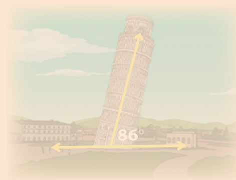
Chapter 5



GEOMETRY

Learning objectives

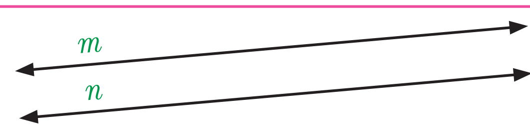
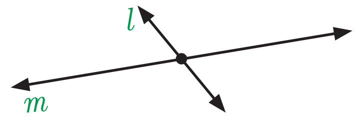
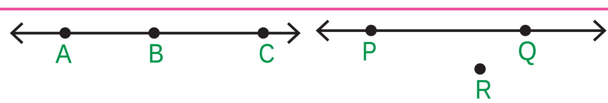
- To understand about adjacent angles, linear pair and vertically opposite angles.
- To understand transversal.
- To identify the different types of angles formed by a pair of lines with a transversal.
- To construct perpendicular bisector of a given line segment.
- To construct angle bisector of a given angle.
- To construct special angles such as 90°, 60°, 30° and 120° without using protractor.

NX9KM

Recap

Lines

Let us recall the following concepts on lines and points which we have learnt in class VI.

A **line** extends along both directions without any end. A line AB is denoted by $\overleftrightarrow{AB}$. Sometimes small letters like l, m, n and so on are used to denote lines.	
A **line segment** has two end points. The line segment 'AB' is represented by $\overline{AB}$.	
A **Ray** is a line that starts from a point 'A' and extends without any end in a particular direction passing through 'B' which is denoted by $\overrightarrow{AB}$.	
If two lines m and n are parallel, then we denote it as $m \| n$. **Parallel lines** never intersect each other.	
When two lines have a common point they are called **intersecting lines** and that point is called the point of intersection of the given two lines.	
If three or more points lie on the same line, then they are called **collinear points**; otherwise they are called **non-collinear points**.	 A,B and C are collinear points P,Q and R are non-collinear points

Try these

1. Complete the following statements.
   (i) A ________ is a straight path that goes on endlessly in two directions.
   (ii) A ________ is a line with two end points.

(iii) A _____ is a straight path that begins at a point and goes on and extends endlessly in the other direction.

(iv) The lines which intersect at right angles are ____________.

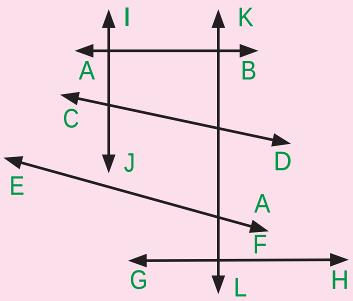
(v) The lines which intersect each other at a point are called _________.

(vi) The lines that never intersect are called ___________.

2. Use a ruler or straightedge to draw each figure.

(i) line CD (ii) ray AB (iii) line segment MN

3. Look at the figure and answer the following questions.



(i) Which line is parallel to AB

(ii) Name a line which intersect CD

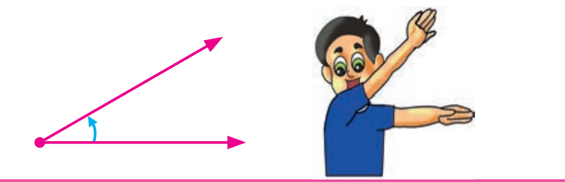
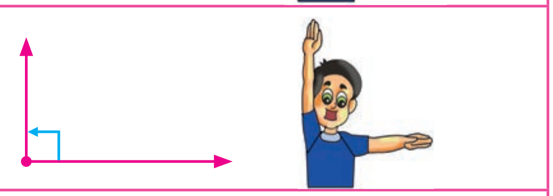
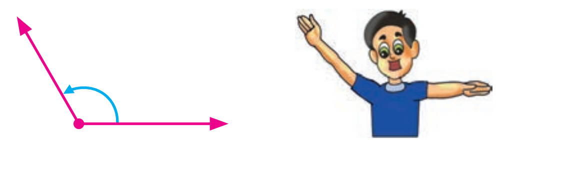
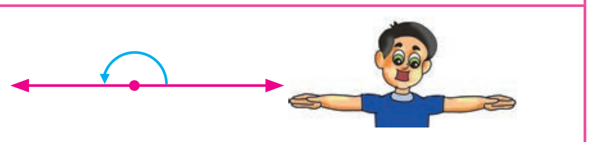
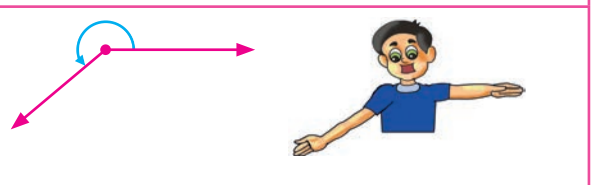
(iii) Name the lines which are perpendicular to GH

(iv) How many lines are parallel to IJ

(v) Will EF intersect AB? Explain.

Angles

Recall that **an angle** is formed when two rays diverge from a common point. The rays forming an angle are called the **arms** of the angle and the common point is called the **vertex** of the angle. You have studied different types of angles, such as **acute angle, right angle, obtuse angle, straight angle** and **reflex angle,** in class VI. We can summarize them as follows:

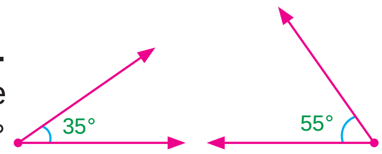
Acute angle An angle whose measure is less than 90º is called an acute angle.	
Right angle An angle whose measure is exactly 90º is called a right angle.	
Obtuse angle An angle whose measure is greater than 90° and less than 180° is called an obtuse angle.	
Straight angle An angle whose measure is exactly 180° is called a straight angle.	
Reflex angle An angle whose measure is greater than 180° and less than 360° is called a reflex angle.	

Also, we have studied about related angles such as complementary and supplementary angles in our previous class. Let us recall them.

Complementary angles

Two angles are called Complementary angles if their sum is 90°.

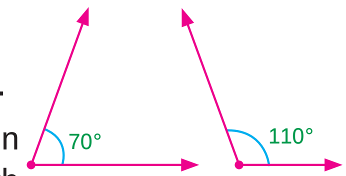
Are the two angles given in the figure complementary? Yes. The pair of angles 35° and 55° are complementary, where the angle 35° is said to be the complement of the other angle 55° and vice versa.



Supplementary angles

Two angles are called Supplementary angles if their sum is 180°.

Observe the sum of measures of the angles 70° and 110° given in the figure is 180°. When two angles are supplementary, each angle is said to be the supplement of the other.



Try these

Choose the correct answer.

1. A straight angle measures

   (a) 45° (b) 90° (c) 180° (d) 100°

2. An angle with measure 128° is called ____________ angle.

   (a) a straight (b) an obtuse (c) an acute (d) Right

3. The corner of the A4 paper has

   (a) an acute angle (b) a right angle (c) straight (d) an obtuse angle

4. If a perpendicular line is bisecting the given line, you would have two

   (a) right angles (b) obtuse angles (c) acute angles (d) reflex angles

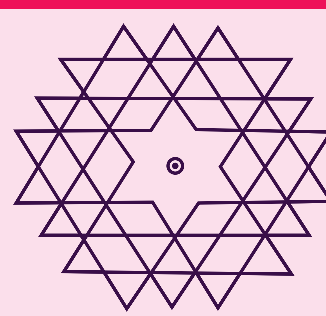
5. An angle that measure 0° is called _______.

   (a) right angle (b) obtuse angle (c) acute angle (d) zero angle

5.1 Introduction

We are familiar with complementary and supplementary angles. Let us see some more related pairs of angles now.

MATHEMATICS ALIVE - GEOMETRY IN REAL LIFE



Beauty of Angles in architecture and kolams

5.2 Pair of Angles formed by Intersecting Lines

We are going to study related angles such as adjacent angles, linear pair of angles and vertically opposite angles.

5.2.1. Adjacent angles

The teacher shows a picture of sliced orange with angles marked on it.

Read the conversation between the teacher and students.

Teacher : How many angles are marked on the picture? Can you name them?

Kavin : Three angles are marked on the picture. They are $\angle AOC, \angle AOB$ and $\angle BOC$

Teacher : Which are the angles seen next to each other?

Thoorigai : Angles such as $\angle AOB$ and $\angle BOC$ are next to each other.

Teacher : How many vertices are there?

Mugil : There is only one common vertex.

Teacher : How many arms are there? Name them.

Amudhan : There are three arms. They are $\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$

Teacher : Is there any common arm for $\angle AOB$ and $\angle BOC$?

Oviya : Yes. $\overrightarrow{OB}$ is the common arm for $\angle AOB$ and $\angle BOC$.

Teacher : What can you say about the arms $\overrightarrow{OA}$ and $\overrightarrow{OC}$?

Kavin : They lie on the either side of the common arm $\overrightarrow{OB}$.

Teacher : Are the interiors of $\angle AOB$ and $\angle BOC$ overlapping?

Mugil : No. Their interiors are not overlapping.

Teacher : Hence the two angles, $\angle AOB$ and $\angle BOC$ have one common vertex (O), one common arm ($\overrightarrow{OB}$), other two arms ($\overrightarrow{OA}$ and $\overrightarrow{OC}$) lie on either side of the common arm and their interiors do not overlap.

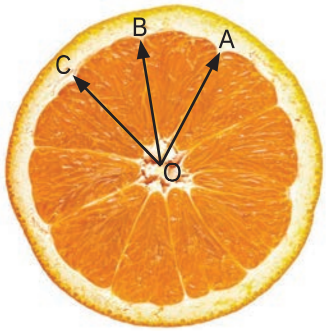


Fig.5.1

Such pair of angles $\angle AOB$ and $\angle BOC$ are called adjacent angles.

So, two angles which have a common vertex and a common arm, whose interiors do not overlap are called adjacent angles.

Now observe the Fig.5.2 in which angles are named $\angle 1$, $\angle 2$ and $\angle 3$.

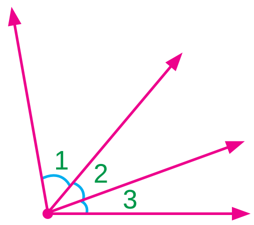


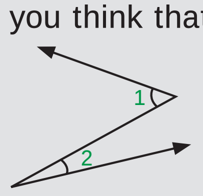
Fig.5.2

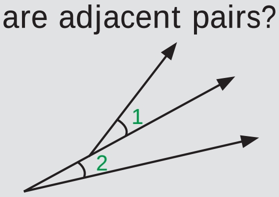
It can be observed that there are two pairs of adjacent angles such as $\angle 1$, $\angle 2$ and $\angle 2$, $\angle 3$. Then what about the pair of angles $\angle 1$ and $\angle 3$?

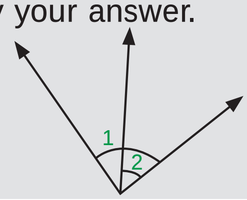
They are not adjacent because this pair of angles have a common vertex but they do not have a common arm as $\angle 2$ is in between $\angle 1$ and $\angle 3$. Also interiors of $\angle 1$ and $\angle 3$ do not overlap. Since the pair of angles does not satisfy one among the three conditions they are not adjacent.

Think

In each of the following figures, observe the pair of angles that are marked as $\angle 1$ and $\angle 2$. Do you think that they are adjacent pairs? Justify your answer.







Try these

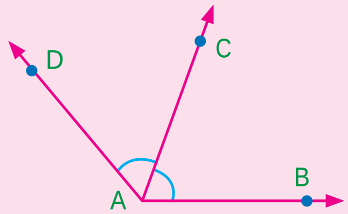
1. Few real life examples depicting adjacent angles are shown below.

Can you give three more examples of adjecent angles seen in real life?

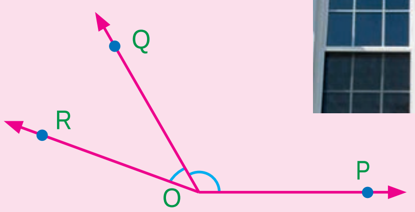
2. Observe the six angles marked in the picture shown (Fig 5.2). Write any four pairs of adjacent angles and that are not.

3. Identify the common arm, common vertex of the adjacent angles and shade the interior with two colours in each of the following figures.

(i)

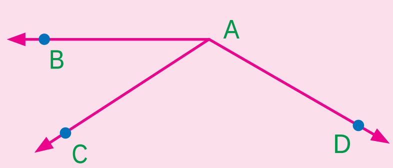


(ii)

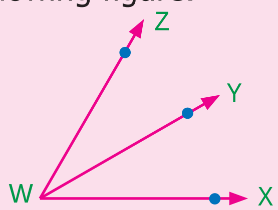


4. Name the adjacent angles in each of the following figure.

(i)



(ii)



5.2.2 Linear pair

Observe the Fig.5.3 $\angle QPR$ and $\angle RPS$ are adjacent angles. It is clear that $\angle QPR$ and $\angle RPS$ together will make $\angle QPS$ which is acute. When $\angle QPR$ and $\angle RPS$ are increased $\angle QPS$ becomes (i) right angle, (ii) obtuse angle, (iii) straight angle and (iv) reflex angle as shown in Fig.5.4.

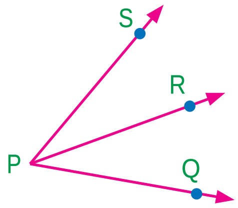
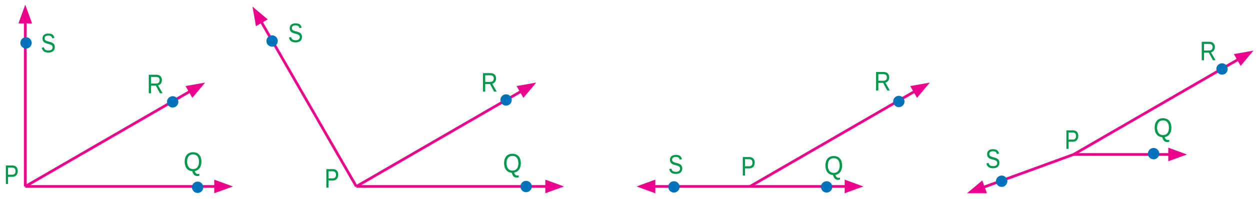


Fig.5.3



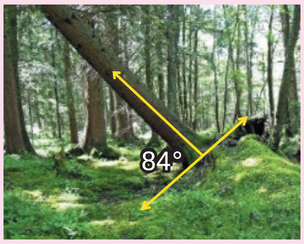
(i) (ii) (iii) (iv)

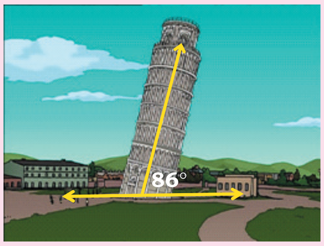
Fig.5.4

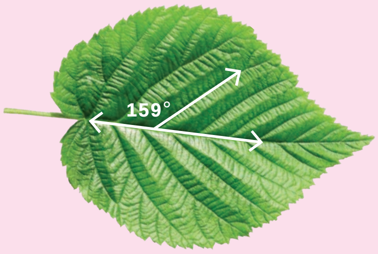
If the resultant angle is a straight angle then the angles are called supplementary angles. The adjacent angles that are supplementary lead us to a pair of angles that lie on straight line (Fig.5.4(iii)). This pair of angles are called linear pair of angles.

Try these

1. Observe the following pictures and find the other angle of linear pair.

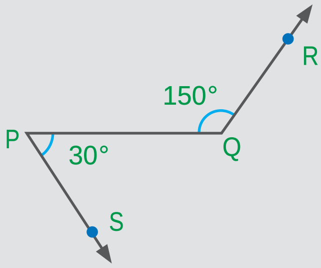






Think

Observe the figure. There are two angles namely $\angle PQR$ = 150° and $\angle QPS$ = 30°. Is all this pair of supplementary angles a linear pair? Discuss.



Example 5.1 In Fig. 5.5, find $\angle AOC$.

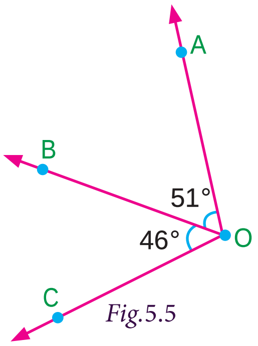


Fig.5.5

Solution

$$\angle AOC = \angle AOB + \angle BOC$$
$$= 51° + 46°$$
$$= 97°$$

Example 5.2 If $\angle POQ$ = 23° and $\angle POR$ = 62° then find $\angle QOR$

Solution

We know that $\angle POR = \angle POQ + \angle QOR$

$62° = 23° + \angle QOR$

Subtracting 23° on both sides

$62° - 23° = 23° + \angle QOR - 23°$

$\angle QOR = 39°$

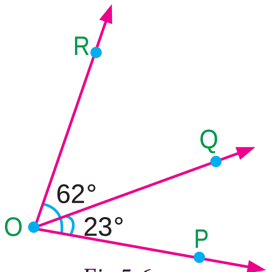


Fig.5.6

Example 5.3 Which of the following pair of adjacent angles will make a linear pair?

(i) 89°, 91° (ii) 105°, 65° (iii) 117°, 62° (iv) 40°, 140°

Solution

(i) Since 89° + 91° = 180°, this pair will be a linear pair.

(ii) Since 105° + 65° = 170° ≠ 180°, this pair cannot make a linear pair.

(iii) Since 117° + 62° = 179° ≠ 180°, this pair cannot make a linear pair.

(iv) Since 40° + 140° = 180°, this pair will be a linear pair.

Example 5.4 Find the missing angle.

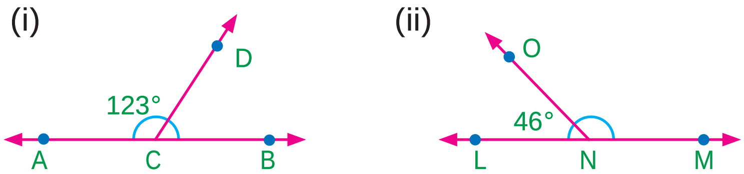


Fig.5.7

Solution

(i) Since the angles are linear pair, $\angle ACD + \angle BCD = 180°$

$123° + \angle BCD = 180°$

Subtracting 123° on both sides

$123° + \angle BCD - 123° = 180° - 123°$

$\angle BCD = 57°$

(ii) Since the angles are linear pair, $\angle LNO + \angle MNO = 180°$

$46° + \angle MNO = 180°$

Subtracting 46° on both sides

$46° + \angle MNO - 46° = 180° - 46°$

$\angle MNO = 134°$

Example 5.5 Two angles are in the ratio 3:2. If they are linear pair, find them.

Solution

Let the angles be $3x$ and $2x$

Since they are linear pair of angles, their sum is 180°.

Therefore, $3x+2x = 180°$

$5x = 180°$

$$x = \frac{180°}{5}$$

$x = 36°$

The angles are $3x = 3\times36 = 108°$

$2x = 2\times36 = 72°$

More on linear pairs

Amudhan asked his teacher what would happen if he drew a ray in between a linear pair of angles? The teacher told him to draw it. Amudhan drew the ray as shown in Fig.5.8.

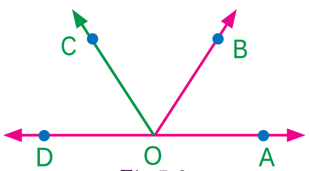


Fig.5.8

Teacher asked Amudhan, "what can you say about the angles $\angle AOB$ and $\angle BOC$?". He said that they are adjacent angles. Also it is true that $\angle AOB + \angle BOC = \angle AOC$.

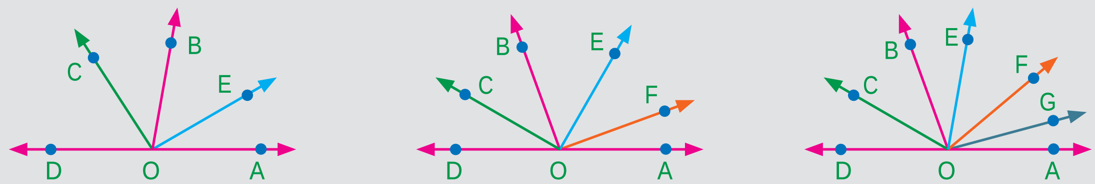
The teacher also asked about the pair of angles $\angle AOC$ and $\angle COD$. He replied that they are linear pair. Therefore, their sum is 180° i.e. $\angle AOC + \angle COD = 180°$.

Combining these two results we get $\angle AOB + \angle BOC + \angle COD = 180°$.

Thus, the sum of all the angles formed at a point on a straight line is 180°.

Think

What would happen to the angles if we add 3 or 4 or 5 rays on a line as given below?



We can learn one more result on linear pairs.
Observe the following Fig.5.9.

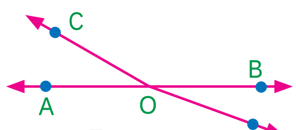


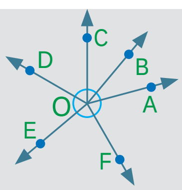
Fig.5.9

AB is a straight line. OC is a ray meeting AB at O.
Here, $\angle AOC$ and $\angle BOC$ are linear pair.
Hence $\angle AOC + \angle BOC = 180°$
Also, OD is another ray meeting AB at O.
Again $\angle AOD$ and $\angle BOD$ are linear pair.
Hence $\angle AOD + \angle BOD = 180°$
Now, $\angle AOC$, $\angle BOC$, $\angle AOD$ and $\angle BOD$ are the angles that are formed at the point O.
We can observe that $(\angle AOC + \angle BOC) + (\angle AOD + \angle BOD) = 180° + 180° = 360°$.
So, the sum of all angles at a point is 360°.

Think

Can you justify the following statement.

$\angle AOB + \angle BOC + \angle COD + \angle DOE + \angle EOF + \angle FOA = 360°$?



UDZAV

Example 5.6 From Fig.5.10, find the measure of $\angle ROS$.

Solution

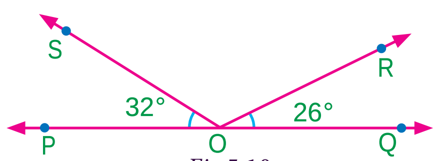


Fig.5.10

We know that $\angle QOR + \angle ROS + \angle SOP = 180°$

$26° + \angle ROS + 32° = 180°$

$\angle ROS + 58° = 180°$

Subtracting 58° on both sides

We get, $\angle ROS = 180° - 58° = 122°$

Example 5.7 In Fig. 5.11, find the value of $x°$

Solution

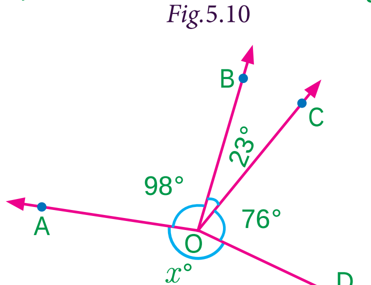


Fig.5.11

$98° + 23° + 76° + x° = 360°$

$197° + x° = 360°$

$x° = 360° - 197° = 163°$

5.2.3 Vertically opposite angles

We have already studied about intersecting lines. Observe the Fig.5.12. There are two lines namely l and m which are intersecting at a point O and forming four angles at that point of intersection. They are $\angle 1$, $\angle 2$, $\angle 3$ and $\angle 4$.

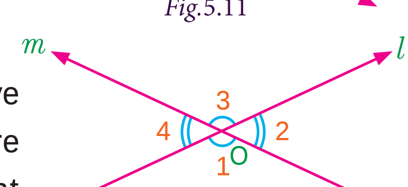


Fig.5.12

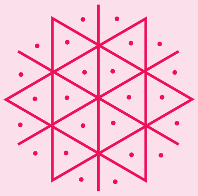
Consider any one angle among this say $\angle 1$. The angles which are adjacent to $\angle 1$ are $\angle 2$ and $\angle 4$, $\angle 3$ is a non-adjacent angle. Similarly, for the remaining three angles two angles will be adjacent and one angle will be non-adjacent. We can observe that an angle and its non-adjacent angle are just opposite to each other at the point of intersection O (vertex). Such angles which are opposite to each other with reference to the vertex are called vertically opposite angles.

When two lines intersect each other, two pairs of non-adjacent angles formed are called vertically opposite angles.

Try these

1. Four real life examples for vertically opposite angles are given below.

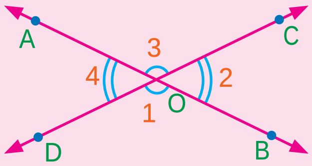


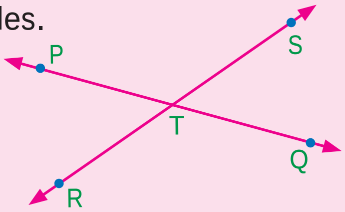
Give four more examples for vertically opposite angles in your surrounding.

2. In the given figure, two lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ intersect at O. Observe the pair of angles and complete the following table. One is done for you.

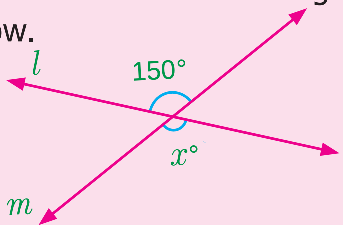
Pair of angles	$\angle AOC$	$\angle AOD$	$\angle BOC$	$\angle BOD$
$\angle AOC$	Same angle	Adjacent angle	Adjacent angle	Non – adjacent angle
$\angle AOD$				
$\angle BOC$				
$\angle BOD$				



3. Name the two pairs of vertically opposite angles.



4. Find the value of $x°$ in the figure given below.

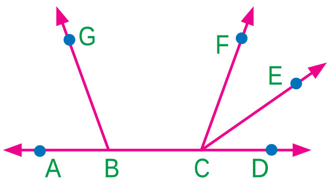


Activity

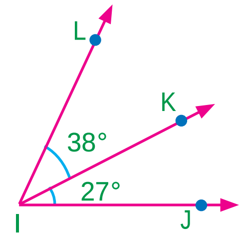
On a paper draw two intersecting lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$. Let the two lines intersect at O. Label the two pairs of vertically opposite angles as $\angle 1$, $\angle 2$ and $\angle 3$, $\angle 4$. Make a trace of angles $\angle 2$ and $\angle 3$. Place the traced angle $\angle 2$ on angle $\angle 1$. Are they equal? Place the traced angle $\angle 3$ on angle $\angle 4$. Are they equal? Continue the same for five different pair of intersecting lines. Record your observations and discuss.

Exercise 5.1

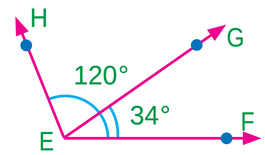
1. Name the pairs of adjacent angles.



2. Find the angle $\angle JIL$ from the given figure.

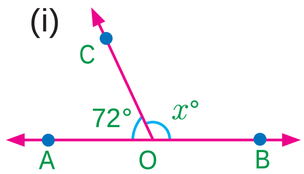


3. Find the angle $\angle GEH$ from the given figure.

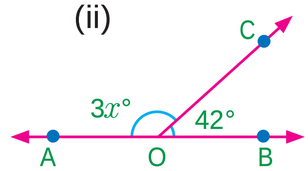


4. Given that AB is a straight line. Calculate the value of $x°$ in the following cases.

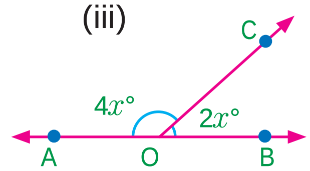
(i)



(ii)



(iii)



5. One angle of a linear pair is a right angle. What can you say about the other angle?

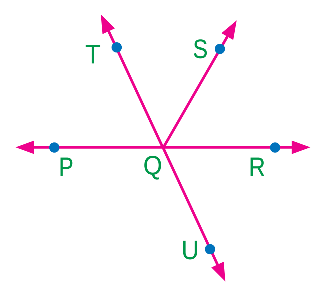
6. If the three angles at a point are in the ratio 1 : 4 : 7, find the value of each angle?

7. There are six angles at a point. One of them is 45° and the other five angles are all equal. What is the measure of all the five angles?

8. In the given figure, identify

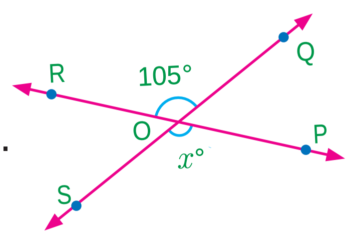
   (i) any two pairs of adjacent angles.

   (ii) two pairs of vertically opposite angles.

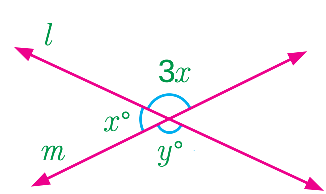


9. The angles at a point are $x°$, $2x°$, $3x°$, $4x°$ and $5x°$. Find the value of the largest angle?

10. From the given figure, find the missing angle.



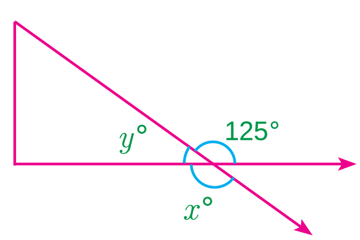
11. Find the angles $x°$ and $y°$ in the figure shown.



12. Using the figure, answer the following questions.

   (i) What is the measure of angle $x°$?

   (ii) What is the measure of angle $y°$?



Objective type questions

13. Adjacent angles have

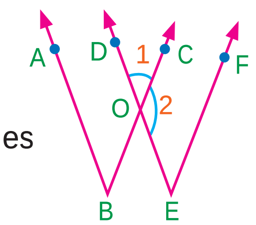
    (i) no common interior, no common arm, no common vertex

    (ii) one common vertex, one common arm, common interior

    (iii) one common arm, one common vertex, no common interior

    (iv) one common arm, no common vertex, no common interior

14. In the given figure the angles $\angle 1$ and $\angle 2$ are



    (i) opposite angles (ii) Adjacent angles

    (iii) Linear pair (iv) Supplementary angles

15. Vertically opposite angles are

    (i) not equal in measure (ii) complementary

    (iii) supplementary (iv) equal in measure

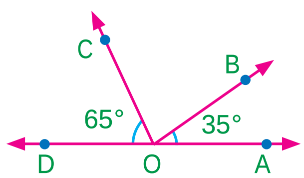
16. The sum of all angles at a point is

    (i) 360° (ii) 180° (iii) 90° (iv) 0°

17. The measure of $\angle BOC$ is

    (i) 90° (ii) 180°

    (iii) 80° (iv) 100°



5.3 Transversal

Observe the Fig.5.13. Here m and n are any two non-parallel lines and l is another line intersecting them at A and B respectively. We call such intersecting line (l) as transversal. Therefore, a transversal is a line that intersects two lines at distinct points. We can extend this idea to any number of lines.

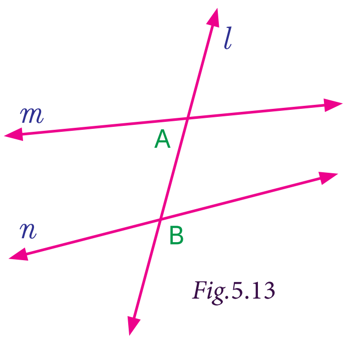
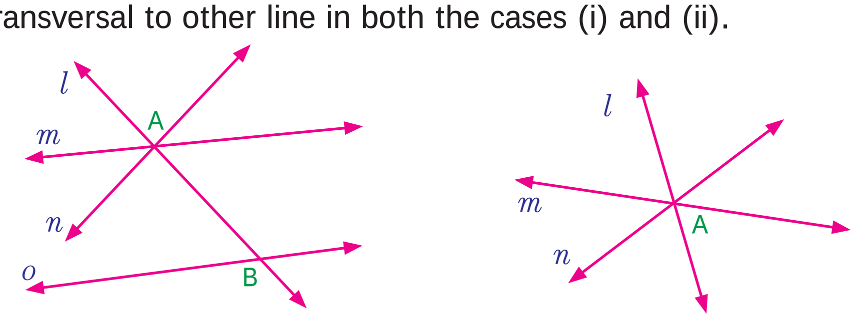


Fig.5.13

Now observe the following Fig.5.14. Check whether the line l is transversal to other line in both the cases (i) and (ii).



(i) (ii)

Fig.5.14

Think

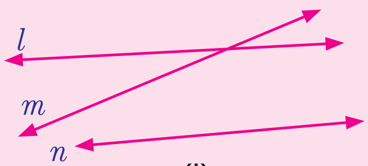
For a given set of lines, is it possible to draw more than one transversal?

In figure (i) the line l is not a transversal to the lines m and n, but it is a transversal to the pair of lines m and o , n and o.

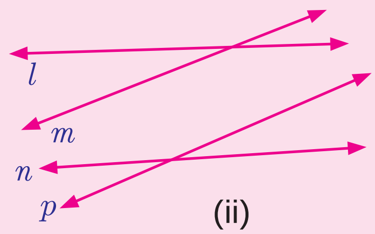
In figure (ii) l does not intersect the lines m and n at distinct points. So, it is not a transversal.

Try these

1. Draw as many possible transversals in the given figures.



(i)



(ii)

2. Draw a line which is not the transversal to the above figures.
3. How many transversals can you draw for the following two lines?

5.3.1. Angles formed by a transversal

If a transversal meet two lines, eight angles are formed at the points of intersection as shown in the Fig.5.15.

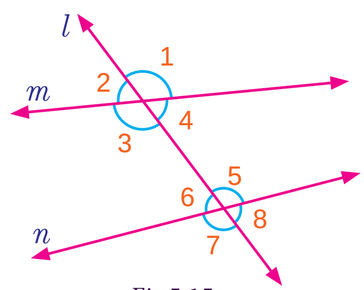


*Fig.*5.15

It is clear that the pairs of angles ∠1, ∠2, ; ∠3, ∠4, ; ∠5, ∠6 and ∠7, ∠8 are linear pairs. Can you find more linear pairs of angles?

Besides, the pairs ∠1, ∠3 ; ∠2, ∠4 ; ∠5, ∠7 and ∠6, ∠8 are vertically opposite angles.

We can further classify the angles shown in the Fig. 5.15 into different categories as follows.

Corresponding angles

Observe that the pair of angles ∠1 and ∠5 that are marked at the right side of the transversal l. In that ∠1 lies above the line m and ∠5 lies above the line n.

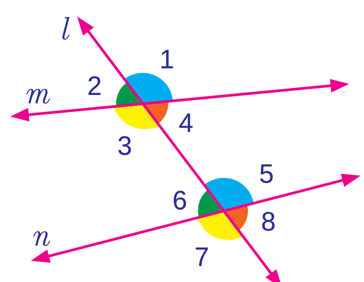


*Fig.*5.16

Also observe the pair of angles ∠2 and ∠6 that are marked on the left of the transversal l. In that ∠2 lies above m and ∠6 lies above n.

In the same way observe the pair of angles ∠3 and ∠7 that are marked on left of transversal l. In that ∠3 lies below m and ∠7 lies below n.

Observe the pair of angles ∠4 and ∠8 that are marked on the right of transversal l. In that ∠4 lies below m and ∠8 lies below n.

VZCNY

So all these pairs of angles have different vertices, lie on the same side (left or right) of the transversal(l), lie above or below the lines m and n. Such pairs are called corresponding angles.

Alternate Interior angles

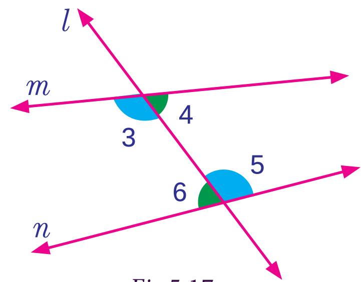


*Fig.*5.17

Each of pair of angles named $\angle 3$ and $\angle 5$, $\angle 4$ and $\angle 6$ are marked on the opposite side of the transversal l and are lying between lines m and n are called alternate interior angles.

Alternate Exterior angles

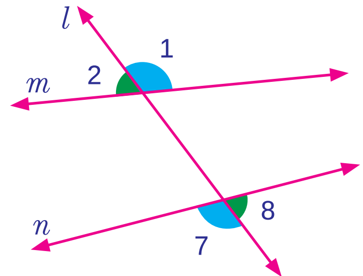


*Fig.*5.18

Each pair of angles named $\angle 1$ and $\angle 7$, $\angle 2$ and $\angle 8$ are marked on the opposite side of the transversal l and are lying outside of the lines m and n are called alternate exterior angles.

Now let us observe some more pairs of angles.

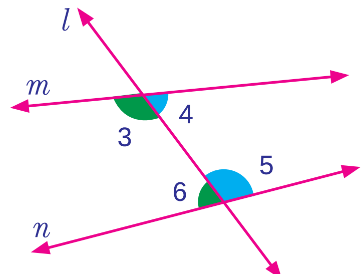


*Fig.*5.19

Each pair of angles named $\angle 3$ and $\angle 6$, $\angle 4$ and $\angle 5$ are marked on the same side of transversal l and are lying between the lines m and n. These angles are lying on the interior of the lines m and n as well as the same side of the transversal l.

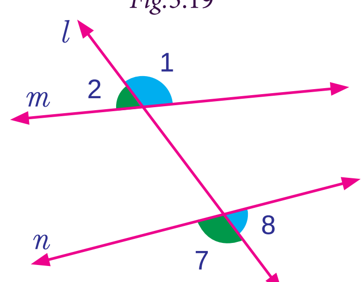


*Fig.*5.20

Each pair of angles named $\angle 1$ and $\angle 8$, $\angle 2$ and $\angle 7$ are marked on the same side of transversal l and are lying outside of the lines m and n. These angles are lying on the exterior of the lines m and n as well as the same side of the transversal l.

How can we call such angles?

We call them as co-interior and co-exterior angles.

DO YOU KNOW?

In Architecture, corresponding angles are used to assure symmetry and balance when designing the structure. Alternate exterior angles are used to ensure symmetry in floor plans. Alternate interior Angles are used to ensure that two beams are parallel and do not let the structure bend or deform in any form.

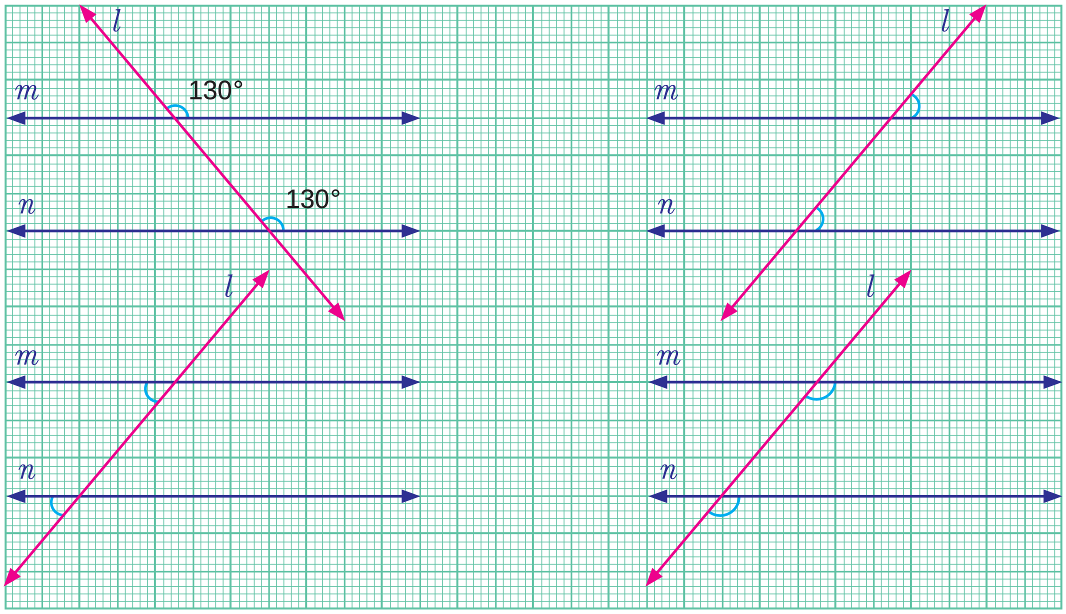
Interior angles on the same side of the transversal are used to determine if two beams are parallel and will not result in any distractions to the overall design. Exterior angles on the same side of the transversal are used to confirm that the walls are indeed straight and not at a different angle.

5.3.2 Angles formed by a transversal with Parallel lines

We saw different types of angles formed by a transversal while intersecting two given lines. Now let us observe some interesting facts on the angles formed by a transversal with the parallel lines from the following activities.

Activity

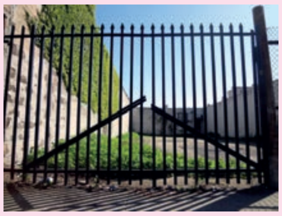
Observe the marked pair of corresponding angles in each figure. One in the interior and other in the exterior of the parallel lines and both lie on the same side of the transversal. One pair of angles are measured and found equal. Measure the remaining three pairs of angles and check.



From the above activity, we can conclude that when two parallel lines are cut by a transversal, each pair of corresponding angles are equal.

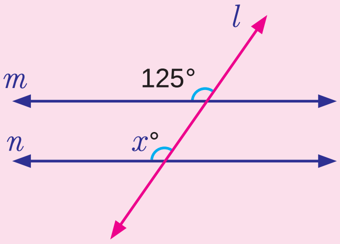
Try these

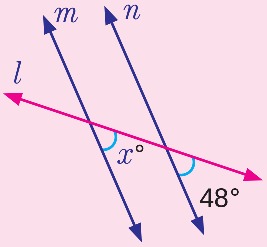
1. Four real life examples for transversal of parallel lines are given below.

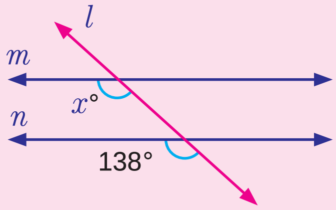




Give four more examples for transversal of parallel lines seen in your surroundings.

2. Find the value of x .

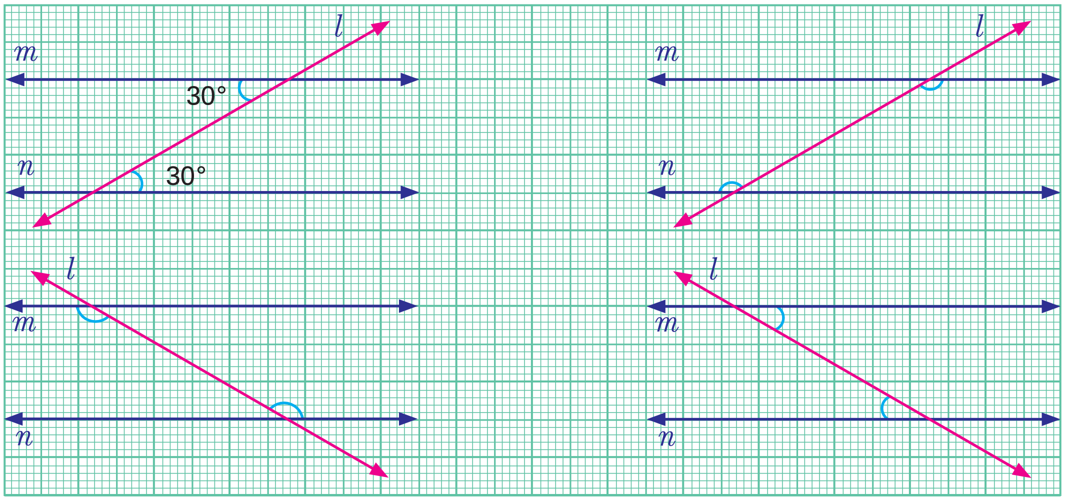






Activity

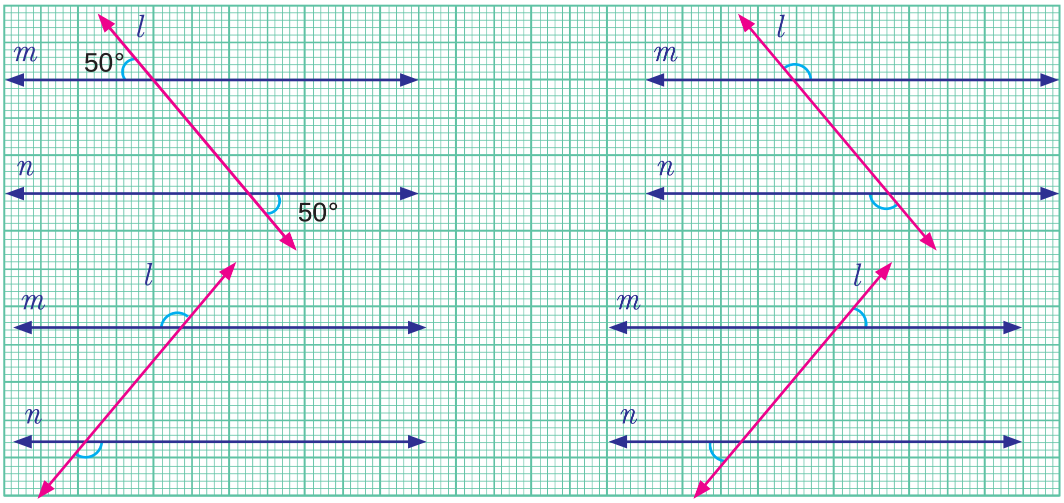
Observe the alternate Interior angles in each figure. Both lying between the interior of the parallel lines and on the opposite sides of the transversal. One pair of angles are measured and found equal. Measure the remaining three pairs of angles and check.



From the above activity we can conclude that when two parallel lines are cut by a transversal, each pair of alternate interior angles are equal.

Activity

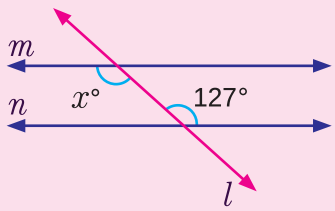
Observe the marked alternate Exterior angles in each figure. Both lying at the exterior of the parallel lines and on the opposite sides of the transversal. One pair of angles are measured and found equal. Measure the remaining three pairs of angles and check.

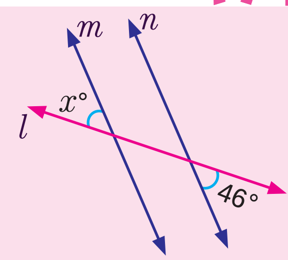


From the above activity we can conclude that when two parallel lines are cut by a transversal, each pair of alternate exterior angles are equal.

Try these

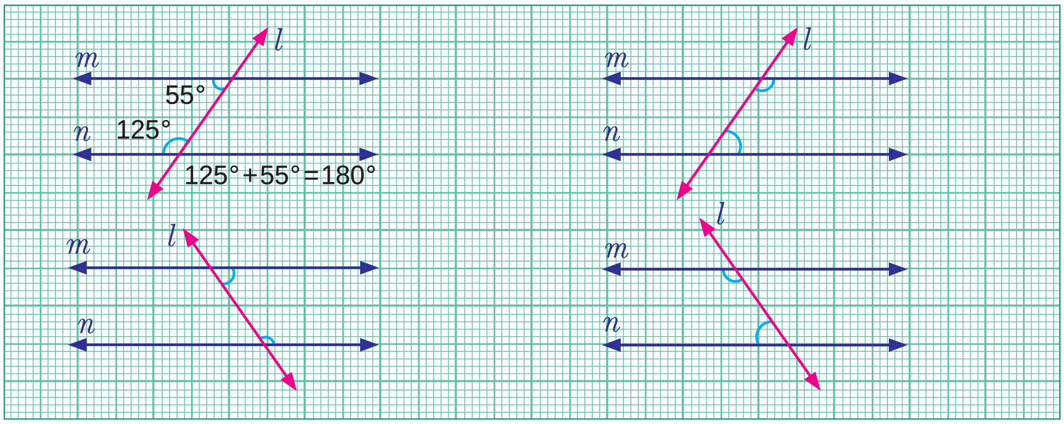
Find the value of $x°$.





Activity

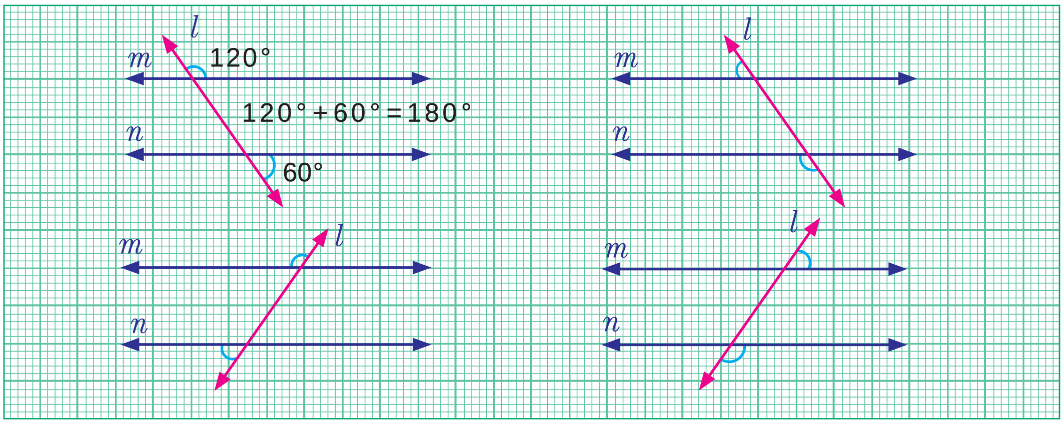
Observe the marked co-interior angles in each figure. Both lying between the interior of the parallel lines and on the same side of the transversal. One pair of angles are measured and found the sum to be 180°. Measure the remaining three pairs of angles and check.



From the above activity we can conclude that when two parallel lines are cut by a transversal, each pair of interior angles that lie on the same side of the transversal are supplementary.

Activity

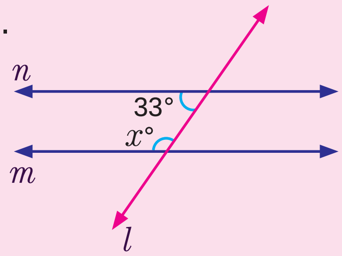
Observe the marked co-exterior angles in each figure. Both lying at the exterior of the parallel lines and on the same side of the transversal. One pair of angles are measured and found that they are supplementary. Measure the remaining three pairs of angles and check.

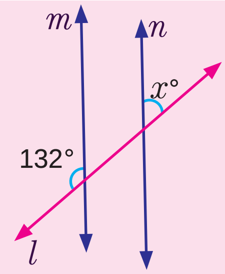


From the above activity we can conclude that when two parallel lines are cut by a transversal, each pair of exterior angles that lie on the same side of the transversal are supplementary.

Try these

Find the value of x .





Example 5.8

(i) Name the angle that corresponds to $\angle 1$.
(ii) Name the angle that is alternate interior to $\angle 3$.
(iii) Name the angle that is alternate exterior to $\angle 8$.
(iv) Name the angle that corresponds to $\angle 8$.
(v) Name the angle that is alternate exterior to $\angle 7$.
(vi) Name the angle that is alternate interior to $\angle 6$.

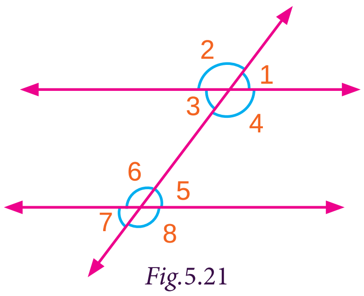


Fig.5.21

Solution

(i) The angle that corresponds to $\angle 1$ is $\angle 5$
(ii) The angle that is alternate interior to $\angle 3$ is $\angle 5$
(iii) The angle that is alternate exterior to $\angle 8$ is $\angle 2$
(iv) The angle that corresponds to $\angle 8$ is $\angle 4$
(v) The angle that is alternate exterior to $\angle 7$ is $\angle 1$
(vi) The angle that is alternate interior to $\angle 6$ is $\angle 4$

Example 5.9

(i) Which angles are corresponding angles to b°?
(ii) What is the measure of b°?
(iii) Which angles have the measure 68°?
(iv) Which angles have the measure 112°?

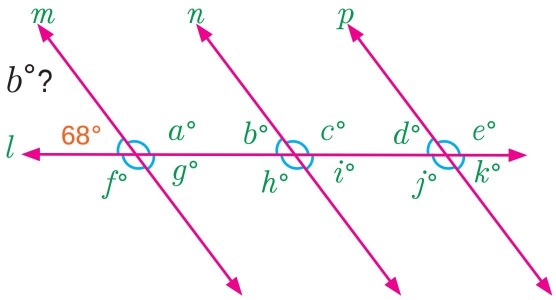


Fig.5.22

Solution

(i) The corresponding angles to b° are $d°$ and 68°.
(ii) The measure of b° is 68° (Because b° corresponds to 68°)
(iii) The angles having measure 68° are $b°$, $d°$, $g°$, $i°$ and $k°$.
(iv) The angles having measure 112° are $a°$, $c°$, $e°$, $f°$, $h°$ and $j°$.

Example 5.10 If l is parallel to m, find the measure of x and y in the figure.

Solution Given l is parallel to m and n is transversal to l and m.

We get, $y = 2x$ [Vertically opposite angles are equal]

$y + 4x = 180°$ [sum of interior angles that lie on the same side of the transversal]

$2x + 4x = 180°$ [since $y = 2x$]

$6x = 180°$

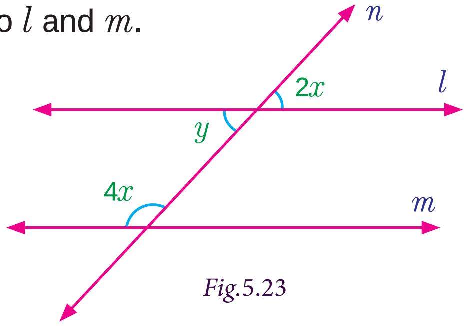


Fig.5.23

Dividing by 6 on both sides

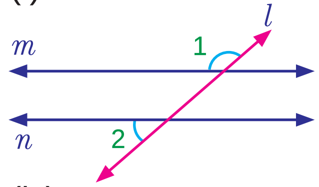
$\frac{x}{6} = \frac{180^\circ}{6}$ gives, $x = 30°$.

Now, $y = 2(30°) = 60°$.

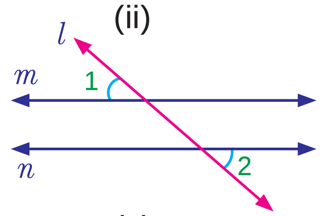
Exercise 5.2

1. From the figures name the marked pair of angles.

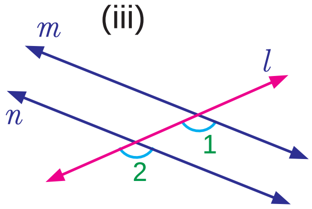
(i)



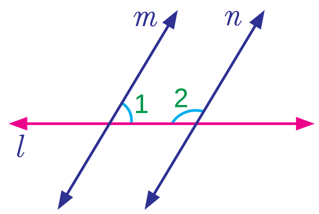
(ii)



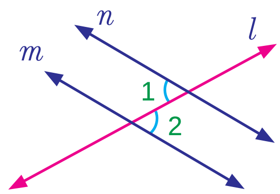
(iii)



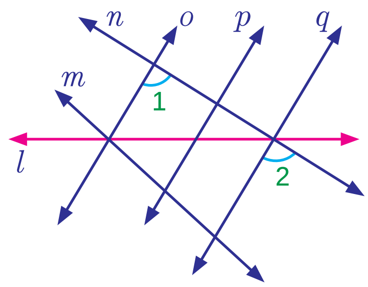
(iv)



(v)

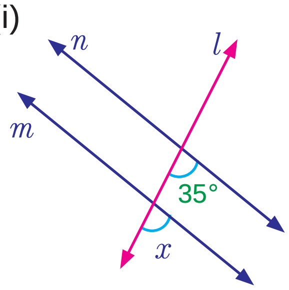


(vi)

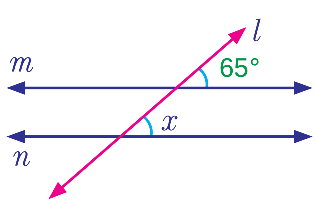


2. Find the measure of angle x in each of the following figures.

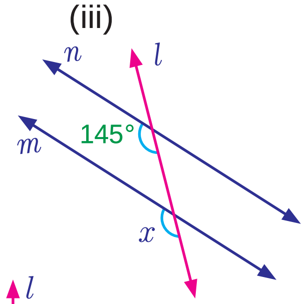
(i)



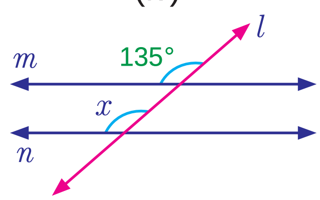
(ii)



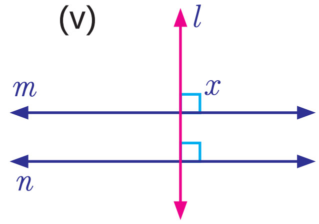
(iii)



(iv)

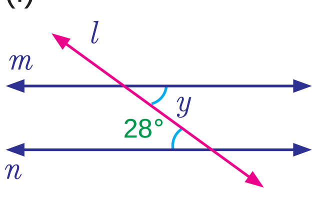


(v)

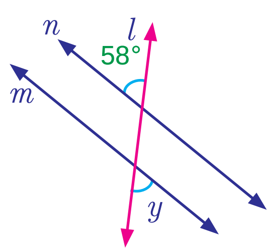


3. Find the measure of angle y in each of the following figures.

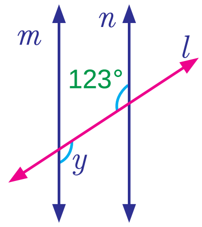
(i)



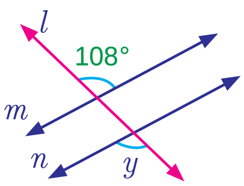
(ii)



(iii)

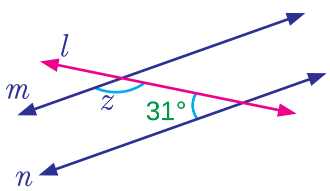


(iv)

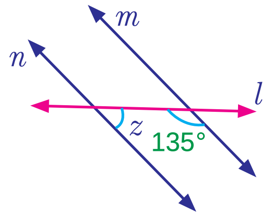


4. Find the measure of angle z in each of the following figures.

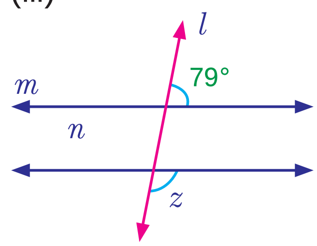
(i)



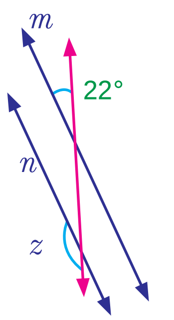
(ii)



(iii)

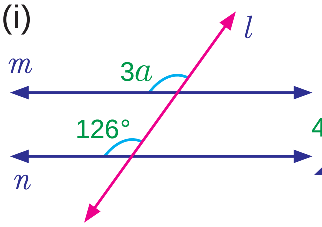


(iv)

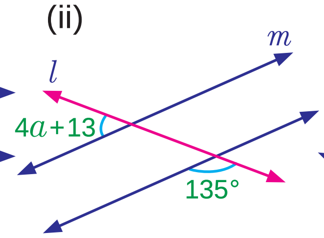


5. Find the value of angle a in each of the following figures.

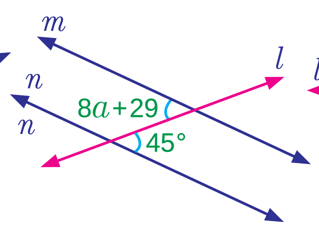
(i)



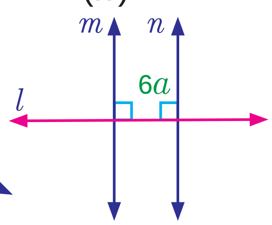
(ii)



(iii)

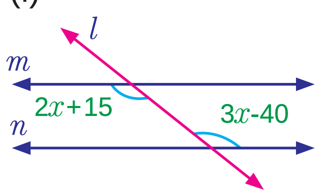


(iv)

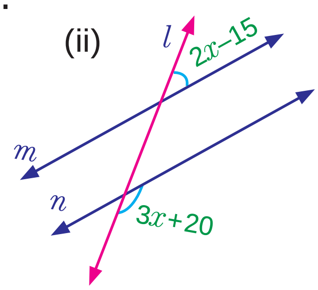


6. Find the value of angle x in both the figures.

(i)

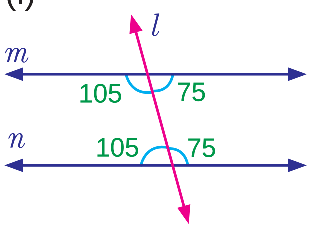


(ii)

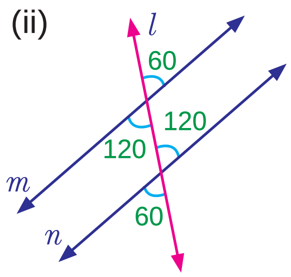


7. Anbu has marked the angles as shown below in (i) and (ii). Check whether both of them are correct. Give reasons.

(i)



(ii)



8. Mention two real-life situations where we use parallel lines.

9. Two parallel lines are intersected by a transversal. What is the minimum number of angles you need to know to find the remaining angles. Give reasons.

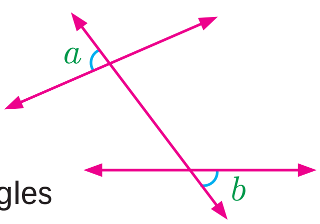
Objective type questions

10. A line which intersects two or more lines in different points is known as

(i) parallel lines (ii) transversal

(iii) non-parallel lines (iv) intersecting line

11. In the given figure, angles a and b are

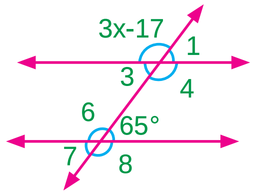


(i) alternate exterior angles (ii) corresponding angles

(iii) alternate interior angles (iv) vertically opposite angles

12. Which of the following statements is ALWAYS TRUE when parallel lines are cut by a transversal
    (i) corresponding angles are supplementary.
    (ii) alternate interior angles are supplementary.
    (iii) alternate exterior angles are supplementary.
    (iv) interior angles on the same side of the transversal are supplementary.

13. In the diagram, what is the value of angle x?



    (i) 43°   (ii) 44°
    (iii) 132°   (iv) 134°

5.4 Construction

In geometry, construction means to draw lines, angles and shapes accurately. In earlier class we learnt to draw a line segment, parallel and perpendicular line to the given line segment and an angle using protractor.

Now we are going to learn to construct, perpendicular bisector of a given line segment, angle bisector of a given angle and angles 60°, 30°, 120°, 90°,45° without using protractor.

All the figures shown are not to scale.

5.4.1 Construction of perpendicular bisector of a line segment

In earlier class, we learnt about perpendicular lines. Observe the Fig.5.24.

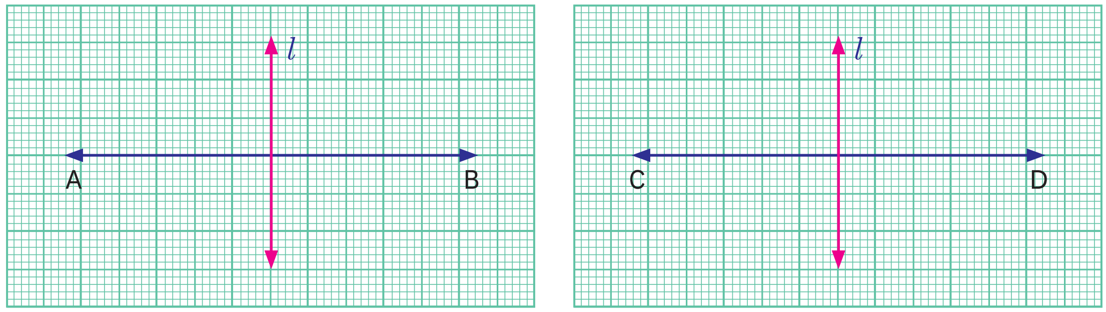


Fig.5.24

These are perpendicular lines. In both the cases the perpendicular line l divides both the line segments into two equal parts. This line is called perpendicular bisector of the line segment. So, a perpendicular line which divides a line segment into two equal parts is a perpendicular bisector of the given line segment.

Now we are going to learn, how to construct a perpendicular bisector to a given line segment.

Example 5.11 Construct a perpendicular bisector of the line segment AB = 6 cm.

Step 1: Draw a line. Mark two points A and B on it so that AB = 6 cm.

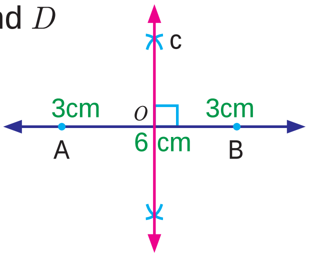
Step 2: Using compass with A as center and radius more than half of the length of AB, draw two arcs of same length, one above AB and one below AB.

Step 3: With the same radius and B as center draw two arcs to cut the arcs drawn in step 2. Mark the points of intersection of the arcs as C and D

Step 4: Join C and D. CD will intersect AB. Mark the point of intersection as O

CD is the required perpendicular bisector of AB.

Measure $\angle AOC$. Measure the length of AO and OB. What do you observe?



Think

1. What will happen if the radius of the arc is less than half of AB?

Exercise 5.3

1. Draw a line segment of given length and construct a perpendicular bisector to each line segment using scale and compass.

(a) 8 cm (b) 7cm (c) 5.6 cm (d) 10.4 cm (e) 58 mm

5.4.2 Construction of angle bisector of an angle.

If a line or line segment divides an angle into two equal angles, then the line or line segment is called angle bisector of the given angle.

In the following figures we can observe some angle bisectors.

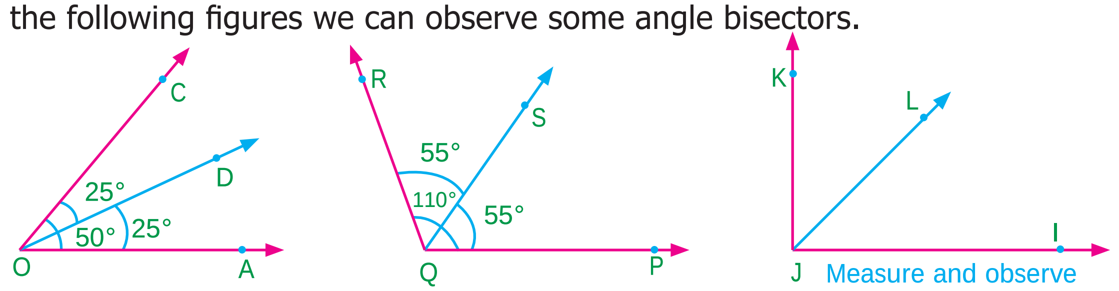


Fig.5.25

Example 5.12 Construct bisector of the $\angle ABC$ with the measure 80°.

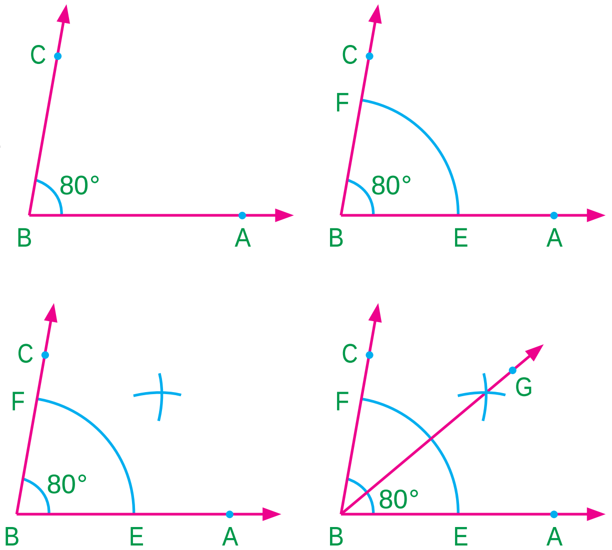
Step 1: Draw the given angle $\angle ABC$ with the measure 80° using protractor.

Step 2: With B as center and convenient radius, draw an arc to cut BA and BC. Mark the points of intersection as E on BA and F on BC.

Step 3: With the same radius and E as center, draw an arc in the interior of $\angle ABC$ and another arc of same measure with center at F to cut the previous arc.

Step 4: Mark the point of intersection as G. Draw a ray BX through G.

BG is the required bisector of the given angle $\angle ABC$



Exercise 5.4

1. Construct the following angles using protractor and draw a bisector to each of the angle using ruler and compass.
(a) 60° (b) 100° (c) 90° (d) 48° (e) 110°

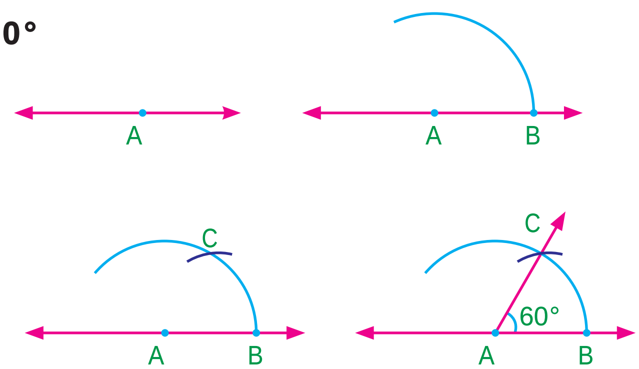
5.4.3 Construction of special angles without using protractor.

(i) Construction of angle of measure 60°

Step 1: Draw a line. Mark a point A on it.

Step 2: With A as center draw an arc of convenient radius to the line to meet at a point B.

Step 3: With the same radius and B as center draw an arc to cut the previous arc at C.



Step 4: Join AC. Then $\angle BAC$ is the required angle with the measure 60°.

(ii) Construction of angle of measure 120°.

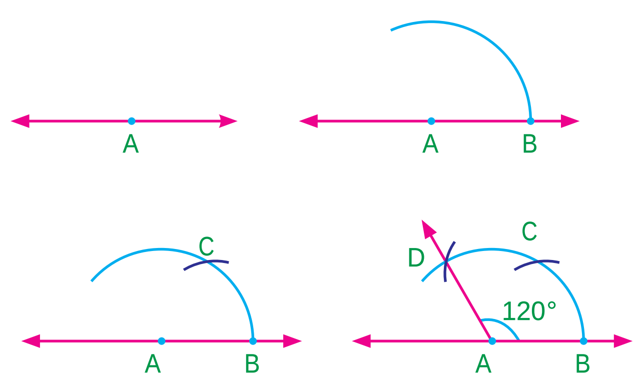
We know that there are two 60° agnels in 120°. Hence, to construct 120°, we can construct two 60° angles consecutively as follows.

Step 1: Draw a line. Mark a point A on it.

Step 2: With A as center, draw an arc of convenient radius to the line at a point B.

Step 3: With the same radius and B as center, draw an arc to cut the previous arc at C.

Step 4: With the same radius and C as center, draw an arc to cut the arc drawn in step 2 at D.



Step 5: Join AD. Then $\angle BAD$ is the required angle with measure 120°.

(iii) Construction of angle of measure 30°

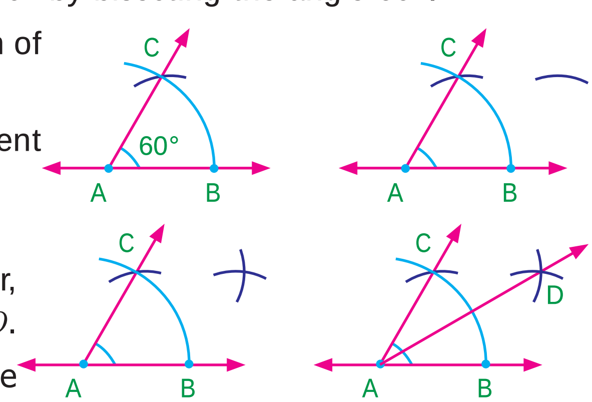
Since 30° is half of 60°, we can construct 30° by bisecting the angle 60°.

Step 1: Construct angle 60° [Refer Construction of angle of measure 60° (i)].

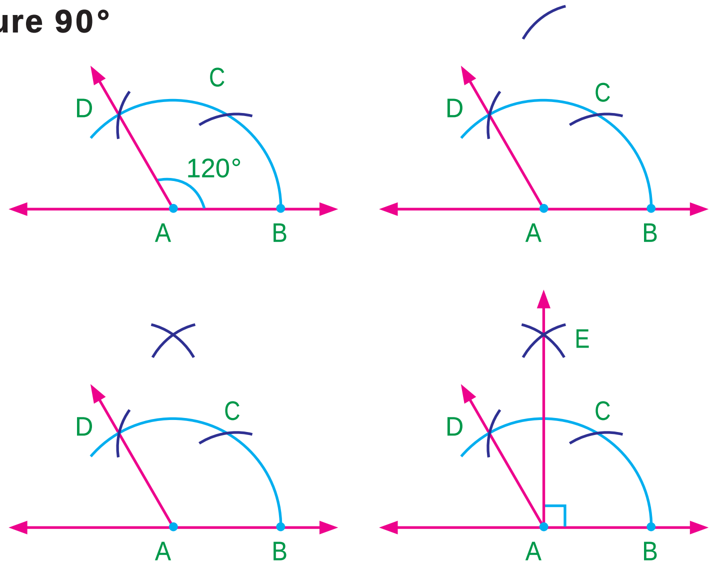
Step 2: With B as center, draw an arc of convenient radius in the interior of $\angle BAC$.

Step 3: With the same radius and C as center, draw an arc to cut the previous arc at D.

Step 4: Join AD. Then $\angle BAD$ is the required angle with measure 30° [Think about $\angle DAC$?]



(iv) Construction of angle of measure 90°



Step 1: Construct angle 120° [Refer Construction of angle of measure 120° (ii)].

Step 2: With C as center, draw an arc of convenient radius in the interior of $\angle CAD$.

Step 3: With the same radius and D as center, draw an arc to cut drawn in step 3 at E.

Step 4: Join AE. Then $\angle BAD = 90°$ is the required angle

Exercise 5.5

1. Construct the following angles using ruler and compass only.

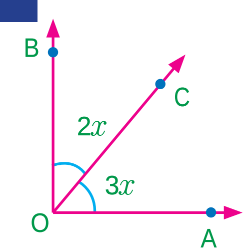
   (i) 60° (ii) 120° (iii) 30° (iv) 90°

   (v) 45° (vi) 150° (vii) 135°

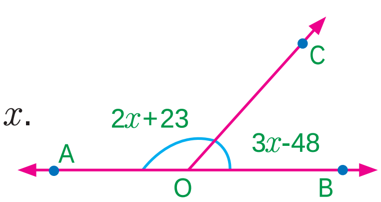
Exercise 5.6

Miscellaneous Practice problems

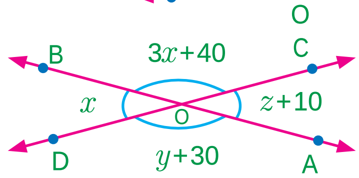
1. Find the value of x if $\angle AOB$ is a right angle.



2. In the given figure, find the value of x.



3. Find the value of x, y and z



4. Two angles are in the ratio 11: 25. If they are linear pair, find the angles.

5. Using the figure, answer the following questions and justify your answer.

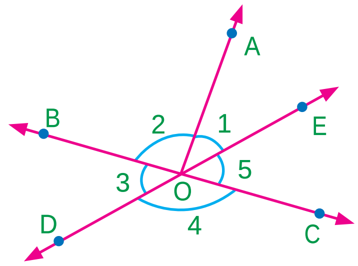
   (i) Is $\angle 1$ adjacent to $\angle 2$?

   (ii) Is $\angle AOB$ adjacent to $\angle BOE$?

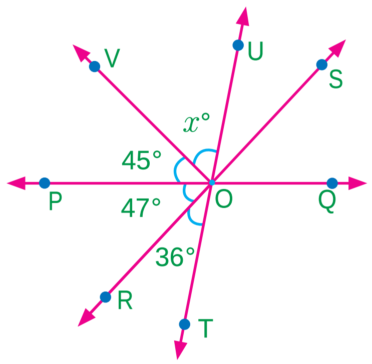
   (iii) Does $\angle BOC$ and $\angle BOD$ form a linear pair?

   (iv) Are the angles $\angle COD$ and $\angle BOD$ supplementary?

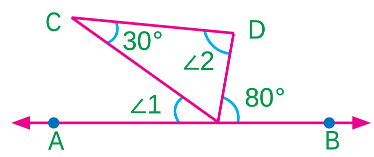
   (v) Is $\angle 3$ vertically opposite to $\angle 1$?



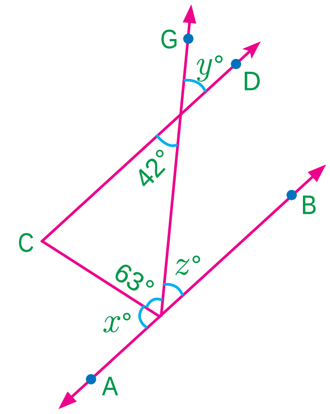
6. In the figure POQ, ROS and TOU are straight lines. Find the $x°$.



7. In the figure AB is parallel to DC. Find the value of $\angle 1$ and $\angle 2$. Justify your answer.

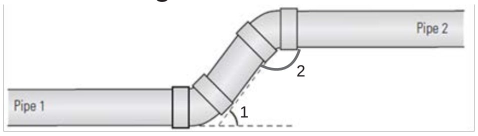


8. In the figure AB is parallel to CD. Find x,y and z.



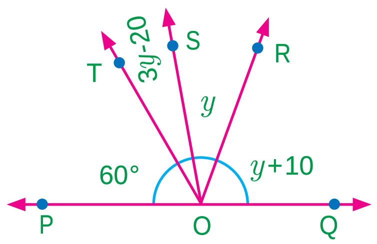
9. Draw two parallel lines and a transversal. Mark two alternate interior angles G and H. If they are supplementary, what is the measure of each angle?

10. A plumber must install pipe 2 parallel to pipe 1. He knows that $\angle 1$ is 53. What is the measure of $\angle 2$?

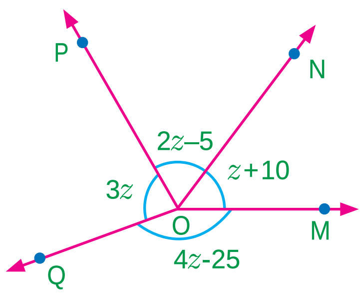


Challenge Problems

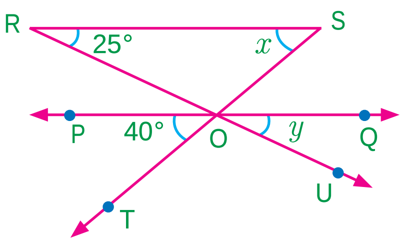
11. Find the value of y.



12. Find the value of z.

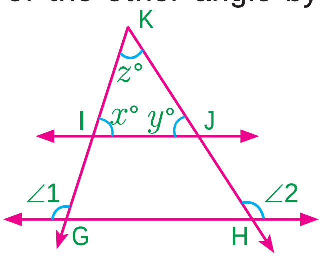


13. Find the value of x and y if RS is parallel to PQ.

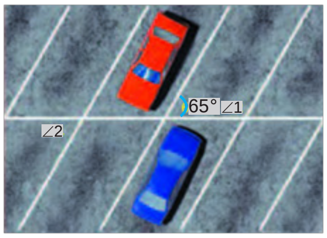


14. Two parallel lines are cut by a transversal. For each pair of interior angles on the same side of the transversal, if one angle exceeds the twice of the other angle by 48°. Find the angles.

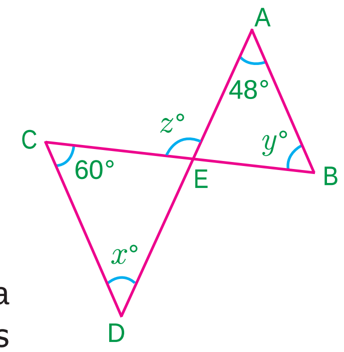
15. In the figure, the lines GH and IJ are parallel. If $\angle 1$=108° and $\angle 2$ = 123°, find the value of x, y and z.



16. In the parking lot shown, the lines that mark the width of each space are parallel. If $\angle 1$ = (x +39)°, $\angle 2$ = ($2x$–$3y$)°, find x and y.

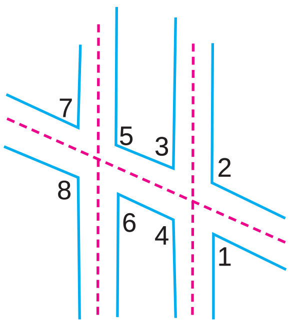


17. Draw two parallel lines and a transversal. Mark two corresponding angles A and B. If $\angle A = 4x$ and $\angle B = 3x + 7$, find the value of x. Explain..



18. In the figure AB is parallel to CD. Find $x°$, $y°$ and $z°$.

19. Two parallel lines are cut by a transversal. If one angle of a pair of corresponding angles can be represented by 42° less than three times the other. Find the corresponding angles.



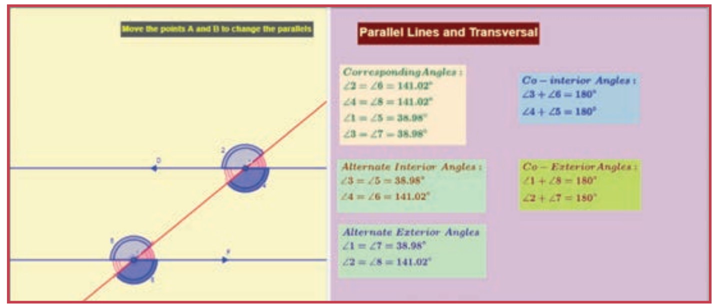
20. In the given figure, $\angle 8 = 107°$, what is the sum of the $\angle 2$ and $\angle 4$?

Summary

- Two angles which have a common vertex and a common arm, whose interiors do not overlap are called adjacent angles.
- The adjacent angles that are supplementary are called linear pair of angles.
- The sum of all the angles formed at a point on a straight line is 180°.
- The sum of the angles at a point is 360°.
- When two lines intersect each other, two pairs of non-adjacent angle formed are called vertically opposite angles.
- A transversal is a line that intersects two or more lines at distinct points.
- when two parallel lines are cut by a transversal,
  - ◇ each pair of corresponding angles are equal.
  - ◇ each pair of alternate Interior angles are equal.
  - ◇ each pair of alternate exterior angles are equal.
  - ◇ interior angles on the same side of the transversal are supplementary.
  - ◇ exterior angles on the same side of the transversal are supplementary.

ICT Corner

Expected Result is shown in this picture

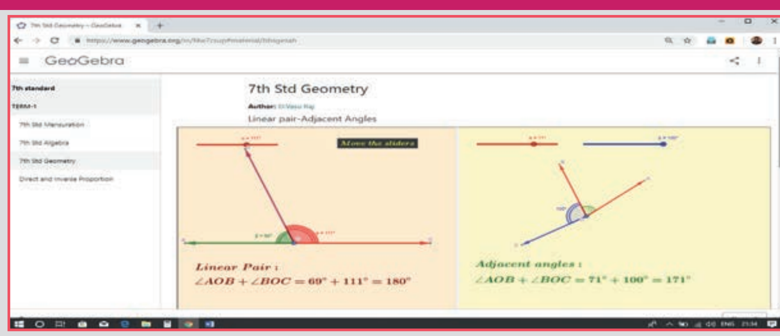


Step – 1 : Open the Browser type the URL Link given below (or) Scan the QR Code. GeoGebra work sheet named "7th std Geometry" will open. There are two activities 1. Linear pair- Adjacent Angles, 2. Parallel lines and Transverse.

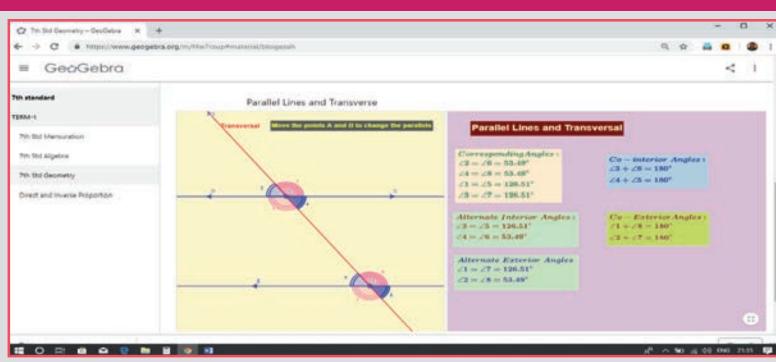
In the second activity "Parallel lines and Transverse" move the points A and B and observe the different angles formed by the transverse line.

Step - 2 : Move the sliders to get, Parallelogram or Rectangle or Square and see the points given and observe.

Step 1



Step 2



Browse in the link

Geometry: https://ggbm.at/bbsgesah
or Scan the QR Code.