



- Introduction of Cartesian Plane
- Explanation of the concept of graph
- To draw the graph after determine the point in different situation
- To reading the graph and to find the result from the graph.

17.1 Introduction

We have already studied the determination of the location of certain points on the number line and how to describe its position. But in daily life we face many situations where for the determination of many such position requires more than one line. We can understand from the example given below.

In the given fig. (17.1), there is arrangement of the 30 students in a class. There is arrangement of 6 columns and 5 rows. Where is Alka sitting in the class?

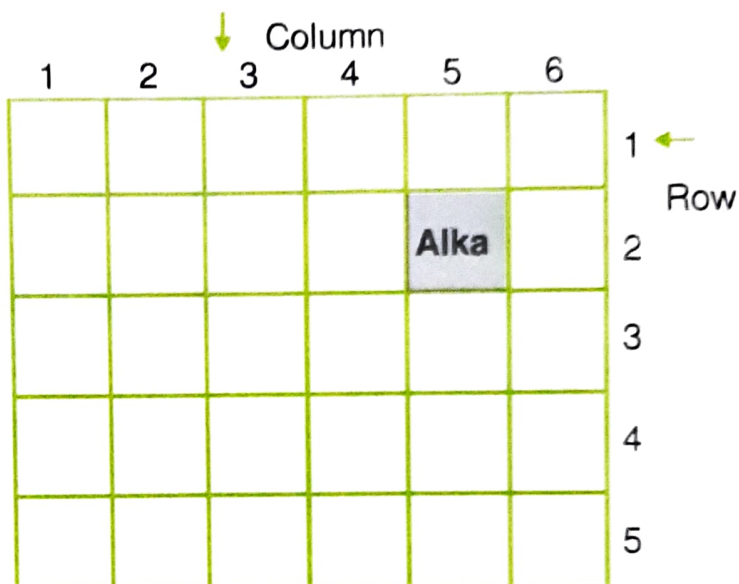


Fig. 17.1

If you say that the row in which Alka is sitting in 'row number 2' this doesn't tell her exact position, because in that row 6 students are sitting. Again you say that Alka is sitting in column 5, then from this also it will not be clear the correct position. Because in this column the number of sitting student is 5. For the correct determination of Alka's position it will say that she is sitting in row 2 column 5.

Similarly the position of any word written on the blackboard is decided by the data of the relative distances along of its length and breadth. From these examples we observe that to determine the exact position of any point located in the plane, we require two independent data. In this unit we will learn determination of the position of a point on graph paper and the data required to describe the position of the point.

17.2 Cartesian Plane and Direction Frame

Do the following, think and conclude

As shown in figure draw two number line $x'x$ and $y'y$ in your note book (exercise book).

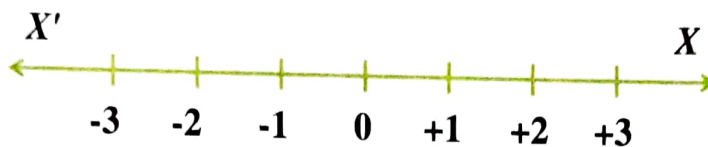


Fig. 17.2

Arrange these two lines on the plane such that these are perpendicular to each other at zero (0) as shown in the figure 17.4.

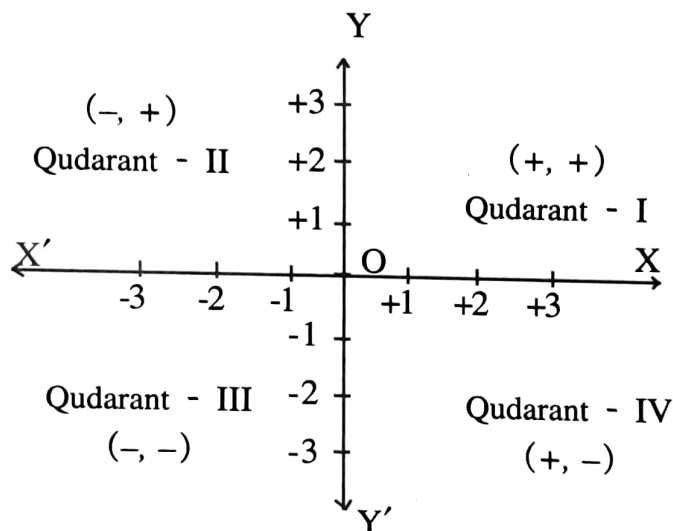


Fig. 17.4



Fig. 17.3

Pay Attention

These two perpendicular lines can be in any direction in this unit, we will consider horizontal and vertical lines for determining the position of a point on the plane.

Like this the plane is divided in four parts. Each part is called a quadrant. In the anti-clockwise direction from OX . These are known as first quadrant (XOY) second quadrant (YOX'), third quadrant ($X'OY'$) and Fourth quadrant ($Y'OX$) respectively. This plane is called the Cartesian Plane.

French mathematician Rene Descartes devised the Cartesian Plane. It is named after him.

In his honor the system of determining the location of a point on a plane has been named as the Cartesian system and the plane whose points are determined by the X axis and Y axis is called as Cartesian Plane.

The horizontal and vertical lines are known as axes, where the horizontal axis is known as XOX' or XX' or X-axis and vertical axis is known as YOY' or YY' or Y-axis.

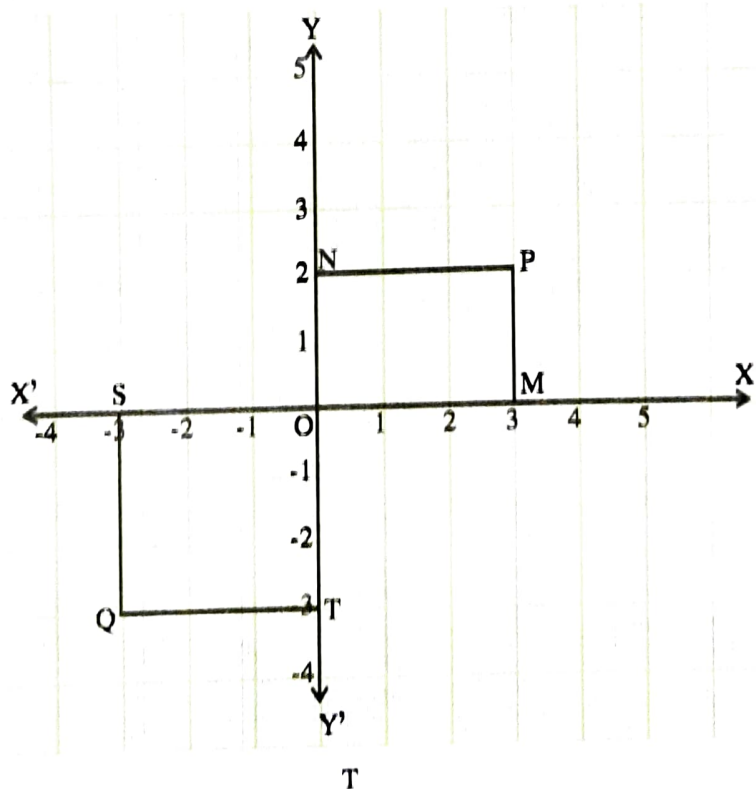
These axes are cut perpendicularly to each other at a point called the origin. Here O is the origin. On the X axis, the left side from the origin is taken as negative and right side from the origin is taken as positive.

Similarly on the Y-axis vertically upward from the origin is taken as positive and vertically downward is taken as negative.

The X axis, Y-axis and the origin point (0) are combinely called as the direction frame.

17.3 Abscissa and Ordinate

Do the following, think and write.



Draw the axis XOX' and YOY' on the graph as shown in figure. Locate the two point P and Q on the graph sheet. With the help of set square, draw perpendicular line PM on the X-axis and PN on the Y-axis from point P. Similarly draw perpendicular line QS on the X-axis and QT on the Y-axis from point Q. Measure and write the length of these lines. PM, PN, QS and QT.

We find that the distance of point P from the X-axis is $PN=OM=3$ unit and the distance of point P from X-axis in $PM=ON=2$ unit. Similarly the distance of point Q from the Y-axis is $QT=OS=3$ units and the distance of Point Q from X-axis is $QS=OT=3$ units.

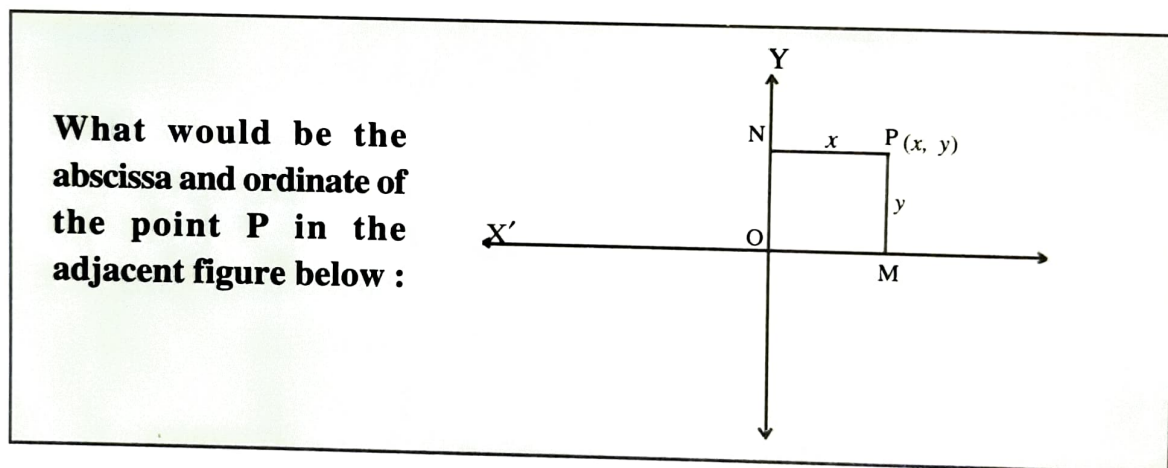
Perpendicular distance from the Y-axis of any point is called abscissa of the point. It is positive on positive direction of X-axis and negative on negative direction of X-axis.

Hence, abscissa of point P is +3 and abscissa of point Q is -3.

Similarly perpendicular distance from X-axis of any point is called ordinate. It is positive in positive direction of Y-axis and negative in negative direction of Y-axis.

Hence the ordinate of point P is +2 and ordinate of point Q is -3.

Try it



x is known as X-coordinate or abscissa of P and y is known as ordinate or Y-coordinate of P. (x, y) is called coordinate of point P.

Conclusion:

- In Cartesian Plane horizontal line XX' is called X-axis.
- In Cartesian Plane vertical line YY' is called Y-axis.
- The coordinate of any point located in Cartesian Plane is written as (x, y)
- In the coordinates (x, y) , x is abscissa and y is ordinate.

17.3.1 Method for writing the coordinate :

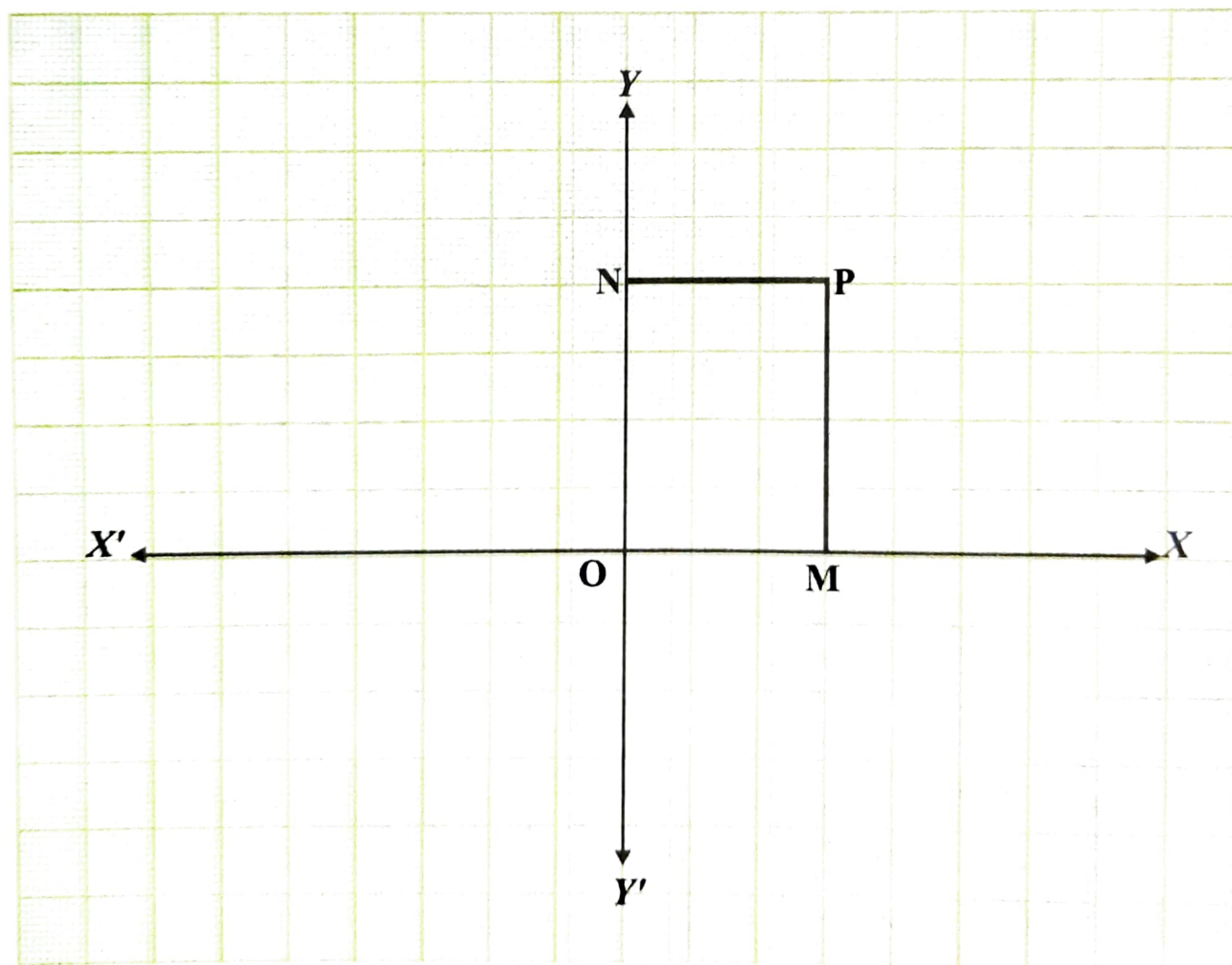
Coordinates are always written in small brackets (). First abscissa, then comma (,) and in last ordinate. Hence, coordinate of point P are (x, y).

Pay Attention

Abscissa and ordinate of origin are both 0 and its coordinates are written as (0, 0) coordinate (x, y) is not same as coordinate (y, x), these represent two different points on the Cartesian Plane.

17.4 To Draw the Graph after determination of points at different locations.

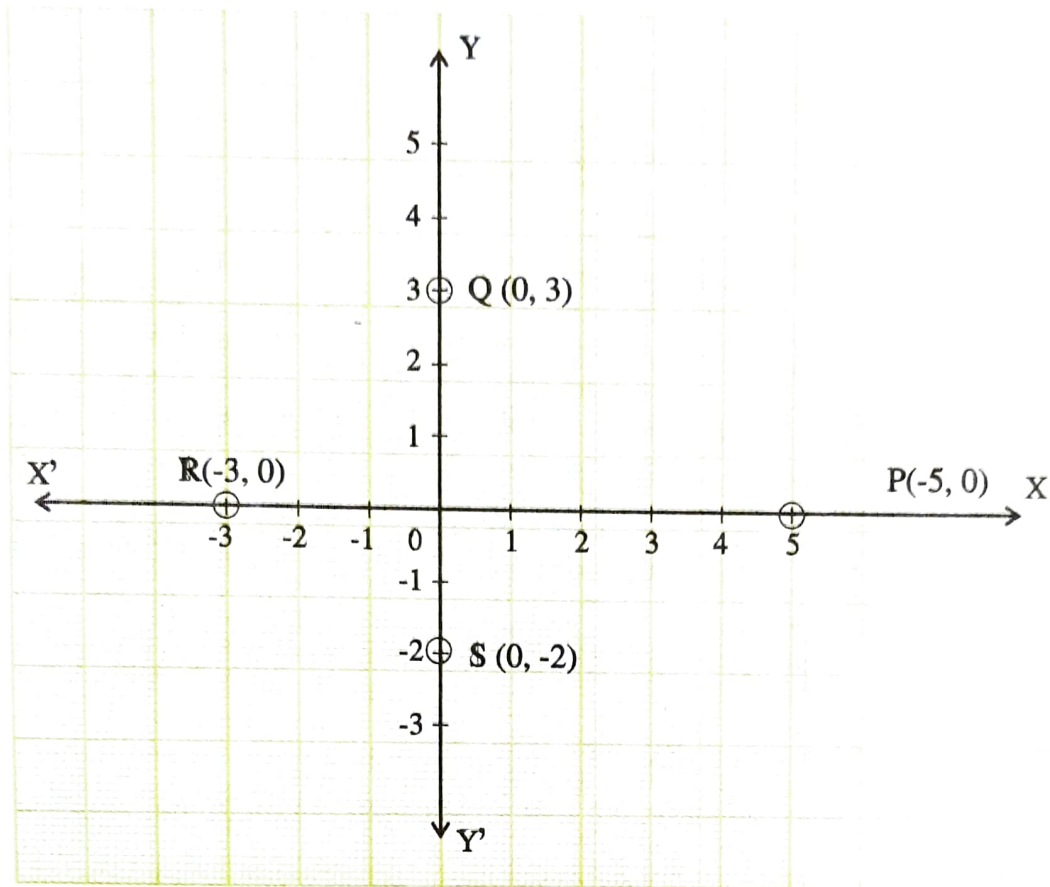
Under any quadrant the direction frame of the Cartesian Plane to determine the location of point P in the quadrant XOY a perpendicular PM is drawn from the point P on X-axis. On the X-axis, distance of OM is x and its perpendicular direction is ON = y location of Point P in a plane is decide on the measurement of Y-axis. Hence point P is represented as (x, y).



Representation of Points

We can decide the location of the point based on its coordinates (abscissa, ordinate) on the graph sheet, this is called the representation of the point.

Observe, think and conclude

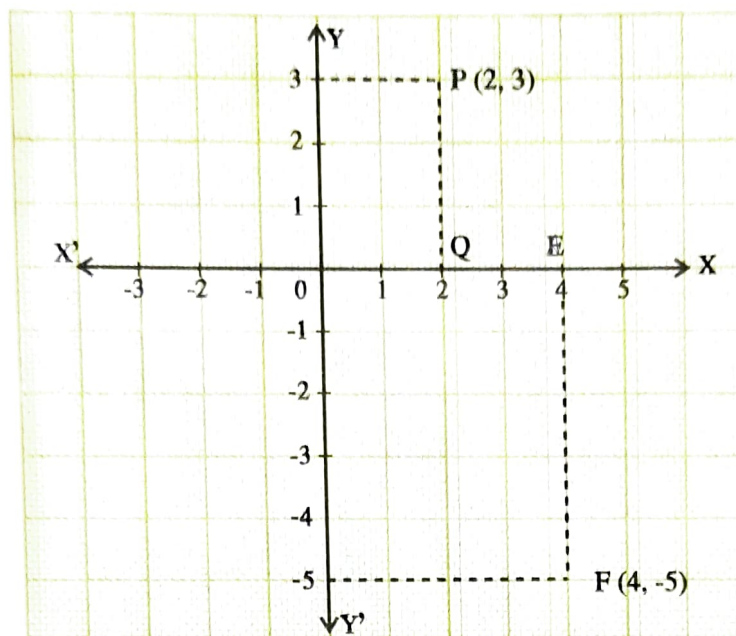


- (i) Here P is located at X-axis at +5 and hence the ordinate of point P is O (Zero). observe that, ordinate of every point on X-axis is O Hence point P is represented as (5, 0).
- (ii) In above figure point Q is located on Y-axis at +3, hence the abscissa of point Q is 0. observe that abscissa of every point of Y-axis is 0. hence point Q is represented as (0, 3).
- (iii) Again in the above figure point R is located at the negative side of the X-axis at -3. Hence R is represented as (-3, 0).
- (iv) In the same figure point S is located at the negative side of the Y-axis at -2. Hence S is represented as (0, -2).

Representation of point (2, 3)

In the given point (2, 3), both the abscissa and ordinate are positive therefore these are located in the first quadrant in the graph.

To determine its position, point Q is marked at +2 on the X-axis. Then from Q upward direction from the X-axis, parallel to Y-axis at distance of 3 unit P is obtained. Hence point P(2, 3) is represented on graph.



Representation of Point (4, -5)

In the point (4, -5) the abscissa is positive and ordinate is negative therefore it is located in the fourth quadrant. In the given graph the point located at +4. On OX at E, Draw a perpendicular on OX from point E and parallel to OY at 5 unit distance, find a point F. point (4, -5) is represented by F.

We observe that

- (i) In first quadrant coordinate of a point is (+, +) form because first quadrant is bounded by positive X-axis and positive Y-axis therefore both the abscissa and ordinate are positive.
- (ii) If the point is located in second quadrant, the coordinate of point is (-, +). Second quadrant is bounded by negative X-axis and positive Y-axis. The abscissa is negative ordinate is positive of second quadrant.
- (iii) If point is situated in third quadrants the sign of coordinate can be in the form of (-, -). The quadrant is bounded by negative X axis and negative Y-axis. Abscissa and ordinate of point both are negative.
- (iv) If point is situated in fourth quadrant the coordinate of point can be (+, -). In fourth quadrant the abscissa of point is positive and ordinate is negative.

Quadrant	Sign of Abscissa	Sign of ordinate
First	+	+
Second	-	+
Third	-	-
Fourth	+	-

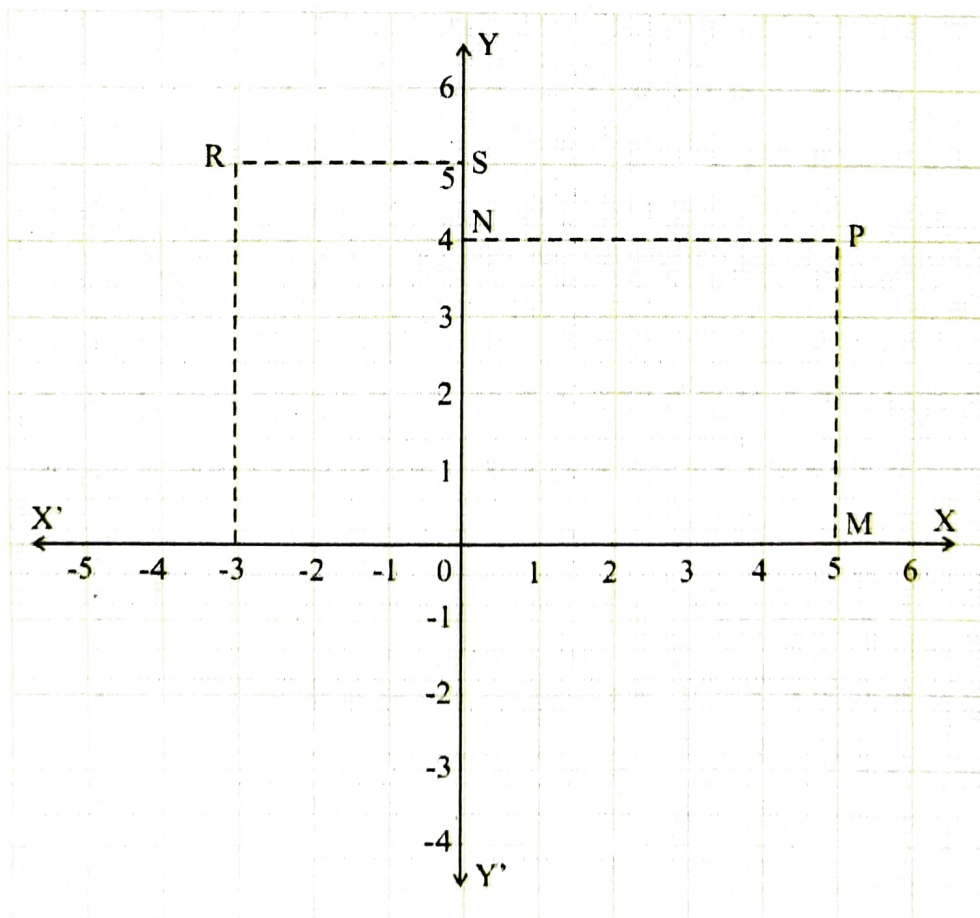
Try it

In which quadrant the position of point $(-2, -4)$ will be ?

17.5 To Read the coordinates of the points given on graph paper

Observe, Argue and conclude

Observe the following graph a perpendicular PM is drawn on X-axis from point P. Similarly perpendicular PN is drawn on Y axis.



Perpendicular distance of point P from Y-axis $PN = OM = 5$ unit

That is in positive direction of X axis.

Therefore abscissa is $= 5$

Perpendicular distance of point P from X-axis positive towards Y-axis $PM = ON = 4$ unit.

Therefore, ordinate $= 4$

Hence the coordinates of point P are $(5, 4)$.

- (i) Observe point R in above fig. Perpendicular distance of point R from Y-axis is in negative direction of X-axis. What is its abscissa ?
- (ii) Perpendicular distance of point R from X-axis is in positive direction of Y-axis what is its ordinate ?

In above (adjacent) graph abscissa and ordinate of point R are respectively -3 and 5 . Hence the coordinate of point R is $(-3, 5)$

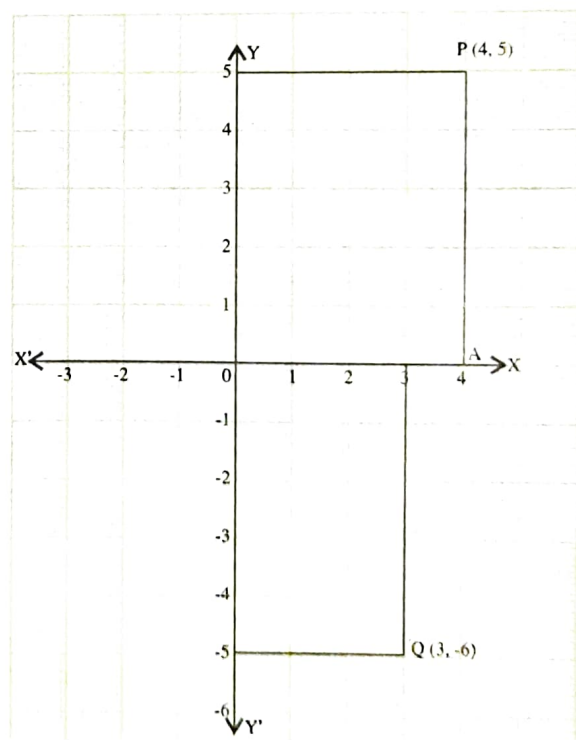
Representation of given Points in Graph

Example 1. Denote the point $(4, 5)$ and $(3, -6)$ on graph paper

Solution : By observation of point $(4, 5)$ we get that abscissa is $+4$ and ordinate is $+5$.

Therefore, distance of this point P on positive X-axis from Y-axis is 4 unit distance on positive Y-axis from X-axis is 5 unit.

Locate the corresponding point A from origin point on positive direction of X-axis at 4 unit distance. Now starting from point A move parallel to positive direction of Y-axis and locate the corresponding point P at distance 5 unit. Hence this point is situated in first quadrant.



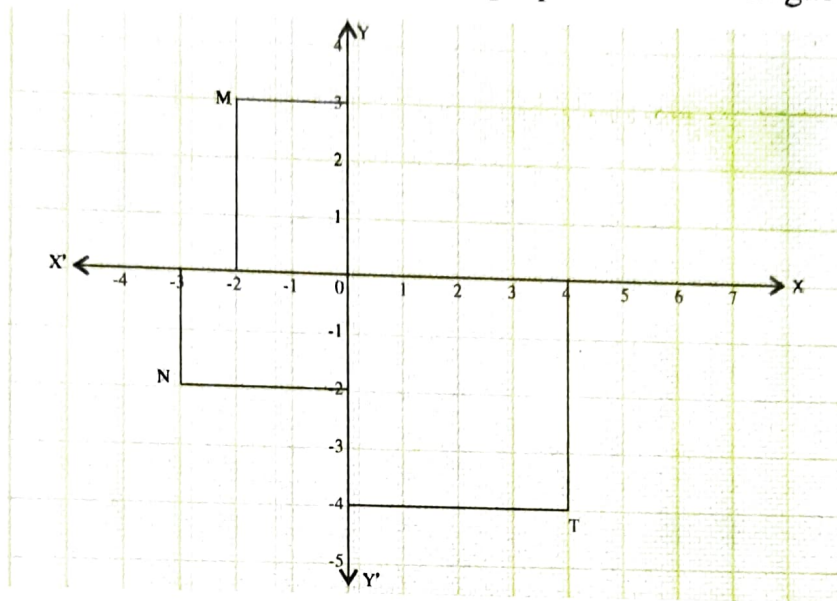
Try it:

Similarly denote the point $(3, -6)$ on a graph paper and state in which quadrant, it lies?

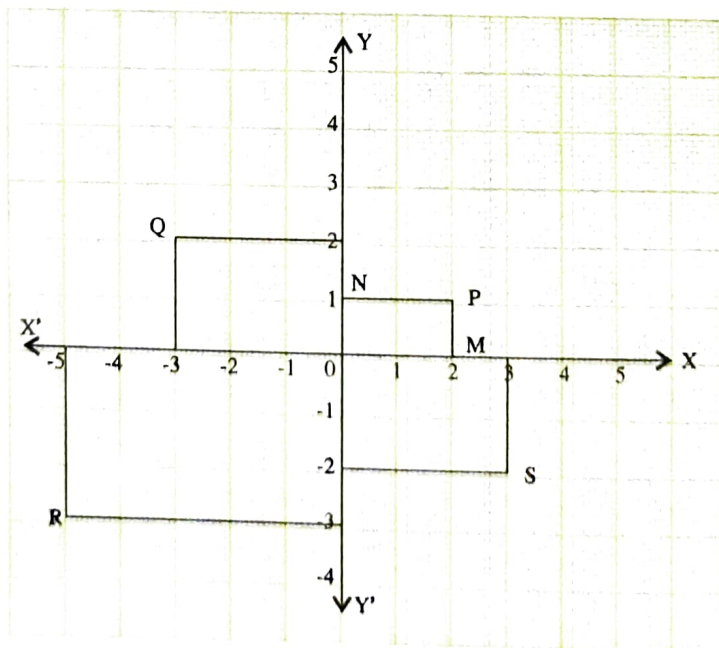
Exercise 17(a)

1. Fill in the blanks from the figure given below :

- (i) Point M, is located direction of X-axis.
- (ii) From point M, on y-axis, distance of perpendicular to origin point is unit.
- (iii) Point N is locate in direction of Y-axis, From point N, on y-axis, distance of perpendicular to origin point is unit.
- (iv) Point T is locate in quadrant.
- (v) From point T, on the X-axis distance of perpendicular to origin point is unit.



2. In the following figure observe the denoted points and fill in the blanks,



Figure

- (i) Abscissa of point P is and ordinate is therefore the coordinates of P are (.....,).
- (ii) Abscissa of point Q is and ordinate is therefore the coordinate of Q are (.....).
- (iii) For the point R, X coordinate is and Y coordinate is , therefore coordinate of R are (.....,).
- (iv) For the point S, X coordinate is and Y coordinate is , therefore coordinates of S are (.....,)

3. In which quadrant the following point are situated :

- (i) $(-3, -7)$ (ii) $(-5, 1)$ (iii) $(2, -10)$
 (iv) $(5, 9)$ (v) $(-6, 5)$ (vi) $(-7, -5)$

4. Represent following points on graph paper :

- (i) $(7, 5)$ (ii) $(7, 0)$ (iii) $(-3, -6)$ (iv) $(0, -4)$
 (v) $(-6, -7)$ (vi) $(10, -5)$ (vii) $(0, 0)$

17.6 Representation of some real relations by graph.

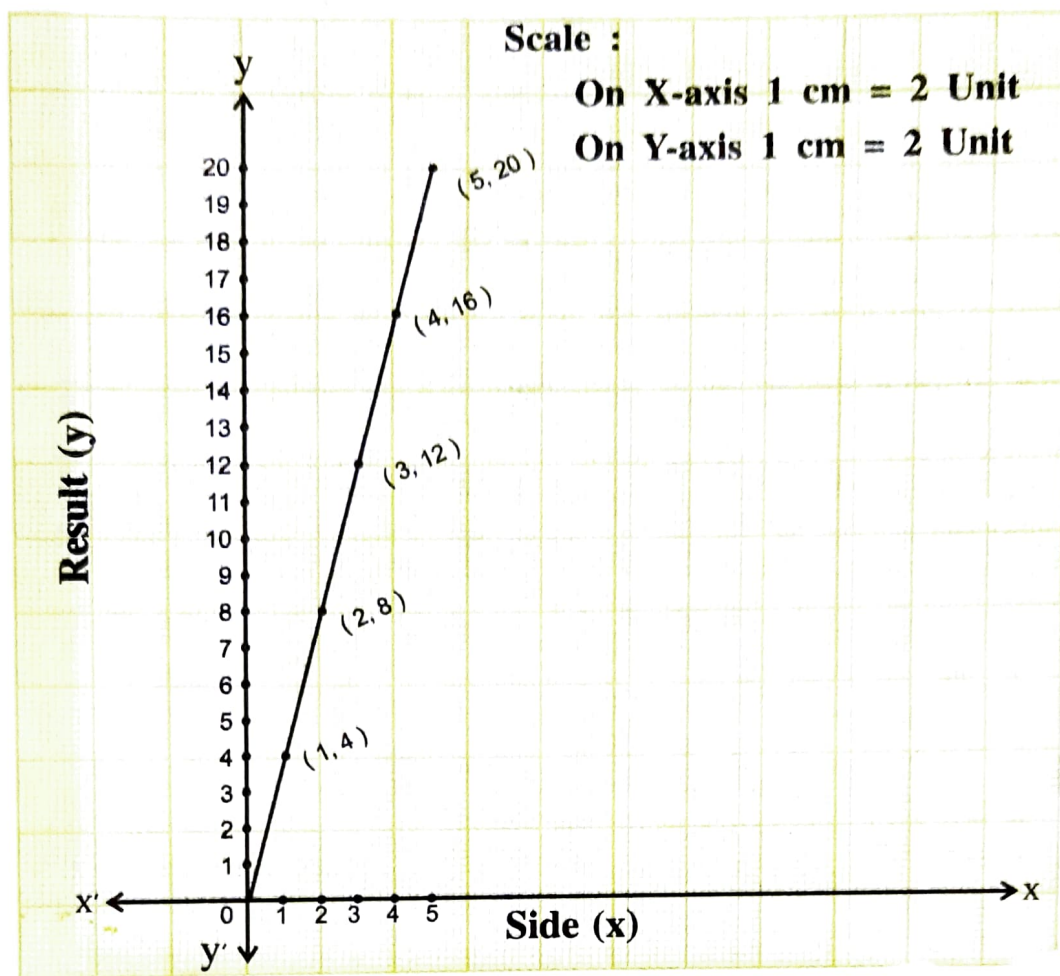
Example 2. Represent the relation between side and corresponding perimeter of squares by the graph.

Solution Let x is side of square and y is its perimeter, then $Y = X + X + X + X = 4X$

For different value of x , corresponding value of y is shown in table :

Side of square (x unit)	0	1	2	3	4	5
Perimeter ($4x$ unit)	0	4	8	12	16	20

Represent the different values of x as abscissa and their corresponding perimeter as ordinate in the given table. The line obtained by joining of these all points in graph shows the relation between its side and perimeter.



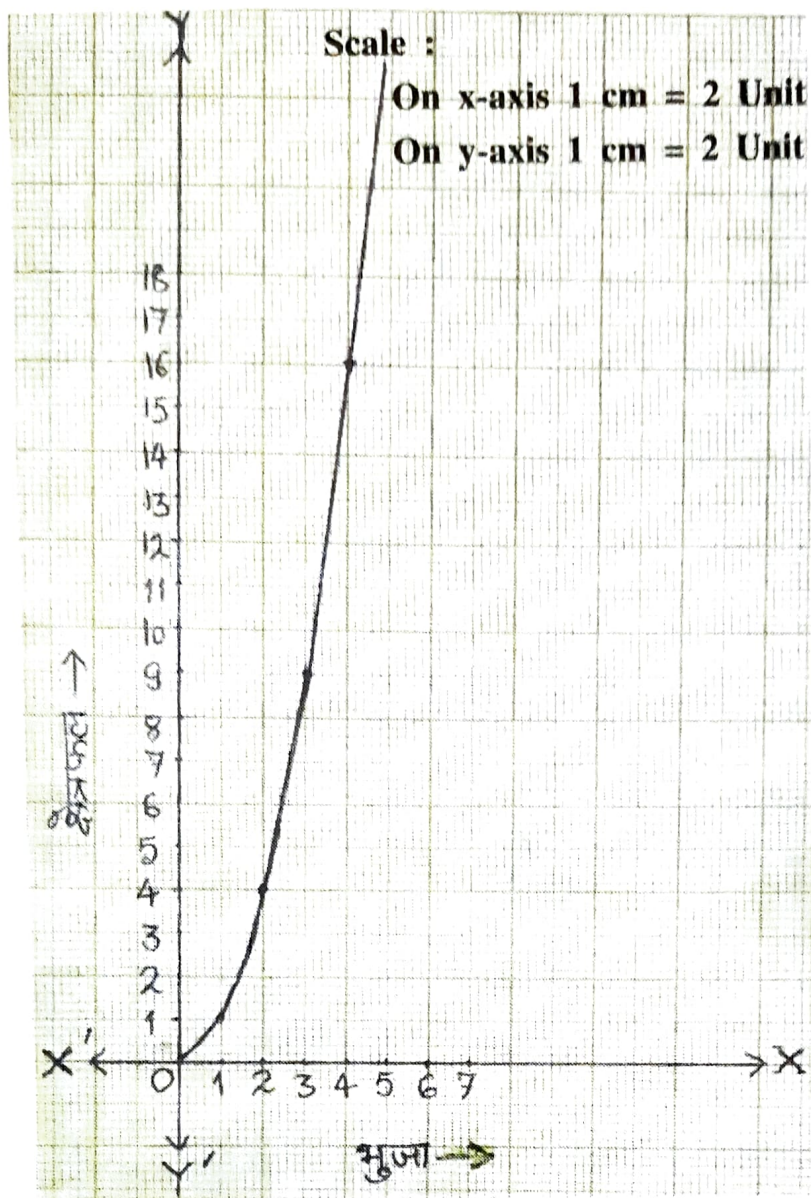
Example 3. Represent the relation of side of squares and their corresponding areas by the graph.

Solution Let X be a side of a square and Y is the area of that square. The relation between X and Y is represented by $Y = X^2$. Hence take some different values of X their corresponding values for the Y is shown in the table given below.

Side of square (x unit)	0	1	2	3	4	5	6	7
Area (y square unit)	0	1	4	9	16	25	36	49

Let in the table given values of X as abscissa and their corresponding area Y as ordinate, points (0,0), (1,1), (2,4), (3,9), (4,16) (5,25) (6,36) (7,49).....are represented in graph paper given below. The curve tracked from these points is representation of the relation of side and area of square.

Area



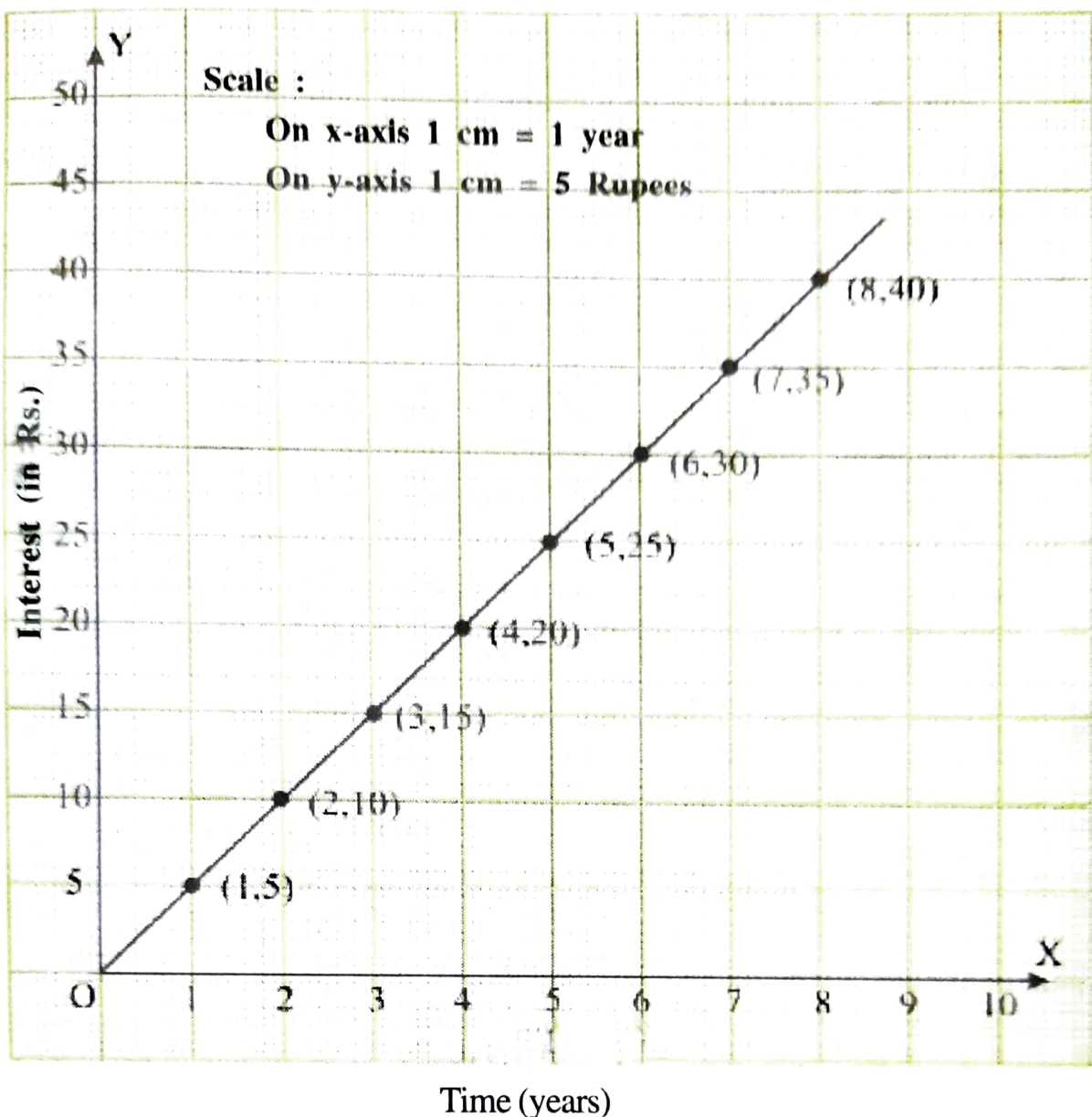
Example 4. Represent by graph, relation between time and simple interest on given principal and rate of interest.

Solution : Given the principal ₹100, let the simple interest be with rate of 5 percent per year. Then relation represents/describes as $I = 5t$. Find various values for time t and the corresponding value of $I = 5t$, written as following table

t(years)	1	2	3	4	5	6	7	8
$I = 5t$ (rupees)	5	10	15	20	25	30	35	40

Points (1,5) (2,10) (3,15) (4,20) (5,25) (6,30) (7,35) (8,40)

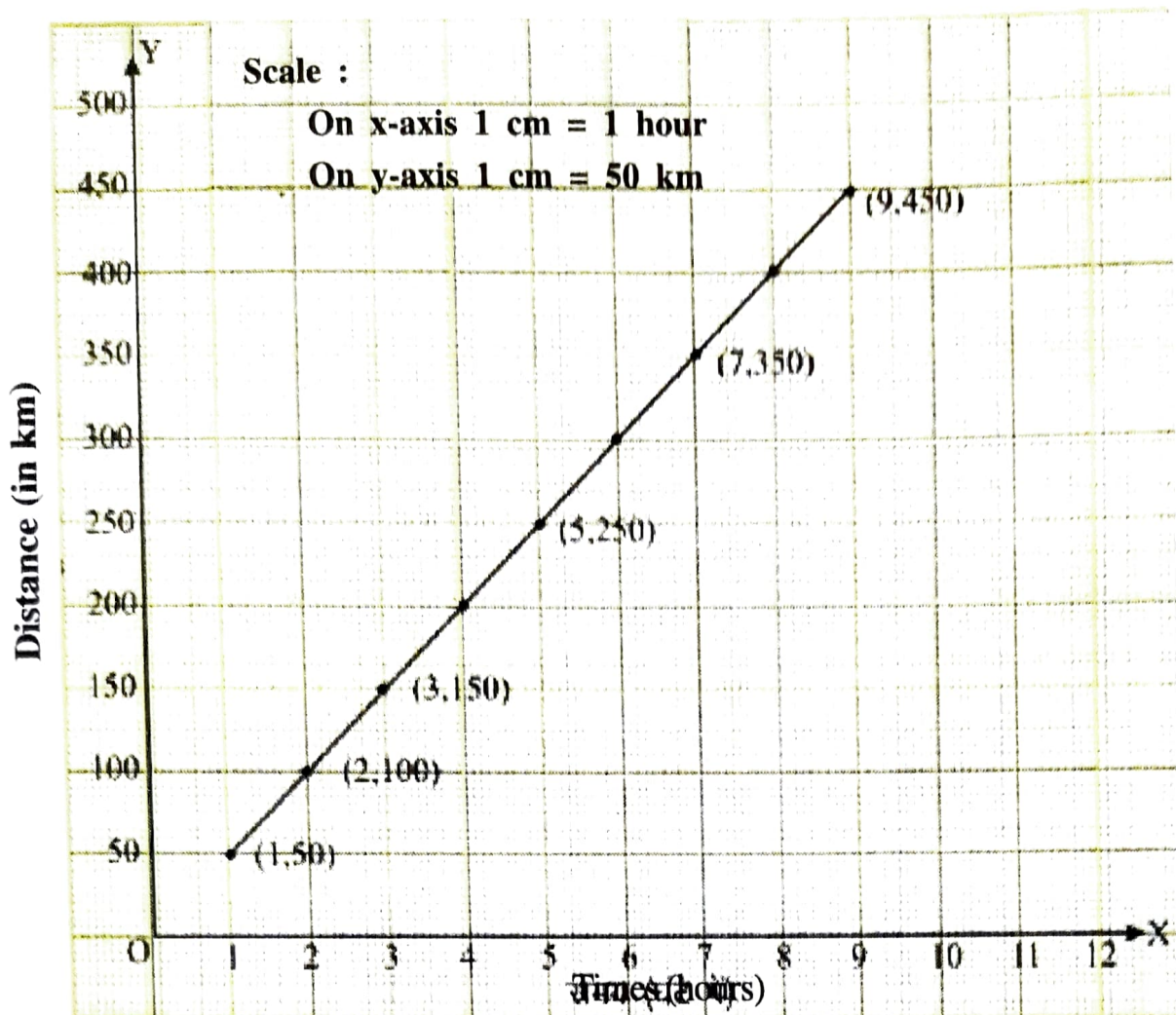
Plot on a graph paper. Relation between years and interest is represented as line given below.



Example 5. A moving car is travelling 50 km per hour. The relation between time and travelled distance by the car is find out from $S = 50t$. Where time t is in hour and distance S is in k.m. Plot this relation in graph paper. Travelled distance for the various values of t is represented by table given below.

t (time in hour)	1	2	3	4	5	6	7	8	9	10
$S = 50 t$ (km)	50	100	150	200	250	300	350	400	450	500

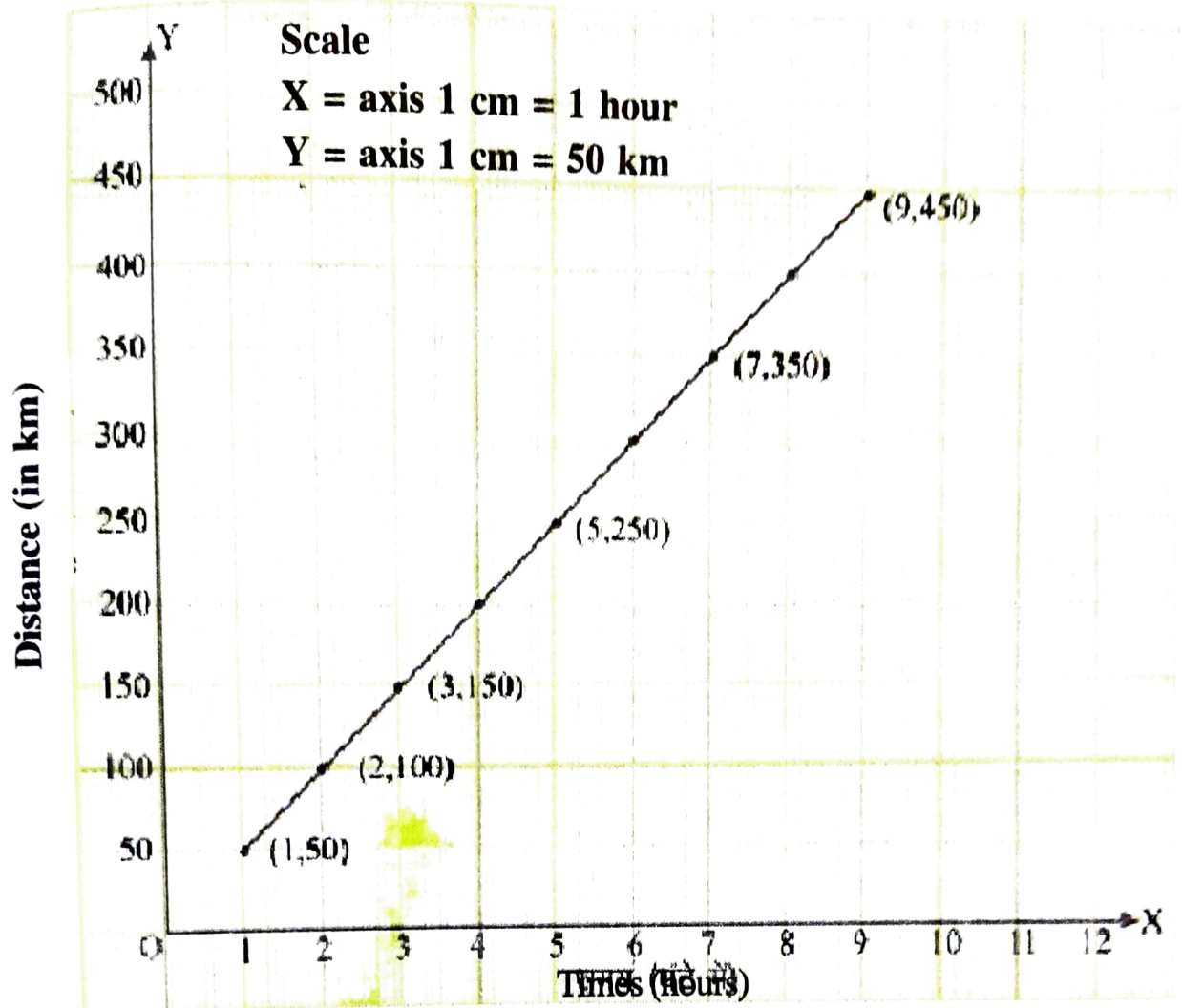
Solution : Points (1,50), (2,100), (3,150), (4,200), (5,250) are plotted on a graph paper, obtain the relation between time and distance that is represented by a line given below.



Exercise 17(b)

- Side of any equilateral triangle is x cm. Plot a graph of relation between its side and perimeter.
- Length is twice of breadth of a rectangle. Plot a graph of relation of its area and breadth. (hint-Area of rectangle $A : 2x \times x = 2x^2$)
- Plot a graph with simple interest of rupees 200 at rate of 3 percent yearly and time is in year.
- A bus has travelled 40 km in 1 hour. Plot the graph relations of distance travelled by bus and time.
- Observe distance travelled in constant time interval by a cyclist from the time-distance graph given below and answer the following questions.
 - Describe the distance from initial point at time 2 o'clock, 3 o'clock, 4 o'clock and 5 o'clock.
 - Observe the above graph and find out the time interval of rest by cyclist during the travel.

Note : Student draw the graph for question 1 to 4



We have learnt

- Cartesian plane is exposed by French mathematician Rene Decartes.
- For the determination of a point in any plane, draw two lines one is horizontal and second is vertical on the plane. This plane is called Cartesian plane.
- On the Cartesian plane horizontal line XX' is called X-axis.
- On the Cartesian plane vertical line YY' is called Y-axis.
- Coordinate of any point in the Cartesian plane written in the form of (x,y)
- In Co-ordinate (x,y) x is abscissa and y is ordinate.
- Coordinate of origin point is $(0,0)$.
- Some actual (original) relations can be represented by the graph.
- Relation between two data can be prescribed by study of the graph.

Rene Descartes (1596-1650) while studying geometry conceived the idea of incorporating algebra that resulted in the concept of Coordinate Geometry. But it took him 18 years to give it structured form. The main objective of this topic is to find the location of any point on a plane Descartes developed this technique in which the distance of that point would be measured from the two mutually perpendicular lines. This technique is now known as Cartesian System in his honor.

In his book "La Geometrie" Descartes included co-ordinate geometry as appendix topic. Descartes paved the way for the modern geometry by interlinking Arithmetic, Algebra, and Geometry. In this way, we can call him the first mathematician of modern mathematics.

ANSWERS

Exercise 17(a)

- 1 (i) Negative (ii) 3 (iii) Negative, 2 (iv) Fourth (v) 4. 2 (i) 2, 1 coordinates (2, 1)
(ii) (-3, 2) coordinates (-3, 2), (iii) -5, -3 coordinates (-5, -3) (iv) 3, -2 coordinates (3, -2)
3 (i) Third (ii) Second (iii) Fourth (iv) First (v) Second (vi) Third

Exercise 17(b)

- 5 (a) 2 km, 2 km, 3 km, 4 km (b) 1 hour (between 2 to 3 O'clock).