

Q1. JEE Main 2026 (21 January Shift 2)

For a triangle ABC, let $\vec{p} = \overrightarrow{BC}$, $\vec{q} = \overrightarrow{CA}$ and $\vec{r} = \overrightarrow{BA}$. If $|\vec{p}| = 2\sqrt{3}$, $|\vec{q}| = 2$ and $\cos \theta = \frac{1}{\sqrt{3}}$, where θ is the angle between $\vec{p}$ and $\vec{q}$, then $|\vec{p} \times (\vec{q} - 3\vec{r})|^2 + 3|\vec{r}|^2$ is equal to :

- (1) 410 (2) 340 (3) 200 (4) 220

Q2. JEE Main 2026 (23 January Shift 1)

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 :

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

Q3. JEE Main 2026 (28 January Shift 2)

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

- (1) 2 (2) $\frac{\sqrt{30}}{4}$ (3) $\frac{3}{2}$ (4) $\frac{\sqrt{26}}{4}$

Q4. JEE Main 2026 (24 January Shift 2)

Let $\vec{a} = 2\hat{i} - 5\hat{j} + 5\hat{k}$ and $\vec{b} = \hat{i} - \hat{j} + 3\hat{k}$. If $\vec{c}$ is a vector such that $2(\vec{a} \times \vec{c}) + 3(\vec{b} \times \vec{c}) = \vec{0}$ and $(\vec{a} - \vec{b}) \cdot \vec{c} = -97$, then $|\vec{c} \times \hat{k}|^2$ is equal to

- (1) 233 (2) 218 (3) 193 (4) 205

Q5. JEE Main 2026 (24 January Shift 2)

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 $\vec{v}$ 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

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

Q6. JEE Main 2026 (22 January Shift 2)

Let $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = \lambda\hat{j} + 2\hat{k}$, $\lambda \in \mathbb{Z}$ be two vectors. Let $\vec{c} = \vec{a} \times \vec{b}$ and $\vec{d}$ be a vector of magnitude 2 in yz -plane. If $|\vec{c}| = \sqrt{53}$, then the maximum possible value of $(\vec{c} \cdot \vec{d})^2$ is equal to :

- (1) 26 (2) 52 (3) 208 (4) 104

Q7. JEE Main 2026 (22 January Shift 2)

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 ____.

Q8. JEE Main 2026 (22 January Shift 1)

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

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

Q9. JEE Main 2026 (23 January Shift 2)

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

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

Q10. JEE Main 2026 (23 January Shift 2)

Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors such that $\vec{a} \times \vec{b} = 2(\vec{a} \times \vec{c})$. If $|\vec{a}| = 1$, $|\vec{b}| = 4$, $|\vec{c}| = 2$, and the angle between $\vec{b}$ and $\vec{c}$ is 60° , then $|\vec{a} \cdot \vec{c}|$ is equal to

- (1) 1 (2) 2 (3) 0 (4) 4

Q11. JEE Main 2026 (21 January Shift 1)

Let $\vec{a} = -\hat{i} + 2\hat{j} + 2\hat{k}$, $\vec{b} = 8\hat{i} + 7\hat{j} - 3\hat{k}$ and $\vec{c}$ be vector such that $\vec{a} \times \vec{c} = \vec{b}$. If $\vec{c} \cdot (\hat{i} + \hat{j} + \hat{k}) = 4$, then $|\vec{a} + \vec{c}|^2$ is equal to :

- (1) 27 (2) 33 (3) 35 (4) 30

Q12. JEE Main 2026 (28 January Shift 1)

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

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

Q13. JEE Main 2026 (28 January Shift 1)

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 $|\vec{PR}| = 9$ and $\vec{PS} = \hat{i} - 7\hat{j} + 2\hat{k}$, then the value of $3a - 4b$ is _____

Q14. JEE Main 2026 (24 January Shift 1)

Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$, $\vec{b} = \hat{i} + \hat{j}$ and $\vec{c} = \vec{a} \times \vec{b}$. Let $\vec{d}$ be a vector such that $|\vec{d} - \vec{a}| = \sqrt{11}$, $|\vec{c} \times \vec{d}| = 3$ and the angle between $\vec{c}$ and $\vec{d}$ is $\frac{\pi}{4}$. Then $\vec{a} \cdot \vec{d}$ is equal to

- (1) 3 (2) 11 (3) 0 (4) 1

 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math
 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 mathongo	 math

ANSWERS AND SOLUTIONS

1. (3) 2. (4) 3. (2) 4. (2) 5. (2) 6. (3) 7. 5 8. (1)

9. (1) 10. (1) 11. (1) 12. (3) 13. 37 14. (3)

1. (3) Given $|\vec{p}| = 2\sqrt{3}$, $|\vec{q}| = 2$, and $\cos \theta = \frac{1}{\sqrt{3}}$ where θ is the angle between $\vec{p}$ and $\vec{q}$.Since $\vec{p} = \overrightarrow{BC}$, $\vec{q} = \overrightarrow{CA}$, and $\vec{r} = \overrightarrow{BA}$, from triangle closure $\vec{r} = \vec{p} + \vec{q}$.

$$\vec{p} \cdot \vec{q} = |\vec{p}||\vec{q}| \cos \theta = 2\sqrt{3} \cdot 2 \cdot \frac{1}{\sqrt{3}} = 4$$

$$|\vec{r}|^2 = |\vec{p}|^2 + |\vec{q}|^2 + 2\vec{p} \cdot \vec{q} = 12 + 4 + 8 = 24$$

$$\vec{q} - 3\vec{r} = \vec{q} - 3(\vec{p} + \vec{q}) = -3\vec{p} - 2\vec{q}$$

$$\vec{p} \times (\vec{q} - 3\vec{r}) = -2(\vec{p} \times \vec{q})$$

$$\sin^2 \theta = 1 - \frac{1}{3} = \frac{2}{3}$$

$$|\vec{p} \times \vec{q}|^2 = 12 \cdot 4 \cdot \frac{2}{3} = 32$$

$$|\vec{p} \times (\vec{q} - 3\vec{r})|^2 = 4 \cdot 32 = 128$$

$$\text{Result: } 128 + 3(24) = 128 + 72 = 200$$

$$2. \quad (4) \quad \vec{c} = \vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & 1 & 2 \\ 1 & -1 & -3 \end{vmatrix} = (-1, -1, 0).$$

$$\vec{d} = \vec{c} \times \vec{a} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & -1 & 0 \\ -1 & 1 & 2 \end{vmatrix} = (-2, 2, -2).$$

$$\vec{a} - \vec{b} = (-2, 2, 5).$$

$$(\vec{a} - \vec{b}) \cdot \vec{d} = (-2)(-2) + (2)(2) + (5)(-2) = 4 + 4 - 10 = -2.$$

3. (2) Since P is equidistant from lines AB and AC through point A, it lies along the angle bisector direction. The unit

$$\text{vectors are } \hat{u}_{AB} = \frac{3\vec{i} + \vec{j} - \vec{k}}{\sqrt{11}} \text{ and } \hat{u}_{AC} = \frac{\vec{i} - \vec{j} + 3\vec{k}}{\sqrt{11}}.$$

The bisector direction is proportional to $2\vec{i} + \vec{k}$, so $\vec{AP} = \lambda(2\vec{i} + \vec{k})$.

$$\text{From } |\vec{AP}| = \frac{\sqrt{5}}{2}: |\lambda|\sqrt{5} = \frac{\sqrt{5}}{2}, \text{ giving } \lambda = \frac{1}{2}.$$

$$\text{Thus } \vec{AP} = \vec{i} + \frac{1}{2}\vec{k}.$$

$$\text{Area of triangle ABP} = \frac{1}{2}|\vec{AB} \times \vec{AP}|.$$

$$\text{Computing: } \vec{AB} \times \vec{AP} = \frac{1}{2}\vec{i} - \frac{5}{2}\vec{j} - \vec{k}.$$

$$|\vec{AB} \times \vec{AP}| = \sqrt{\frac{1}{4} + \frac{25}{4} + 1} = \sqrt{\frac{30}{4}} = \frac{\sqrt{30}}{2}.$$

$$\text{Area} = \frac{\sqrt{30}}{4}.$$

$$4. (2) \quad 2(\vec{a} \times \vec{c}) + 3(\vec{b} \times \vec{c}) = \vec{0} \Rightarrow (2\vec{a} + 3\vec{b}) \times \vec{c} = \vec{0}.$$

$$\text{So } \vec{c} \parallel (2\vec{a} + 3\vec{b}) = (7, -13, 19). \text{ Let } \vec{c} = t(7, -13, 19).$$

$$\vec{a} - \vec{b} = (1, -4, 2).$$

$$(\vec{a} - \vec{b}) \cdot \vec{c} = t(7 + 52 + 38) = 97t = -97 \Rightarrow t = -1.$$

$$\vec{c} = (-7, 13, -19).$$

$$\vec{c} \times \hat{k} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -7 & 13 & -19 \\ 0 & 0 & 1 \end{vmatrix} = (13, 7, 0).$$

$$|\vec{c} \times \hat{k}|^2 = 169 + 49 = 218.$$

$$5. (2) \vec{v} = \lambda \vec{a} + \mu \vec{b} = (2\lambda + \mu, -\lambda + 3\mu, -\lambda - \mu).$$

$$\vec{v} \cdot \vec{c} = 2(2\lambda + \mu) + (-\lambda + 3\mu) + 3(-\lambda - \mu) = 2\mu.$$

$$|\vec{c}| = \sqrt{4 + 1 + 9} = \sqrt{14}.$$

$$\text{Projection length} = \frac{|2\mu|}{\sqrt{14}} = \frac{1}{\sqrt{14}} \Rightarrow |\mu| = \frac{1}{2}.$$

$$|\vec{v}|^2 = 6\lambda^2 + 11\mu^2 = 6(1) + \frac{11}{4} = \frac{35}{4}.$$

$$|\vec{v}| = \frac{\sqrt{35}}{2}.$$

$$6. (3) \vec{a} = 2\hat{i} - \hat{j} + \hat{k}$$

$$\vec{b} = \lambda\hat{j} + 2\hat{k}; \lambda \in \mathbb{Z}$$

$$\vec{c} = \vec{a} \times \vec{b} = (-2 - \lambda)\hat{i} - 4\hat{j} + 2\lambda\hat{k}$$

$$|\vec{c}| = \sqrt{53}$$

$$\Rightarrow 5\lambda^2 + 4\lambda - 33 = 0$$

$$\lambda = 2.2 \text{ or } -3$$

$$\Rightarrow \boxed{\lambda = -3}$$

$$\vec{c} = \hat{i} - 4\hat{j} - 6\hat{k}$$

$$\text{let } \vec{d} = y\hat{j} + z\hat{k}$$

$$|\vec{d}| = 2$$

$$\Rightarrow y^2 + z^2 = 4$$

$$(\vec{c} \cdot \vec{d})^2 = (4y + 6z)^2 \leq \left(\sqrt{4^2 + 6^2} \times \sqrt{y^2 + z^2} \right)^2 \leq 208$$

$$7. (5) \frac{\vec{a} \cdot \hat{k}}{|\vec{a}|} = \cos \theta \Rightarrow \frac{\lambda}{\sqrt{3 + \lambda^2}} = \cos \theta$$

$$\Rightarrow 0 < \frac{\lambda}{\sqrt{3 + \lambda^2}} < \frac{\sqrt{3}}{2}$$

$$\Rightarrow \lambda > 0 \& 4\lambda^2 < 9 + 3\lambda^2 \Rightarrow \lambda^2 < 9$$

$$\Rightarrow \lambda \in (0, 3) \dots (1)$$

$$\Rightarrow \vec{a} \cdot \vec{b} < 0 \Rightarrow -\sqrt{2}\lambda^2 - 4\sqrt{2} + 4\sqrt{2}\lambda < 0$$

$$\Rightarrow \lambda^2 - 4\lambda + 4 > 0 \Rightarrow (\lambda - 2)^2 > 0$$

$$\Rightarrow \lambda \neq 2$$

$$\text{from (1) \& (2)}$$

$$\lambda \in (0, 3) - \{2\}$$

$$\therefore \alpha = 0, \beta = 3, \gamma = 2$$

$$\Rightarrow \alpha + \beta + \gamma = 5$$

8. (1) $\vec{AC} = \vec{AB} + \vec{AD} = 3\hat{i} + 6\hat{j} + (\lambda - 5)\hat{k}$.

Projection of $\vec{v} = \hat{i} + \hat{j} + \hat{k}$ on $\vec{AC}$: $\frac{|\vec{v} \cdot \vec{AC}|}{|\vec{AC}|} = 1$.

$$\vec{v} \cdot \vec{AC} = 3 + 6 + (\lambda - 5) = \lambda + 4, |\vec{AC}| = \sqrt{45 + (\lambda - 5)^2}.$$

$$(\lambda + 4)^2 = 45 + (\lambda - 5)^2$$

$$\Rightarrow 8\lambda + 16 = 45 - 10\lambda + 25$$

$$\Rightarrow 18\lambda = 54 \Rightarrow \lambda = 3.$$

Equation: $9x^2 - 18x + 5 = 0$

$$\Rightarrow (3x - 1)(3x - 5) = 0$$

$$\Rightarrow x = \frac{1}{3}, \frac{5}{3}.$$

$$\alpha = \frac{5}{3}, \beta = \frac{1}{3}.$$

$$2\alpha - \beta = \frac{10}{3} - \frac{1}{3} = 3.$$

9. (1) $\vec{v} = \vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 3 \\ 2 & 1 & -1 \end{vmatrix} = -\hat{i} + 7\hat{j} + 5\hat{k}.$

$$\vec{v} \cdot \vec{c} = -\lambda + 7 + 5 = 11 \Rightarrow \lambda = 1.$$

$$\vec{c} = \hat{i} + \hat{j} + \hat{k}, |\vec{c}| = \sqrt{3}.$$

$$\vec{b} \cdot \vec{c} = 2 + 1 - 1 = 2.$$

Projection $p = \frac{|\vec{b} \cdot \vec{c}|}{|\vec{c}|} = \frac{2}{\sqrt{3}}.$

$$9p^2 = 9 \times \frac{4}{3} = 12.$$

10. (1) $\vec{a} \times \vec{b} = 2(\vec{a} \times \vec{c}) \Rightarrow \vec{a} \times (\vec{b} - 2\vec{c}) = \vec{0}$, so $\vec{b} - 2\vec{c} = k\vec{a}.$

$$\vec{b} \cdot \vec{c} = 4 \cdot 2 \cdot \cos 60^\circ = 4.$$

Dot with $\vec{c}$: $4 = 2(4) + k(\vec{a} \cdot \vec{c}) \Rightarrow k(\vec{a} \cdot \vec{c}) = -4.$

Dot with $\vec{a}$: $\vec{a} \cdot \vec{b} = 2(\vec{a} \cdot \vec{c}) + k.$

Dot with $\vec{b}$: $16 = 8 + k\vec{a} \cdot \vec{b} = 8 + k\left(-\frac{8}{k} + k\right) = k^2 \Rightarrow k = \pm 4.$

$$\vec{a} \cdot \vec{c} = -\frac{4}{k} = \mp 1 \Rightarrow |\vec{a} \cdot \vec{c}| = 1.$$

11. (1) Let $\vec{c} = x\hat{i} + y\hat{j} + z\hat{k}.$

From $\vec{a} \times \vec{c} = \vec{b}$: $z - y = 4, z + 2x = 7, y + 2x = 3.$

From $\vec{c} \cdot (\hat{i} + \hat{j} + \hat{k}) = 4$: $x + y + z = 4.$

Solving: $y = -1, z = 3, x = 2.$

$$\vec{c} = 2\hat{i} - \hat{j} + 3\hat{k}.$$

$$\vec{a} + \vec{c} = (-1 + 2)\hat{i} + (2 - 1)\hat{j} + (2 + 3)\hat{k} = \hat{i} + \hat{j} + 5\hat{k}.$$

$$|\vec{a} + \vec{c}|^2 = 1 + 1 + 25 = 27.$$

12. (3) Expanding $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 9$ with unit vectors gives $6 - 2(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}) = 9.$

$$\text{So } \vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a} = -3/2.$$

For the symmetric case where vectors are equally spaced (e.g., on a circle at 120° intervals), we have

$$\vec{a} \cdot \vec{b} = \vec{b} \cdot \vec{c} = \vec{c} \cdot \vec{a} = -1/2.$$

$$\text{Expanding } |2\vec{a} + k\vec{b} + k\vec{c}|^2 = 9 \text{ gives } 4 + 2k^2 + 4k(\vec{a} \cdot \vec{b} + \vec{a} \cdot \vec{c}) + 2k^2\vec{b} \cdot \vec{c} = 9.$$

Substituting the symmetric values: $4 + 2k^2(1/2) + 4k(-1) + 2k^2(-1/2) = 9$, which simplifies to

$$k^2 - 4k - 5 = 0.$$

Factoring: $(k - 5)(k + 1) = 0$, giving $k = 5$ as the positive solution.

$$13. (37) \text{ Given: } \vec{PQ} = -2\hat{i} - \hat{j} + 2\hat{k}, \vec{PR} = a\hat{i} + b\hat{j} - 4\hat{k} \ (a, b \in \mathbb{Z}), \vec{PS} = \hat{i} - 7\hat{j} + 2\hat{k}, |\vec{PR}| = 9$$

$$\text{From } |\vec{PR}| = 9: a^2 + b^2 + 16 = 81 \Rightarrow a^2 + b^2 = 65 \dots (1)$$

Since S is on QR equidistant from lines PQ and PR, PS is the angle bisector. So:

$$\cos \theta = \frac{\vec{PQ} \cdot \vec{PS}}{|\vec{PQ}| |\vec{PS}|} = \frac{-2+7+4}{3 \cdot 3\sqrt{6}} = \frac{9}{9\sqrt{6}} = \frac{1}{\sqrt{6}}$$

$$\text{Similarly: } \frac{1}{\sqrt{6}} = \frac{\vec{PS} \cdot \vec{PR}}{|\vec{PS}| |\vec{PR}|} = \frac{a-7b-8}{3\sqrt{6} \cdot 9}$$

$$a - 7b = 35 \dots (2)$$

$$\text{From (1) and (2): } a = 7, b = -4$$

$$3a - 4b = 21 + 16 = 37 \text{ (NTA Answer)}$$

However, $\vec{QS} = 3\hat{i} - 6\hat{j}$ and $\vec{SR} = 6\hat{i} + 3\hat{j} - 6\hat{k}$ are not parallel, so Q, S, R are not collinear. Also

$$\cos \theta = \frac{2\sqrt{2}}{\sqrt{3}} > 1, \text{ which is impossible. Hence no such triangle exists.}$$

So, this should be a bonus question.

$$14. (3) \vec{c} = \vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix} = 2\hat{i} - 2\hat{j} + \hat{k}$$

$$|\vec{c}| = \sqrt{4+4+1} = 3, |\vec{a}| = \sqrt{4+1+4} = 3$$

$$\text{From } |\vec{c} \times \vec{d}| = 3 \text{ and } \cos(\angle(\vec{c}, \vec{d})) = \frac{1}{\sqrt{2}}:$$

$$|\vec{c}| |\vec{d}| \sin \frac{\pi}{4} = 3 \rightarrow 3 |\vec{d}| \cdot \frac{1}{\sqrt{2}} = 3 \rightarrow |\vec{d}| = \sqrt{2}$$

$$\text{From } |\vec{d} - \vec{a}|^2 = 11:$$

$$|\vec{d}|^2 - 2\vec{a} \cdot \vec{d} + |\vec{a}|^2 = 11$$

$$2 - 2\vec{a} \cdot \vec{d} + 9 = 11$$

$$\vec{a} \cdot \vec{d} = 0$$