

**Topic: Vector Algebra**

Mathematics

Topic-wise JEE Main PYQ Part-2

Chetan Sir

Topic 1: Scalar Triple Product**Q1. JEE Main 2024**

Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{b}| = 1$ and $|\vec{b} \times \vec{a}| = 2$. Then $|\vec{b} \times \vec{a} - \vec{b}|^2$ is equal to

- (A) 1 (B) 3
(C) 5 (D) 4

Q2. JEE Main 2024

Let $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$ and $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ be two vectors such that $|\vec{a}| = 1$, $\vec{a} \cdot \vec{b} = 2$ and $|\vec{b}| = 4$. If $\vec{c} = 2(\vec{a} \times \vec{b}) - 3\vec{b}$, then the angle between $\vec{b}$ and $\vec{c}$ is equal to:

- (A) $\cos^{-1}\left(-\frac{1}{\sqrt{3}}\right)$
(B) $\cos^{-1}\left(\frac{2}{3}\right)$
(C) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$
(D) $\cos^{-1}\left(-\frac{\sqrt{3}}{2}\right)$

Q3. JEE Main 2024

Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{a}| = 1$, $|\vec{b}| = 4$, and $\vec{a} \cdot \vec{b} = 2$. If $\vec{c} = (2\vec{a} \times \vec{b}) - 3\vec{b}$ and the angle between $\vec{b}$ and $\vec{c}$ is α , then $192 \sin^2 \alpha$ is equal to _____.

Q4. JEE Main 2024

Let $\vec{a} = \hat{i} + 2\hat{j} + \hat{k}$, $\vec{b} = 3(\hat{i} - \hat{j} + \hat{k})$.

Let $\vec{c}$ be the vector such that $\vec{a} \times \vec{c} = \vec{b}$ and $\vec{a} \cdot \vec{c} = 3$.

Then $\vec{a} \cdot ((\vec{c} \times \vec{b}) - \vec{b} - \vec{c})$ is equal to :

- (A) 32 (B) 36 (C) 24 (D) 20

Q5. JEE Main 2024

Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{c} = x\hat{i} + 2\hat{j} + 3\hat{k}$, $x \in \mathbb{R}$.

If $\vec{d}$ is the unit vector in the direction of $\vec{b} + \vec{c}$ such that $\vec{a} \cdot \vec{d} = 1$, then $(\vec{a} \times \vec{b}) \cdot \vec{c}$ is equal to

- (A) 3 (B) 9 (C) 11 (D) 6

Q6. JEE Main 2023

Let $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{b} = \hat{i} + \hat{j} - \hat{k}$. If $\vec{c}$ is a vector such that $\vec{a} \cdot \vec{c} = 11$, $\vec{b} \cdot (\vec{a} \times \vec{c}) = 27$ and $\vec{b} \cdot \vec{c} = -\sqrt{3}|\vec{b}|$, then $|\vec{a} \times \vec{c}|^2$ is equal to _____.

Q7. JEE Main 2023

Let $\vec{a} = 4\hat{i} + 3\hat{j}$ and $\vec{b} = 3\hat{i} - 4\hat{j} + 5\hat{k}$. If $\vec{c}$ is a vector such that $\vec{c} \cdot (\vec{a} \times \vec{b}) + 25 = 0$, $\vec{c} \cdot (\hat{i} + \hat{j} + \hat{k}) = 4$, and projection of $\vec{c}$ on $\vec{a}$ is 1, then the projection of $\vec{c}$ on $\vec{b}$ equals :

- (A) $\frac{3}{\sqrt{2}}$ (B) $\frac{1}{\sqrt{2}}$ (C) $\frac{1}{5}$ (D) $\frac{5}{\sqrt{2}}$

Q8. JEE Main 2021

Let $\vec{a} = \hat{i} - \alpha\hat{j} + \beta\hat{k}$, $\vec{b} = 3\hat{i} + \beta\hat{j} - \alpha\hat{k}$ and $\vec{c} = -\alpha\hat{i} - 2\hat{j} + \hat{k}$, where α and β are integers. If $\vec{a} \cdot \vec{b} = -1$ and $\vec{b} \cdot \vec{c} = 10$, then $(\vec{a} \times \vec{b}) \cdot \vec{c}$ is equal to _____.

Q9. JEE Main 2021

If $\vec{a} = \alpha\hat{i} + \beta\hat{j} + 3\hat{k}$,

$\vec{b} = -\beta\hat{i} - \alpha\hat{j} - \hat{k}$ and

$\vec{c} = \hat{i} - 2\hat{j} - \hat{k}$ such that $\vec{a} \cdot \vec{b} = 1$ and $\vec{b} \cdot \vec{c} = -3$, then $\frac{1}{3}((\vec{a} \times \vec{b}) \cdot \vec{c})$ is equal to _____.

Q10. JEE Main 2014

If $[\vec{a} \times \vec{b} \quad \vec{b} \times \vec{c} \quad \vec{c} \times \vec{a}] = \lambda [\vec{a} \quad \vec{b} \quad \vec{c}]^2$ then λ is equal to :

- (A) 0 (B) 1 (C) 2 (D) 3

Q11. JEE Main 2021

Let a vector $\vec{a}$ be coplanar with vectors $\vec{b} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} + \hat{k}$. If $\vec{a}$ is perpendicular to $\vec{d} = 3\hat{i} + 2\hat{j} + 6\hat{k}$, and $|\vec{a}| = \sqrt{10}$. Then a possible value of $[\vec{a} \quad \vec{b} \quad \vec{c}] + [\vec{a} \quad \vec{b} \quad \vec{d}] + [\vec{a} \quad \vec{c} \quad \vec{d}]$ is equal to :

- (A) -42 (B) -40 (C) -29 (D) -38

Topic 2: Coplanar**Q12. JEE Main 2023**

Let S be the set of all (λ, μ) for which the vectors $\lambda\hat{i} - \hat{j} + \hat{k}$, $\hat{i} + 2\hat{j} + \mu\hat{k}$ and $3\hat{i} - 4\hat{j} + 5\hat{k}$, where $\lambda - \mu = 5$, are coplanar, then $\sum_{(\lambda, \mu) \in S} 80(\lambda^2 + \mu^2)$ is equal to :

- (A) 2370 (B) 2130 (C) 2210 (D) 2290

Q13. JEE Main 2023

If the vectors $\vec{a} = \lambda\hat{i} + \mu\hat{j} + 4\hat{k}$, $\vec{b} = -2\hat{i} + 4\hat{j} - 2\hat{k}$ and $\vec{c} = 2\hat{i} + 3\hat{j} + \hat{k}$ are coplanar and the projection of $\vec{a}$ on the vector $\vec{b}$ is $\sqrt{54}$ units, then the sum of all possible values of $\lambda + \mu$ is equal to :

- (A) 24 (B) 0 (C) 18 (D) 6

Q14. JEE Main 2023

If the four points, whose position vectors are $3\hat{i} - 4\hat{j} + 2\hat{k}$, $\hat{i} + 2\hat{j} - \hat{k}$, $-2\hat{i} - \hat{j} + 3\hat{k}$ and $5\hat{i} - 2\alpha\hat{j} + 4\hat{k}$ are coplanar, then α is equal to :

- (A) $\frac{73}{17}$ (B) $-\frac{73}{17}$ (C) $-\frac{107}{17}$ (D) $\frac{107}{17}$

Q15. JEE Main 2023

Let the vectors $\vec{u}_1 = \hat{i} + \hat{j} + a\hat{k}$, $\vec{u}_2 = \hat{i} + b\hat{j} + \hat{k}$ and $\vec{u}_3 = c\hat{i} + \hat{j} + \hat{k}$ be coplanar. If the vectors $\vec{v}_1 = (a+b)\hat{i} + c\hat{j} + c\hat{k}$, $\vec{v}_2 = a\hat{i} + (b+c)\hat{j} + a\hat{k}$ and $\vec{v}_3 = b\hat{i} + b\hat{j} + (c+a)\hat{k}$ are also coplanar, then $6(a+b+c)$ is equal to :

- (A) 12 (B) 6 (C) 0 (D) 4

Q16. JEE Main 2023

Let the position vectors of the points A, B, C and D be $5\hat{i} + 5\hat{j} + 2\lambda\hat{k}$, $\hat{i} + 2\hat{j} + 3\hat{k}$, $-2\hat{i} + \lambda\hat{j} + 4\hat{k}$ and $-\hat{i} + 5\hat{j} + 6\hat{k}$. Let the set $S = \{\lambda \in \mathbb{R} : \text{the points A, B, C and D are coplanar}\}$.

Then $\sum_{\lambda \in S} (\lambda + 2)^2$ is equal to :

- (A) $\frac{37}{2}$ (B) 25 (C) 13 (D) 41

Q17. JEE Main 2023

The sum of all values of α , for which the points whose position vectors are $\hat{i} - 2\hat{j} + 3\hat{k}$, $2\hat{i} - 3\hat{j} + 4\hat{k}$, $(\alpha + 1)\hat{i} + 2\hat{k}$ and $9\hat{i} + (\alpha - 8)\hat{j} + 6\hat{k}$ are coplanar, is equal to :

- (A) 6 (B) 4 (C) -2 (D) 2

Q18. JEE Main 2022

If $\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}$, $\vec{b} = 3\hat{i} + 3\hat{j} + \hat{k}$ and $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$ are coplanar vectors and $\vec{a} \cdot \vec{c} = 5$, $\vec{b} \perp \vec{c}$, then $122(c_1 + c_2 + c_3)$ is equal to _____.

Q19. JEE Main 2021

Let a, b and c be distinct positive numbers. If the vectors $a\hat{i} + a\hat{j} + c\hat{k}$, $\hat{i} + \hat{k}$ and $c\hat{i} + c\hat{j} + b\hat{k}$ are co-planar, then c is equal to :

- (A) $\frac{2}{\frac{1}{a} + \frac{1}{b}}$ (B) $\frac{a+b}{2}$
(C) $\frac{1}{a} + \frac{1}{b}$ (D) $\sqrt{ab}$

Q20. JEE Main 2020

If the vectors, $\vec{p} = (a+1)\hat{i} + a\hat{j} + a\hat{k}$, $\vec{q} = a\hat{i} + (a+1)\hat{j} + a\hat{k}$ and $\vec{r} = a\hat{i} + a\hat{j} + (a+1)\hat{k}$ ($a \in \mathbb{R}$) are coplanar and $3(\vec{p} \cdot \vec{q})^2 - \lambda |\vec{r} \times \vec{q}|^2 = 0$, then the value of λ is _____.

Q21. JEE Main 2019

Let $\vec{a} = \hat{i} + 2\hat{j} + 4\hat{k}$, $\vec{b} = \hat{i} + \lambda\hat{j} + 4\hat{k}$ and $\vec{c} = 2\hat{i} + 4\hat{j} + (\lambda^2 - 1)\hat{k}$ be coplanar vectors. Then the non-zero vector $\vec{a} \times \vec{c}$ is :

- (A) $-10\hat{i} - 5\hat{j}$
(B) $-10\hat{i} + 5\hat{j}$
(C) $-14\hat{i} + 5\hat{j}$
(D) $-14\hat{i} - 5\hat{j}$

Q22. JEE Main 2019

Let $\alpha \in \mathbb{R}$ and the three vectors

$\vec{a} = \alpha\hat{i} + \hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} - \alpha\hat{k}$ and $\vec{c} = \alpha\hat{i} - 2\hat{j} + 3\hat{k}$.

Then the set

$S = \{\alpha :$

$\vec{a},$

$\vec{b}$ and

$\vec{c}$ are coplanar $\}$:

- (A) contains exactly two numbers only one of which is positive
(B) is singleton
(C) contains exactly two positive numbers
(D) is empty

Q23. JEE Main 2019

The sum of the distinct real values of μ , for which the vectors, $\mu\hat{i} + \hat{j} + \hat{k}$, $\hat{i} + \mu\hat{j} + \hat{k}$, $\hat{i} + \hat{j} + \mu\hat{k}$ are co-planar, is :

- (A) 2 (B) -1 (C) 0 (D) 1

Q24. JEE Main 2007

Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + 2\hat{k}$ and $\vec{c} = x\hat{i} + (x-2)\hat{j} - \hat{k}$. If the vectors $\vec{c}$ lies in the plane of $\vec{a}$ and $\vec{b}$, then x equals :

- (A) -4 (B) -2 (C) 0 (D) 1.

Topic 3: Application of STP Volumn**Q25. JEE Main 2020**

Let the volume of a parallelopiped whose cotermious edges are given by

$\vec{u} = \hat{i} + \hat{j} + \lambda\hat{k}$, $\vec{v} = \hat{i} + \hat{j} + 3\hat{k}$ and

$\vec{w} = 2\hat{i} + \hat{j} + \hat{k}$ be 1 cu. unit. If θ be the angle between the edges $\vec{u}$ and $\vec{w}$, then $\cos\theta$ can be :

- (A) $\frac{7}{6\sqrt{3}}$ (B) $\frac{7}{6\sqrt{6}}$ (C) $\frac{5}{7}$ (D) $\frac{5}{3\sqrt{3}}$

Q26. JEE Main 2020

If the volume of a parallelopiped, whose cotermious edges are given by the

vectors $\vec{a} = \hat{i} + \hat{j} + n\hat{k}$,

$\vec{b} = 2\hat{i} + 4\hat{j} - n\hat{k}$ and

$\vec{c} = \hat{i} + n\hat{j} + 3\hat{k}$ ($n \geq 0$), is 158 cu. units, then :

- (A) $n = 7$ (B) $\vec{b} \cdot \vec{c} = 10$
(C) $\vec{a} \cdot \vec{c} = 17$ (D) $n = 9$

Q27. JEE Main 2019

If the volume of parallelepiped formed by the vectors $\hat{i} + \lambda\hat{j} + \hat{k}$, $\hat{j} + \lambda\hat{k}$ and $\lambda\hat{i} + \hat{k}$ is minimum, then λ is equal to :

- (A) $-\frac{1}{\sqrt{3}}$ (B) $\sqrt{3}$
(C) $-\sqrt{3}$ (D) $\frac{1}{\sqrt{3}}$

Q28. JEE Main 2023

Let the vectors $\vec{a}, \vec{b}, \vec{c}$ represent three coterminal edges of a parallelepiped of volume V . Then the volume of the parallelepiped, whose coterminal edges are represented by $\vec{a}, \vec{b} + \vec{c}$ and $\vec{a} + 2\vec{b} + 3\vec{c}$ is equal to :

- (A) $3V$ (B) $2V$
(C) $6V$ (D) V

Topic 4: STP-2**Q29. JEE Main 2025**

Let $\vec{a} = 2\hat{i} - 3\hat{j} + \hat{k}$, $\vec{b} = 3\hat{i} + 2\hat{j} + 5\hat{k}$ and a vector $\vec{c}$ be such that $(\vec{a} - \vec{c}) \times \vec{b} = -18\hat{i} - 3\hat{j} + 12\hat{k}$ and $\vec{a} \cdot \vec{c} = 3$. If $\vec{b} \times \vec{c} = \vec{d}$, then $|\vec{a} \cdot \vec{d}|$ is equal to :

- (A) 15 (B) 18 (C) 12 (D) 9

Q30. JEE Main 2025

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

- (A) 31 (B) 29 (C) 24 (D) 27

Q31. JEE Main 2023

Let $\vec{v} = \alpha\hat{i} + 2\hat{j} - 3\hat{k}$, $\vec{w} = 2\alpha\hat{i} + \hat{j} - \hat{k}$ and $\vec{u}$ be a vector such that $|\vec{u}| = \alpha > 0$. If the minimum value of the scalar triple product $[\vec{u} \ \vec{v} \ \vec{w}]$ is $-\alpha\sqrt{3401}$, and $|\vec{u} \cdot \hat{i}|^2 = \frac{m}{n}$ where m and n are coprime natural numbers, then $m + n$ is equal to _____.

Q32. JEE Main 2022

Let a vector $\vec{c}$ be coplanar with the vectors $\vec{a} = -\hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} - \hat{k}$. If the vector $\vec{c}$ also satisfies the conditions $\vec{c} \cdot [(\vec{a} + \vec{b}) \times (\vec{a} \times \vec{b})] = -42$ and $(\vec{c} \times (\vec{a} - \vec{b})) \cdot \hat{k} = 3$, then the value of $|\vec{c}|^2$ is equal to :

- (A) 24 (B) 29 (C) 35 (D) 42

Q33. JEE Main 2022

Let the vectors $\vec{a} = (1+t)\hat{i} + (1-t)\hat{j} + \hat{k}$, $\vec{b} = (1-t)\hat{i} + (1+t)\hat{j} + 2\hat{k}$ and $\vec{c} = t\hat{i} - t\hat{j} + \hat{k}$, $t \in \mathbf{R}$ be such that for $\alpha, \beta, \gamma \in \mathbf{R}$, $\alpha\vec{a} + \beta\vec{b} + \gamma\vec{c} = \vec{0} \Rightarrow \alpha = \beta = \gamma = 0$. Then, the set of all values of t is :

- (A) a non-empty finite set
(B) equal to $\mathbf{N}$
(C) equal to $\mathbf{R} - \{0\}$
(D) equal to $\mathbf{R}$

Q34. JEE Main 2021

Let three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ be such that $\vec{a} \times \vec{b} = \vec{c}$, $\vec{b} \times \vec{c} = \vec{a}$ and $|\vec{a}| = 2$. Then which one of the following is not true?

- (A) $\vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} \times \vec{c})) = \vec{0}$
(B) Projection of $\vec{a}$ on $(\vec{b} \times \vec{c})$ is 2
(C) $[\vec{a} \ \vec{b} \ \vec{c}] + [\vec{c} \ \vec{a} \ \vec{b}] = 8$
(D) $|3\vec{a} + \vec{b} - 2\vec{c}|^2 = 51$

Q35. JEE Main 2021

Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$. If $\vec{c}$ is a vector such that $\vec{a} \times \vec{c} = \vec{b}$ and $\vec{a} \cdot \vec{c} = 3$, then $\vec{a} \cdot (\vec{b} \times \vec{c})$ is equal to :

- (A) -2 (B) -6 (C) 6 (D) 2

Q36. JEE Main 2020

Let x_0 be the point of Local maxima of $f(x) = \vec{a} \cdot (\vec{b} \times \vec{c})$, where

$\vec{a} = x\hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = -2\hat{i} + x\hat{j} - \hat{k}$, $\vec{c} = 7\hat{i} - 2\hat{j} + x\hat{k}$. Then the value of

$\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$ at $x = x_0$ is :

- (A) 14 (B) -30 (C) -4 (D) -22

Topic 5: VTP-1**Q37. JEE Main 2026**

Let $\vec{a} = -\hat{i} + \hat{j} + 2\hat{k}$, $\vec{b} = \hat{i} - \hat{j} - 3\hat{k}$, $\vec{c} = \vec{a} \times \vec{b}$ and $\vec{d} = \vec{c} \times \vec{a}$. Then $(\vec{a} - \vec{b}) \cdot \vec{d}$ is equal to :

- (A) 2 (B) -2 (C) 4 (D) -4

Q38. JEE Main 2024

Let $\vec{a} = -5\hat{i} + \hat{j} - 3\hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - 4\hat{k}$ and $\vec{c} = ((\vec{a} \times \vec{b}) \times \hat{i}) \times \hat{i}$. Then $\vec{c} \cdot (-\hat{i} + \hat{j} + \hat{k})$ is equal to :

- (A) -12 (B) -10 (C) -13 (D) -15

Q39. JEE Main 2021

If $\vec{a}$ and $\vec{b}$ are perpendicular, then $\vec{a} \times (\vec{a} \times (\vec{a} \times (\vec{a} \times \vec{b})))$ is equal to :

- (A) $\frac{1}{2}|\vec{a}|^4\vec{b}$ (B) $\vec{0}$
(C) $\vec{a} \times \vec{b}$ (D) $|\vec{a}|^4\vec{b}$

Q40. JEE Main 2021

Let $\vec{a} = \hat{i} + \hat{j} + 2\hat{k}$ and $\vec{b} = -\hat{i} + 2\hat{j} + 3\hat{k}$. Then the vector product $(\vec{a} + \vec{b}) \times ((\vec{a} \times ((\vec{a} - \vec{b}) \times \vec{b})) \times \vec{b})$ is equal to :

- (A) $5(34\hat{i} - 5\hat{j} + 3\hat{k})$
(B) $7(34\hat{i} - 5\hat{j} + 3\hat{k})$
(C) $7(30\hat{i} - 5\hat{j} + 7\hat{k})$
(D) $5(30\hat{i} - 5\hat{j} + 7\hat{k})$

Q41. JEE Main 2022

Let $\vec{a} = 2\hat{i} - \hat{j} + 5\hat{k}$ and $\vec{b} = \alpha\hat{i} + \beta\hat{j} + 2\hat{k}$. If $((\vec{a} \times \vec{b}) \times \hat{i}) \cdot \hat{k} = \frac{23}{2}$, then $|\vec{b} \times 2\hat{j}|$ is equal to :

- (A) 4 (B) 5
(C) $\sqrt{21}$ (D) $\sqrt{17}$

Q42. JEE Main 2020

If $\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$, then the value of $|\hat{i} \times (\vec{a} \times \hat{i})|^2 + |\hat{j} \times (\vec{a} \times \hat{j})|^2 + |\hat{k} \times (\vec{a} \times \hat{k})|^2$ is equal to _____

Q43. JEE Main 2023

Let $\lambda \in \mathbb{R}$, $\vec{a} = \lambda\hat{i} + 2\hat{j} - 3\hat{k}$, $\vec{b} = \hat{i} - \lambda\hat{j} + 2\hat{k}$. If $((\vec{a} + \vec{b}) \times (\vec{a} \times \vec{b})) \times (\vec{a} - \vec{b}) = 8\hat{i} - 40\hat{j} - 24\hat{k}$, then $|\lambda(\vec{a} + \vec{b}) \times (\vec{a} - \vec{b})|^2$ is equal to :

- (A) 136
(B) 140
(C) 144
(D) 132

Topic 6: VTP-2**Q44. JEE Main 2025**

Let $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 3\hat{i} + \hat{j} - \hat{k}$ and $\vec{c}$ be three vectors such that $\vec{c}$ is coplanar with $\vec{a}$ and $\vec{b}$. If the vector $\vec{C}$ is perpendicular to $\vec{b}$ and $\vec{a} \cdot \vec{c} = 5$, then $|\vec{c}|$ is equal to

- (A) $\sqrt{\frac{11}{6}}$ (B) $\frac{1}{3\sqrt{2}}$
(C) 18 (D) 16

Q45. JEE Main 2019

Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three unit vectors, out of which vectors $\vec{b}$ and $\vec{c}$ are non-parallel. If α and β are the angles which vector $\vec{a}$ makes with vectors $\vec{b}$ and $\vec{c}$ respectively and $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{1}{2}\vec{b}$, then $|\alpha - \beta|$ is equal to :

- (A) 90° (B) 30° (C) 45° (D) 60°

Q46. JEE Main 2016

Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three unit vectors such that $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{\sqrt{3}}{2}(\vec{b} + \vec{c})$. If $\vec{b}$ is not parallel to $\vec{c}$, then the angle between $\vec{a}$ and $\vec{b}$ is:

- (A) $\frac{2\pi}{3}$ (B) $\frac{5\pi}{6}$ (C) $\frac{3\pi}{4}$ (D) $\frac{\pi}{2}$

Q47. JEE Main 2022

Let $\vec{a} = 3\hat{i} + \hat{j}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$. Let $\vec{c}$ be a vector satisfying $\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b} + \lambda\vec{c}$. If $\vec{b}$ and $\vec{c}$ are non-parallel, then the value of λ is :

- (A) -5 (B) 5 (C) 1 (D) -1

Q48. JEE Main 2011

If $\vec{a} = \frac{1}{\sqrt{10}}(3\hat{i} + \hat{k})$ and $\vec{b} = \frac{1}{7}(2\hat{i} + 3\hat{j} - 6\hat{k})$, then the value of $(2\vec{a} - \vec{b}) \cdot [(\vec{a} \times \vec{b}) \times (\vec{a} + 2\vec{b})]$ is :

- (A) -3 (B) 5 (C) 3 (D) -5

Q49. JEE Main 2024

Let $\vec{a} = 6\hat{i} + \hat{j} - \hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that $|\vec{c}| \geq 6$, $\vec{a} \cdot \vec{c} = 6|\vec{c}|$, $|\vec{c} - \vec{a}| = 2\sqrt{2}$ and the angle between $\vec{a} \times \vec{b}$ and $\vec{c}$ is 60° , then $|(\vec{a} \times \vec{b}) \times \vec{c}|$ is equal to:

- (A) $\frac{3}{2}\sqrt{6}$ (B) $\frac{9}{2}(6 - \sqrt{6})$
(C) $\frac{9}{2}(6 + \sqrt{6})$ (D) $\frac{3}{2}\sqrt{3}$

Q50. JEE Main 2021

Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that $\vec{a} \cdot \vec{c} = |\vec{c}|$, $|\vec{c} - \vec{a}| = 2\sqrt{2}$ and the angle between $(\vec{a} \times \vec{b})$ and $\vec{c}$ is $\frac{\pi}{6}$, then the value of $|(\vec{a} \times \vec{b}) \times \vec{c}|$ is :

- (A) $\frac{2}{3}$ (B) 4 (C) 3 (D) $\frac{3}{2}$

Q51. JEE Main 2020

Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}| = \sqrt{3}$, $|\vec{b}| = 5$, $\vec{b} \cdot \vec{c} = 10$ and the angle between $\vec{b}$ and $\vec{c}$ is $\frac{\pi}{3}$. If $\vec{a}$ is perpendicular to the vector $\vec{b} \times \vec{c}$, then $|\vec{a} \times (\vec{b} \times \vec{c})|$ is equal to _____.

Q52. JEE Main 2017

Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. Let $\vec{c}$ be a vector such that $|\vec{c} - \vec{a}| = 3$, $|(\vec{a} \times \vec{b}) \times \vec{c}| = 3$ and the angle between $\vec{c}$ and $\vec{a} \times \vec{b}$ is 30° . Then $\vec{a} \cdot \vec{c}$ is equal to :

- (A) 2 (B) 5 (C) $\frac{1}{8}$ (D) $\frac{25}{8}$

Topic 7: Scalar Triple Product of 4 Vectors**Q53. JEE Main 2023**

Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non zero vectors such that $\vec{b} \cdot \vec{c} = 0$ and $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{\vec{b} - \vec{c}}{2}$. If $\vec{d}$ be a vector such that $\vec{b} \cdot \vec{d} = \vec{a} \cdot \vec{b}$, then $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d})$ is equal to

- (A) $\frac{1}{2}$ (B) $-\frac{1}{4}$ (C) $\frac{1}{4}$ (D) $\frac{3}{4}$

Topic 8: Angle Bisector**Q54. JEE Main 2026**

Let P be a point in the plane of the vectors $\vec{AB} = 3\hat{i} + \hat{j} - \hat{k}$ and $\vec{AC} = \hat{i} - \hat{j} + 3\hat{k}$ such that P is equidistant from the lines AB and AC. If $|\vec{AP}| = \frac{\sqrt{5}}{2}$, then the area of the triangle ABP is :

- (A) $\frac{3}{2}$ (B) $\frac{\sqrt{30}}{4}$ (C) $\frac{\sqrt{26}}{4}$ (D) 2

Q55. JEE Main 2026

Let PQR be a triangle such that $\vec{PQ} = -2\hat{i} - \hat{j} + 2\hat{k}$ and $\vec{PR} = a\hat{i} + b\hat{j} - 4\hat{k}$, $a, b \in \mathbb{Z}$. Let S be the point on QR, which is equidistant from the lines PQ and PR. If $|\vec{PS}| = 9$ and $\vec{PS} = \hat{i} - 7\hat{j} + 2\hat{k}$, then the value of $3a - 4b$ is _____

Q56. JEE Main 2025

Let A, B, C be three points in xy -plane, whose position vector are given by $\sqrt{3}\hat{i} + \hat{j}$, $\hat{i} + \sqrt{3}\hat{j}$ and $a\hat{i} + (1-a)\hat{j}$ respectively with respect to the origin O . If the distance of the point C from the line bisecting the angle between the vectors $\vec{OA}$ and $\vec{OB}$ is $\frac{9}{\sqrt{2}}$, then the sum of all the possible values of a is :

- (A) 2 (B) 0 (C) $\frac{9}{2}$ (D) 1

Q57. JEE Main 2024

The position vectors of the vertices A, B and C of a triangle are $2\hat{i} - 3\hat{j} + 3\hat{k}$, $2\hat{i} + 2\hat{j} + 3\hat{k}$ and $-\hat{i} + \hat{j} + 3\hat{k}$ respectively. Let l denotes the length of the angle bisector AD of $\angle BAC$ where D is on the line segment BC , then $2l^2$ equals :

- (A) 45 (B) 50 (C) 42 (D) 49

Q58. JEE Main 2020

A vector $\vec{a} = \alpha\hat{i} + 2\hat{j} + \beta\hat{k}$ ($\alpha, \beta \in R$) lies in the plane of the vectors, $\vec{b} = \hat{i} + \hat{j}$ and $\vec{c} = \hat{i} - \hat{j} + 4\hat{k}$. If $\vec{a}$ bisects the angle between $\vec{b}$ and $\vec{c}$, then:

- (A) $\vec{a} \cdot \hat{i} + 3 = 0$ (B) $\vec{a} \cdot \hat{k} - 4 = 0$
(C) $\vec{a} \cdot \hat{i} + 1 = 0$ (D) $\vec{a} \cdot \hat{k} + 2 = 0$

Q59. JEE Main 2019

Let $\sqrt{3}\hat{i} + \hat{j}$, $\hat{i} + \sqrt{3}\hat{j}$ and $\beta\hat{i} + (1-\beta)\hat{j}$ respectively be the position vectors of the points A, B and C with respect to the origin O . If the distance of C from the bisector of the acute angle between OA and OB is $\frac{3}{\sqrt{2}}$, then the sum of all possible values of β is :

- (A) 4 (B) 1 (C) 2 (D) 3

Q60. JEE Main 2018

If the position vectors of the vertices A, B and C of a ΔABC are respectively $4\hat{i} + 7\hat{j} + 8\hat{k}$, $2\hat{i} + 3\hat{j} + 4\hat{k}$, and $2\hat{i} + 5\hat{j} + 7\hat{k}$, then the position vectors of the point, where the bisector of $\angle A$ meets BC is :

- (A) $\frac{1}{2}(4\hat{i} + 8\hat{j} + 11\hat{k})$
(B) $\frac{1}{3}(6\hat{i} + 11\hat{j} + 15\hat{k})$
(C) $\frac{1}{3}(6\hat{i} + 13\hat{j} + 18\hat{k})$
(D) $\frac{1}{4}(8\hat{i} + 14\hat{j} + 19\hat{k})$

Topic 9: Position Vector

Q61. JEE Main 2026

Let O be the origin, $\vec{OP} = \vec{a}$ and $\vec{OQ} = \vec{b}$. If R is the point on $\vec{OP}$ such that $\vec{OR} = 5\vec{OR}$, and M is the point such that $\vec{OQ} = 5\vec{RM}$, then $\vec{PM}$ is equal to :

- (A) $\frac{1}{5}(\vec{a} - 4\vec{b})$ (B) $\frac{1}{5}(\vec{b} - 4\vec{a})$
(C) $\frac{1}{5}(-\vec{a} + 4\vec{b})$ (D) $\frac{1}{5}(-\vec{b} + 4\vec{a})$

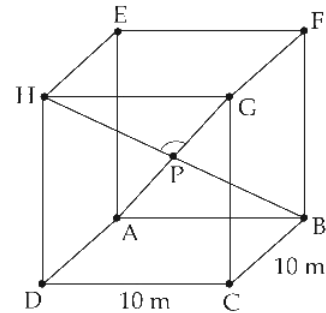
Q62. JEE Main 2023

Let $ABCD$ be a quadrilateral. If E and F are the mid points of the diagonals AC and BD respectively and $(\vec{AB} - \vec{BC}) + (\vec{AD} - \vec{DC}) = k\vec{FE}$, then k is equal to :

- (A) -2 (B) 4
(C) -4 (D) 2

Q63. JEE Main 2021

A hall has a square floor of dimension $10 \text{ m} \times 10 \text{ m}$ (see the figure) and vertical walls. If the angle GPH between the diagonals AG and BH is $\cos^{-1}\frac{1}{5}$, then the height of the hall (in meters) is :



- (A) 5 (B) $2\sqrt{10}$
(C) $5\sqrt{3}$ (D) $5\sqrt{2}$

Q64. JEE Main 2013

If the vectors $\vec{AB} = 3\hat{i} + 4\hat{k}$ and $\vec{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$ are the sides of a triangle ABC , then the length of the median through A is :

- (A) $\sqrt{18}$ (B) $\sqrt{72}$ (C) $\sqrt{33}$ (D) $\sqrt{45}$

Q65. JEE Main 2006

The values of a , for which the points A, B, C with position vectors $2\hat{i} - \hat{j} + \hat{k}$, $\hat{i} - 3\hat{j} - 5\hat{k}$ and $a\hat{i} - 3\hat{j} + \hat{k}$ respectively are the vertices of a right angled triangle with $C = \frac{\pi}{2}$ are :

- (A) 2 and 1 (B) -2 and -1
(C) -2 and 1 (D) 2 and -1

Q66. JEE Main 2003

The vectors $\vec{AB} = 3\hat{i} + 4\hat{k}$ & $\vec{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$ are the sides of triangle ABC . The length of the median through A is :

- (A) $\sqrt{288}$ (B) $\sqrt{18}$ (C) $\sqrt{72}$ (D) $\sqrt{33}$

Q67. JEE Main 2003

A tetrahedron has vertices at $O(0, 0, 0)$, $A(1, 2, 1)$, $B(2, 1, 3)$ and $C(-1, 1, 2)$. Then the angle between the faces OAB and ABC will be :

- (A) 90°
(B) $\cos^{-1}\left(\frac{19}{35}\right)$
(C) $\cos^{-1}\left(\frac{17}{31}\right)$
(D) 30°

Topic 10: Centre of Triangle

Q68. JEE Main 2025

Let the position vectors of three vertices of a triangle be $4\vec{p} + \vec{q} - 3\vec{r}$, $-5\vec{p} + \vec{q} + 2\vec{r}$ and $2\vec{p} - \vec{q} + 2\vec{r}$. If the position vectors of the orthocenter and the circumcenter of the triangle are $\frac{\vec{p} + \vec{q} + \vec{r}}{4}$ and $\alpha\vec{p} + \beta\vec{q} + \gamma\vec{r}$ respectively, then $\alpha + 2\beta + 5\gamma$ is equal to :

- (A) 4 (B) 3
(C) 1 (D) 6

Q69. JEE Main 2025

Let the three sides of a triangle ABC be given by the vectors $2\hat{i} - \hat{j} + \hat{k}$, $\hat{i} - 3\hat{j} - 5\hat{k}$ and $3\hat{i} - 4\hat{j} - 4\hat{k}$. Let G be the centroid of the triangle ABC . Then $6(|\vec{AG}|^2 + |\vec{BG}|^2 + |\vec{CG}|^2)$ is equal to _____.

Q70. JEE Main 2024

Let the position vectors of the vertices A, B and C of a triangle be $2\hat{i} + 2\hat{j} + \hat{k}$, $\hat{i} + 2\hat{j} + 2\hat{k}$ and $2\hat{i} + \hat{j} + 2\hat{k}$ respectively. Let l_1, l_2 and l_3 be the lengths of perpendiculars drawn from the ortho center of the triangle on the sides AB, BC and CA respectively, then $l_1^2 + l_2^2 + l_3^2$ equals:

- (A) $\frac{1}{4}$ (B) $\frac{1}{5}$ (C) $\frac{1}{3}$ (D) $\frac{1}{2}$

Q71. JEE Main 2019

Let A (3, 0, -1), B(2, 10, 6) and C(1, 2, 1) be the vertices of a triangle and M be the midpoint of AC. If G divides BM in the ratio, 2 : 1, then $\cos(\angle GOA)$ (O being the origin) is equal to :

- (A) $\frac{1}{\sqrt{15}}$ (B) $\frac{1}{6\sqrt{10}}$
(C) $\frac{1}{\sqrt{30}}$ (D) $\frac{1}{2\sqrt{15}}$

Q72. JEE Main 2016

Let ABC be a triangle whose circumcentre is at P. If the position vectors of A, B, C and P are $\vec{a}$, $\vec{b}$, $\vec{c}$ and $\frac{\vec{a} + \vec{b} + \vec{c}}{4}$ respectively, then the position vector of the orthocentre of this triangle, is :

- (A) $\vec{a} + \vec{b} + \vec{c}$
(B) $-\left(\frac{\vec{a} + \vec{b} + \vec{c}}{2}\right)$
(C) $\vec{0}$
(D) $\left(\frac{\vec{a} + \vec{b} + \vec{c}}{2}\right)$

Topic 11: Vector Equation Take Dot/Cross

Q73. JEE Main 2023

Let $\vec{a}$ and $\vec{b}$ be two vectors, Let $|\vec{a}| = 1$, $|\vec{b}| = 4$ and $\vec{a} \cdot \vec{b} = 2$. If $\vec{c} = (2\vec{a} \times \vec{b}) - 3\vec{b}$, then the value of $\vec{b} \cdot \vec{c}$ is :

- (A) -48
(B) -60
(C) -84
(D) -24

Q74. JEE Main 2022

Let $\vec{a}$ and $\vec{b}$ be the vectors along the diagonals of a parallelogram having area $2\sqrt{2}$. Let the angle between $\vec{a}$ and $\vec{b}$ be acute, $|\vec{a}| = 1$, and $|\vec{a} \cdot \vec{b}| = |\vec{a} \times \vec{b}|$. If $\vec{c} = 2\sqrt{2}(\vec{a} \times \vec{b}) - 2\vec{b}$, then an angle between $\vec{b}$ and $\vec{c}$ is :

- (A) $\frac{\pi}{4}$ (B) $-\frac{\pi}{4}$ (C) $\frac{5\pi}{6}$ (D) $\frac{3\pi}{4}$

Q75. JEE Main 2025

Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 2\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{d} = \vec{a} \times \vec{b}$. If $\vec{c}$ is a vector such that $\vec{a} \cdot \vec{c} = |\vec{c}|$, $|\vec{c} - 2\vec{a}|^2 = 8$ and the angle between $\vec{d}$ and $\vec{c}$ is $\frac{\pi}{4}$, then $|10 - 3\vec{b} \cdot \vec{c}| + |\vec{d} \times \vec{c}|^2$ is equal to _____.

Q76. JEE Main 2026

Let $\hat{u}$ and $\hat{v}$ be unit vectors inclined at an acute angle such that $|\hat{u} \times \hat{v}| = \frac{\sqrt{3}}{2}$. If $\vec{A} = \lambda\hat{u} + \hat{v} + (\hat{u} \times \hat{v})$, then λ is equal to:

- (A) $\frac{4}{3}(\vec{A} \cdot \hat{u}) - \frac{2}{3}(\vec{A} \cdot \hat{v})$
(B) $\frac{2}{3}(\vec{A} \cdot \hat{u}) - \frac{1}{3}(\vec{A} \cdot \hat{v})$
(C) $\frac{4}{3}(\vec{A} \cdot \hat{u}) + \frac{2}{3}(\vec{A} \cdot \hat{v})$
(D) $(\vec{A} \cdot \hat{u}) - \frac{1}{2}(\vec{A} \cdot \hat{v})$

ANSWER KEY

1. C	2. D	3. 48	4. C	5. C	6. 285	7. D	8. 9	9. 2	10. B
11. A	12. D	13. A	14. A	15. A	16. D	17. D	18. 150	19. D	20. 1
21. B	22. D	23. B	24. B	25. A	26. B	27. D	28. D	29. A	30. B
31. 3501	32. C	33. C	34. D	35. A	36. D	37. B	38. A	39. D	40. B
41. B	42. 18	43. B	44. A	45. B	46. B	47. A	48. D	49. C	50. D
51. 30	52. A	53. C	54. B	55. 37	56. D	57. A	58. B	59. B	60. C
61. B	62. C	63. D	64. C	65. A	66. D	67. B	68. B	69. 164	70. D
71. A	72. D	73. A	74. D	75. 6	76. A				