NCERT Solutions for 11th Class Maths: Chapter 12-Introduction to three Dimensional Geometry

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Class 11: Maths Chapter 12 solutions. Complete Class 11 Maths Chapter 12 Notes.

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NCERT 11th Maths Chapter 12, class 11 Maths Chapter 12 solutions

Exercise 12.1

Question 1:

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A point is on the x-axis. What are its y-coordinates and z-coordinates?

Ans:

If a point is on the x-axis, then its y-coordinates and z-coordinates are zero.

Question 2:

A point is in the XZ-plane. What can you say about its y-coordinate?

Ans:

If a point is in the XZ plane, then its y-coordinate is zero.

Question 3:

Name the octants in which the following points lie:

(1, 2, 3), (4, −2, 3), (4, −2, −5), (4, 2, −5), (−4, 2, −5), (−4, 2, 5),

(−3, −1, 6), (2, −4, −7)

Ans:

The x-coordinate, y-coordinate, and z-coordinate of point (1, 2, 3) are all positive. Therefore, this point lies in octant **I**.

The x-coordinate, y-coordinate, and z-coordinate of point (4, −2, 3) are positive, negative, and positive respectively. Therefore, this point lies in octant **IV**.

The x-coordinate, y-coordinate, and z-coordinate of point (4, −2, −5) are positive, negative, and negative respectively. Therefore, this point lies in octant **VIII**.

The x-coordinate, y-coordinate, and z-coordinate of point (4, 2, −5) are positive, positive, and negative respectively. Therefore, this point lies in octant **V**.

The x-coordinate, y-coordinate, and z-coordinate of point (−4, 2, −5) are negative, positive, and negative respectively. Therefore, this point lies in octant **VI**.

The x-coordinate, y-coordinate, and z-coordinate of point (−4, 2, 5) are negative, positive, and positive respectively. Therefore, this point lies in octant **II**.

The x-coordinate, y-coordinate, and z-coordinate of point (−3, −1, 6) are negative, negative, and positive respectively. Therefore, this point lies in octant **III**.

The x-coordinate, y-coordinate, and z-coordinate of point (2, −4, −7) are positive, negative, and negative respectively. Therefore, this point lies in octant **VIII**.

Question 4:

Fill in the blanks:

Ans:

(i) The x-axis and y-axis taken together determine a plane known as $\underline{\text{XY}-\text{plane}}$.

(ii) The coordinates of points in the XY-plane are of the form $\underline{(x, y, 0)}$.

(iii) Coordinate planes divide the space into $\underline{\text{eight}}$ octants.

Exercise 12.2

NCERT 11th Maths Chapter 12

Question 1:

Find the distance between the following pairs of points:

(i) (2, 3, 5) and (4, 3, 1) (ii) (−3, 7, 2) and (2, 4, −1)

(iii) (−1, 3, −4) and (1, −3, 4) (iv) (2, −1, 3) and (−2, 1, 3)

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Ans:

The distance between points P(x_1, y_1, z_1) and P(x_2, y_2, z_2) is given by

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

(i) Distance between points (2, 3, 5) and (4, 3, 1)

$$= \sqrt{(4-2)^2 + (3-3)^2 + (1-5)^2}$$

$$= \sqrt{(2)^2 + (0)^2 + (-4)^2}$$

$$= \sqrt{4+16}$$

$$= \sqrt{20}$$

$$= 2\sqrt{5}$$

(ii) Distance between points (−3, 7, 2) and (2, 4, −1)

$$= \sqrt{(2+3)^2 + (4-7)^2 + (-1-2)^2}$$

$$= \sqrt{(5)^2 + (-3)^2 + (-3)^2}$$

$$= \sqrt{25+9+9}$$

$$= \sqrt{43}$$

(iii) Distance between points (−1, 3, −4) and (1, −3, 4)

$$= \sqrt{(1+1)^2 + (-3-3)^2 + (4+4)^2}$$

$$= \sqrt{(2)^2 + (-6)^3 + (8)^2}$$

$$= \sqrt{4+36+64} = \sqrt{104} = 2\sqrt{26}$$

(iv) Distance between points (2, −1, 3) and (−2, 1, 3)

$$= \sqrt{(-2-2)^2 + (1+1)^2 + (3-3)^2}$$

$$= \sqrt{(-4)^2 + (2)^2 + (0)^2}$$

$$= \sqrt{16+4}$$

$$= \sqrt{20}$$

$$= 2\sqrt{5}$$

Question 2:

Show that the points (−2, 3, 5), (1, 2, 3) and (7, 0, −1) are collinear.

Ans:

Let points (−2, 3, 5), (1, 2, 3), and (7, 0, −1) be denoted by P, Q, and R respectively.

Points P, Q, and R are collinear if they lie on a line.

$$PQ = \sqrt{(1+2)^2 + (2-3)^2 + (3-5)^2}$$
$$= \sqrt{(3)^2 + (-1)^2 + (-2)^2}$$
$$= \sqrt{9+1+4}$$
$$= \sqrt{14}$$

$$QR = \sqrt{(7-1)^2 + (0-2)^2 + (-1-3)^2}$$
$$= \sqrt{(6)^2 + (-2)^2 + (-4)^2}$$
$$= \sqrt{36+4+16}$$
$$= \sqrt{56}$$
$$= 2\sqrt{14}$$

$$PR = \sqrt{(7+2)^2 + (0-3)^2 + (-1-5)^2}$$
$$= \sqrt{(9)^2 + (-3)^2 + (-6)^2}$$
$$= \sqrt{81+9+36}$$
$$= \sqrt{126}$$
$$= 3\sqrt{14}$$

Here, PQ + QR $= \sqrt{14} + 2\sqrt{14} = 3\sqrt{14}$ = PR

Hence, points P(−2, 3, 5), Q(1, 2, 3), and R(7, 0, −1) are collinear.

Question 3:

Verify the following:

(i) (0, 7, −10), (1, 6, −6) and (4, 9, −6) are the vertices of an isosceles triangle.

(ii) (0, 7, 10), (−1, 6, 6) and (−4, 9, 6) are the vertices of a right angled triangle.

(iii) (−1, 2, 1), (1, −2, 5), (4, −7, 8) and (2, −3, 4) are the vertices of a parallelogram.

Ans:

(i) Let points (0, 7, −10), (1, 6, −6), and (4, 9, −6) be denoted by A, B, and C respectively.

$$AB = \sqrt{(1-0)^2 + (6-7)^2 + (-6+10)^2}$$
$$= \sqrt{(1)^2 + (-1)^2 + (4)^2}$$
$$= \sqrt{1+1+16}$$
$$= \sqrt{18}$$
$$= 3\sqrt{2}$$

$$BC = \sqrt{(4-1)^2 + (9-6)^2 + (-6+6)^2}$$
$$= \sqrt{(3)^2 + (3)^2}$$
$$= \sqrt{9+9} = \sqrt{18} = 3\sqrt{2}$$

$$CA = \sqrt{(0-4)^2 + (7-9)^2 + (-10+6)^2}$$
$$= \sqrt{(-4)^2 + (-2)^2 + (-4)^2}$$
$$= \sqrt{16+4+16} = \sqrt{36} = 6$$

Here, AB = BC ≠ CA

Thus, the given points are the vertices of an isosceles triangle.

(i) Let (0, 7, 10), (−1, 6, 6), and (−4, 9, 6) be denoted by A, B, and C respectively.

$$AB = \sqrt{(-1-0)^2 + (6-7)^2 + (6-10)^2}$$
$$= \sqrt{(-1)^2 + (-1)^2 + (-4)^2}$$
$$= \sqrt{1+1+16} = \sqrt{18}$$
$$= 3\sqrt{2}$$

$$BC = \sqrt{(-4+1)^2 + (9-6)^2 + (6-6)^2}$$
$$= \sqrt{(-3)^2 + (3)^2 + (0)^2}$$
$$= \sqrt{9+9} = \sqrt{18}$$
$$= 3\sqrt{2}$$

$$CA = \sqrt{(0+4)^2 + (7-9)^2 + (10-6)^2}$$
$$= \sqrt{(4)^2 + (-2)^2 + (4)^2}$$
$$= \sqrt{16+4+16}$$
$$= \sqrt{36}$$
$$= 6$$

$$\text{Now, } AB^2 + BC^2 = \left(3\sqrt{2}\right)^2 + \left(3\sqrt{2}\right)^2 = 18+18 = 36 = AC^2$$

Therefore, by Pythagoras theorem, ABC is a right triangle.

Hence, the given points are the vertices of a right-angled triangle.

(ii) Let (−1, 2, 1), (1, −2, 5), (4, −7, 8), and (2, −3, 4) be denoted by A, B, C, and D respectively.

$$AB = \sqrt{(1+1)^2 + (-2-2)^2 + (5-1)^2}$$
$$= \sqrt{4+16+16}$$
$$= \sqrt{36}$$
$$= 6$$

$$BC = \sqrt{(4-1)^2 + (-7+2)^2 + (8-5)^2}$$
$$= \sqrt{9+25+9} = \sqrt{43}$$

$$CD = \sqrt{(2-4)^2 + (-3+7)^2 + (4-8)^2}$$
$$= \sqrt{4+16+16}$$
$$= \sqrt{36}$$
$$= 6$$

$$DA = \sqrt{(-1-2)^2 + (2+3)^2 + (1-4)^2}$$
$$= \sqrt{9+25+9} = \sqrt{43}$$

Here, AB = CD = 6, BC = AD = $\sqrt{43}$

Hence, the opposite sides of quadrilateral ABCD, whose vertices are taken in order, are equal.

Therefore, ABCD is a parallelogram.

Hence, the given points are the vertices of a parallelogram.

Question 4:

Find the equation of the set of points which are equidistant from the points (1, 2, 3) and (3, 2, −1).

Ans:

Let P (x, y, z) be the point that is equidistant from points A(1, 2, 3) and B(3, 2, −1).

Accordingly, PA = PB

$$\Rightarrow PA^2 = PB^2$$

$$\Rightarrow (x-1)^2 + (y-2)^2 + (z-3)^2 = (x-3)^2 + (y-2)^2 + (z+1)^2$$

$x^2 - 2x + 1 + y^2 - 4y + 4 + z^2 - 6z + 9 = x^2 - 6x + 9 + y^2 - 4y + 4 + z^2 + 2z + 1$

$-2x - 4y - 6z + 14 = -6x - 4y + 2z + 14$

$-2x - 6z + 6x - 2z = 0$

$4x - 8z = 0$

$x - 2z = 0$

Thus, the required equation is $x - 2z = 0$.

Question 5:

Find the equation of the set of points P, the sum of whose distances from A (4, 0, 0) and B (−4, 0, 0) is equal to 10.

Ans:

Let the coordinates of P be (x, y, z).

The coordinates of points A and B are (4, 0, 0) and (−4, 0, 0) respectively.

It is given that PA + PB = 10.

$$\Rightarrow \sqrt{(x-4)^2+y^2+z^2}+\sqrt{(x+4)^2+y^2+z^2}=10$$

$$\Rightarrow \sqrt{(x-4)^2+y^2+z^2}=10-\sqrt{(x+4)^2+y^2+z^2}$$

On squaring both sides, we obtain

$$\Rightarrow (x-4)^2+y^2+z^2=100-20\sqrt{(x+4)^2+y^2+z^2}+(x+4)^2+y^2+z^2$$

$$\Rightarrow x^2-8x+16+y^2+z^2=100-20\sqrt{x^2+8x+16+y^2+z^2}+x^2+8x+16+y^2+z^2$$

$$\Rightarrow 20\sqrt{x^2+8x+16+y^2+z^2}=100+16x$$

$$\Rightarrow 5\sqrt{x^2+8x+16+y^2+z^2}=(25+4x)$$

On squaring both sides again, we obtain

$25\,(x^2 + 8x + 16 + y^2 + z^2) = 625 + 16x^2 + 200x$

$25x^2 + 200x + 400 + 25y^2 + 25z^2 = 625 + 16x^2 + 200x$

$9x^2 + 25y^2 + 25z^2 - 225 = 0$

Thus, the required equation is $9x^2 + 25y^2 + 25z^2 - 225 = 0$.

Exercise 12.3

NCERT 11th Maths Chapter 12

Question 1:

Find the coordinates of the point which divides the line segment joining the points (−2, 3, 5) and (1, −4, 6) in the ratio (i) 2:3 internally, (ii) 2:3 externally.

Ans:

(i) The coordinates of point R that divides the line segment joining points P (x_1, y_1, z_1) and Q (x_2, y_2, z_2) internally in the ratio m: n are

$$\left(\frac{mx_2+nx_1}{m+n}, \frac{my_2+ny_1}{m+n}, \frac{mz_2+nz_1}{m+n}\right).$$

Let R (x, y, z) be the point that divides the line segment joining points(−2, 3, 5) and (1, −4, 6) internally in the ratio 2:3

$$x=\frac{2(1)+3(-2)}{2+3}, y=\frac{2(-4)+3(3)}{2+3}, \text{ and } z=\frac{2(6)+3(5)}{2+3}$$

$$\text{i.e., } x=\frac{-4}{5}, y=\frac{1}{5}, \text{ and } z=\frac{27}{5}$$

Thus, the coordinates of the required point are $\left(-\frac{4}{5}, \frac{1}{5}, \frac{27}{5}\right)$.

(ii) The coordinates of point R that divides the line segment joining points P (x_1, y_1, z_1) and Q (x_2, y_2, z_2) externally in the ratio m: n are

$$\left(\frac{mx_2-nx_1}{m-n}, \frac{my_2-ny_1}{m-n}, \frac{mz_2-nz_1}{m-n}\right).$$

Let R (x, y, z) be the point that divides the line segment joining points(−2, 3, 5) and (1, −4, 6) externally in the ratio 2:3

$$x=\frac{2(1)-3(-2)}{2-3}, y=\frac{2(-4)-3(3)}{2-3}, \text{ and } z=\frac{2(6)-3(5)}{2-3}$$

$$\text{i.e., } x=-8, y=17, \text{ and } z=3$$

Thus, the coordinates of the required point are (−8, 17, 3).

Question 2:

Given that P (3, 2, −4), Q (5, 4, −6) and R (9, 8, −10) are collinear. Find the ratio in which Q divides PR.

Ans:

Let point Q (5, 4, −6) divide the line segment joining points P (3, 2, −4) and R (9, 8, −10) in the ratio $k:1$.

Therefore, by section formula,

$$(5,4,-6)=\left(\frac{k(9)+3}{k+1},\frac{k(8)+2}{k+1},\frac{k(-10)-4}{k+1}\right)$$

$$\Rightarrow \frac{9k+3}{k+1}=5$$

$$\Rightarrow 9k+3=5k+5$$

$$\Rightarrow 4k=2$$

$$\Rightarrow k=\frac{2}{4}=\frac{1}{2}$$

Thus, point Q divides PR in the ratio 1:2.

Question 3:

Find the ratio in which the YZ-plane divides the line segment formed by joining the points (−2, 4, 7) and (3, −5, 8).

Ans:

Let the YZ planedivide the line segment joining points (−2, 4, 7) and (3, −5, 8) in the ratio $k:1$.

Hence, by section formula, the coordinates of point of intersection are given by $\left(\frac{k(3)-2}{k+1},\frac{k(-5)+4}{k+1},\frac{k(8)+7}{k+1}\right)$

On the YZ plane, the x-coordinate of any point is zero.

$$\frac{3k-2}{k+1}=0$$

$$\Rightarrow 3k-2=0$$

$$\Rightarrow k=\frac{2}{3}$$

Thus, the YZ plane divides the line segment formed by joining the given points in the ratio 2:3.

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Question 4:

Using section formula, show that the points A (2, −3, 4), B (−1, 2, 1) and $C\left(0,\frac{1}{3},2\right)$ are collinear.

Ans:

The given points are A (2, −3, 4), B (−1, 2, 1), and $C\left(0,\frac{1}{3},2\right)$.

Let P be a point that divides AB in the ratio k:1.

Hence, by section formula, the coordinates of P are given by

$$\left(\frac{k(-1)+2}{k+1},\frac{k(2)-3}{k+1},\frac{k(1)+4}{k+1}\right)$$

Now, we find the value of k at which point P coincides with point C.

By taking $\frac{-k+2}{k+1}=0$, we obtain k = 2.

For k = 2, the coordinates of point P are $\left(0,\frac{1}{3},2\right)$.

i.e., $C\left(0,\frac{1}{3},2\right)$ is a point that divides AB externally in the ratio 2:1 and is the same as point P.

Hence, points A, B, and C are collinear.

NCERT 11th Maths Chapter 12

Question 5:

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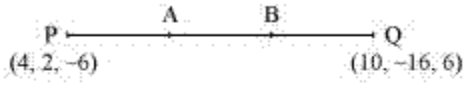
Find the coordinates of the points which trisect the line segment joining the points P (4, 2, −6) and Q (10, −16, 6).

Ans:

Let A and B be the points that trisect the line segment joining points P (4, 2, −6) and Q (10, −16, 6)



Point A divides PQ in the ratio 1:2. Therefore, by section formula, the coordinates of point A are given by

$$\left(\frac{1(10)+2(4)}{1+2}, \frac{1(-16)+2(2)}{1+2}, \frac{1(6)+2(-6)}{1+2}\right) = (6, -4, -2)$$

Point B divides PQ in the ratio 2:1. Therefore, by section formula, the coordinates of point B are given by

$$\left(\frac{2(10)+1(4)}{2+1}, \frac{2(-16)+1(2)}{2+1}, \frac{2(6)-1(6)}{2+1}\right) = (8, -10, 2)$$

Thus, (6, −4, −2) and (8, −10, 2) are the points that trisect the line segment joining points P (4, 2, −6) and Q (10, −16, 6).

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