Yakeen NEET 2.0 (2026)

KPP 21

Physics By Saleem Sir

Motion in a plane

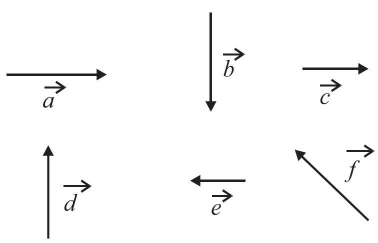
SCALARS AND VECTORS:

1. Identify the vector quantity among the following. **[1997]**

(1) Distance (2) Angular momentum
(3) Heat (4) Energy

ADDITION AND SUBTRACTION OF VECTORS-GRAPHICAL METHOD:

2. Six vectors, $\vec{a}$ through $\vec{f}$ fhave the magnitudes and directions indicated in the figure. Which of the following statements is true? **[2010]**



(1) $\vec{b}+\vec{c}=\vec{f}$ (2) $\vec{d}+\vec{c}=\vec{f}$
(3) $\vec{d}+\vec{e}=\vec{f}$ (4) $\vec{b}+\vec{e}=\vec{f}$

RESOLUTION OF VECTORS:

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: **[1999]**

(1) $\sqrt{0.01}$ (2) $\sqrt{0.11}$
(3) 1 (4) $\sqrt{0.39}$

VECTOR ADDITION-ANALYTICAL METHOD:

4. 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: **[NEET-I 2016]**

(1) 45° (2) 180°
(3) 0° (4) 90°

5. 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: **[2006, 1996, 1991]**

(1) 45° (2) 90°
(3) 60° (4) 75°

6. If $|\vec{A}+\vec{B}|=|\vec{A}|+|\vec{B}|$ then angle between A and B will be: **[2001]**

(1) 90° (2) 120°
(3) 0° (4) 60°

7. The magnitude of vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are 3, 4 and 5 units respectively. If $\vec{A}+\vec{B}=\vec{C}$, the angle between $\vec{A}$ and $\vec{B}$ is: **[1988]**

(1) $\pi/2$ (2) $\cos^{-1}(0.6)$
(3) $\tan^{-1}(7/5)$ (4) $\pi/4$

MOTION IN A PLANE:

8. The position of a particle is given by:
$\vec{r}(t)=4t\hat{i}+2t^2\hat{j}+5\hat{k}$
where t is in seconds and r in metre. Find the magnitude and direction of velocity $v(t)$, at $t = 1$ s, with respect to x-axis. **[Manipur NEET 2023]**

(1) $4\sqrt{2}\,\text{ms}^{-1}, 45^\circ$ (2) $4\sqrt{2}\,\text{ms}^{-1}, 60^\circ$
(3) $3\sqrt{2}\,\text{ms}^{-1}, 30^\circ$ (4) $3\sqrt{2}\,\text{ms}^{-1}, 45^\circ$

9. The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and y are in metres and t in seconds. The acceleration of the particle at t = 2s is: **[NEET 2017]**

(1) 5 ms^{-2} (2) –4 ms^{-2}
(3) –8 ms^{-2} (4) 0

10. 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? **[2015]**

(1) Magnitude of the velocity of particle is 8π meter/second.
(2) Path of the particle is a circle of radius 4 meter.
(3) Acceleration vector is along $-\vec{R}$.
(4) Magnitude of acceleration vector is $\frac{v^2}{R}$, where v is the velocity of particle.

11. A particle is moving such that its position coordinates (x, y) are (2 m, 3 m) at time $t = 0$, (6 m, 7 m) at time $t = 2$ s and (13 m, 14 m) at time $t = 5$ s. Average velocity vector $(\vec{v}_{av})$ from $t = 0$ to $t = 5$ s is:

[2014]

(1) $\frac{1}{5}(13\hat{i}+14\hat{j})$ (2) $\frac{7}{3}(\hat{i}+\hat{j})$

(3) $2(\hat{i}+\hat{j})$ (4) $\frac{11}{5}(\hat{i}+\hat{j})$

12. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is:

[2011]

(1) 1 m/s^2 (2) 7 m/s^2

(3) $\sqrt{7}$ m/s^2 (4) 5 m/s^2

13. A particle moves in x-y plane according to rule $x = a\sin\omega t$ and $y = a\cos\omega t$. The particle follows

[Mains 2010]

(1) an elliptical path
(2) a circular path
(3) a parabolic path
(4) a straight line path inclined equally to x and y-axes

14. A particle starting from the origin (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

[2007]

(1) 45° (2) 60°

(3) 0° (4) 30°

15. A bus is moving on a straight road towards north with a uniform speed of 50 km/hour then it turns left through 90°. If the speed remains unchanged after turning, the increase in the velocity of bus in the turning process is:

[1989]

(1) 70.7 km/hr along south-west direction
(2) zero
(3) 50 km/hr along west
(4) 70.7 km/hr along north-west direction

MOTION IN A PLANE WITH CONSTANT ACCELERATION:

16. A car starts from rest and accelerates at 5 m/s^2. At t = 4s, a ball is dropped out of a window by a person sitting in the car. What is the velocity and acceleration of the ball at t = 6s?

[2021]

(1) $20\sqrt{2}$ m/s, 10 m/s^2
(2) 20 m/s, 5 m/s^2
(3) 20 m/s, 0
(4) $20\sqrt{2}$ m/s, 0

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

[NEET 2019]

(1) $1:2\sqrt{3}$ (2) $1:\sqrt{2}$

(3) $\sqrt{2}:1$ (4) $1:\sqrt{3}$

18. A particle has initial velocity $(2\hat{i}+3\hat{j})$ and acceleration $(0.3\hat{i}+0.2\hat{j})$. The magnitude of velocity after 10 seconds will be:

[2012]

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

(3) 5 units (4) 9 units

19. A particle has initial velocity $(3\hat{i}+4\hat{j})$ and has acceleration $(0.4\hat{i}+0.3\hat{j})$. Its speed after 10 s is:

[2010]

(1) 7 units (2) $7\sqrt{2}$ units

(3) 8.5 units (4) 10 units

20. A man is slipping on a frictionless inclined plane and a bag falls down from the same height. Then the velocity of both is related as
(v_m = velocity of man and v_B = velocity of bag)

[2000]

(1) $v_B > v_m$
(2) $v_B < v_m$
(3) $v_B > v_m$
(4) v_B and v_m can't be related

RELATIVE VELOCITY IN TWO DIMENSIONS:

21. The speed of a swimmer in still water is 20 m/s. The speed of river water is 10 m/s and is flowing due east. If he is standing on the south bank and wishes to cross the river along the shortest path, the angle at which he should make his strokes w.r.t. north is, given by:

[NEET 2019]

(1) 45° west (2) 30° west
(3) 0° (4) 60° west

22. The width of river is 1 km. The velocity of boat is 5 km/hr. The boat covered the width of river in shortest time 15 min. Then the velocity of river stream is:

[2000, 1998]

(1) 3 km/hr (2) 4 km/hr
(3) $\sqrt{29}$ km/hr (4) $\sqrt{41}$ km/hr

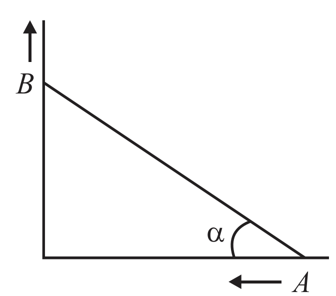
23. A person aiming to reach exactly opposite point on the bank of a stream is swimming with a speed of 0.5 m/s at an angle of 120° with the direction of flow of water. The speed of water in the stream, is:

[1999]

(1) 0.25 m/s (2) 0.5 m/s
(3) 1.0 m/s (4) 0.433 m/s

24. Two particles A and B are connected by a rigid rod AB. The rod slides along perpen-dicular rails as shown here. The velocity of A to the left is 10 m/s. What is the velocity of B when angle $\alpha = 60°$?

[1998]



(1) 10 m/s (2) 9.8 m/s
(3) 5.8 m/s (4) 17.3 m/s

25. 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:

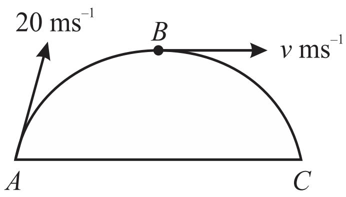
[1994, 1993]

(1) 12.8 km h^{-1} (2) 6 km h^{-1}
(3) 8 km h^{-1} (4) 10 km h^{-1}

PROJECTILE MOTION:

26. A ball is projected from point A with velocity 20 ms^{-1} at an angle 60° to the horizontal direction. At the highest point B of the path (as shown in figure), the velocity v ms^{-1} of the ball will be:

[2023-Manipur]



(1) 20 (2) $10\sqrt{3}$
(3) Zero (4) 10

27. A bullet is fired from a gun at the speed of 280 m/s in the direction 30° above the horizontal. The maximum height attained by the bullet is: ($g = 9.8$ ms^{-2}, sin 30° = 0.5)

[2023]

(1) 1000 m (2) 3000 m
(3) 2800 m (4) 2000 m

28. A ball is projected with a velocity, 10 ms^{-1}, at an angle of 60° with the vertical direction. Its speed at the highest point of its trajectory will be:

[2022]

(1) Zero (2) $5\sqrt{3}$ ms^{-1}
(3) 5 ms^{-1} (4) 10 ms^{-1}

29. A particle moving in a circle of radius R with a uniform speed takes a time T to complete one revolution. If this particle were projected with the same speed at an angle 'θ' to the horizontal, the maximum height attained by it equals $4R$. The angle of projection, θ, is then given by:

[2021]

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

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

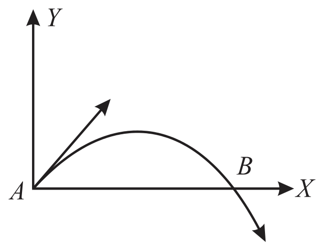
(3) $\theta = \cos^{-1}\left(\frac{\pi^2 R}{gT^2}\right)^{1/2}$

(4) $\theta = \sin^{-1}\left(\frac{\pi^2 R}{gT^2}\right)^{1/2}$

30. A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) is (Given $g = 9.8$ ms^{-2}). **[2014]**

(1) 3.5 (2) 5.9
(3) 16.3 (4) 110.8

31. The velocity of a projectile at the initial point A is $(2\hat{i}+3\hat{j})$ m/s. Its velocity (in m/s) at point B is: **[NEET 2013]**



(1) $2\hat{i}-3\hat{j}$ (2) $2\hat{i}+3\hat{j}$
(3) $-2\hat{i}-3\hat{j}$ (4) $-2\hat{i}+3\hat{j}$

32. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is: **[2012]**

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

33. A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10$ m/s^2, the range of the missile is: **[2011]**

(1) 40 m (2) 50 m
(3) 60 m (4) 20 m

34. 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: **[Mains 2011]**

(1) 45° (2) 60°
(3) $\tan^{-1}\left(\frac{1}{2}\right)$ (4) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

35. The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is: **[Mains 2010]**

(1) 60° (2) 15°
(3) 30° (4) 45°

36. A particle of mass m is projected with velocity v making an angle of 45° with the horizontal. When the particle lands on the level ground the magnitude of the change in its momentum will be: **[2008]**

(1) $mv\sqrt{2}$ (2) zero
(3) $2mv$ (4) $mv/\sqrt{2}$

37. For angles of projection of a projectile at angle (45°– θ) and (45° + θ), the horizontal range described by the projectile are in the ratio of **[2006]**

(1) 2 : 1 (2) 1 : 1
(3) 2 : 3 (4) 1 : 2

38. A particle A is dropped from a height and another particle B is projected in horizontal direction with speed of 5 m/s from the same height then correct statement is: **[2002]**

(1) particle A will reach at ground first with respect to particle B
(2) particle B will reach at ground first with respect to particle A
(3) both particles will reach at ground simultaneously
(4) both particles will reach at ground with same speed

39. Two projectiles of same mass and with same velocity are thrown at an angle 60° and 30° with the horizontal, then which will remain same **[2000]**

(1) time of flight
(2) range of projectile
(3) maximum height acquired
(4) all of them

40. If a body A of mass M is thrown with velocity v at an angle of 30º to the horizontal and another body B of the same mass is thrown with the same speed at an angle of 60° to the horizontal, the ratio of horizontal range of A to B will be: **[1992, 1990]**

(1) 1 : 3 (2) 1 : 1
(3) $1:\sqrt{3}$ (4) $\sqrt{3}:1$

Answer Key

1. (2)	**11. (4)**	**21. (2)**	**31. (1)**
2. (3)	**12. (2)**	**22. (1)**	**32. (2)**
3. (2)	**13. (2)**	**23. (1)**	**33. (1)**
4. (4)	**14. (2)**	**24. (4)**	**34. (3)**
5. (2)	**15. (1)**	**25. (2)**	**35. (1)**
6. (3)	**16. (1)**	**26. (4)**	**36. (1)**
7. (1)	**17. (4)**	**27. (1)**	**37. (2)**
8. (1)	**18. (2)**	**28. (2)**	**38. (3)**
9. (2)	**19. (2)**	**29. (1)**	**39. (2)**
10. (1)	**20. (3)**	**30. (1)**	**40. (2)**

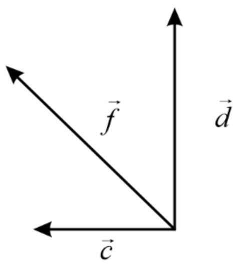
Solution

1. **(2)**

Sol. Since the angular momentum has both magnitude and direction, it is a vector quantity.

2. **(3)**

Sol.



From figure, $\vec{d}+\vec{e}=\vec{f}$

3. **(2)**

Sol. For a unit vector $\hat{n}, |\hat{n}|=1$

$\left|0.5\hat{i}-0.8\hat{j}+c\hat{k}\right|^2=1^2 \Rightarrow 0.25+0.64+c^2=1$ or

$c=\sqrt{0.11}$

4. **(4)**

Sol. Let the two vectors be $\vec{A}$ and $\vec{B}$.

Then, magnitude of sum $\vec{A}$ and $\vec{B}$,

$\left|\vec{A}+\vec{B}\right|=\sqrt{A^2+B^2+2AB\cos\theta}$

And magnitude of difference of $\vec{A}$ and $\vec{B}$

$\left|\vec{A}-\vec{B}\right|=\sqrt{A^2+B^2-2AB\cos\theta}, \left|\vec{A}+\vec{B}\right|=\left|\vec{A}-\vec{B}\right|$

(given)

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

$\Rightarrow 4AB\cos\theta=0 \quad \because 4AB\neq 0,$

$\therefore \cos\theta=0 \; or \; \theta=90°$

5. **(2)**

Sol. Let θ be angle between $\vec{A}$ and $\vec{B}$

$\left|\vec{A}+\vec{B}\right|=\left|\vec{A}-\vec{B}\right|$, then $\left|\vec{A}+\vec{B}\right|^2=\left|\vec{A}-\vec{B}\right|^2$

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

Or $4AB\cos\theta=0$ or $\cos\theta=0$ or $\theta=90°$

6. **(3)**

Sol. $\left|\vec{A}+\vec{B}\right|=\left|\vec{A}\right|+\left|\vec{B}\right|$ if $\vec{A}\parallel\vec{B}$. $\theta=0°$

7. **(1)**

Sol. Let θ be angle between $\vec{A}$ and $\vec{B}$.

Givne : $A=\left|\vec{A}\right|=3\ units,\ B=\left|\vec{B}\right|=4\ units,$

$C=\left|\vec{C}\right|=5\ units,$

$\left|\vec{A}+\vec{B}\right|=\left|\vec{C}\right| \Rightarrow A^2+2AB\cos\theta+B^2=C^2$

$9+2AB\cos\theta+16=25$ or $2AB\cos\theta=0$ or $\cos\theta=0$

$\therefore \theta=90°$.

8. **(1)**

Sol. $\vec{v}=\frac{d\vec{r}}{dt}=4\hat{i}+4t\hat{j}+0\hat{k}$

At $t=1$ sec; $\vec{v}=4\hat{i}+4(1)\hat{j}$

Magnitude, $|\vec{v}|=\sqrt{(4)^2+(4)^2}=4\sqrt{2}m/s$

Direction, $\tan\theta=\frac{v_y}{v_x}=1$ *or* $\theta=45°$

9. **(2)**

Sol. $x=5t-2t^2, y=10t$

$\frac{dx}{dt}=5-4t, \frac{dy}{dt}=10 \qquad \therefore v_x=5-4t, v_y=10$

$\frac{dv_x}{dt}=-4, \frac{dv_y}{dt}=0 \qquad \therefore a_x=-4, a_y=0$

Acceleration, $\vec{a}=a_x\hat{i}+a_y\hat{j}=-4\hat{i}$

$\therefore$ The acceleration of the particle at $t=2s$ is $-4\ ms^{-2}$.

10. **(1)**

Sol. Here, $\vec{R}=4\sin(2\pi t)\hat{i}+4\cos(2\pi t)\hat{j}$

The velocity of the particle is

$\vec{v}=\frac{d\vec{R}}{dt}=\frac{d}{dt}\left[4\sin(2\pi t)\hat{i}+4\cos(2\pi t)\hat{j}\right]$

$=8\pi\cos(2\pi t)\hat{i}-8\pi\sin(2\pi t)\hat{j}$

Its magnitude is

$|\vec{v}|=\sqrt{(8\pi\cos(2\pi t))^2+(-8\pi\sin(2\pi t))^2}$

$=\sqrt{64\pi^2\cos^2(2\pi t)+64\pi^2\sin^2(2\pi t)}$

$=\sqrt{64\pi^2\left[\cos^2(2\pi t)+\sin^2(2\pi t)\right]}$

$=\sqrt{64\pi^2} \quad \left(As\ \sin^2\theta+\cos^2\theta=1\right)$

$=8\pi\ m/s$

11. (4)

Sol. At time t = 0, the position vector of the particle is

$\vec{r}_1 = 2\hat{i} + 3\hat{j}$

At time t = 5 s, the position vector of the particle is

$\vec{r}_2 = 13\hat{i} + 14\hat{j}$.

Displacement from $\vec{r}_1$ to $\vec{r}_2$ is

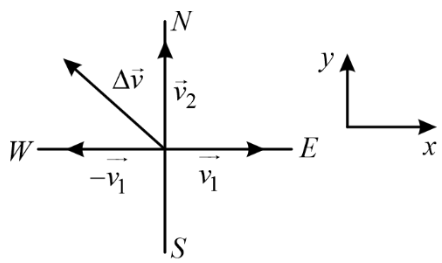
$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = (13\hat{i} + 14\hat{j}) - (2\hat{i} + 3\hat{j}) = 11\hat{i} + 11\hat{j}$

$\therefore$ Averate velocity,

$$\vec{v}_{av} = \frac{\Delta\vec{r}}{\Delta t} = \frac{11\hat{i} + 11\hat{j}}{5-0} = \frac{11}{5}(\hat{i} + \hat{j})$$

12. (2)

Sol.



Velocity towards east direction, $\vec{v}_1 = 30\hat{i} m/s$

Velocity towards north direction, $\vec{v}_1 = 40\hat{j} m/s$

Change in velocity, $\Delta\vec{v} = \vec{v}_2 - \vec{v}_1 = (40\hat{j} - 30\hat{i})$

$\therefore \quad |\Delta\vec{v}| = |40\hat{j} - 30\hat{i}| = 50 m/s$

Average acceleration, $\vec{a}_{av} = \dfrac{\text{Change in velocity}}{\text{Time interval}}$

$$\vec{a}_{av} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{\Delta\vec{v}}{\Delta t}; |\vec{a}_{av}| = \frac{|\Delta\vec{v}|}{\Delta t} = \frac{50 \text{ m/s}}{10\text{s}} = 5 \text{ m/s}^2$$

13. (2)

Sol. $x = a\sin\omega t \;\; or \;\; \dfrac{x}{a} = \sin\omega t$

$y = a\cos\omega t \;\; or \;\; \dfrac{y}{a} = \cos\omega t$

Squaring and adding, we get

$$\frac{x^2}{a^2} + \frac{y^2}{a^2} = 1 \qquad (\because \cos^2\omega t + \sin^2\omega t = 1)$$

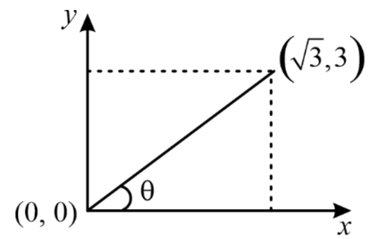
Or $x^2 + y^2 = a^2$

This is the equation of a circle. Hence, particle follows a circular path.

14. (2)

Sol. Let θ be the angel which the particle makes with an x-axis.

From figure,



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

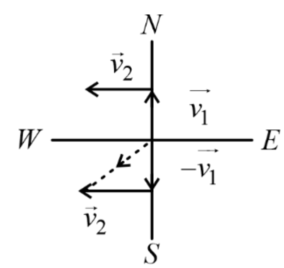
or, $\theta = \tan^{-1}(\sqrt{3}) = 60°$

15. (1)

Sol. $\vec{v}_1$ = 50 km/hr due north

$\vec{v}_2$ = 50 km/hr due west

$-\vec{v}_1$ = 50 km/hr due south



Magnitude of change in velocity

$|\vec{v}_2 - \vec{v}_1| = |\vec{v}_1 + (-\vec{v}_1)| = \sqrt{v_2^2 + (-v_1)^2}$

$= \sqrt{(50)^2 + (50)^2}$ = 70.7 km/hr

$\vec{v}$ = 70.7 km/hr along south-west direction

16. (1)

Sol. Given = $u_x = 0, a_x = 5m/s^2$

At t = 4 s ball is dropped $a_y = g$ = 10 m/s^2

Let v_x is the velocity of ball at the time t = 4s.

$v_x = u_x + a_x t = 0 + 5 \times 4 =$ 20 m/s

v_y is the velocity of ball after leaving at t = 6s

$v_y = u_y + a_y t' = 0 + g \times 2 =$ 20 m/s

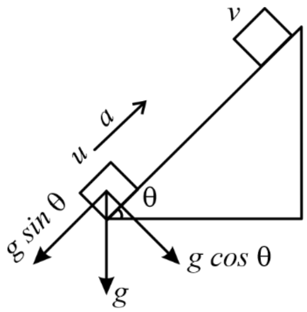
Resultant velocity of ball at t = 6s

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{20^2 + 20^2} \Rightarrow v = 20\sqrt{2}$ m/s

Acceleration of the ball will be due to gravity i.e., a = 10 m/s^2.

17. (4)

Sol. $v^2 - u^2 = 2ax$



For case I : $v^2 = u^2 - 2(g\sin\theta_1)x_1$

$[\because a = -g\sin\theta]$

$x_1 = \dfrac{u^2}{2g\sin\theta_1}$

$[\because v = 0]$

For case II :

$v^2 = u^2 - (2g\sin\theta_2)x_2$

$x_2 = \dfrac{u^2}{2g\sin\theta_2}$

$\therefore \dfrac{x_1}{x_2} = \dfrac{\sin\theta_2}{\sin\theta_1} = \dfrac{\sin 30^\circ}{\sin 60^\circ} = \dfrac{1}{\sqrt{3}}$

18. (2)

Sol. Here, $\vec{u} = 2\hat{i} + 3\hat{j}, \vec{a} = 0.3\hat{i} + 0.2\hat{j}, t = 10s$

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

$\therefore$

$\vec{v} = (2\hat{i} + 3\hat{j}) + (0.3\hat{i} + 0.2\hat{j})(10) = 2\hat{i} + 3\hat{j} + 3\hat{i} + 2\hat{j} = 5\hat{i} + 5$

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

19. (2)

Sol. Here, Initial velocity , $\vec{u} = 3\hat{i} + 4\hat{j}$

Acceleration, $\vec{a} = 0.4\hat{i} + 0.3\hat{j}$; time, t = 10 s

Let $\vec{v}$ be velocity of a particle after 10 s.

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

$\therefore \ \vec{v} = (3\hat{i} + 4\hat{j}) + (0.4\hat{i} + 0.3\hat{j})(10)$

$= 3\hat{i} + 4\hat{j} + 4\hat{i} + 3\hat{j} = 7\hat{i} + 7\hat{j}$

Speed of the particle after

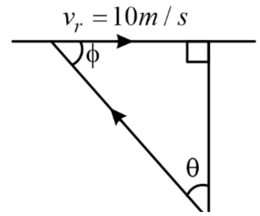
$10s = |\vec{v}| = \sqrt{(7)^2 + (7)^2} = 7\sqrt{2}$ units

20. (3)

Sol. Vertical acceleration in both the cases is g, whereas horizontal velocity is constant.

21. (2)

Sol.



$\cos\phi = \dfrac{10}{20} = \dfrac{1}{2}$ or $\phi = 60^\circ \Rightarrow \theta = 180^\circ - (90^\circ + 60^\circ) = 30^\circ$

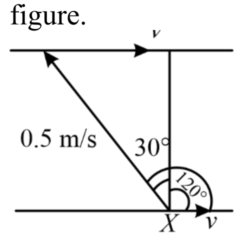
22. (1)

Sol. $v_{\text{Resultant}} = \dfrac{1km}{1/4hr} = 4$ km/hr

$\therefore \quad v_{\text{River}} = \sqrt{5^2 - 4^2} = 3$ km/hr

23. (1)

Sol. Let v be the velocity of river water. As shown in figure.



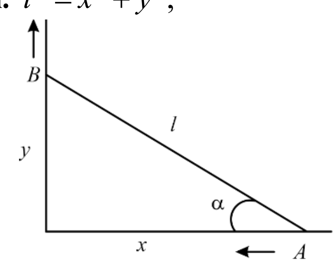
$\sin 30^\circ = \dfrac{v}{0.5}$

Or, $v = \sin 30°$

0.5 × (1/2) = 0.25 m/s

24. (3)

Sol. $l^2 = x^2 + y^2$,



Differentiate both sides, $2x\dfrac{dx}{dt} + 2y\dfrac{dy}{dt} = 0$

$2xv_x = 2yv_y \Rightarrow v_y = \dfrac{x}{y}v_x$

As, $\tan 60^\circ = \dfrac{y}{x}$

$v_y = \dfrac{1}{\tan 60^\circ}v_x = \dfrac{1}{\sqrt{3}} \times 10 = 5.8$ m/s

25. (2)

Sol. Let the velocity of rive be v_R and velocity of boat is v_B.

$\therefore$ Resultant velocity $= \sqrt{v_B^2 + v_R^2 + 2v_B v_R \cos\theta}$

$$(10) = \sqrt{v_B^2 + v_R^2 + 2v_B v_R \cos 90^\circ}$$

$$(10) = \sqrt{(8)^2 + v_R^2} \text{ or } (10)^2 = (8)^2 + v_R^2$$

$$v_R^2 = 100 - 64 \text{ or } v_R = 6 \text{ km/hr}$$

26. (4)

Sol. Given, $u = 20$ m/s; $\theta = 60°$; $v = ?$

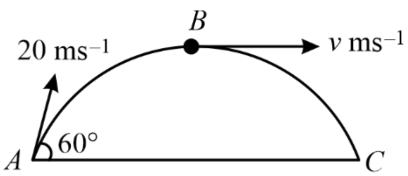
At highest point, the object doesn't have vertical velocity, it has only horizontal and moves in the horizontal direction.

So, $\theta' = 0°$

At $\theta = 60°$, horizontal velocity $= v\cos\theta'$

During motion, its horizontal component remains constant i.e., $u\cos\theta = v\cos\theta'$

Or $20\cos 60° = v\cos 0°$



$v = 10$ m/s

The velocity of the projectile at the highest point is 10 m/s.

27. (1)

Sol. Maximum height attained by porjectile, is

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

Given that, $u = 280$ ms^{-1} and $\theta = 30°$

$$\therefore \quad H = \frac{(280)^2 \times \sin^2 30^\circ}{2\times 9.8} = \frac{(280)^2 \times (0.25)}{2\times 9.8}$$

$= 1000$ m

28. (2)

Sol. Ball is porjected with a velocity, $u = 10$ m/s

Angle of projection, $0 = 90° - 60° = 30°$

The velocity ofa projectile at the highest point will be $v = u\cos\theta = 10\times\cos 30°$

$$= 10\times\frac{\sqrt{3}}{2} = 5\sqrt{3} \text{ m/s}$$

29. (1)

Sol. We know, $T = \dfrac{2\pi R}{u} \Rightarrow u = \dfrac{2\pi R}{T}$

Here : $H_{max} = 4R$

$$H_{max} = \frac{u^2 \sin^2\theta}{2g} \qquad \text{...(i)}$$

Putting the value of u and H_{max} in equation (i), we get

$$4R = \left(\frac{2\pi R}{T}\right)^2 \times \frac{\sin^2\theta}{2g} \Rightarrow \theta = \sin^{-1}\left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$$

30. (1)

Sol. The equation of trajectory is

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

Where θ is the angle of projection and u is the velocity with which projectile is projected.

For equal trajectories and for same angles of projection,

$$\frac{g}{u^2} = \text{constant}$$

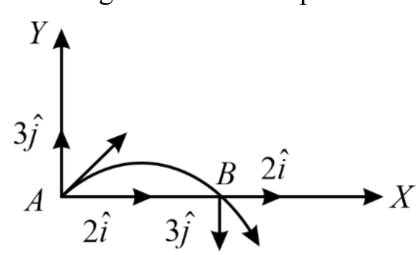
As per question, $\dfrac{9.8}{5^2} = \dfrac{g'}{3^2}$

Where g' is acceleration due to gravity on the planet.

$$g' = \frac{9.8\times 9}{25} = 3.5 \text{ ms}^{-2}$$

31. (1)

Sol. At point B, X component of velocity remains unchanged while Y component reverses its direction.



$\therefore$ The velocity of the porjectile at point B is $2\hat{i} - 3\hat{j}$ m/s.

32. (2)

Sol. Horizontal range, $R = \dfrac{u^2 \sin 2\theta}{g}$

Where u is the velocity of projection and θ is the angle of projection.

Maximum height, $H = \dfrac{u^2 \sin^2 \theta}{2g}$

According to question $R = H$

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

or $\dfrac{2u^2 \sin\theta \cos\theta}{g} = \dfrac{u^2 \sin^2 \theta}{2g}$

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

33. (1)

Sol. Here, $u = 20$ m/s, $g = 10$ m/s^2

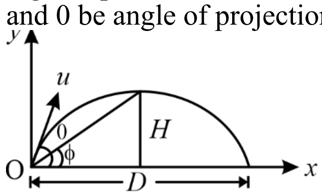
For maximum range, angle of projection is θ = 45°

$\therefore R_{\max} = \dfrac{u^2 \sin 90^\circ}{g} = \dfrac{u^2}{g}\left(\because R = \dfrac{u^2 \sin 2\theta}{g}\right)$

$= \dfrac{(20m/s)^2}{(10m/s^2)} = 40$ m

34. (3)

Sol. Let ϕ be elevation angle of the projectile at its highest point as seen from the point of projection O and 0 be angle of projection with the horizontal.



From figure, $\tan\phi = \dfrac{H}{R/2}$

In case of projectile motion

Maximum height, $H = \dfrac{u^2 \sin^2 \theta}{2g}$

Horizontal range, $R = \dfrac{u^2 \sin 2\theta}{g}$

Substituting these values of H and R in (i), we get

$$\tan\phi = \dfrac{\dfrac{u^2 \sin^2 \theta}{2g}}{\dfrac{u^2 \sin 2\theta}{2g}} = \dfrac{\sin^2\theta}{\sin 2\theta} = \dfrac{\sin^2\theta}{2\sin\theta\cos\theta} = \dfrac{1}{2}\tan\theta$$

Here, θ = 45° $\therefore$ $\tan\phi = \dfrac{1}{2}$ $\tan 45^\circ = \dfrac{1}{2}$

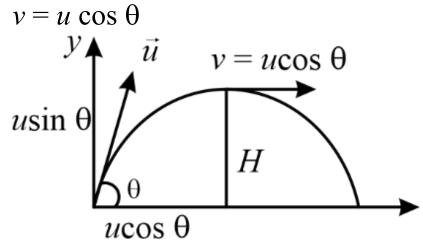
($\because$ tan 45° = 1)

$\phi = \tan^{-1}\left(\dfrac{1}{2}\right)$

35. (1)

Sol. Let v be velocity of a projectile at maximum height H.

$v = u\cos\theta$



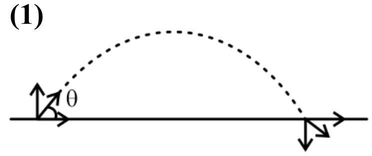
According to given problem,

$v = \dfrac{u}{2}$

$\therefore \dfrac{u}{2} = u\cos\theta \Rightarrow \cos\theta = \dfrac{1}{2} \Rightarrow \theta = 60^\circ$

36. (1)

Sol.



The horizontal momentum does not change. The changei is vertical momentum is, $\Delta p = p_f - p_i$

$-mv\sin\theta - mv\sin\theta = -2mv\dfrac{1}{\sqrt{2}} = \left|-\sqrt{2}mv\right| = \sqrt{2}mv$

37. (2)

Sol. Horizontal range, $R = \dfrac{u^2 \sin 2\theta}{g}$

For angle of projection (45° – θ), the horizontal range is

$\therefore$

$R_1 = \dfrac{u^2 \sin[2(45^\circ - \theta)]}{g} = \dfrac{u^2 \sin(90^\circ - 2\theta) g}{g} = \dfrac{u^2 \cos 2\theta}{g}$

For angle of projection (45° + θ), the horizontal range is

$R_2 = \dfrac{u^2 \sin[2(45^\circ + \theta)]}{g} = \dfrac{u^2 \sin(90^\circ + 2\theta) g}{g} = \dfrac{u^2 \cos 2\theta}{g}$

$\therefore \dfrac{R_1}{R_2} = \dfrac{u^2 \cos 2\theta / g}{u^2 \cos 2\theta / g} = \dfrac{1}{1}$

38. (3)

Sol. Time required to reach the ground is dependent on the vertical motion of the particle. Vertical motion of both the particles A and B are exactly same. Although particle B has an initial velocity, but that is in horizontal direction and it has no component in vertical (component of a vector at a direction of 90° = 0) direction. Hence they will reach the ground simultaneously.

39. (2)

Sol. As $\theta_2 = (90 - \theta_1)$,

So range of projectile, $R_1 = \dfrac{v_0^2 \sin 2\theta}{g} = \dfrac{v_0^2 2\sin\theta\cos\theta}{g}$

$$R_2 = \frac{v_0^2 2\sin(90-\theta_1)\cos(90-\theta_1)}{g}$$

$$R_2 = \frac{v_0^2 2\cos\theta_1 \sin\theta_1}{g} = R_1$$

40. (2)

Sol. For the given velocity of projection u, the horizontal range is the same for the angle of projection θ and $90° - \theta$.

Horizontal range, $R = \dfrac{u^2 \sin 2\theta}{g}$

$\therefore$ For body A, $R_A = \dfrac{u^2 \sin(2 \times 30°)}{g} = \dfrac{u^2 \sin 60°}{g}$

For body B, $R_B = \dfrac{u^2 \sin(2 \times 60°)}{g}$

$$R_B = \frac{u^2 \sin 120°}{g} = \frac{u^2 \sin(180° - 60°)}{g} = \frac{u^2 \sin 60°}{g}$$

The range is the same whether the angle is θ or $90° - \theta$.

$\therefore$ The ratio of ranges is 1 : 1.