

In the plane of the figure alongside, the group of points like point N, point M, point T which are not on the arms of the angle, form the **interior** of the $\angle PQR$.

The group of points in the plane of the angle like point G, point D, point E, which are neither on the arms of the angle nor in its interior, form the **exterior** of the angle.



Adjacent Angles

Look at the angles in the figure alongside. The ray MQ is a common arm of the angles \angle BMQ and \angle QMD while M is their common vertex. The interiors of these angles do not have a single common point. They may be said to be neighbouring angles. Such angles are called adjacent angles.

Adjacent angles have one common arm and the other arms lie on opposite sides of the common arm. They have a common vertex. Adjacent angles have separate interiors.

In the given figure, MB is the common arm of the angles \angle BMD and \angle BMQ. However, they are not adjacent angles because they do not have separate interiors.

M D

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Now I know!

Two angles which have a common vertex, a common arm and separate interiors are said to be adjacent angles.

Practice Set 15

1. Observe the figure and complete the table for $\angle AWB$.



2. Name the pairs of adjacent angles in the figures below.



If the sum of the measures of two angles is 90° they are known as complementary angles.

Here, $\angle PQS$ and $\angle SQR$ are mutually complementary angles.

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Example Observe the angles in the figure and enter the proper number in the box.



The sum of the measures of $\angle ABC$ and $\angle PQR$ is 90°. Therefore, they are complementary angles.



2. $(y-20)^{\circ}$ and $(y + 30)^{\circ}$ are the measures of complementary angles. Find the measure of each angle.



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Example Observe the angles in the figure below and enter the proper number in the box.



The measures of	some angles are given	below. Ose them to	make pairs of
complementary an	nd supplementary angle	es.	
$m \angle B = 60^{\circ}$	$m \angle N = 30^{\circ}$	$m \angle Y = 90^{\circ}$	$m \angle J = 150^{\circ}$

$m \angle D = 75^{\circ}$	$m \angle E = 0^{\circ}$	$m \angle F = 15^{\circ}$	$m \angle G = 120^{\circ}$

- 3. In $\triangle XYZ$, $m \angle Y = 90^\circ$. What kind of a pair do $\angle X$ and $\angle Z$ make?
- 4. The difference between the measures of the two angles of a complementary pair is 40°. Find the measures of the two angles.
- 5. □PTNM is a rectangle. Write the names of the pairs of supplementary angles.



- 6^{*}. If $m \angle A = 70^{\circ}$, what is the measure of the supplement of the complement of $\angle A$?
- 7. If $\angle A$ and $\angle B$ are supplementary angles and $m \angle B = (x + 20)^\circ$, then what would be $m \angle A$?

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Discuss the following statements. If a statement is right, give an example. If it is wrong, state why.

- Two acute angles can make a pair of complementary angles.
- Two right angles can make a pair of complementary angles.
- One acute angle and one obtuse angle can make a pair of complementary angles.
- Two acute angles can form a pair of supplementary angles.
- Two right angles can form a pair of supplementary angles.
- One acute angle and one obtuse angle can form a pair of supplementary angles.



Opposite Rays

- (1) Name the rays in the figure alongside.
- (2) Name the origin of the rays.
- (3) Name the angle in figure (i).



(1) Name the angle in figure (ii) alongside.

(2) Name the rays whose origin is point B.

In figure (i), ray BC and ray BA meet to form an obtuse angle while in figure (ii) ray BC and ray BA meet to form a straight angle and we get a straight line. Here, ray BC and ray BA are opposite rays.

Now I know!

Т

Two rays which have a common origin and form a straight line are said to be opposite rays.

Practice Set 18

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- 1. Name the pairs of opposite rays in the figure alongside.
- 2. Are the ray PM and PT opposite rays? Give reasons for your answer.

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The angles $\angle PQR$ and $\angle RQS$ in the figure above are adjacent angles and are also supplementary angles. The arms that are not common to both angles form a pair of opposite rays i.e. these arms form a straight line. We say that these angles form a linear pair. **The sum of the measures of the angles in a linear pair is 180°.**

Now I know!

Angles which have a common arm and whose other arms form a straight line are said to be angles in a linear pair. Angles in a linear pair are supplementary angles.

Activity : Use straws or sticks to make all the kinds of angles that you have learnt about.

Practice Set 19

Draw the pairs of angles as described below. If that is not possible, say why.

- (i) Complementary angles that are not adjacent.
- (iii) Complementary angles that do not form a linear pair.
- (v) Angles which are neither complementary nor adjacent.
- (ii) Angles in a linear pair which are not supplementary.
- (iv) Adjacent angles which are not in a linear pair.
- (vi) Angles in a linear pair which are complementary.

Let's learn. Vertically Opposite Angles

In the figure alongside, line PT and line RS intersect each other at point Q. Thus, four angles are formed. \angle PQR is formed by the rays QP and QR. The rays opposite to ray QP and QR are QT and QS respectively. These opposite rays form the angle \angle SQT. Hence, \angle SQT is called the opposite angle of \angle PQR.





Now I know!

The angle formed by the opposite rays of the arms of an angle is said to be its opposite angle.

Let's learn. The Property of Vertically Opposite Angles

• Name the angle opposite to $\angle PQS$ in the figure.

As shown in the figure, $m \angle PQS = a$, $m \angle SQT = b$, $m \angle TQR = c$, $m \angle PQR = d$.

 $\angle PQS$ and $\angle SQT$ are the angles in a linear pair.

 $\therefore a + b = 180^{\circ}$

Also $m \angle SQT$ and $m \angle TQR$ are two angles in a linear pair.

$$\therefore b + c = 180^{\circ}$$

$$\therefore a + b = b + c$$

 $\therefore a = c$ (Subtracting *b* from both sides.)

 \therefore $\angle PQS$ and $\angle TQR$ are congruent angles.

Also, $m \angle PQR = m \angle SQT$

i.e. \angle PQR and \angle SQT are congruent angles.

🖖 Now I know !

R d p c a T b S

The vertically opposite angles formed when two lines intersect, are of equal measure.

Practice Set 20

Interior Angles of a Polygon

- 1. Lines AC and BD intersect at point P. $m \angle APD = 47^{\circ}$ Find the measures of $\angle APB$, $\angle BPC$, $\angle CPD$.
- 2. Lines PQ and RS intersect at point M. $m \angle PMR = x^{\circ}$ What are the measures of $\angle PMS$, $\angle SMQ$ and $\angle QMR$?



Let's learn.

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Interior Angles of a Triangle

 $\angle A$, $\angle B$, $\angle C$ are the interior angles of $\triangle ABC$.

 $m \angle ABC + m \angle BAC + m \angle ACB =$



Number of sides	Name of the polygon	Polygon	Number of triangles	Sum of interior angles
3	Triangle	\sum	1	180° × 1 =
4	Quadrilateral		2	180° × 2 =
5	Pentagon		3	180° × 3 =
6	Hexagon		4	180° × =
7	Heptagon		5	
8	Octagon		6	
:	:	:	:	:
n	A figure with n sides		(n-2)	$180^{\circ} \times (n-2)$

Observe the table given below and draw your conclusions.

Note that the number of triangles formed in a polygon as shown above is two less than the number of sides the polygon has.

The sum of the measures of the interior angles of a polygon is = $180^{\circ} \times (n-2)$

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The Exterior Angle of a Triangle



If the side BC of \triangle ABC is extended as shown in the figure, an angle \angle ACD is formed which lies outside the triangle.

 \angle ACD is an exterior angle of \triangle ABC. \angle ACD and \angle ACB are angles in a linear pair. \angle PAB and \angle QBC are also exterior angles of \triangle ABC.

On extending one side of a triangle, the angle obtained which forms a linear pair with the adjacent interior angle of the triangle is called an exterior angle of that triangle.

Example In the figure alongside, all exterior angles of a triangle are shown. a, b, c, d, e, f are the exterior angles of Δ PQR. In the same way, every triangle has six exterior angles.



Let's learn. The Property of an Exterior Angle of a Triangle

In the figure alongside, $\angle PRS$ is an exterior angle of $\triangle PQR$. The interior angle adjacent to it is $\angle PRQ$. The other two interior angles, $\angle P$ and $\angle Q$ are further away from $\angle PRS$. They are called the remote interior angles of $\angle PRS$.



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 $m \angle P + m \angle Q + m \angle PRQ =$ °.....(sum of the three angles of a triangle) $m \angle PRS + m \angle PRQ =$ °.....(angles in a linear pair) $\therefore m \angle P + m \angle Q + m \angle PRQ = m \angle PRS + m \angle PRQ$ $\therefore m \angle P + m \angle Q = m \angle PRS$ (subtracting $m \angle PRQ$ from both sides)

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The measure of an exterior angle of a triangle is equal to the sum of the measures of its remote interior angles.

Practice Set 21

- 1. $\angle ACD$ is an exterior angle of $\triangle ABC$. The measures of $\angle A$ and $\angle B$ are equal. If $m \angle ACD = 140^\circ$, find the measures of the angles $\angle A$ and $\angle B$.
- 2. Using the measures of the angles given in the figure alongside, find the measures of the remaining three angles.



3^{*}. In the isosceles triangle ABC, $\angle A$ and $\angle B$ are equal. $\angle ACD$ is an exterior angle of $\triangle ABC$. The measures of $\angle ACB$ and $\angle ACD$ are $(3x - 17)^{\circ}$ and $(8x + 10)^{\circ}$ respectively. Find the measures of $\angle ACB$ and $\angle ACD$. Also find the measures of $\angle A$ and $\angle B$.



ICT Tools or Links

- With the help of Geogebra, draw two rays with a common origin. Using the 'Move' option, turn one ray and observe the position where the two rays become opposite rays.
- Form angles in a linear pair. By 'moving' the common arm, form many different pairs of angles all of which are linear pairs.
- Using Polygon Tools from Geogebra, draw many polygons. Verify the property of the interior angles of a polygon.

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