# DPP - Daily Practice Problems

## Chapter-wise Sheets

Date : | Start Time : | End Time :

# PHYSICS

**CP03**

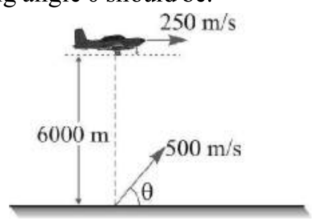
**SYLLABUS :** Motion in a Plane

**Max. Marks : 180** **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

**INSTRUCTIONS** : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

**1.** A projectile is given an initial velocity of $(\hat{i}+2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10 m/s$^2$, the equation of its trajectory is :
(a) $y = x - 5x^2$ (b) $y = 2x - 5x^2$
(c) $4y = 2x - 5x^2$ (d) $4y = 2x - 25x^2$

**2.** An aircraft moving with a speed of 250 m/s is at a height of 6000 m, just overhead of an anti aircraft–gun. If the muzzle velocity is 500 m/s, the firing angle θ should be:
(a) 30°
(b) 45°
(c) 60°
(d) 75°



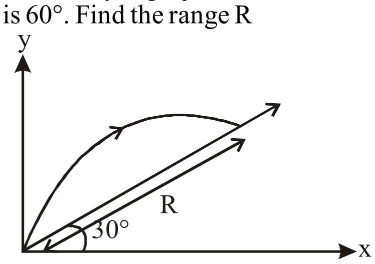

**3.** Two racing cars of masses $m_1$ and $m_2$ are moving in circles of radii $r_1$ and $r_2$ respectively. Their speeds are such that each makes a complete circle in the same duration of time t. The ratio of the angular speed of the first to the second car is
(a) $m_1 : m_2$ (b) $r_1 : r_2$
(c) 1 : 1 (d) $m_1r_1 : m_2r_2$

**4.** A boy playing on the roof of a 10 m high building throws a ball with a speed of 10m/s at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground ?
$[g = 10\text{m/s}^2,\ \sin 30^o = \frac{1}{2},\ \cos 30^o = \frac{\sqrt{3}}{2}]$
(a) 5.20m (b) 4.33m (c) 2.60m (d) 8.66m

**5.** A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the ground in 10 sec. Angle at which it strikes the ground wil be (g = 10 m/s$^2$)
(a) $\tan^{-1}\left(\frac{1}{5}\right)$ (b) $\tan\left(\frac{1}{5}\right)$
(c) $\tan^{-1}(1)$ (d) $\tan^{-1}(5)$

**6.** Two particles start simultaneously from the same point and move along two straight lines, one with uniform velocity $v$ and other with a uniform acceleration $a$. If α is the angle between the lines of motion of two particles then the least value of relative velocity will be at time given by
(a) $\frac{v}{a}\sin\alpha$ (b) $\frac{v}{a}\cos\alpha$ (c) $\frac{v}{a}\tan\alpha$ (d) $\frac{v}{a}\cot\alpha$

**7.** Initial velocity with which a body is projected is 10 m/sec and angle of projection is 60°. Find the range R
(a) $\frac{15\sqrt{3}\text{m}}{2}$
(b) $\frac{40}{3}$m
(c) $5\sqrt{3}$m
(d) $\frac{20}{3}$m




| RESPONSE GRID | | | | | |
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*Space for Rough Work*

**8.** The position vectors of points A, B, C and D are $A = 3\hat{i}+4\hat{j}+5\hat{k}, B = 4\hat{i}+5\hat{j}+6\hat{k}, C = 7\hat{i}+9\hat{j}+3\hat{k}$ and $D = 4\hat{i}+6\hat{j}$ then the displacement vectors $\overrightarrow{AB}$ and $\overrightarrow{CD}$ are
(a) perpendicular (b) parallel
(c) antiparallel (d) inclined at an angle of 60°

**9.** A person swims in a river aiming to reach exactly on the opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle of 120º with the direction of flow of water. The speed of water is
(a) 1.0 m/s (b) 0.5 m/s (c) 0.25 m/s (d) 0.43 m/s

**10.** A projectile thrown with velocity v making angle θ with vertical gains maximum height H in the time for which the projectile remains in air, the time period is
(a) $\sqrt{H\cos\theta/g}$ (b) $\sqrt{2H\cos\theta/g}$
(c) $\sqrt{4H/g}$ (d) $\sqrt{8H/g}$

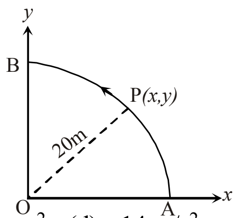
**11.** A ball is thrown from a point with a speed '$v_0$' at an elevation angle of θ. From the same point and at the same instant, a person starts running with a constant speed $\frac{'v_0'}{2}$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection θ ?
(a) No, 0° (b) Yes, 30° (c) Yes, 60° (d) Yes, 45°

**12.** If vectors $\vec{A} = \cos\omega t\hat{i} + \sin\omega t\hat{j}$ and $\vec{B} = \cos\frac{\omega t}{2}\hat{i} + \sin\frac{\omega t}{2}\hat{j}$ are functions of time, then the value of t at which they are orthogonal to each other is :
(a) $t = \frac{\pi}{2\omega}$ (b) $t = \frac{\pi}{\omega}$ (c) $t = 0$ (d) $t = \frac{\pi}{4\omega}$

**13.** A bus is moving on a straight road towards north with a uniform speed of 50 km/hour turns through 90°. If the speed remains unchanged after turning, the increase in the velocity of bus in the turning process is
(a) 70.7 km/hour along south-west direction
(b) 70.7 km/hour along north-west direction.
(c) 50 km/hour along west
(d) zero

**14.** The velocity of projection of oblique projectile is $(6\hat{i}+8\hat{j})\,ms^{-1}$. The horizontal range of the projectile is
(a) 4.9m (b) 9.6m (c) 19.6m (d) 14m

**15.** A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and $t$ is in seconds. The radius of the path is 20 m. The acceleration of 'P' when $t = 2$ s is nearly




(a) 13 m/s$^2$ (b) 12 m/s$^2$ (c) 7.2 ms$^2$ (d) 14 m/s$^2$

**16.** The resultant of two vectors $\vec{A}$ and $\vec{B}$ is perpendicular to the vector $\vec{A}$ and its magnitude is equal to half the magnitude of vector $\vec{B}$. The angle between $\vec{A}$ and $\vec{B}$ is
(a) 120° (b) 150° (c) 135° (d) 180°

**17.** A man running along a straight road with uniform velocity $\vec{u} = u\hat{i}$ feels that the rain is falling vertically down along $-\hat{j}$. If he doubles his speed, he finds that the rain is coming at an angle θ with the vertical. The velocity of the rain with respect to the ground is
(a) $ui - uj$ (b) $ui - \frac{u}{\tan\theta}\hat{j}$
(c) $2u\hat{i} + u\cot\theta\hat{j}$ (d) $ui + u\sin\theta\hat{j}$

**18.** Two projectiles A and B thrown with speeds in the ratio $1 : \sqrt{2}$ acquired the same heights. If A is thrown at an angle of 45° with the horizontal, the angle of projection of B will be
(a) 0° (b) 60° (c) 30° (d) 45°

**19.** A projectile can have the same range '$R$' for two angles of projection. If '$T_1$' and '$T_2$' be time of flights in the two cases, then the product of the two time of flights is directly proportional to
(a) $R$ (b) $\frac{1}{R}$ (c) $\frac{1}{R^2}$ (d) $R^2$

**20.** A man standing on the roof of a house of height h throws one particle vertically downwards and another particle horizontally with the same velocity u. The ratio of their velocities when they reach the earth's surface will be
(a) $\sqrt{2gh+u^2} : u$ (b) $1:2$
(c) $1:1$ (d) $\sqrt{2gh+u^2} : \sqrt{2gh}$

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

**22.** An aeroplane is flying at a constant horizontal velocity of 600 km/hr at an elevation of 6 km towards a point directly above the target on the earth's surface. At an appropriate time, the pilot releases a ball so that it strikes the target at the earth. The ball will appear to be falling
(a) on a parabolic path as seen by pilot in the plane
(b) vertically along a straight path as seen by an observer on the ground near the target
(c) on a parabolic path as seen by an observer on the ground near the target
(d) on a zig-zag path as seen by pilot in the plane

| RESPONSE GRID | | | | | |
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| | 13. ⓐⓑⓒⓓ | 14. ⓐⓑⓒⓓ | 15. ⓐⓑⓒⓓ | 16. ⓐⓑⓒⓓ | 17. ⓐⓑⓒⓓ |
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*Space for Rough Work*

**23.** A particle is projected with a velocity $v$ such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)

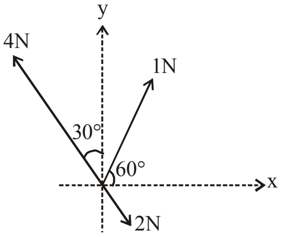
(a) $\frac{4v^2}{5g}$ (b) $\frac{4g}{5v^2}$ (c) $\frac{v^2}{g}$ (d) $\frac{4v^2}{\sqrt{5}g}$

**24.** Two stones are projected from the same point with same speed making angles $(45° + \theta)$ and $(45° - \theta)$ with the horizontal respectively. If $\theta \le 45°$, then the horizontal ranges of the two stones are in the ratio of

(a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) 1 : 4

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

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




**26.** A particle moves in x-y plane under the action of force $\vec{F}$ and $\vec{p}$ at a given time t $p_x = 2\cos\theta$, $p_y = 2\sin\theta$. Then the angle $\theta$ between $\vec{F}$ and $\vec{p}$ at a given time t is :

(a) $\theta = 30°$ (b) $\theta = 180°$ (c) $\theta = 0°$ (d) $\theta = 90°$

**27.** A person sitting in the rear end of the compartment throws a ball towards the front end. The ball follows a parabolic path. The train is moving with velocity of 20 m/s. A person standing outside on the ground also observes the ball. How will the maximum heights ($y_m$) attained and the ranges (R) seen by the thrower and the outside observer compare with each other?

(a) Same $y_m$ different R (b) Same $y_m$ and R
(c) Different $y_m$ same R (d) Different $y_m$ and R

**28.** A car moves on a circular road. It describes equal angles about the centre in equal intervals of time. Which of the following statement about the velocity of the car is true ?

(a) Magnitude of velocity is not constant
(b) Both magnitude and direction of velocity change
(c) Velocity is directed towards the centre of the circle
(d) Magnitude of velocity is constant but direction changes

**29.** Three particles A, B and C are thrown from the top of a tower with the same speed. A is thrown up, B is thrown down and C is horizontally. They hit the ground with speeds $v_A$, $v_B$ and $v_C$ respectively then,

(a) $v_A = v_B = v_C$ (b) $v_A = v_B > v_C$
(c) $v_B > v_C > v_A$ (d) $v_A > v_B = v_C$

**30.** A particle is moving such that its position coordinate (x, y) are

(2m, 3m) at time t = 0
(6m, 7m) at time t = 2 s and
(13m, 14m) at time t = 5s.

Average velocity vector $(\vec{V}_{av})$ 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) $\frac{11}{5}(\hat{i} + \hat{j})$

**31.** A particle moves so that its position vector is given by $\vec{r} = \cos\omega t\hat{x} + \sin\omega t\hat{y}$. Where $\omega$ is a constant. Which of the following is true ?

(a) Velocity and acceleration both are perpendicular to $\vec{r}$
(b) Velocity and acceleration both are parallel to $\vec{r}$
(c) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin
(d) Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin

**32.** 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

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

**33.** 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°

**34.** 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 meter, t 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?

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

**35.** 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° (b) 75° (c) 45° (d) 90°

| RESPONSE GRID | | | | | |
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| | 28. ⓐⓑⓒⓓ | 29. ⓐⓑⓒⓓ | 30. ⓐⓑⓒⓓ | 31. ⓐⓑⓒⓓ | 32. ⓐⓑⓒⓓ |
| | 33. ⓐⓑⓒⓓ | 34. ⓐⓑⓒⓓ | 35. ⓐⓑⓒⓓ | | |

*Space for Rough Work*

36. The velocity of projection of oblique projectile is $(6\hat{i}+8\hat{j})\,\text{m s}^{-1}$. The horizontal range of the projectile is
(a) 4.9m (b) 9.6m (c) 19.6m (d) 14m

37. An artillary piece which consistently shoots its shells with the same muzzle speed has a maximum range R. To hit a target which is R/2 from the gun and on the same level, the elevation angle of the gun should be
(a) 15° (b) 45° (c) 30° (d) 60°

38. 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, 10 m/s (b) 10 m/s, 10 m/s
(c) 10 m/s, 0 (d) 0, 0

39. A vector of magnitude b is rotated through angle θ. What is the change in magnitude of the vector?
(a) $2b\sin\frac{\theta}{2}$ (b) $2b\cos\frac{\theta}{2}$ (c) $2b\sin\theta$ (d) $2b\cos\theta$

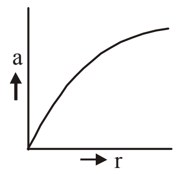
40. A stone projected with a velocity u at an angle θ with the horizontal reaches maximum height $H_1$. When it is projected with velocity u at an angle $\left(\frac{\pi}{2}-\theta\right)$ with the horizontal, it reaches maximum height $H_2$. The relation between the horizontal range R of the projectile, heights $H_1$ and $H_2$ is
(a) $R = 4\sqrt{H_1H_2}$ (b) $R=4(H_1-H_2)$
(c) $R=4(H_1+H_2)$ (d) $R=\frac{H_1^2}{H_2^2}$

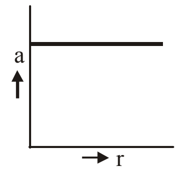
41. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces
(a) cannot be predicted
(b) are equal to each other
(c) are equal to each other in magnitude
(d) are not equal to each other in magnitude

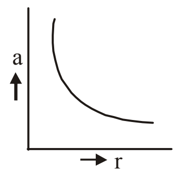
42. A particle crossing the origin of co-ordinates at time t = 0, moves in the xy-plane with a constant acceleration a in the y-direction. If its equation of motion is $y = bx^2$ (b is a constant), its velocity component in the x-direction is
(a) $\sqrt{\frac{2b}{a}}$ (b) $\sqrt{\frac{a}{2b}}$ (c) $\sqrt{\frac{a}{b}}$ (d) $\sqrt{\frac{b}{a}}$

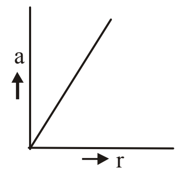
43. A vector $\vec{A}$ is rotated by a small angle Δθ radian (Δθ << 1) to get a new vector $\vec{B}$ In that case $|\vec{B}-\vec{A}|$ is :
(a) $|\vec{A}|\Delta\theta$ (b) $|\vec{B}|\Delta\theta-|\vec{A}|$
(c) $|\vec{A}|\left(1-\frac{\Delta\theta^2}{2}\right)$ (d) 0

44. If a body moving in circular path maintains constant speed of 10 $\text{ms}^{-1}$, then which of the following correctly describes relation between acceleration and radius ?

(a) 

(b) 

(c) 

(d) 


45. The position of a projectile launched from the origin at $t = 0$ is given by $\vec{r} = \left(40\hat{i}+50\hat{j}\right)$m at $t = 2$s. If the projectile was launched at an angle θ from the horizontal, then θ is (take $g = 10\ \text{ms}^{-2}$)
(a) $\tan^{-1}\frac{2}{3}$ (b) $\tan^{-1}\frac{3}{2}$ (c) $\tan^{-1}\frac{7}{4}$ (d) $\tan^{-1}\frac{4}{5}$

| RESPONSE GRID | | | | | |
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| | 36. ⓐⓑⓒⓓ | 37. ⓐⓑⓒⓓ | 38. ⓐⓑⓒⓓ | 39. ⓐⓑⓒⓓ | 40. ⓐⓑⓒⓓ |
| | 41. ⓐⓑⓒⓓ | 42. ⓐⓑⓒⓓ | 43. ⓐⓑⓒⓓ | 44. ⓐⓑⓒⓓ | 45. ⓐⓑⓒⓓ |

| DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP03 - PHYSICS | | | |
|---|---|---|---|
| Total Questions | 45 | Total Marks | 180 |
| Attempted | | Correct | |
| Incorrect | | Net Score | |
| Cut-off Score | 50 | Qualifying Score | 70 |
| Success Gap = Net Score – Qualifying Score | | | |
| Net Score = (Correct × 4) – (Incorrect × 1) | | | |

***Space for Rough Work***

**DAILY PRACTICE PROBLEMS**

# PHYSICS SOLUTIONS

**DPP/CP03**

**1.** **(b)** $\vec{u} = \hat{i} + 2\hat{j} = u_x\hat{i} + u_y\hat{j} \Rightarrow u\cos\theta = 1,\ u\sin\theta = 2$

$$y = x\tan\theta - \frac{1}{2}\frac{gx^2}{u_x^2}$$

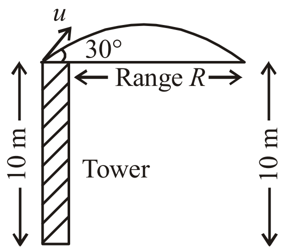
$$\therefore\ y = 2x - \frac{1}{2}gx^2 = 2x - 5x^2$$

**2.** **(c)** $500\cos\theta = 250 \Rightarrow \cos\theta = \frac{1}{2}$

or $\theta = 60°$.

**3.** **(c)** As time periods are equal therefore ratio of angular speeds will be 1 : 1. $\left(\omega = \frac{2\pi}{T}\right)$.

**4.** **(d)**

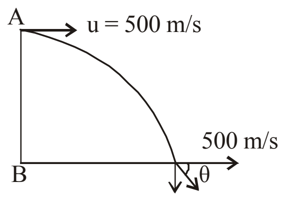



From the figure it is clear that range is required

$$R = \frac{u^2\sin 2\theta}{g} = \frac{(10)^2\sin(2\times 30°)}{10} = 5\sqrt{3} = 8.66\text{ m}$$

**5.** **(a)** Horizontal component of velocity $v_x = 500$ m/s and vertical component of velocity while striking the ground.

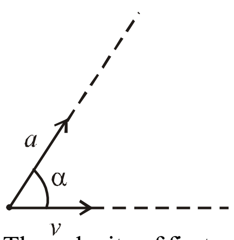
$u_v = 0 + 10 \times 10 = 100$ m/s




$\therefore$ Angle with which it strikes the ground

$$\theta = \tan^{-1}\left(\frac{u_v}{u_x}\right) = \tan^{-1}\left(\frac{100}{500}\right) = \tan^{-1}\left(\frac{1}{5}\right)$$

**6.** **(b)**




The velocity of first particle, $v_1 = v$

The velocity of second particle, $v_2 = at$

Relative velocity, $\vec{v}_{12} = \vec{v}_1 - \vec{v}_2$

or $v_{12}^2 = v^2 + (at)^2 - 2v(at\cos\alpha)$

For least value of relative velocity, $\frac{dv_{12}}{dt} = 0$

or $\frac{d}{dt}\left[v^2 + a^2t^2 - 2vat\cos\alpha\right] = 0$

or $0 + a^2 \times 2t - 2va\cos\alpha = 0$

or $t = \frac{v\cos\alpha}{a}$

**7.** **(d)** $t = \frac{2u\sin 30°}{g\cos 30°} = \frac{2(10)(1/2)}{10(\sqrt{3}/2)} = \frac{2}{\sqrt{3}}\text{sec}$

$$R = 10\cos 30°\ t - \frac{1}{2}\ g\sin 30°\ t^2$$

$$= \frac{10\sqrt{3}}{2}\left(\frac{2}{\sqrt{3}}\right) - \frac{1}{2}(10)\left(\frac{1}{2}\right)\frac{4}{3} = 10 - \frac{10}{3} = \frac{20}{3}\text{m}$$

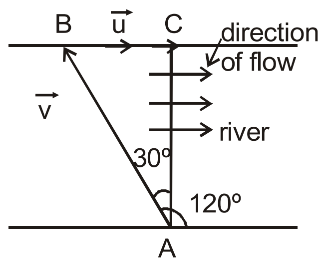
**8.** **(b)** $\overrightarrow{AB} = (4\hat{i} + 5\hat{j} + 6\hat{k}) - (3\hat{i} + 4\hat{j} + 5\hat{k}) = \hat{i} + \hat{j} + \hat{k}$

$\overrightarrow{CD} = (4\hat{i} + 6\hat{j}) - (7\hat{i} + 9\hat{j} + 3\hat{k}) = 3\hat{i} - 3\hat{j} + 3\hat{k}$

$\overrightarrow{AB}$ and $\overrightarrow{CD}$ are parallel, because its cross-product is 0.

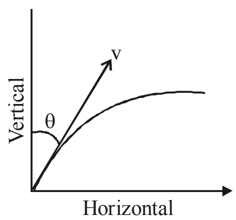
**9.** **(c)** Here v = 0.5 m/sec. u = ?

so $\sin\theta = \frac{u}{v} \Rightarrow \frac{u}{.5} = \frac{1}{2}$ or $u = 0.25\ ms^{-1}$




**10.** **(d)** Max. height = $H = \frac{v^2\sin^2(90-\theta)}{2g}$ .....(i)

Time of flight, $T = \frac{2v\sin(90-\theta)}{g}$ ...(ii)




From (i), $\frac{v\cos\theta}{g} = \sqrt{\frac{2H}{g}}$

From (ii), $T = 2\sqrt{\frac{2H}{g}} = \sqrt{\frac{8H}{g}}$

**11. (c)** Yes, the person can catch the ball when horizontal velocity is equal to the horizontal component of ball's velocity, the motion of ball will be only in vertical direction with respect to person for that,

$$\frac{v_o}{2} = v_o \cos\theta \text{ or } \theta = 60°$$

**12. (b)** Two vectors are

$\vec{A} = \cos\omega t\hat{i} + \sin\omega t\hat{j}$

$\vec{B} = \cos\frac{\omega t}{2}\hat{i} + \sin\frac{\omega t}{2}\hat{j}$

For two vectors $\vec{A}$ and $\vec{B}$ to be orthogonal $A.B = 0$

$\vec{A}.\vec{B} = 0 = \cos\omega t.\cos\frac{\omega t}{2} + \sin\omega t.\sin\frac{\omega t}{2}$

$= \cos\left(\omega t - \frac{\omega t}{2}\right) = \cos\left(\frac{\omega t}{2}\right)$

So, $\frac{\omega t}{2} = \frac{\pi}{2}$ $\quad\therefore\ t = \frac{\pi}{\omega}$

**13. (a)** $\vec{v_1} = 50\,\text{km h}^{-1}$ due North;

$\vec{v_2} = 50\,\text{km h}^{-1}$ due West. Angle between $\vec{v_1}$ and $\vec{v_2} = 90°$

$-\vec{v_1} = 50\,\text{km h}^{-1}$ due South

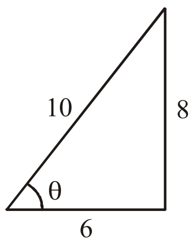
$\therefore$ Change in velocity

$= |\vec{v_2} - \vec{v_1}| = |\vec{v_2} + (-\vec{v_1})|$

$= \sqrt{v_2^2 + v_1^2} = \sqrt{50^2 + 50^2} = 70.7$ km/h

The direction of this change in velocity is in South-West.

**14. (b)** $\vec{v} = 6\hat{i} + 8\hat{j}$




Comparing with $\vec{v} = v_x\hat{i} + v_y\hat{j}$, we get

$v_x = 6\text{ms}^{-1}$ and $v_y = 8\text{ ms}^{-1}$

Also, $v^2 = v_x^2 + v_y^2 = 36 + 64 = 100$

or $v = 10\text{ ms}^{-1}$

$\sin\theta = \frac{8}{10}$ and $\cos\theta = \frac{6}{10}$

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

$R = 2\times10\times10\times\frac{8}{10}\times\frac{6}{10}\times\frac{1}{10} = 9.6\,\text{m}$

**15. (d)** $s = t^3 + 5$

$\Rightarrow$ velocity, $v = \frac{ds}{dt} = 3t^2$

Tangential acceleration $a_t = \frac{dv}{dt} = 6t$

Radial acceleration $a_c = \frac{v^2}{R} = \frac{9t^4}{R}$

At $t = 2s$, $a_t = 6\times2 = 12\ \text{m/s}^2$

$a_c = \frac{9\times16}{20} = 7.2\ \text{m/s}^2$

$\therefore$ Resultant acceleration

$= \sqrt{a_t^2 + a_c^2} = \sqrt{(12)^2 + (7.2)^2} = \sqrt{144 + 51.84}$

$= \sqrt{195.84} = 14\,\text{m/s}^2$

**16. (b)** $\frac{B}{2} = \sqrt{A^2 + B^2 + 2AB\cos\theta}$ ...... (i)

$\therefore\quad \tan 90° = \frac{B\sin\theta}{A + B\cos\theta} \Rightarrow A + B\cos\theta = 0$

$\therefore\quad \cos\theta = -\frac{A}{B}$

Hence, from (i) $\frac{B^2}{A} = A^2 + B^2 - 2A^2 \Rightarrow A = \sqrt{3}\frac{B}{2}$

$\Rightarrow\quad \cos\theta = -\frac{A}{B} = -\frac{\sqrt{3}}{2}\quad\therefore\ \theta = 150°$

**17. (b)** Suppose velocity of rain

$\vec{v}_R = v_x\hat{i} - v_y\hat{j}$

and the velocity of the man

$\vec{v}_m = u\,\hat{i}$

$\therefore$ Velocity of rain relative to man

$\vec{v}_{Rm} = \vec{v}_R - \vec{v}_m = (v_x - u)\hat{i} - v_y\hat{j}$

According to given condition that rain appears to fall vertically, so $(v_x - u)$ must be zero.

$\therefore\quad v_x - u = 0$ or $v_x = u$

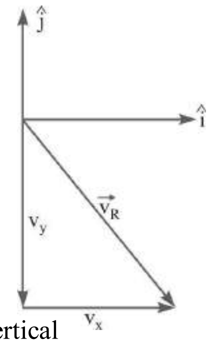
When he doubles his speed,

$\vec{v'}_m = 2u\,\hat{i}$

Now $\vec{v}_{Rm} = \vec{v}_R - \vec{v'}_m$

$= (v_x\hat{i} - v_y\hat{j}) - (2u\hat{i})$

$= (v_x - 2u)\hat{i} - v_y\hat{j}$

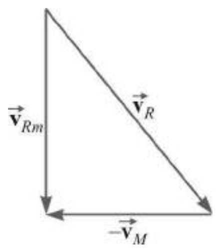



The $\vec{v}_{Rm}$ makes an angle θ with the vertical

$\tan\theta = \frac{x - \text{componend of } \vec{v}_{Rm}}{y - \text{componend of } \vec{v}_{Rm}}$

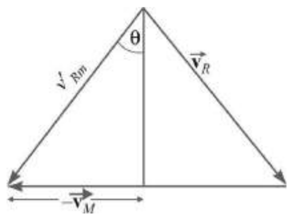
$= \frac{(v_x - 2u)}{-v_y}$

$= \frac{u - 2u}{-v_y}$



which gives

$$v_y = \frac{u}{\tan\theta}$$




Thus the velocity of rain

$$\vec{\mathbf{v}}_R = v_x\hat{\mathbf{i}} - v_y\hat{\mathbf{i}}$$

$$= u\,\hat{\mathbf{i}} - \frac{u}{\tan\theta}\hat{\mathbf{j}}.$$

**18. (c)** For projectile A

Maximum height, $H_A = \frac{u_A^2 \sin^2 45°}{2g}$

For projectile B

Maximum height, $H_B = \frac{u_B^2 \sin^2 \theta}{2g}$

As we know, $H_A = H_B$

$$\frac{u_A^2 \sin^2 45°}{2g} = \frac{u_B^2 \sin^2 \theta}{2g}$$

$$\frac{\sin^2\theta}{\sin^2 45°} = \frac{u_A^2}{u_B^2}$$

$$\sin^2\theta = \left(\frac{u_A}{u_B}\right)^2 \sin^2 45°$$

$$\sin^2\theta = \left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{1}{4}$$

$$\sin\theta = \frac{1}{2} \Rightarrow \theta = \sin^{-1}\left(\frac{1}{2}\right) = 30°$$

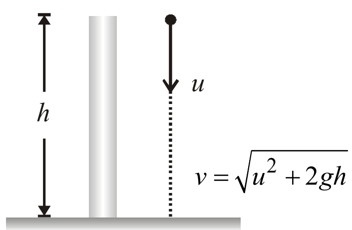
**19. (a)** The angle for which the ranges are same is complementary.
Let one angle be θ, then other is $90° - \theta$

$$T_1 = \frac{2u\sin\theta}{g}, T_2 = \frac{2u\cos\theta}{g}$$

$$T_1T_2 = \frac{4u^2\sin\theta\cos\theta}{g} = 2R \qquad \left(\because R = \frac{u^2\sin^2\theta}{g}\right)$$

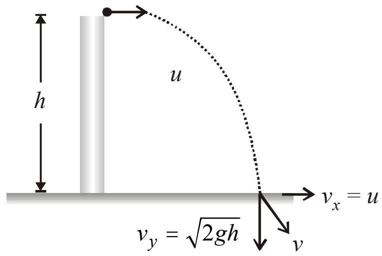
Hence it is proportional to $R$.

**20. (c)** When particle thrown in vertically downward direction with velocity u then final velocity at the ground level




$$v^2 = u^2 + 2gh \quad \therefore\ v = \sqrt{u^2 + 2gh}$$

Another particle is thrown horizontally with same velocity then velocity of particle at the surface of earth.




Horizontal component of velocity $v_x = u$

$\therefore$ Resultant velocity, $v = \sqrt{u^2 + 2gh}$

For both the particles, final velocities when they reach the earth's surface are equal.

**21. (b)** $\hat{r} = 0.5\hat{i} + 0.8\hat{j} + c\hat{k}$

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

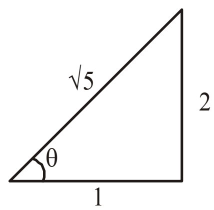
$$(0.5)^2 + (0.8)^2 + c^2 = 1$$

$$c^2 = 0.11 \Rightarrow c = \sqrt{0.11}$$

**22. (c)** The pilot will see the ball falling in straight line because the reference frame is moving with the same horizontal velocity but the observer at rest will see the ball falling in parabolic path.

**23. (a)** R = 2H (given)

We know, $R = 4H\cot\theta \Rightarrow \cot\theta = \frac{1}{2}$




From triangle we can say that $\sin\theta = \frac{2}{\sqrt{5}}, \cos\theta = \frac{1}{\sqrt{5}}$

$\therefore$ Range of projectile $R = \frac{2v^2\sin\theta\cos\theta}{g}$

$$= \frac{2v^2}{g}\times\frac{2}{\sqrt{5}}\times\frac{1}{\sqrt{5}} = \frac{4v^2}{5g}$$

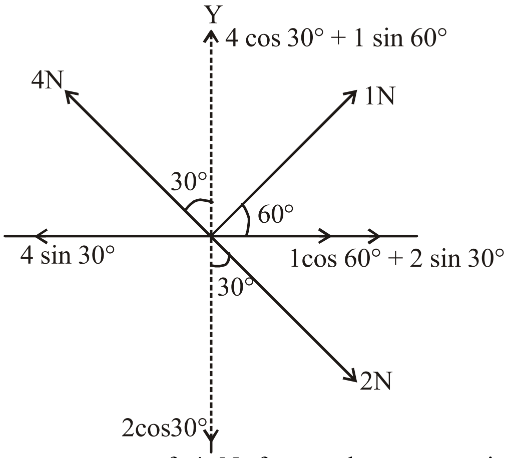
**24. (a)** Note that the given angles of projection add upto 90°.
For complementary angles of projection $(45° + \alpha)$ and $(45° - \alpha)$ with same initial velocity u, range R is same.

$\theta_1 + \theta_2 = (45° + \alpha) + (45° - \alpha) = 90°$

So, the ratio of horizontal ranges is 1 : 1.

**25. (a)** The components of 1 N and 2N forces along + x axis = 1 cos 60° + 2 sin 30°

$$= 1\times\frac{1}{2} + 2\times\frac{1}{2} = \frac{1}{2} + 1 = \frac{3}{2} = 1.5\text{N}$$




The component of 4 N force along –x-axis

$= 4 \sin 30° = 4 \times \frac{1}{2} = 2N$.

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

**26. (d)** $F_x = \frac{dp_x}{dt} = -2\sin\theta$.

Similarly, $F_y = \frac{dp_y}{dx} = 2\cos\theta$.

Angle $\theta$ between two vectors

$$\cos\theta = \frac{F_x p_x + F_y p_y}{|\vec{F}||\vec{p}|}$$

$$= \frac{(-2\sin\theta)(2\cos\theta) + (2\cos\theta)(2\sin\theta)}{|\vec{F}||\vec{p}|}$$

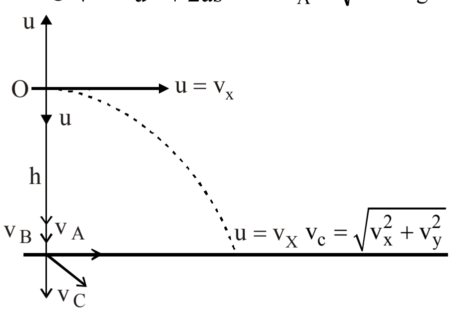
$\Rightarrow \cos\theta = 0 \Rightarrow \theta = 90°$

**27. (a)** The motion of the train will affect only the horizontal component of the velocity of the ball. Since, vertical component is same for both observers, the $y_m$ will be same, but R will be different.

**28. (d)** As body covers equal angle in equal time intervals. Its angular velocity and hence magnitude of linear velocity is constant.

**29. (a)** **For A:** It goes up with velocity *u* will it reaches its maximum height (i.e. velocity becomes zero) and comes back to O and attains velocity *u*.

Using $v^2 = u^2 + 2as \Rightarrow v_A = \sqrt{u^2 + 2gh}$




**For B,** going down with velocity u

$\Rightarrow v_B = \sqrt{u^2 + 2gh}$

**For C,** horizontal velocity remains same, i.e. u. Vertical velocity $= \sqrt{0 + 2gh} = \sqrt{2gh}$

The resultant $v_C = \sqrt{v_x^2 + v_y^2} = \sqrt{u^2 + 2gh}$.

Hence $v_A = v_B = v_C$

**30. (d)** $\vec{v}_{av} = \frac{\Delta\vec{r}\text{ (displacement)}}{\Delta t\text{ (time taken)}}$

$$= \frac{(13-2)\hat{i} + (14-3)\hat{j}}{5-0} = \frac{11}{5}(\hat{i} + \hat{j})$$

**31. (c)** Position vector

$\vec{r} = \cos wt\ \hat{x} + \sin \omega t\ \hat{y}$

$\therefore$ Velocity, $\vec{v} = -\omega \sin \omega t\ \hat{x} + \omega \cos \omega t\ \hat{y}$

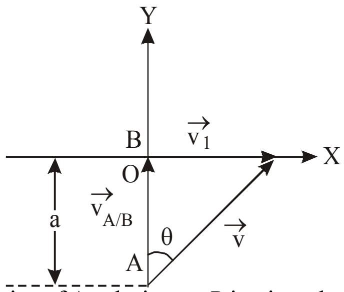
and acceleration,

$\vec{a} = -\omega^2 \cos \omega t\ \hat{x} + \omega \sin \omega t\ \hat{y} = -\omega 2\ \vec{r}$

$\vec{r} \cdot \vec{v} = 0$ hence $\vec{r} \perp \vec{v}$ and

$\vec{a}$ is directed towards the origin.

**32. (d)**




Velocity of A relative to *B* is given by

$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B = \vec{v} - \vec{v}_1$ .... (1)

By taking x-components of equation (1), we get

$0 = v \sin\theta - v_1 \Rightarrow \sin\theta = \frac{v_1}{v}$ .... (2)

By taking *Y*-components of equation (1), we get

$v_y = v\cos\theta$ .....(3)

Time taken by boy at *A* to catch the boy at *B* is given by

$$t = \frac{\text{Relative displacement along Y - axis}}{\text{Relative velocity along Y - axis}}$$

$$= \frac{a}{v\cos\theta} = \frac{a}{v.\sqrt{1-\sin^2\theta}} = \frac{a}{v.\sqrt{1-\left(\frac{v_1}{v}\right)^2}}$$

[From equation (1)]

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

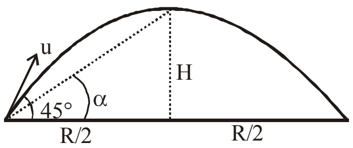
**33. (b)** $H = \frac{u^2 \sin^2 45°}{2g} = \frac{u^2}{4g}$ ...(1)

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

$$\therefore \frac{R}{2} = \frac{u^2}{2g} \quad ...(2)$$

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

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




**34.** **(b)** Here, $x = 4\sin(2\pi t)$ ...(*i*)

$y = 4\cos(2\pi t)$ ...(*ii*)

Squaring and adding equation (*i*) and (*ii*)

$x^2 + y^2 = 4^2 \Rightarrow R = 4$

Motion of the particle is circular motion, acceleration vector is along $-\vec{R}$ and its magnitude $= \frac{v^2}{R}$

Velocity of particle, $v = \omega R = (2\pi)(4) = 8\pi$

**35.** **(d)** $|\vec{A}+\vec{B}|^2 = |\vec{A}-\vec{B}|^2$

$|\vec{A}+\vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2 + 2\vec{A}.\vec{B} = A^2 + B^2 + 2AB\cos\theta$

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

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

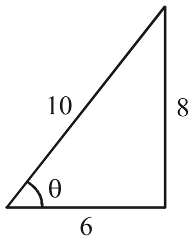
So, $A^2 + B^2 + 2AB\cos\theta$
$= A^2 + B^2 - 2AB\cos\theta$

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

$\therefore \theta = 90°$

So, angle between $A$ & $B$ is 90°.

**36.** **(b)** $\vec{v} = 6\hat{i} + 8\hat{j}$




Comparing with $\vec{v} = v_x\hat{i} + v_y\hat{j}$, we get

$v_x = 6\,ms^{-1}$ and $v_y = 8\,ms^{-1}$

Also, $v^2 = v_x^2 + v_y^2 = 36 + 64 = 100$

or $v = 10\ ms^{-1}$

$\sin\theta = \frac{8}{10}$ and $\cos\theta = \frac{6}{10}$

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

$$R = 2\times 10\times 10\times\frac{8}{10}\times\frac{6}{10}\times\frac{1}{10} = 9.6\,m$$

**37.** **(a)** Range of a projectile is maximum when it is projected at an angle of 45° and is given by

$R_{max} = \frac{u^2}{g}$, where u is the velocity of projection

$\Rightarrow R = \frac{u^2}{g} \quad \therefore u^2 = Rg \quad ...(i)$

Now, to hit a target at a distance (R/2) from the gun, we must have

$\frac{R}{2} = \frac{u^2 \sin 2\theta}{g}$, where θ is the angle of projection.

$\Rightarrow \frac{R}{2} = \frac{Rg\sin 2\theta}{g}$; from (i)

$\Rightarrow \sin 2\theta = \frac{1}{2} \Rightarrow \sin 2\theta = \sin 30°$

$\Rightarrow 2\theta = 30° \quad \therefore \theta = 15°$

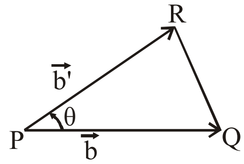
**38.** **(a)** Distance covered in one circular loop $= 2\pi r$
$= 2\times 3.14\times 100 = 628$ m

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

Displacement in one circular loop = 0

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

**39.** **(a)** $\overrightarrow{PQ} + \overrightarrow{QR} = \overrightarrow{PR}$




$\therefore \overrightarrow{QR} = \vec{b}' - \vec{b}$

Now $|\vec{b}' - \vec{b}|^2 = (\vec{b}' - \vec{b}).(\vec{b}' - \vec{b})$

$= b'^2 - 2bb'\cos\theta + b^2$

$= 2b^2(1-\cos\theta) \qquad [\because b' = b]$

$\vec{b}' - \vec{b} = \sqrt{2}b\sqrt{1-\cos\theta}$

$= \sqrt{2}b\left(\sqrt{2}\sin\frac{\theta}{2}\right) = 2b\sin\frac{\theta}{2}$

**40.** **(a)** $H_1 = \frac{u^2 \sin^2\theta}{2g}$

and $H_2 = \frac{u^2 \sin^2(90°-\theta)}{2g} = \frac{u^2\cos^2\theta}{2g}$

$H_1 H_2 = \frac{u^2\sin^2\theta}{2g}\times\frac{u^2\cos^2\theta}{2g} = \frac{(u^2\sin 2\theta)^2}{16g^2} = \frac{R^2}{16}$

$\therefore R = 4\sqrt{H_1 H_2}$

**41.** **(c)** $\vec{P}$ = vector sum $= \vec{A} + \vec{B}$

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

Since $\vec{P}$ and $\vec{Q}$ are perpendicular

$\therefore \vec{P}.\vec{Q}=0$

$\Rightarrow (\vec{A}+\vec{B}).(\vec{A}-\vec{B})=0 \Rightarrow A^2=B^2 \Rightarrow |A|=|B|$

**42. (b)** $y=bx^2$

Differentiating w.r.t to t an both sides, we get

$$\frac{dy}{dx}=b2x\frac{dx}{dt}$$

$v_y=2bxv_x$

Again differentiating w.r.t to t on both sides we get

$$\frac{dv_y}{dt}=2bv_x\frac{dx}{dt}+2bx\frac{dv_x}{dt}=2bv_x^2+0$$

[$\frac{dv_x}{dt}$ = 0, because the particle has constant acceleration along y-direction]

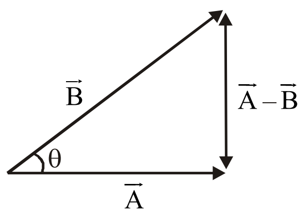
Now, $\frac{dv_y}{dt}=a=2bv_x^2$;

$$v_x^2=\frac{a}{2b}$$

$$v_x=\sqrt{\frac{a}{2b}}$$

**43. (a)** Arc length = radius × angle

So, $|\vec{B}-\vec{A}|=|\vec{A}|\Delta\theta$




**44. (c)** Speed, $V$ = constant (from question)

Centripetal acceleration,

$$a=\frac{V^2}{r}$$

$ra$ = constant

Hence graph (c) correctly describes relation between acceleration and radius.

**45. (c)** From question,

Horizontal velocity (initial),

$$u_x=\frac{40}{2}=20\,\text{m/s}$$

Vertical velocity (initial), $50=u_y t+\frac{1}{2}gt^2$

$\Rightarrow \quad u_y\times 2+\frac{1}{2}(-10)\times 4$

or, $\quad 50=2u_y-20$

or, $\quad u_y=\frac{70}{2}=35\,\text{m/s}$

$\therefore \quad \tan\theta=\frac{u_y}{u_x}=\frac{35}{20}=\frac{7}{4}$

$\Rightarrow \quad$ Angle $\theta=\tan^{-1}\frac{7}{4}$