Motion in a Plane Important Questions With Answers

NEET Physics 2023

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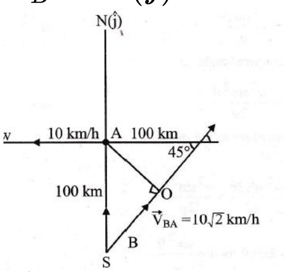
1. A ship A is moving Westwards with a speed of 10 km h^{-l} and a ship B 100 km South of A is moving Northwards with a speed of l0 km h^{-l}. The time after which the distance between them becomes shortest, is ___________ .
   a) 5 h b) $5\sqrt{2}$ h c) $10\sqrt{2}$ h d) 0 h

   Solution : -

   $We\ have, \vec{V}_A = 10(-\hat{i})\ and$

   $\vec{V}_B = 10(\hat{j})$

   $\vec{V}_{BA} = |10\hat{j} + 10\hat{i}|$

   $= \sqrt{10^2 + 10^2} = \sqrt{200}$

   $= 10\sqrt{2}\ \mathrm{km/h}$

   Time taken to reach the shortest distance between

   $A \text{ and } B = \frac{OB}{V_{BA}} = \frac{50\sqrt{2}}{10\sqrt{2}} = 5 \text{ hours.}$

2. 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 ___________
   a) $\mathrm{BA}^2 \sin\theta$ b) $\mathrm{BA}^2 \cos\theta$ c) $\mathrm{BA}^2 \sin\theta \cos\theta$ **d) zero**

   Solution : -

   $(\vec{B} \times \vec{A}) \cdot \vec{A} = \vec{C} \cdot \vec{A} = CA \cos 90^\circ = 0$

3. If a unit vector is represented by $0.5\hat{i} - 0.8\hat{j} + c\hat{k}$, then the value of c is _________
   a) 1 **b)** $\sqrt{0.11}$ c) $\sqrt{0.01}$ d) 0.39

   Solution : -

   Concept Unit vector can be found by dividing a vector with its magnitude i.e. $\hat{A} = \frac{A}{|A|}$

   Let we represent the unit vector by $\vec{n}$. We also know that the modulus of unit vector is 1 i.e. $|\boldsymbol{\hat{n}}| = 1$

   $|\hat{n}| = |0.5\hat{i} + 0.8\hat{j} + c\hat{k}| = 1$

   $\sqrt{(0.5)^2 + (0.8)^2 + c^2} = 1$

   $0.25 + 0.64 + c^2 = 1$

   $0.89 + c^2 = 1$

   $c^2 = 1 + 0.89 = 0.11 \Rightarrow c = \sqrt{0.11}$

4. From a 10 m high building a stone 'A' is dropped, and simultaneously another identical stone 'B' is thrown horizontally with an initial speed of 5 ms^{-1}. Which one of the following statements is true?

a) It is not possible to calculate which one of the two stones will reach the ground first

b) Both the stones ('A' and 'B') will reach the ground simultaneously

c) 'A' stone reaches the ground earlier than 'B' d) 'B' stone reaches the ground earlier than 'A'

Solution : -

Here. vertical height $= h = \frac{1}{2}gt^2$

As h and g are same for both the balls, therefore time of fall 't'will also be the same for both of them.

5. A missile is fired for maximum range with an initial velocity of 20 m is. If g = 10 m/s^2, the range of the missile is ______________ .

a) 40m b) 50m c) 60m d) 20m

Solution : -

For maximum range, the angle of projection, θ = 45°

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

$= \frac{(20)^2 \sin(2\times 45^\circ)}{10}$

$= \frac{400\times 1}{10} = 40 \text{ m.}$

6. A particle moves in a circle of radius 5 cm with constant speed and time period 0.2 πs. The acceleration of the particle is __________

a) 5m/s² b) 15m/s² c) 25m/s² d) 35m/s²

Solution : -

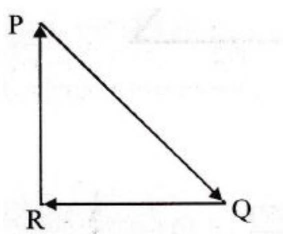
$Centripetal\ acceleration\ a_c = \text{w}^2 r = \left(\frac{2\pi}{T}\right)^2 r$

$= \left(\frac{2\pi}{0.2\pi}\right)^2 \times 5 \times 10^{-2} = 5 \text{ m/s}^2$

7. A particle moving with velocity $\vec{v}$ is acted by three forces shown by the vector triangle PQR. The velocitv of the particle will ___________

a) Decrease **b) Remain constant** c) Change according to the smallest force $\overrightarrow{OR}$ d) Increase

Solution : -



As forces are forming closed loop in same order

so, $\bar{F}_{\text{net}} = 0$

$\Rightarrow m\frac{dv}{dt} = 0$

$\Rightarrow \vec{V} = \text{ constant}$

8. If the magnitude of sum of two vectors is equal to the magnitude of difference of the two vectors, the angle between these vectors is _____________

a) 90° b) 45° c) 180° d) 45°

Solution : -

Suppose two vectors are P and Q. It is given that

$$|\mathbf{P}+\mathbf{Q}|=|\mathbf{P}-\mathbf{Q}|$$

$Let\ angle\ between$ P and Q is f.

$$\therefore \mathrm{P}^2+\mathrm{Q}^2+2\mathrm{PQ}\cos\phi=P^2+Q^2-2PQ\cos\phi$$

$$\Rightarrow\ 4PQ\cos\phi=0$$

$$\Rightarrow\ \cos\phi=0\left[\mathrm{Q}P,Q^1 0\right]$$

$$\Rightarrow\ \phi=\frac{\pi}{2}=90^\circ$$

9. If $|\vec{A}\times\vec{B}|=\sqrt{3A\cdot B}$ then the value of $|\vec{A}\times\vec{B}|$ is ____________

a) $\left(A^2+B^2+\sqrt{3}AB\right)^{1/2}$ **b)** $\left(A^2+B^2+AB\right)^{1/2}$ c) $\left(A^2+B^2+\frac{AB}{\sqrt{3}}\right)^{1/2}$ d) A+B

Solution : -

$$|\vec{A}\times\vec{B}|=AB\sin\theta$$

$$\vec{A}\cdot\vec{B}=AB\cos\theta$$

$$\Rightarrow |\vec{A}\times\vec{B}|=\sqrt{3}\vec{A}\cdot\vec{B}\Rightarrow AB\sin\theta$$

$$=\sqrt{3}AB\cos\theta$$

$$or,\tan\theta=\sqrt{3}=\tan 60^\circ\ \therefore\theta=60^\circ$$

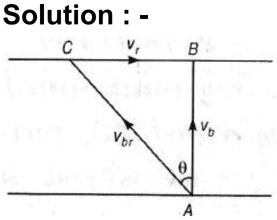
$$\therefore|\vec{A}+\vec{B}|=\sqrt{A^2+B^2+2AB\cos 60^\circ}$$

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

10. The speed of a boat is 5 km/h in still water. It crosses a river of width 1.0 km along the shortest possible path in 15 min. The velocity of the river water is (in km/h)

a) 5 b) 1 **c) 3** d) 4

Solution : -



$$Let\ v_r=velocity\ of\ water$$

$$v_{br}=velocity\ of\ boat\ in\ still\ water\ and\ w=width\ of\ river$$

$$Time\ taken\ to\ cross\ the\ river\ =15\ \mathrm{min}$$

$$=\frac{15}{60}h=\frac{1}{4}h$$

$$Shortest\ path\ is\ taken\ when\ v_b\ is\ along\ AB.\ In\ this\ case,\ v_{br}^2=v_r^2+v_b^2$$

$$Now$$

$$t=\frac{w}{v_b}=\frac{w}{\sqrt{v_{br}^2-v_r^2}}$$

$$\therefore\ \frac{1}{4}=\frac{1}{\sqrt{5^2-v_r^2}}$$

$$\Rightarrow\ 5^2-v_r^2=16$$

$$\Rightarrow\ v_r^2=25-16=9$$

$$\therefore\ v_r=\sqrt{9}=3\ \mathrm{km/h}$$

11. An electric fan has blades of length 30 cm measured from the axis of rotation. If the fan is rotating at 120 rev/min, the acceleration of a point on the tip of the blade is ___________ .

a) 1600 ms^{-2} **b) 47.4 ms^{-2}** c) 23.7 ms^{-2} d) 50.55 ms^{-2}

Solution : -

Centripetal acceleration ofrotating body is given by

$a_c = \frac{v^2}{r} = \frac{r^2\omega^2}{r} = r\omega^2$ (as $v = r$w)

$a_c = r(2\text{pn})^2 = r4\text{p}^2\text{n}^2$

$r = 30 \text{ cm} = 30 \times 10^{-2} \text{ m} = 0.30 \text{ m}$

$v = 120\text{rev/m} = \frac{120}{60}\text{rev/s} = 2\text{rev/s}$

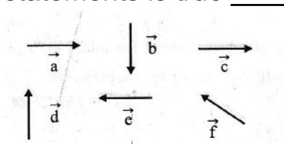
$a = (0.30 \times 4 \times 3.14 \times 3.14 \times 2 \times 2) = 47.4 \text{ ms}^{-2}$

12. The position vector of a particle is r = $(a\cos wt)\hat{i} + (a\sin wt)\hat{j}$. The velocity of the particle is ___________ .

a) directed towards the origin b) directed away from the origin c) parallel to the position vector

d) perpendicular to the position vector

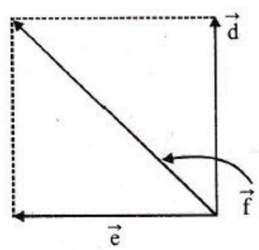
13. Six vectors, $\vec{a}$ through $\vec{d}$ haue the magnitudes and directions, indicated in the figure. Which of the following statements is true ________



a) $\vec{b} + \vec{c} = \vec{f}$ b) $\vec{d} + \vec{c} = \vec{f}$ **c)** $\vec{d} + \vec{e} = \vec{f}$ d) $\vec{e} + \vec{b} = \vec{f}$

Solution : -

According to the law of vector addition $(\vec{d} + \vec{e})$ is as shown in the following figure



$\therefore \vec{d} + \vec{e} = \vec{f}$

14. A particle moves along a circle of radius $\left(\frac{20}{\pi}\right)$ m with constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

____

a) 40pm/s^2 **b) 40m/s^2** c) 640pm/s^2 d) 160pm/s^2

Solution : -

Circumference $2\pi r = 2\pi \times \frac{20}{\pi} = 40 \text{ m}$

Distance covered in 2 revolutions $= 2 \times 40 = 80 \text{ m}$

Initial velocity = u = 0

Final velocity v = 80 m/sec

Using the formula $v^2 = u^2 = 2as$,we get

$(80)^2 = 0^2 + 2 \times a \times 80 \Rightarrow a = 40 \text{ m/sec}^2$

15. A body is whirled in a horizontal circle of radius 20 cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on circular path?

a) $\sqrt{2}$ m/s **b) 2 m/s** c) 10 m/s d) 20 m/s

Solution : -

$\text{Linear speed} = \text{radius} \times \text{angular speed}$
$v = r\text{w}$
$r = 20 \text{ cm} = 0.20 \text{ m}$
$\text{w} = 10 \text{rad/s}$
$v = 0.20 \times 10$
$v = 2 \text{ m/s}$

16. A body of 3 kg moves in the XY plane under the action of a force given by $6t\hat{i} + 4t\hat{j}$. Assuming that the body is at rest at title t = 0, the velocity of the body at t = 3s is _____________ .

a) $6\hat{i} + 6\hat{j}$ b) $18\hat{i} + 6\hat{j}$ **c)** $18\hat{i} + 12\hat{j}$ d) $12\hat{i} + 18\hat{j}$

Solution : -

$\vec{F} = 6t\hat{i} + 4\hat{t}$
$\therefore F_x = 6t, F_y = 4t$
$\therefore a_x = \frac{6t}{3} = 2t \text{ and } a_y = \frac{4t}{3}$
$\therefore v_x = 0 + 2t \cdot t = 18 \text{ for } t = 3 \text{ seconds}$
$\text{and } v_y = 0 + \frac{4}{3}t \cdot t = 12 \text{ for } t = 3 \text{ seconds Velocity is given by } 18\hat{i} + 12\hat{j}$

17. A particle is moving such that its position coordinate (x,y) are
(2m 3m) at time r = 0
(6m, 7m) attime t = 2s and
(13m, 14m) at time r = 5s.
Average velocity vector $\left(\vec{V}_{av}\right)$ from t = 0 to t = 5s is __________ .

a) $\frac{1}{5}(13\hat{i} + 14\hat{j})$ b) $\frac{7}{3}(\hat{i} + \hat{j})$ c) $2(\hat{i} + \hat{j})$ **d)** $\frac{11}{5}(\hat{i} + \hat{j})$

Solution : -

$\vec{v}_{av} = \frac{\Delta\vec{r}(\text{ displacement })}{\Delta t(\text{ time taken })}$
$= \frac{(13-2)\hat{i} + (14-3)\hat{j}}{5-0} = \frac{11\hat{i} + 11\hat{j}}{5}$
$= \frac{11}{5}(\hat{i} + \hat{j})$

18. Find the torque of a force F = $-3\hat{i} + \hat{j} + 5\hat{k}$ acting at the point $\mathbf{r} = 7\hat{i} + 3\hat{j} + \hat{k}$.

a) $-21\hat{i} + 3\hat{j} + 5\hat{k}$ b) $-14\hat{i} - 3\hat{j} + \hat{k}$ c) $4\hat{i} + 4\hat{j} + 6\hat{k}$ **d)** $14\hat{i} - 38\hat{j} + 16\hat{k}$

Solution : -

$r = 7\hat{i} + 3\hat{j} + \hat{k}, \ \mathbf{F} = -3\hat{i} + \hat{j} + 5\hat{k}$
$\text{t} = \mathbf{r} \times \mathbf{F} = |\mathbf{r}||\mathbf{F}|\sin\theta$
$= (7\hat{i} + 3\hat{j} + \hat{k}) \times (-3\hat{i} + \hat{j} + 5\hat{k})$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 3 & 1 \\ -3 & 1 & 5 \end{vmatrix} = \hat{i}(15-1) - \hat{j}(35+3) + \hat{k}(7+9)$$

$= 14\hat{i} - 38\hat{j} + 16\hat{k}$

19. If a vector $2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $4\hat{j} - 4\hat{i} + \alpha\hat{k}$ of, then the value of a is ____________

a) 1/2 **b) -1/2** c) 1 d) -1

Solution : -

For two vectors to be perpendicular to each other, we have their dot product is equal to 0

$$\Rightarrow \vec{A} \cdot \vec{B} = 0$$

$$\Rightarrow (2\hat{i} + 3\hat{j} + 8\hat{k}) \cdot (4\hat{j} - 4\hat{i} + \alpha\hat{k}) = 0$$

$$\Rightarrow -8 + 12 + 8\alpha = 0 \Rightarrow 8\alpha = -4$$

$$\Rightarrow \quad \alpha = -\frac{4}{8} = -\frac{1}{2}$$

20. What is the linear velocity, if angular velocity vector $w = 3\hat{i} - 4\hat{j} + \hat{k}$ and position vector r = $5\hat{i} - 6\hat{j} + 6\hat{k}$?

a) $6\hat{i} - 2\hat{j} - 3\hat{k}$ **b)** $-18\hat{i} - 13\hat{j} + 2\hat{k}$ c) $18\hat{i} + 13\hat{j} + 2\hat{k}$ d) $6\hat{i} - 2\hat{j} + 8\hat{k}$

Solution : -

$$\mathbf{v} = \mathbf{w} \times \mathbf{r}$$

$$= (3\hat{i} - 4\hat{j} + \hat{k}) \times (5\hat{i} - 6\hat{j} + 6\hat{k})$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & -4 & 1 \\ 5 & -6 & 6 \end{vmatrix}$$

$$= \hat{i}\begin{vmatrix} -4 & 1 \\ -6 & 6 \end{vmatrix} - \hat{j}\begin{vmatrix} 3 & 1 \\ 5 & 6 \end{vmatrix} + \hat{k}\begin{vmatrix} 3 & -4 \\ 5 & -6 \end{vmatrix}$$

$$(-24 + 6)\hat{i} - (18 - 5)\hat{j} + (-18 + 20)\hat{k}$$

$$-18\hat{i} - 13\hat{j} + 2\hat{k}$$

21. Two particles of mass M and m are moving in a circle of radii R and r. If their time-periods are same, what will be the ratio of their linear velocities?

a) MR:mr b) M:m **c) R:r** d) 1:1

Solution : -

$$Linear\ velocity\ v = r\omega, where\ \omega = angularvelocity.$$

$$v_1 = \omega r_1, v_2 = \omega r_2$$

$$[As\ time\ period\ is\ same,\ \omega\ is\ same\ in\ both\ cases]$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{r_1}{r_2} = \frac{R}{r} = R : r$$

22. A bullet is fired from a gun with a speed of 1000 m/s in order to hit a target 100 m away. At what height above the target should the gun be aimed? (The resistance of air is negligible and g =10 m/s^2)

a) 5cm b) 10cm c) 15cm d) 20cm

Solution : -

Horizontal distance of the target is 100 m.

Speed of bullet = 1000 m/s

Time taken by bullet to cover the horizontal distance

$$t = \frac{100}{1000} = \frac{1}{10}\ \text{s}$$

the bullet will fall down vertically due to gravitational acceleration.

Therefore, height above the target, so that the bullet hit the target is

$$h = ut + \frac{1}{2}gt^2 = \left(0 \times \frac{1}{10}\right) + \frac{1}{2} \times 10 \times (0.1)^2$$

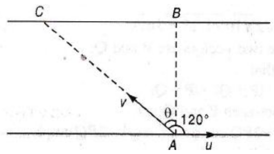
$$= 0.05\ \text{m} = 5\ \text{cm}$$

23. A person swims in a river aiming to reach exactly opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle 120^o with the direction of flow of water. The speed of water in stream is _____________

a) 1.0m/s b) 0.5m/s **c) 0.25m/s** d) 0.43m/s

Solution : -

Let u be the speed of stream and v be the speed of person started from A. He wants to reach at point B directed opposite to 1.



As given, v makes an angle of 120° with direction of flow a, the resultant of v and u is along AB. From figure

$u = v\sin\theta = v\sin 30^\circ$

$u = \frac{v}{2} = \frac{0.5}{2} (\because v = 0.5 \text{ m/s})$

$= 0.25 \text{ m/s}$

24. Aparticle has initial velocity $(2\vec{i} + 3\vec{j})$ and acceleration $(0.3\vec{i} + 0.2\vec{j})$. The magnitude of velocity after 10 seconds wiil be ___________ .

a) $9\sqrt{2}\, units$ **b)** $5\sqrt{2}\, units$ c) 5 units d) 9 units

Solution : -

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

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

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

$|\vec{v}| = \sqrt{5^2 + 5^2}$

$|\vec{v}| = 5\sqrt{2}$

25. When milk is churned, cream gets separated due to ___________.

a) centripetal force **b) centrifugal force** c) frictional force d) gravitational force

Solution : -

By the concept of centrifugal force cream is separated from milk. A mass n of milk revolving at a distance r from the axis of rotation of the centrifuge requires a centripetal force mrw^2, where w is the angular speed of the centrifuge. If in place of this mass of milk, lighter particles of mass (cream) m'(m' < m) are present, then the centripetal force (mrw^2) on the milk will be greater than the centripetal force (m'rw^2) on the cream.

As a result, cream move towards the axis of rotation under the effect of the net force (m-m')rw^2. When the centrifuge is stopped, the cream is found at the top and milk at the bottom.

26. A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is ________

a) 60° **b)** $\tan^{-1}\left(\frac{1}{2}\right)$ c) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ d) 45°

Solution : -

We know that angle of projection θ = 45° maximum height reached the projectile.

$H = \frac{u^2 \sin^2 45^\circ}{2g} = \frac{u^2}{4g}$

Horizontal range of the particle

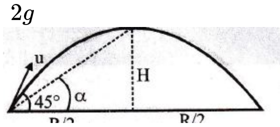
$R = \frac{u^2 \sin 90^\circ}{g} = \frac{u^2}{g}$

$\therefore$ We get $\frac{R}{2} = \frac{u^2}{2g}$

$\therefore \tan\alpha = \frac{H}{R/2}$

$\frac{u^2}{4g} = \frac{1}{2} \quad \therefore \alpha = \tan^{-1}\left(\frac{1}{2}\right)$

$\frac{u^2}{2g}$



27. A child is swinging a swing. Minimum and maximum heights of swing from earth's surface are 0.75 m and 2 m respectively. The maximum velocity of this swing is ____________ .

a) 5 m/s b) 10 m/s c) 15 m/s d) 20 m/s

Solution : -

We have, $\frac{1}{2}mv_{\max}^2 = mg\left(\mathrm{H}_2 - \mathrm{H}_1\right)$

$\Rightarrow v_{\max}^2 = 2g\left(\mathrm{H}_2 - \mathrm{H}_1\right)$

$\Rightarrow v_{\max} = \sqrt{2g\left(\mathrm{H}_2 - \mathrm{H}_1\right)}$

$= \sqrt{2 \times 10 \times (2 - 0.75)}$

$= \sqrt{2 \times 10 \times 1.25} = 5 \mathrm{~m/s}$

28. The angle between the vector $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ will be ___________

a) 45^o **b) 90^o** c) 180^o d) 0

Solution : -

$Here, \vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k},$

$\vec{B} = 3\hat{i} + 3\hat{j} - 5\hat{k}$

$\therefore \vec{A} \cdot \vec{B} = (3\hat{i} + 4\hat{j} + 5\hat{k}) \cdot (3\hat{i} + 4\hat{j} - 5\hat{k})$

$|\vec{A}||\vec{B}| \cos\theta = 3 \times 3 + 4 \times 4 - 5 \times 5$

$= 9 + 16 - 25 = 0$

$|\vec{A}| \neq 0, |\vec{B}| \neq 0, \text{ hence, } \cos\theta = 0,$

$\Rightarrow \quad \theta = 90^\circ$

29. Vectors $\vec{A}, \vec{B}\ and\ \vec{C}$ are such that $\vec{A} \cdot \vec{B} = 0$ and $\vec{A} \cdot \vec{C} = 0$ then the vector parallel to $\vec{A}$is _____________

a) $\vec{B}\ and\ \vec{C}$ b) $\vec{A} \times \vec{B}$ c) $\vec{B} + \vec{C}$ **d)** $\vec{B} \times \vec{C}$

Solution : -

vector triple product

$\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}(\vec{A} \cdot \vec{C}) - \vec{C}(\vec{A} \cdot \vec{B}) = 0$

$\Rightarrow \vec{A} \| (\vec{B} \times \vec{C})$

$[\text{ Because } \vec{A} \cdot \vec{B} = 0 \text{ and } \vec{A} \cdot \vec{C} = 0]$

30. Two boys are standing at the end A and B of a ground where AB = α. 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_2 and catches the other boy at time r, where r is ___________

a) $a/\sqrt{v^2 + v_1^2}$ b) $a/\left(v + v_1\right)$ c) $a/\left(v - v_1\right)$ **d)** $\sqrt{a^2/\left(v^2 - v_1^2\right)}$

31. A boat is sent across a river with a velocity of 8 km h^{-1}. If the resultant velocity of boat is 10 km h^{-1}, then velocity of river is __________ .

a) (a) l2.8 kmh^{-1} (b) (c) (d) **b) 6 kmh^{-1}** c) 8 kmh^{-1} d) 10 kmh^{-1}

Solution : -

$$v_{rb}^2 = v_r^2 + v_b^2$$
$$v_r = \sqrt{v_{rb}^2 - v_b^2} = \sqrt{10^2 - 8^2} = 6 \text{ km h}^{-1}$$

32. Two bodies of same mass are projected with the same velocity at an angle 30^o and 60^o respectively. The ratio of their horizontal ranges will be ___________

a) 1:1 b) 1:2 c) 1:3 d) 2:$\sqrt{2}$

Solution : -

When an object is projected with velocity a making an angle q with the horizontal direction, then horizontal range will be

$$R_1 = \frac{u^2 \sin 2\theta}{g}$$

when an object is projected with velocity u making an angle (90^o - q) with the horizontal direction, then horizontal range will be

$$R_2 = \frac{u^2 \sin 2(90^\circ - \theta)}{g} = \frac{u^2}{g}\sin(180^\circ - 2\theta)$$
$$= \frac{u^2}{g}\sin 2\theta$$

From both equation we get

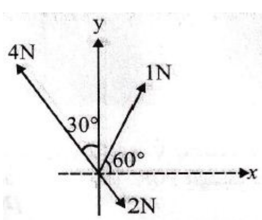
$$\frac{R_1}{R_2} = 1$$

33. The resultant of A $\times$ 0 will be equal to ____________ .

a) zero b) A **c) zero vector** d) unit vector

Solution : -

From the properties of vector product, the cross product of any vector with zero is a null vector or zero vector.

34. 

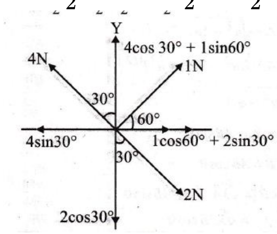
Three forces acting on a body are shown rn the figure. To have the resultant force only along the y-direction, the magnitude of the minimum additional force needed is __________ .

a) $\sqrt{3}$ N **b) 0.5 N** c) 1.5 N d) $\frac{\sqrt{3}}{4}$ N

Solution : -

The components of l N and 2 N forces along + x axis

$$1 \cos 60^\circ + 2 \sin 30^\circ$$
$$1 \times \frac{1}{2} + 2 \times \frac{1}{2} = \frac{1}{2} + 1 = \frac{3}{2} = 1.5 \text{ N}$$



The component of 4 N force along -x-axis

$= 4\sin 30^\circ = 4 \times \frac{1}{2} = 2\ \mathrm{N}$

So, if a force of 0.5 N is applied along +x-axis, the resultant force along x-axis will become zero and the resultant force wiil be obtained only alongy-axis.

35. The circular motion of a particle with constant speed is __________

a) periodic but not simple harmonic b) simple harmonic but not periodic c) periodic and simple harmonic d) neither periodic nor simple harmonic

Solution : -

As we know, in a circular motion of a particle with constant speed, particle repeats its motion after a fixed interval of time but does not oscillate about a fixed point. So, motion ofparticle is periodic but not simple harmonic.

36. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectiles is____________

a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$ **b)** $\theta = \tan^{-1}(4)$ c) $\theta = \tan^{-1}(2)$ d) $\theta = 45^\circ$

Solution : -

Horizantal range

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

$Maximumheight$

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

$Accordingtothequestion$

$R = H$

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

$2\cos\theta = \frac{\sin\theta}{2}$

$\Rightarrow \quad \cot\theta = \frac{1}{4}$

$\Rightarrow \quad \tan\theta = 4$

$\Rightarrow \quad \theta = \left[\tan^{-1}(4)\right]$

37. The maximum range of a gun of horizontal terrain is i 6 km. If g=10 ms^{-2}, then muzzle velocity of a shell must be _________

a) 160 ms^{-1} b) $200\sqrt{2}$ ms^{-1} **c) 400 ms^{-1}** d) 800 ms^{-1}

Solution : -

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

$For\ range\ to\ be\ maximum\ angle\ \mathrm{q}\ should\ be\ of\ 45^\circ$

$\therefore\ R_{\max} = \frac{u^2 \sin 2\times 45^\circ}{g} = \frac{u^2 \sin 90^\circ}{g}$

$or R_{\max} = \frac{u^2}{g}$

$Here, R_{\max} = \frac{u^2}{g} = 16\ \mathrm{km} = 16000\ \mathrm{m}$

$or\ u = \sqrt{16000\ \mathrm{g}} = \sqrt{16000 \times 10} = 400\ \mathrm{ms}^{-1}$

38. $\vec{A}$ and $\vec{B}$are two vectors and θ is the angle between them if $|\vec{A} \times \vec{B}| = \sqrt{3}(\vec{A} \cdot \vec{B})$ the value θ is ___________

a) 45^o b) 30^o **c) 60^o** d) 90^o

Solution : -

$|\vec{A} \times \vec{B}| = \sqrt{3}(\vec{A} \cdot \vec{B})$

$\Rightarrow AB \sin\theta = \sqrt{3} AB \cos\theta$

$\Rightarrow \tan\theta = \sqrt{3} = \tan 60^\circ \Rightarrow \theta = 60^\circ$

39. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces ______________

    a) cannot be predicted b) are equal to each other **c) are equal to each other in magnitude**
    d) are not equal to each other in magnitude

    Solution : -

    $\vec{P} = \ vector\ sum = \vec{A} + \vec{B}$

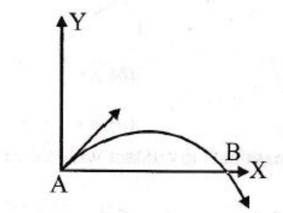
    $\vec{Q} = \ vector\ difference = \vec{A} - \vec{B}$

    $As\ \vec{P}\ and\ \vec{Q}\ areperpendicular\ to\ each\ other,$

    $\therefore \vec{P} \cdot \vec{Q} = 0 \Rightarrow (\vec{A} + \vec{B}) \cdot (\vec{A} + \vec{B}) = 0$

    $\Rightarrow A^2 = B^2 \Rightarrow |\vec{A}| = |\vec{B}|$

40. The velocity of a projectile at the initial point A is $(2\hat{i} + 3\hat{j})$m/s. It's velocity (in m/s) at point.B is ____________

    a) $-2\hat{i} + 3\hat{j}$ **b)** $2\hat{i} - 3\hat{j}$ c) $2\hat{i} + 3\hat{j}$ d) $2\hat{i} - 3\hat{j}$

    Solution : -

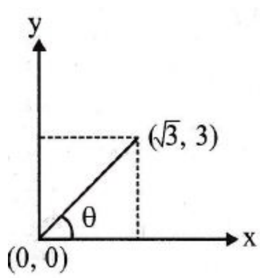
    At point B the direction of Y-axis reverses.

    $\overrightarrow{V_B} := 2\hat{i} - 3\hat{j}$

41. A particle starting from the origtn (0,0) moves in a straight line in the (x, y) plane. Its coordinates at a later time are ($\sqrt{3}$, 3). The path of the particle makes with the x-axis an angle of ____________

    a) 45^o **b) 60^o** c) 0^o d) 30^o

    Solution : -

    $Suppose\ \theta\ be\ the\ angle\ that\ the\ particle\ makes\ with\ x-axis.$

    $From\ the\ above\ figure\ we$

    $have\ \tan\theta = \frac{3}{\sqrt{3}} = \sqrt{3} \Rightarrow \theta = \tan^{-1}(\sqrt{3}) = 60^\circ$

42. A bus is moving on a straight road towards North with a uniform speed of 50 km/h. If the speed remains unchanged after turning through 90^o, the increase in the velocity of bus in the turning process is ____________

    a) 70.7 km/h along South-West direction b) zero c) 50 km/h West d) 70.7 km/h North-West direction

43. Two particles A and B are connected by a rigid rod AB. The rod slides along perpendicular rails as shown here. The velocity of A to the right is 10 m/s. What is the velocity of.B when angle a =60^o?

    a) 9.8m/s b) 10m/s c) 5.8m/s **d) 17.3m/s**

Solution : -

$v_x = \frac{dx}{dt}$ and $v_y = \frac{dy}{dt}$

From figure

$\tan a = \frac{y}{x} \Rightarrow y = x \tan a$

$Differentiating\ Eq.(i), w.r.t.\ weget$

$\frac{dy}{dt} = \frac{dx}{dt} \tan a$

$\Rightarrow dv_y = v_x \tan a$

Here, $v'_x = 10\ \text{m/s}, a = 60^\circ$

$\therefore\ v_y = 10 \tan 60^\circ$

$= 10\sqrt{3} = 17.3\ \text{m/s}$

44. A stone is tied to a string of length 1 and is whirled in a vertical circle with the other end of the string as the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is ___________.

a) $\sqrt{2g\ell}$ **b)** $\sqrt{2u^2 - g\ell}$ c) $\sqrt{u^2 - g\ell}$ d) $u - \sqrt{u^2 - 2g\ell}$

Solution : -

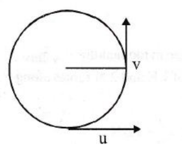
$W_{mg} = \Delta K$

$\Rightarrow -mg\ell = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$\Rightarrow mv^2 = m\left(u^2 - 2g\ell\right)$

$\Rightarrow\ v = \sqrt{u^2 - 2g\ell}\,\hat{j}$

$\vec{u} = u\hat{i}$



$\therefore \vec{v} - \vec{u} = \sqrt{u^2 - 2g\ell}\,\hat{j} - u\hat{i}$

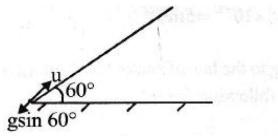
$\therefore |\vec{v} - \vec{u}| = \left[\left(u^2 - 2g\ell\right) + u^2\right]^{1/2}$

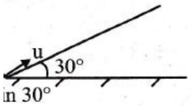
$= \sqrt{2\left(u^2 - g\ell\right)}$

45. When an object is shot from the bottom of a long smooth inclined plane kept at an angle 60^o with horizontal, it can travel a distance x_1 along the plane. But when the inclination is decreased to 30^o and the same object is shot with the same velocity, it can havel x_2 distance. Then x_1: x_2 will be ____________

a) $1 : \sqrt{2}$ b) $\sqrt{2} : 1$ **c)** $1 : \sqrt{3}$ d) $1 : 2\sqrt{3}$

Solution : -





$x_1 = \frac{u^2}{2g \sin 60^\circ}$

$(Stopping\ distance)$

$x_2 = \frac{u^2}{2g \sin 30^\circ}$

$\Rightarrow \frac{x_1}{x_2} = \frac{\sin 30^\circ}{\sin 60^\circ} = \frac{1 \times 2}{2 \times \sqrt{3}} = 1 : \sqrt{3}$

46. Which of the following is not a vector quantiry?

a) Speed b) Velocity c) Torque d) Displacement

Solution : -

Speed is a scalar quantity. It gives no idea about the direction of motion of the object. Velocity is a vector quantity, as it has both magnitude and direction. Displacement is a vector as it possesses both magnitude and direction. When an object goes on the path. ABC in figure), then the displacement of the object is AC. The arrow head at C shows that the object is displaced from ,4 to C.

Torque is hrming effect of force which is a vector quantity

47. The vectors $\vec{A}\ and\ \vec{B}$ are such that $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$. The angle between the two vectors is ___________ .

a) 60^o b) 75^o c) 45^o **d) 90^o**

Solution : -

$|\vec{A} + \vec{B}|^2 = |\vec{A} - \vec{B}|^2$

$= |\vec{A}|^2 + |\vec{B}|^2 + 2\vec{A} \cdot \vec{B}$

$= A^2 + B^2 + 2AB \cos\theta$

$= |\vec{A} - \vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2 - 2\vec{A} \cdot \vec{B}$

$= A^2 + B^2 - 2AB \cos\theta$

$Therefore, A^2 + B^2 + 2AB \cos\theta = A^2 + B^2 - 2AB \cos\theta$

$\Rightarrow 4AB \cos\theta = 0$

$\Rightarrow \cos\theta = 0 = \cos 90^\circ$

$\Rightarrow \theta = 90^\circ$

48. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 seconds in every circular loop. The average velocity and average speed for each circular loop respectively is ____________

a) 0,10m/s b) 10m/s, 10m/s c) 10m/s,0 d) 0,0

Solution : -

$Distance\ covered\ in\ one\ circular\ loop = 2\text{pr} = 2 \times 3.14 \times 100 = 628\ \text{m}$

$\therefore\ Speed\ = \frac{628}{62.8} = 10\ \text{m/sec}$

$Displacement\ in\ one\ circular\ loop\ = 0$

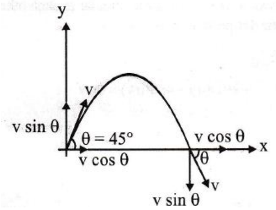
$\therefore\ Velocity\ = \frac{0}{\text{time}} = 0$

49. A particle of mass m is projected with velocity v making an angle of 45^o with the horizontal. When the particles lands on the level ground the magnitude of the change in its momentum will be _____________

a) 2mv b) $\text{mv}/\sqrt{2}$ **c) mv$\sqrt{2}$** d) zero

Solution : -

The magnitude of the resultant velocity at the point of projection and the meeting point at the ground is same.



Obviousiy, change in momentum along, x-axis.

= mv cos θ- mv cosθ = 0

Change in momentum alongy-axis

= mv sinθ - (-mv sinθ)

2mv sin θ=2mv $\times$ sin 45^o

$2mv \times \frac{1}{\sqrt{2}} = \sqrt{2}mv$

Hence, required change in momentum = $\sqrt{2}$ mv

50. For angles of projection of a projectile (45^o-θ) and (45^o + θ), the horizontal ranges described by the projectile are in the ratio of _____________ .

a) 1:3 b) 1:2 c) 2:1 **d) 1:1**

Solution : -

(45^o-θ) and (45^o + θ) are complementary angles as 45^o- θ+ 45^o+ θ = 90^o. If angles of projection of two projectiles make complementary angles, their ranges are equa1. In this case also, the range will be same. So, the ratio is 1: 1.