rightarrow$ corresponding




(ii) Converse of Corresponding angles axiom: If a transversal intersects two lines, such that a pair of corresponding angles is equal, then the two lines are parallel.

# Theorem-6.2

If a transversal intersects two parallel lines, then each pair of alternate interior angles is equal.

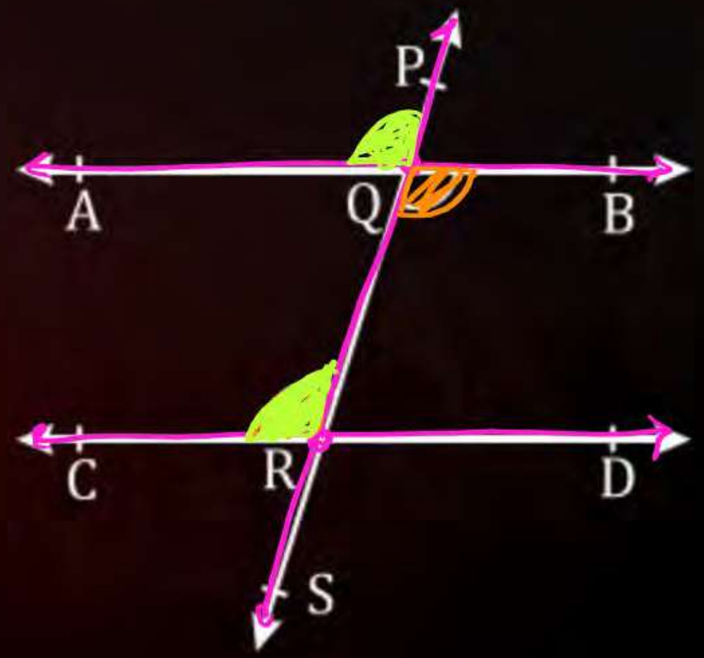
Pair of correspoing angles are same in measure.

$\angle AQP = \angle CRQ$

(V.O.P)

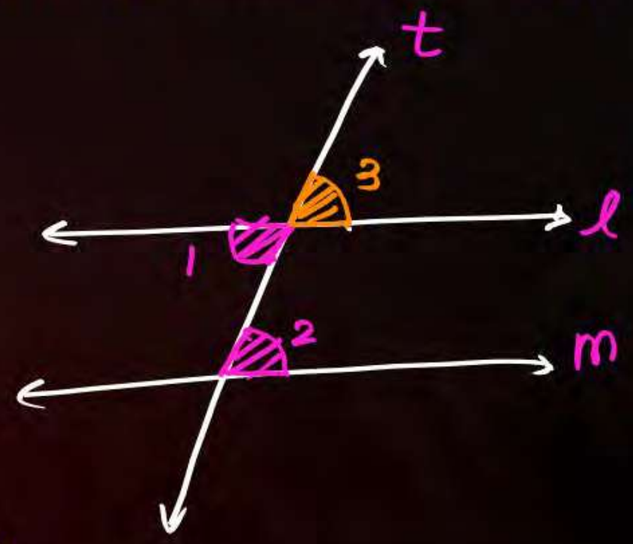
$\boxed{\angle BQR = \angle CRQ}$

Hence, proved !!



# Theorem-6.3

If a transversal intersects two lines in such a way that a pair of alternate interior angles is equal, then the lines are parallel.




Given; $\angle 1 = \angle 2$ (A.I.A → equal)

$\angle 3 = \angle 2$ → corresponding angle

Agar ye equal hua to sirf aur sirf parallel ke case me hoga!!

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# Theorem-6.4

If a transversal intersects two parallel lines, then each pair of co-interior angles on the same side of the transversal is supplementary.

mark alternate interior angle as $\angle 2$ as $\angle 3$.

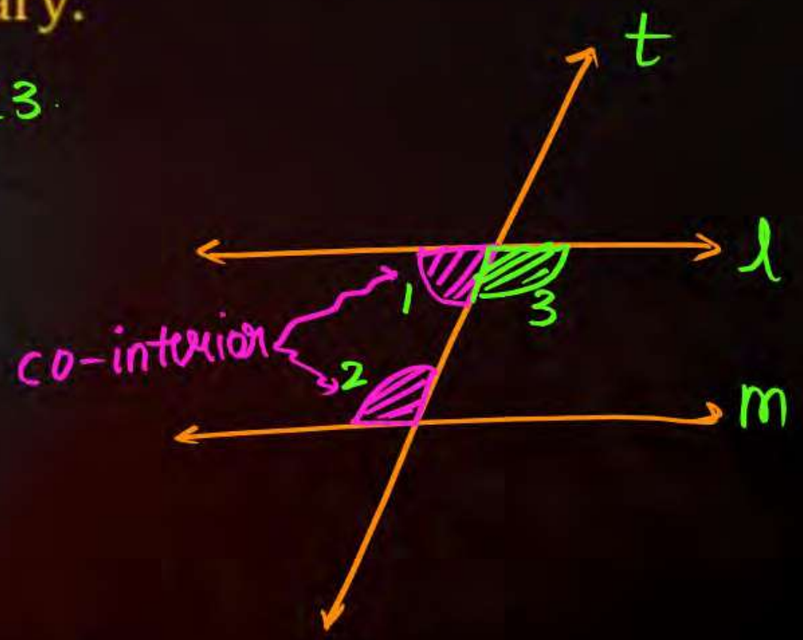
$\boxed{\angle 2 = \angle 3}$ ..... eq$^n$ ①

$l$ is a straight line

$\angle 1 + \angle 3 = 180^\circ$

$\boxed{\angle 3 = 180^\circ - \angle 1}$ ... eq$^n$ ②

$\Rightarrow \angle 2 = 180^\circ - \angle 1 \Rightarrow \boxed{\angle 2 + \angle 1 = 180^\circ} \rightarrow$ supplementary Angle.

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# Theorem-6.5

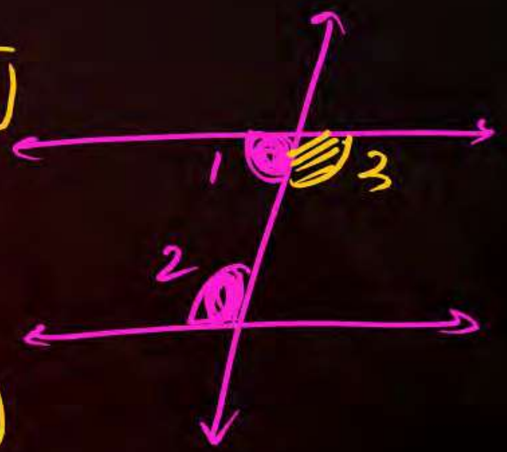
If the transversal intersects two lines such that a pair of co-interior angles on the same side of the transversal is supplementary, then the lines are parallel.

$\angle 1 + \angle 2 = 180^\circ$

$\angle 2 = 180^\circ - \angle 1$

$\angle 3 + \angle 1 = 180^\circ$

$\angle 3 = 180^\circ - \angle 1$




$\angle 2 = \angle 3$

Alternate Interior Angles

Parallel line ke case me hold karega!!

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# Theorem-6.6

Lines which are parallel to the same line are-parallel to each other.

given: $l \parallel n \rightarrow \angle 1 = \angle 3$

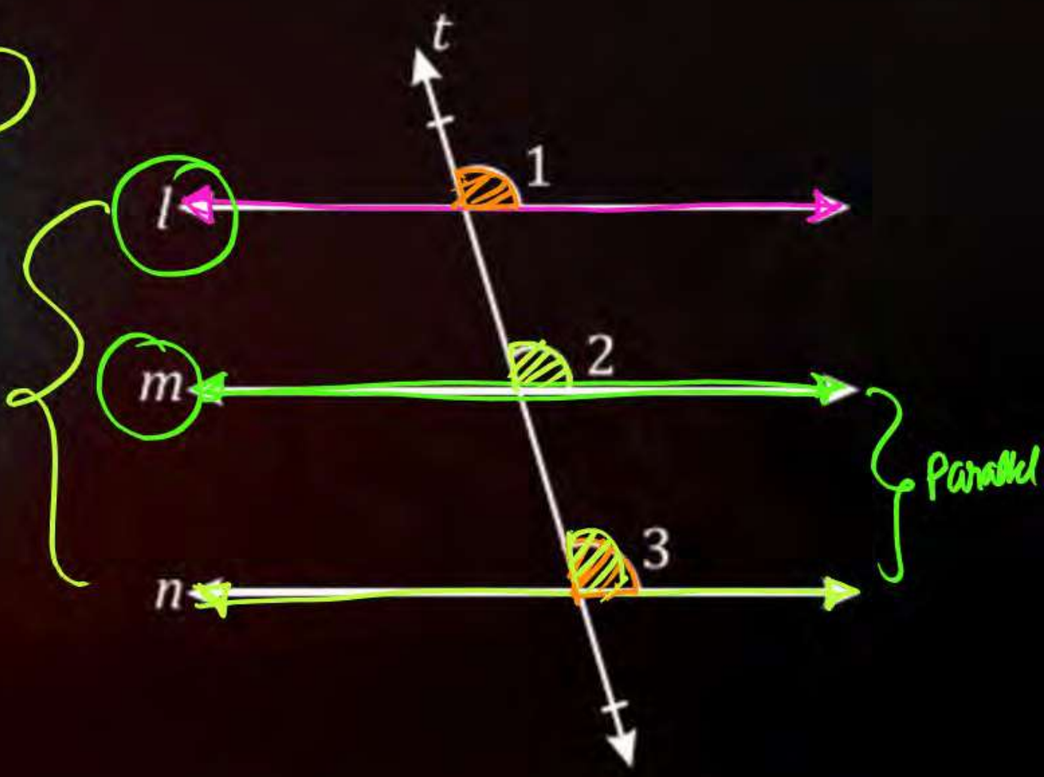
$m \parallel n \rightarrow \angle 2 = \angle 3$

$\angle 1 = \angle 2$

since $\angle 1$ & $\angle 2$ are corresponding angle and are also equal. parallel

This will only held in case $\parallel$ lines

$l \parallel m$ ✓

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Question

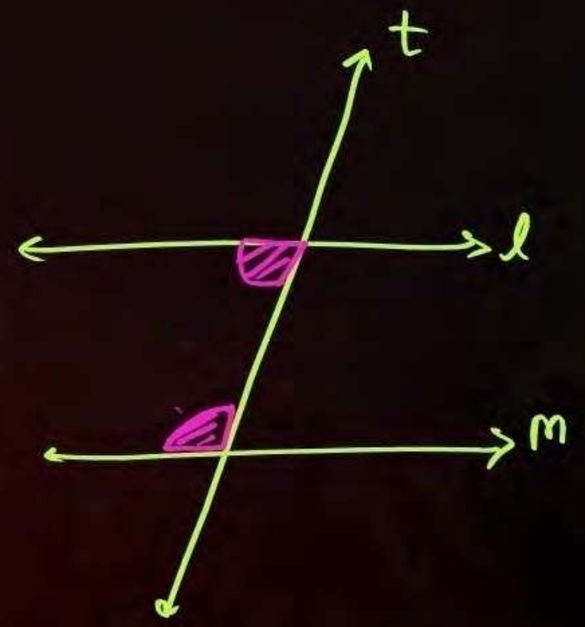
If two interior angles on the same side of a transversal intersecting two parallel lines are in the ratio 4 : 5, then the greater of the two angles is

54°

100°

120°

136°

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If two interior angles on the same side of a transversal intersecting two parallel lines are in the ratio 4 : 5, then the greater of the two angles is

A 54°

B 100°

C 120°

D 136°

since, $\boxed{l \parallel m}$ → co-interior are supplementary

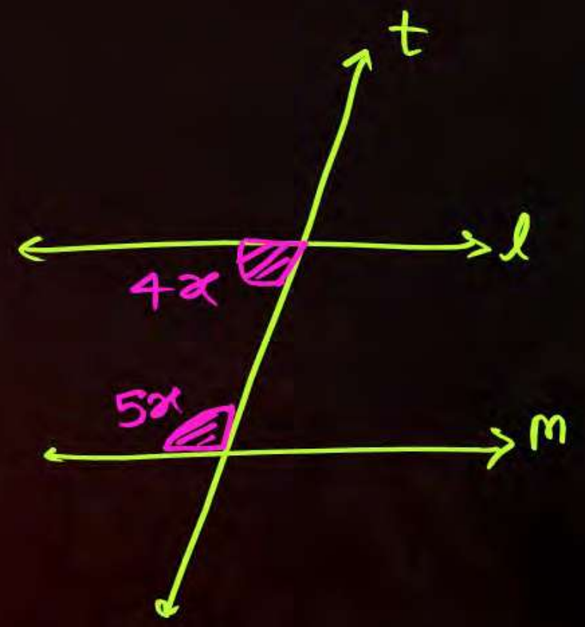
$4x + 5x = 180°$

$9x = 180$

$\boxed{x = 20°}$

1st angle ⇒ $4 \times 20° = \boxed{80°}$ → smaller

2nd Angle ⇒ $5 \times 20° = \boxed{100°}$ → greater

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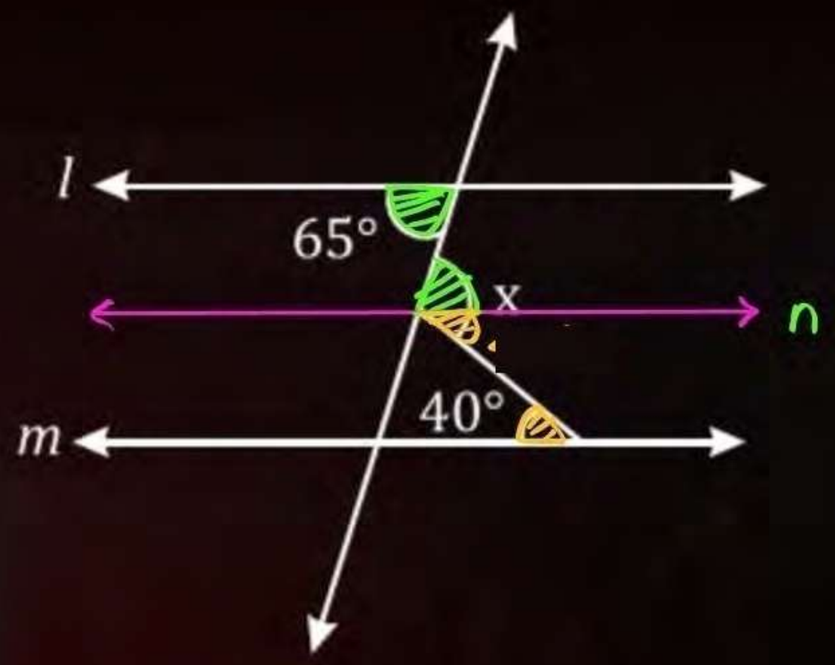
Question

In the given figure, if $l \parallel m$, then find value of $x$




105°

100°

140°

25°

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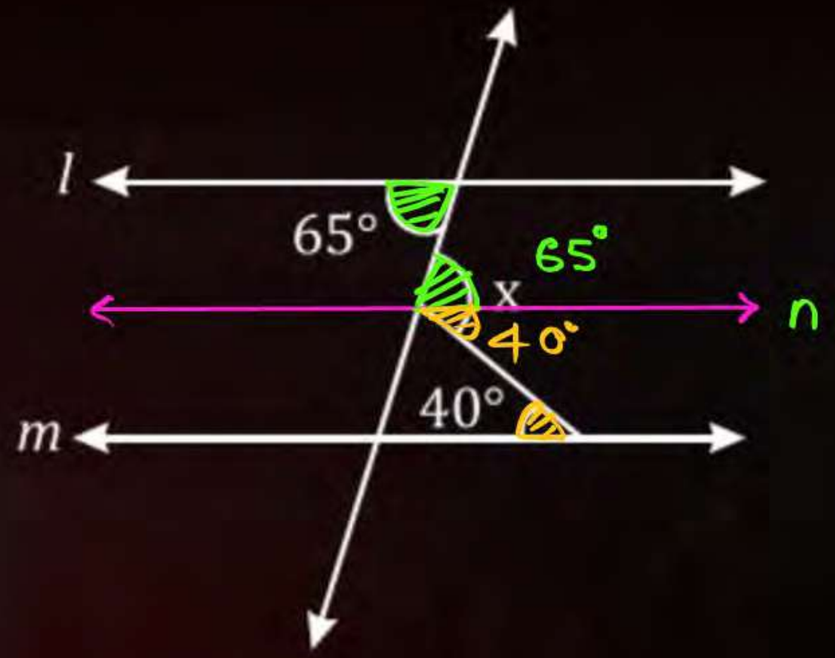
In the given figure, if $l \parallel m$, then find value of $x$




A 105°

B 100°

C 140°

D 25°

$x = 65° + 40°$

$= \boxed{105°}$

- Alternate interior
- co-interior

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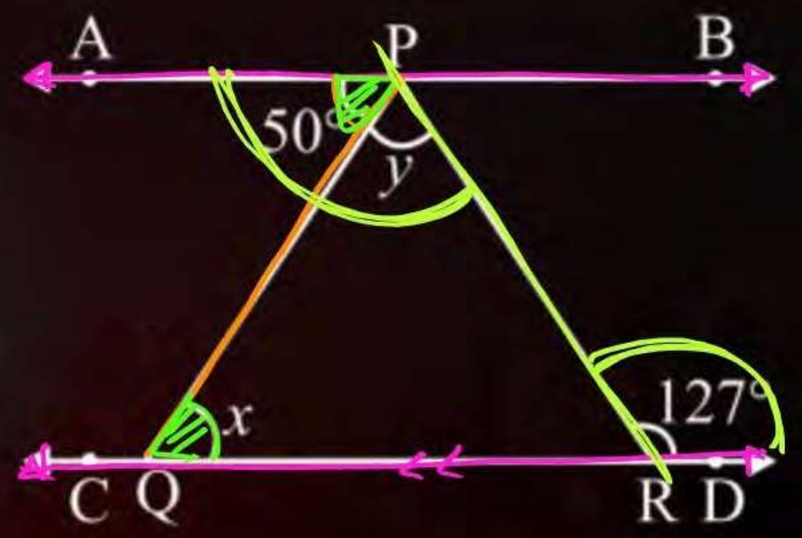
**Question**

In figure, if AB||CD, ∠APQ = 50° and ∠PRD = 127°, find x and y.

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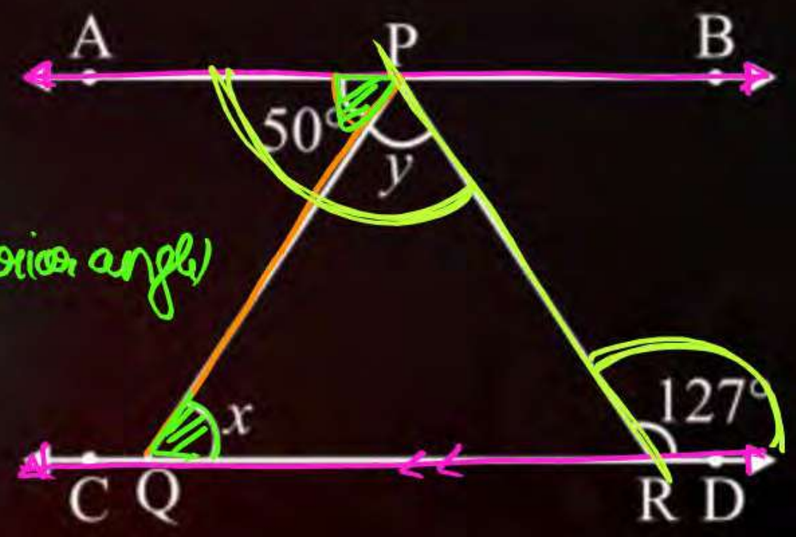


Since AB||CD,

Therefore, ∠APQ = ∠RQP

(Because of Alternate Interior angles)

$\boxed{50^\circ = x}$ ✓

AB || CD

$50^\circ + y = 127^\circ$

$\boxed{y = 77^\circ}$ ✓

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**Question**

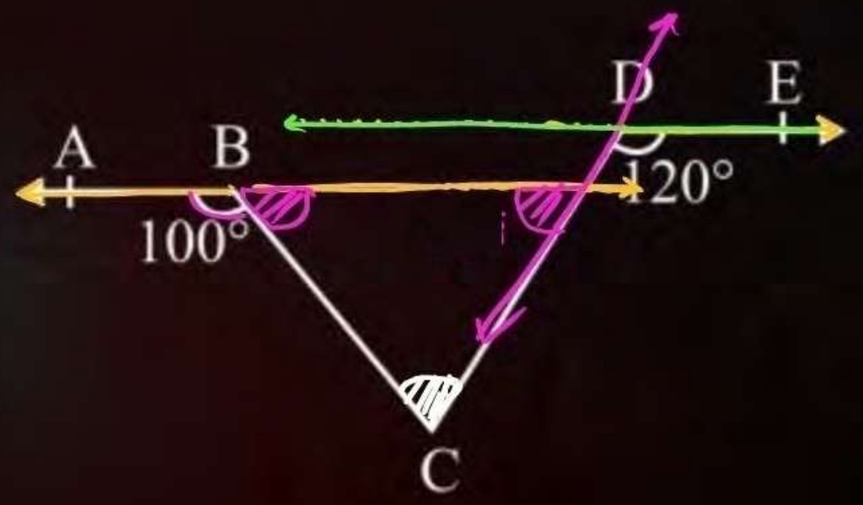
In the figure, AB || DE, $\angle ABC = 100°$ and $\angle CDE = 120°$. Find $\angle BCD$.

40°

20°

90°

110°

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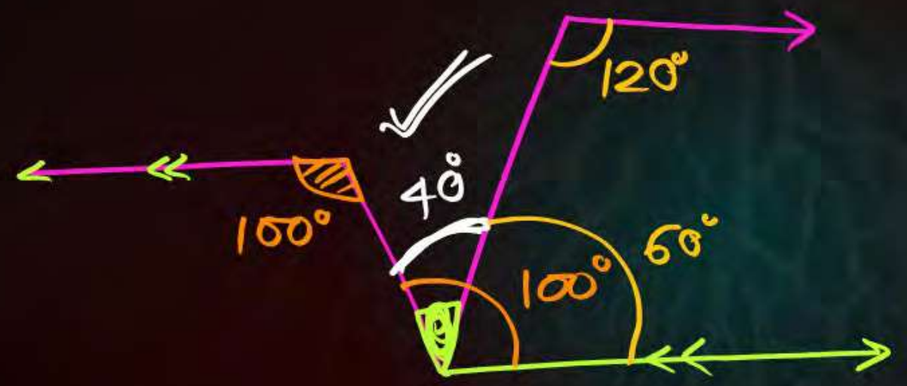
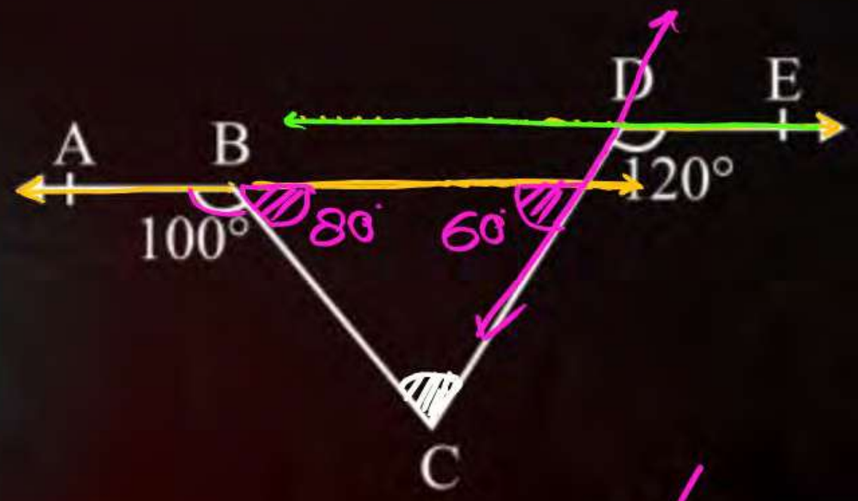
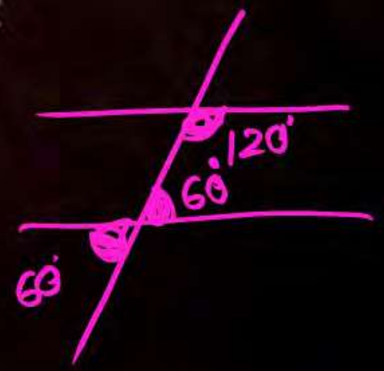
In the figure, AB || DE, ∠ABC = 100° and ∠CDE = 120°. Find ∠BCD.

- **A** 40°
- **B** 20°
- **C** 90°
- **D** 110°

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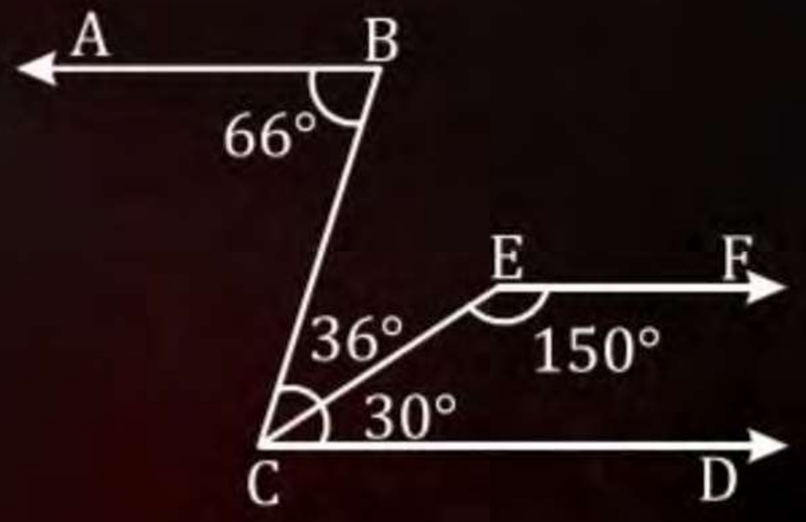
**Question**

In figure, show that AB||EF

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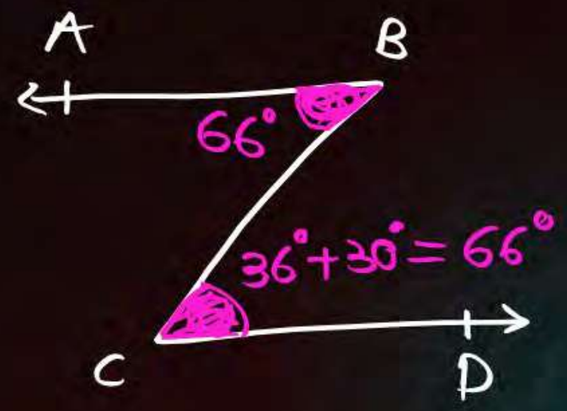
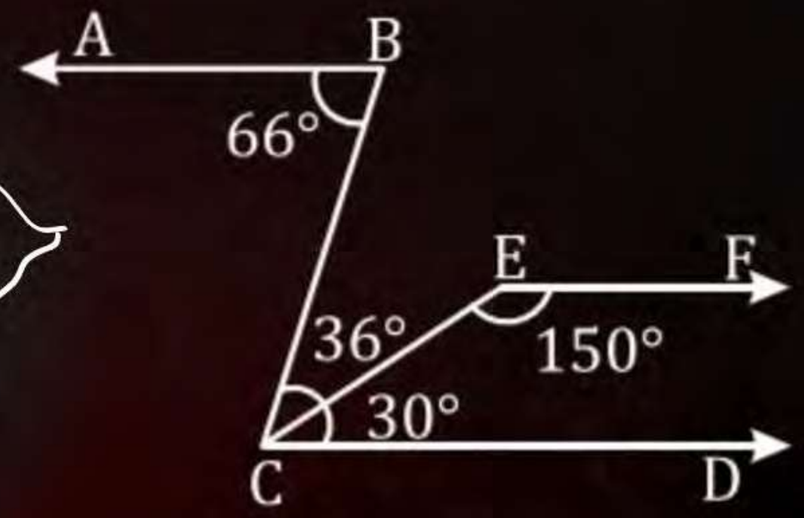
In figure, show that AB||EF



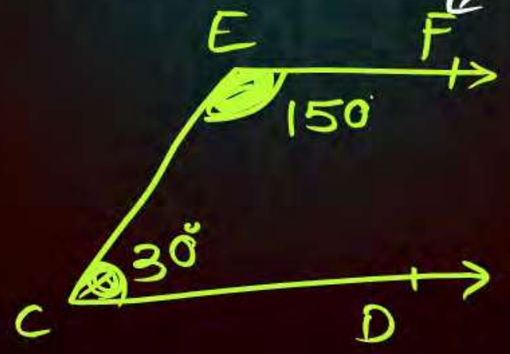




$\boxed{AB \| CD}$ ---- ①

$\boxed{EF \| CD}$ ---- ②

$\Downarrow$

$\boxed{AB \| EF}$ Hence, proved!!

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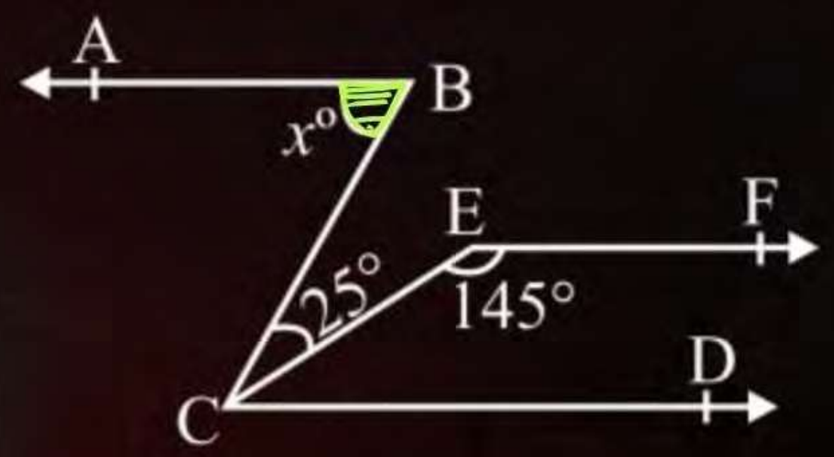
**Question**

In the given figure, AB || CD || EF. If ∠BCE = 25° and ∠CEF = 145°, then find the measure of ∠ABC




120°

170°

60°

90°

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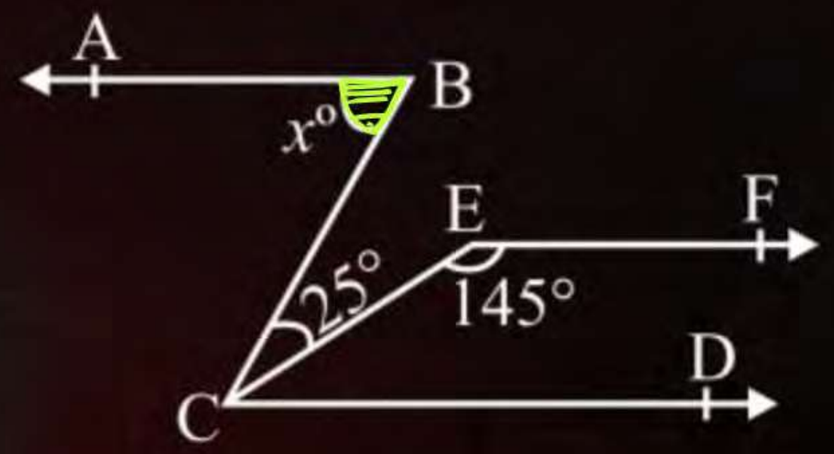
## Question

In the given figure, AB || CD || EF. If ∠BCE = 25° and ∠CEF = 145°, then find the measure of ∠ABC




(A) 120°

(B) 170°

(C) 60°

(D) 90°

$x = 25° + 35°$

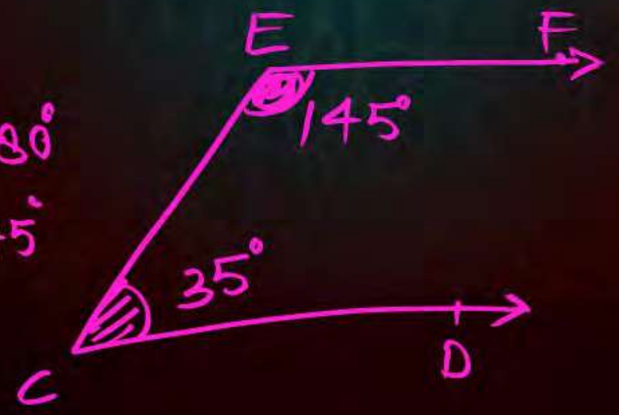
$\boxed{x = 60°}$

since EF || CD

$\angle FEE + \angle DCE = 180°$

$\angle DCE = 180° - 145°$

$= 35°$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

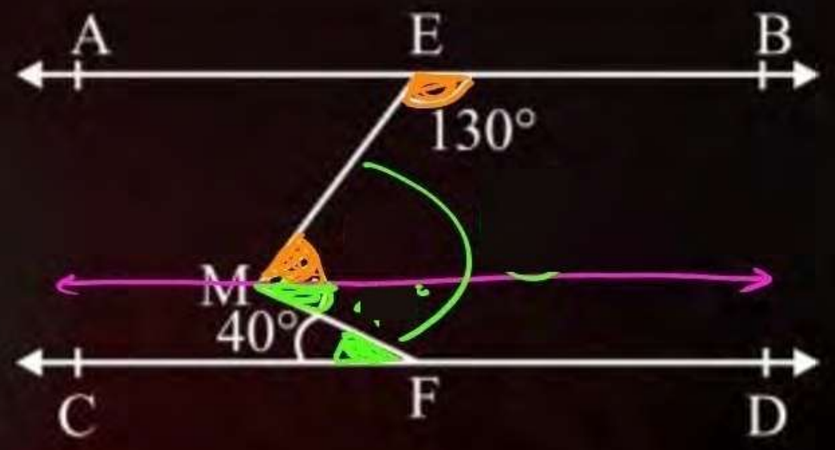
In the given figure, AB||CD. If ∠MEB = 130° and ∠MFC = 40°, then find ∠EMF.

170°

90°

10°

25°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

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A. 170°

B. 90°

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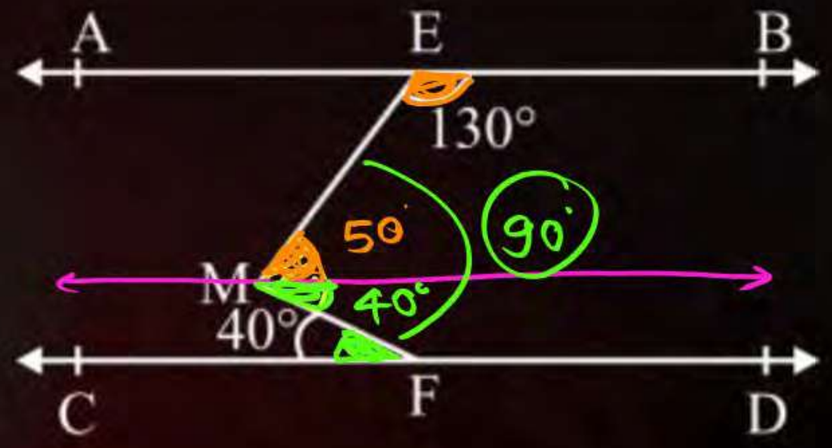
D. 25°




# Paneel Sawal

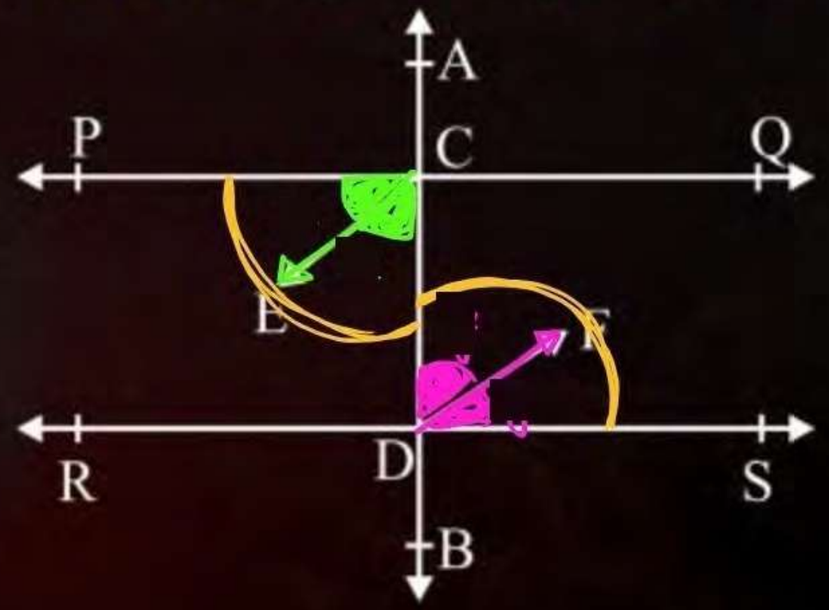
Key points

- A.I.A
- Sum of co-interior

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In the given figure, PQ||RS and AB is a transversal that meets PQ and RS at C and D respectively. $\overrightarrow{CE}$ and $\overrightarrow{DF}$ are the bisector of ∠PCD and ∠SDC respectively. Prove that CE||DF




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

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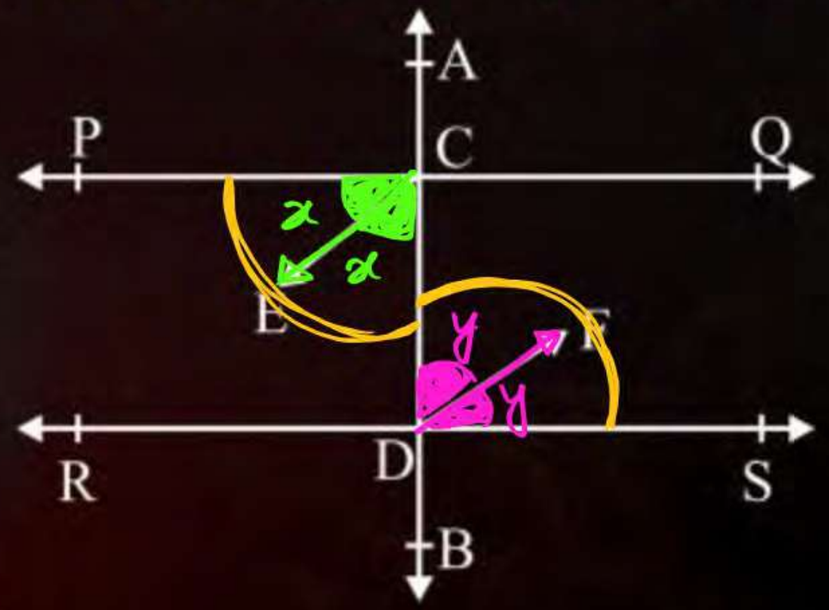


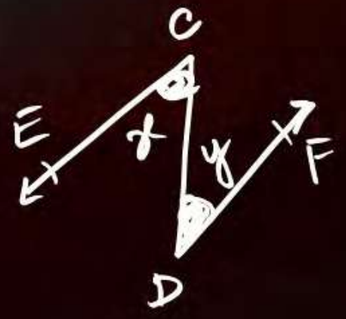

PQ || RS

↳ Alternate interior angles are equal.

$\angle PCD = \angle SDC$

$2x = 2y \Rightarrow x = y$

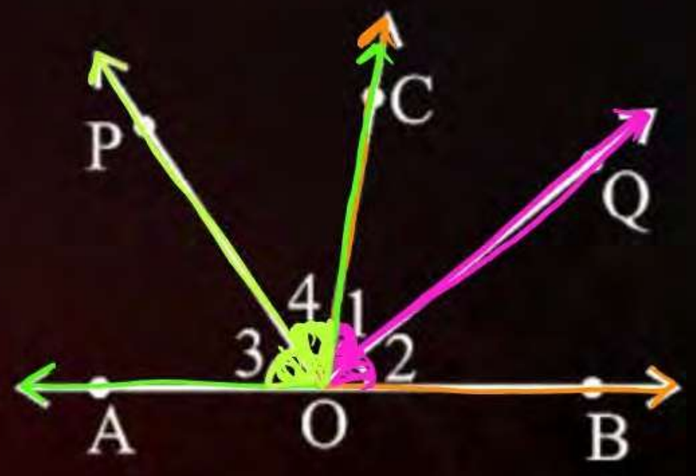
CE || DF




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

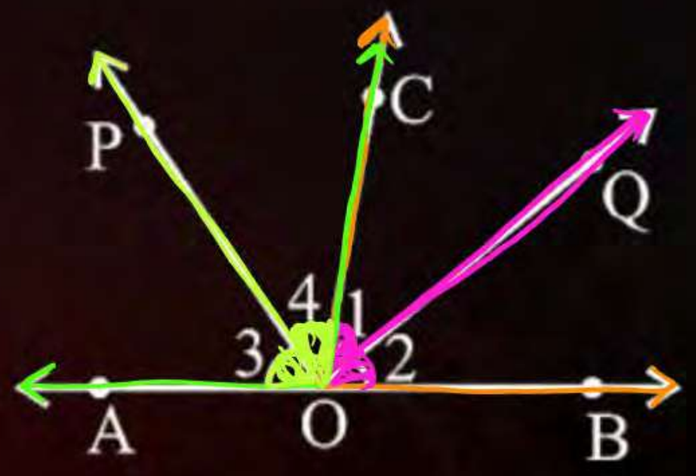
In the figure given below, OQ bisects $\angle BOC$ and OP bisects $\angle AOC$. Show that $\angle POQ = 90°$.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In the figure given below, OQ bisects ∠BOC and OP bisects ∠AOC. Show that ∠POQ = 90°.




OQ bisect ∠BOC

$\boxed{\angle 1 = \angle 2}$

OP bisect ∠AOC

$\boxed{\angle 3 = \angle 4}$

since AOB is a straight,

$\angle 1 + \angle 2 + \angle 3 + \angle 4 = 180^\circ$

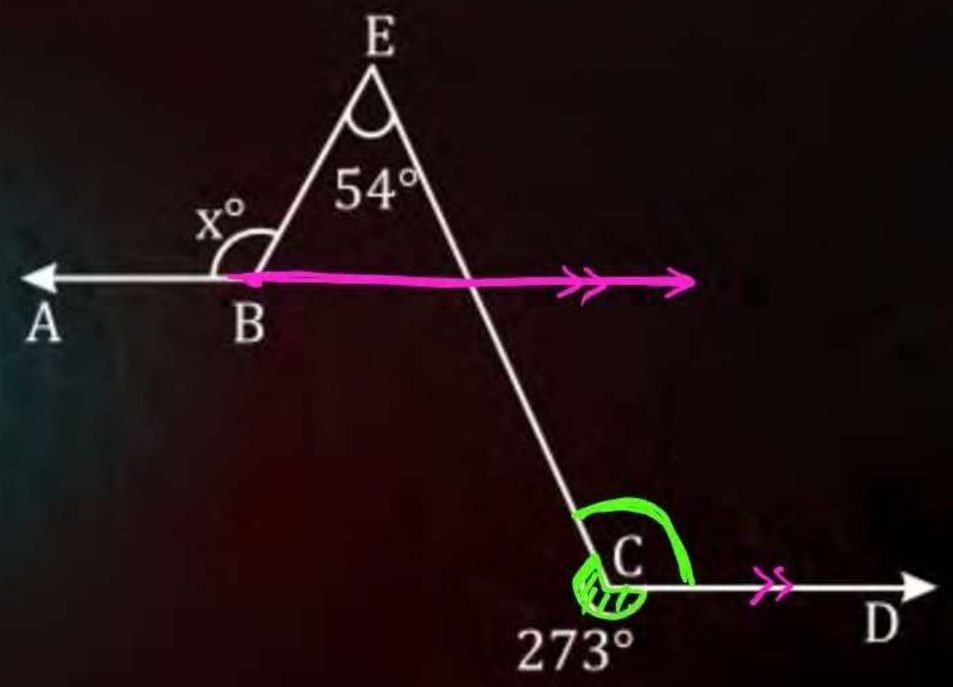
$\angle 1 + \angle 1 + \angle 4 + \angle 4 = 180^\circ \Rightarrow 2(\angle 1 + \angle 4) = 180^\circ \Rightarrow \angle 1 + \angle 4 = \frac{180^\circ}{2}$

$\boxed{\angle POQ = 90^\circ}$

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

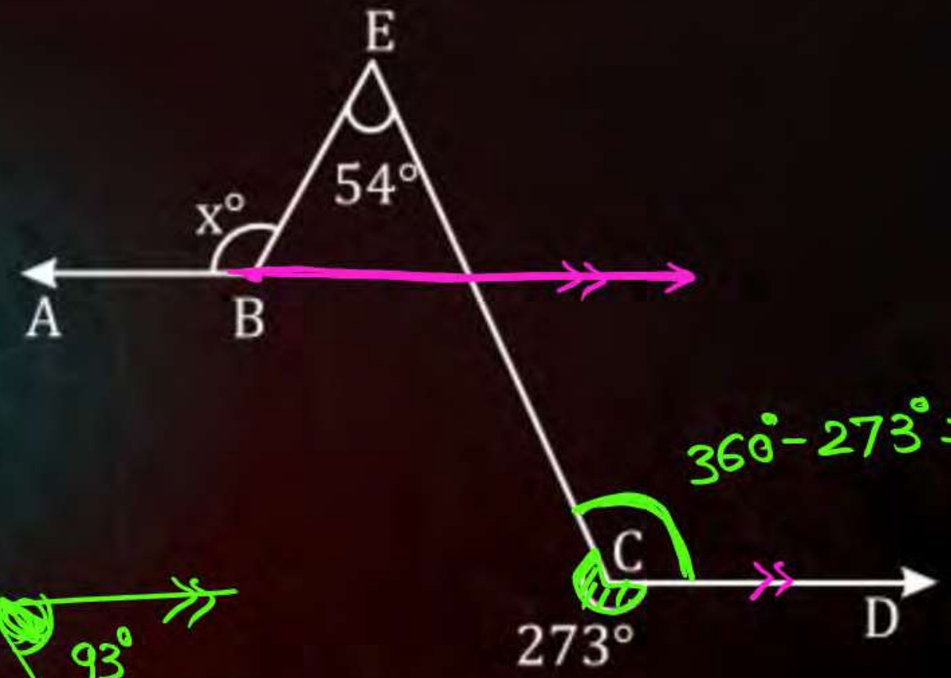
In figure, if AB || CD, then the value of x = ?




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In figure, if AB || CD, then the value of x = ?




$360° - 273° = 87°$

$x = 54° + 93°$

$x = 147°$ Ans

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

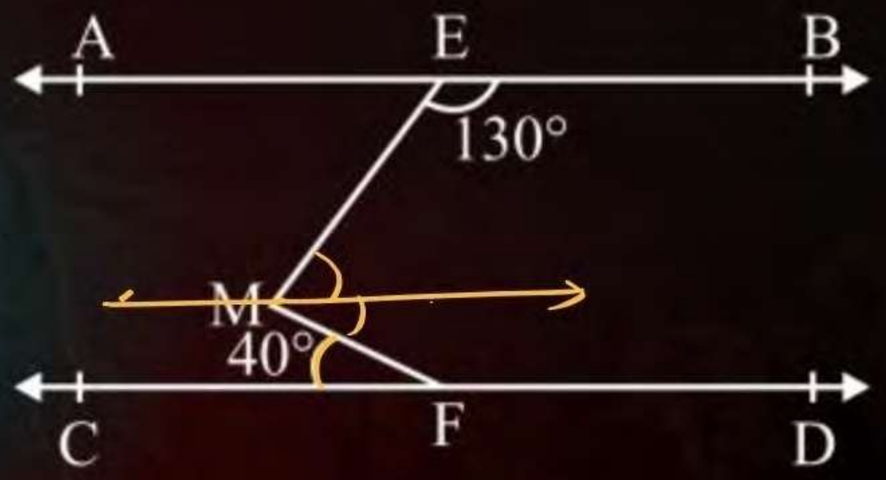
In the given figure, AB||CD. If ∠MEB = 130° and ∠MFC = 40°, then find ∠EMF.

170°

90°

10°

25°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

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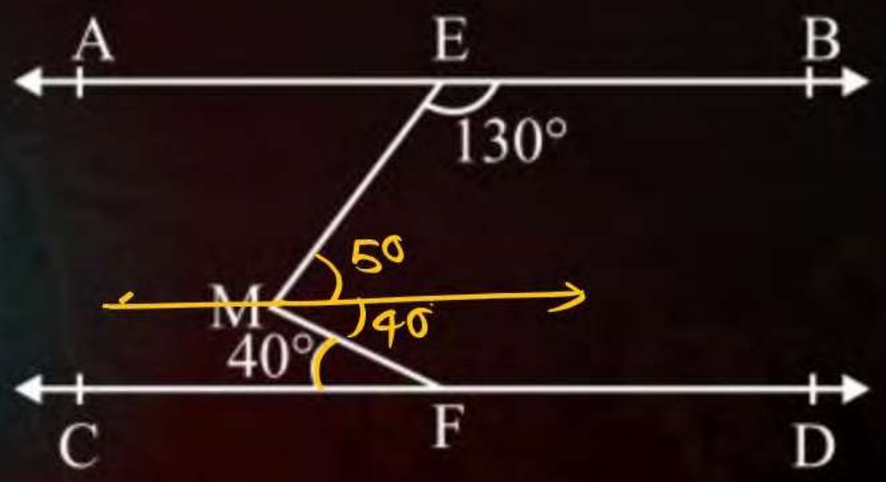
A 170°

B 90°

C 10°

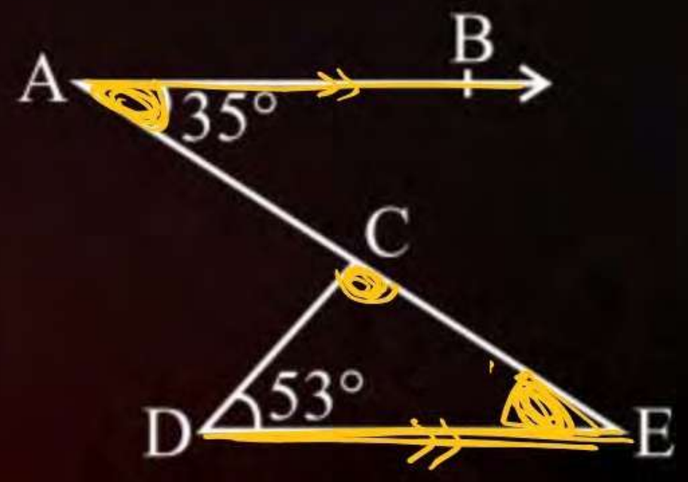
D 25°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In figure, if AB || DE, $\angle BAC = 35°$ and $\angle CDE = 53°$, find $\angle DCE$.

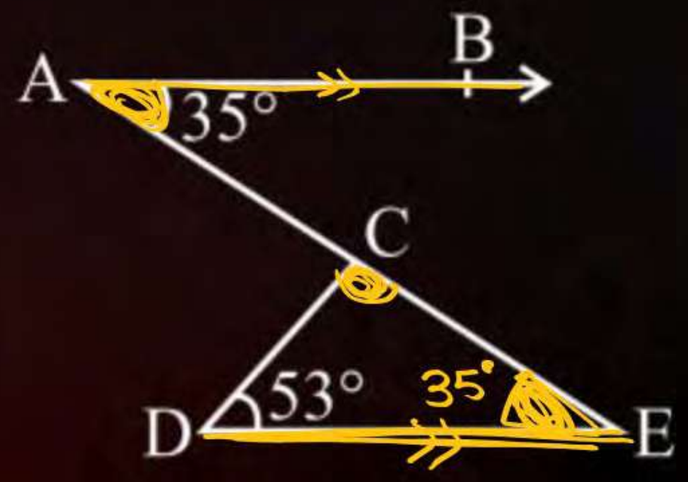



VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In figure, if AB || DE, ∠BAC = 35° and ∠CDE = 53°, find ∠DCE.

$\angle DCE + 53^\circ + 35^\circ = 180^\circ$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

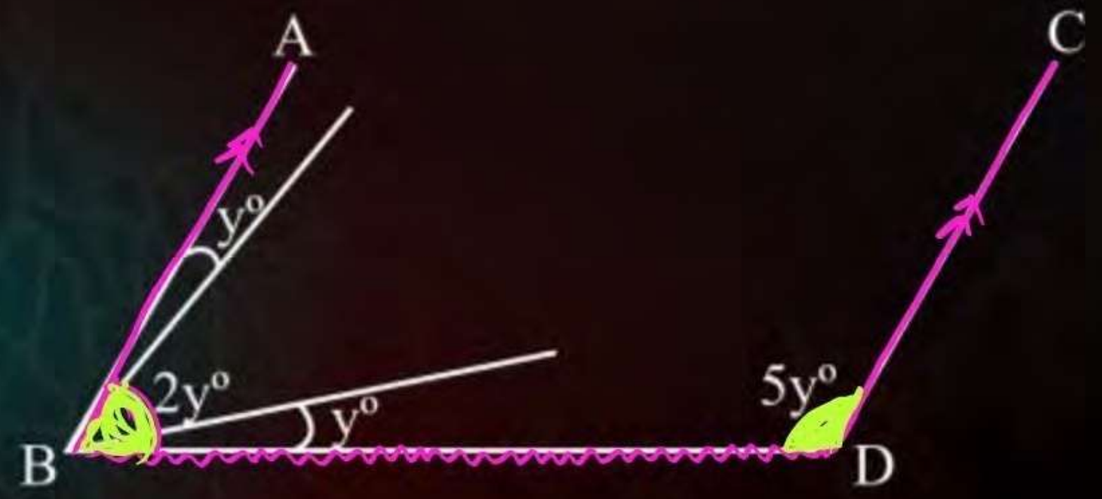
In figure, if line segment AB is parallel to the line segment CD, what is the value of y?

12

15

18

20




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In figure, if line segment AB is parallel to the line segment CD, what is the value of y?

A 12

B 15

C 18

D 20

sum of co-interior = 180°

$4y^\circ + 5y^\circ = 180^\circ$

$9y = 180^\circ$

$y = 20^\circ$

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

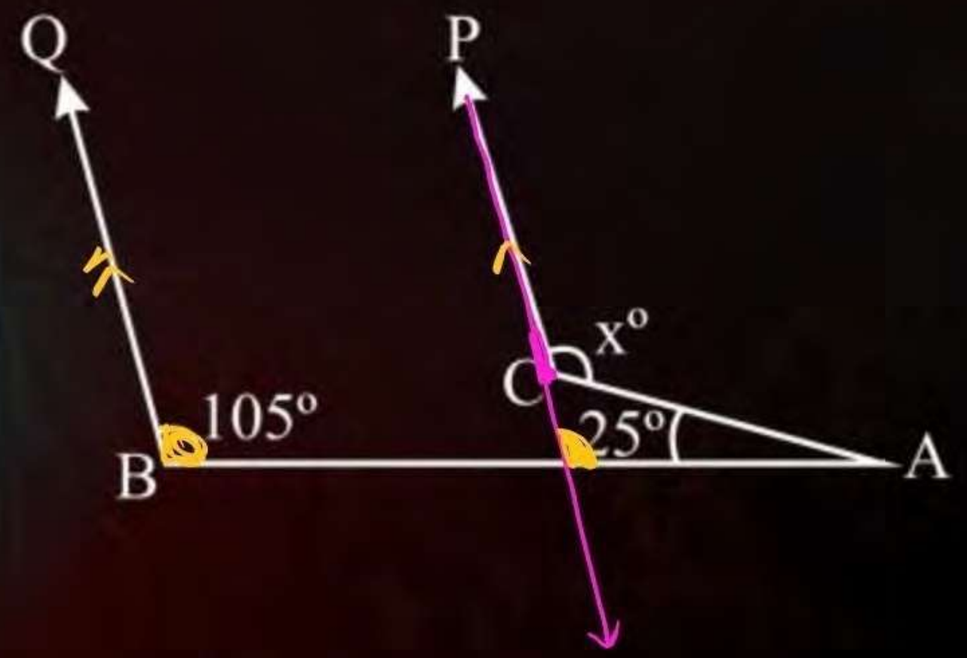
In figure, if CP || BQ, then measure of x is

130°

105°

175°

175°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In figure, if CP || BQ, then measure of x is

A. 130°

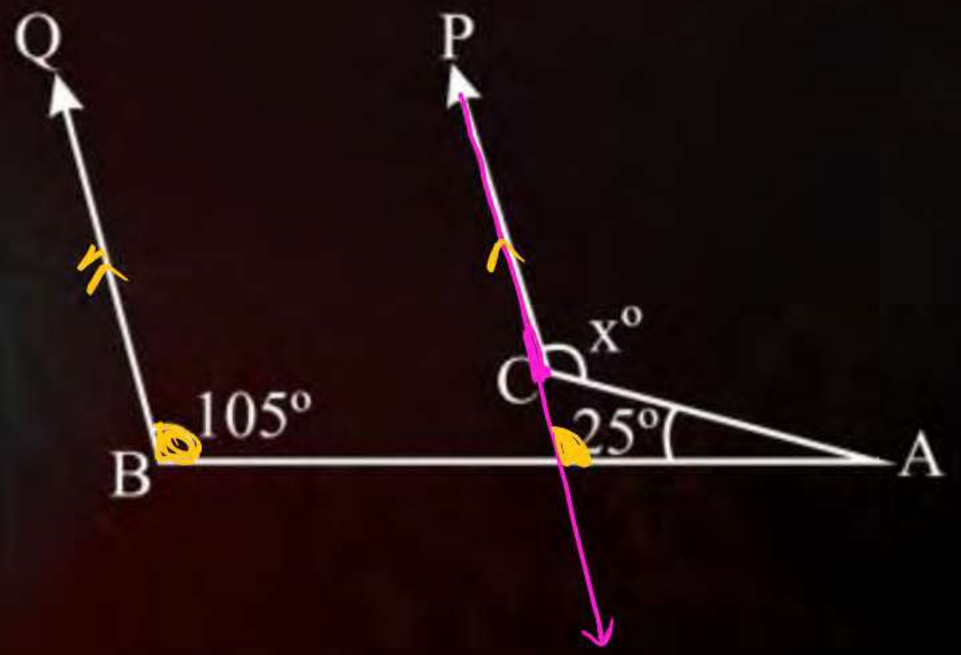
B. 105°

C. 175°

D. 175°

$x = 105^\circ + 25^\circ$

$= \boxed{130^\circ}$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

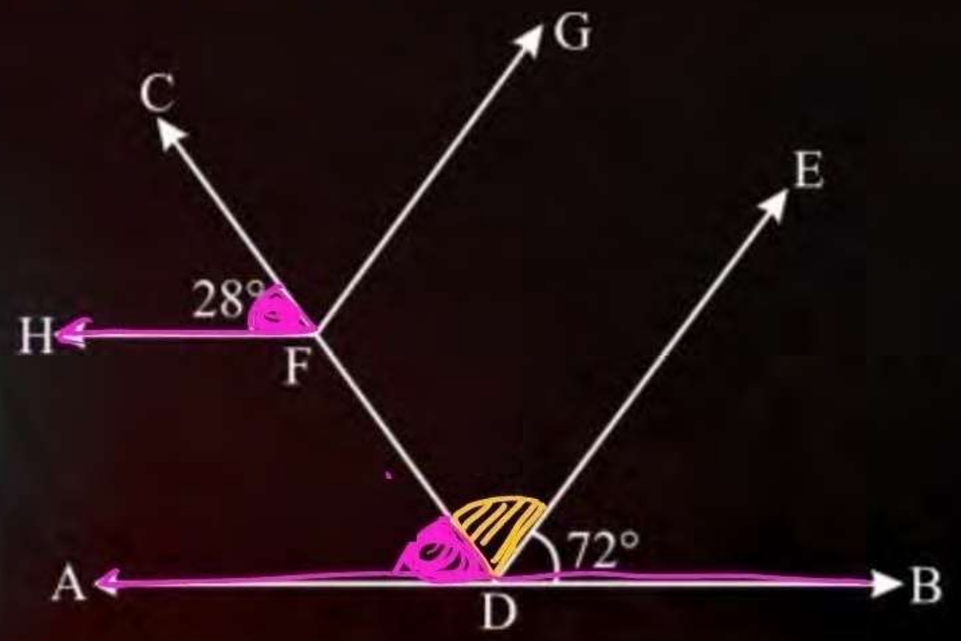
In figure, if AB || HF and DE || FG, then the measure of ∠FDE is

108°

80°

100°

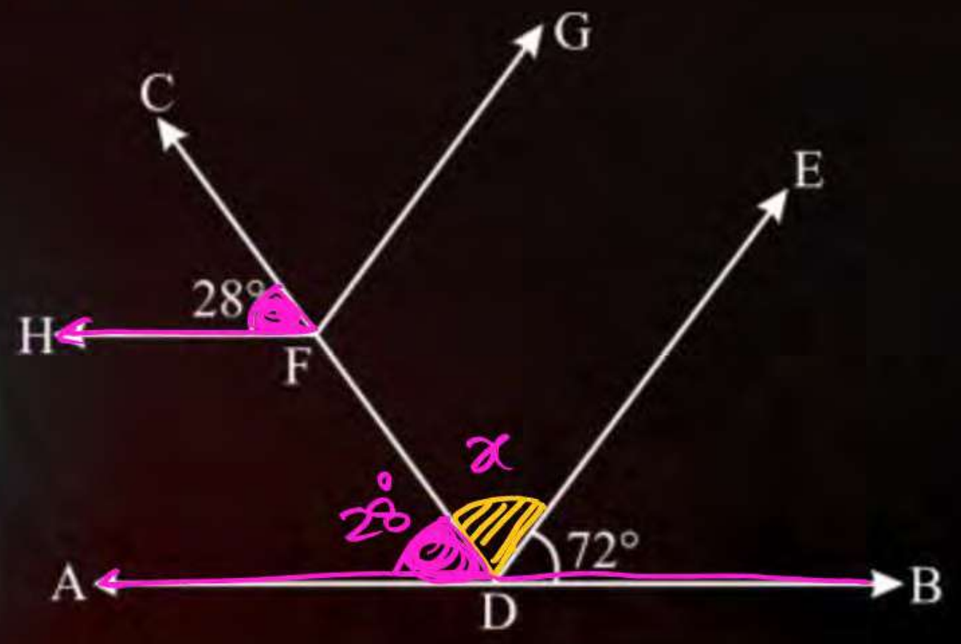
90°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In figure, if AB || HF and DE || FG, then the measure of ∠FDE is




A 108°

B 80°

C 100°

D 90°

AB || HF

$\angle HFC = \angle ADF = 28^\circ$

↳ corresponding angle

since, AB is a straight line

$28^\circ + x + 72^\circ = 180^\circ$

$100^\circ + x = 180^\circ$

$x = 80^\circ$

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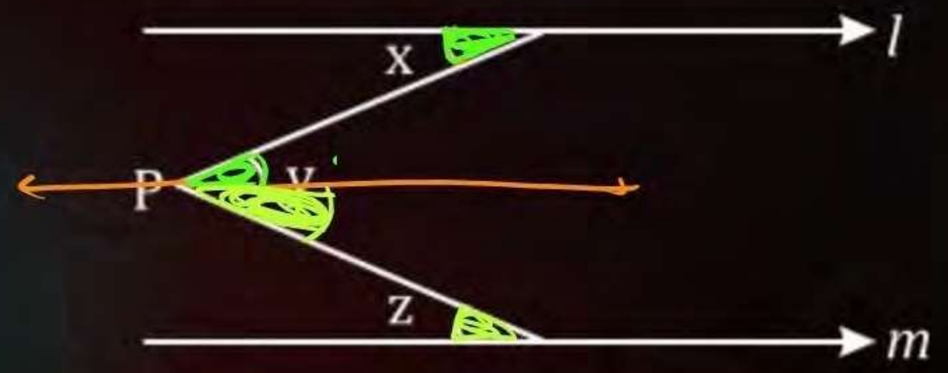
## Bonus Question

In the above figure, find the value of $\frac{z}{15°}$, if x is two third of y which is complement of 45°.




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

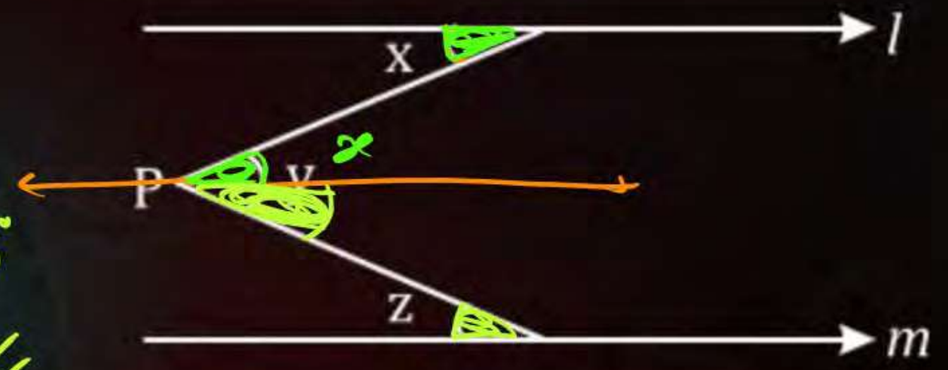
## Bonus Question

$\frac{15^\circ}{15^\circ} = \boxed{1}$

In the above figure, find the value of $\frac{z}{15^\circ}$, if x is two third of y which is complement of 45°.

$\frac{2}{3} \times 45^\circ = 30^\circ$

$\boxed{x = \frac{2}{3} y}$




$y = 90^\circ - 45^\circ$

$\boxed{y = 45^\circ}$

H.W

$\boxed{y = x + z}$

$45^\circ = 30^\circ + z$

$z = 15^\circ$

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## Bonus Question

In the given figure which of the following is true?

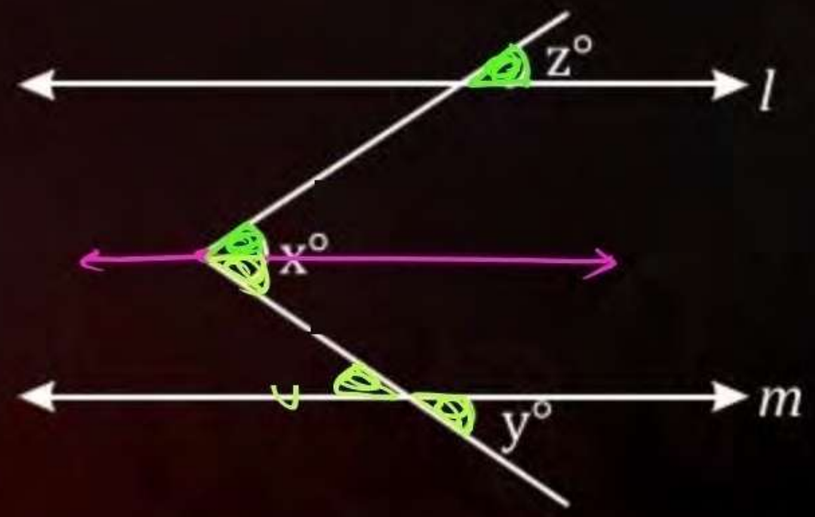
Hint : $l \parallel m$

$z + x + y = 180°$

$z = y + x$

$x = z + y$

$z + y = 90°$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

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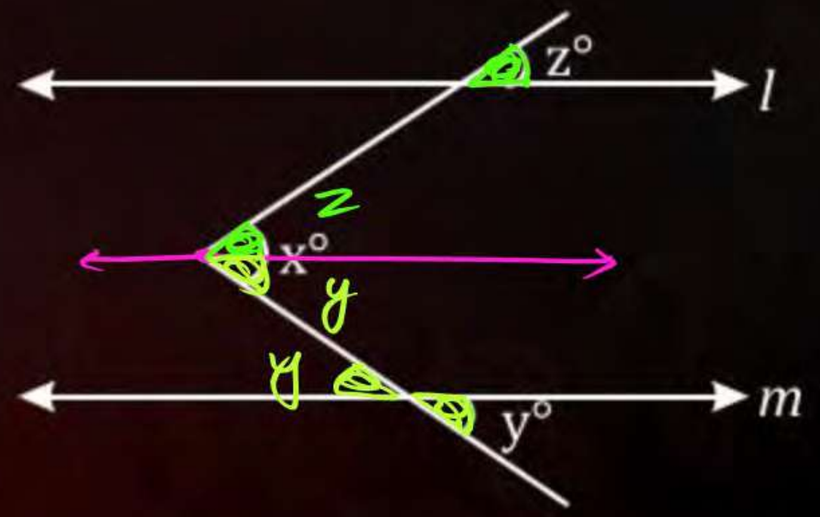



**A** $z + x + y = 180°$

**B** $z = y + x$

**C** $x = z + y$

**D** $z + y = 90°$

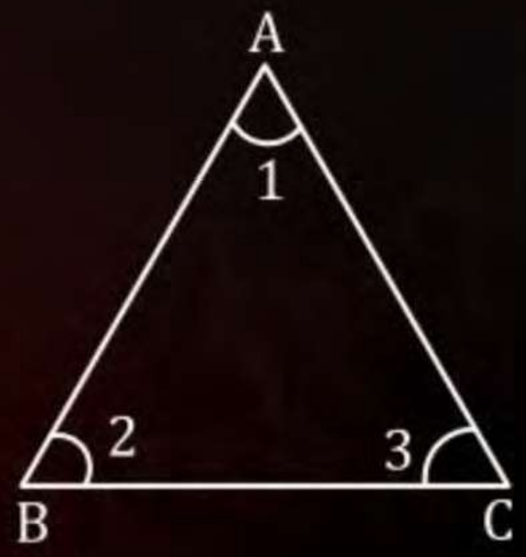
$x = z + y$

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

# Angle Sum Property of a Triangle

Angle sum property of triangle states that the sum of interior angles of a triangle is 180°.

$$\boxed{\angle 1 + \angle 2 + \angle 3 = 180^\circ}$$

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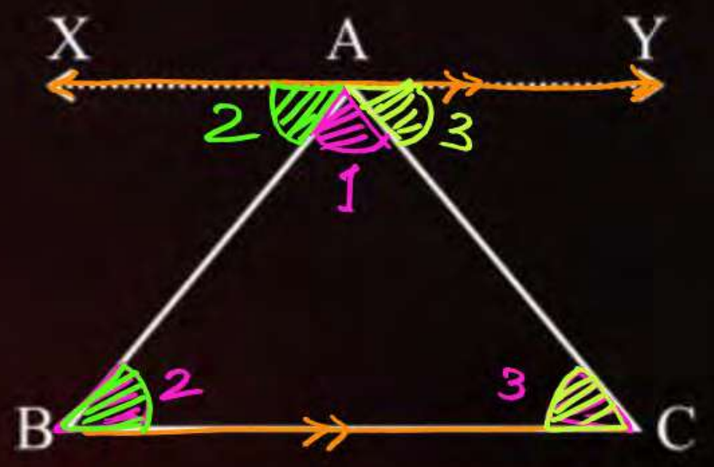
# Theorem 6.7

**Statement:** The sum of the angles of a triangle is 180°.




since, XY is a straight line,

$$\boxed{\angle 1 + \angle 2 + \angle 3 = 180^\circ}$$

**Note** : The elements of a triangle include 3 sides, 3 angles and 3 vertices.

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**Question**

If two angles of a triangles are 48° and 77°, then find the third angles.

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**Question**

The sum of the two angles of a triangle is $\boxed{80°}$ and their difference is 20°. Find all the angles.

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

The sum of the two angles of a triangle is $\boxed{80°}$ and their difference is 20°. Find all the angles.

$\angle 1 - \angle 2 = 20°$

$\angle 1 = 20° + \angle 2$

$\angle 1 + \angle 2 = 80°$

$20° + \angle 2 + \angle 2 = 80°$

$2\angle 2 = 60°$

$\boxed{\angle 2 = 30°}$

$\boxed{\angle 1 = 50°}$

Angle sum property

$\angle 1 + \angle 2 + \angle 3 = 180°$

$80° + \angle 3 = 180°$

$\boxed{\angle 3 = 100°}$

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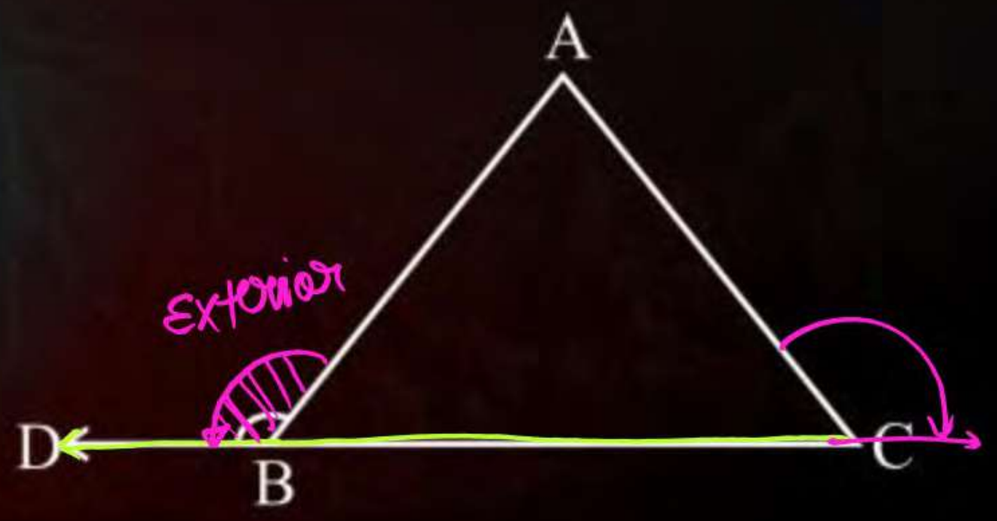
# Exterior Angles of a Triangle

The exterior angle of a triangle is the angle that is formed between one of its sides and its adjacent extended side. The exterior angles of a triangle are those angles that are formed outside it.

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# Theorem 6.8

If a side of a triangle is produced, then the exterior angle so formed is equal to the sum of the two interior opposite angles.

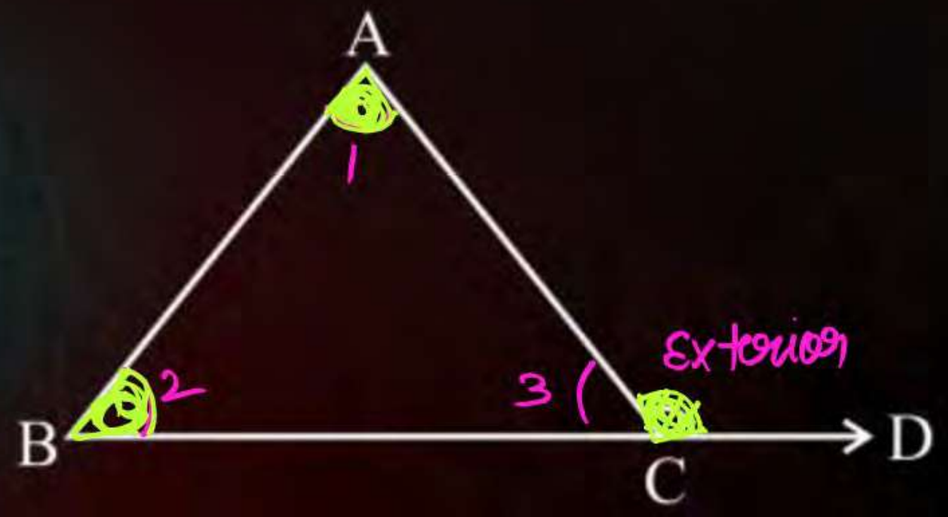
Angle sum property of Δ

$\Rightarrow \angle 1 + \angle 2 + \angle 3 = 180^\circ$

$\Rightarrow \angle 1 + \angle 2 = \boxed{180^\circ - \angle 3}$

$\Rightarrow \angle 1 + \angle 2 =$ exterior

$\boxed{\Rightarrow \text{Exterior Angle} = \text{sum of opposite Interior angle}}$




Exterior $+ \angle 3 = 180^\circ$

$\boxed{\text{Exterior} = 180^\circ - \angle 3}$

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# Remarks

- For obtaining exterior angles, the sides are to be produced in one direction only, either in a clockwise or in an anticlockwise manner.
- Every triangle has two set of three exterior angles i.e., three clockwise and three anticlockwise.
- The sum of all the three (either clockwise or anticlockwise) exterior angles of a triangles is 360°. In fact, the sum of all (either clockwise or anticlockwise) exterior angles of any polygon is 360°

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

An exterior angle of triangle is 120° and if one of the interior opposite angle is 40°, then the other two angles of triangle are

80°, 40°

80°, 60°

90°, 30°

50°, 70°

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

An exterior angle of triangle is 120° and if one of the interior opposite angle is 40°, then the other two angles of triangle are

A. 80°, 40°

B. 80°, 60°

C. 90°, 30°

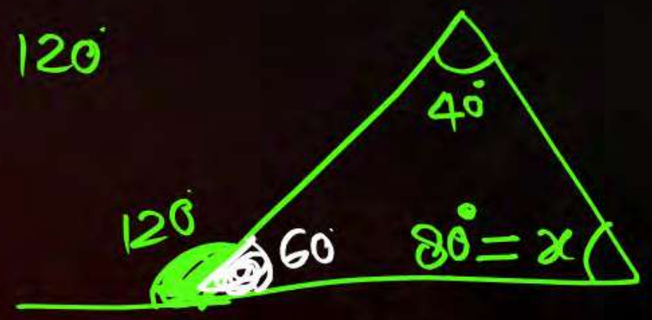
D. 50°, 70°

Exterior Angle = 120°

sum of opposite Interior = 120°

$40° + x = 120°$

$x = 80°$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

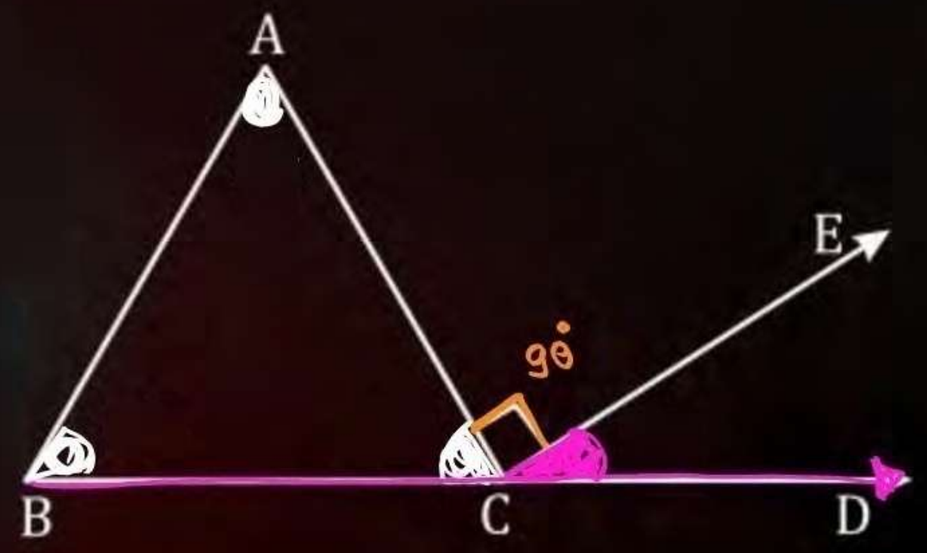
In the given figure, interior angles of $\Delta ABC$ are in the ratio $\angle A : \angle B : \angle C = 3 : 2 : 1$. Side BC is produced to D and $EC \perp AC$. Find $\angle DCE$.

30°

60°

45°

90°




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

In the given figure, interior angles of $\Delta ABC$ are in the ratio $\angle A : \angle B : \angle C = 3 : 2 : 1$. Side BC is produced to D and $EC \perp AC$. Find $\angle DCE$.

A. 30°

B. 60°

C. 45°

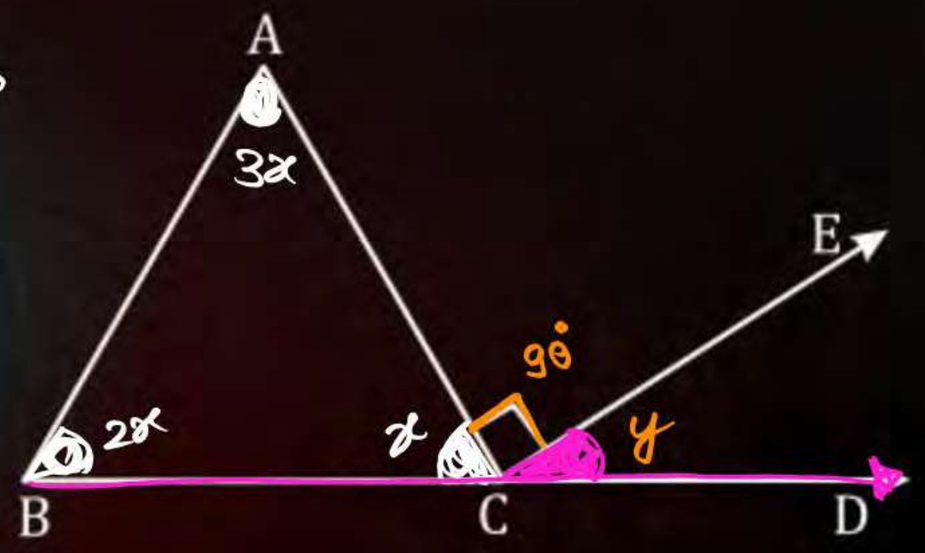
D. 90°

Angle sum property of a triangle,

$3x + 2x + x = 180^\circ$

$6x = 180^\circ$

$x = 30^\circ$




BCD is a straight line

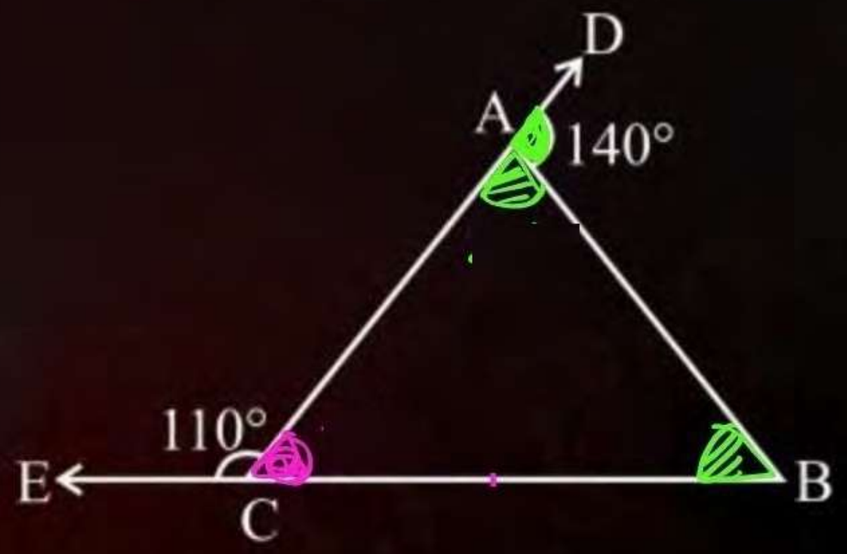
$x + 90^\circ + y = 180^\circ$

$30^\circ + 90^\circ + y = 180^\circ \Rightarrow y = 60^\circ$

VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

## Question

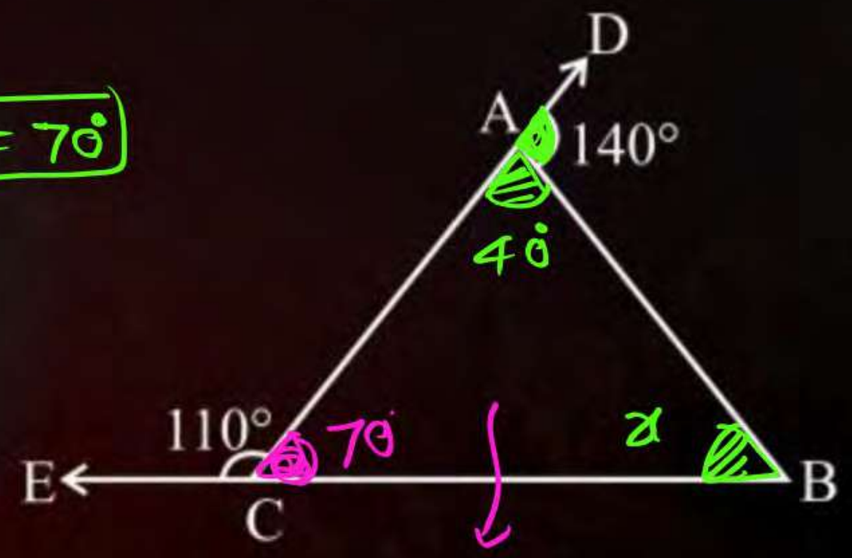
In the given figure, lines CA and DC of triangle ABC are produced to D and E respectively, if $\angle BAD = 140°$, $\angle ACE = 110°$, then find the measure of $\angle ABC =$




VIPIN KAUSHIK ASOSE SURAJMAL VIHAR

**Question**

In the given figure, lines CA and DC of triangle ABC are produced to D and E respectively, if $\angle BAD = 140°$, $\angle ACE = 110°$, then find the measure of $\angle ABC =$




$110° = x + 40° \Rightarrow \boxed{x = 70°}$

$40° + 70° + x = 180°$

$x = 180° - 110°$

$\boxed{x = 70°}$

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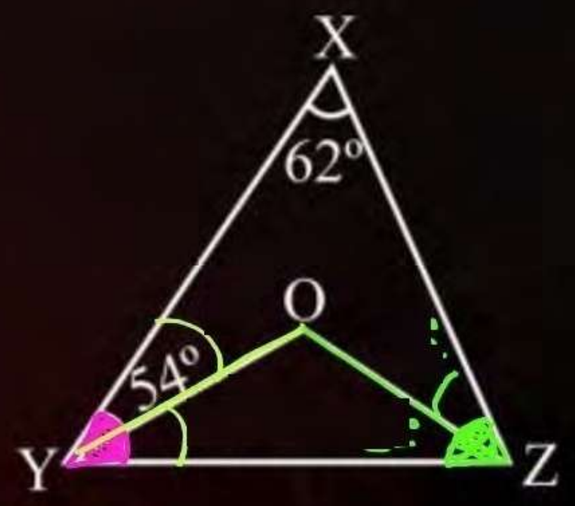
## Question

In figure, $\angle X = 62°$, $\angle XYZ = 54°$. If YO and ZO are the bisector of $\angle XYZ$ and $\angle XZY$ respectively of $\Delta XYZ$, find $\angle OZY$ and $\angle YOZ$.

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**Question**

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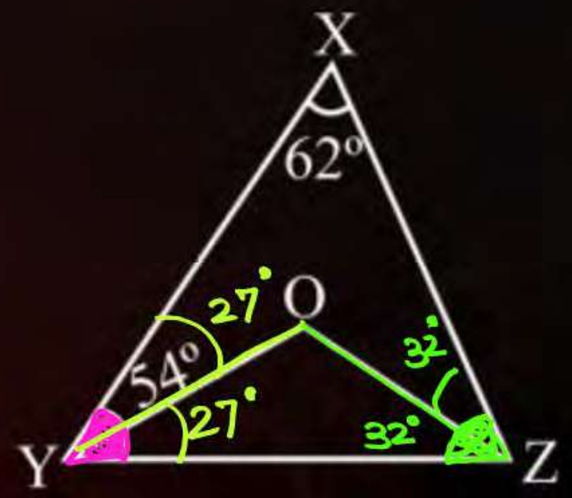


$\angle Z = 180° - (62° + 54°)$

$= 180° - 116°$

$\boxed{\angle Z = 64°}$

$\alpha + 27° + 32° = 180°$

$\alpha + 59° = 180°$

$\boxed{\alpha = 121°}$ ✓

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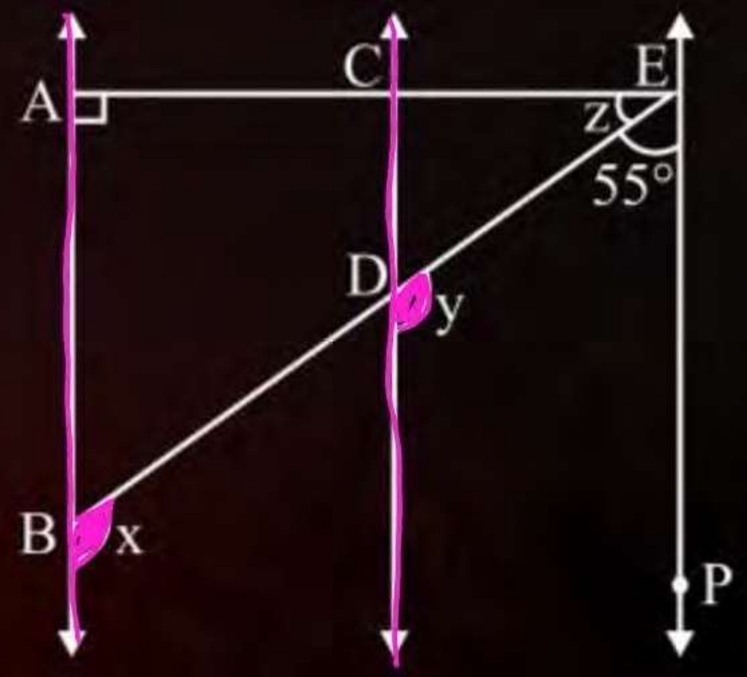
## Question

AB || CD and CD || EP Also EA ⊥ AB. If ∠BEF = 55°, if find the x, y and z.

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## Question

AB || CD and CD || EP. Also EA ⊥ AB. If ∠BEF = 55°, if find the x, y and z.

AB || EF

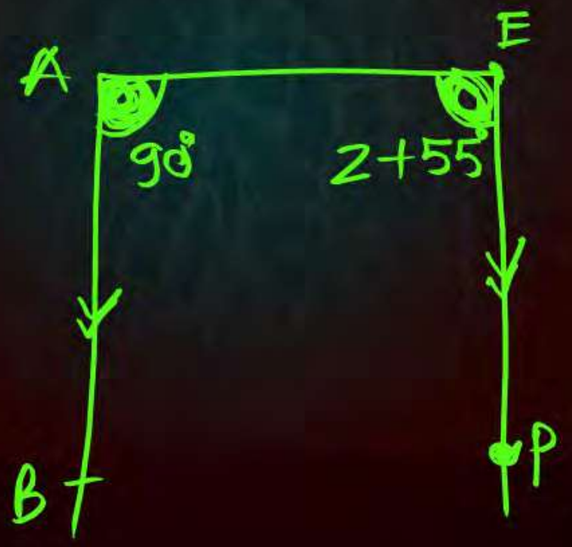
$x = y$ → corresponding

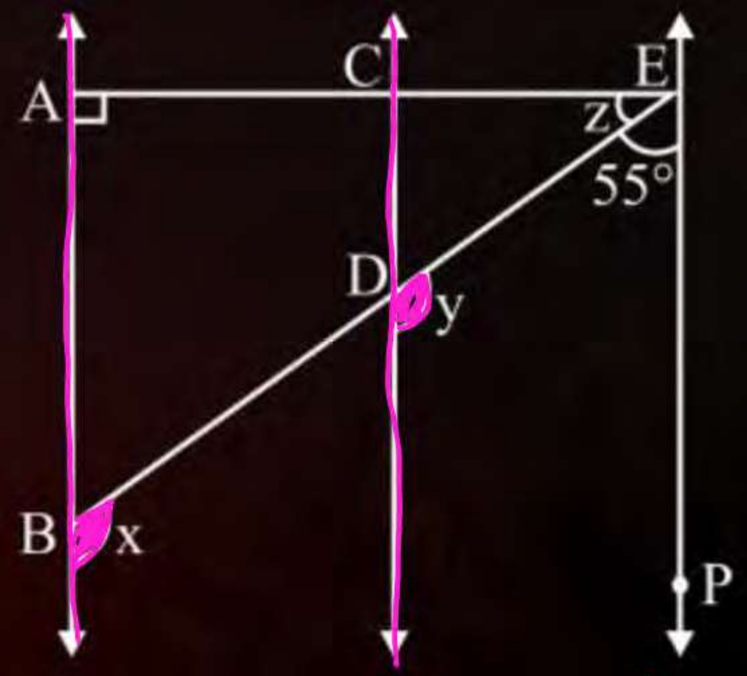
$y + 55° = 180°$

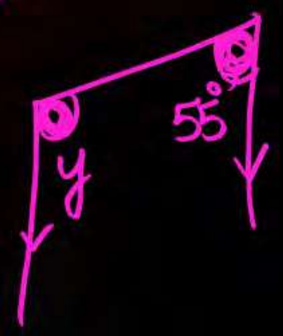
$x = y = 125°$

$90° + z + 55° = 180°$

$z = 35°$

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## Question

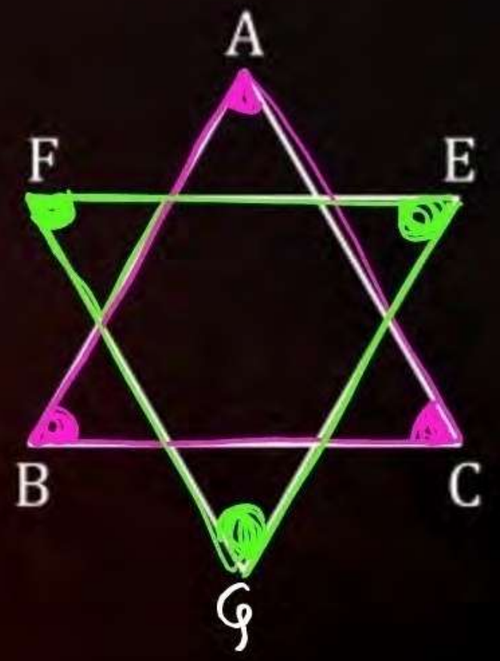
In figure if $\angle A + \angle B + \angle C + \angle D + \angle E + \angle F = (k) \times 90°$, then value of k will be

2

3

4

5

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## Question

In figure if $\angle A + \angle B + \angle C + \angle D + \angle E + \angle F = k \times 90°$, then value of k will be

$+\angle G$

A 2

B 3

C 4

D 5

$\angle A + \angle B + \angle C = 180°$

$\angle E + \angle F + \angle G = 180°$

$k \times 90° = 360°$

$k = \frac{360°}{90°} \Rightarrow \boxed{k = 4}$

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# Some Important Point

- Two angles that sum to 360° are called Conjugate or Explementary angles.
- All linear pairs are supplementary but all supplementary angles are not linear pairs.
- Two adjacent angles form a linear pair if and only if they are supplementary.
- If each of the two adjacent angles is 90°, then their non-common arms are in a straight line.
- If one pair of the vertically opposite angles is of obtuse angles, then the other pair of angles will be of acute angle.

# Some Important Points

- Alternate interior angles are generally called as alternate angles.
- The pairs of co-interior angles on the same side of the transversal are also called allied angles.
- Corresponding angles lie on the same side of the transversal.
- Alternate angles lie on the opposite side of the transversal.
- Perpendicular distance between two parallel lines is always equal.
- Two non-parallel lines cannot have more than one point in common in a plane.
- If two straight lines in a plane meet at more than one point, then the lines coincide with each other.

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# SAARI AXIOMS

**Axioms 1 :** If a ray stands on a line, then the sum of two adjacent angles is 180°.

**Axioms 2 :** If the sum of two adjacent angles is 180°, then the non-common arms form a line.

**Axioms 3 :** If a transversal intersects two parallel lines, then each pair of corresponding angles is equal.

**Axioms 4 :** If a transversal intersect two lines such that a pair of corresponding angles is equal, then the two lines are parallel to each other.

**Axioms 5 :** If a side of a triangle is produced, then the exterior angle so formed is equal to the sum of the two interior opposite angles.

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# SAARI THEOREMS

**Theorem 1 :** If two lines intersect each other, then the vertically opposite angles are equal.

**Theorem 2 :** If a transversal intersects two parallel lines, then each pair of alternate interior angles is equal.

**Theorem 3 :** If a transversal intersects two lines such that a pair of alternate interior angles is equal, then the two lines are parallel.

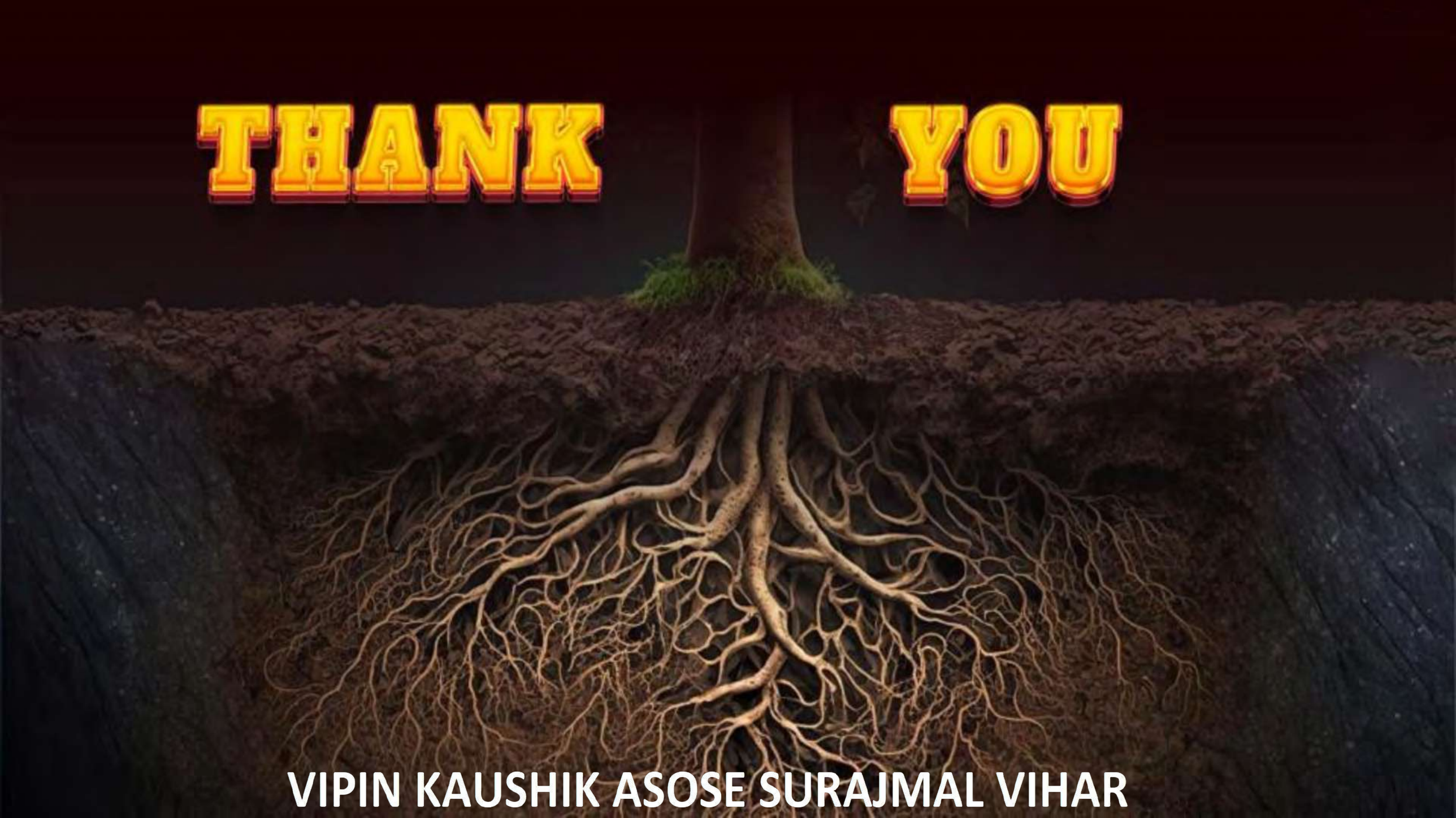
**Theorem 4 :** If a transversal intersect two parallel lines, then each pair of interior angles on the same side of the transversal is supplementary.

# SAARI THEOREMS

**Theorem 5 :** If a transversal intersects two lines such that a pair of interior angles on the same side of the transversal is supplementary, then the two lines are parallel.

**Theorem 6 :** Lines parallel to the same line are parallel to each other.

**Theorem 7 :** The sum of the angles of a triangles is 180°.


THANK YOU
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