7. $\vec{A}$ is a vector of magnitude 2.7 units due east. What is the magnitude and direction of vector $4\vec{A}$?

(1) 4 units due east (2) 4 units due west (3) 2.7 units due east (4) 10.8 units due east

Sol. Answer (4)

$\vec{A} = 2.7\,\hat{i}$

Vector $4\vec{A}$

$\Rightarrow 4(2.7\hat{i}) = 10.8\hat{i}$ or 10.8 units due east.

8. Two forces of magnitude 8 N and 15 N respectively act at a point. If the resultant force is 17 N, the angle between the forces has to be

(1) 60° (2) 45° (3) 90° (4) 30°

Sol. Answer (3)

$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

A = 8, B = 15, R = 17

$17^2 = 8^2 + 15^2 + 2 \times 8 \times 15 \times \cos\theta$

$289 = 64 + 225 + 240\cos\theta$

$\Rightarrow 289 = 289 + 24\cos\theta$

$24\cos\theta = 0$

$\cos\theta = 0 \Rightarrow \theta = 90°$

9. A particle is moving in a circle of radius r having centre at O, with a constant speed v. The magnitude of change in velocity in moving from A to B is

(1) $2v$ (2) 0 (3) $\sqrt{3}\,v$ (4) v

Sol. Answer (4)

$[\Delta\vec{V}] = 2V\sin\frac{\theta}{2} = 2\times V\times\sin\left(\frac{60°}{2}\right) = 2\times V\times\frac{1}{2} \Rightarrow V = |\Delta\vec{V}|$

10. Two forces of 10 N and 6 N act upon a body. The direction of the forces are unknown. The resultant force on the body may be

(1) 15 N (2) 3 N (3) 17 N (4) 2 N

Sol. Answer (1)

The resultant of two vectors always lie between (A + B) & (A – B).

So the resultant of 10 N & 6 N should lie between 16 N & 4 N.

So answer is 15 N.

$\Rightarrow \cos\theta = \frac{\sqrt{3}}{2}$

$\theta = 30^\circ$

$R = \frac{u^2 \sin 2\theta}{g}$

$= \frac{u^2 \sin 60^\circ}{g} \Rightarrow \frac{\sqrt{3}u^2}{2g} = R$

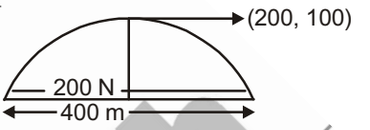
30. A projectile is thrown into space so as to have a maximum possible horizontal range of 400 metres. Taking the point of projection as the origin, the co-ordinates of the point where the velocity of the projectile is minimum are

(1) (400, 100) (2) (200, 100) (3) (400, 200) (4) (200, 200)

Sol. Answer (2)

R_{max} = 400 m

The velocity is minimum at the highest point



$\Rightarrow H \to \frac{R}{2}$

$R = 4H$

$400 = 4 \times H$

$H = 100$ m

31. If the time of flight of a bullet over a horizontal range R is T, then the angle of projection with horizontal is

(1) $\tan^{-1}\left(\frac{gT^2}{2R}\right)$ (2) $\tan^{-1}\left(\frac{2R^2}{gT}\right)$ (3) $\tan^{-1}\left(\frac{2R}{g^2T}\right)$ (4) $\tan^{-1}\left(\frac{2R}{gT}\right)$

Sol. Answer (1)

$T = \frac{2u\sin\theta}{g} \Rightarrow u = \frac{gT}{2\sin\theta}$

$R = \frac{2u^2 \sin\theta\cos\theta}{g}$

$R = \frac{2u\sin\theta}{g} \times u\cos\theta$

$R = T \times u\cos\theta$

$R = T \times \frac{gT\cos\theta}{2\sin\theta}$

$R = \frac{gT^2}{2}\frac{1}{\tan\theta}$

$\tan\theta = \frac{gT^2}{2R}$

$\theta = \tan^{-1}\left(\frac{gT^2}{2R}\right)$

$$\theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

27. A man moves in an open field such that after moving 10 m on a straight line, he makes a sharp turn of 60º to his left. The total displacement after 8 such turn is equal to

(1) 12 m (2) 15 m (3) 17.32 m (4) 14.14 m

Sol. Answer (3)

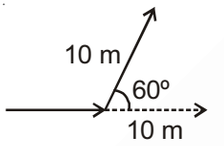
After 8 such turns object is at '*B*'.

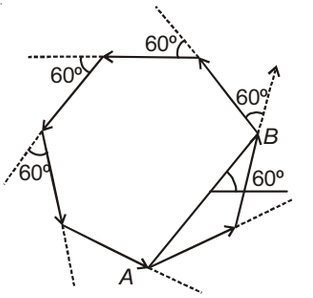
Displacement = *AB*

Two vectors are at 60º

$$\sqrt{10^2 + 10^2 + 2\times 10^2 \times \frac{1}{2}} = 10\sqrt{3} \text{ m}$$

$$\Rightarrow \boxed{17.32 \text{ m} = AB}$$





SECTION - C

Previous Years Questions

1. The position vector of a particle $\vec{R}$ as a function of time is given by $\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j}$, where *R* is in meters, *t* is in seconds and $\hat{i}$ and $\hat{j}$ denote unit vectors along *x*-and *y*-directions, respectively. Which one of the following statements is wrong for the motion of particle? **[Re-AIPMT-2015]**

(1) Path of the particle is a circle of radius 4 meter

(2) Acceleration vector is along $-\vec{R}$

(3) Magnitude of acceleration vector is $\frac{v^2}{R}$, where *v* is the velocity of particle

(4) Magnitude of the velocity of particle is 8 meter/second

Sol. Answer (4)

$\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j} = x\hat{i} + y\hat{j}$

Now, $x^2 + y^2 = 4^2$ which is equation of circle of radius *R*.

So, the motion is UCM with speed

$V = 8\pi\sqrt{2}$ m/s

2. Two particles *A* and *B*, move with constant velocities $\vec{v}_1$ and $\vec{v}_2$. At the initial moment their position vectors are $\vec{r}_1$ and $\vec{r}_2$ respectively. The condition for particles *A* and *B* for their collision is **[Re-AIPMT-2015]**

(1) $\vec{r}_1 - \vec{r}_2 = \vec{v}_1 - \vec{v}_2$ (2) $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|}$ (3) $\vec{r}_1 \cdot \vec{v}_1 = \vec{r}_2 \cdot \vec{v}_2$ (4) $\vec{r}_1 \times \vec{v}_1 = \vec{r}_2 \times \vec{v}_2$

Sol. Answer (2)

For collision final positions should be equal

$\Rightarrow \vec{r}_1 + \vec{v}_1 t = \vec{r}_2 + \vec{v}_2 t$

$\Rightarrow \vec{r}_1 - \vec{r}_2 = (\vec{v}_2 - \vec{v}_1)t$

The change is only in the *y*-component

So, $\boxed{v_f = 2\hat{i} - 3\hat{j}}$ $\boxed{\because\ a_x = 0}$

7. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is **[AIPMT (Prelims)-2012]**

(1) $\theta = \tan^{-1}(2)$ (2) $\theta = 45°$ (3) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$ (4) $\theta = \tan^{-1}(4)$

Sol. Answer (4)

$H = R$

$\tan\theta = 4$ $\left(\because\ \frac{H}{R} = \frac{1}{4}\tan\theta\right)$

$\boxed{\theta = \tan^{-1}(4)}$

8. A particle has initial velocity $\left(2\vec{i} + 3\vec{j}\right)$ and acceleration $\left(0.3\vec{i} + 0.2\vec{j}\right)$. The magnitude of velocity after 10 s will be **[AIPMT (Prelims)-2012]**

(1) 5 units (2) 9 units (3) $9\sqrt{2}$ units (4) $5\sqrt{2}$ units

Sol. Answer (4)

$\vec{u} = 3\hat{i} + 3\hat{j}$, $\vec{a} = 0.3\hat{i} + 0.2\hat{j}$

$\Delta t = 10$ s

$\vec{v} = \vec{u} + \vec{a}t$

$\vec{v} = 2\hat{i} + 3\hat{j} + (0.3\hat{i} + 0.2\hat{j}) \times 10$

$= 2\hat{i} + 3\hat{j} + 3\hat{i} + 2\hat{j}$

$\vec{v} = 5\hat{i} + 5\hat{j}$

$v = \sqrt{5^2 + 5^2} = \sqrt{50}$

$\boxed{v \Rightarrow 5\sqrt{2}\ \text{ms}^{-1}}$

9. A particle moves in a circle of radius 5 cm with constant speed and time period 0.2 π s. The acceleration of the particle is **[AIPMT (Prelims)-2011]**

(1) 5 m/s^2 (2) 15 m/s^2 (3) 25 m/s^2 (4) 36 m/s^2

Sol. Answer (1)

$r = 5$ cm, $v = ?$, $T = 0.2\ \pi$ s

$T = \frac{2\pi}{\omega} \Rightarrow \omega = \frac{20\pi}{0.2\pi} = 10\ \text{rad s}^{-1}$

$a = r\omega^2 = 5 \times 10^{-2} \times 100$

$\boxed{a = 5\ \text{ms}^{-2}}$

25. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 s, what is the magnitude and direction of acceleration of the stone?

[AIPMT (Prelims)-2005]

(1) $\frac{\pi^2}{4}$ ms^{-2} and direction along the radius towards the centre

(2) π^2 ms^{-2} and direction along the radius away from centre

(3) π^2 ms^{-2} and direction along the radius towards the centre

(4) π^2 ms^{-2} and direction along the tangent to the circle

Sol. Answer (3)

$$\omega = \frac{22 \times 2\pi}{44 \text{ s}} \Rightarrow \pi \text{ rad s}^{-1}$$

Centripetal acceleration, $a = r\omega^2$

$$\boxed{a = 1 \times \pi^2} \text{ ms}^{-2} \text{ along the radius towards the centre}$$

26. Two boys are standing at the ends A and B of a ground, where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is

[AIPMT (Prelims)-2005]

(1) $\frac{a}{\sqrt{v^2 + v_1^2}}$

(2) $\sqrt{\frac{a^2}{v^2 - v_1^2}}$

(3) $\frac{a}{(v - v_1)}$

(4) $\frac{a}{(v + v_1)}$

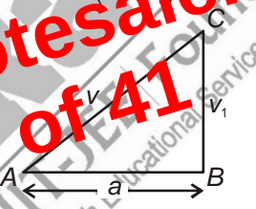
Sol. Answer (2)

The distance travelled by body at B,

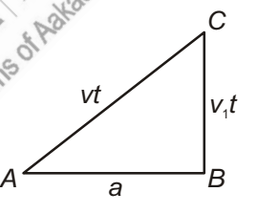
= Speed × t

= $v_1 t$

So, $BC = v_1 t$, similarly, $AC = vt$



Applying pythagoras in ΔABC,



$$v^2t^2 = v_1^2t^2 + a^2$$

$$(v^2 - v_1^2)t^2 = a^2$$

$$t^2 = \frac{a^2}{v^2 - v_1^2}$$

$$\boxed{t = \frac{a}{\sqrt{v^2 - v_1^2}}}$$

27. If the angle between the vectors $\vec{A}$ and $\vec{B}$ is θ, the value of the product $(\vec{B} \times \vec{A}) \cdot \vec{A}$ is equal to

[AIPMT (Prelims)-2005]

(1) $BA^2 \cos\theta$

(2) $BA^2 \sin\theta$

(3) $BA^2 \sin\theta \cos\theta$

(4) Zero

Sol. Answer (4)

4. A : At the highest point the velocity of projectile is zero.

R : At maximum height projectile comes to rest.

Sol. Answer (4)

5. A : Horizontal range of a projectile is always same for angle of projection θ with horizontal or θ with vertical.

R : Horizontal range depends only on angle of projection.

Sol. Answer (4)

6. A : Horizontal motion of projectile without effect of air is uniform motion.

R : Without air effect the horizontal acceleration of projectile is zero.

Sol. Answer (1)

7. A : Path of a projectile with respect to another projectile is straight line.

R : Acceleration of a projectile with respect to another projectile is zero.

Sol. Answer (1)

8. A : In the case of ground to ground projection of a projectile from ground the angle of projection with horizontal is $\theta = 30^\circ$. There is no point on its path such that instantaneous velocity is normal to the initial velocity.

R : Maximum deviation of the projectile is $2\theta = 60^\circ$.

Sol. Answer (1)

9. A : Three vectors having magnitudes 10, 10 and 25 cannot produce zero resultant.

R : If three vectors are producing zero resultant, then sum of magnitude of any two is more than or equal to magnitude of third and difference is less than or equal to the magnitude of third.

Sol. Answer (1)

10. A : Uniform circular motion is accelerated motion still speed remains unchanged.

R : Instantaneous velocity is always normal to instantaneous acceleration in uniform circular motion.

Sol. Answer (1)

11. A : When a body moves on a curved path with increasing speed, then angle between instantaneous velocity and acceleration is acute angle.

R : When the speed is increasing, its tangential acceleration is in the direction of instantaneous velocity.

Sol. Answer (1)

12. A : A uniform circular motion have non uniform acceleration.

R : The direction of acceleration of a particle in uniform circular motion changes continuously.

Sol. Answer (1)

13. A : Angular displacement is vector quantity only for small values.

R : The direction of angular displacement is perpendicular to plane of rotation of object.

Sol. Answer (2)

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