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LEARNING STUDIO

Mathematics

Chapter 4: Basic Geometrical Ideas

BASIC GEOMETRICAL IDEAS

Basic Definitions in Geometry

Terms	Definition
Point	It determines a location and is usually determined by a capital letter.
Line segment	The shortest distance between two points is called a line segment.
Line	By extending a line segment indefinitely on both sides, a line is obtained.
Intersecting lines	If two distinct lines meet or cross at a point, they are called intersecting lines.
Parallel lines	Parallel lines are lines which are always the same distance apart and never intersect anywhere in a plane.
Ray	A ray is a line which starts from a particular point and goes infinitely towards a particular direction.
Curve	It is a drawing which is done without lifting the pencil.
Simple curve	A curve that never crosses itself is a simple curve.
Closed and open curves	A curve is closed if its ends are joined. Otherwise, it is an open curve.
Angle	It is made up of two rays which are starting from a common point.

Polygons

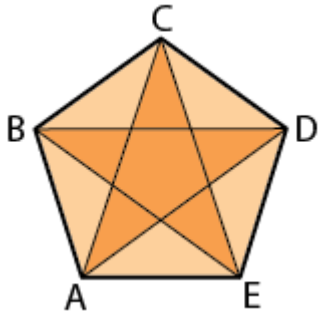
A polygon can be defined as a closed curve which is made up of line segments. Polygons can be of numerous types like triangles (having 3 line segments), quadrilaterals (having 4 line segments), pentagon (having 5 line segments), and so on. A few important terms related to polygons are.

Terms	Definition

Sides of a polygon	The line segments are known as the sides of the polygon.
Adjacent sides	Two points having the same endpoint are called adjacent sides.
Vertex	Vertex is the meeting or intersecting point of a pair of sides.
Diagonal	Diagonal is obtained by joining any two non-adjacent vertices of a polygon.

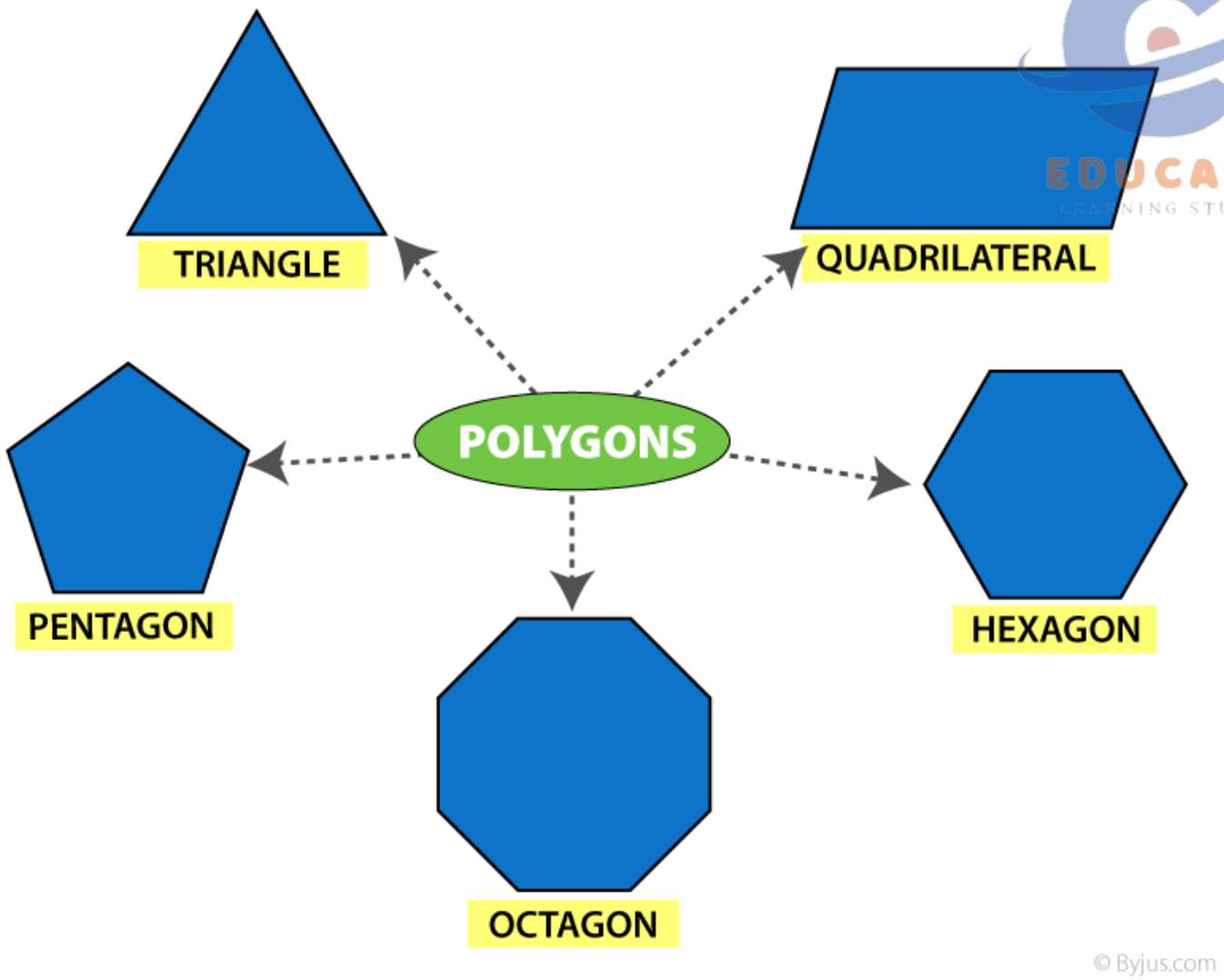
A polygon is a two-dimensional geometric figure that has a finite number of sides. The sides of a polygon are made of straight line segments connected to each other end to end. Thus, the line segments of a polygon are called sides or edges. The point where two line segments meet is called vertex or corners, henceforth an angle is formed. An example of a polygon is a triangle with three sides. A circle is also a plane figure but it is not considered a polygon, because it is a curved shape and does not have sides or angles. Therefore, we can say, all the polygons are 2d shapes but not all the two-dimensional figures are polygons.

A simple closed figure made up line segments is called a polygon.



Polygon shape

By definition, we know that the polygon is made up of line segments. Below are the shapes of some polygons that are enclosed by the different number of line segments.



Types of Polygon

Depending on the sides and angles, the polygons are classified into different types, namely:

- Regular Polygon
- Irregular Polygon
- Convex Polygon
- Concave polygon

Regular Polygon: If all the sides and interior angles of the polygon are equal, then it is known as a regular polygon. The examples of regular polygons are square, rhombus, equilateral triangle, etc.

Irregular Polygon: If all the sides and the interior angles of the polygon are of different measure, then it is known as an irregular polygon. For example, a scalene triangle, a rectangle, a kite, etc.

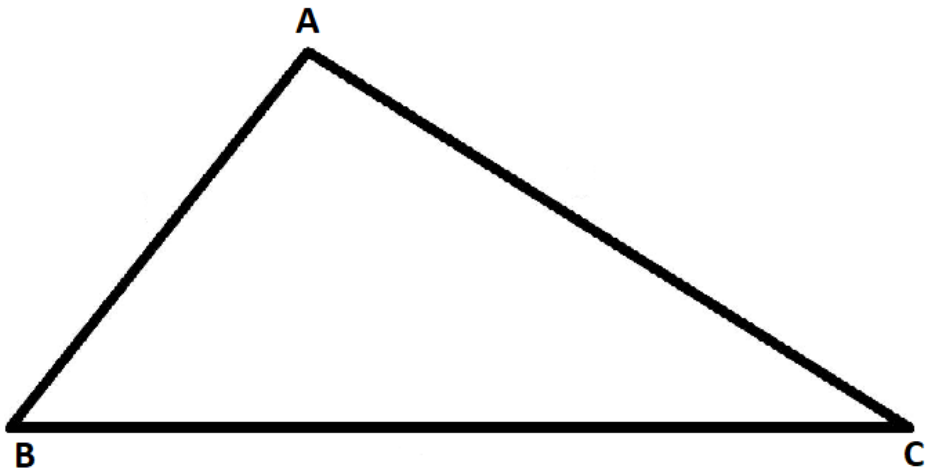
Convex Polygon: If all the interior angles of a polygon are strictly less than 180 degrees, then it is known as a convex polygon. The vertex will point outwards from the center of the shape.

Concave Polygon: If one or more interior angles of a polygon are more than 180

degrees, then it is known as a concave polygon. A concave polygon can have at least four sides. The vertex points towards the inside of the polygon.

Triangles

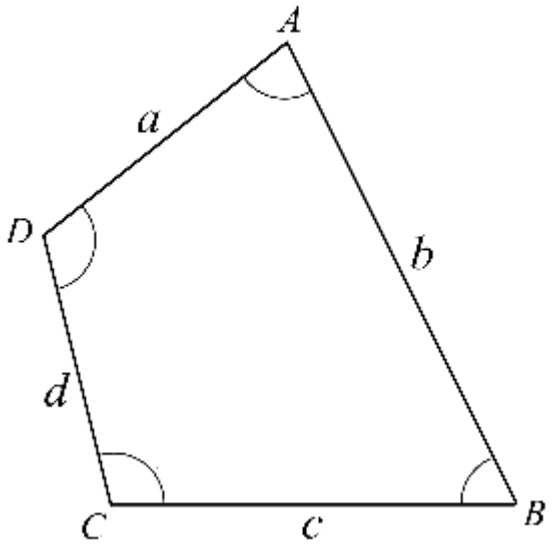
A triangle is as a polygon having three-line segments or sides. A triangle ABC is written as ΔABC as given below



In this triangle, AB, BC, and AC are sides of the triangle and A, B, C are the vertices of the triangle. Also, the angle between BC and AB is the $\angle B$, between BC and AC, it is $\angle C$, and between AB and AC, it is $\angle A$.

Quadrilaterals

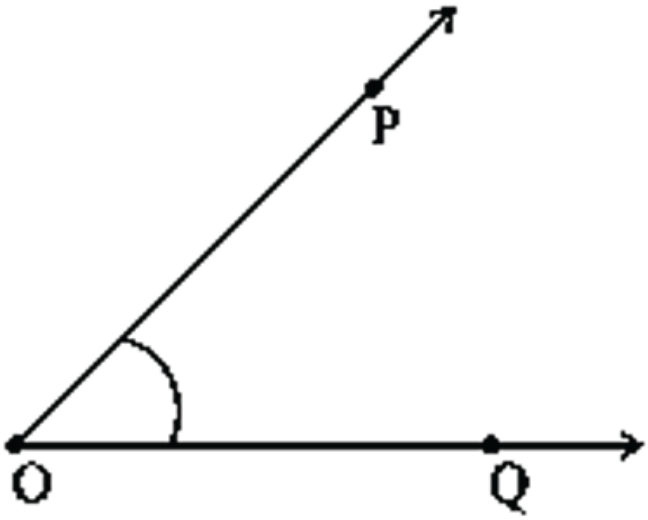
A quadrilateral is defined as a four-sided polygon i.e. having 4 line segments or sides and thus, 4 angles. A diagram of a quadrilateral is given for better understanding. It should be noted that the vertices of a quadrilateral are named in a cyclic manner.



In this diagram, AD and DC are one of the examples of adjacent sides. Also, AD and BC are one of the opposite sides. Here, angle A and angle C are opposite angles. In this, if the line segment is drawn from A to C or from B to D, it becomes a diagonal.

Angles

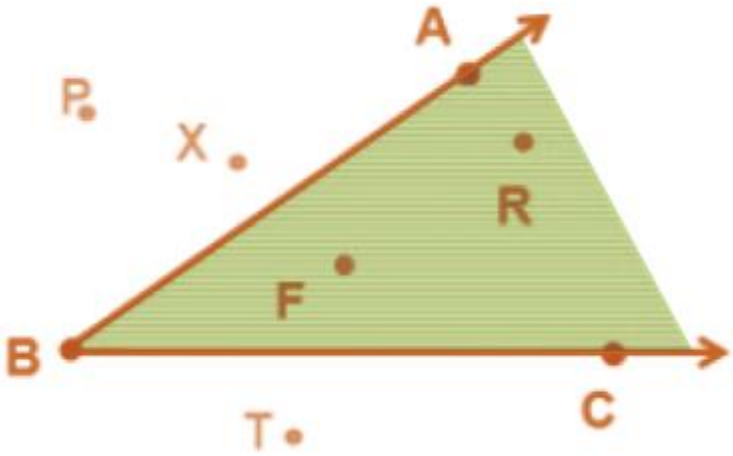
- An angle is made by two rays starting at a common endpoint.
- These rays are called the arms of the angle.
- The common endpoint is called the vertex of the angle.
- While naming an angle the vertex of the angle has to be in the middle.
- For example: Ray OP and Ray OQ form an angle. It can be denoted as ∠POQ.



- Ray OP and OQ are the arms or sides of the angle. O is the vertex of the angle POQ

Exterior and interior points to an angle

- An angle separates its plane into three regions.
- These regions are the angle, interior of the angle and exterior of the angle.

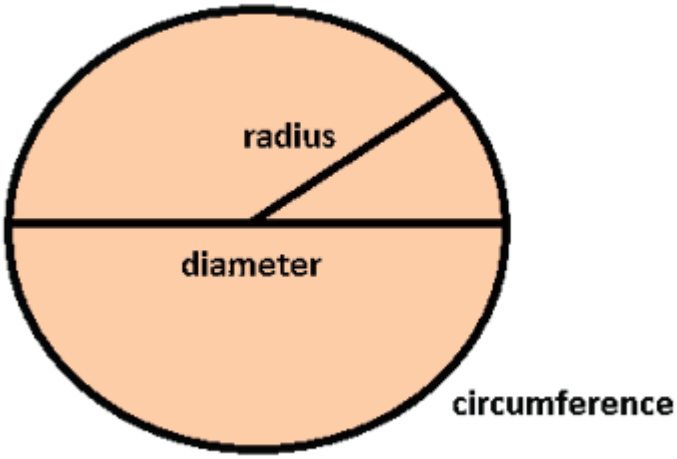


- In the figure above, points F and R lie in the interior of ∠ABC. Point A, B and C lie on the angle ∠ABC and P, X and T lie on the exterior of angle ∠ABC.

Circle

- A circle is a simple closed curve which is not a polygon.

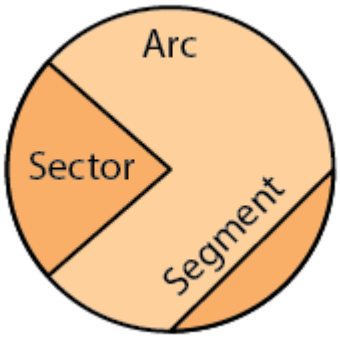
- A circle is basically formed when a point is moving at a fixed distance from a fixed point.



- This fixed point in the middle is called the centre.
- The distance moved by the point around the circle is called the circumference.

Terms related to circle

- The chord of a circle is a line segment joining any two points of a circle.
- A diameter is a chord passing through the centre of a circle.
- The diameter divides a circle into two equal halves called semicircle.



- A region in the interior of a circle enclosed by an arc on one side and a pair of radii on the other two sides is called a sector.
- A region in the interior of a circle enclosed by a chord and an arc is called a segment.

Line segment

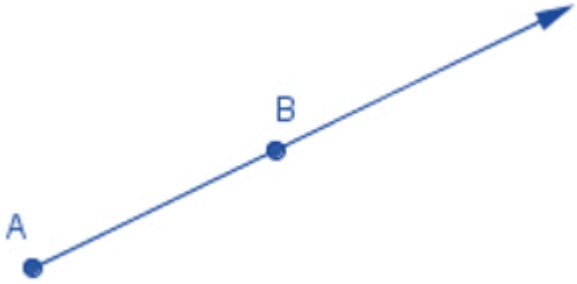
- The shortest distance between two points is called a line segment.
- Those points are called endpoints of the line segment.
- Here A and B are the endpoints of line segment $\overline{AB}$.

Lines

- When a line segment is extended on both sides infinitely, then it is called a line. Here m is a line.
- It contains an infinite number of points on it.

Ray

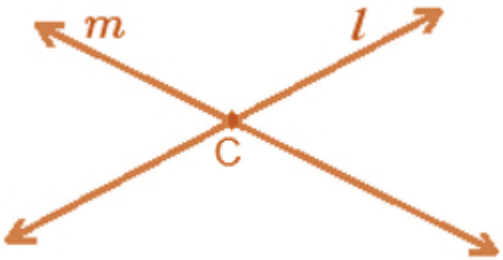
- A ray is a portion of a line. It starts at one point, called its starting point, and goes endlessly in the other direction.



- In the ray AB, A is the starting point and B is just a point on the path of the ray.
- The ray is denoted as $\overrightarrow{AB}$.

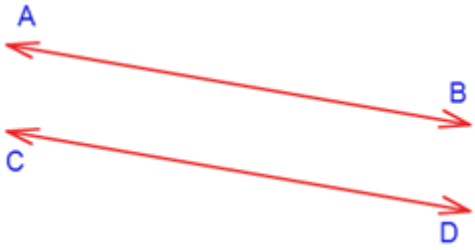
Intersecting and parallel lines

- If two lines have a common point, then they are said to be intersecting.



- Lines l and m here have a common point P, hence they are intersecting lines with P being the point of intersection.

- If two lines have no common point, then they are said to be parallel. Here AB and CD are parallel lines.



Position in a figure

There are three important parts of a closed curve. In the figure below, L is in the interior of the curve, M is on the boundary while N is in the exterior of the curve.

About Circles

A circle can be defined as a closed figure formed by a set of points in a plane which are located at the same distance from a fixed point which is the centre. A few important terms related to circles are:

Terms	Definitions
Radius	The fixed distance at which the points are located from the centre is called the radius.
Diameter	Diameter is the length of a line segment which joins any two points on the circle by passing through the centre. Diameter is always double than the radius.
Circumference	The distance around the circle is known as its circumference or perimeter.
Chord	A line segment joining any two points on the circle is a chord.
Sector	It is the region in the interior of a circle which is enclosed by an arc on one side and a pair of radii on the other two

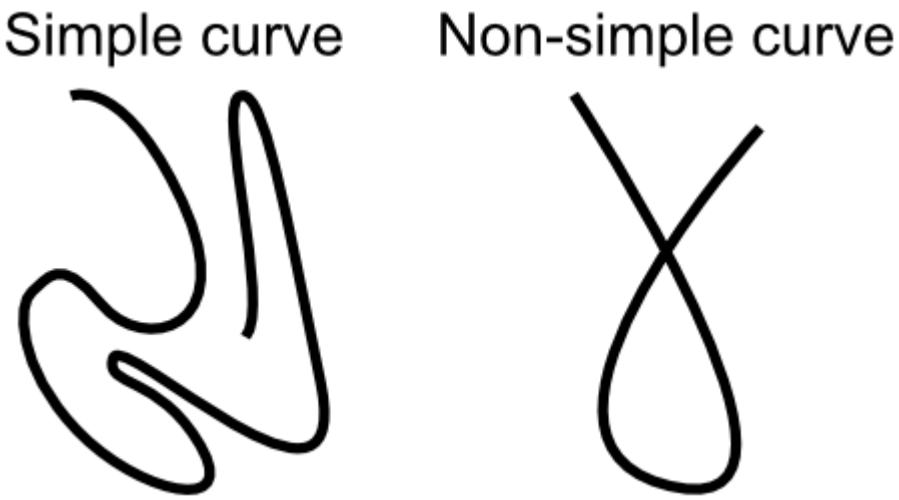
	sides.
Segment	It is a region in the interior of the circle enclosed by an arc and a chord.

Points

- A point determines a specific location.
- They are denoted by any capital letter of the English Alphabet.

Curves

- In simple terms, any line that is not straight is said to be a curve.
- If a curve does not cross itself, then it is called a simple curve.

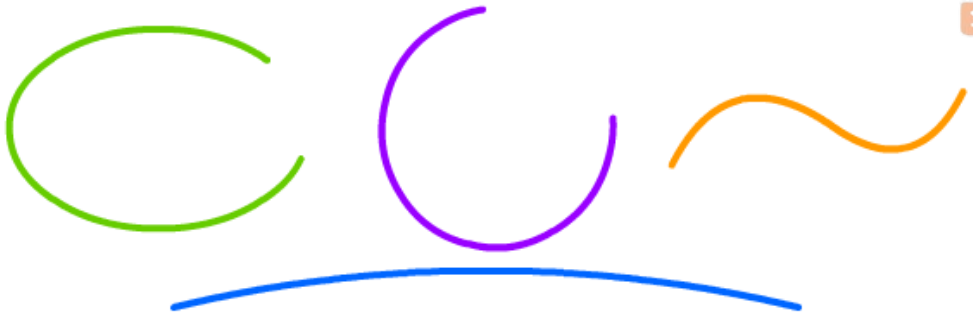


Closed and open curves

- A curve is said to be closed if it ends are joined.
- A curve whose ends are opened is said to be open curves.

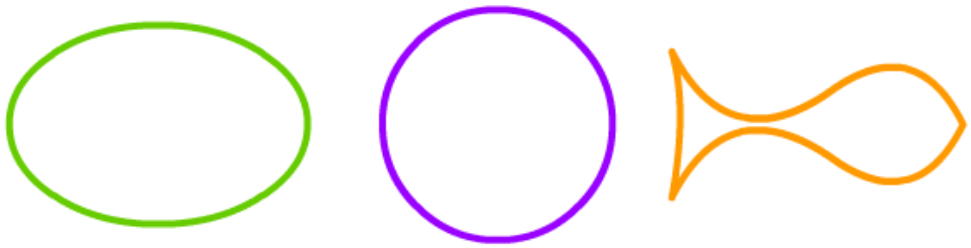
An open curve has two endpoints.
It does not enclose an area.

open curves



closed curves

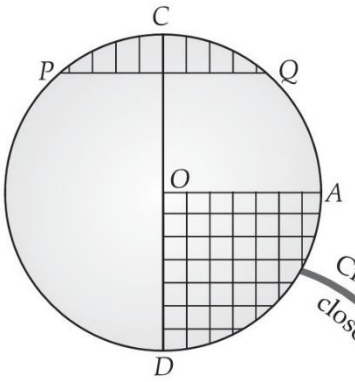
A closed curve has no endpoints and
completely encloses an area.



Closed curves include circles, ellipses
and ovoids.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER-4



PC QA DP → circumference Eg.
OA → Radius
PQ → Chord
CD → Diameter
O → Centre
DA → Arc
PCQ → Segment
ODA → Sector

Basic Geometrical Ideas

- Point
  - Exact location in space
  - A
- Line
  - Ray
    - It has one end point
    - A B
    - Figure
  - set of points with no end points
    - Intersecting lines
      - A C D B
    - Parallel lines
      - A B C D
    - Figure
      - A B
- Line Segment
  - Portion of line having 2 end points
  - Figure
    - A B
- Circle is a simple closed curve
  - Closed curve
  - Open curve
- Curve-drawing
  - drawn without lifting the pencil
- Polygon
  - eg.
  - Triangle 3 sided polygon
    - A B C
    - Sides –AB, BC, CA.
    - Angles –$\angle A, \angle B, \angle C$.
    - Vertices – A, B, C.
  - Quadrilateral 4 sided polygon
    - A B D C
    - AC & DB → Diagonals
    - AB & DC; BC & AD → opposite sides
    - $\angle A$ & $\angle C$ &;$\angle B$ & $\angle D$ → opposite angles
    - AB & BC; BC & CD;
    - CD & DA; DA & AB → adjacent sides
    - $\angle A$ & $\angle B$; $\angle B$ & $\angle C$;
    - $\angle C$ & $\angle D$; $\angle D$ & $\angle A$ → adjacent angles.
- Angle
  - Arm
  - Angle
  - Arm
  - Vertex

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Important Questions

Multiple Choice Questions:

1. A triangle has:
   - **A.** one element
   - **B.** two elements
   - **C.** 6 elements
   - **D.** none of these
2. A point where three or more lines meet is called:
   - **A.** point of concurrence
   - **B.** meeting point
   - **C.** collinear point
   - **D.** non-collinear point
3. What are used to represent points?
   - **A.** Numerals.
   - **B.** Capital letters of alphabet.
   - **C.** Lower case letters of alphabet.
   - **D.** All of the above
4. Which instrument is used to compare two line segments?
   - **A.** Compasses
   - **B.** A divider
   - **C.** Set squares
   - **D.** A protractor
5. A _____ of a circle is a line segment joining any two points on the circle.
   - **A.** chord
   - **B.** diameter
   - **C.** radius
   - **D.** None of these
6. A quadrilateral has:
   - **A.** one vertex
   - **B.** two vertices
   - **C.** three vertices

D. four vertices

7. The meeting point of a pair of adjacent sides of a polygon is called its:

A. vertex

B. diagonal

C. adjacent angles

D. none of these

8. An angle is made up of two _____ starting from common end point.

A. rays

B. vertices

C. lines

D. points

9. If two lines intersects each other then the common point between them is known as point of _____.

A. concurrence

B. intersection

C. vertex

D. contact

10. What is a set of points extending infinitely in all directions on the same flat surface called?

A. A line

B. A plane

C. Ray

D. A point

11. A quadrilateral has:

A. one diagonal

B. two diagonals

C. three diagonals

D. four diagonals

12. Three or more points are collinear if they lie on the:

A. same line

B. two lines

C. same surface

D. none of these

13. Flat surface in which two points are joined by using straight line is classified as:
    - **A.** line
    - **B.** plane
    - **C.** ray
    - **D.** intersecting line
14. What is the number of end points of a line?
    - **A.** Zero
    - **B.** Two
    - **C.** One
    - **D.** Three
15. Angle which is less than 90° is called
    - **A.** reflex angle
    - **B.** obtuse angle
    - **C.** acute angle
    - **D.** right angle

Match The Following:

	Column I		Column II
1.	Every circle has a point at	**A.**	Diameter
2.	Line segment passing through the centre of a circle	**B.**	Centre
3.	Half of the diameter	**C.**	Arc
4.	The path in the circle formed from two points on the circle	**D.**	Radius

Fill in the blanks:

1. _____ has no length, breadth, height or thickness.
2. A line segment has a definite _____ .
3. Curves that do not intersect themselves are called _____ curves.
4. An ‘angle’ is made up of _____ rays having a common end point.

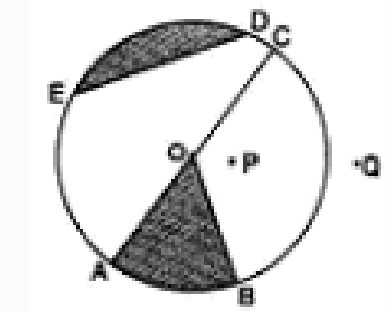
True /False:

1. A point indicates a definite position.
2. A line segment is a part of a plane.
3. A line is a set of points closely arranged.

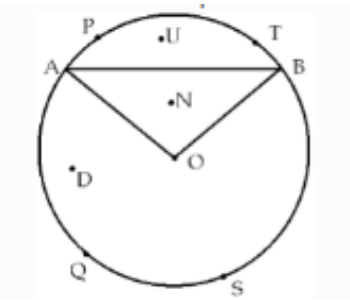
4. Two lines in a plane always intersect in a point.

Very Short Questions:

1. Draw rough diagrams to illustrate the following:
   a. Open curve.
   b. Closed curve.
2. How many end points a line segment have?
3. Illustrate, if possible, each one of the following with a rough diagram:
   a. A closed curve that is not a polygon.
   b. An open curve made up entirely of line segments.
   c. A polygon with two sides.
4. From the figure identify
   a. the center of circle.
   b. three radii
   c. a diameter

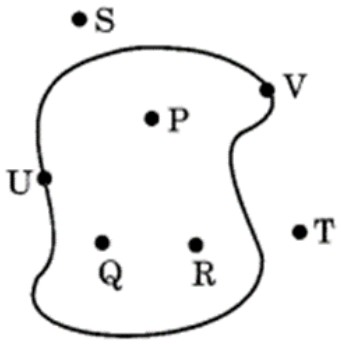


5. Write the points which are:

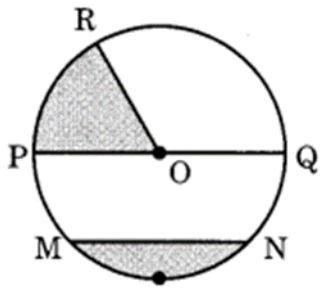


   i. in the minor sector OAPB
   ii. minor segment ATB
   iii. major sector OAQB
   iv. major arc AQB
   v. minor arc APB
6. Define the following terms:
   i. Line segment,
   ii. Line,
   iii. Intersecting lines,
   iv. Parallel lines

7. Draw a rough sketch of closed curve made up of line segments.
8. Draw two different angles having common point and a common arm.
9. Identify the points which are:
   (i) in the interior
   (ii) in the exterior
   (iii) on the closed curve in the given figure.

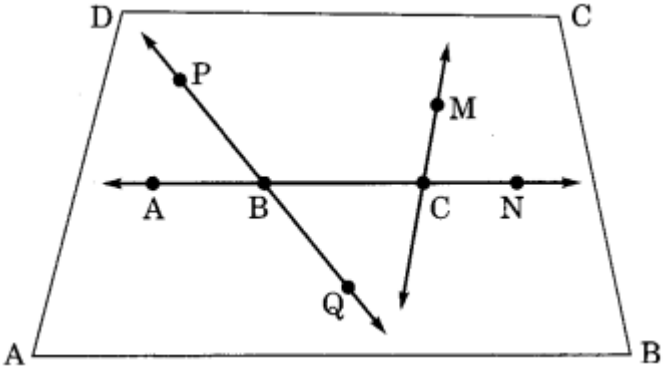


10. Identify the following in the given figure:
    (a) Sector
    (b) Chord
    (c) Diameter
    (d) Segment.



Short Questions:

1. Using the given figure, name the following:

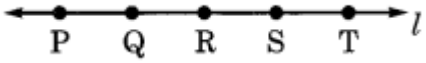


   (a) Line containing point M.
   (b) Line passing through four points.

(c) Line passing through three points.

(d) Two pairs of intersecting lines.

2. On the given line, some points are given, write down the names of all segments.



How many lines can pass through

(i) one given point?

(ii) two given points?

(iii) three non-collinear points+

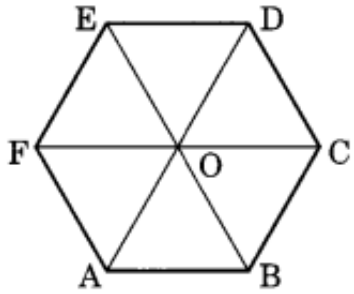
3. How many lines can pass through,

(i) one given point?

(ii) two given points?

(iii) three non-collinear points

4. Look at the given figure and answer the following:



(a) Name the sides of the polygon ABCDEF.

(b) Name any two pairs of adjacent sides. .

(c) Name all the segments which intersect each other at one point.

(d) Name all the diagonals of the given polygon.

Long Questions:

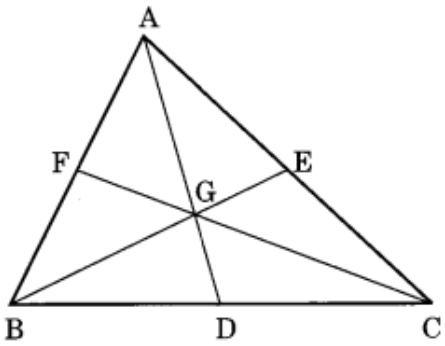
1. Draw the medians of a AABC and answer the following:

(a) Name the three medians.

(b) Do the medians intersect each other at the same point?

(c) What is that point called?

(d) Can this point be outside the triangle?



2. Draw an equilateral ΔABC of any size. Draw AD as its median and an altitude AM.

(i) Does AD coincide with AM?

(ii) Name the point on the median which divides it in the ratio 1:2.

(iii) What is the measure of ∠ADC and ∠ADB?

(iv) Are D and M the same points?

3. In the given figure, l, m and n are three parallel lines, x and y intersect these lines.

(i) Name the points lying on the line x.

(ii) Name the points lying on the line y.

(iii) Name the points inside the quadrilateral ABED.

(iv) Name the points outside the quadrilaterals ABED and BCFE.

(v) Name the lines passing through three points.

Assertion and Reason Questions:

1.) Assertion (A) –The term 'Geometry' is the English equivalent of the Greek word 'Geometron'.

Reason (R) –'Geo' means Earth and 'metron' means Measurement.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

2.) Assertion (A) –All objects have different shapes.

Reason (R) –Even today geometrical ideas are reflected in all forms of art, measurements, architecture, engineering, cloth designing etc.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

ANSWER KEY -

Multiple Choice questions:

1. **C.** 6 elements
2. **A.** point of concurrence
3. **B.** Capital letters of alphabet.
4. **B.** A divider
5. **A.** chord
6. **D.** four vertices
7. **A.** vertex
8. **A.** rays
9. **B.** intersection
10. **B.** A plane
11. **B.** two diagonals
12. **A.** same line
13. **B.** plane
14. **A.** Zero
15. **C.** acute angle

Match The Following:

	Column I		Column II
1.	Every circle has a point at	**B.**	Centre
2.	Line segment passing through the centre of a circle	**A.**	Diameter
3.	Half of the diameter	**D.**	Radius
4.	The path in the circle formed from two points on the circle	**C.**	Arc

Fill in the blanks:

1. **Point** has no length, breadth, height or thickness.
2. A line segment has a definite **length**.
3. Curves that do not intersect themselves are called Simple curves.
4. An ‘angle’ is made up of **Two** rays having a common end point.

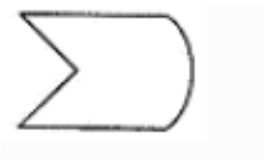
True /False:

1. True
2. False. A line segment is a part of a line that has two end points
3. False. A line is a straight path that is endless.
4. False. Two lines in a plane intersect in a point or parallel.

Very Short Answer:

1. (a) 

   (b) 

2. 2
3. (a) 

   (b) 

   (c) Not possible.
4. (a) O is the centre of the circle.

   (b) $\overline{OA}, \overline{OB}, \overline{OC}$ are three radii of the circle.

   (c) $\overline{AC}$ is the diameter of the circle.
5. i. U and N

   ii. U

   iii. D

   iv. A, Q, S and B

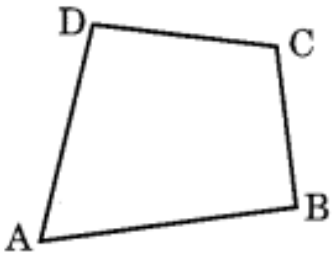
   v. A, P, T and B
6. **i. Line segment:** A straight line drawn from any point to any other point is called as line segment.

   ii. Line: Line is a straight path of points that goes on forever in two directions. It has infinite length, but no breadth and height.

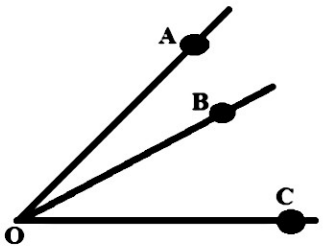
   iii. Intersecting lines: Interesting lines are lines that pass through the same point.

   iv. Parallel lines: Parallel lines are never cross and always stay the same distance apart.

7. Required curve is ABCD closed with the line segments $\overline{AB}, \overline{BC}, \overline{CD}$ and $\overline{DA}$



8. ∠AOB and ∠COB are two different angles with common point O and common arm $\overrightarrow{OB}$.



9. (i) Points P, Q and R are in the interior of the closed curve.

(ii) points S and T are in the exterior of the closed curve.

(iii) U and V are on the closed curve.

10. (a) OPR (shaded) is the sector of the circle.

(b) $\overline{MN}$ is the chord.

(c) $\overline{PQ}$ is the diameter.

(d) MXN (shaded) is the segment.

Short Answer:

1. (a) $\overleftrightarrow{MC}$ is the line containing the point M.

(b) $\overleftrightarrow{AN}$ is the line passing through four points A, B, C and N.

(c) $\overleftrightarrow{PQ}$ is the line passing through three points P, B and Q.

(d) Pairs for intersecting lines are

(i) $\overleftrightarrow{AN}$ and $\overleftrightarrow{PQ}$

(ii) $\overleftrightarrow{AN}$ and $\overleftrightarrow{MC}$

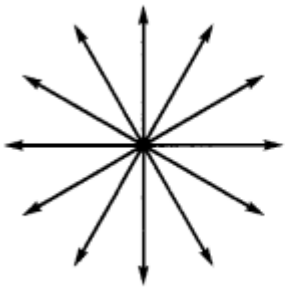
2. Segments are:

$\overline{PQ}, \overline{RP}, \overline{PS}, \overline{PT}, \overline{QR}, \overline{QS}, \overline{QT}, \overline{RS}, \overline{RT}, \overline{ST}$

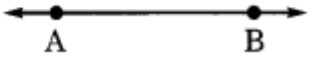
3. (i) Infinite number of lines can be passed through one given point.

(ii) Only one line can pass through two given points.

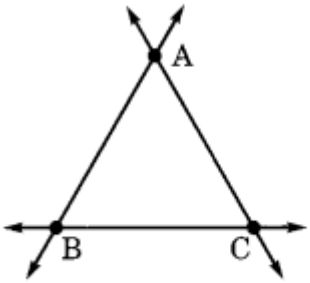
(iii) Three lines can pass through three non- collinear points.



(i)



(ii)



(iii)

4. (a) The sides of the polygon are:

$\overline{AB}$, $\overline{BC}$, $\overline{CD}$, $\overline{DE}$, $\overline{EF}$ and $\overline{FA}$.

(b) $\overline{AB}$ and $\overline{BC}$, $\overline{BC}$ and $\overline{CD}$ are the pairs of adjacent sides.

(c) $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ intersect each other at O.

(d) Name of the diagonals are:

$\overline{AD}$, $\overline{BE}$ and $\overline{CF}$.

Long Answer:

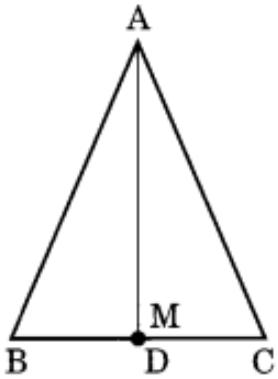
1. (a) Names of the medians are $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$.

(b) Yes, the medians intersect each other at the same point G.

(c) The point of intersection of the medians of a triangle is called 'Centroid'.

(d) No, this point cannot be out of the triangle.

2. (i) Yes, AD coincides with AM.



(ii) The point on the median which divides it in the ratio 1: 2 is called centroid of the triangle.

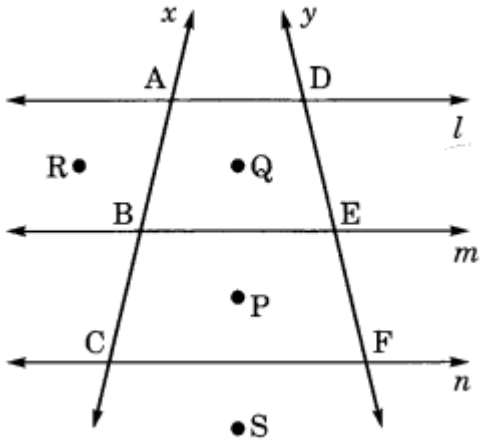
(iii) ∠ADC = ∠ADB = 90°

(iv) Yes, D and M are the same points.

3. (i) A, B and C lie on the line x.

(ii) D, E and F lie on the line y.

(iii) Q is the point inside ▢ABED



(iv) Points R and S are outside the quadrilaterals ABED and BCFE.

(v) Lines x and y pass through the three points A, B, C and D, E, F respectively.

Assertion and Reason Answers:

1) b) Both A and R are true but R is not the correct explanation of A

2) b) Both A and R are true but R is not the correct explanation of A