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# **JEE Main & Advanced** **Physics DPP**

**DPP-4 Vectors (Cross product)**  
**By Physicsaholics Team**

Q) If  $\vec{A} \times \vec{B} = \vec{C}$ , then which of the following statements is wrong:

(a)  $\vec{C} \perp \vec{A}$

(b)  $\vec{C} \perp \vec{B}$

(c)  $\vec{C} \perp (\vec{A} + \vec{B})$

(d)  $\vec{C} \perp (\vec{A} \times \vec{B})$

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Ans. d



$$\vec{A} \times \vec{B} = \vec{C}$$

means;  $\vec{C} \perp \vec{A}$   
and  $\vec{C} \perp \vec{B}$

and  $\vec{C}$  is  $\perp$  to plane of  
 $\vec{A}$  &  $\vec{B}$ .

$\therefore \vec{A} + \vec{B}$  is in the plane of  
 $\vec{A}$  &  $\vec{B}$

$$\therefore \vec{C} \perp (\vec{A} + \vec{B})$$

$$\& \vec{C} = \vec{A} \times \vec{B}$$

so;  $\vec{C}$  can't be  $\perp$  to  $\vec{A} \times \vec{B}$

$\therefore \vec{C}$  is equal to  $\vec{A} \times \vec{B}$

Q) If two vectors  $2\hat{i} + 3\hat{j} - \hat{k}$  and  $-4\hat{i} - 6\hat{j} - \lambda\hat{k}$  are parallel to each other then value of  $\lambda$  be:

(a) 0

(b) -2

(c) -3

(d) -4

Q) If two vectors  $2\hat{i} + 3\hat{j} - \hat{k}$  and  $-4\hat{i} - 6\hat{j} - \lambda\hat{k}$  are parallel to each other then value of  $\lambda$  be:

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Ans. b

$$\vec{a} = 2\hat{i} + 3\hat{j} - \hat{k}, \quad \vec{b} = -4\hat{i} - 6\hat{j} - d\hat{k}$$

$$\vec{a} \parallel \vec{b}; \text{ then } \vec{a} \times \vec{b} = 0$$

$$\begin{aligned} \therefore \vec{a} \times \vec{b} &= (2\hat{i} + 3\hat{j} - \hat{k}) \times (-4\hat{i} - 6\hat{j} - d\hat{k}) \\ &= \hat{i}(-3d - 6) + \hat{j}(2d + 4) + \hat{k}(-12 + 12) \end{aligned}$$

$$= \hat{i}(-3d - 6) + \hat{j}(2d + 4) + \hat{k}(0)$$

$$\therefore \vec{a} \times \vec{b} = 0$$

$$\Rightarrow \hat{i}(-3d - 6) + \hat{j}(2d + 4) + \hat{k}(0) = 0$$

$$-3d - 6 = 0 \Rightarrow d = -2$$

$$2d + 4 = 0 \Rightarrow d = -2$$

$$\therefore \boxed{d = -2}$$

Q) What is the value of  $(\vec{A} + \vec{B}) \cdot (\vec{A} \times \vec{B}) = ?$

(a) 0

(c)  $A^2 + B^2 + 2AB$

(b)  $A^2 - B^2$

(d) None of these

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Ans. a

$$1) (\vec{A} + \vec{B}) \cdot (\vec{A} \times \vec{B}) = ?$$

$$\text{let } \vec{C} = \vec{A} \times \vec{B}$$

then  $\vec{C}$  is  $\perp$  to  $\vec{A}$

&  $\vec{C}$  is  $\perp$  to  $\vec{B}$

and  $\vec{C}$  is  $\perp$  to  $(\vec{A} + \vec{B})$

$\therefore$  dot product of  $\perp$  vectors  
is zero.

$$\therefore (\vec{A} + \vec{B}) \cdot (\vec{A} \times \vec{B})$$

$$= (\vec{A} + \vec{B}) \cdot (\vec{C})$$

$$(\vec{A} + \vec{B}) \cdot (\vec{C}) = \text{zero}$$

Q) Let  $\vec{A} = \hat{i} + \hat{j} + \hat{k}$ ,  $\vec{B} = \hat{j} - \hat{k}$ . If  $\vec{C}$  is a vector satisfying  $\vec{A} \times \vec{C} = \vec{B}$  and  $\vec{A} \cdot \vec{C} = 3$ , then  $\vec{C}$  is:

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

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

(c)  $3\hat{i} - \hat{j} - \hat{k}$

(d) None of these

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Ans. a



$$\vec{A} = \hat{i} + \hat{j} + \hat{k}$$

$$\vec{B} = \hat{j} - \hat{k}$$

Given;  $\vec{A} \times \vec{C} = \vec{B}$

$$\vec{A} \cdot \vec{C} = 3$$

Let;  $\vec{C} = x\hat{i} + y\hat{j} + z\hat{k}$

$$\therefore \vec{A} \times \vec{C} = \vec{B}$$

$$(\hat{i} + \hat{j} + \hat{k}) \times (x\hat{i} + y\hat{j} + z\hat{k}) = \hat{j} - \hat{k}$$

$$\hat{i}(z-y) + \hat{j}(x-z) + \hat{k}(y-x) = \hat{j} - \hat{k}$$

$$\Rightarrow z-y=0; x-z=1, y-x=-1$$

$$\boxed{y=z}; \boxed{x=1+z}; \boxed{y=x-1}$$

$$1. \vec{A} \cdot \vec{C} = 3$$

$$(\hat{i} + \hat{j} + \hat{k}) \cdot (x\hat{i} + y\hat{j} + z\hat{k}) = 3$$

$$x + y + z = 3$$

$$(1+z) + (z) + z = 3$$

$$3z = 2 \Rightarrow \boxed{z = \frac{2}{3}}$$

$$\Rightarrow x = 1 + \frac{2}{3} = \frac{5}{3} \Rightarrow \boxed{x = \frac{5}{3}}$$

$$\boxed{y = z = \frac{2}{3}}$$

$$\vec{C} = \frac{5}{3}\hat{i} + \frac{2}{3}\hat{j} + \frac{2}{3}\hat{k}$$

$$\vec{C} = \frac{5}{3}\hat{i} + \frac{2}{3}\hat{j} + \frac{2}{3}\hat{k}$$

$$\boxed{\vec{C} = \frac{1}{3}(5\hat{i} + 2\hat{j} + 2\hat{k})}$$

Q) The vector perpendicular to the vectors  $4\hat{i} - \hat{j} + 3\hat{k}$  and  $-2\hat{i} + \hat{j} - 2\hat{k}$  whose magnitude is 9:

(a)  $3\hat{i} + 6\hat{j} - 6\hat{k}$

(b)  $3\hat{i} - 6\hat{j} + 6\hat{k}$

(c)  $-3\hat{i} + 6\hat{j} + 6\hat{k}$

(d) None of these

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Ans. c

$$\vec{a} = 4\hat{j} - \hat{j} + 3\hat{k}$$

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

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

$$\Rightarrow \vec{c} \text{ is } \perp \vec{a}$$

$$\wedge \vec{c} \perp \vec{b}$$

$$\therefore \vec{c} = (4\hat{j} - \hat{j} + 3\hat{k}) \times (-2\hat{j} + \hat{j} - 2\hat{k})$$

$$\vec{c} = \hat{j}(2-3) + \hat{j}(8-6) + \hat{k}(4-2)$$

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

$$|\vec{c}| = \sqrt{1^2 + 2^2 + 2^2} = \sqrt{9} = 3$$

$$\hat{c} = \frac{-\hat{j} + 2\hat{j} + 2\hat{k}}{3}$$

$$\vec{a} = 3\hat{c}$$

$$\vec{a} = 3 \left( \frac{-\hat{j} + 2\hat{j} + 2\hat{k}}{3} \right)$$

$$\boxed{\vec{a} = -3\hat{j} + 6\hat{j} + 6\hat{k}}$$

Q) Find  $\vec{a} \times (\vec{b} + \vec{c}) + \vec{b} \times (\vec{c} + \vec{a}) + \vec{c} \times (\vec{a} + \vec{b}) = ?$

(a)  $\vec{a} + \vec{b} + \vec{c}$

(b)  $\vec{a} \cdot (\vec{a} + \vec{b} + \vec{c})$

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

(d) zero

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Ans. d

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

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

$$\therefore \vec{a} \times \vec{b} = -\vec{b} \times \vec{a} \Rightarrow (\vec{a} \times \vec{b}) + (\vec{b} \times \vec{a}) = 0$$

$$\& \vec{b} \times \vec{c} = -\vec{c} \times \vec{b} \Rightarrow (\vec{b} \times \vec{c}) + (\vec{c} \times \vec{b}) = 0$$

$$\& \vec{a} \times \vec{c} = -\vec{c} \times \vec{a} \Rightarrow (\vec{a} \times \vec{c}) + (\vec{c} \times \vec{a}) = 0$$

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

$$= 0 + 0 + 0$$

$$= 0$$



Q) Find  $[2\hat{j} \times (3\hat{i} - 4\hat{k})] \cdot [(\hat{i} - 2\hat{k}) \times \hat{k}] = ?$

(a) 0

(b)  $\hat{i} + \hat{j} - \hat{k}$

(c)  $2\hat{i} + \hat{j} - 3\hat{k}$

(d) 16

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Ans. a

$$[2\hat{j} \times (3\hat{j} - 4\hat{k})] \cdot [(\hat{j} - 2\hat{k}) \times \hat{k}]$$

$$\Rightarrow [-6\hat{k} - 8\hat{j}] \cdot [-\hat{j} + \hat{k}]$$

$$= (-6\hat{k} - 8\hat{j}) \cdot (-\hat{j})$$

$$= 8$$

Q) Find  $\hat{i} \cdot (\hat{j} \times \hat{k}) + (\hat{i} \times \hat{k}) \cdot \hat{j} = ?$

(a)  $2\hat{i} + \hat{j}$

(c) 0

(b) 1

(d)  $\hat{i} + \hat{j} + \hat{k}$

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Ans. c

$$K = \hat{j} \cdot (\hat{j} \times \hat{k}) + (\hat{j} \times \hat{k}) \cdot \hat{j} = ?$$

$$K = \hat{j} \cdot (\hat{j}) + (-\hat{j}) \cdot \hat{j}$$

$$K = 1 + (-1)$$

$$K = 1 - 1$$

$$\boxed{K = 0}$$

Q) If  $|\vec{a}| = 13$ ,  $|\vec{b}| = 5$  and  $\vec{a} \cdot \vec{b} = 30$ , then  $|\vec{a} \times \vec{b}| = ?$

(a) 30

(b)  $\frac{30}{25} \sqrt{233}$

(c)  $\frac{30}{33} \sqrt{193}$

(d)  $\frac{65}{13} \sqrt{133}$

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Ans. d

$$|\vec{a}| = 13, |\vec{b}| = 5; \vec{a} \cdot \vec{b} = 30$$

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

$$30 = (13)(5) \cos \theta$$

$$\cos \theta = \frac{6}{13}$$

$$\sin \theta = \frac{\sqrt{13^2 - 6^2}}{13}$$

$$\sin \theta = \frac{\sqrt{133}}{13}$$

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

$$\sin \theta =$$
$$|\vec{a} \times \vec{b}| = (13)(5) \left( \frac{\sqrt{133}}{13} \right)$$

$$|\vec{a} \times \vec{b}| = 5 \sqrt{133}$$

or

$$|\vec{a} \times \vec{b}| = \frac{65}{13} \sqrt{133}$$

Q) Vector  $\vec{A}$  &  $\vec{B}$  have scalar product 6.00 and their vector product has magnitude +9.00 What is the angle between these two vectors?

(a)  $\tan^{-1}(1.5)$

(b)  $\tan^{-1}(3)$

(c)  $\tan^{-1}(2)$

(d)  $\tan^{-1}\left(\frac{2}{3}\right)$

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Ans. a

$$\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta = 6 \quad \text{--- (1)}$$

$$|\vec{A} \times \vec{B}| = |\vec{A}| |\vec{B}| \sin \theta = 9 \quad \text{--- (2)}$$

$$\frac{(2)}{(1)} = \frac{\sin \theta}{\cos \theta} = \frac{9}{6}$$

$$\tan \theta = \frac{3}{2}$$

$$\tan \theta = 1.5$$

$$\boxed{\theta = \tan^{-1}(1.5)}$$

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