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NCERT Solutions for Class 11 Maths Chapter 11: Introduction to Three Dimensional Geometry – Free PDF Download

Chapter 11, Introduction to Three Dimensional Geometry, extends the two-dimensional coordinate system you studied earlier into three-dimensional space by introducing coordinate axes, coordinate planes, octants, and the distance formula. In the current (2026-27) rationalised NCERT syllabus, this chapter has been trim...

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Chapter 11, Introduction to Three Dimensional Geometry, extends the two-dimensional coordinate system you studied earlier into three-dimensional space by introducing coordinate axes, coordinate planes, octants, and the distance formula. In the current (2026-27) rationalised NCERT syllabus, this chapter has been trimmed down to two exercises — 11.1 and 11.2 — plus a Miscellaneous Exercise, and no longer includes the section formula. These Class 11 Maths Chapter 11 solutions are also useful as quick revision notes before exams.

Exercise 11.1

Q1. A point is on the x-axis. What are its y-coordinate and z-coordinates?

Any point lying on the x-axis has zero perpendicular distance from both the XY-plane and the XZ-plane along the y and z directions. Hence its y-coordinate and z-coordinate are both 0. Such a point is of the form (x, 0, 0).

Q2. A point is in the XZ-plane. What can you say about its y-coordinate?

Every point that lies in the XZ-plane has zero perpendicular distance from that plane, so its y-coordinate must be 0. Such a point is of the form (x, 0, z).

Q3. 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).

The octant of a point is decided by the signs of its x, y and z coordinates, using the sign convention: Octant I (+,+,+), II (–,+,+), III (–,–,+), IV (+,–,+), V (+,+,–), VI (–,+,–), VII (–,–,–), VIII (+,–,–).

(1, 2, 3): signs (+, +, +) $\rightarrow$ Octant I

(4, -2, 3): signs (+, –, +) $\rightarrow$ Octant IV

(4, -2, -5): signs (+, –, –) $\rightarrow$ Octant VIII

(4, 2, -5): signs (+, +, –) $\rightarrow$ Octant V

(-4, 2, -5): signs (–, +, –) $\rightarrow$ Octant VI

(-4, 2, 5): signs (–, +, +) $\rightarrow$ Octant II

(-3, -1, 6): signs (–, –, +) $\rightarrow$ Octant III

(-2, -4, -7): signs (–, –, –) $\rightarrow$ Octant VII

Q4. Fill in the blanks: (i) The x-axis and y-axis taken together determine a plane known as______. (ii) The coordinates of points in the XY-plane are of the form ______. (iii) Coordinate planes divide the space into ______ octants.

The x-axis and y-axis together determine the **XY-plane**.

The coordinates of any point in the XY-plane are of the form **(x, y, 0)**, since the z-coordinate is always zero on this plane.

The three coordinate planes divide space into **eight (8)** octants.

Exercise 11.2

Q1. 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)

Using the distance formula between two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$: $PQ = \sqrt{[(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2]}$

Distance = $\sqrt{[(4-2)^2 + (3-3)^2 + (1-5)^2]} = \sqrt{[4 + 0 + 16]} = \sqrt{20} = 2\sqrt{5}$ units.

Distance = $\sqrt{[(2-(-3))^2 + (4-7)^2 + (-1-2)^2]} = \sqrt{[25 + 9 + 9]} = \sqrt{43}$ units.

Distance = $\sqrt{[(1-(-1))^2 + (-3-3)^2 + (4-(-4))^2]} = \sqrt{[4 + 36 + 64]} = \sqrt{104} = 2\sqrt{26}$ units.

Distance = $\sqrt{[(-2-2)^2 + (1-(-1))^2 + (3-3)^2]} = \sqrt{[16 + 4 + 0]} = \sqrt{20} = 2\sqrt{5}$ units.

Q2. Show that the points (-2, 3, 5), (1, 2, 3) and (7, 0, -1) are collinear.

Let A(-2, 3, 5), B(1, 2, 3) and C(7, 0, -1).

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

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

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

Since $AB + BC = \sqrt{14} + 2\sqrt{14} = 3\sqrt{14} = AC$, the points A, B and C are collinear.

Q3. 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.

Let A(0, 7, -10), B(1, 6, -6), C(4, 9, -6).
$AB = \sqrt{[(1-0)^2 + (6-7)^2 + (-6+10)^2]} = \sqrt{[1 + 1 + 16]} = \sqrt{18}$
$BC = \sqrt{[(4-1)^2 + (9-6)^2 + (-6+6)^2]} = \sqrt{[9 + 9 + 0]} = \sqrt{18}$
Since $AB = BC = \sqrt{18}$, triangle ABC is isosceles. (Verified)

Let A(0, 7, 10), B(-1, 6, 6), C(-4, 9, 6).
$AB^2 = (-1-0)^2 + (6-7)^2 + (6-10)^2 = 1 + 1 + 16 = 18$
$BC^2 = (-4+1)^2 + (9-6)^2 + (6-6)^2 = 9 + 9 + 0 = 18$
$CA^2 = (0+4)^2 + (7-9)^2 + (10-6)^2 = 16 + 4 + 16 = 36$
Since $AB^2 + BC^2 = 18 + 18 = 36 = CA^2$, the triangle is right angled at B. (Verified)

Let A(-1, 2, 1), B(1, -2, 5), C(4, -7, 8), D(2, -3, 4).
$AB = \sqrt{[(1+1)^2 + (-2-2)^2 + (5-1)^2]} = \sqrt{[4+16+16]} = \sqrt{36} = 6$
$CD = \sqrt{[(2-4)^2 + (-3+7)^2 + (4-8)^2]} = \sqrt{[4+16+16]} = \sqrt{36} = 6$
$BC = \sqrt{[(4-1)^2 + (-7+2)^2 + (8-5)^2]} = \sqrt{[9+25+9]} = \sqrt{43}$
$AD = \sqrt{[(2+1)^2 + (-3-2)^2 + (4-1)^2]} = \sqrt{[9+25+9]} = \sqrt{43}$
Since AB = CD and BC = AD (opposite sides are equal), ABCD is a parallelogram. (Verified)

Q4. Find the equation of the set of points which are equidistant from the points (1, 2, 3) and (3, 2, -1).

Let P(x, y, z) be any point equidistant from A(1, 2, 3) and B(3, 2, -1), so PA = PB, i.e., $PA^2 = PB^2$.

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

Expanding: $x^2 - 2x + 1 + z^2 - 6z + 9 = x^2 - 6x + 9 + z^2 + 2z + 1$

$-2x - 6z + 10 = -6x + 2z + 10$

$4x - 8z = 0$, i.e., $\mathbf{x - 2z = 0}$, which is the required equation of the set of points.

Q5. 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.

Let P(x, y, z) be such that PA + PB = 10, where A(4, 0, 0) and B(-4, 0, 0).

$PA = \sqrt{[(x-4)^2 + y^2 + z^2]}$ and $PB = \sqrt{[(x+4)^2 + y^2 + z^2]}$

So PA = 10 – PB. Squaring both sides: $(x-4)^2 + y^2 + z^2 = 100 - 20PB + (x+4)^2 + y^2 + z^2$

Simplifying: $-8x = 100 - 20PB + 8x$, so $20PB = 16x + 100$, i.e., $PB = (4x + 25)/5$

Squaring again: $25[(x+4)^2 + y^2 + z^2] = (4x + 25)^2$

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

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

Dividing throughout by 225, the required equation is: $\mathbf{x^2/25 + y^2/9 + z^2/9 = 1}$

Miscellaneous Exercise

Q1. Three vertices of a parallelogram ABCD are A(3, -1, 2), B (1, 2, -4) and C (-1, 1, 2). Find the coordinates of the fourth vertex.

In a parallelogram ABCD, the diagonals AC and BD bisect each other, so the midpoint of AC equals the midpoint of BD.

Midpoint of AC = ((3−1)/2, (−1+1)/2, (2+2)/2) = (1, 0, 2)

Let D = (x, y, z). Midpoint of BD = ((1+x)/2, (2+y)/2, (−4+z)/2). Equating this to (1, 0, 2):

(1+x)/2 = 1 → x = 1; (2+y)/2 = 0 → y = −2; (−4+z)/2 = 2 → z = 8

Hence, the coordinates of the fourth vertex D are **(1, -2, 8)**.

Q2. Find the lengths of the medians of the triangle with vertices A (0, 0, 6), B (0, 4, 0) and (6, 0, 0).

Let A(0, 0, 6), B(0, 4, 0), C(6, 0, 0). The median from a vertex goes to the midpoint of the opposite side.

Midpoint of BC = (3, 2, 0). Median from A = $\sqrt{[(3-0)^2 + (2-0)^2 + (0-6)^2]} = \sqrt{[9+4+36]} = \sqrt{49} = 7$

Midpoint of AC = (3, 0, 3). Median from B = $\sqrt{[(3-0)^2 + (0-4)^2 + (3-0)^2]} = \sqrt{[9+16+9]} = \sqrt{34}$

Midpoint of AB = (0, 2, 3). Median from C = $\sqrt{[(0-6)^2 + (2-0)^2 + (3-0)^2]} = \sqrt{[36+4+9]} = \sqrt{49} = 7$

The lengths of the three medians are **7, √34 and 7** units.

Q3. If the origin is the centroid of the triangle PQR with vertices P (2a, 2, 6), Q (-4, 3b, -10) and R (8, 14, 2c), then find the values of a, b and c.

The centroid of a triangle with vertices (x_1, y_1, z_1), (x_2, y_2, z_2), (x_3, y_3, z_3) is $[(x_1+x_2+x_3)/3, (y_1+y_2+y_3)/3, (z_1+z_2+z_3)/3]$. Since the centroid is the origin (0, 0, 0):

(2a − 4 + 8)/3 = 0 → 2a + 4 = 0 → **a = −2**

(2 + 3b + 14)/3 = 0 → 3b + 16 = 0 → **b = −16/3**

(6 − 10 + 2c)/3 = 0 → 2c − 4 = 0 → **c = 2**

Q4. If A and B be the points (3, 4, 5) and (-1, 3, -7), respectively, find the equation of the set of points P such that $PA^2 + PB^2 = k^2$, where k is a constant.

Let P(x, y, z). Then:

$PA^2 = (x-3)^2 + (y-4)^2 + (z-5)^2$

$PB^2 = (x+1)^2 + (y-3)^2 + (z+7)^2$

Given $PA^2 + PB^2 = k^2$:

$(x-3)^2 + (x+1)^2 + (y-4)^2 + (y-3)^2 + (z-5)^2 + (z+7)^2 = k^2$

Expanding each pair: $(2x^2 - 4x + 10) + (2y^2 - 14y + 25) + (2z^2 + 4z + 74) = k^2$

$2x^2 + 2y^2 + 2z^2 - 4x - 14y + 4z + 109 = k^2$

So the required equation of the set of points is: $\mathbf{2x^2 + 2y^2 + 2z^2 - 4x - 14y + 4z + 109 - k^2 = 0}$

Class 11 Maths Chapter 11 – Notes and Extra Questions

In three dimensions, the coordinate axes are three mutually perpendicular lines called the x-axis, y-axis and z-axis, meeting at a common point called the origin O(0, 0, 0).

The three coordinate planes formed by pairs of axes are the XY-plane, YZ-plane and ZX-plane.

The three coordinate planes divide space into eight parts called octants, denoted I to VIII, based on the signs of the coordinates.

The coordinates of a point P in space are always written as an ordered triplet (x, y, z), representing its perpendicular distances from the YZ, ZX and XY planes respectively.

Any point on the x-axis has the form (x, 0, 0); on the y-axis, (0, y, 0); and on the z-axis, (0, 0, z).

Any point in the XY-plane has the form (x, y, 0); in the YZ-plane, (0, y, z); and in the ZX-plane, (x, 0, z).

Distance formula: the distance between two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$ is $PQ = \sqrt{[(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2]}$.

The distance of a point Q(x, y, z) from the origin O is $OQ = \sqrt{(x^2 + y^2 + z^2)}$.

The midpoint of the segment joining (x_1, y_1, z_1) and (x_2, y_2, z_2) is $[(x_1+x_2)/2, (y_1+y_2)/2, (z_1+z_2)/2]$, and the centroid of a triangle with vertices (x_1,y_1,z_1), (x_2,y_2,z_2), (x_3,y_3,z_3) is $[(x_1+x_2+x_3)/3, (y_1+y_2+y_3)/3, (z_1+z_2+z_3)/3]$.

How many exercises are there in Class 11 Maths Chapter 11?

In the current NCERT textbook (Reprint 2026-27), Chapter 11 “Introduction to Three Dimensional Geometry” has two exercises — Exercise 11.1 and Exercise 11.2 — plus a Miscellaneous Exercise at the end. The section formula, which was part of this chapter in older editions, has been removed as part of the NEP 2020 syllabus rationalisation.

What is the distance formula in three-dimensional geometry?

The distance between two points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$ in three-dimensional space is given by $PQ = \sqrt{[(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2]}$. This is a direct extension of the two-dimensional distance formula, with the z-coordinate difference added under the square root.

What are octants in 3D geometry?

The three coordinate planes (XY, YZ and ZX) divide three-dimensional space into eight regions called octants, numbered I through VIII. The octant a point belongs to is determined entirely by the signs (positive or negative) of its x, y and z coordinates.

Is Class 11 Maths Chapter 11 important for the board exam?

Yes. Introduction to Three Dimensional Geometry lays the foundation for the more advanced “Three Dimensional Geometry” chapter in Class 12, which carries direct and vector equations of lines and planes. A solid understanding of coordinate axes, octants and the distance formula from this chapter makes the Class 12 chapter much easier to master.