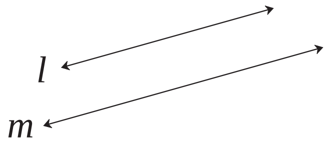
2 Parallel lines and transversal

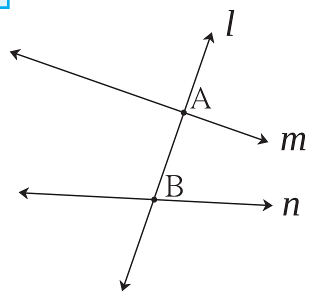
Let's recall.



The lines in the same plane which do not intersect each other are called parallel lines.
'Line l and line m are parallel lines,' is written as
'line $l \parallel$ line m'.

Let's learn.

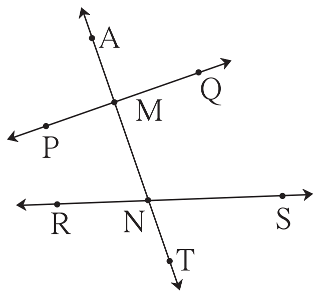
Transversal



In the adjoining figure, line l intersects line m and line n in two distinct points. line l is a transversal of line m and line n.

If a line intersects given two lines in two distinct points then that line is called a transversal of those two lines.

Angles made by a transversal



In the adjoining figure, due to the transversal, there are two distinct points of intersection namely M and N. At each of these points, four angles are formed. Hence there are 8 angles in all. Each of these angles has one arm on the transversal and the other is on one of the given lines. These angles are grouped in different pairs of angles. Let's study the pairs.

• Corresponding angles

If the arms on the transversal of a pair of angles are in the same direction and the other arms are on the same side of the transversal, then it is called a pair of corresponding angles.

• Interior angles

A pair of angles which are on the same side of the transversal and inside the given lines is called a pair of interior angles.

pairs of corresponding angles in the given figure -

(i) $\angle$AMP and $\angle$MNR

(ii) $\angle$PMN and $\angle$RNT

(iii) $\angle$AMQ and $\angle$MNS

(iv) $\angle$QMN and $\angle$SNT

pairs of interior angles in the given figure -

(i) $\angle$PMN and $\angle$MNR

(ii) $\angle$QMN and $\angle$MNS

• Alternate angles

Pairs of angles which are on the opposite sides of transversal and their arms on the transversal show opposite directions is called a pair of alternate angles.

In the figure, there are two pairs of interior alternate angles and two pairs of exterior alternate angles.

Interior alternate angles
(Angles at the inner side of lines)

(i) $\angle$PMN and $\angle$MNS

(ii) $\angle$QMN and $\angle$RNM

Exterior alternate angles
(Angles at the outer side of lines)

(i) $\angle$AMP and $\angle$TNS

(ii) $\angle$AMQ and $\angle$RNT

Practice Set 2.1

1. In the adjoining figure, each angle is shown by a letter. Fill in the boxes with the help of the figure.

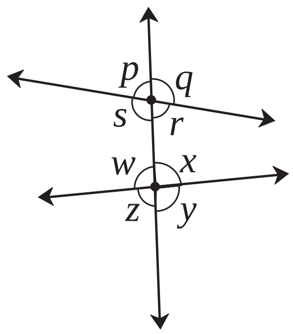
Corresponding angles.

(1) $\angle p$ and $\square$ (2) $\angle q$ and $\square$

(3) $\angle r$ and $\square$ (4) $\angle s$ and $\square$

Interior alternate angles.

(5) $\angle s$ and $\square$ (6) $\angle w$ and $\square$

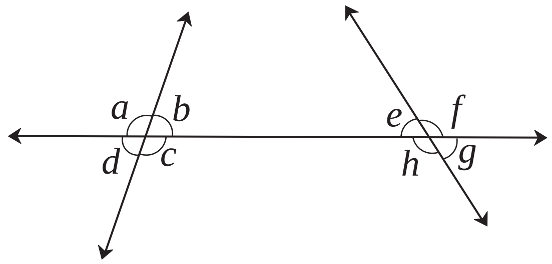


2. Observe the angles shown in the figure and write the following pair of angles.

(1) Interior alternate angles

(2) Corresponding angles

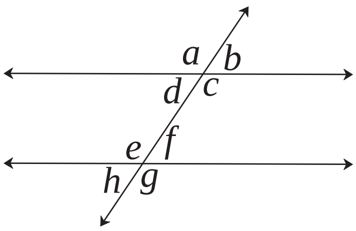
(3) Interior angles



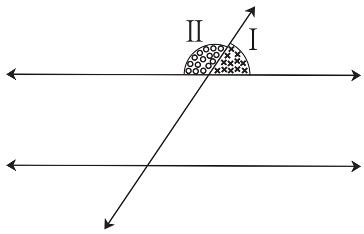
Let's learn.

Properties of angles formed by two parallel lines and a transversal

Activity (I) : As shown in the figure (A), draw two parallel lines and their transversal on a paper. Draw a copy of the figure on another blank sheet using a trace paper, as shown in the figure (B). Colour part I and part II with different colours. Cut out the two parts with a pair of scissors.



(A)



(B)

Note that the angles shown by part I and part II form a linear pair. Place, part I and part II on each angle in the figure A.

Which angles coincide with part I ?

Which angles coincide with part II ?

We see that, $\angle b \cong \angle d \cong \angle f \cong \angle h$, because these angles coincide with part I.

$\angle a \cong \angle c \cong \angle e \cong \angle g$, because these angles coincide with part II.

(1) $\angle a \cong \angle e$, $\angle b \cong \angle f$, $\angle c \cong \angle g$, $\angle d \cong \angle h$

(These are pairs of corresponding angles.)

(2) $\angle d \cong \angle f$ and $\angle e \cong \angle c$ (These are pairs of interior alternate angles.)

(3) $\angle a \cong \angle g$ and $\angle b \cong \angle h$ (These are pairs of exterior alternate angles.)

(4) $m\angle d + m\angle e = 180°$ and $m\angle c + m\angle f = 180°$

(These are interior angles.)

Let's discuss.

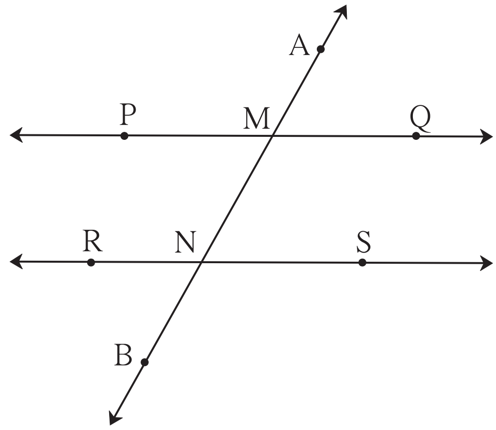
When two parallel lines are intersected by a transversal eight angles are formed. If the measure of one of these eight angles is given, can we find measures of remaining seven angles ?

Let's learn.

(1) Property of corresponding angles

Each pair of corresponding angles formed by two parallel lines and their transversal is of congruent angles.

In the adjoining figure line PQ || line RS. Line AB is a transversal.



Corresponding angles

$\angle AMP \cong \angle MNR$ $\qquad$ $\angle PMN \cong \angle RNB$

$\angle AMQ \cong \angle MNS$ $\qquad$ $\angle QMN \cong \angle SNB$

(2) Property of alternate angles

Each pair of alternate angles formed by two parallel lines and their transversal is of congruent angles.

Interior alternate angles	Exterior alternate angles
$\angle PMN \cong \angle MNS$	$\angle AMP \cong \angle SNB$
$\angle QMN \cong \angle MNR$	$\angle AMQ \cong \angle RNB$

(3) Property of interior angles

Each pair of interior angles formed by two parallel lines and their transversal is of supplementary angles.

Interior angles

$m\angle PMN + m\angle MNR = 180°$

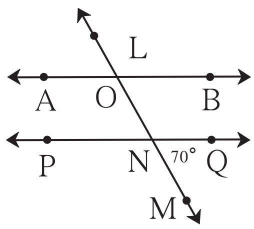
$m\angle QMN + m\angle MNS = 180°$

Solved Examples

Ex. (1) In the adjoining figure line AB || line PQ.

Line LM is a transversal.

$m\angle MNQ = 70°$, then find $m\angle AON$.



Solution :

Method I

$m\angle MNQ = m\angle ONP = 70°$...(Opposite angles)

$m\angle AON + m\angle ONP = 180°$...(Interior angles)

$\therefore\ m\angle AON = 180° - m\angle ONP$

$= 180° - 70°$

$= 110°$

Method II

$m\angle MNQ = 70°$

$\therefore m\angle NOB = 70°$...(Corresponding angles)

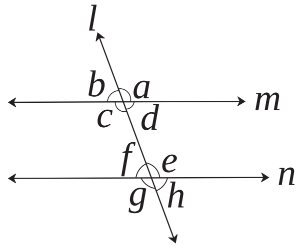
$m\angle AON + m\angle NOB = 180°$

$\therefore\ m\angle AON + 70° = 180°$

$\therefore\ m\angle AON = 110°$

(The above example can be solved by another method also.)

Ex. (2) In the adjoining figure line $m \parallel$ line n line l is a transversal.
If $m\angle b = (x + 15)^\circ$ and $m\angle e = (2x + 15)^\circ$, find the value of x.



Solution : $\angle b \cong \angle f$ .... (corresponding angles) $\therefore\ m\angle f = m\angle b = (x + 15)^\circ$

$m\angle f + m\angle e = 180^\circ$ .... (Angles in linear pair)

substituting values in the equation,

$x + 15 + 2x + 15 = 180^\circ$ $\therefore\ 3x + 30 = 180^\circ$

$\therefore\ 3x = 180^\circ - 30^\circ = 150^\circ$ .... (subtracting 30 from both sides)

$x = \frac{150^\circ}{3}$ .... (dividing both sides by 3)

$\therefore\ x = 50^\circ$

Now I know.

When two parallel lines are intersected by a transversal, the angles formed in each pair of

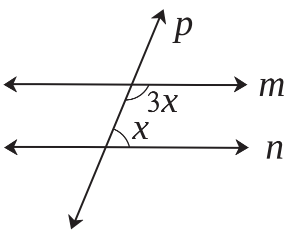
- corresponding angles are congruent.
- alternate angles are congruent.
- interior angles are supplementary.

Practice Set 2.2

1. Choose the correct alternative.

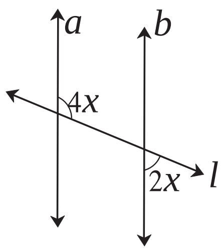
(1) In the adjoining figure, if line $m \parallel$ line n and line p is a transversal then find x.

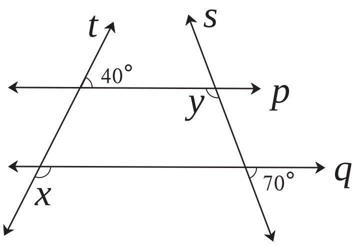
(A) 135° (B) 90° (C) 45° (D) 40°



(2) In the adjoining figure, if line $a \parallel$ line b and line l is a transversal then find x.

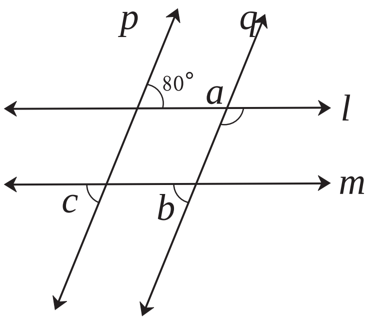
(A) 90° (B) 60° (C) 45° (D) 30°

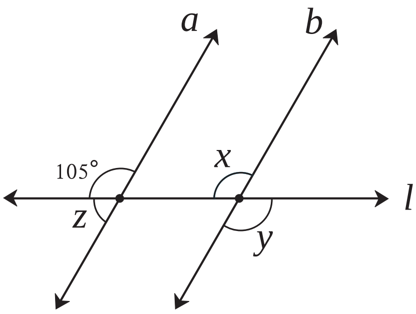




2. In the adjoining figure line $p \parallel$ line q. Line t and line s are transversals. Find measure of $\angle x$ and $\angle y$ using the measures of angles given in the figure.

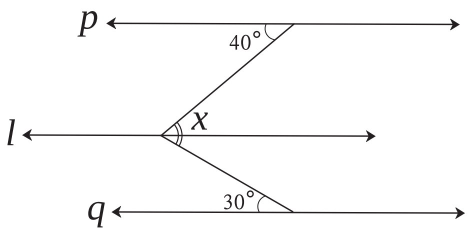
3. In the adjoining figure. line $p \parallel$ line q. line $l \parallel$ line m. Find measures of $\angle a$, $\angle b$, and $\angle c$, using the measures of given angles. Justify your answers.





4★. In the adjoining figure, line $a \parallel$ line b. line l is a transversal. Find the measures of $\angle x$, $\angle y$, $\angle z$ using the given information.

5★. In the adjoining figure, line $p \parallel$ line $l \parallel$ line q. Find $\angle x$ with the help of the measures given in the figure.



For more information :

If a transversal intersects two coplaner lines and a pair of

- corresponding angles is congruent then the lines are parallel.
- alternate angles is congruent then the lines are parallel.
- interior angles is supplementary then the lines are parallel.

To draw a line parallel to the given line

Construction (I) : To draw a line parallel to the given line through a point outside the given line using set - square.

Method I : Steps of the construction

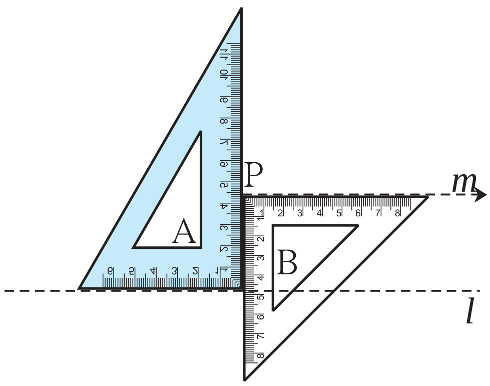
(1) Draw line l.

(2) Take a point P outside the line l.

(3) As shown in the figure, place two set - squares touching each other. Hold set - squares A and B. One edge of set - square A is close to point P. Draw a line along the edge of B.

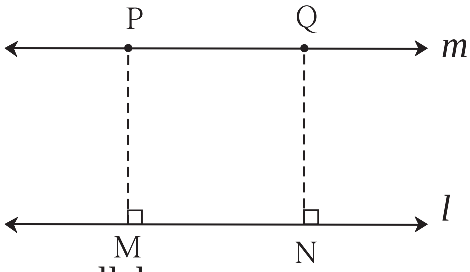
(4) Name the line as m.

(5) Line m is parallel to line l.



Method II : Steps of construction

(1) Draw line l. Take a point P outside the line.



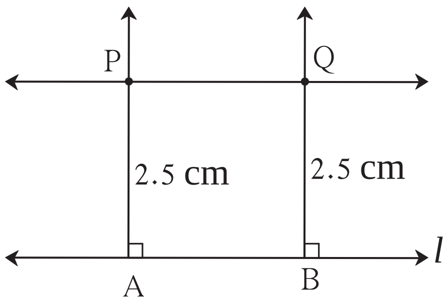
(2) Draw a seg PM $\perp$ line l.

(3) Take another point N on line l.

(4) Draw seg NQ $\perp$ line l.
such that l(NQ) = l(MP).

(5) The line m passing through points P and Q is parallel to the line l.

Construction (II) : To draw a parallel line to a given line at a given distance.



Method : Draw a line parallel to line l at a distance 2.5 cm.

Steps of construction :

(1) Draw line l. (2) Take two points A and B on the line l.

(3) Draw perpendiculars to the line l from points A and B.

(4) On the perpendicular lines take points P and Q at a distance of 2.5cm from A and B respectively.

(5) Draw line PQ. (6) Line PQ is a line parallel to the line l at a distance 2.5cm.

Practice Set 2.3

1. Draw a line l. Take a point A outside the line. Through point A draw a line parallel to line l.

2. Draw a line l. Take a point T outside the line. Through point T draw a line parallel to line l.

3. Draw a line m. Draw a line n which is parallel to line m at a distance of 4 cm from it.

Answers

Parctice Set 2.1 **1.** (1) $\angle w$ (2) $\angle x$ (3) $\angle y$ (4) $\angle z$ (5) $\angle x$ (6) $\angle r$

2. (1) $\angle c$ and $\angle e$, $\angle b$ and $\angle h$ (2) $\angle a$ and $\angle e$, $\angle b$ and $\angle f$, $\angle c$ and $\angle g$, $\angle d$ and $\angle h$ (3) $\angle c$ and $\angle h$, $\angle b$ and $\angle e$.

Parctice Set 2.2 **1.** (1) C (2) D **2.** $\angle x = 140°$, $\angle y = 110°$

3. $\angle a = 100°$, $\angle b = 80°$, $\angle c = 80°$ **4.** $\angle x = 105°$, $\angle y = 105°$, $\angle z = 75°$

5. $\angle x = 70°$