PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

MOTION IN A PLANE

Example

1. A particle is given velocity $3m/s$ along the positive x-axis subjected to constant

accelaration $4m/s^2$ along the positive y-axis. Find the distaplacement of the particle in $2s$ and trajectory followed by the particle.

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2. At $t = 0$, the particle is at the origin and its velocity is $10m/s$ at an angle 37° with the x-axis. The particle moves in $x - y$ plane with a constant acceleration of $1m/s^2$ along the y-axis. Find the magnitude and direction of the velocity after $2s$.

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3. A particle is given velocity $4m/s$ along the positive y-axis subjected to constant accelaration $10m/s^2$ at 53° with the x-axis. Find the distaplacement of a particle along the coordinate axes after $3s$.

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4. A particle moves in the $x-y$ plane under acceleration $\overrightarrow{a} = 3\hat{i} + 4\hat{j}m/s^2$. If the initial

velocities is $\overrightarrow{u} = 6\hat{i} + 8\hat{j}m/s$. Find the velocity and the position vector of a particle after $2s$.

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5. A particle moves in the $x - y$ plane such that its coordinates are given $x = 10\sqrt{3}t, y = 10t - t^2$ and t is time, find the initial velocity of the particle.

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6. The position vector of a particle is given by $\vec{r} = k\cos\omega\hat{i} + k\sin\omega\hat{j} = x\hat{i} + y\hat{j}$, where k and ω are constants and t time. Find the angle between the position vector and the velocity vector. Also determine the trajectory of the particle.

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7. Two particles A and B are moving in the $x-y$ plane such that their velocity components are $v_x = 1m/s, v_y = \frac{1}{\sqrt{3}}m/s$

(for A) and $v_x = 2m/s, v_y = 2m/s$ (for B). If both the particles start moving from the same point, what is the angle between their paths ?

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8. A particle is moving in a plane with velocity $\vec{v} = u_0\hat{i} + k\omega\cos\omega t\hat{j}$. If the particle is at origin at $t = 0$, (a) determine the trajectory of the particle. (b) Find its distance from the origin at $t = 3\pi/2\omega$.

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9. A radius vector of a point A relative to the origin varies with time t as $r = ati - bt^2 j$, where a and b are positive constants, and i and j are the unit vectors of the x and y axes. Find:

(a) the equation of the point's trajectory $y(x)$, plot this function,

(b) the time dependence of the velocity v and acceleration w vectors, as well as of the moduli of these quantities,

(c) the time dependence of the angle α

between the vectors w and v,

(d) the mean velocity vector averaged over the first t seconds of motion, and the modulus of this vector.

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10. A point moves in the plane xy according to the law $x = \alpha \sin \omega t, y = \alpha(1 - \cos \omega t)$, where α and ω are positive constant and t is time. Find the distance traversed by point in time t_0.

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11. A particle is thrown with speed of $50m/s$ at an angle of projection 37° with the horizontal. Find (a) the time of flight, (b) the maximum height attained and (c) the horizontal range.

$\left(\sin 37^\circ = \frac{3}{5}, \cos 37^\circ = \frac{4}{5}\right)$

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12. A particle is thrown with a velocity $10m/s$ and its horizontal range is $5m$. Find angle/angles of the projection.

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13. If in a projection motion, the maximum height is equal to a horizontal range, find the angles of projection $\left[\tan^{-1}(4) = 76^\circ\right]$

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14. An object is projected so that its horizontal range R is maximum. If the maximum height of projectile is H, find the value of H / R.

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15. If an object is thrown at an angle of 60° with horizontal, find elevation angle of the object at its highest point as seen from the point of projection.

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16. A ball is thrown such that the time of flight is $5s$ and the horizontal range is $200m$. Find the magnitude and direction of velocity of projection.

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17. A large number of bullets are fired in all directions with the same speed v. Find the maximum area on the ground on which these bullets will spread.

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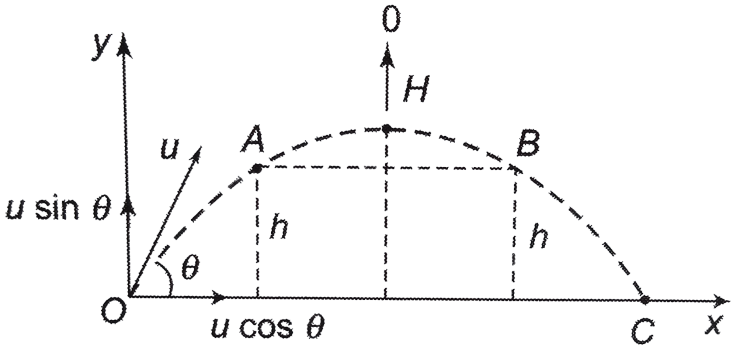
18. A particle is thrown with speed u at an angle θ with horizontal.



Find the average velocity of particle:

(a) O to C (b) A to B (c) O to H

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19. For a projectile if the time of flight is T, the maximum height is H and the horizontal range is R. Find the (a) the maximum height in terms of T and (b) the maximum horizontal range in terms of R and H.

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20. A particle is thrown such that for two angles of projection range R is same. If T_1 and T_2 are the time of flights and H_1 and H_2 are

the maximum hrights corresponding to these angles, find (a) $\frac{T_1 T_2}{R}$ and (b) $\frac{4\sqrt{H_1 H_2}}{R}$.

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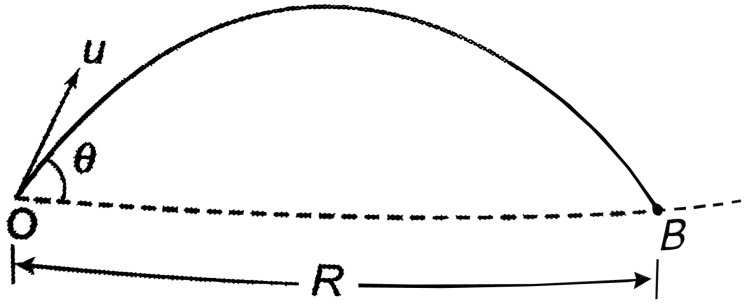
21. A projectile is aimed at a mark on the horizontal plane through the point of projection and falls $12m$ short when the angle of projection is 15°, white it overshoots the mark by $24m$ when the angle of projection is 45°. Find the angle of projection to hit the

mark.



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22. A shell bursts on contact with the gorund and pieces from it fly in all directions with velocities up to $60m/s$. Show that a man $180m$ away is in danger for $6\sqrt{2}s$.

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23. A ball is thrown horizontally with speed $20m/s$ from a tower of height $80m$.

(a) After how much time and at what horizontal distance from the foot of tower it strikes the ground.

(b) Find the magnitude and direction of the velocity with which it strikes the ground.

(c) Find the velocity vector of ball after $1s$.

(d) Trajectory followed by the ball.

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24. A bomb is released from an aeroplane flying at a speed of $720 km/h$ in the horizontal direction $8000 m$ above the gorund. At what horizontal distance from the initial position of areoplane it strikes the ground.

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25. A body is thrown horizontally from the top of a tower of height $5 m$. It touches the ground

at a distance of $10m$ from the foot of the tower. Find the initial velocity of the body.

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26. A ball rolls off top of a staircase with a horizontal velocity ums^{-1}. If the steps are h metre high and b mere wide, the ball will just hit the edge of nth step. Find the value of n.

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27. A staircase contains four steps each $20cm$ high and $40cm$ wide. What should be the minimum horizontal velocity of a ball rolling off the uppermost plane so as to hit directly the lowest plane ?

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28. A ball is projected horizontally with a speed u from the top of inclined plane of

inclination α with horizontal. At what distance along the plane, the ball will strike the plane ?

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29. From the top of the tower, two balls are thrown horizontally in opposite directions with velocities u_1 and u_2. Find the distacne between the balls at the moment when their velocity vectors becomes mutually perpendicular. (Assume the height of tower very large)

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30. A person standing on the top of a tower $36m$ high has to throw a packet to his friend standing on the ground $48m$ horizontally away. If the throws a packet directly aiming the friend with a speed of $10m/s$, how short will the packet fall ?

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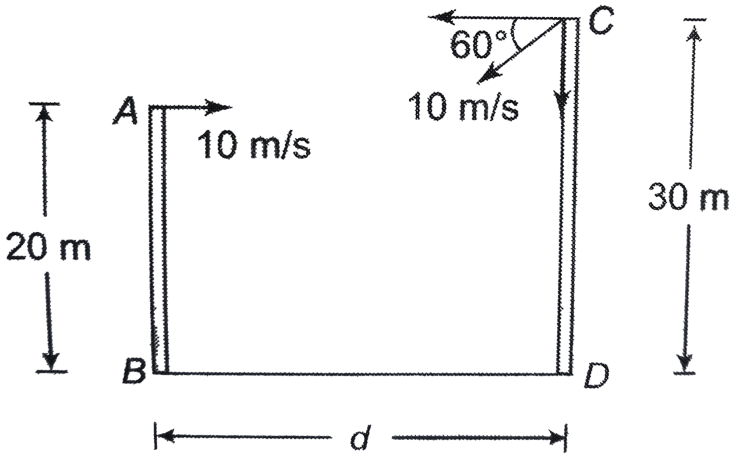
31. Consider the situation as shown in the figure.



Two balls are thrown simultaneously with same speed $10m/s$, one horizontally and another at angle 60° in downward direction. After sometime balls cllide in mid-air, find distance d.

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32. A ball is thrown with velocity $40m/s$ at angle 30° with horizontal from the top of a tower of height $60m$. At what horizontal distance from the foot of tower, the ball will strike the gorund ?

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33. Two guns situated at the top of a hill of height $10m$ fire one shot each with the same

speed $5\sqrt{3}m/s$ at some interval of time. One gun fires horizontal and the other fores upwards at an angle of 60° with the horizontal. Two shots collide in air at a poit P. Find (i) time-interval between the firing and (ii) coordinates of the point P. Take the origin of coordinates system at the foot of the hill right below the muzzle and trajectorise in the $x-y$ plane.

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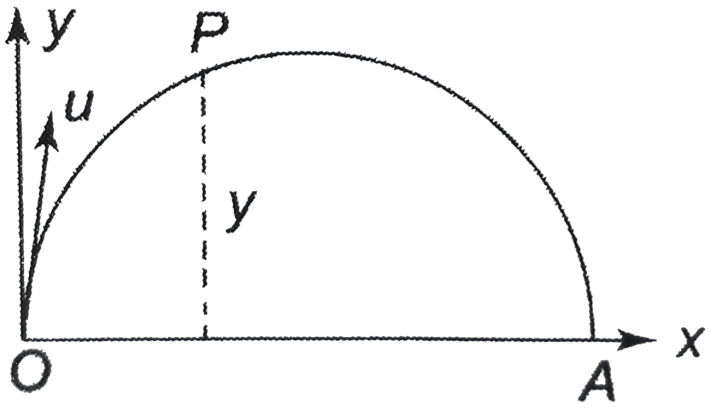
34. A particle is thrown at an angle with horizontal from the ground. After $4s$ it reaches to a point P and after 5 more seconds it strikes the ground. Find the height of P the maximum height attained by the particle.



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35. A particle is thrown with speed u at an angle α with horizontal from the ground. After how much time, the velocity of particle will make an angle β with horizontal.

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36. Two second after projection, a projectile is travelling in a direction inclined at 30° to the horizontal. After one more second, it is travelling horizontally. Find the magnitude and direction of the velocity of projection.

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37. A ball is thrown with speed u at an angle θ with horizontally. After how much time it will move perpendicular to the initial direction of motion.

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38. Two bodies are thrown simultaneously from the same point. One thrown straight up

and the other at an angle α with the horizontal. Both the bodies have velocity equal to u. Find the separation between the bodies at time t.

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39. A gun kept on a striaght horizontal is used to hit a car, traveling along the same road away form the gun with a unfrom speed $20m/s$. The car is at a distance Of $160m$ from the gun, when the gun is fired at an angle of

45° with the horizontal Find the distance of the car from the gun when the shell hits it and the speed of projection of the shell from the gun.

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40. Shots are fired simultaneously from the top and the bottom of a vertical cliff with elevation 37° and 53° respectively, strike an object at the ground simultaneously.If the

horizontal distance of the object from the cliff is $60m$, find the height of the cliff.

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41. The trajectory of a projectile in a vertical plane is $y = ax - bx^2$, where a and b are constantsn and x and y are respectively horizontal and vertical distances of the projectile from the point of projection. The maximum height height attained by the

particle and the angle of projection form the horizontal are:

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42. A particle moves in the xy plane with a constant acceleration ω directed along the negative y-axis. The equation of motion of particle has the form $y = cx - dx^2$, where c and d are positive constants. Find the velocity of the particle at the origin of coordinates.

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43. A ball is thrown from a point at a distance $40m$ from a wall of height $15m$. It just clears the wall and then attains maximum height. Find the maximum height the angle of projection is 45°.

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44. A ball is projected at an angle 45° with horizontal. It passes through a wall of height h at horizontal distance d_1 from the point of

projection and strikes the ground at a horizontal distance $(d_1 + d_2)$ from the point of projection, then

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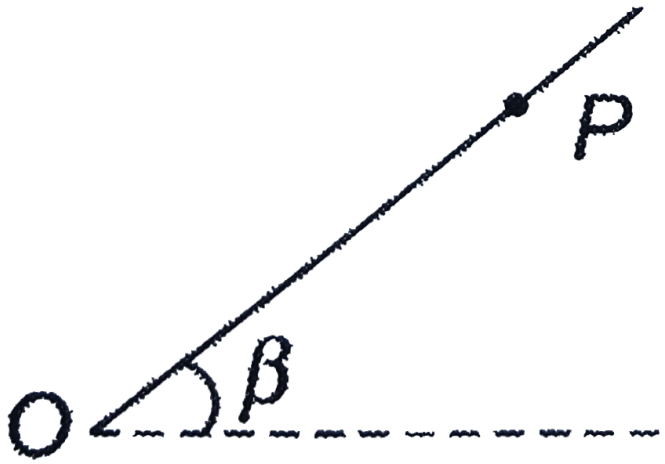
45. Consider an object P on an inclined plane of inclination β.

A shot is fired O at an angle α with horizontal.

Find the relation between α and β, if the shot

hits the object horizontally.



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46. A particle is thrown over a triangle from one end of a horizontal base and after grazing the vertex falls on the other end of the base. If

α and β be the base angles and θ the angle of projection, prove that $\tan\theta = \tan\alpha + \tan\beta$.

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47. A particle is projected from origin with speed u. Find the minimum value of u if the particle passes through a poiny $P\left(a, \sqrt{3}a\right)$.

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48. A body falling freely from a given height H hits an inlclined plane in its path at a height h. As a result of this impact the direction of the velocity of the body becomes horizontal. For what value of h/H, the body will take the maximum time to reach the ground.

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49. A stone is projected from the ground in such a direction so as to hit a bird on the top

of a telegraph post of height h and attains the maximum height of 2h above the ground. If at the insatant of projection, the bird were to fly away horizontally with a uniform speed, find the ratio between the horizontal velocity of bird and the horizontal component of velocity of stone, if the stone hits the bird while descending.

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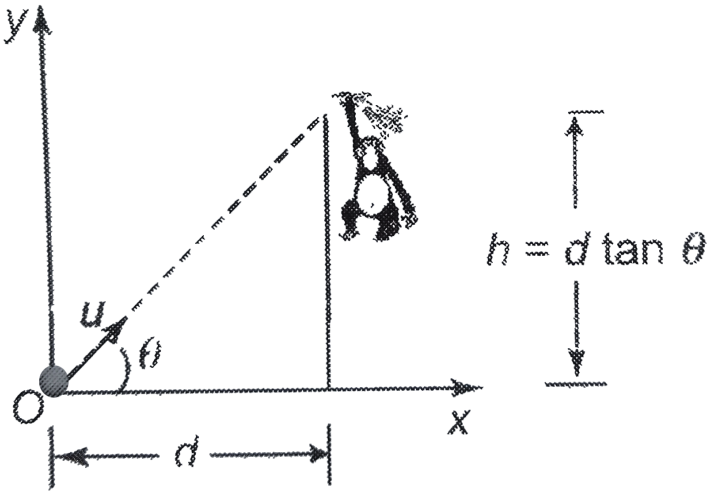
50. Consider the situation as shown.



When a ball is thrown aiming the monkey, at the same time the monkey drops himself. Will the ball hit the monkey ?

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51. A ball with projection velocity $10m/s$ is to hit a target $6m$ away in the same horizontal line. How high above the target must the ball be aimed so that the ball will hit the target ? $(\tan 18.5^\circ = 1/3, \tan 71.5^\circ = 3)$

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52. A ball is thrown from a point O aiming a target at angle 37° with the horizontal so that the ball hits the target at C but the ball

hits at point D, a vertical distance y_0 below C. If the initial velocity of the ball is $10m/s$ and the horizontal distance between O and C is $5m$. Find y_0.

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53. A boy is standing on a truck moving with a constant velocity of $15m/s$ on the horizontal road. The boy throws a ball in such a way that it returns to the truck after the truck has moved $60m$. Find the speed and the angle of

projection (a) as seen by the truck and (b) as seen from the road.

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54. A man standing on a long rail road car throws a ball vertically upward with speed $20m/s$. The car starts from rest and moves with acceleration $2m/s^2$. How far behind the man will the ball fall on the car ?

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55. The path of one projectile as seen by an observer on another projectile is a/an:

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Exercises

1. Two balls are rolling on a flat surface. One has velocity components m/s and $\sqrt{3}m/s$ along the rectangular axes x and y, respectively and the other has component $2m/s$ and $2m/s$, respectively. If both the

balls start moving from the same point, the angle between their directions of motion is

A. 15°

B. 30°

C. 45°

D. 60°

Answer: A

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2. A particle moving with a velocity equal to $0.4m/s$ is subjected to an acceleration of $0.15m/s^2$ for $2s$. in a direction at the right angle to its direction of motion. The resultant velocity is

A. $0.7m/s$

B. $0.5m/s$

C. $0.1m/s$

D. Between 0.7 and $0.1m/s$

Answer: B

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3. The height y and distance x along the horizontal plane of a projectile on a certain planet are given by $x = 6tm$ and $y = \left(8t^2 - 5t^2\right)m$. The velocity with which the projectile is projected is

A. $8m / s$

B. $6m / s$

C. $10m / s$

D. 0

Answer: C

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4. In the above problem the direction of the initial velocity with the x-axis is

A. $\tan^{-1}\left(\frac{3}{4}\right)$

B. $\tan^{-1}\left(\frac{4}{3}\right)$

C. $\sin^{-1}\left(\frac{3}{4}\right)$

D. $\cos^{-1}\left(\frac{3}{4}\right)$

Answer: B

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5. The coordinates of a moving particle at any time t are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time t is given by

A. $\sqrt{\alpha^2 + \beta^2}$

B. $3t\sqrt{\alpha^+ \beta^2}$

C. $3t^2\sqrt{\alpha^2+\beta^2}$

D. $t^2\sqrt{\alpha^2+\beta^2}$

Answer: C

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6. A body starts from rest from the origin with an acceleration of $3m/s(2)$ along the x-axis and $4m/s^2$ along the y-axis. Its distance from the origin after $2s$ will be

A. $5m$

B. $10m$

C. $15m$

D. $20m$

Answer: B

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7. A ball is thrown upwards and returns to the ground describing a parabolic path. Which of the following quantities remains constant ?

A. Kinetic energy of the ball

B. The speed of the ball

C. The vertical component of velocity

D. The horizontal component of velocity

Answer: D

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8. At what angle to the horizontal should an object be projected so that the maximum

height reached is equal to the horizontal range.

A. $\tan\theta = 2$

B. $\tan\theta = 4$

C. $\tan\theta = 3$

D. $\tan\theta = 3$

Answer: B

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9. The velocity at the maximum height of a projectile is half of its velocity of projection u. Its range on the horizontal plane is

A. $\frac{3u^2}{g}$

B. $\frac{\sqrt{3}u^2}{2g}$

C. $\frac{3u^2}{g^2}$

D. $\frac{u^2}{3g}$

Answer: B

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10. The range of a projectile, thrown with an initial speed u at the angle of projection 15° is R. What will be the range if it is thrown with an initial speed $2u$ at an angle 30° ?

A. $4\sqrt{3}R$

B. $2\sqrt{3}R$

C. $\sqrt{R}$

D. $5\sqrt{3}R$

Answer: A

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11. A projectile is projected with a kinetic energy K. If it has the maximum possible horizontal range, then its kinetic energy at the highest point will be

A. $K/4$

B. $K/2$

C. $3K/4$

D. K

Answer: B

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12. A projectile is projected with the initial velocity $(6i + 8j)m/s$. The horizontal range is $(g = 10m/s^2)$

A. $96m$

B. $960m$

C. $9.6m$

D. $4.8m$

Answer: C

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13. A projectile is thrown at an angle of 40° with the horizontal and its range is R_1. Another projectile is thrown at an angle of 40° with the vertical and its range is R_2. What is the relation between R_1 and R_2 ? (projection speed is same in both cases)

A. $R_= R_2$

B. $R_1 = 2R_2$

C. $2R_1 = R_2$

D. $R_1 = 0.8R_2$

Answer: A

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14. Two projectiles A and B are projected with an angle of projection 15° for the projectile A and 45° for the projectile B. If R_A and R_B be

the horizontal range for the two projectiles, then

A. $R_A < R_B$

B. $R_A = R_B$

C. $R_A > R_B$

D. the information is insufficient to decide the relation of R_A with R_B

Answer: D

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15. It was calculated that a shell when fired from a gun with a certain velocity and at an angle of elevation $5\pi/36$ radius should strike a given target. In actual practice it was found that a hill just intervened in the trajectory. At what angle of elevation should the gun be fired to hit the target ?

A. $\frac{5\pi}{36} radius$

B. $\frac{7\pi}{36} radius$

C. $\frac{11\pi}{36} radius$

D. $\frac{13\pi}{36} radius$

Answer: D

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16. Galileo writes that for angles of projection of a projectile at angles $(45+\theta)$ and $(45-\theta)$, the horizontal ranges described by the projectile are in the ratio of (if $\theta \leq 45$)

A. $2:1$

B. $1:2$

C. $1:1$

D. $2:3$

Answer: C

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17. Choose the correct option

(i) The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is 60°.

(ii) A missile is fired for maximum range with an initial velocity of $20m/s$, the range of the

missile is $40m$.

(iii) A ball is projected with a kinetic energy E at an angle of 45° to the horizontal. At the highest point during its flight, its kinetic energy will be $E/2$.

(iv) An object is projected at an angle of 45° with horizontal. The horizontal range and the maximum height will be in the ratio $4:1$

A. (i), (ii)

B. (ii), (iii)

C. (i), (iv)

D. all option are correct

Answer: D

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18. If a body A of mass m is thrown with velocity v at an angle of 30° to the horizontal and another body B of mass $2m$ is thrown with the same speed at an angle of 60° to the horizontal. Then

A. $\frac{R_A}{R_B} = \frac{1}{1}$

B. $\frac{(H_A)_{\max}}{(H_B)_{\max}} = \frac{1}{3}$

C. $\frac{T_A}{T_B} = \frac{1}{\sqrt{3}}$

D. (1), (2), (3)

Answer: D

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19. A particle is thrown such that its time of flight is $10s$ and horizontal range is $500m$.

(i) $H_{\max} = 125m$

(ii) $u = 50\sqrt{2}m/s$

(iii) $\theta = 45^\circ$

(iv) velocity at highest point $= 50m/s$

A. (i), (ii), (iii)

B. (ii), (iii), (iv)

C. (i), (ii), (iv)

D. all option are correct

Answer: D

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20. A ball of mass m is thrown vertically upwards. Another ball of same mass is thrown at an angle θ to the horizontal. If the time if flights for both is same, the ratio of maximum height attained by them

A. $1:2$

B. $1:\sin^2\theta$

C. $1:1$

D. $\cos^2\theta:1$

Answer: C

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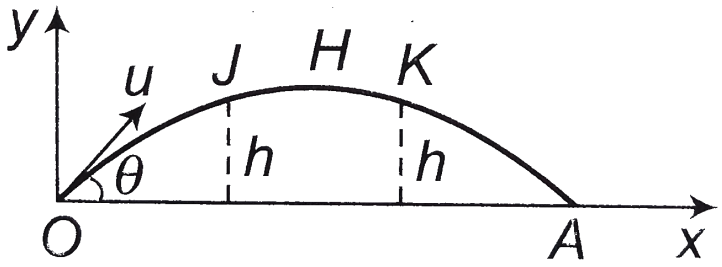
21. A particle is thrown with speed u at an angle of projection θ with horizontal as shown.



(i) The avergae velocity of particle from O to A is $u\cos\theta$

(ii) The average velocity of particle from O to H (highest point) is $\frac{u}{2}\sqrt{1+3\cos^2\theta}$

(iii) The average velocity of particle from J to K is $u\cos\theta$

(iv) The angle between the velocity and the acceleration between O and H is greater than 90°, between H to A is less than 90° and at highest point is 90°

A. (i), (ii)

B. (i), (iii)

C. (ii), (iv)

D. all option are correct

Answer: D

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22. A projectile is thrown into air so as to have the maximum possible range equal to 200. Taking projection point as origin, the coordinates of the point where the velocity of the projectile is minimum, are

A. $(200, 50)$

B. $(100, 50)$

C. $(100, 50)$

D. $(100, 100)$

Answer: B

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23. Two projectiles, one fired from from surface of earth with velocity $10m/s$ and other fired from the surface of another planet with initial speed $5m/s$ trace idential trajectories. The value of acceleration due to the gravity on the planet is

A. $2.5m / s^2$

B. $3.6m / s^2$

C. $4.9m / s^2$

D. $6.4m / s^2$

Answer: A

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24. A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the

projection at its highest point as seen from the point of projection is

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

B. 45°

C. 60°

D. $\tan^{-1}\left(\frac{1}{2}\right)$

Answer: D

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25. A large number of bullets are fired in all directions with the same speed v. Find the maximum area on the ground on which these bullets will spread.

A. $\frac{\pi v^2}{g}$

B. $\frac{\pi v^4}{g^2}$

C. $\frac{\pi v^2}{g^2}$

D. $\frac{\pi v^2}{g^4}$

Answer: B

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26. Four balls A, B, C and D are projected with equal velocities having angles of projection 15°, 30°, 45° and 60° with the horizontal, respectively. The ball having the smallest range is

A. A

B. B

C. C

D. D

Answer: A

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27. A ball A is projected with speed $20m/s$ at an angle of 30° with the horizontal from the ground. Another ball B is released simultaneously from a point on the vertical line along the maximum height of the projectile. Both the balls collide at the maximum height of the first ball. The initial height of ball B is

A. $5m$

B. $10m$

C. $15m$

D. $20m$

Answer: B

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28. A boy can throw a stone up to a maximum height of $10m$. The maximum horizontal

distance that the boy can throw the same stone up to will be :

A. $20\sqrt{2}m$

B. $10m$

C. $10\sqrt{2}m$

D. $20m$

Answer: D

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29. A cricketer can throw a ball to a maximum horizontal distance of 100m. With the same speed how much high above the ground can the cricketer throw the same ball?

A. $100m$

B. $80m$

C. $60m$

D. $50m$

Answer: D

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30. A bullet is to be fired with a speed of $2000m/s$ to hit a target $200m$ away on a level ground. If $g = 10m/s^2$, the gun should be aimed

A. Directly at the target

B. $5cm$ below the target

C. $5cm$ above the target

D. $2cm$ above the target

Answer: C

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31. A particle is projected at an angle with horizontal. If T is the time of flight and R is a horizontal range, then θ is

A. $\cot^{-1}\left(\frac{gT^2}{R}\right)$

B. $\cot^{-1}\left(\frac{gT^2}{2R}\right)$

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

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

Answer: D

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32. For a given velocity, a projectile has the same range R for two angles of rpojection if t_1 and t_2 are the times of flight in the two cases then

A. $t_1 t_2 \propto R^2$

B. $t_1 t_\propto R$

C. $t_1 t_2 \propto \frac{1}{R}$

D. $t_1 t_2 \propto \frac{1}{R^2}$

Answer: B

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33. In the previous problem, if H_1 and H_2 are the maximum heights in the two cases, then

A. $R = 2\sqrt{H_1 H_2}$

B. $R = 4\sqrt{H_1 H_2}$

C. $R = \sqrt{H_1^2 + H_2^2}$

D. $R = H_1 - H_2$

Answer: B

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34. A ball is thrown horizontally with speed $10m/s$ from the top of tower of height $80m$. After how much time and at what horizontal distance from the tower it strikes the ground ?

A. $2s, 40m$

B. $2s, 20m$

C. $4s, 40m$

D. $4s, 80m$

Answer: C

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35. A body is projected horizontally from a height of $20m$. It reaches the ground at a horizontally distance of $40m$. The speed of practicle when it hits the ground is

A. $10m/s$

B. $10\sqrt{m}/s$

C. $20m/s$

D. $20\sqrt{2}m/s$

Answer: d

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36. A body thrown horizontally from the top of a building with a speed $20m/s$, strikes the

ground $40m$ away from the foot of tower. The height of the tower is

A. $5m$

B. $10m$

C. $15m$

D. $20m$

Answer: D

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37. An areoplane is flying horizontally with a velocity $720km/h$ at a height of $2000m$. When it is vertically at a point A on the ground, a bomb is released from it. The bomb strikes the gound at point B. The distance AB is

A. $1km$

B. $2km$

C. $3km$

D. $4km$

Answer: D

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38. A bomber plane moves horizontally with a speed of $600m/s$ and a bomb released from it, strikes the ground in $10s$. The angle with horizontally at which it strikes the ground will be

A. $\tan^{-1}(1/2)$

B. $\tan^{-1}(1/6)$

C. $\tan^{-1}(4/5)$

D. $\tan^{-1}(3/4)$

Answer: B

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39. At the height $320m$, an aeroplane is moving with $100m/s$. A bomb is droped from it so as to hit a target. At what horizontal distance from the target should the bomb be dropped

A. $200m$

B. $400m$

C. $600m$

D. $800m$

Answer: D

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40. A ball is rolled off the edge of a horizontally table at as speed of $4m/s$. It hits the ground after $0.8s$.

(i) it hits the ground at a horizontal distance

$3.2m$ from the edge of the table

(ii) The speed with which it hits the ground is

$4\sqrt{5}m/s$

(iii) Height of the table is $3.2m$

(iv) it hits the ground at an angle of $\tan^{-1}(2)$

to the horizontally

A. (i), (ii)

B. (ii), (iii), (iv)

C. (i), (ii), (iii)

D. all option are correct

Answer: D

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41. A body, rpojected horizontally with a speed u from the top of a tower of height h, reaches the ground at a horizontally distance R from the tower. Another body, projected horizontally from the top of a tower of height $4h$, reaches the ground at horizontal distance $2R$ from the tower. The initial speed of the second body is

A. u

B. $2u$

C. $3u$

D. $4u$

Answer: A

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42. From the top of the tower, a ball A is dropped and another ball B is thrown horizontally at the same time. Which ball strikes the ground first ?

A. A

B. B

C. simultaneously

D. depends on the masses

Answer: C

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43. A ball rolls off the top of a stairway with a horizontal velocity u. If the height and width

of steps are b and h respectively and the ball hits the edge of n^{th} step, then n is equal to

A. $\frac{hu^2}{gb^2}$

B. $\frac{hu^2}{2gb^2}$

C. $\frac{2hu^2}{gb^2}$

D. $\frac{hu^2}{4gb^2}$

Answer: C

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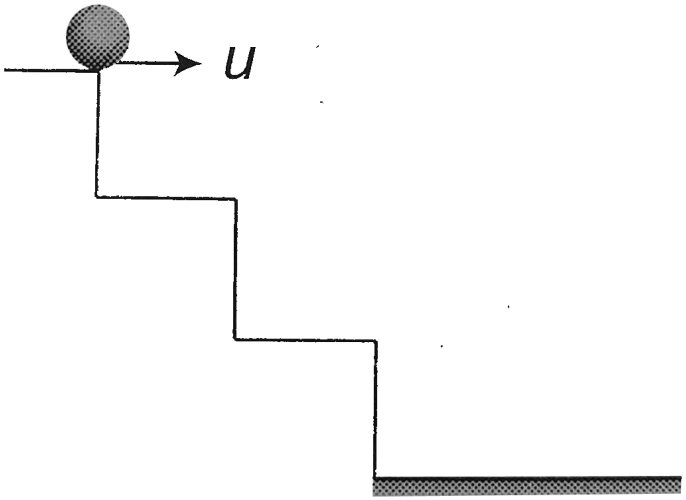
44. A staircase contains four steps each $10cm$ high and $20cm$ wide. The minimum horizontal velocity of a ball rolling off the uppermost plane so as to hit directly the lowest plane is



A. $1m/s$

B. $2m/s$

C. $3m/s$

D. $4m/s$

Answer: B

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45. A ball is thrown with speed $40m/s$ at an angle 30° with horizontally from the top of a tower of height $60m$. Choose the correct option

A. the vertical component of velocity first decreases to zero and then increases

B. the ball reaches the ground after $6s$

C. if the ball strikes the ground at maximum horizontal distance from the tower for this the angle of projection should be less than 45°

D. all option are correct

Answer: D

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46. Two balls are thrown horizontally from the top of a tower with velocities v_1 and v_2 in opposite directions at the same time. After how much time the angle between velocities of balls becomes 90° ?

A. $\frac{2\sqrt{v_1 v_2}}{g}$

B. $\frac{\sqrt{v_1 v_2}}{g}$

C. $\frac{\sqrt{v_1 v_2}}{2g}$

D. $\frac{g}{\sqrt{v_1 v_2}}$

Answer: B

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47. In the previous problem, the distance between the balls when their velocity vectors are perpendicular is

A. $\frac{2(v+v_2)\sqrt{v_1v_2}}{g}$

B. $\frac{v_1+v_2\sqrt{v_1v_2}}{g}$

C. $\frac{v_1+v_2\sqrt{v_1v_2}}{g}$

D. $\frac{v_1+v_2\sqrt{v_1v_2}}{2g}$

Answer: C

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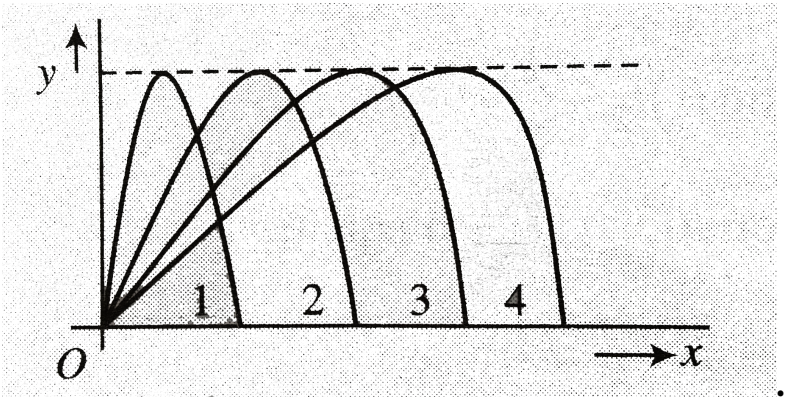
48. Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to the initial horizontal velocity component, highest first.



A. $1, 2, 3, 4$

B. $2, 3, 4, 1$

C. $3, 4, 1, 2$

D. $4, 3, 2, 1$

Answer: A

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49. A projectile is projected and it takes $9s$ to reach in the horizontal plane through the point of projection. In its path it passes a

point P after $4s$. The height of P above the horizontal plane is

A. $10m$

B. $50m$

C. $100m$

D. $200m$

Answer: C

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50. A projectile is projected with a speed u at an angle θ with the horizontal. What is the speed when its direction of motion makes an angle $\theta/2$ with the horizontal

A. $\frac{u\cos\theta}{2}$

B. $u\cos\theta$

C. $u\left(2\frac{\cos(\theta)}{2}-\frac{\sec(\theta)}{2}\right)$

D. $u\left(\frac{\cos(\theta)}{2}-\frac{\sec(\theta)}{2}\right)$

Answer: C

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51. Choose the correct option

Two seconds after the projection, a projectile is moving at 30° above the horizontal, after one more second it moves horizontally $(g = 10m/s^2)$.

A. the magnitude of the initial velocity is $20\sqrt{3}m/s$

B. the angle of projection is 60°

C. the maximum height attained by the projectile is $45m$

D. the horizontal range is $60m$

Answer: D

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52. A hose lying on the ground shoots a stream of water at an angle 30° to the horizontal. The speed of water is $20m/s$ as it

leaves the hose. How high will it strike a wall $8\sqrt{3}m$ away from the hose $\left(g = 10m / s^2\right)$

A. $4m$

B. $4.8m$

C. $9.6m$

D. $2.4m$

Answer: B

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53. A particle I projected at an angle of elevation α after time t it makes an angle β with horizontal. The velocity of projection is

A. $\frac{2gt\cos\beta}{\sin(\alpha-\beta)}$

B. $\frac{gt\cos\beta}{\sin(\alpha-\beta)}$

C. $\frac{gt}{2\sin(\alpha-\beta)}$

D. $\frac{4gt}{\sin(\alpha-\beta)}$

Answer: B

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54. A particle is thrown with a speed u at an angle θ with horizontal. After how much time the velocity of particle will be perpendicular to the initial motion of direction

A. $\frac{u}{g\cos\theta}$

B. $\frac{u}{g\sin\theta}$

C. $\frac{u\sin\theta}{g}$

D. $\frac{u\cos\theta}{g}$

Answer: B

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55. The equation of trajectory of an oblique projectile $y = \sqrt{3}x - \frac{gx^2}{2}$. The angle of projection is

A. 30°

B. 45°

C. 60°

D. 15°

Answer: C

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56. An object is projected with a velocity of $10m/s$ at an angle 45° with horizontal. The equation of trajectory followed by the projectile is $y = ax - \beta x^2$, the ratio α/β is

A. 5

B. 10

C. 15

D. 20

Answer: B

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57. 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. Yes, 60°

B. Yes, 30°

C. No

D. Yes, 45°

Answer: A

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58. A particle starts from the origin of coordinates at time t = 0 and moves in the xy plane with a constant acceleration α in the y-

direction. Its equation of motion is $y = \beta x^2$.

Its velocity component in the x-direction is

A. $\sqrt{\frac{\alpha}{\beta}}$

B. $\sqrt{\frac{\beta}{\alpha}}$

C. $\sqrt{\frac{\alpha}{2\beta}}$

D. $\sqrt{\frac{\beta}{2\alpha}}$

Answer: D

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59. A particle moves in a plane with constant acceleration in a direction different from the initial velocity. The path of the particle will be

A. A straight will be

B. An arc of a circle

C. A parabola

D. An ellipse

Answer: C

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60. A boy throws a ball vertically upwards froma moving open car on a horizontal straight road

(i) The ball will fall behind the boy, if car is accelerating

(ii) The ball will fall in front of the boy, if car is decelerating

(iii) The ball will fall in the hands of boy if car is moving with uniform velocity

(iv) The path of ball as seen by the boy will be vertical straight line if car is moning uniformly

(v) The path of ball as seen by observer on ground will be parabola

A. (i), (ii), (iii)

B. (ii), (iii), (iv)

C. (i), (ii), (iv)

D. All option are correct

Answer: D

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61. Two particles are projected simultaneously in the same vertical plane, from the with speed u_1 and u_2 at angle of projection θ_1 and θ_2 respectively with the horizontal. The path followed by one, as seen by other (as long as both are in flight), is

A. an inclined straight line

B. a vertical straight line if

$$u_1 \cos\theta_1 = u_{\cos\theta} \_ (2)$$

C. both (1), (2)

D. none

Answer: C

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62. A person is standing on an open car moving with a constant velocity of $30m/s$ on a striaght upward direction and it returns to person after the car has moved $240m$. The speed and the angle of projection

A. as seen from the car is $40m/s, 90^\circ$

B. as seen from the road is $50m/s$,

$\tan^{-1}(4/3)$

C. both (1) and (2)

D. none

Answer: C

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63. In the previous problem if the car is moving with a constant acceleration of $2m/s^2$

, the ball will fall behind the person at a distance

A. $32m$

B. $64m$

C. $96m$

D. $16m$

Answer: B

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64. A ball is projected at an angle 45° with horizontal. It passes through a wall of height h at horizontal distance d_1 from the point of projection and strikes the ground at a horizontal distance $(d_1 + d_2)$ from the point of projection, then

A. $h = \dfrac{2d_d\ _{-}\ (2)}{d_{+}d_2}$

B. $h = \dfrac{d_1 d_2}{d_1 + d_2}$

C. $h = \dfrac{\sqrt{2}d_1 d_2}{d_1 + d_2}$

D. $h = \dfrac{d_1 d_2}{2(d_1 + d_2)}$

Answer: B

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65. A ball is thrown from the ground so as to just clear a wall $10m$ high at a distance of $20m$ and falls at a distance of $40m$ from the wall. The magnitude and direction of the projection velocity is

A. $10m/s, 30^\circ$

B. $25m/s, 60^\circ$

C. $25m/s, \tan^{-1}(3/4)$

D. $10m/s, \tan^{-1}(3/4)$

Answer: C

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66. Two balls are thrown with the same speed from a point O at the same time so that their horizontal ranges are same. If the difference of the maximum height attained by them is equal

to half of the sum of the maximum heights, then the angles of projection for the balls are

A. $15^\circ, 75^\circ$

B. $30^\circ, 60^\circ$

C. $0^\circ, 90^\circ$

D. $37^\circ, 53^\circ$

Answer: B

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67. In ain oblique projectile motion if the velocity of projection is increased by 2%, the percentage increase in horizontal range will be

A. 1%

B. 2%

C. 3%

D. 4%

Answer: D

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68. A particle has an initial velocity $\left(2\hat{i}+3\hat{j}\right)$ and an accelaration $\left(0.3\hat{i}+0.2\hat{j}\right)$. The magnitude of velocity after $10s$ will be

A. $9\sqrt{2}units$

B. $5\sqrt{units}$

C. $5units$

D. $9units$

Answer: B

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69. a projectile is fired from the surface of the earth with a velocity of $5ms^{-1}$ and angle θ with the horizontal. Another projectile fired from another planet with a velocity of $3ms^{-1}$ 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 $\left(g = 9.8ms^{-2}\right)$

A. 5.9

B. 16.3

C. 110.8

D. 3.5

Answer: D

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