

## Q1 (20 July 2021 Shift 1)

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 :

(1)  $\frac{2}{3}$

(2) 4

(3) 3

(4)  $\frac{3}{2}$

## Q2 (20 July 2021 Shift 1)

Let  $\vec{a}$ ,  $\vec{b}$ ,  $\vec{c}$  be three mutually perpendicular vectors of the same magnitude and equally inclined at an angle  $\theta$ , with the vector  $\vec{a} + \vec{b} + \vec{c}$ . Then  $36 \cos^2 2\theta$  is equal to \_\_\_\_

## Q3 (20 July 2021 Shift 2)

In a triangle ABC, if  $|\vec{BC}| = 3$ ,  $|\vec{CA}| = 5$  and  $|\vec{BA}| = 7$ , then the projection of the vector  $\vec{BA}$  on  $\vec{BC}$  is equal to

(1)  $\frac{19}{2}$

(2)  $\frac{13}{2}$

(3)  $\frac{11}{2}$

(4)  $\frac{15}{2}$

## Q4 (20 July 2021 Shift 2)

For  $p > 0$ , a vector  $\vec{v}_2 = 2\hat{i} + (p+1)\hat{j}$  is obtained by rotating the vector  $\vec{v}_1 = \sqrt{3}p\hat{i} + \hat{j}$  by an angle  $\theta$  about origin in counter clockwise direction. If

$\tan \theta = \frac{(\alpha\sqrt{3}-2)}{(4\sqrt{3}+3)}$ , then the value of  $\alpha$  is equal to

## Q5 (22 July 2021 Shift 1)

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  $[\vec{a} \ \vec{b} \ \vec{c}] + [\vec{a} \ \vec{b} \ \vec{d}] + [\vec{a} \ \vec{c} \ \vec{d}]$  is equal to:

(1)  $-42$

(2)  $-40$

(3)  $-29$

(4)  $-38$

## Q6 (22 July 2021 Shift 1)

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 ?

(1)  $\vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} - \vec{c})) = \vec{0}$

(2) Projection of  $\vec{a}$  on  $(\vec{b} \times \vec{c})$  is 2

(3)  $[\vec{a} \ \vec{b} \ \vec{c}] + [\vec{c} \ \vec{a} \ \vec{b}] = 8$

(4)  $|3\vec{a} + \vec{b} - 2\vec{c}|^2 = 51$

## Q7 (25 July 2021 Shift 1)

Let the vectors

$$(2 + a + b)\hat{i} + (a + 2b + c)\hat{j} - (b + c)\hat{k}, (1 + b)\hat{i} + 2\hat{j} - b\hat{k}$$

and  $(2 + b)\hat{i} + 2b\hat{j} + (1 - b)\hat{k}$   $a, b, c, \in \mathbf{R}$

be co-planar. Then which of the following is true?

(1)  $2b = a + c$

(2)  $3c = a + b$

## Questions with Answer Keys

MathonGo

(3)  $a = b + 2c$

(4)  $2a = b + c$

## Q8 (25 July 2021 Shift 1)

Let  $\vec{p} = 2\hat{i} + 3\hat{j} + \hat{k}$  and  $\vec{q} = \hat{i} + 2\hat{j} + \hat{k}$  be two vectors.

If a vector  $\vec{r} = (\alpha\hat{i} + \beta\hat{j} + \gamma\hat{k})$  is perpendicular to

each of the vectors  $(\vec{p} + \vec{q})$  and  $(\vec{p} - \vec{q})$ , and  $|\vec{r}| = \sqrt{3}$ , then  $|\alpha| + |\beta| + |\gamma|$  is equal to

## Q9 (25 July 2021 Shift 2)

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:

(1)  $\frac{2}{\frac{1}{a} + \frac{1}{b}}$

(2)  $\frac{a+b}{2}$

(3)  $\frac{1}{a} + \frac{1}{b}$

(4)  $\sqrt{ab}$

## Q10 (25 July 2021 Shift 2)

If  $|\vec{a}| = 2$ ,  $|\vec{b}| = 5$  and  $|\vec{a} \times \vec{b}| = 8$ , then  $|\vec{a} \cdot \vec{b}|$  is equal to:

(1) 6

(2) 4

(3) 3

(4) 5

## Q11 (25 July 2021 Shift 2)

If  $(\vec{a} + 3\vec{b})$  is perpendicular to  $(7\vec{a} - 5\vec{b})$  and  $(\vec{a} - 4\vec{b})$  is perpendicular to  $(7\vec{a} - 2\vec{b})$ , then the angle between  $\vec{a}$  and  $\vec{b}$  (in degrees) is \_\_\_\_\_

## Questions with Answer Keys

MathonGo

## Q12 (27 July 2021 Shift 1)

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 :

(1)  $5(34\hat{i} - 5\hat{j} + 3\hat{k})$

(2)  $7(34\hat{i} - 5\hat{j} + 3\hat{k})$

(3)  $7(30\hat{i} - 5\hat{j} + 7\hat{k})$

(4)  $5(30\hat{i} - 5\hat{j} + 7\hat{k})$

## Q13 (27 July 2021 Shift 1)

Let  $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ ,  $\vec{b}$  and  $\vec{c} = \hat{j} - \hat{k}$  be three vectors

such that  $\vec{a} \times \vec{b} = \vec{c}$  and  $\vec{a} \cdot \vec{b} = 1$ . If the length of projection vector of the vector  $\vec{b}$  on the vector  $\vec{a} \times \vec{c}$  is  $l$ , then the value of  $3l^2$  is equal to

## Q14 (27 July 2021 Shift 2)

Let  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  be three vectors such that

$$\vec{a} = \vec{b} \times (\vec{b} \times \vec{c}).$$

If magnitudes of the vectors  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  are  $\sqrt{2}$ , 1 and 2 respectively and the angle between  $\vec{b}$  and  $\vec{c}$  is  $\theta$  ( $0 < \theta < \frac{\pi}{2}$ ), then the value of  $1 + \tan \theta$  is equal to:

(1)  $\sqrt{3} + 1$

(2) 2

(3) 1

(4)  $\frac{\sqrt{3}+1}{\sqrt{3}}$

## Q15 (27 July 2021 Shift 2)

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  $\alpha$  and  $\beta$  are integers.

## Questions with Answer Keys

MathonGo

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

**Answer Key**

Q1 (4)

Q2 (4)

Q3 (3)

Q4 (6)

Q5 (1)

Q6 (4)

Q7 (1)

Q8 (3)

Q9 (4)

Q10 (1)

Q11 (60)

Q12 (2)

Q13 (2)

Q14 (2)

Q15 (9)

Q1

$$|\vec{a}| = 3 = a; \vec{a} \cdot \vec{c} = c$$

$$\text{Now } |\vec{c} - \vec{a}| = 2\sqrt{2}$$

$$\Rightarrow c^2 + a^2 - 2\vec{c} \cdot \vec{a} = 8$$

$$\Rightarrow c^2 + 9 - 2(c) = 8$$

$$\Rightarrow c^2 - 2c + 1 = 0 \Rightarrow c = 1 = |\vec{c}|$$

$$\text{Also, } \vec{a} \times \vec{b} = 2\hat{i} - 2\hat{j} + \hat{k}$$

Given

$$\begin{aligned} (\vec{a} \times \vec{b}) \cdot \vec{c} &= |\vec{a} \times \vec{b}| |\vec{c}| \sin \frac{\pi}{6} \\ &= (3)(1)(1/2) \\ &= 3/2 \end{aligned}$$

Q2

$$\begin{aligned} |\vec{a} + \vec{b} + \vec{c}|^2 &= |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2(\vec{a} \cdot \vec{b} + \vec{a} \cdot \vec{c} + \vec{b} \cdot \vec{c}) \\ &= 3 \end{aligned}$$

$$\Rightarrow |\vec{a} + \vec{b} + \vec{c}| = \sqrt{3}$$

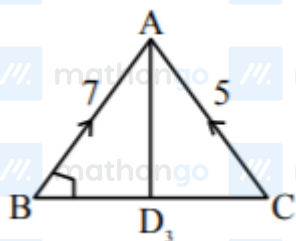
$$\vec{a} \cdot (\vec{a} + \vec{b} + \vec{c}) = |\vec{a}| |\vec{a} + \vec{b} + \vec{c}| \cos \theta$$

$$\Rightarrow 1 = \sqrt{3} \cos \theta$$

$$\Rightarrow \cos 2\theta = -\frac{1}{3}$$

$$\Rightarrow 36 \cos^2 2\theta = 4$$

Q3



Projection of  $\vec{BA}$

## Hints and Solutions

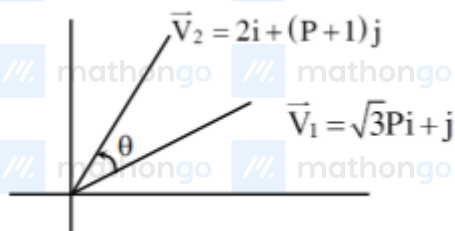
MathonGo

on  $\overrightarrow{BC}$  is equal to

$$= |\overrightarrow{BA}| \cos \angle ABC$$

$$= 7 \left| \frac{7^2 + 3^2 - 5^2}{2 \times 7 \times 3} \right| = \frac{11}{2}$$

Q4



$$|\overrightarrow{V_1}| = |\overrightarrow{V_2}|$$

$$3P^2 + 1 = 4 + (P + 1)^2$$

$$2P^2 - 2P - 4 = 0 \Rightarrow P^2 - P - 2 = 0$$

$$P = 2, -1 \text{ (rejected)}$$

$$\cos \theta = \frac{\overrightarrow{V_1} \cdot \overrightarrow{V_2}}{|\overrightarrow{V_1}| |\overrightarrow{V_2}|} = \frac{2\sqrt{3}P + (P+1)}{\sqrt{(P+1)^2 + 4} \sqrt{3P^2 + 1}}$$

$$\cos \theta = \frac{4\sqrt{3} + 3}{\sqrt{13}\sqrt{13}} = \frac{4\sqrt{3} + 3}{13}$$

$$\tan \theta = \frac{\sqrt{112 - 24\sqrt{3}}}{4\sqrt{3} + 3} = \frac{6\sqrt{3} - 2}{4\sqrt{3} + 3} = \frac{\alpha\sqrt{3} - 2}{4\sqrt{3} + 3}$$

$$\Rightarrow \alpha = 6$$

Q5

$$\overrightarrow{a} = \lambda \overrightarrow{b} + \mu \overrightarrow{c} = \hat{i}(2\lambda + \mu) + \hat{j}(\lambda - \mu) + \hat{k}(\lambda + \mu)$$

$$\overrightarrow{a} \cdot \overrightarrow{d} = 0 = 3(2\lambda + \mu) + 2(\lambda - \mu) + 6(\lambda + \mu)$$

$$\Rightarrow 14\lambda + 7\mu = 0 \Rightarrow \mu = -2\lambda$$

$$\Rightarrow \overrightarrow{a} = (0)\hat{i} - 3\lambda\hat{j} + (-\lambda)\hat{k}$$

$$\Rightarrow |\overrightarrow{a}| = \sqrt{10}|\lambda| = \sqrt{10} \Rightarrow |\lambda| = 1$$

$$\Rightarrow \lambda = 1 \text{ or } -1$$

$$[\overrightarrow{a} \ \overrightarrow{b} \ \overrightarrow{c}] = 0$$

## Hints and Solutions

MathonGo

$$[\vec{a} \vec{b} \vec{c}] + [\vec{a} \vec{b} \vec{d}] + [\vec{a} \vec{c} \vec{d}] = \begin{vmatrix} \vec{a} & \vec{b} + \vec{c} & \vec{d} \end{vmatrix}$$

$$= \begin{vmatrix} 0 & -3\lambda & \lambda \\ 3 & 0 & 2 \\ 3 & 2 & 6 \end{vmatrix}$$

$$= 3\lambda(12) + \lambda(6) = 42\lambda = -42$$

Q6

$$(1) \vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} - \vec{c}))$$

$$= \vec{a} \times (-\vec{b} \times \vec{c} + \vec{c} \times \vec{b}) = -2(\vec{a} \times (\vec{b} \times \vec{c}))$$

$$= -2(\vec{a} \times \vec{a}) = \vec{0}$$

$$(2) \text{Projection of } \vec{a} \text{ on } \vec{b} \times \vec{c}$$

$$= \frac{\vec{a} \cdot (\vec{b} \times \vec{c})}{|\vec{b} \times \vec{c}|} = \frac{\vec{a} \cdot \vec{a}}{|\vec{a}|} = |\vec{a}| = 2$$

$$(3) [\vec{a} \vec{b} \vec{c}] + [\vec{c} \vec{a} \vec{b}] = 2[\vec{a} \vec{b} \vec{c}] = 2\vec{a} \cdot (\vec{b} \times \vec{c})$$

$$= 2\vec{a} \cdot \vec{a} = 2|\vec{a}|^2 = 8$$

$$(4) \vec{a} \times \vec{b} = \vec{c} \text{ and } \vec{b} \times \vec{c} = \vec{a}$$

$$\Rightarrow \vec{a}, \vec{b}, \vec{c} \text{ are mutually } \perp \text{ vectors.}$$

$$\therefore |\vec{a} \times \vec{b}| = |\vec{c}| \Rightarrow |\vec{a}||\vec{b}| = |\vec{c}| \Rightarrow |\vec{b}| = |\vec{c}|/2$$

$$\text{Also, } |\vec{b} \times \vec{c}| = |\vec{a}| \Rightarrow |\vec{b}||\vec{c}| = 2 \Rightarrow |\vec{c}| = 2 \& |\vec{b}| = 1$$

$$|3\vec{a} + \vec{b} - 2\vec{c}|^2 = (3\vec{a} + \vec{b} - 2\vec{c}) \cdot (3\vec{a} + \vec{b} - 2\vec{c})$$

$$= 9|\vec{a}|^2 + |\vec{b}|^2 + 4|\vec{c}|^2$$

$$= (9 \times 4) + 1 + (4 \times 4)$$

$$= 36 + 1 + 16 = 53$$

Q7

$$\text{If the vectors are co-planar, } \begin{vmatrix} a+b+2 & a+2b+c & -b-c \\ b+1 & 2b & -b \\ b+2 & 2b & 1-b \end{vmatrix} = 0$$

$$\text{Now } R_3 \rightarrow R_3 - R_2, R_1 \rightarrow R_1 - R_2$$

## Hints and Solutions

MathonGo

$$\text{So } \begin{vmatrix} a+1 & a+c & -c \\ b+1 & 2b & -b \\ 1 & 0 & 1 \end{vmatrix} = 0$$

$$= (a+1)2b - (a+c)(2b+1) - c(-2b)$$

$$= 2ab + 2b - 2ab - a - 2bc - c + 2bc$$

$$= 2b - a - c = 0$$

Q8

$$\vec{p} = 2\hat{i} + 3\hat{j} + \hat{k} \quad (\text{Given})$$

$$\vec{q} = \hat{i} + 2\hat{j} + \hat{k}$$

$$\text{Now } (\vec{p} + \vec{q}) \times (\vec{p} - \vec{q}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 5 & 2 \\ 1 & 1 & 0 \end{vmatrix}$$

$$= -2\hat{i} - 2\hat{j} - 2\hat{k}$$

$$\Rightarrow \vec{r} = \pm \sqrt{3} \frac{((\vec{p} + \vec{q}) \times (\vec{p} - \vec{q}))}{|(\vec{p} + \vec{q}) \times (\vec{p} - \vec{q})|} = \pm \frac{\sqrt{3}(-2\hat{i} - 2\hat{j} - 2\hat{k})}{\sqrt{2^2 + 2^2 + 2^2}}$$

$$\vec{r} = \pm(-\hat{i} - \hat{j} - \hat{k})$$

According to question

$$\vec{r} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$$

$$\text{So } |\alpha| = 1, |\beta| = 1, |\gamma| = 1$$

$$\Rightarrow |\alpha| + |\beta| + |\gamma| = 3$$

Q9

Because vectors are coplanar

$$\text{Hence } \begin{vmatrix} a & a & c \\ 1 & 0 & 1 \\ c & c & b \end{vmatrix} = 0$$

$$\Rightarrow c^2 = ab \Rightarrow c = \sqrt{ab}$$

Q10

$$|\vec{a}| = 2, |\vec{b}| = 5$$

$$|\vec{a} \times \vec{b}| = |\vec{a}| |\vec{b}| \sin \theta = \pm 8$$

## Hints and Solutions

MathonGo

$$\sin \theta = \pm \frac{4}{5}$$

$$\therefore \vec{a} \cdot \vec{b} = |\vec{a}| |\vec{b}| \cos \theta$$

$$= 10 \cdot \left( \pm \frac{3}{5} \right) = \pm 6$$

$$|\vec{a} \cdot \vec{b}| = 6$$

Q11

$$(\vec{a} + 3\vec{b}) \perp (7\vec{a} - 5\vec{b})$$

$$(\vec{a} + 3\vec{b}) \cdot (7\vec{a} - 5\vec{b}) = 0$$

$$7|\vec{a}|^2 - 15|\vec{b}|^2 + 16\vec{a} \cdot \vec{b} = 0 \quad \dots (1)$$

$$(\vec{a} - 4\vec{b}) \cdot (7\vec{a} - 2\vec{b}) = 0$$

$$7|\vec{a}|^2 + 8|\vec{b}|^2 - 30\vec{a} \cdot \vec{b} = 0 \quad \dots (2)$$

from (1) &amp; (2)

$$|\vec{a}| = |\vec{b}|$$

$$\cos \theta = \frac{|\vec{b}|}{2|\vec{a}|} \therefore \theta = 60^\circ$$

Q12

$$\vec{a} = \hat{i} + \hat{j} + 2\hat{k}$$

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

$$\vec{a} + \vec{b} = 3\hat{j} + 5\hat{k}; \vec{a} \cdot \vec{b} = -1 + 2 + 6 = 7$$

$$((\vec{a} \times ((\vec{a} - \vec{b}) \times \vec{b})) \times \vec{b})$$

$$((\vec{a} \times (\vec{a} \times \vec{b} - \vec{b} \times \vec{b})) \times \vec{b})$$

$$(\vec{a} \times (\vec{a} \times \vec{b} - 0)) \times \vec{b}$$

$$(\vec{a} \times (\vec{a} \times \vec{b})) \times \vec{b}$$

$$((\vec{a} \cdot \vec{b})\vec{a} - (\vec{a} \cdot \vec{a})\vec{b}) \times \vec{b}$$

$$(\vec{a} \cdot \vec{b})\vec{a} \times \vec{b} - (\vec{a} \cdot \vec{a})(\vec{b} \times \vec{b})$$

$$(\vec{a} \cdot \vec{b})(\vec{a} \times \vec{b})$$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 2 \\ -1 & 2 & 3 \end{vmatrix} = -\hat{i} - 5\hat{j} + 3\hat{k}$$

## Hints and Solutions

MathonGo

$$\therefore 7(-\hat{i} - 5\hat{j} + 3\hat{k})$$

$$(\vec{a} + \vec{b}) \times (7(-\hat{i} - 5\hat{j} + 3\hat{k}))$$

$$7(0\hat{i} + 3\hat{j} + 5\hat{k}) \times (-\hat{i} - 5\hat{j} + 3\hat{k})$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 3 & 5 \\ -1 & -5 & 3 \end{vmatrix}$$

$$\Rightarrow 34\hat{i} - (5)\hat{j} + (3\hat{k})$$

$$\Rightarrow 34\hat{i} - 5\hat{j} + 3\hat{k}$$

$$\therefore 7(34\hat{i} - 5\hat{j} + 3\hat{k})$$

Q13

$$\vec{a} \times \vec{b} = \vec{c}$$

Take Dot with  $\vec{c}$ 

$$(\vec{a} \times \vec{b}) \cdot \vec{c} = |\vec{c}|^2 = 2$$

Projection of  $\vec{b}$  or  $\vec{a} \times \vec{c} = \ell$ 

$$\frac{|\vec{b} \cdot (\vec{a} \times \vec{c})|}{|\vec{a} \times \vec{c}|} = \ell$$

$$\therefore \ell = \frac{2}{\sqrt{6}} \Rightarrow \ell^2 = \frac{4}{6}$$

$$3\ell^2 = 2$$

Q14

$$\vec{a} = (\vec{b} \cdot \vec{c})\vec{b} - (\vec{b} \cdot \vec{b})\vec{c}$$

$$= 1.2 \cos \theta \vec{b} - \vec{c}$$

$$\Rightarrow \vec{a} = 2 \cos \theta \vec{b} - \vec{c}$$

$$|\vec{a}|^2 = (2 \cos \theta)^2 + 2^2 - 2 \cdot 2 \cos \theta \cdot \vec{b} \cdot \vec{c}$$

$$\Rightarrow 2 = 4 \cos^2 \theta + 4 - 4 \cos \theta \cdot 2 \cos \theta$$

$$\Rightarrow -2 = -4 \cos^2 \theta$$

$$\Rightarrow \cos^2 \theta = \frac{1}{2}$$

$$\Rightarrow \sec^2 \theta = 2$$

$$\Rightarrow \tan^2 \theta = 1$$

## Hints and Solutions

MathonGo

$$\Rightarrow \theta = \frac{\pi}{4}$$

$$1 + \tan \theta = 2.$$

**Q15**

$$\vec{a} = (1, -\alpha, \beta)$$

$$\vec{b} = (3, \beta, -\alpha)$$

$$\vec{c} = (-\alpha, -2, 1); \alpha, \beta \in I$$

$$\vec{a} \cdot \vec{b} = -1 \Rightarrow 3 - \alpha\beta - \alpha\beta = -1$$

$$\Rightarrow \alpha\beta = 2$$

$$12$$

$$2 - 1$$

$$-1 - 2$$

$$-2 - 1$$

$$\vec{b} \cdot \vec{c} = 10$$

$$\Rightarrow -3\alpha - 2\beta - \alpha = 10$$

$$\Rightarrow 2\alpha + \beta + 5 = 0$$

$$\therefore \alpha = -2; \beta = -1$$

$$[\vec{a}\vec{b}\vec{c}] = \begin{vmatrix} 1 & 2 & -1 \\ 3 & -1 & 2 \\ 2 & -2 & 1 \end{vmatrix}$$

$$= 1(-1 + 4) - 2(3 - 4) - 1(-6 + 2)$$

$$= 3 + 2 + 4 = 9$$