

# MATHEMATICS

Chapter 5: Introduction to Euclid's Geometry



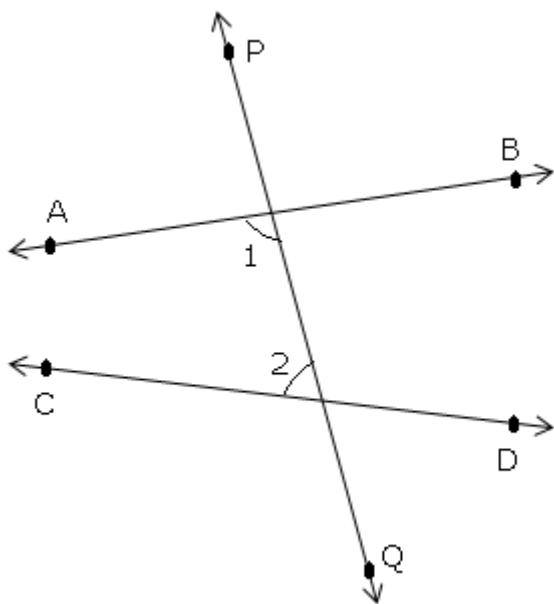
## Introduction to Euclid's Geometry

1. A **point** is that which has no part.
2. A **line** is a breadthless length. The ends of a line are points.
3. A **straight line** is a line which lies evenly with the points on itself.
4. A **surface** is that which has length and breadth only.
5. The **edges** of a surface are lines.
6. A **plane surface** is a surface which lies evenly with the straight lines on itself.
7. Though Euclid defined a **point**, a **line** and a **plane**, but the definitions are not accepted by mathematicians. Therefore, these terms are taken as **undefined**.
8. An **axiom** is a statement accepted as true without proof, throughout mathematics.
9. A **postulate** is a statement accepted as true without proof, specifically in geometry.
10. **Euclid's Axioms:**
  - i. Things which are equal to the same things are equal to one another.
  - ii. If equals are added to equals, the wholes are equal.
  - iii. If equals are subtracted from equals, the remainders are equal.
  - iv. Things which coincide with one another are equal to one another.
  - v. The whole is greater than a part.
  - vi. Things which are double of same things are equal to one another.
  - vii. Things which are halves of same things are equal to one another.
11.  $A > B$  means that there is some quantity C such that  $A = B + C$ .
12. **Theorems** are statements which are proved using definitions, axioms, previously proved statement and deductive reasoning.
13. **Euclid's 5 Postulates:**
  - i. A straight line may be drawn from any one point to any other point.
  - ii. A terminated line can be produced indefinitely.
  - iii. A circle can be drawn with any centre and any radius.
  - iv. All right angles are equal to one another.
  - v. If a straight line falling on two straight lines makes the interior angles on the same side of it taken together, is less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than



two right angles.

This is known as the parallel postulate.



In the figure,  $\angle 1 + \angle 2 < 180^\circ$ . The lines AB and CD will eventually intersect on the left side of PQ.

14. Given two distinct points, there is a unique line that passes through them.
15. Two distinct lines cannot have more than one point in common.
16. **Equivalent version of Euclid's fifth postulate:**
  - i. For every line l and for every point P not lying on l, there exists a unique line m passing through P and parallel to l.

This result is also known as 'Playfair's Axiom'.

  - ii. Two distinct intersecting lines cannot be parallel to the same line.
17. All attempts to prove Euclid's fifth postulate using first four postulates failed and led to several other geometries called non-Euclidean geometries.
18. The distance of a point from a line is the length of the perpendicular from the point to the line.

## Euclid's Geometry

The word "geometry" comes from the Greek words "geo", which means the "earth", and "metron", which means "to measure". Euclidean geometry is a mathematical system attributed to Euclid a teacher of mathematics in Alexandria in Egypt. Euclid gave us an exceptional idea regarding the basic concepts of geometry, in his book called "Elements".

Euclid listed 23 definitions in his book "Elements". Some important points are mentioned below:

- A line is an endless length.
- A point has no dimension (length, breadth and width).

- A line which lies evenly with the points on itself is a straight line.
- Points are the ends of a line.
- A surface is that which has breadth and length only.
- A plane surface is a surface which lies evenly with the straight lines on itself.
- Lines are the edges of a surface.

Euclid realized that a precise development of geometry must start with the foundations. Euclid's axioms and postulates are still studied for a better understanding of geometry.

## Euclidean Geometry

Euclidean geometry is the study of geometrical shapes (plane and solid) and figures based on different axioms and theorems. It is basically introduced for flat surfaces or plane surfaces. Geometry is derived from the Greek words 'geo' which means earth and 'metrein' which means 'to measure'.

Euclidean geometry is better explained especially for the shapes of geometrical figures and planes. This part of geometry was employed by the Greek mathematician Euclid, who has also described it in his book, Elements. Therefore, this geometry is also called Euclid geometry.

The axioms or postulates are the assumptions that are obvious universal truths, they are not proved. Euclid has introduced the geometry fundamentals like geometric shapes and figures in his book elements and has stated 5 main axioms or postulates. Here, we are going to discuss the definition of euclidean geometry, its elements, axioms and five important postulates.

## History of Euclid Geometry

The excavations at Harappa and Mohenjo-Daro depict the extremely well-planned towns of Indus Valley Civilization (about 3300-1300 BC). The flawless construction of Pyramids by the Egyptians is yet another example of extensive use of geometrical techniques used by the people back then. In India, the Sulba Sutras, textbooks on Geometry depict that the Indian Vedic Period had a tradition of Geometry.

The development of geometry was taking place gradually, when Euclid, a teacher of mathematics, at Alexandria in Egypt, collected most of these evolutions in geometry and compiled it into his famous treatise, which he named 'Elements'.

## Euclidean Geometry

Euclidean Geometry is considered an axiomatic system, where all the theorems are derived from a small number of simple axioms. Since the term "Geometry" deals with things like points, lines, angles, squares, triangles, and other shapes, Euclidean Geometry is also known as "plane geometry". It deals with the properties and relationships between all things.

Plane Geometry	Solid Geometry
<ol style="list-style-type: none"> <li>1. Congruence of triangles</li> <li>2. Similarity of triangles</li> <li>3. Areas</li> <li>4. Pythagorean theorem</li> <li>5. Circles</li> <li>6. Regular polygons</li> <li>7. Conic sections</li> </ol>	<ol style="list-style-type: none"> <li>1. Volume</li> <li>2. Regular solids</li> </ol>

### Examples of Euclidean Geometry

The two common examples of Euclidean geometry are angles and circles. Angles are said as the inclination of two straight lines. A circle is a plane figure, that has all the points at a constant distance (called the radius) from the center.

### Euclidean and Non-Euclidean Geometry

There is a difference between Euclidean and non-Euclidean geometry in the nature of parallel lines. In Euclidean geometry, for the given point and line, there is exactly a single line that passes through the given points in the same plane and it never intersects.

Non-Euclidean is different from Euclidean geometry. The spherical geometry is an example of non-Euclidean geometry because lines are not straight here.

### Properties of Euclidean Geometry

- It is the study of plane geometry and solid geometry
- It defined point, line and a plane
- A solid has shape, size, position, and can be moved from one place to another.
- The interior angles of a triangle add up to 180 degrees
- Two parallel lines never cross each other
- The shortest distance between two points is always a straight line

### Elements in Euclidean Geometry

In Euclidean geometry, Euclid's Elements is a mathematical and geometrical work consisting of 13 books written by ancient Greek mathematician Euclid in Alexandria, Ptolemaic Egypt. Further, the 'Elements' was divided into thirteen books that popularized geometry all over the world. As a whole, these Elements is a collection of definitions, postulates (axioms), propositions (theorems and constructions), and mathematical proofs of the propositions.

Book 1 to 4th and 6th discuss plane geometry. He gave five postulates for plane geometry known as Euclid's Postulates and the geometry is known as Euclidean geometry. It was through his works, we have a collective source for learning geometry; it lays the foundation

for geometry as we know it now.

## Euclidean Axioms

Here are the seven axioms are given by Euclid for geometry.

- Things which are equal to the same thing are equal to one another.
- If equals are added to equals, the wholes are equal.
- If equals are subtracted from equals, the remainders are equal.
- Things which coincide with one another are equal to one another.
- The whole is greater than the part.
- Things which are double of the same things are equal to one another.
- Things which are halves of the same things are equal to one another.

## Euclid's Five Postulates

Before discussing Postulates in Euclidean geometry, let us discuss a few terms as listed by Euclid in his book 1 of the 'Elements'. The postulated statements of these are:

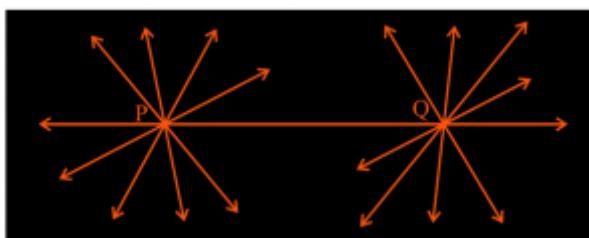
- Assume the three steps from solids to points as solids-surface-lines-points. In each step, one dimension is lost.
- A solid has 3 dimensions, the surface has 2, the line has 1 and the point is dimensionless.
- A point is anything that has no part, a breadthless length is a line and the ends of a line point.
- A surface is something that has length and breadth only.

It can be seen that the definition of a few terms needs extra specification. Now let us discuss these Postulates in detail.

### Euclid's Postulate 1

"A straight line can be drawn from any one point to another point."

This postulate states that at least one straight line passes through two distinct points but he did not mention that there cannot be more than one such line. Although throughout his work he has assumed there exists only a unique line passing through two points.



### Euclid's Postulate 2

“A terminated line can be further produced indefinitely.”

In simple words what we call a line segment was defined as a terminated line by Euclid. Therefore this postulate means that we can extend a terminated line or a line segment in either direction to form a line. In the figure given below, the line segment AB can be extended as shown to form a line.



### Euclid's Postulate 3

“A circle can be drawn with any centre and any radius.”

Any circle can be drawn from the end or start point of a circle and the diameter of the circle will be the length of the line segment.

### Euclid's Postulate 4

“All right angles are equal to one another.”

All the right angles (i.e. angles whose measure is  $90^\circ$ ) are always congruent to each other i.e. they are equal irrespective of the length of the sides or their orientations.

### Euclid's Postulate 5

“If a straight line falling on two other straight lines makes the interior angles on the same side of it taken together less than two right angles, then the two straight lines, if produced indefinitely, meet on the side on which the sum of angles is less than two right angles.”

Further, these Postulates and axioms were used by him to prove other geometrical concepts using deductive reasoning. No doubt the foundation of present-day geometry was laid by him and his book the ‘Elements’.

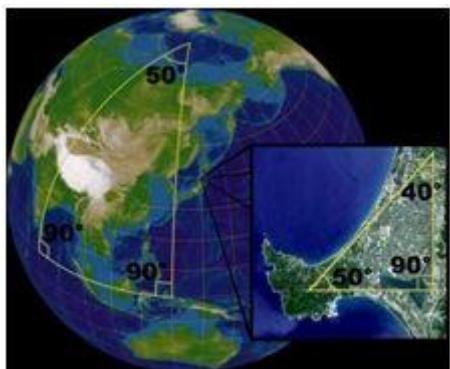
## Geometry In Daily Life

Geometry is an ancient science and an important branch of mathematics. The ancient mathematician Euclid is credited as the Father of Geometry; who used the word formally in his book “Elements”. It is derived from the old Greek word Geometron meaning to measure the earth (geo: earth and metron: measurement). For an elementary or middle school student, it is all about different basic shapes, including their naming, properties and formulas related to their areas and volumes. But modern geometry has diverged much more from these basic concepts. But none of these has changed their existence and applications in daily life, and it still reflects in our everyday experience.

## Applications of Geometry in Everyday Life

Geometry is the most influential branch of mathematics. A keen observation will give you many examples. It was moulded up in ancient era; hence its impact on life is also wide. It's a potential problem solver, especially in practical life. Its applications began long back during Egyptian civilization. They used geometry in different fields such as in art, measurement and architecture. Glorious temples, palaces, dams and bridges are the results

of these. In addition to construction and measurements, it has influenced many more fields of engineering, biochemical modelling, designing, computer graphics, and typography.



Daily, we do a lot of tasks with the help of geometry. Some of the common applications include measurement of a line and surface area of land, wrapping gifts, filling of a box or tiffin without overflow, shapes used for different signboards. A person with good practical knowledge of geometry can help himself to measure the dimensions of a land without a chance of conflict. Other advanced applications include robotics, fashion designing, computer graphics and modelling. For example, in fashion designing, a fashion designer has to know about different shapes and their symmetry for developing the best design.

## Geometry Symbols

**Geometry Symbols:** Geometry is a branch of mathematics that deals with the properties of configurations of geometric objects – (straight) lines, circles and points being the most basic.

The area of mathematics that deals with space, lines, shapes and points

- Plane Geometry is about flat shapes like triangles, circles, and lines,
- Solid Geometry is about solid (3-dimensional) shapes like spheres and cubes.

## Geometry Symbol Chart

Let's explore the typical Geometry symbols and meanings used in both basic Geometry and more advanced levels through this geometry symbol chart.

Symbol	Symbol Name	Meaning/definition of the Symbols	Example
$\angle$	angle	formed by two rays	$\angle ABC = 30^\circ$
$\perp$	right angle	$= 90^\circ$	$\alpha = 90^\circ$
$\sphericalangle$	spherical angle		$AOB = 30^\circ$
'	arcminute	$1^\circ = 60'$	$\alpha = 60^\circ 59'$

$\circ$	degree	1 turn = $360^\circ$	$\alpha = 60^\circ$
$''$	arcsecond	$1' = 60''$	$\alpha = 60^\circ 59' 59''$
$\overrightarrow{AB}$	ray	line that start from point A	
AB	line segment	the line from point A to point B	
$\perp$	perpendicular	perpendicular lines ( $90^\circ$ angle)	$AC \perp BC$
$\cong$	congruent to	equivalence of geometric shapes and size	$\Delta ABC \cong \Delta XYZ$
$\parallel$	parallel	parallel lines	$AB \parallel CD$
$\Delta$	triangle	triangle shape	$\Delta ABC \cong \Delta BCD$
$\sim$	similarity	same shapes, not the same size	$\Delta ABC \sim \Delta XYZ$
$\pi$	pi constant	$\pi = 3.141592654\dots$ is the ratio between the circumference and diameter of a circle	$c = \pi \cdot d = 2 \cdot \pi \cdot r$
$ x-y $	distance	distance between points x and y	$ x-y  = 5$
grad	grads	grads angle unit	$360^\circ = 400$ grad
rad	radians	radians angle unit	$360^\circ = 2\pi$ rad

The symbols for angles and triangles are most important and frequently used symbols in geometry.

## Analytic Geometry

Analytic Geometry is a branch of algebra, a great invention of Descartes and Fermat, which deals with the modelling of some geometrical objects, such as lines, points, curves, and so on. It is a mathematical subject that uses algebraic symbolism and methods to solve the problems. It establishes the correspondence between the algebraic equations and the geometric curves. The alternate term which is used to represent the analytic geometry is “coordinate Geometry”.

It covers some important topics such as midpoints and distance, parallel and perpendicular lines on the coordinate plane, dividing line segments, distance between the line and a point, and so on. The study of analytic geometry is important as it gives the knowledge for the next level of mathematics. It is the traditional way of learning the logical thinking and

the problem solving skills. In this article, let us discuss the terms used in the analytic geometry, formulas, Cartesian plane, analytic geometry in three dimensions, its applications, and some solved problems.

## Planes

To understand how analytic geometry is important and useful, First, We need to learn what a plane is? If a flat surface goes on infinitely in both the directions, it is called a Plane. So, if you find any point on this plane, it is easy to locate it using Analytic Geometry. You just need to know the coordinates of the point in X and Y plane.

## Coordinates

Coordinates are the two ordered pair, which defines the location of any given point in a plane. Let's understand it with the help of the box below.

	A	B	C
1			
2		x	
3			

In the above grid, The columns are labelled as A, B, C, and the rows are labelled as 1, 2, 3. The location of letter x is B2 i.e. Column B and row 2. So, B and 2 are the coordinates of this box, x.

As there are several boxes in every column and rows, but only one box has the point x, and we can find its location by locating the intersection of row and column of that box. There are different types of coordinates in analytical geometry. Some of them are as follows:

- Cartesian Coordinates
- Polar Coordinates
- Cylindrical Coordinates
- Spherical Coordinates

Let us discuss all these types of coordinates are here in brief.

## Cartesian Coordinates

The most well-known coordinate system is the Cartesian coordinate to use, where every point has an x-coordinate and y-coordinate expressing its horizontal position, and vertical position respectively. They are usually addressed as an ordered pair and denoted as  $(x, y)$ . We can also use this system for three-dimensional geometry, where every point is represented by an ordered triple of coordinates  $(x, y, z)$  in Euclidean space.

## Polar Coordinates

In the case of polar coordinates, each point in a plane is denoted by the distance 'r' from

the origin and the angle  $\theta$  from the polar axis.

### Cylindrical Coordinates

In the case of cylindrical coordinates, all the points are represented by their height, radius from z-axis and the angle projected on the xy-plane with respect to the horizontal axis. The height, radius and the angle are denoted by  $h$ ,  $r$  and  $\theta$ , respectively.

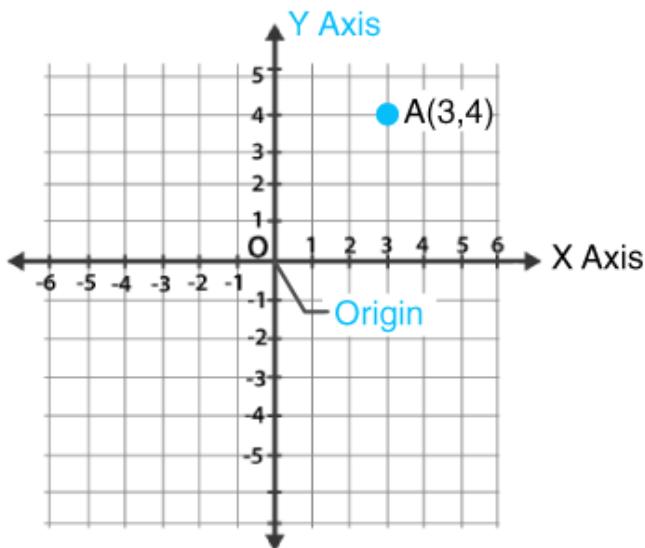
### Spherical Coordinates

In spherical coordinates, the point in space is denoted by its distance from the origin ( $\rho$ ), the angle projected on the xy-plane with respect to the horizontal axis ( $\theta$ ), and another angle with respect to the z-axis ( $\phi$ ).

### Cartesian Plane

In coordinate geometry, every point is said to be located on the coordinate plane or cartesian plane only.

Look at the figure below.



The above graph has x-axis and y-axis as it's Scale. The x-axis is running across the plane and Y-axis is running at the right angle to the x-axis. It is similar to the box explained above.

Let's learn more about Co-ordinates:

**Origin:** It is the point of intersection of the axis(x-axis and y-axis). Both x and y-axis are zero at this point.

### Values of the different sides of the axis

**x-axis** – The values at the right-hand side of this axis are positive and those on the left-hand side are negative.

**y-axis** – The values above the origin are positive and below the origin are negative.

**To locate a point:** We need two numbers to locate a plane in the order of writing the location of X-axis first and Y-axis next. Both will tell the single and unique position on the

plane. You need to compulsorily follow the order of the points on the plane i.e., the x coordinate is always the first one from the pair. (x, y).

If you look at the figure above, point A has a value 3 on the x-axis and value 2 on the Y-axis. These are the rectangular coordinates of Point A represented as (3, 2).

Using the Cartesian coordinates, we can define the equation of a straight lines, equation of planes, squares and most frequently in the three dimensional geometry. The main function of the analytic geometry is that it defines and represents the various geometrical shapes in the numerical way. It also extracts the numerical information from the shapes.

## Analytic Geometry Formulas

Graphs and coordinates are used to find measurements of geometric figures. There are many important formulas in analytic Geometry. Since science and engineering involves the study of rate of change in varying quantities, it helps to show the relation between the quantities involved. The branch of Mathematics called “calculus” requires the clear understanding of the analytic geometry. Here, some of the important ones are being used to find the distance, slope or to find the equation of the line.

### Distance Formula

Let the two points be A and B, having coordinates to be  $(x_1, y_1)$  and  $(x_2, y_2)$  respectively.

Thus, the distance between two points is given as-

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

### Midpoint Theorem Formula

Let A and B are some points in a plane, which is joined to form a line, having coordinates  $(x_1, y_1)$  and  $(x_2, y_2)$ , respectively. Suppose, M (x, y) is the midpoint of the line connecting the point A and B then its formula is given by;

$$M(x, y) = [(x_1 + x_2)/2, (y_1 + y_2)/2]$$

### Angle Formula

Let two lines have slope  $m_1$  and  $m_2$  and  $\theta$  is the angle formed between the two lines A and B, which is represented as;

$$\tan \theta = (m_1 - m_2) / (1 + m_1 m_2)$$

### Section Formula

Let two lines A and B have coordinates  $(x_1, y_1)$  and  $(x_2, y_2)$ , respectively. A point P the two lines in the ratio of  $m:n$ , then the coordinates of P is given by;

- When the ratio  $m:n$  is internal:

$$\left( \frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n} \right)$$

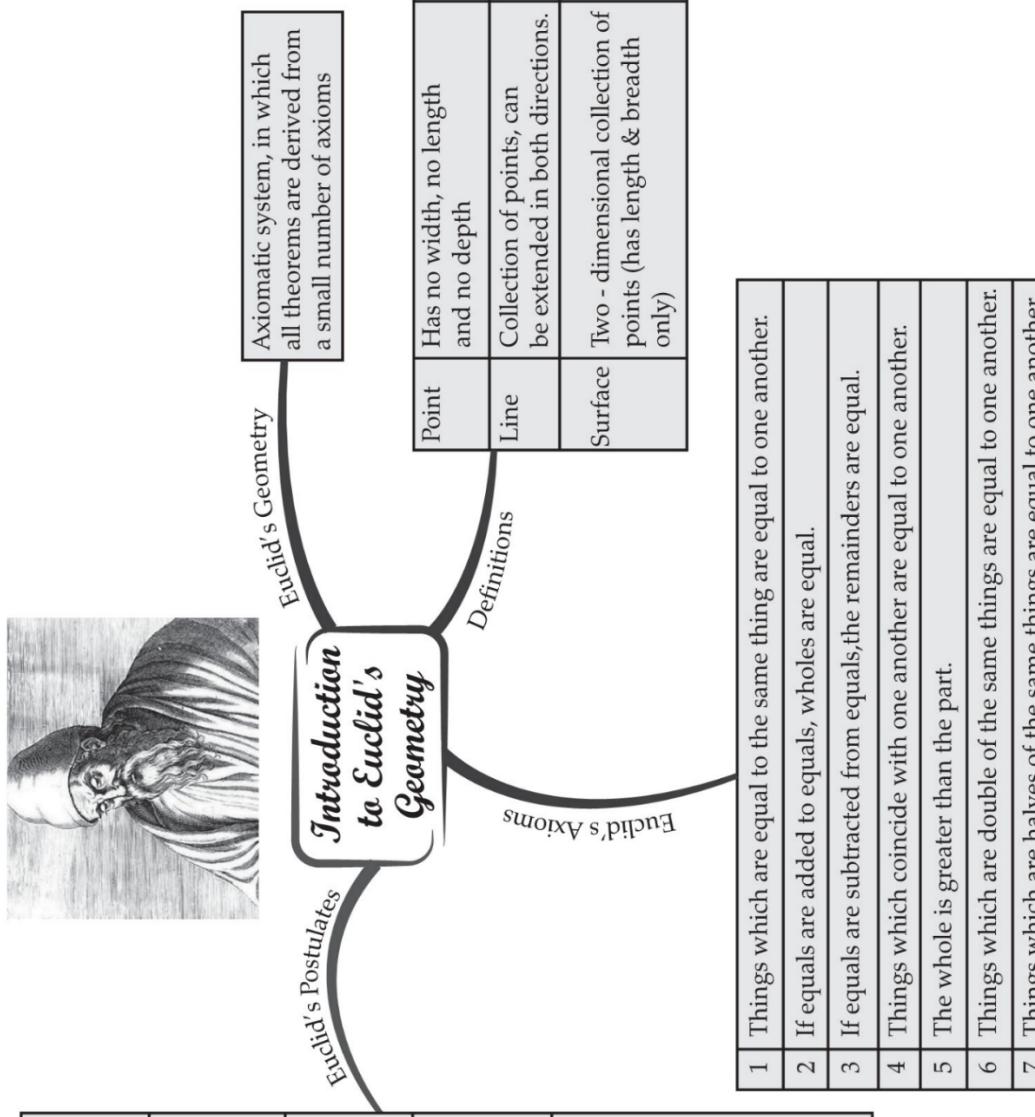
- When the ratio  $m:n$  is external:

$$\left( \frac{mx_2 - nx_1}{m-n}, \frac{my_2 - ny_1}{m-n} \right)$$

## CHAPTER : 5 INTRODUCTION TO EUCLID'S GEOMETRY



1 A straight line can be drawn from any one point to any other point.	
2 A terminated line can be produced infinitely.	
3 A circle can be drawn with any centre and of any radius.	
4 All right angles are equal to one another.	
5 If a straight line falling on two straight lines makes the interior angles on the same side of it, taken together makes less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of the angles is less than two right angles.	



## Important Questions

### Multiple Choice Questions-

Question 1. Which of the following statements are true?

- a) Only one line can pass through a single point.
- b) There is an infinite number of lines which pass through two distinct points.
- c) A terminated line can be produced indefinitely on both the sides
- d) If two circles are equal, then their radii are unequal.

Question 2. A solid has \_\_\_\_\_ dimensions.

- a) One
- b) Two
- c) Three
- d) Zero

Question 3. A point has \_\_\_\_\_ dimension.

- a) One
- b) Two
- c) Three
- d) Zero

Question 4. The shape of base of Pyramid is:

- a) Triangle
- b) Square
- c) Rectangle
- d) Any polygon

Question 5. The boundaries of solid are called:

- a) Surfaces
- b) Curves
- c) Lines
- d) Points

Question 6. A surface of a shape has:

- a) Length, breadth and thickness
- b) Length and breadth only
- c) Length and thickness only

d) Breadth and thickness only

Question 7. The edges of the surface are :

a) Points

b) Curves

c) Lines

d) None of the above

Question 8. Which of these statements do not satisfy Euclid's axiom?

a) Things which are equal to the same thing are equal to one another

b) If equals are added to equals, the wholes are equal.

c) If equals are subtracted from equals, the remainders are equal.

d) The whole is lesser than the part.

Question 9. The line drawn from the center of the circle to any point on its circumference is called:

a) Radius

b) Diameter

c) Sector

d) Arc

Question 10. There are \_\_\_\_\_ number of Euclid's Postulates

a) Three

b) Four

c) Five

d) Six

### Very Short:

1. Give a definition of parallel lines. Are there other terms that need to be defined first? What are they and how might you define them?

2. Give a definition of perpendicular lines. Are there other terms that need to be defined first ? What are they and how might you define them?

3. Give a definition of line segment. Are there other terms that need to be defined first? What are they and how might you define them?

4. Solve the equation  $a - 15 = 25$  and state which axiom do you use here.

5. Ram and Ravi have the same weight. If they each gain weight by 2kg, how will their new weights be compared?

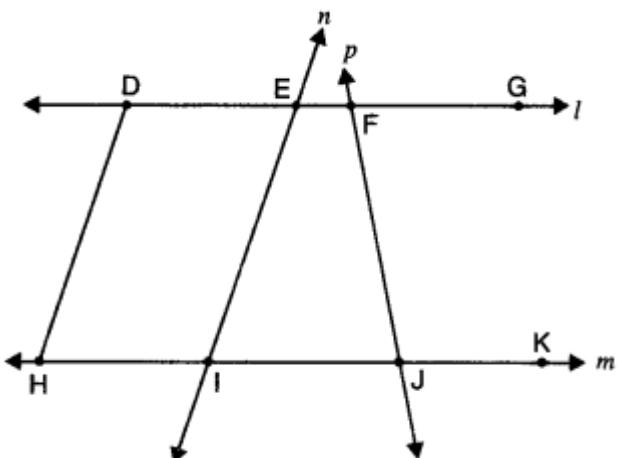
6. If a point C be the mid-point of a line segment AB, then write the relation among AC, BC and AB.

7. If a point P be the mid-point of MN and C is the mid-point of MP, then write the relation between MC and MN
  8. How many lines does pass through two distinct points?
  9. In the given figure, if  $AB = CD$ , then prove that  $AC = BD$ . Also, write the Euclid's axiom used for proving it.

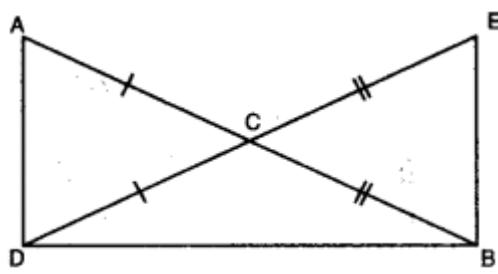


## Short Questions:

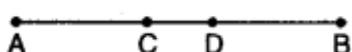
1. Define:
    - (a) a square
    - (b) perpendicular line
  2. In the given figure, name the following:
    - (i) Four collinear points
    - (ii) Five rays
    - (iii) Five-line segments
    - (iv) Two-pairs of non-intersecting line segments.



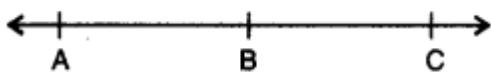
3. In the given figure,  $AC = DC$  and  $CB = CE$ . Show that  $AB = DE$ . Write the Euclid's axiom to support this



4. In figure, it is given that  $AD=BC$ . By which Euclid's axiom it can be proved that  $AC = BD$ ?

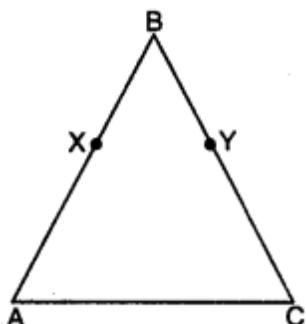


5. If A, B and C are any three points on a line and B lies between A and C (see figure), then prove that  $AB + BC = AC$



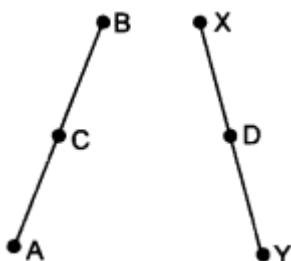
6. In the given figure,  $AB = BC$ ,  $BX = BY$ , show that

$$AX = CY.$$

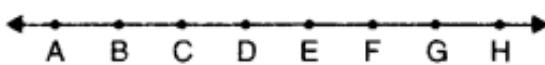


### Long Questions:

1. For given four distinct points in a plane, find the number of lines that can be drawn through:
- (i) When all four points are collinear.
  - (ii) When three of the four points are collinear.
  - (iii) When no three of the four points are collinear.



2. Show that: length AH > sum of lengths of  $AB + BC + CD$ .



3. Rohan's maid has two children of same age. Both of them have equal number of dresses. Rohan on his birthday plans to give both of them same number of dresses. What can you say about the number of dresses each one of them will have after Rohan's birthday? Which Euclid's axiom is used to answer this question? What value is Rohan depicting by doing so? Write one more Euclid's axiom.
4. Three lighthouse towers are located at points A, B and C on the section of a national forest to protect animals from hunters by the forest department as shown in figure. Which value is department exhibiting by locating extra towers? How many straight lines can be drawn from A to C? State the

Euclid Axiom which states the required result. Give one more. Postulate.



### Assertion and Reason Questions-

**1.** In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- c) Assertion is correct statement but reason is wrong statement.
- d) Assertion is wrong statement but reason is correct statement.

**Assertion:** There can be infinite number of lines that can be drawn through a single point.

**Reason:** From this point we can draw only two lines.

**2.** In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- c) Assertion is correct statement but reason is wrong statement.
- d) Assertion is wrong statement but reason is correct statement.

**Assertion:** Through two distinct points there can be only one line that can be drawn.

**Reason:** From this two point we can draw only one line.

### Answer Key:

#### MCQ:

1. (c) A terminated line can be produced indefinitely on both the sides
2. (c) Three
3. (d) Zero

4. (d) Any polygon
5. (a) Surfaces
6. (b) Length and breadth only
7. (c) Lines
8. (d) The whole is lesser than the part.
9. (a) Radius
- 10.(c) Five

### **Very Short Answer:**

1. Two coplanar lines in a plane which are not intersecting are called parallel lines. The other term intersecting is undefined.
2. Two coplanar (in a plane) lines are perpendicular if the angle between them at the point of intersection is one right angle. The other terms point of intersection and one right angle are undefined.
3. A line segment PQ of a line 'l' is the continuous part of the line l with end points P and Q.



Here, continuous part of the line 'l' is undefined.

4.  $a - 15 = 25$

On adding 15 to both sides, we obtain

$$a - 15 + 15 = 25 + 15 \text{ [using Euclid's second axiom]}$$

$$a = 40$$

5. Let  $x$  kg be the weight each of Ram and Ravi.

On adding 2kg,

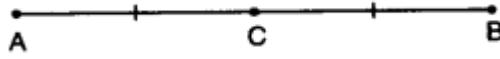
Weight of Ram and Ravi will be  $(x + 2)$  kg each.

According to Euclid's second axiom, when equals are added to equals, the wholes are equal.

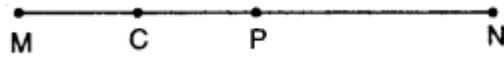
6. Here, C is the mid-point of AB

$$\Rightarrow AC = BC$$

$$\Rightarrow AC = BC = \frac{1}{2}AB$$



7. Here, P is the mid-point of MN and C is the mid-point of MP.



$$\therefore MC = \frac{1}{4}MN$$

8. One and only one.

9. Here, given that

$$AB = CD$$

By using Euclid's axiom 2, if equals are added to equals, then the wholes are equal, we have

$$AB + BC = CD + BC$$

$$\Rightarrow AC = BD$$

## **Short Answer:**

**Ans: 1.** (a) A square: A square is a rectangle having same length and breadth. Here, undefined terms are length, breadth, and rectangle.

(b) Perpendicular lines: Two coplanar (in a plane) lines are perpendicular, if the angle between them at the point of intersection is one right angle. Here, the term one right angle is undefined.

**Ans: 2.** (i) Four collinear points are D, E, F, G and H, I, J, K

(ii) Five rays are DG, EG, FG, HK, IK.

(iii) Five-line segments are DH, EI, FJ, DG, HK.

(iv) Two-pairs of non-intersecting line segments are (DH, EI) and (DG, HK).

**Ans: 3.** We have

$$AC = DC$$

$$CB = CE$$

By using Euclid's axiom 2, if equals are added to equals, then wholes are equal.

$$\Rightarrow AC + CB = DC + CE$$

$$\Rightarrow AB = DE.$$

**Ans: 4.** We can prove it by Euclid's axiom 3. "If equals are subtracted from equals, the remainders are equal."

We have  $AD = BC$

$$\Rightarrow AD - CD = BC - CD$$

$$\Rightarrow AC = BD$$

**Ans: 5.** In the given figure, AC coincides with AB + BC. Also, Euclid's axiom 4, states that things

which coincide with one another are equal to one another. So, it is evident that:

$AB + BC = AC$ .

**Ans: 6.** Given that  $AB = BC$

and  $BX = BY$

By using Euclid's axiom 3, equals subtracted from equals, then the remainders are equal, we have

$$AB - BX = BC - BY$$

$$AX = CY$$

### Long Answer:

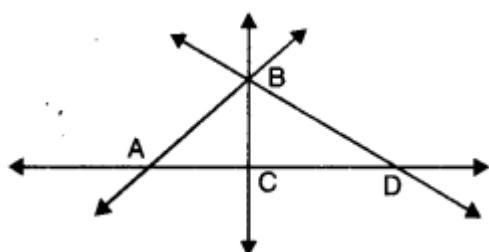
**Ans: 1.**



(i) Consider the points given are A, B, C and D.

When all the four points are collinear:

One line  $\overleftrightarrow{AD}$ .



(ii) When three of the four points are collinear:

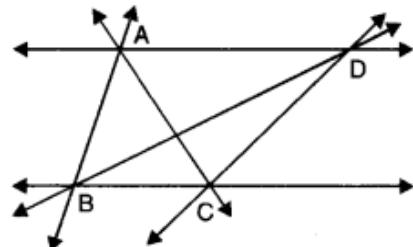
4 lines

Here, we have four lines  $\overleftrightarrow{AB}, \overleftrightarrow{BC}, \overleftrightarrow{BD}, \overleftrightarrow{AD}$  (four).

(iii) When no three of the four points are collinear:

6 lines Here, we have

$\overleftrightarrow{AB}, \overleftrightarrow{BC}, \overleftrightarrow{AC}, \overleftrightarrow{AD}, \overleftrightarrow{BD}, \overleftrightarrow{CD}$  (six)



**Ans: 2.** We have

$$AH = AB + BC + CD + DE + EF + FG + GH$$

Clearly,  $AB + BC + CD$  is a part of AH.

$$\Rightarrow AH > AB + BC + CD$$

Hence, length AH > sum of lengths AB + BC + CD.

**Ans: 3.** Here, Rohan's maid has two children of same age group and both of them have equal number of dresses. Rohan on his birthday plans to give both of them same number of dresses.

∴ By using Euclid's Axiom 2, if equals are added to equals, then the whole are equal. Thus, again both of them have equal number of dresses. Value depicted by Rohan are caring and other social values. According to Euclid's Axiom 3, if equals are subtracted from equals, then the remainders are equal.

**Ans: 4.** One and only one line can be drawn from A to C. According to Euclid's Postulate, "A straight line may be drawn from any point to any other point;" Another postulate: "A circle may be described with any Centre and any radius." Wildlife is a part of our environment and conservation of each of its element is important for ecological balance.

### Assertion and Reason Answers-

1. c) Assertion is correct statement but reason is wrong statement.
2. a) Assertion and reason both are correct statements and reason is correct explanation for assertion.