

JEE MAIN VECTOR ALGEBRA — SCALAR (DOT) PRODUCT AND PROJECTION — PYQS

Max. Marks: 56
Questions: 14

Section A (MCQ) — 13 questions

Q.1 If $\vec{a}$ and $\vec{b}$ are two vectors such that $|\vec{a}|=2$ and $|\vec{b}|=3$, then the maximum value of $3|(3\vec{a}+2\vec{b})|+4|(3\vec{a}-2\vec{b})|$ is :

[JEE Main 2026 (Online) 2nd April Morning Shift]

- (1) 30 (2) 36 (3) 60 (4) 72

Scan or tap for the full solution 

Q.2 Let the vectors $\vec{a} = -\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{b} = \hat{i} + 3\hat{j} + \hat{k}$. For some $\lambda, \mu \in \mathbb{R}$, let $\vec{c} = \lambda\vec{a} + \mu\vec{b}$. If $\vec{c} \cdot (3\hat{i} - 6\hat{j} + 2\hat{k}) = 10$ and $\vec{c} \cdot (\hat{i} + \hat{j} + \hat{k}) = -2$, then $|\vec{c}|^2$ is equal to :

[JEE Main 2026 (Online) 2nd April Evening Shift]

- (1) 8 (2) 12 (3) 14 (4) 15

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Q.3 Two adjacent sides of a parallelogram PQRS are given by $\vec{PQ} = \hat{j} + \hat{k}$ and $\vec{PS} = \hat{i} - \hat{j}$. If the side PS is rotated about the point P by an acute angle α in the plane of the parallelogram so that it becomes perpendicular to the side PQ, then $\sin^2\left(\frac{5\alpha}{2}\right) - \sin^2\left(\frac{\alpha}{2}\right)$ is equal to:

[JEE Main 2026 (Online) 2nd April Evening Shift]

- (1) $\frac{1}{2}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\frac{\sqrt{3}}{4}$ (4) $\frac{2\sqrt{3}}{5}$

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Q.4 For three unit vectors $\vec{a}, \vec{b}, \vec{c}$ satisfying $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 9$ and $|2\vec{a} + k\vec{b} + k\vec{c}| = 3$, the positive value of k is :

[JEE Main 2026 (Online) 28th January Morning Shift]

- (1) 4 (2) 5 (3) 6 (4) 3

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Q.5 Let $\vec{a} = 2\hat{i} - \hat{j} - \hat{k}$, $\vec{b} = \hat{i} + 3\hat{j} - \hat{k}$ and $\vec{c} = 2\hat{i} + \hat{j} + 3\hat{k}$. Let $\vec{v} = \vec{a} + \lambda\vec{b}$, $\lambda \in \mathbb{R}$, be the vector in the plane of the vectors $\vec{a}$ and $\vec{b}$, such that the length of its projection on the vector $\vec{c}$ is $\frac{1}{\sqrt{14}}$. Then $|\vec{v}|$ is equal to

[JEE Main 2026 (Online) 24th January Evening Shift]

- (1) $\frac{\sqrt{35}}{2}$ (2) 13 (3) $\frac{\sqrt{21}}{2}$ (4) 7

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Q.6 Let $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{c} = \lambda\hat{i} + \hat{j} + \hat{k}$ and $\vec{v} = \vec{a} \times \vec{b}$. If $\vec{v} \cdot \vec{c} = 11$ and the length of the projection of $\vec{b}$ on $\vec{c}$ is p , then $9p^2$ is equal to

[JEE Main 2026 (Online) 23rd January Evening Shift]

- (1) 9 (2) 6 (3) 4 (4) 12

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Q.7 Let $\vec{AB} = 2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{AD} = \hat{i} + 2\hat{j} + \lambda\hat{k}$, $\lambda \in \mathbb{R}$. Let the projection of the vector $\vec{v} = \hat{i} + \hat{j} + \hat{k}$ on the diagonal $\vec{AC}$ of the parallelogram ABCD be of length one unit. If α, β , where $\alpha > \beta$, be the roots of the equation $\lambda^2 x^2 - 6\lambda x + 5 = 0$, then $2\alpha - \beta$ is equal to

[JEE Main 2026 (Online) 22nd January Morning Shift]

- (1) 3 (2) 6 (3) 4 (4) 1

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Q.8 Let $\vec{a} = \hat{i} + 2\hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} - \hat{k}$. Let $\hat{c}$ be a unit vector in the plane of the vectors $\vec{a}$ and $\vec{b}$ and be perpendicular to $\vec{a}$. Then such a vector $\hat{c}$ is:

[JEE Main 2025 (Online) 8th April Evening Shift]

- (1) $\frac{1}{\sqrt{2}}(-\hat{i} + \hat{k})$ (2) $\frac{1}{\sqrt{5}}(\hat{j} - 2\hat{k})$
 (3) $\frac{1}{\sqrt{3}}(\hat{i} - \hat{j} + \hat{k})$ (4) $\frac{1}{\sqrt{3}}(-\hat{i} + \hat{j} - \hat{k})$

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Q.9 Let the angle θ , $0 < \theta < \frac{\pi}{2}$ between two unit vectors $\hat{a}$ and $\hat{b}$ be $\sin^{-1}\left(\frac{\sqrt{65}}{9}\right)$. If the vector $\vec{c} = 3\hat{a} + 6\hat{b} + 9(\hat{a} \times \hat{b})$, then the value of

$$9(\vec{c} \cdot \hat{a}) - 3(\vec{c} \cdot \hat{b}) \text{ is}$$

- [JEE Main 2025 (Online) 7th April Morning Shift]
 (1) 31 (2) 29 (3) 24 (4) 27

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Q.10 Let $\vec{a}$ and $\vec{b}$ be the vectors of the same magnitude such that $\frac{|\vec{a} + \vec{b}| + |\vec{a} - \vec{b}|}{|\vec{a} + \vec{b}| - |\vec{a} - \vec{b}|} = \sqrt{2} + 1$. Then $\frac{|\vec{a} + \vec{b}|^2}{|\vec{a}|^2}$ is :

- [JEE Main 2025 (Online) 7th April Evening Shift]
 (1) $2 + \sqrt{2}$ (2) $2 + 4\sqrt{2}$
 (3) $4 + 2\sqrt{2}$ (4) $1 + \sqrt{2}$

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Q.11 Consider two vectors $\vec{u} = 3\hat{i} - \hat{j}$ and $\vec{v} = 2\hat{i} + \hat{j} - \lambda\hat{k}$, $\lambda > 0$. The angle between them is given by $\cos^{-1}\left(\frac{\sqrt{5}}{2\sqrt{7}}\right)$. Let $\vec{v} = \vec{v}_1 + \vec{v}_2$, where $\vec{v}_1$ is parallel to $\vec{u}$ and $\vec{v}_2$ is perpendicular to $\vec{u}$. Then the value of $|\vec{v}_1|^2 + |\vec{v}_2|^2$ is equal to

- [JEE Main 2025 (Online) 4th April Morning Shift]
 (1) $\frac{23}{2}$ (2) $\frac{25}{2}$ (3) 10 (4) 14

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Q.12 If $\vec{a}$ is a nonzero vector such that its projections on the vectors $2\hat{i} - \hat{j} + 2\hat{k}$, $\hat{i} + 2\hat{j} - 2\hat{k}$ and $\hat{k}$ are equal, then a unit vector along $\vec{a}$ is :

[JEE Main 2025 (Online) 2nd April Morning Shift]

- (1) $\frac{1}{\sqrt{155}}(-7\hat{i} + 9\hat{j} + 5\hat{k})$
 (2) $\frac{1}{\sqrt{155}}(-7\hat{i} + 9\hat{j} - 5\hat{k})$
 (3) $\frac{1}{\sqrt{155}}(7\hat{i} + 9\hat{j} - 5\hat{k})$
 (4) $\frac{1}{\sqrt{155}}(7\hat{i} + 9\hat{j} + 5\hat{k})$

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Q.13 If the components of $\vec{a} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$ along and perpendicular to $\vec{b} = 3\hat{i} + \hat{j} - \hat{k}$ respectively, are $\frac{16}{11}(3\hat{i} + \hat{j} - \hat{k})$ and $\frac{1}{11}(-4\hat{i} - 5\hat{j} - 17\hat{k})$, then $\alpha^2 + \beta^2 + \gamma^2$ is equal to:

- [JEE Main 2025 (Online) 28th January Evening Shift]
 (1) 16 (2) 23 (3) 26 (4) 18

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Section B (Numerical) — 1 question

Q.14 Let a vector $\vec{a} = \sqrt{2}\hat{i} - \hat{j} + \lambda\hat{k}$, $\lambda > 0$, make an obtuse angle with the vector $\vec{b} = -\lambda^2\hat{i} + 4\sqrt{2}\hat{j} + 4\sqrt{2}\hat{k}$ and an angle θ , $\frac{\pi}{6} < \theta < \frac{\pi}{2}$, with the positive z-axis. If the set of all possible values of λ is $(\alpha, \beta) - \{\gamma\}$, then $\alpha + \beta + \gamma$ is equal to _____.

[JEE Main 2026 (Online) 22nd January Evening Shift]

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ANSWER KEY

Section A (MCQ) — 13 questions

Ques.	1	2	3	4	5	6	7	8	9	10	11
Ans.	3	2	2	2	1	4	1	1	2	1	4
Ques.	12	13									
Ans.	4	3									

Section B (Numerical) — 1 question

Ques.	14										
Ans.	5										