Introduction to Three-dimensional Geometry

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The point (−2, 9, 2) lies in octant:
(a) II **(b)** VI **(c)** VIII **(d)** VII

2. The point (−8, 0, −2) lies on:
(a) the xz-plane **(b)** the z-axis **(c)** the yz-plane **(d)** the x-axis

3. The distance between (3, 4, 8) and (2, −8, 20) is:
(a) 17 **(b)** 18 **(c)** 289 **(d)** 25

4. The distance of the point (3, −5, −6) from the y-axis is:
(a) $\sqrt{46}$ **(b)** 5 **(c)** $\sqrt{70}$ **(d)** $3\sqrt{5}$

5. The three coordinate planes divide space into:
(a) three parts **(b)** six regions **(c)** four quadrants **(d)** eight octants

6. The perpendicular distance of (7, 5, 8) from the yz-plane is:
(a) $\sqrt{138}$ **(b)** 8 **(c)** 7 **(d)** 5

7. The distance between (k, 2, 4) and (−4, 10, −4) is 12. The possible values of k are:
(a) 0 only **(b)** −8 and 0 **(c)** −9 and 1 **(d)** 0 and 8

8. Assertion (A): The distance between (−5, 6, 7) and (−1, 14, 15) is 20.
Reason (R): The distance between two points is $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$.
(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.

Section B — Short answer — 8 × 2 = 16 marks

9. Find the distance between (1, 8, 7) and (4, 5, −2).

10. Show that the points A(1, 0, −8), B(0, 2, −6) and C(−3, 8, 0) are collinear.

11. Find the lengths of the sides of the triangle with vertices A(−2, 0, 7), B(2, 2, 7) and C(2, −2, 7). Is it right-angled, isosceles, both or neither?

12. Find the equation satisfied by the points P(x, y, z) that are equidistant from A(8, 7, 5) and B(−7, 1, 2).

13. Name the octant in which each point lies: (8, −2, −9), (3, 8, 5), (−6, −7, −1).

14. Find the coordinates of the feet of the perpendiculars from (8, 2, −4) to the three coordinate planes.

15. Find k if the distance between (k, −9, 15) and (−7, 0, 3) is 17.

16. Find the distance of the point (8, 3, 8) from (a) the origin, (b) the x-axis, (c) the y-axis, (d) the z-axis.

Section C — Word problems — 4 × 4 = 16 marks

17. A triangle has vertices A(8, 1, −6), B(5, −3, −4) and C(1, 8, 5). Find AB, BC and CA. Is the triangle right-angled? Is it isosceles?

18. Find the point on the x-axis that is equidistant from (4, −4, 8) and (−2, 4, −8).

19. Show that A(−5, 4, −6), B(−4, 6, −4) and C(−3, 8, −2) are collinear, and find the ratio AB : BC.

20. A cuboid has one vertex at the origin and edges of length 2, 5 and 14 along the positive x-, y- and z-axes. Write the coordinates of all eight vertices and find the length of a diagonal of the cuboid.

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Answer key

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Q	Answer	Working
1	**(a) II**	signs (−, +, +)
2	**(a) the xz-plane**	look at which coordinates are zero
3	**(a) 17**	$\sqrt{(1^2 + 12^2 + 12^2)} = \sqrt{289}$
4	**(d) $3\sqrt{5}$**	$\sqrt{(3^2 + (-6)^2)}$
5	**(d) eight octants**	—
6	**(c) 7**	the x-coordinate, ignoring the sign
7	**(b) −8 and 0**	$(k + 4)^2 = 144 - 64 - 64 = 16$
8	**(d) A is false, but R is true.**	A is false: $\sqrt{(4^2 + 8^2 + 8^2)} = 12$. R is true.
9	**$3\sqrt{11}$**	$\sqrt{(3^2 + (-3)^2 + (-9)^2)} = \sqrt{99}$
10	**AB = 3, BC = 9, AC = 12; AB + BC = AC, so they are collinear**	find the three distances
11	**AB = $2\sqrt{5}$, BC = 4, CA = $2\sqrt{5}$; isosceles**	$AB^2 = 20$, $BC^2 = 16$, $CA^2 = 20$
12	**$-30x - 12y - 6z = -84$**	$PA^2 = PB^2$; the x^2, y^2, z^2 terms cancel
13	**(8, −2, −9): VIII; (3, 8, 5): I; (−6, −7, −1): VII**	—
14	**xy-plane (8, 2, 0); yz-plane (0, 2, −4); xz-plane (8, 0, −4)**	set the missing coordinate to 0
15	**k = −15 or 1**	$(k - (-7))^2 = 289 - 81 - 144 = 64$
16	**(a) $\sqrt{137}$; (b) $\sqrt{73}$; (c) $8\sqrt{2}$; (d) $\sqrt{73}$**	distance from the x-axis is $\sqrt{(y^2 + z^2)}$, and so on
17	**AB = $\sqrt{29}$, BC = $\sqrt{218}$, CA = $\sqrt{219}$. Not right-angled. Not isosceles.**	$AB^2 = 29$, $BC^2 = 218$, $CA^2 = 219$
18	**(1, 0, 0)**	$(x - 4)^2 + 80 = (x - (-2))^2 + 80$
19	**AB = 3, BC = 3, AC = 6; AB + BC = AC, so they are collinear; AB : BC = 1 : 1**	compute the three distances
20	**(0, 0, 0), (2, 0, 0), (0, 5, 0), (0, 0, 14), (2, 5, 0), (2, 0, 14), (0, 5, 14), (2, 5, 14); diagonal 15**	$\sqrt{(2^2 + 5^2 + 14^2)}$

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