PRACTICE PAPER 01 (2026-27) – ANSWER KEY WITH SOLUTIONS
CHAPTER 10 : VECTOR ALGEBRA

SUBJECT: MATHEMATICS	**MAX. MARKS:** 40
CLASS: XII	**DURATION:** 1½ hrs

SECTION – A

Questions 1 to 10 carry 1 mark each.

1. Magnitude of $2\hat{i} - 3\hat{j} + 6\hat{k}$

Ans: (b) 7

$\sqrt{2^2 + (-3)^2 + 6^2} = \sqrt{4 + 9 + 36} = \sqrt{49} = 7$.

2. Direction cosines of $2\hat{i} + 2\hat{j} - \hat{k}$

Ans: (c) 2/3, 2/3, −1/3

Magnitude = $\sqrt{4 + 4 + 1} = 3$. Direction cosines are the components divided by the magnitude: 2/3, 2/3, −1/3.

3. Angle between the vectors

Ans: (d) 60°

$\cos\theta = \frac{\vec{a} \cdot \vec{b}}{|\vec{a}||\vec{b}|} = \frac{6}{3 \times 4} = \frac{1}{2}$, so θ = 60°.

4. |a × b|

Ans: (b) 6

$|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}|\sin\theta = 4 \times 3 \times \sin 30^\circ = 6$.

5. Parallel vectors

Ans: (b) −4

Parallel vectors have proportional components: 2/1 = λ/(−2) = 6/3. So 2 = λ/(−2), giving λ = −4.

6. Projection of a on b

Ans: (c) 10/3

$\vec{a} \cdot \vec{b} = 2(1) + 3(2) + 1(2) = 10$ and $|\vec{b}| = \sqrt{1 + 4 + 4} = 3$. Projection = 10/3.

7. Section formula (internal, 1 : 2)

Ans: (b) $\frac{2\vec{a} + \vec{b}}{3}$

For ratio m : n, the position vector is $\frac{m\vec{b} + n\vec{a}}{m + n}$. With m = 1, n = 2 we get $\frac{\vec{b} + 2\vec{a}}{3}$.

8. k · (i × j)

Ans: (c) 1

$\hat{i} \times \hat{j} = \hat{k}$, so $\hat{k} \cdot \hat{k} = 1$.

9. Assertion–Reason

Ans: (d) A is false but R is true

A is false: for non-zero perpendicular vectors the dot product is 0 although neither vector is zero (e.g. $\hat{i} \cdot \hat{j} = 0$). R is true.

10. Assertion–Reason

Ans: (c) A is true but R is false

$\vec{a} \times \vec{b}$ is perpendicular to $\vec{a}$, so the dot product is 0. A is true. R is false since $\vec{a} \times \vec{b} = -\vec{b} \times \vec{a}$.

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. Unit vector along a + b

$\vec{a} + \vec{b} = 3\hat{i} + \hat{j} - 2\hat{k}$ and $|\vec{a} + \vec{b}| = \sqrt{9 + 1 + 4} = \sqrt{14}$. (1)

Unit vector = $\frac{1}{\sqrt{14}}(3\hat{i} + \hat{j} - 2\hat{k})$. (1)

12. Angle between $\hat{i} + \hat{j}$ and $\hat{j} + \hat{k}$

$\vec{a} \cdot \vec{b} = 0 + 1 + 0 = 1,\ |\vec{a}| = \sqrt{2},\ |\vec{b}| = \sqrt{2}$. (1)

$\cos\theta = \frac{1}{\sqrt{2} \cdot \sqrt{2}} = \frac{1}{2}$, so **θ = 60°**. (1)

13. Mid-point and length of AB

Mid-point = $\frac{1}{2}\left[(\hat{i} + 2\hat{j} + 3\hat{k}) + (3\hat{i} - 2\hat{j} + \hat{k})\right] = \frac{1}{2}(4\hat{i} + 4\hat{k}) = 2\hat{i} + 2\hat{k}$. (1)

$\vec{AB} = 2\hat{i} - 4\hat{j} - 2\hat{k}$, so AB = $\sqrt{4 + 16 + 4} = \sqrt{24} = 2\sqrt{6}$ units. (1)

14. Perpendicular vectors

Perpendicular ⇒ dot product = 0: 2(1) + λ(−2) + 1(3) = 0. (1)

5 − 2λ = 0, so **λ = 5/2**. (1)

SECTION – C

Questions 15 to 17 carry 3 marks each.

15. Vector of magnitude 9 perpendicular to a = i + 2j and b = 2j + k

A vector perpendicular to both is $\vec{a} \times \vec{b}$:

$\vec{a} \times \vec{b} = \hat{i}(2 \cdot 1 - 0 \cdot 2) - \hat{j}(1 \cdot 1 - 0 \cdot 0) + \hat{k}(1 \cdot 2 - 2 \cdot 0) = 2\hat{i} - \hat{j} + 2\hat{k}$. (1)

$|\vec{a} \times \vec{b}| = \sqrt{4 + 1 + 4} = 3$. Unit vector = $\frac{1}{3}(2\hat{i} - \hat{j} + 2\hat{k})$. (1)

Required vector = $9 \times \frac{1}{3}(2\hat{i} - \hat{j} + 2\hat{k}) = 6\hat{i} - 3\hat{j} + 6\hat{k}$ (or its negative). (1)

16. Area of triangle A(1, 1, 1), B(3, 2, 1), C(1, 2, 4)

$\vec{AB} = 2\hat{i} + \hat{j},\ \vec{AC} = \hat{j} + 3\hat{k}$. (1)

$\vec{AB} \times \vec{AC} = \hat{i}(3-0) - \hat{j}(6-0) + \hat{k}(2-0) = 3\hat{i} - 6\hat{j} + 2\hat{k}$. (1)

Area = $\frac{1}{2}|\vec{AB} \times \vec{AC}| = \frac{1}{2}\sqrt{9+36+4} = \frac{7}{2}$ sq. units. (1)

17. a, b, c unit vectors with a + b + c = 0

Take the dot product of the given relation with itself: $|\vec{a} + \vec{b} + \vec{c}|^2 = 0$. (1)

$|\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}) = 0$. (1)

1 + 1 + 1 + 2(S) = 0, so S = **−3/2**. (1)

SECTION – D

Question 18 carries 5 marks.

18. A(1, 0, 2), B(2, 2, 4), C(3, 1, 0)

$\vec{AB} = \hat{i} + 2\hat{j} + 2\hat{k}$, $\vec{AC} = 2\hat{i} + \hat{j} - 2\hat{k}$, $\vec{BC} = \hat{i} - \hat{j} - 4\hat{k}$. (1)

Right angle at A: $\vec{AB} \cdot \vec{AC} = 1(2) + 2(1) + 2(-2) = 0$. (1)

Hence AB is perpendicular to AC and the triangle is right-angled at A. (1)

Area: $|\vec{AB}| = \sqrt{1+4+4} = 3$ and $|\vec{AC}| = \sqrt{4+1+4} = 3$. (1)

Area = $\frac{1}{2}|\vec{AB}||\vec{AC}| = \frac{1}{2} \times 3 \times 3 = \frac{9}{2}$ sq. units. (Check: $\vec{AB} \times \vec{AC} = -6\hat{i} + 6\hat{j} - 3\hat{k}$, whose magnitude is 9.) (1)

OR

$\vec{AB} = 3\hat{i} - \hat{j} - 2\hat{k}$ and $\vec{BC} = 6\hat{i} - 2\hat{j} - 4\hat{k}$. (2)

$\vec{BC} = 2\vec{AB}$, so the vectors are parallel, and they share the point B. Hence A, B, C are collinear. (1)

AB : BC = |AB| : |BC| = 1 : 2, since BC = 2AB. (1)
So B divides AC internally in the ratio **1 : 2**. (1)

SECTION – E (Case Study Based Questions)

Questions 19 and 20 carry 4 marks each.

19. Force F = 2i + 3j + k, A(1, 1, 1) to B(4, 3, 2)

(i) $\vec{AB} = (4-1)\hat{i} + (3-1)\hat{j} + (2-1)\hat{k} = 3\hat{i} + 2\hat{j} + \hat{k}$. (1)

(ii) $|\vec{AB}| = \sqrt{9+4+1} = \sqrt{14} \approx 3.74$ m. (1)

(iii) Work done = $\vec{F} \cdot \vec{AB} = 2(3) + 3(2) + 1(1) = 13$. (1)

So the work done is **13 joules**. (1)

OR

(iii) $|\vec{F}| = \sqrt{4+9+1} = \sqrt{14}$ and $\vec{F} \cdot \vec{AB} = 13$. (1)

$\cos\theta = \frac{13}{\sqrt{14}\sqrt{14}} = \frac{13}{14}$, so **θ = cos⁻¹(13/14)**. (1)

20. Torque, F = 2k acting at r = 3i + 4j

(i) **τ = r × F** = determinant with rows (i, j, k), (3, 4, 0), (0, 0, 2). (1)

(ii) $\vec{\tau} = \hat{i}(4 \cdot 2 - 0 \cdot 0) - \hat{j}(3 \cdot 2 - 0 \cdot 0) + \hat{k}(0 - 0) = 8\hat{i} - 6\hat{j}$ N m. (1)

(iii) $|\vec{\tau}| = \sqrt{64 + 36} = 10$ N m. (1)

Unit vector along the axis = $\frac{8\hat{i} - 6\hat{j}}{10} = \frac{4\hat{i} - 3\hat{j}}{5}$. (1)

OR

(iii) $\vec{r} \cdot \vec{F} = 0$, so cos θ = 0 and **θ = 90°**. (1)

|r| = 5, |F| = 2, sin 90° = 1, so |r||F| sin θ = 10 = |τ|. Verified. (1)

— End of Solutions —