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Vector Algebra — CBSE Class 12 Mathematics Chapter Test

FREE CHAPTER TEST · CLASS XII · MATHEMATICS (041) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	40	19 (A 10 · B 3 · C 2 · D 2 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 19 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. In Section A, Questions 1 to 8 are multiple choice questions (MCQs) and Questions 9 and 10 are assertion-reason based questions of 1 mark each.
4. In Section B, Q11–13 are very short answer (VSA) type questions, carrying 2 marks each.
5. In Section C, Q14–15 are short answer (SA) type questions, carrying 3 marks each.
6. In Section D, Q16–17 are long answer (LA) type questions, carrying 5 marks each.
7. In Section E, Q18–19 are case study based questions, carrying 4 marks each, with sub-parts of the values of 1, 1 and 2 marks.
8. There is no overall choice. However, an internal choice has been provided in 1 question of Section B, 1 question of Section C, 1 question of Section D and in the 2-mark sub-part of each question of Section E.
9. Use of calculators is not allowed. log x denotes the natural logarithm of x.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Mathematics (041) Sample Question Paper 2026-27, released on 21 September 2026 at cbseacademic.nic.in, at half the length of the 80-mark board paper: 40 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Vector Algebra · **Topics:** Magnitude and direction cosines · Section formula · Scalar (dot) product · Projection of a vector · Vector (cross) product and area · Collinearity and applications

SECTION A

This section comprises 10 questions of 1 mark each: 8 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. The magnitude of the vector $2\hat{i} - 3\hat{j} + 6\hat{k}$ is 1

(A) 7 (B) 5

(C) 49 (D) $\sqrt{11}$

2. The value of λ for which the vectors $2\hat{i} + \lambda\hat{j} + \hat{k}$ and $\hat{i} - 2\hat{j} + 3\hat{k}$ are perpendicular is 1

(A) $-\frac{5}{2}$ (B) $\frac{5}{2}$

(C) 2 (D) $\frac{3}{2}$

3. The projection of the vector $\hat{i} + 2\hat{j} + 2\hat{k}$ on the vector $3\hat{i} + 4\hat{k}$ is 1

(A) $\frac{11}{3}$ (B) 11

(C) $\frac{11}{5}$ (D) $\frac{5}{11}$

4. The direction cosines of the vector $\hat{i} + \hat{j} + \hat{k}$ are 1

(A) 1, 1, 1 (B) $\frac{1}{3}, \frac{1}{3}, \frac{1}{3}$

(C) $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ (D) $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}$

5. If $|\vec{a}| = 2$, $|\vec{b}| = 3$ and the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{6}$, then $|\vec{a} \times \vec{b}|$ is 1

(A) 3 (B) $3\sqrt{3}$

(C) 6 (D) $\frac{3}{2}$

6. If $\vec{a} \cdot \vec{b} = |\vec{a} \times \vec{b}|$ for non-zero vectors $\vec{a}$ and $\vec{b}$, then the angle between them is 1

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{4}$ (D) 0

7. The area of the parallelogram whose adjacent sides are $\hat{i} + \hat{j}$ and $\hat{j} + \hat{k}$ is 1

(A) 3 sq units (B) $\sqrt{3}$ sq units

(C) $\sqrt{2}$ sq units (D) 1 sq unit

8. The position vector of the point which divides the join of the points with position vectors $\hat{i} + 2\hat{j}$ and $4\hat{i} + 5\hat{j}$ internally in the ratio 1 : 2 is 1

(A) $3\hat{i} + 4\hat{j}$ (B) $\frac{5}{3}\hat{i} + \frac{7}{3}\hat{j}$

(C) $5\hat{i} + 7\hat{j}$ (D) $2\hat{i} + 3\hat{j}$

9. **Assertion (A):** $\hat{i} \times \hat{j} = \hat{k}$ and $\hat{j} \times \hat{i} = -\hat{k}$. 1

Reason (R): For any two vectors, $\vec{a} \times \vec{b} = -(\vec{b} \times \vec{a})$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

10. **Assertion (A):** If $\vec{a}$ and $\vec{b}$ are non-zero vectors with $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$, then $\vec{a}$ is perpendicular to $\vec{b}$. 1

Reason (R): For any two vectors, $|\vec{a} + \vec{b}| \le |\vec{a}| + |\vec{b}|$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

SECTION B

This section comprises 3 very short answer (VSA) type questions of 2 marks each.

11. Find a unit vector in the direction of $\vec{a} + \vec{b}$, where $\vec{a} = 3\hat{i} - 2\hat{j} + \hat{k}$ and $\vec{b} = -\hat{i} + 4\hat{j} + \hat{k}$. 2

12. (a) Find the angle between the vectors $\vec{a} = \hat{i} - \hat{j}$ and $\vec{b} = \hat{j} - \hat{k}$. 2

OR

(b) Find $|\vec{a} \times \vec{b}|$, where $\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} + 5\hat{j} - 2\hat{k}$.

13. If $|\vec{a}| = 3$, $|\vec{b}| = 4$ and $\vec{a} \cdot \vec{b} = 6$, find $|\vec{a} - \vec{b}|$. 2

SECTION C

This section comprises 2 short answer (SA) type questions of 3 marks each.

14. (a) Find a vector of magnitude 9 units that is perpendicular to both $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. 3

OR

(b) Using vectors, show that the points A(2, −1, 3), B(3, 1, 1) and C(5, 5, −3) are collinear.

15. Using vectors, find the area of the triangle with vertices A(1, 0, 2), B(2, 1, 4) and C(3, 2, 1). 3

SECTION D

This section comprises 2 long answer (LA) type questions of 5 marks each.

16. (a) The vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ satisfy $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, with $|\vec{a}| = 3$, $|\vec{b}| = 8$ and $|\vec{c}| = 7$. Find the angle between $\vec{a}$ and $\vec{b}$, and the value of $\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}$. 5

OR

(b) If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - \hat{j}$, find a vector $\vec{c}$ such that $\vec{a} \times \vec{c} = \vec{b}$ and $\vec{a} \cdot \vec{c} = 3$.

17. The scalar product of the vector $\hat{i} + \hat{j} + \hat{k}$ with a unit vector along the sum of the vectors $3\hat{i} + 2\hat{j} - 4\hat{k}$ and $\lambda\hat{i} + \hat{j} + 2\hat{k}$ is equal to 1. Find the value of λ and the unit vector. 5

SECTION E

This section comprises 2 case study based questions of 4 marks each, with sub-parts of 1, 1 and 2 marks.

18. A triangular solar panel frame has corners at A(1, 2, 1), B(3, 3, 3) and C(1, 6, 4), with lengths in metres.

(i) Write the vector $\vec{AB}$. [1]

(ii) Find $\vec{AB} \cdot \vec{AC}$. [1]

(iii) Find the area of the panel ABC. [2]

OR

(iii) Find the projection of $\vec{AB}$ on $\vec{AC}$. [2]

19. A constant force $\vec{F} = 4\hat{i} + \hat{j} + 3\hat{k}$ (in newtons) moves a particle from the point A(1, 2, 3) to the point B(5, 4, 1) (in metres). The work done is $\vec{F} \cdot \vec{d}$, where $\vec{d}$ is the displacement.

(i) Find the displacement vector $\vec{d}$. [1]

(ii) Find the magnitude of the displacement. [1]

(iii) Find the work done by the force. [2]

OR

(iii) Find the projection of $\vec{F}$ on $\vec{d}$. [2]

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
(A)	(B)	(C)	(D)	(A)	(C)	(B)	(D)	(A)	(B)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (A). $\sqrt{(4 + 9 + 36)} = \sqrt{49} = 7$.

Q2. Answer (B). Dot product $= 2 - 2\lambda + 3 = 0 \Rightarrow \lambda = 5/2$.

Q3. Answer (C). Projection $= \vec{a}\cdot\vec{b}/|\vec{b}| = (3 + 0 + 8)/5 = 11/5$.

Q4. Answer (D). Each component divided by the magnitude $\sqrt{3}$.

Q5. Answer (A). $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}| \sin\theta = 2 \times 3 \times 1/2 = 3$.

Q6. Answer (C). $|\vec{a}||\vec{b}| \cos\theta = |\vec{a}||\vec{b}| \sin\theta \Rightarrow \tan\theta = 1 \Rightarrow \theta = \pi/4$.

Q7. Answer (B). $(\hat{i} + \hat{j}) \times (\hat{j} + \hat{k}) = \hat{i} - \hat{j} + \hat{k}$, whose magnitude is $\sqrt{3}$.

Q8. Answer (D). $(2(\hat{i} + 2\hat{j}) + 1(4\hat{i} + 5\hat{j}))/(1 + 2) = (6\hat{i} + 9\hat{j})/3 = 2\hat{i} + 3\hat{j}$.

Q9. Answer (A). $\hat{i} \times \hat{j} = \hat{k}$ by definition, and $\hat{j} \times \hat{i} = -(\hat{i} \times \hat{j}) = -\hat{k}$ by the property in R. Answer (A).

Q10. Answer (B). Squaring, $|\vec{a}|^2 + 2\vec{a}\cdot\vec{b} + |\vec{b}|^2 = |\vec{a}|^2 - 2\vec{a}\cdot\vec{b} + |\vec{b}|^2 \Rightarrow \vec{a}\cdot\vec{b} = 0$, so A is true. R (the triangle inequality) is true but is not what proves A. Answer (B).

Q11. (2 marks) Answer: $(1/\sqrt{3})(\hat{i} + \hat{j} + \hat{k})$.
$\vec{a} + \vec{b} = 2\hat{i} + 2\hat{j} + 2\hat{k}$, with magnitude $2\sqrt{3}$. [1]
Unit vector $= (1/\sqrt{3})(\hat{i} + \hat{j} + \hat{k})$. [1]

Q12. (2 marks) Answer: (a) $2\pi/3$; (b) $13\sqrt{3}$.
(a) $\vec{a}\cdot\vec{b} = 0 - 1 + 0 = -1$, $|\vec{a}| = |\vec{b}| = \sqrt{2}$. [1] $\cos\theta = -1/2$, so $\theta = 2\pi/3$. [1]
OR (b) $\vec{a} \times \vec{b} = (1\cdot(-2) - 3\cdot5)\hat{i} - (2\cdot(-2) - 3\cdot3)\hat{j} + (2\cdot5 - 1\cdot3)\hat{k} = -17\hat{i} + 13\hat{j} + 7\hat{k}$. [1] $|\vec{a} \times \vec{b}| = \sqrt{(289 + 169 + 49)} = \sqrt{507} = 13\sqrt{3}$. [1]

Q13. (2 marks) Answer: $\sqrt{13}$.
$|\vec{a} - \vec{b}|^2 = |\vec{a}|^2 - 2\,\vec{a}\cdot\vec{b} + |\vec{b}|^2 = 9 - 12 + 16 = 13$. [1]
$|\vec{a} - \vec{b}| = \sqrt{13}$. [1]

Q14. (3 marks) Answer: (a) $\pm(6\hat{i} - 6\hat{j} + 3\hat{k})$; (b) AC = 3AB, so collinear.
(a) $\vec{a} \times \vec{b} = (1\cdot0 - (-2)\cdot1)\hat{i} - (2\cdot0 - (-2)\cdot1)\hat{j} + (2\cdot1 - 1\cdot1)\hat{k} = 2\hat{i} - 2\hat{j} + \hat{k}$. [1½] $|\vec{a} \times \vec{b}| = 3$. [½] Required vector $= \pm9(2\hat{i} - 2\hat{j} + \hat{k})/3 = \pm(6\hat{i} - 6\hat{j} + 3\hat{k})$. [1]
OR (b) $\vec{AB} = \hat{i} + 2\hat{j} - 2\hat{k}$ and $\vec{BC} = 2\hat{i} + 4\hat{j} - 4\hat{k}$. [1] $\vec{AC} = 3\hat{i} + 6\hat{j} - 6\hat{k} = 3\vec{AB}$. [1] So $\vec{AB}$ and $\vec{AC}$ are parallel with the common point A: A, B, C are collinear. [1]

Q15. (3 marks) Answer: $5\sqrt{2}/2$ sq units.
$\vec{AB} = \hat{i} + \hat{j} + 2\hat{k}$, $\vec{AC} = 2\hat{i} + 2\hat{j} - \hat{k}$. [1]
$\vec{AB} \times \vec{AC} = (1\cdot(-1) - 2\cdot2)\hat{i} - (1\cdot(-1) - 2\cdot2)\hat{j} + (1\cdot2 - 1\cdot2)\hat{k} = -5\hat{i} + 5\hat{j} + 0\hat{k}$. [1]
Area $= (1/2)\sqrt{(25 + 25)} = 5\sqrt{2}/2$ sq units. [1]

Q16. (5 marks) Answer: (a) $2\pi/3$; -61; (b) $\vec{c} = (2/3)\hat{i} + (2/3)\hat{j} + (5/3)\hat{k}$.
(a) $\vec{c} = -(\vec{a} + \vec{b})$, so $|\vec{c}|^2 = |\vec{a}|^2 + |\vec{b}|^2 + 2\vec{a}\cdot\vec{b}$: $49 = 9 + 64 + 2\vec{a}\cdot\vec{b}$, $\vec{a}\cdot\vec{b} = -12$. [2] $\cos\theta = -12/(3 \times 8) = -1/2$, $\theta = 2\pi/3$. [1]
Squaring $\vec{a} + \vec{b} + \vec{c} = \vec{0}$: $9 + 64 + 49 + 2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}) = 0$ [1], so $\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a} = -61$. [1]
OR (b) Let $\vec{c} = x\hat{i} + y\hat{j} + z\hat{k}$. $\vec{a} \times \vec{c} = (z - y)\hat{i} + (x - z)\hat{j} + (y - x)\hat{k} = \hat{i} - \hat{j}$ gives $z - y = 1$, $x - z = -1$, $y - x = 0$. [2] $\vec{a}\cdot\vec{c} = x + y + z = 3$. [1] With $y = x$ and $z = x + 1$: $3x + 1 = 3$, so $x = y = 2/3$, $z = 5/3$. [1] $\vec{c} = (2/3)\hat{i} + (2/3)\hat{j} + (5/3)\hat{k}$. [1]

Q17. (5 marks) Answer: $\lambda = 3$; $(6\hat{i} + 3\hat{j} - 2\hat{k})/7$.
Sum $= (3 + \lambda)\hat{i} + 3\hat{j} - 2\hat{k}$, magnitude $\sqrt{((3 + \lambda)^2 + 13)}$. [1]
Scalar product with $\hat{i} + \hat{j} + \hat{k}$: $(3 + \lambda + 3 - 2)/\sqrt{((3 + \lambda)^2 + 13)} = 1$. [1]
$(\lambda + 4)^2 = (\lambda + 3)^2 + 13 \Rightarrow 8\lambda + 16 = 6\lambda + 22 \Rightarrow \lambda = 3$. [2]
Unit vector $= (6\hat{i} + 3\hat{j} - 2\hat{k})/7$. [1]

Q18. (4 marks) Answer: (i) $2\hat{i} + \hat{j} + 2\hat{k}$; (ii) 10; (iii) $5\sqrt{5}/2$ m², or 2 m.
(i) $\vec{AB} = 2\hat{i} + \hat{j} + 2\hat{k}$. [1]
(ii) $\vec{AC} = 4\hat{j} + 3\hat{k}$, so $\vec{AB}\cdot\vec{AC} = 0 + 4 + 6 = 10$. [1]
(iii)(a) $\vec{AB} \times \vec{AC} = (3 - 8)\hat{i} - (6 - 0)\hat{j} + (8 - 0)\hat{k} = -5\hat{i} - 6\hat{j} + 8\hat{k}$. [1] Area $= (1/2)\sqrt{(25 + 36 + 64)} = (1/2)\sqrt{125} = 5\sqrt{5}/2$ m². [1]
OR (iii)(b) $|\vec{AC}| = 5$. [1] Projection $= \vec{AB}\cdot\vec{AC}/|\vec{AC}| = 10/5 = 2$ m. [1]

Q19. (4 marks) Answer: (i) $4\hat{i} + 2\hat{j} - 2\hat{k}$; (ii) $2\sqrt{6}$ m; (iii) 12 J, or $\sqrt{6}$ N.
(i) $\vec{d} = \vec{AB} = 4\hat{i} + 2\hat{j} - 2\hat{k}$. [1]
(ii) $|\vec{d}| = \sqrt{(16 + 4 + 4)} = 2\sqrt{6}$ m. [1]
(iii)(a) $W = \vec{F}\cdot\vec{d} = 16 + 2 - 6$ [1] $= 12$ J. [1]
OR (iii)(b) Projection $= \vec{F}\cdot\vec{d}/|\vec{d}| = 12/(2\sqrt{6})$ [1] $= \sqrt{6}$ N. [1]

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