JEE Mains & Advanced Past Years Questions

JEE-MAIN PREVIOUS YEAR'S

1. The energy required to take a satellite to a height 'h' above Earth surface (radius of Earth = 6.4×10^3 km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal is **[*JEE Main-2019* (*January*)]**

(*a*) 1.6×10^3 km (*b*) 3.2×10^3 km

(*c*) 6.4×10^3 km (*d*) 1.28×10^4 km

2. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $(\vec{A}+\vec{B})$ is 'n' times the magnitude of $(\vec{A}-\vec{B})$. The angle between $\vec{A}$ and $\vec{B}$ is:

[*JEE Main-2019* (*January*)]

(*a*) $\cos^{-1}\left[\frac{n^2-1}{n^2+1}\right]$

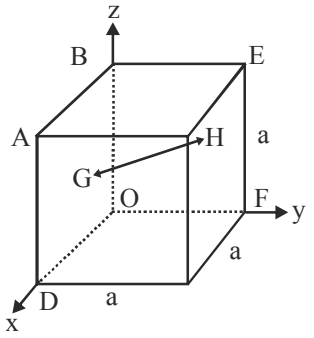
(*b*) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$

(*c*) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$

(*d*) $\sin^{-1}\left[\frac{n-1}{n+1}\right]$

3. In the cube of side 'a' shown in the figure, the vector from the central point of the face ABOD to the central point of the face BEFO will be:

[*JEE Main-2019* (*January*)]



(*a*) $\frac{1}{2}a\left(\hat{k}-\hat{i}\right)$ (*b*) $\frac{1}{2}a\left(\hat{i}-\hat{k}\right)$

(*c*) $\frac{1}{2}a\left(\hat{j}-\hat{i}\right)$ (*d*) $\frac{1}{2}a\left(\hat{j}-\hat{k}\right)$

4. Two forces P and Q, of magnitude 2F and 3F, respectively, are at an angle θ with each other. If the force Q is doubled, then their resultant also gets doubled. then, the angle θ is:

[*JEE Main-2019* (*January*)]

(*a*) 120° (*b*) 60°

(*c*) 90° (*d*) 30°

5. Let $\left|\vec{A}_1\right|=3,\left|\vec{A}_2\right|=5$ and $\left|\vec{A}_1+\vec{A}_2\right|=5$. The value of $\left(2\vec{A}_1+3\vec{A}_2\right).\left(3\vec{A}_1-2\vec{A}_2\right)$ is :-

[*JEE Main-2019* (*April*)]

(*a*) -112.5 (*b*) -106.5

(*c*) -118.5 (*d*) -99.5

6. The sum of two forces $\vec{P}$ and $\vec{Q}$ is $\vec{R}$ such that $|\vec{R}|=|\vec{P}|$. The angle θ (in degrees) that the resultant of $2\vec{P}$ and $\vec{Q}$ will make with $\vec{Q}$ is,_____.

[*JEE Main-2020* (*January*)]

7. Statement I:Two forces $(\vec{P}+\vec{Q})$ and $(\vec{P}-\vec{Q})$ where $\vec{P}\perp\vec{Q}$, when act at an angle θ_1 to each other, the magnitude of their resultant is $\sqrt{3\left(P^2+Q^2\right)}$, when they act at an angle θ_2, the magnitude of their resultant becomes $\sqrt{2\left(P^2+Q^2\right)}$. This is possible only when $\theta_1<\theta_2$.

Statement II :In the situation given above.

$\theta_1=60^\circ$ and $\theta_2=90^\circ$ **[*JEE Main-2021* (*August*)]**

In the light of the above statements, choose the most appropriate answer from the options given below:-

(*a*) Statement I is false but Statement II is true

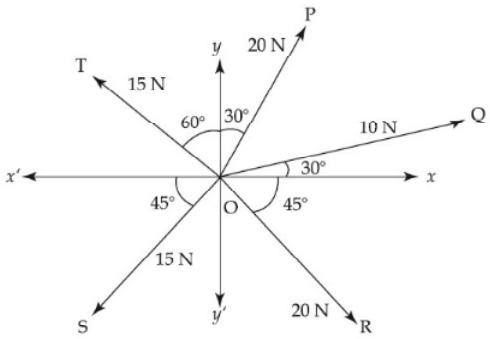
(*b*) Both Statement I and Statement II are true

(*c*) Statement I is true but Statement II is false

(*d*) Both Statement I and Statement II are false.

8. The resultant of these forces $\overrightarrow{OP},\overrightarrow{OQ},\overrightarrow{OR},\overrightarrow{OS}$ and $\overrightarrow{OT}$ is approximately N.

[Take $\sqrt{3}=1.7,\sqrt{2}=1.4$ Given $\hat{i}$ and $\hat{j}$ unit vectors along x, y axis] **[*JEE Main-2021* (*August*)]**

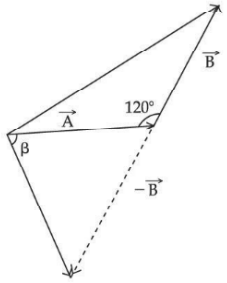


(*a*) $9.25\hat{i}+5\hat{j}$ (*b*) $3\hat{i}+15\hat{j}$

(*c*) $2.5\hat{i}-14.5\hat{j}$ (*d*) $-1.5\hat{i}-15.5\hat{j}$

9. The angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is :

[*JEE Main-2021* (*August*)]



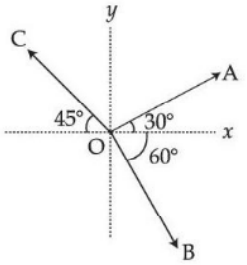
(*a*) $\tan^{-1}\left(\frac{-\frac{B}{2}}{A-B\frac{\sqrt{3}}{2}}\right)$

(*b*) $\tan^{-1}\left(\frac{A}{0.7B}\right)$

(*c*) $\tan^{-1}\left(\frac{\sqrt{3}B}{2A-B}\right)$

(*d*) $\tan^{-1}\left(\frac{B\cos\theta}{A-B\sin\theta}\right)$

10. The magnitude of vectors $\overrightarrow{OA}, \overrightarrow{OB}$ and $\overrightarrow{OC}$ in the given figure are equal. The direction of $\overrightarrow{OA}+\overrightarrow{OB}-\overrightarrow{OC}$ with x-axis will be : **[*JEE Main-2021 (August)*]**



(*a*) $\tan^{-1}\dfrac{(1-\sqrt{3}-\sqrt{2})}{(1+\sqrt{3}+\sqrt{2})}$

(*b*) $\tan^{-1}\dfrac{(\sqrt{3}-1+\sqrt{2})}{(1+\sqrt{3}-\sqrt{2})}$

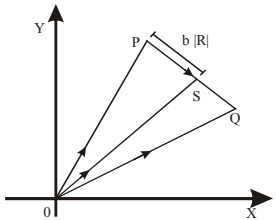
(*c*) $\tan^{-1}\dfrac{(\sqrt{3}-1+\sqrt{2})}{(1-\sqrt{3}+\sqrt{2})}$

(*d*) $\tan^{-1}\dfrac{(1+\sqrt{3}-\sqrt{2})}{(1-\sqrt{3}-\sqrt{2})}$

JEE-ADVANCED PREVIOUS YEAR'S

1. Three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$ are shown in the figure. Let S be any point on the vector $\vec{R}$ .The distance bvetween the point P and S is b$|\vec{R}|$. The general relation among vectors $\vec{P}$, $\vec{Q}$ and $\vec{S}$ is:

[*JEE Advanced-2017*]



(*a*) $\vec{S}=(b-1)\vec{P}+b\vec{Q}$ (*b*) $\vec{S}=(1-b^2)\vec{P}+b\vec{Q}$

(*c*) $\vec{S}=(1-b)\vec{P}+b^2\vec{Q}$ (*d*) $\vec{S}=(1-b)\vec{P}+b\vec{Q}$

2. Two vectors $\vec{A}$ and $\vec{B}$ are defined as $\vec{A}=a\hat{i}$ and $\vec{B}=a(\cos\omega t\,\hat{i}+\sin\omega t\hat{j})$, where a is a constant and $\omega=\pi/6 \text{rad s}^{-1}$. If $|\vec{A}+\vec{B}|=\sqrt{3}\,|\vec{A}-\vec{B}|$ at time $t=\tau$ for the first time, the value of τ, in seconds, is____

[*JEE Advanced-2018*]

JEE Mains & Advanced Past Years Questions

JEE-MAIN
PREVIOUS YEAR'S

1. (*b*) $E_1 = -\frac{GMm}{R+h} - \left(-\frac{GMm}{R}\right)$

$$E_2 = -\frac{1}{2}m\left(\sqrt{\frac{GM}{R+h}}\right)^2 = -\frac{GMm}{2(R+h)}$$

$$E_1 = E_2 ; h = \frac{R}{2}$$

2. (*a*) $|\vec{A}+\vec{B}| = n|\vec{A}-\vec{B}|$

$\Rightarrow A^2 + B^2 + 2AB\cos\theta$
$= n^2(A^2 + B^2 - 2AB\cos\theta)$

$$\Rightarrow \cos\theta(1+n^2) = \frac{2a^2(n^2-1)}{2a^2} \quad [A = B = a]$$

$$\cos\theta = \frac{n^2-1}{n^2+1}$$

3. (*b*) $1\left(0, \frac{a}{2}, \frac{a}{2}\right)$

$$2\left(\frac{a}{2}, \frac{a}{2}, 0\right)$$

$$\vec{r}_2 - \vec{r}_1 = \frac{a}{2}\hat{i} - \frac{a}{2}\hat{k}$$

$$\text{Unit vector} = \frac{\hat{i}-\hat{k}}{\sqrt{2}}$$

4. (*a*) $2|\vec{P}+\vec{Q}| = |\vec{P}+2\vec{Q}|$

$\Rightarrow 13 + 12\cos\theta = 10 + 6\cos\theta$

$$\cos = -\frac{1}{2}$$

$\theta = 120^o$.

5. (*c*) $|\vec{A}_1| = 3 \qquad |\vec{A}_2| = 5 \qquad |\vec{A}_1 + \vec{A}_2| = 5$

$$|\vec{A}_1 + \vec{A}_2| = \sqrt{|\vec{A}_1|^2 + |\vec{A}_2|^2 + 2|\vec{A}_1||\vec{A}_2|\cos\theta}$$

$$5 = \sqrt{9 + 25 + 2\times 3\times 5\cos\theta}$$

$$\cos\theta = -\frac{9}{2\times 3\times 5} = -\frac{3}{10}$$

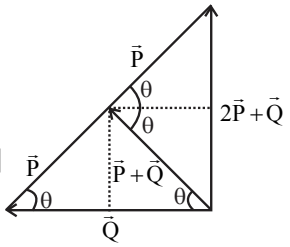
$$(2\vec{A}_1 + 3\vec{A}_2).(3\vec{A}_1 - 2\vec{A}_2)$$

$$= 6|\vec{A}_1|^2 + 9\vec{A}_1.\vec{A}_2 - 4\vec{A}_1\vec{A}_2 - 6|\vec{A}_2|^2$$

$$54+5\times3\times5\left(-\frac{3}{10}\right)-6\times25$$

$$=54-150-\frac{45}{2}=-118.5$$

6. [90°]



So angle between $(2\vec{P}+\vec{Q})$ and $\vec{Q}$ is 90°

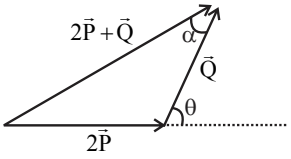
Alternate solution

$|\vec{P}+\vec{Q}|=|\vec{P}|$

$P^2+Q^2+2PQ\cos\theta=P^2$

$\Rightarrow Q+2P\cos\theta=0$

$\Rightarrow \cos\theta=-\frac{Q}{2P}$



$$\tan\alpha=\frac{2P\sin\theta}{2P\cos\theta+Q}=\infty\ \because\ [2P\cos\theta+Q=0]$$

$\alpha=90^o$

7. (*b*) According to question the given data is two forces $(\vec{P}+\vec{Q})$ and $(\vec{P}-\vec{Q})$

$\vec{A}=\vec{P}+\vec{Q}\Rightarrow\vec{B}=\vec{P}-\vec{Q}\Rightarrow\vec{P}\perp\vec{Q}$

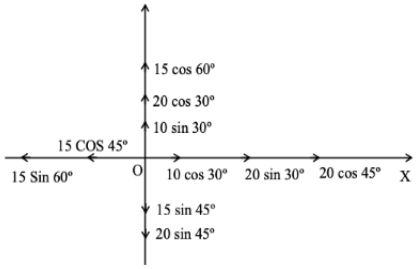
$\Rightarrow|\vec{A}|=|\vec{B}|=\sqrt{2\left(P^2+Q^2\right)(1+\cos\theta)}$

$\Rightarrow$ For $|\vec{A}+\vec{B}|=\sqrt{3\left(P^2+Q^2\right)}\Rightarrow\theta_1=60^\circ$

$\Rightarrow$ For $|\vec{A}+\vec{B}|=\sqrt{2\left(P^2+Q^2\right)}n\Rightarrow\theta_2=90^\circ n$

According to solution Both Statement I and Statement II are true

8. (*a*)



Force in x-direction,

$$\overrightarrow{F_x}=\left(10\times\frac{\sqrt{3}}{2}+20\left(\frac{1}{2}\right)+20\left(\frac{1}{\sqrt{2}}\right)-15\left(\frac{1}{\sqrt{2}}\right)-15\left(\frac{\sqrt{3}}{2}\right)\right)\hat{i}$$

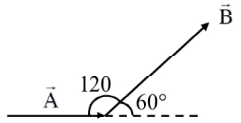
$$=9.25\hat{i}$$

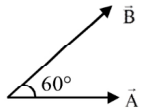
Force in y-direction,

$$\vec{F}_y=\left(15\left(\frac{1}{2}\right)+20\left(\frac{\sqrt{3}}{2}\right)+10\left(\frac{1}{2}\right)-15\left(\frac{1}{\sqrt{2}}\right)-20\left(\frac{1}{\sqrt{2}}\right)\right)\hat{j}$$

$$=5\hat{j}$$

9. (*c*)





According to digram,

Angle between $\vec{A}$ and $\vec{B},\theta=60^\circ$

Angle between $\vec{A}$ and $-\vec{B},\theta=120^\circ$

If angle between $\vec{A}$ and $\vec{A}-\vec{B}$ is α

then $\tan\alpha=\frac{|-\vec{B}|\sin\theta}{\vec{A}+|-\vec{B}|_{\cos\theta}}$

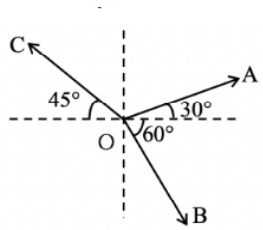
$$=\frac{B\sin120^\circ}{A+B\cos120^\circ}$$

$$=\frac{B\frac{\sqrt{3}}{2}}{A-\frac{B}{2}}$$

$\Rightarrow\tan\alpha=\frac{\sqrt{3}B}{2A-B}$

Hence, the angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is $\tan\alpha=\frac{\sqrt{3}B}{2A-B}$

10. (*a*)



According to diagram, let magnitude be equal to

$$\overrightarrow{OA} = \lambda\left[\cos 30^\circ \hat{i} + \sin 30 \hat{j}\right] = \lambda\left[\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right]$$

$$\overrightarrow{OB} = \lambda\left[\cos 60^\circ \hat{i} - \sin 60 \hat{j}\right] = \lambda\left[\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right]$$

$$\overrightarrow{OC} = \lambda\left[\cos 45^\circ (-\hat{i}) + \sin 45 \hat{j}\right] = \lambda\left[-\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$

$$\therefore \overrightarrow{OA} + \overrightarrow{OB} - \overrightarrow{OC}$$

$$= \lambda\left[\left(\frac{\sqrt{3}+1}{2} + \frac{1}{\sqrt{2}}\right)\hat{i} + \left(\frac{1}{2} - \frac{\sqrt{3}}{2} - \frac{1}{\sqrt{2}}\right)\hat{j}\right]$$

$$\tan^{-1}\left[\frac{\frac{1}{2} - \frac{\sqrt{3}}{2} - \frac{1}{\sqrt{2}}}{\frac{\sqrt{3}}{2} + \frac{1}{2} + \frac{1}{\sqrt{2}}}\right] = \tan^{-1}\left[\frac{\sqrt{2} - \sqrt{6} - 2}{\sqrt{6} + \sqrt{2} + 2}\right]$$

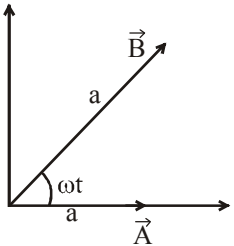
$$= \tan^{-1}\left[\frac{1 - \sqrt{3} - \sqrt{2}}{\sqrt{3} + 1 + \sqrt{2}}\right]$$

Hence option (*a*).

JEE-ADVANCED PREVIOUS YEAR'S

1. (*d*) $\vec{S} = \vec{P} + b\vec{R} = \vec{P} + b\left(\vec{Q} - \vec{P}\right) = \vec{P}(1-b) + b\vec{Q}$

2. [2.00 sec]



$$|\vec{A} + \vec{B}| = 2a\cos\frac{\omega t}{2}$$

$$|\vec{A} + \vec{B}| = 2a\sin\frac{\omega t}{2}$$

$$\text{So, } 2a\cos\frac{\omega t}{2} = \sqrt{3}\left(2a\sin\frac{\omega t}{2}\right)$$

$$\tan\frac{\omega t}{2} = \frac{\pi}{6} \Rightarrow \omega t = \frac{\pi}{3}$$

$$\frac{\pi}{6}t = \frac{\pi}{3} \qquad t = 2.00 \text{ sec}$$