KINEMATICS

- The study of motion of objects without any reference to the cause of motion is called kinematics.
- The actual path length traversed by a body is called the distance travelled.
- The shortest distance between the initial and final positions of a body is called displacement.
- Displacement of a body may be zero, or positive or negative but distance travelled is always positive. Only when displacement is treated as a scalar
- The speed of a body is the rate at which it describes its path.
- The rate of change of displacement is called velocity.
- Average speed = total distance / total time
- Average velocity = net displacement / total time

LINEAR MOTION :

- a) Average velocity =

$$v = \frac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3} = \frac{v_1 t_1 + v_2 t_2 + v_3 t_3}{t_1 + t_2 + t_3}$$

b) If a body travels with a velocity v_1 for the first half of the journey time and with a velocity v_2 for the second half of the journey time, then the average velocity $v = \frac{v_1 + v_2}{2}$

c) If a body covers first half of its journey with uniform velocity v_1 and the second half of the journey with uniform velocity v_2, then the average velocity $v = \frac{2v_1 v_2}{v_1 + v_2}$

d) If a body travels first $\frac{1}{3}rd$ of the distance with a speed v_1, and second $\frac{1}{3}rd$ of the distance with a speed v_2 and the last $\frac{1}{3}rd$ of the distance with a speed v_3 then the average speed is

$$v = \frac{3v_1 v_2 v_3}{v_1 v_2 + v_2 v_3 + v_3 v_1}$$

- The rate of change of velocity is called acceleration.
- Equations of motion for a body moving with uniform acceleration.

a) $v = u + at$ b) $s = ut + \frac{1}{2}at^2$

c) $v^2 - u^2 = 2as$ d) $s_n = u + \frac{a}{2}(2n-1)$

e) $s = \left(\frac{u+v}{2}\right)t$

- When the body starts from rest $(u = 0)$ and moves with uniform acceleration 'a', then

a) $v = at \Rightarrow v \alpha t$

b) $s = \frac{1}{2}at^2 \Rightarrow s \alpha t^2$ (or) $t \alpha \sqrt{s}$

c) $v^2 = 2as \Rightarrow v^2 \alpha s \Rightarrow v \alpha \sqrt{s}$

d) $s_n = \frac{a}{2}(2n-1) \Rightarrow s_n \alpha\ (2n-1)$

- Ratio of displacements in the 1^{st}s, 2^{nd}s, 3^{rd} s... n^{th} s = 1:3:5:....:(2n-1)
- Ratio of displacements in the first 1s, first 2s, first 3s .... etc.... is 1:4:9:.... etc.
- Moving with uniform acceleration from rest, a body attains a velocity 'v' after a displacement 'x', then its velocity becomes 'nv' after a further displacement $(n^2-1)x$.
- Moving with uniform acceleration, a body crosses a point 'x' with a velocity 'u' and another point 'y' with a velocity 'v'. Then it will cross the mid point of 'x' and 'y' with velocity of $\sqrt{\frac{v^2 + u^2}{2}}$.
- If a bullet looses $(1/n)^{th}$ of its velocity while passing through a plank, then the no. of such planks required to just stop the bullet is $\frac{n^2}{2n-1}$.
- The velocity of a body becomes $\left(\frac{1}{n}\right)^{th}$ of its initial velocity after a displacement of 'x', then it will come to rest after a further displacement of $\frac{x}{n^2-1}$.
- A body is describing uniform circular motion with a speed 'v'. When it describes an angle 'θ' at the center then the change in velocity is $\Delta v = 2v\sin(\theta/2)$
- If the displacement of a body is proportional to the square of time, then its initial velocity is zero.
- Starting from rest a body travels with an acceleration 'α' for some time and then with

deceleration 'β' and finally comes to rest. If the total time of journey is 't', then the maximum velocity and displacement and average velocity are respectivelly

i) $v_{max} = \frac{\alpha\beta t}{\alpha+\beta}$, ii) $s = \frac{\alpha\beta t^2}{2(\alpha+\beta)}$

iii) average velocity $= \left(\frac{v_{max}}{2}\right)$

- If a particle starts from rest and moves with uniform accelaration 'a' such that it travels distances s_m and s_n in the m^{th} and n^{th} seconds then $a = \frac{s_m - s_n}{(m-n)}$
- A particle starts from rest and moves along a straight line with uniform accelaration. If s is the distance travelled by it n seconds and s_n is the distance travelled in the n^{th} second, then $\frac{s_n}{s} = \frac{(2n-1)}{n^2}$

MOTION UNDER GRAVITY

Body projected vertically downwards and a freely falling body :

- When a body is projected vertically down then a=g; s = h,

a) $v = u + gt$ b) $h = ut + \frac{1}{2}gt^2$

c) $v^2 - u^2 = 2gh$ d) $S_n = u + \frac{g}{2}(2n-1)$

- When a body is dropped freely, then u=0; a=g; and s=h

a) $v = gt \Rightarrow v \alpha t$

b) $h = \frac{1}{2}gt^2 \Rightarrow h \alpha t^2$, also $t = \sqrt{\frac{2h}{g}} \Rightarrow t \alpha h^{1/2}$

c) $v^2 = 2gh \Rightarrow v = \sqrt{2gh} \Rightarrow v \alpha h^{1/2}$

d) $h_n = \frac{g}{2}(2n-1) \Rightarrow h_n \alpha (2n-1)$

e) Acceleration due to gravity is same for all bodies in vacuum.

- All the above results that are true for a body falling freely under gravity, are also true for a body starting from rest and moving with uniform acceleration.
- In the presence of air resistance, the acceleration of a denser body is greater.
- The acceleration of a body in a medium is $g^1 = g\left(1 - \frac{d_m}{d_b}\right)$. this takes into account only buoyancy force

where d_m = density of the medium

d_b = density of the body

- If $d_m = d_b$; $g^1 = 0$. In this case it will remain at rest or in uniform motion.
- A freely falling body passes through two points A and B in time intervals of t_1 and t_2 from the start, then the distance between the two points A and B is $= \frac{g}{2}\left(t_2^2 - t_1^2\right)$
- A freely falling body passes through two points A and B distant h_1 and h_2 from the start, then the time taken by it to move from A to B is

$$T = \sqrt{\frac{2h_2}{g}} - \sqrt{\frac{2h_1}{g}} = \sqrt{\frac{2}{g}}\left(\sqrt{h_2} - \sqrt{h_1}\right)$$

- Two bodies are dropped from heights h_1 and h_2 simultaneously. Then after any time the distance between them is equal to $(h_2 \sim h_1)$.
- A stone is dropped into a well of depth 'h', then the sound of splash is heard after a time of 't'

$$t = \sqrt{\frac{2h}{g}} + \frac{h}{v_{sound}}$$

- A stone is dropped into a river from the bridge and after 'x' seconds another stone is projected down into the river from the same point with a velocity of 'u'. If both the stones reach the water simultaneously, then $S_{1(t)} = S_{2(t-x)}$

$$\frac{1}{2}gt^2 = u(t-x) + \frac{1}{2}g(t-x)^2$$

Body Projected Vertically up

- Acceleration (a) = -g

a) $v = u - gt$ b) $s = ut - \frac{1}{2}gt^2$

c) $v^2 - u^2 = -2gh$ d) $s_n = u - \frac{g}{2}(2n-1)$

- Angle between velocity vector and acceleration vector is 180^0 until the body reaches the highest point.
- At maximum height, v = 0 and a = g
- $H_{max} = \frac{u^2}{2g} \Rightarrow H_{max} \propto u^2$ (independent of mass of the body)

$$\Rightarrow \frac{H_1}{H_2} = \frac{u_1^2}{u_2^2} = \left(\frac{u_1}{u_2}\right)^2$$

- $t_a = t_d = \frac{u}{g} \Rightarrow T = t_a + t_d = \frac{2u}{g}$ (or)$T \propto u$
- In the absence of air resistance, time of ascent and time of descent are equal.
- In the presence of air resistance, the time of ascent is less than the time of descent.
- At any point of the journey, a body possesses the same speed while moving up and while moving down.
- The height reached in the first second of ascent is equal to the height of fall in the last second of descent.
- Irrespective of velocity of projection, all the bodies pass through a height $\frac{g}{2}$ in the last second of ascent.
- The change in velocity over the complete journey is '2u' (downwards)
- If a vertically projected body rises through a height 'h' in n^{th} s, then in $(n-1)^{th}$ s it will rise through a height (h+g) and in $(n+1)^{th}$s it will rise through height (h-g).
- A body is dropped from the top edge of a tower of height 'h' and at the same time another body is projected vertically up from the foot of the tower with a velocity 'u'.

  a) The separation between them after 't' seconds is = $(h - ut)$

  b) The time after which they meet $t = \frac{h}{u}$

  c) The height at which they meet above the ground = $\left(h - \frac{gh^2}{2u^2}\right)$

  d) The time after which their velocities are equal in magnitudes is $t = \frac{u}{2g}$

  e) If they meet at mid point, velocity of thrown body is $u = gt$ and its velocity of meeting is zero
- A body projected vertically up crosses a point P at a height 'h' above the ground at time 't_1' seconds and at time t_2 seconds to same point while coming down. Then total time of its flight $T = t_1 + t_2$

  a) Height of P is $h = \frac{1}{2} g t_1 t_2$

  b) Maximum height reached above the ground $H = \frac{1}{8} g (t_1 + t_2)$

  c) Magnitude of velocity while crossing P is $\frac{g(t_2 - t_1)}{2}$
- A body is projected vertically up with velocity u_1 and after 't' seconds another body is projected vertically up with a velocity u_2.

  a) If $u_2 > u_1$, the time after which both the bodies will meet with each other is $\frac{u_2 t + \frac{1}{2} g t^2}{(u_2 - u_1) + gt}$ for the first body.

  b) In this case if $u_1 = u_2 = u$ ie the two bodies are projected with same velocity, the time after which they meet is $\left(\frac{u}{g} + \frac{1}{2}\right)$ for the first body and $\left(\frac{u}{g} - \frac{1}{2}\right)$ for the second body.
- A rocket moves up with a resultant acceleration a. If its fuel exhausts completely after time 't' seconds, the maximum height reached by the rocket above the ground is $h = \frac{1}{2} a t^2 \left(1 + \frac{a}{g}\right)$

Body Projected Vertically up from a Tower :

- A body projected vertically up from a tower of height 'h' with a velocity 'u' (or) a body dropped from a rising balloon (or) a body dropped from an helicopter rising up vertically with constant velocity 'u' reaches the ground exactly below the point of projection after a time 't'. Then

  (a) Height of the tower is $h = -ut + \frac{1}{2} g t^2$

  (b) Time taken by the body to reach the ground $t = \frac{u + \sqrt{u^2 + 2gh}}{g}$

(c) The velocity of the body at the foot of the tower $v = \sqrt{u^2 + 2gh}$

(d) Velocity of the body after 't' sec. is $v = u - gt$

- The height of the balloon by the time the body reaches the ground is $\frac{1}{2}gt^2$.
- A body projected vertically down from a tower with a velocity 'u' reaches the foot of the tower after a time 't_1' with a velocity 'v_1'. Another body projected vertically up from the tower with same velocity reaches the foot of the tower after a time 't_2' with a velocity 'v_2'. A freely dropped body reaches the foot of the tower after a time 't' with a velocity 'v', then

(a) $t = \sqrt{t_1 t_2}$ (b) $h = \frac{1}{2}gt_1t_2$

(c) $u = \frac{1}{2}g(t_1 - t_2)$ (d) $v_1 = v_2 = \sqrt{u^2 + 2gh}$

(e) $v = \sqrt{2gh}$

PROJECTILES :

i) Oblique Projectile :

- Any body projected into air with some velocity at angle of 'θ' [$\theta \neq (90^0$ and $0^0)$] is called an oblique projectile.
- Horizontal component of velocity $u_x = u\text{Cos}\theta$, remains constant throughout the journey.
- Vertical component of velocity $u_y = u\text{Sin}\theta$, varies at the rate of 'g'.
- After a time 't'

(a) Horizontal component of velocity

$$v_x = u\text{Cos}\theta$$

(b) Vertical component of velocity

$$v_y = u_y - gt = u\text{Sin}\theta - gt$$

(c) Resultant velocity $v = \sqrt{v_x^2 + v_y^2}$

(d) Direction of velocity is given by

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

(e) Horizontal displacement during a time t

$$x = u_x t = (u\text{Cos}\theta)t$$

(f) Vertical displacement during a time t

$$y = u_y t - \frac{1}{2}gt^2 = (u\sin\theta)t - \frac{1}{2}gt^2$$

(g) Net displacement of the body $= \sqrt{x^2 + y^2}$

(h) Equation of a projectile

$$y = \tan\theta\, x - \frac{g}{2u^2\cos^2\theta}x^2 = Ax - Bx^2$$

(i) From the above equation

- $\theta = \tan^{-1}(A)$
- Range of the projectile $R = \frac{A}{B}$
- Maximum height $H = \frac{A^2}{4B}$
- Time of ascent = Time of descent $= \frac{u\sin\theta}{g}$
- Time of flight $T = t_a + t_d = \frac{2u\sin\theta}{g}$
- Maximum height $H = \frac{u^2\sin^2\theta}{2g}$

(a) At the maximum height, the vertical component of velocity becomes zero.

(b) The velocity of the projectile is minimum at the highest point and equal to ucosθ.

(c) Acceleration is equal to acceleration due to gravity 'g', and it always acts vertically downwards.

(d) The angle between minimum velocity and acceleration is 90^0.

- Horizantal range

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

(a) Range is maximum when $\theta = 45^0$

(b) Maximum range, $R_{Max} = \frac{u^2}{g}$

(c) When 'R' is maximum, $H_{Max} = \frac{R_{Max}}{4} = \frac{u^2}{4g}$

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

If $\theta = 45^0$ then $R = \frac{gT^2}{2} \Rightarrow T = \sqrt{\frac{2R}{g}}$

(e) When two bodies are projected with same initial velocity but at two different angles of projection

(i) θ and $(90-\theta)$ (or)

(ii) $(45-\theta)$ and $(45+\theta)$ (or)

(iii) θ with horizontal and θ with vertical

Then If T_1 and T_2 are the times of flight then

a) $\frac{T_1}{T_2} = \tan\theta$

b) $T_1 T_2 = \frac{2R}{g}$

- If H_1 and H_2 are maximum heights then

a) $\frac{H_1}{H_2} = \tan^2\theta$ b) $H_1 + H_2 = \frac{u^2}{2g}$

c) $R = 4\sqrt{H_1 H_2}$

- $4H = R\tan\theta$
- When $R = H$ then $\theta = \tan^{-1}(4) = 76^0$
- If a man throws a body to a maximum distance 'R' then he can project the body to vertical height R/2.
- If a man throws a body to a maximum distance 'R' then the greatest height attained by the body during flight is R/4.
- (a) The angle between velocity and acceleration during the rise of projectile is $180^0 < \theta < 90^0$
  (b) The angle between velocity and acceleration during the fall of projectile is $0^0 < \theta < 90^0$
- At the maximum height

(a) Kinetic energy $= \frac{1}{2} mu_x^2 = \frac{1}{2} mu^2 \cos^2\theta$

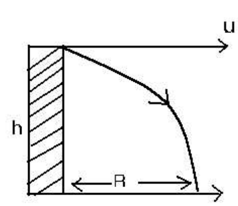
(b) Potential energy $= mgH_{max} = \frac{1}{2} mu^2 \sin^2\theta$

(c) Total energy = K.E. + P.E. $= \frac{1}{2} mu^2$

(d) If K.E. = P.E. then $\theta = 45^0$

HORIZONTAL PROJECTILE :

- When a body is projected horizontally with a velocity from a point above the ground level, it is called a *Horizantal Projectile*. When a stone is projected horizantally with a velocity 'u' from the top of a tower of height 'h' it describes a parabolic path as shown in *figure*.



a) Time of descent $t = \sqrt{\frac{2h}{g}}$ (independent of u)

b) The horinzontal displacement (or) range

$$R = u\sqrt{\frac{2h}{g}}$$

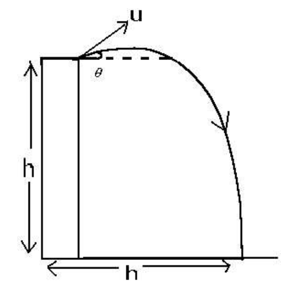
c) The velocity with which it hits the ground

$$V = \sqrt{u^2 + 2gh} = \sqrt{u^2 + g^2t^2}$$

d) The angle at which is strikes the ground

$$\theta = \tan^{-1}\left(\frac{gt}{u}\right) = \tan^{-1}\left(\frac{\sqrt{2gh}}{u}\right)$$

Case (i) : If the body is projected at angle θ upward direction from the top of the tower, then



a) $h = (-u\sin\theta)t + \frac{1}{2}gt^2$

b) $x = u\cos\theta \times t$

c) The velocity with which it strikes the ground

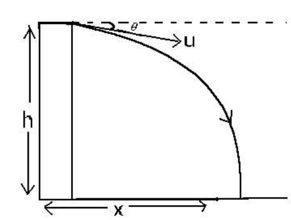
$$v = \sqrt{u^2 + 2gh}$$

d) The angle at which is strikes the ground

$$\alpha = \tan^{-1}\left[\frac{u\sin\theta + gt}{u\cos\theta}\right]$$

(or) $\alpha = \tan^{-1}\left[\frac{u^2\sin^2\theta + 2gh}{u\cos\theta}\right]$

Case (ii) : If the body is projected at angle θ from top of the tower in the downward direction, then



a) $h = u\sin\theta.\, t + \frac{1}{2}gt^2$

b) $x = u\cos\theta.t$

c) The velocity with which it strikes the ground

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

d) The angle at which it strikes the ground

$$\alpha = \tan^{-1}\left[\frac{\sqrt{u^2\sin^2\theta + 2gh}}{u\cos\theta}\right]$$

- Two bodies are projected horizantally from top of the tower of height h in opposite directions with velocity u_1 and u_2

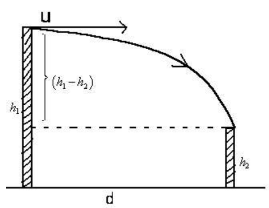
  a) The time after which their velocity vectors are perpendicular to each other $= \frac{\sqrt{u_1 u_2}}{g}$

  b) The distance between them when their velocity vectors are perpendicular to each other $x = (u_1 + u_2)\frac{\sqrt{u_1 u_2}}{g}$

  c) The time after which their position vectors are perpendicular to each other $= \frac{2\sqrt{u_1 u_2}}{g}$

  d) The distance between them when their displacement velocity perpendicular to each other is $x = (u_1 + u_2)\frac{2\sqrt{u_1 u_2}}{g}$.

- Two tall towers having heights h_1 and h_2 are separated by a distance d. A person throws a ball horizantally with velocity u from the top of the first tower to reach the top of the second tower then

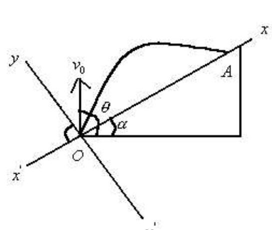


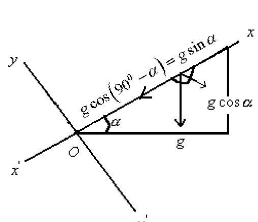
  a) Time taken $t = \sqrt{\frac{2(h_1 - h_2)}{g}}$

  b) Horizontal distance travelled $d = ut$

<u>Motion of a Body on an inclined plane</u> (Additional)

- A body is projected up the inclined plane from the point O with an inital velocity v_0 at an angle θ with horizontal.





a) Acceleration along $x - axis$ $a_x = -g\sin\alpha$

b) Acceleration along $y - axis$ $a_y = -g\cos\alpha$

c) Component of velocity along $x - axis$

$$u_x = v_0\cos(\theta - \alpha)$$

d) Component of velocity along $y - axis$

$$u_y = v_0\sin(\theta - \alpha)$$

e) Time of flight $T = \frac{2v_0\sin(\theta - \alpha)}{g\cos\alpha}$

f) Range of projectile

$$R = \frac{v_0^2}{g\cos^2\alpha}\left[\sin(2\theta - \alpha) - \sin\alpha\right].$$

For maximum range $(2\theta - \alpha) = \frac{\pi}{2}$

$$\therefore R_{max} = \frac{v_0(1 - \sin\alpha)}{g\cos^2\alpha}$$

g) $T^2 g = 2R_{max}$

<u>CONCEPTUAL QUESTIONS</u>

<u>Motion In Horizontal Plane :</u>

1. Correct statement among the following is
   1) When displacement is zero, distance travelled is not zero.
   2) When displacement is zero, distance travelled is also zero.
   3) When distance is zero, displacement is not zero.
   4) Distance travelled and displacement are always equal.
2. The numerical ratio of displacement to distance is
   1) Always less than 1. 2) Always greater than 1.
   3) Always equal to 1.
   4) May be less than 1 or equal to one.
3. If a particle moves in a circle describing equal angles in equal intervals of time, the velocity vector
   1) remains constant. 2) changes in magnitude.
   3) changes in direction.
   4) changes both in magnitude and direction.
4. Among the following, the one which moves with non-uniform velocity is
   1) Light in a homogeneous medium.
   2) Sound in a homogeneous medium.
   3) A freely falling body. 4) All the above.
5. A ball hangs from a string inside a rail road car moving along a straight track. The string is observed to be inclined towards the rear end of the car making a constant small angle with the vertical. It shows that the car is

1) moving with uniform acceleration.
2) moving with uniform velocity.
3) moving with uniform retardation.
4) moving with an acceleration which is increasing uniformly.

6. The distance covered by a moving body is directly proportional to the square of the time. The acceleration of the body is
1) increasing 2) decreasing
3) zero 4) constant

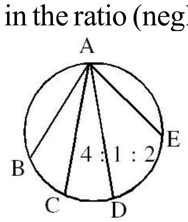
7. Choose the correct statement :
1) The area of displacement - time graph gives velocity.
2) The slope of velocity - time graph gives acceleration.
3) The slope of displacement - time graph gives acceleration.
4) The area of velocity - time graph gives average velocity.

8. A person sitting in a train moving with uniform velocity tossed a coin vertically up. The coin will fall.
1) back into the hands of the person,
2) behind the person. 3) before the person.
4) by the side of the person.

Motion Under Gravity :

9. Velocity-time graph of a body thrown vertically up is
1) a straight line 2) a parabola
3) a hyperbola 4) circle

10. A disc arranged in a vertical plane has several grooves directed along chords drawn from a point 'A' as shown in the figure. Several bodies begin to slide down the respective grooves from 'A' simultaneously. The ratio of their times of slide will be in the ratio (neglect friction and air resistance)



1) AB : AC : AD : AE 2) 1 : 1 : 1 : 1
3) AE : AD : AC : AB 4) 1:2:3:4

11. A ball dropped from one metre above the top of a window crosses the window in 't_1' second. If the same ball is dropped from 2m above the top of the same window, time taken by it to cross the window is 't_2's. Then
1) $t_2 = t_1$ 2) $t_2 = 2t_1$ 3) $t_2 > t_1$ 4) $t_2 < t_1$

12. To reach the same height on the moon as on the earth, a body must be projected up with
1) Higher velocity on the moon.
2) Lower velocity on the moon.
3) Same velocity on the moon and earth.
4) It depends on the mass of the body.

13. A body is projected up with velocity 'u'. It reaches a point in its path at t_1 and t_2 from the time of projection. Then t_1+t_2 is
1) $\frac{2u}{g}$ 2) $\frac{u}{g}$ 3) $\sqrt{\frac{2u}{g}}$ 4) $\sqrt{\frac{u}{g}}$

14. At the maximum height of a body thrown vertically up
1) Velocity is not zero but acceleration is zero.
2) Acceleration is not zero but velocity is zero.
3) Both acceleration and velocity is zero.
4) Both acceleration and velocity are not zero.

15. A ball is dropped freely while another is thrown vertically downward with an initial velocity 'v' from the same point simultaneously. After 't' second they are separated by a distance of
1) $\frac{vt}{2}$ 2) $\frac{1}{2}gt^2$ 3) vt 4) $vt+\frac{1}{2}gt^2$

16. The average velocity of a freely falling body is numerically equal to half of the acceleration due to gravity. The velocity of the body as it reaches the ground is
1) g 2) $\frac{g}{2}$ 3) $\frac{g}{\sqrt{2}}$ 4) $\sqrt{2}g$

17. Two bodies of different masses are dropped simultaneously from the top of a tower. If air resistance is proportional to the mass of the body, then,
1) the heavier body reaches the ground earlier.
2) the lighter body reaches the ground earlier.
3) both the bodies reach the ground simultaneously.
4) cannot be decided.

18. In the case of a body falling freely from small height
1) the changes of position are equal in equal intervals of time.
2) the changes of velocity are equal in unequal intervals of time.
3) the changes of acceleration is zero in unequal intervals of time.
4) All the above are true.

19. Velocity - displacement graph of a freely falling body is
1) Straight line passing through the origin
2) Straight line interesting 'x' and 'y' axes
3) Parabola 4) Hyperbola

20. Displacement - time graph of a body projected vertically up is
1) a straight line 2) a parabola
3) a hyperbola 4) a circle

21. Two balls of different masses are thrown vertically upwards with the same speed. They pass through the point of projection in their downward motion, with the
1) heavier ball having more speed
2) lighter ball having more speed
3) both having same speed
4) both having different speeds

22. A man standing in a lift falling under gravity releases a ball from his hand. As seen by him, the ball
1) falls down 2) remains stationary
3) goes up 4) executes SHM

23. If the acceleration due to gravity is gms^{-2}, a sphere of lead of density $\delta kg/m^3$ is gently released in a column of liquid of density 'd' kg/m^3 ($\delta > d$), the sphere will fall vertically with
1) an accleration of $8m/s^2$
2) no acceleration
3) an accleration of $g\left(1-\frac{d}{\delta}\right)m/s^2$
4) an acceleration $g\ \delta/d\ m/s^2$

Projectile Motion :

24. A passenger in a train drops a ball from the window of a train running at an acceleration 'a'. A pedestrian, on the ground by the side of the rails, observes the ball falling along
1) the vertical with an acceleration $\sqrt{g^2+a^2}$
2) the vertical with an acceleration $\sqrt{g^2-a^2}$
3) a parabola with an acceleration $\sqrt{g^2+a^2}$
4) a parabola with an acceleration 'g'

25. For a body thrown horizontally from the top a tower
1) The time of flight depends both on 'h' and 'u'.
2) The horizontal distance depends only on 'u', but not on 'h'.
3) The time of flight and horizontal distance depend on 'h' but not 'u'.
4) The horizontal distance depends on 'u' and 'h'.

26. Velocity of a projectile in its flight
1) remains constant
2) first decreases, becomes zero and then increases.
3) first decreases reaches minimum and then increases.
4) First increases reaches maximum and then decreases.

27. The path of one projectile as seen from another projectile is a
1) straight line 2) parabola
3) hyperbola 4) circle

28. When atmospheric resistance is taken into account for the projectile, the time of flight compared to that without atmospheric resistance
1) increase 2) decrease
3) remains the same 4) data insufficient

29. From the top of a building a ball 'A' is dropped while another ball 'B' is thrown horizontally at the same time. Then
1) the ball 'A' hits the ground first
2) the ball 'B' hits the ground first
3) both A&B hit the ground at the same time
4) any ball may hit the ground first

30. A particle moves in a plane with a constant acceleration in a direction different from the initial velocity. The path of the particle is
1) Straight line 2) Arc of circle
3) Parabola 4) Ellipse

31. At the maximum height of a projectile, the velocity and acceleration are
1) parallel to each other
2) antiparallel to each other
3) perpendicular to each other
4) inclined to each other at 45^0

32. A projectile has
1) minimum velocity at the point of projection and maximum at the maximum height.
2) maximum at the point of projection and minimum at the maximum height.
3) same velocity at any point in its path.
4) zero velocity at the maximum height irrespective of the velocity of projection.

33. For a projectile, the physical quantity that remains constant is
1) Vertical component of velocity and kinetic energy.
2) Potential energy and kinetic energy.
3) Horizontal component of velocity and acceleration.
4) Potential energy and accleration.

34. A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant the bullet leaves the gun, the monkey drops. The bullet
1) cannot hit the monkey.
2) may hit the monkey if its weight is more than 30 kg. wt.
3)may hit the monkey if its weight is less than 30 kg. wt.
4) hits the monkey irrespective of its weight.

KEY

1) 1	2) 4	3) 3	4) 3	5) 1
6) 4	7) 2	8) 1	9) 1	10) 2
11) 4	12) 2	13) 1	14) 2	15) 3
16) 1	17) 1	18) 3	19) 3	20) 2
21) 3	22) 2	23) 3	24) 3	25) 4
26) 3	27) 1	28) 1	29) 3	30) 3
31) 3	32) 2	33) 3	34) 4	

LEVEL - I

1. A body is moving along the circumference of a circle of radius 'R' and completes half of the revolution. Then, the ratio of its displacement to distance is
1) π:2 2) 2:1 3) 2:π 4) 1:2

2. A particle experiences constant acceleration for 6s after starting from rest. If it travels a distance s_1 in the first 2s and a distance s_2 in the next 2s and a distance s_3 in the last 2s, then $s_1:s_2:s_3$ is
1) 1:1:1 2) 1:2:3 3) 1:3:5 4) 1:5:9

3. A body starting from rest with uniform acceleration travels distance s_1 in the first 't' second and travels a distance s_2 with uniform velocity in the next 2t second. Then
1) $s_2 = 4s_1$ 2) $s_2 = 2s_1$ 3) $s_1 = 4s_2$ 4) $s_1 = 2s_2$

4. Starting from rest a body travels 36m in the first 2 second of its journey. Distance it can travel in the 11^{th} second is
1) 72 m 2) 108 m 3) 144 m 4) 189 m

5. A bullet travelling horizontally loosess $1/20^{th}$ of its velocity while piercing a wooden plank. Number of such planks required to stop the bullet is
1) 6 2) 9 3) 11 4) 13

6. A body starting from rest and travelling with uniform acceleration has a velocity of 40 m/s after 10 second at A. Velocity of the body 4 second before it crosses the point 'A' is
1) 16 m/s 2) 20 m/s 3) 24 m/s 4) 32 m/s

7. A bullet fired into a fixed target looses half of its velocity in penetrating 15 cm. Before coming to rest, it can penetrate a further distance of
1) 5 cm 2) 15 cm 3) 7.5 cm 4) 10 cm

8. A body moves from one corner of an equilateral triangle of side 10 cm to the same corner along the sides. Then the distance and displacement are respectively
1) 30 cm & 10 cm 2) 30 cm & 0 cm
3) 0 cm & 30 cm 4) 30 cm & 30 cm

9. A body completes one round of a circle of radius 'R' in 20 second. The displacement of the body after 45 second is
1) $\frac{R}{\sqrt{2}}$ 2) $\sqrt{2}\,R$ 3) $2\sqrt{R}$ 4) 2R

10. For a body moving with uniform acceleration 'a', initial and final velocities in a time interval 't' are 'u' and 'v' respectively. Then, its average velocity in the time interval 't' is
1) $\left(v+\frac{at}{2}\right)$ 2) $\left(v-\frac{at}{2}\right)$
3) (v-at) 4) $\left(u+\frac{at}{2}\right)$

11. A body moves from A to B with a constant speed of 20 kmph and then from B to A with a constant speed of 30 kmph. Then the average speed of the car is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

12. A body moves with a speed of 20 kmph in the first 5s and with a speed of 30 kmph in the next 5s. Then, the average speed of the body is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

13. If a body moves half of the distance between two points with a speed of 10 kmph and remaining half with a constant speed of 15kmph, then the average speed of the body is
1) 12.5 kmph 2) 12 kmph
3) 0 kmph 4) 10 kmph

14. If the distance between the sun and the earth is 1.5×10^{11} m and velocity of light is 3×10^8 m/s, then the time taken by a light ray to reach the earth from the sun is
1) 500 s 2) 500 minute 3) 50 s 4) 5×10^3s

15. A body moves with constant speed 'v' along the circumference of a circle of radius 'r'. If it completes half of the revolution in 't's, then the magnitude of the average acceleration is
1) 0 2) $\frac{2v}{t}$ 3) $\frac{v}{t}$ 4) All the above

16. Velocity of a body moving with uniform acceleration of $3m/s^2$ is changed through 30m/s in certain time. Average velocity of body during this time is 30m/s. Distance covered by it during this time is
1) 300 m 2) 200 m 3) 400 m 4) 250 m

17. If a body travels 30m in an interval of 2s and 50m in the next interval of 2s, then the acceleration of the body is
1) 10 m/s^2 2) 5 m/s^2 3) 20 m/s^2 4) 25 m/s^2

18. Two motor cars starting off with a time gap of 2 minute, travel in the same direction with the same acceleration. Time taken by the second car since its departure to complete $(1/9)^{th}$ of the distance covered by the first car is
1) 1 s 2) 1 m 3) 2 s 4) 2 m

19. A body starts from rest and moves with an uniform acceleration. The ratio of distance covered in the n^{th} second to the distance covered in 'n' second is
1) $\left(\frac{2}{n}-\frac{1}{n^2}\right)$ 2) $\left(\frac{1}{n^2}-\frac{1}{n}\right)$
3) $\left(\frac{2}{n^2}-\frac{1}{n}\right)$ 4) $\frac{2}{n}+\frac{1}{n^2}$

Motion Under Gravity :

20. A body falls freely from rest. If the velocity acquired is numerically equal to the displacement, then the velocity acquired is
1) 9.8 m/s 2) 19.6 m/s
3) 29.4 m/s 4) 39.2 m/s

21. A body dropped from the top of a tower reaches the ground in 4s. Height of the tower is
1) 39.2 m 2) 44.1 m 3) 58.8 m 4) 78.4 m

22. A ball dropped freely takes 0.2s to cross the last 6m distance before hitting the ground. Total time of fall is $(g = 10\ m/s^2)$
1) 2.9 s 2) 3.1 s 3) 2.7 s 4) 0.2 s

23. Bodies are dropped from a height in successive intervals of half a second. The relative velocity of one with respect to the other is
1) g 2) g/2 3) $g^{1/2}$ 4) g^2

24. A body thrown vertically upwards reaches the highest point in 2s. Velocity of projection is
1) 9.8 m/s 2) 19.6 m/s
3) 29.4 m/s 4) 39.2 m/s

25. Two balls are projected simultaneously with the same velocity 'u' from the top of a tower, one vertically upwards and the other vertically downwards. Their respective times of the journeys are t_1 and t_2. At the time of reaching the ground, the ratio of their final velocities is
1) 1:1 2) 1:2 3) 2:3 4) 2:1

26. Two bodies are projected simultaneously with the same velocity of 19.6 m/s from the top of a tower, one vertically upwards and the other vertically downwards. As they reach the ground, the time gap is
1) 0 s 2) 2 s 3) 4 s 4) 6 s

27. The time taken by a vertically projected body before reaching the ground is
1) directly proportional to initial velocity.
2) directly proportional to square of initial velocity.
3) inversely proportional to square of initial velocity.
4) inversely proportional to initial velocity.

28. A body projected vertically upwards with a velocity of 19.6 m/s reaches a height of 19.8m on earth. If it is projected vertically up with the same velocity on moon, then the maximum height reached by it is
1) 19.18 m 2) 3.3 m
3) 9.9 m 4) 118.8 m

29. A body projected vertically up with a velocity of 10m/s reaches a height of 20m. If it is projected with a velocity of 20m/s, then the maximum height reached by the body is
1) 20 m 2) 10 m
3) 80 m 4) 40 m

30. A body projected up with a velocity 'u' reaches a height 'h'. To reach double the height, it must be projected up with a velocity of
1) 2u 2) u/2 3) $\sqrt{2}u$ 4) $\frac{u}{\sqrt{2}}$

31. A body is dropped from the top of a tower. Simultaneously, another body is projected vertically up. If they meet with equal velocity 'V', then initial velocity of the body projected upwards is
1) V 2) V/2 3) V/4 4) 2V

32. A body dropped from a height reaches the ground is 5s. The velocity with which it reaches the ground is
1) 0 m/s 2) 49 m/s 3) 29 m/s 4) 9.8 m/s

Projectile Motion :

33. If a body is thrown with a velocity of 19.6m/s making an angle of 30^0 with the horizontal, then the time of flight is
1) 1 s 2) 2 s 3) $2\sqrt{3}$ s 4) 5 s

34. If a body is projected with a velocity of 9.8 m/s making an angle of 45^0 with the horizontal, then the range of the projectile is
1) 39.2 s 2) 9.8 s 3) 4.9 s 4) 19.6 s

35. The angle of projection to have maximum height and range in the ratio 1:4 is
1) 30^0 2) 45^0 3) 60^0 4) 75^0

36. A body projected horizontally with a velocity 'v' from a height 'h' has a range 'R'. With what velocity a body is to be projected horizontally from a height h/2 to have the same range ?
1) $\sqrt{2}$ v 2) 2v 3) 6v 4) 8v

37. A body projected at an angle 45^0 reaches the top of a wall of height 10m located at a distance of 20m from the point of projection. Initial velocity of the projectile is $(g = 10\ m/s^2)$
1) 10 m/s 2) 20 m/s 3) 30 m/s 4) 25 m/s

38. If a body is projected with a velocity 'u' making an angle of 30^0 with the horizontal and another with the same velocity making an angle of 60^0 with the horizontal, then maximum heights reached are in the ratio
1) 3:1 2) 1:2 3) 1:3 4) 2:1

39. Two particles are projected with the same velocity but at angles of projection $(45^0-\theta)$ and $(45^0+\theta)$ to have maximum range. Then their horizontal ranges are in the ratio of
1) 1:2 2) 2:1 3) 1:1 4) 1:4

40. A projectile can have the same range 'R' for two angles of projection. If t_1 and t_2 be the times of flight in the two cases then,
1) $t_1 \alpha R^2$ 2) $t_1 t_2 \alpha R$
3) $t_1 t_2 \alpha \frac{1}{R}$ 4) $t_1 t_2 \alpha \frac{1}{R^2}$

41. Two bodies are thrown from the same point with the same velocity of $50ms^{-1}$. If their angles of projection are complimentary to each other and the difference of maximum heights is 30m, the maximum heights are ($g=10\ m/s^2$)
1) 50 m & 80 m 2) 47.5 m & 77.5 m
3) 30 m & 60 m 4) 25 m & 55 m

42. Keeping the velocity of projection constant, the angle of projection is increased from 0^0 to 90^0, then the horizontal range of the projectile
1) goes on increasing upto 90^0
2) decreases upto 90^0
3) increases upto 45^0 and decreases afterwards
4) decreases upto 45^0 and increases afterwards

43. A particle is projected with an initial velocity of 200 m/s in a direction making an angle of 30^0 with the vertical. The horizontal distance covered by the particle in 3s is
1) 300 m 2) 150 m 3) 175 m 4) 125 m

44. A ball is projected from the ground with a velocity 'u' such that its range is maximum
1) Its velocity at half the maximum height is $\frac{\sqrt{3}}{2}u$
2) Its velocity at the maximum height is 'u'.
3) Change in its velocity when it returns to the ground is 'u'.
4) all the above are true.

45. Displacement of a particle is proportional to the cube of time. Then, magnitude of its acceleration
1) increases with time 2) decreases with time
3) constant but not zero 4) zero

46. Trajectory of a projectile is $(y=Ax-Bx^2)$. Its horizontal range is
1) AB 2) A/B 3) B/A 4) A^2+B^2

47. A boy throws a ball with a velocity of $20ms^{-1}$ such that its horizontal range is maximum. If $g = 10m/s^2$, range of the ball is
1) 20 m 2) 25 m 3) 30 m 4) 40 m

48. A base ball player can throw a ball to a maximum distance of 60m. Then he can throw it vertically to a maximum height of
1) 10 m 2) 30 m 3) 60 m 4) 100 m

49. A bullet is fired with a velocity of $196ms^{-1}$ at an angle of 30^0 with the horizontal. Time of flight of the bullet is
1) 10 s 2) 20 s 3) 30 s 4) 40 s

50. A ball thrown with a velocity of 49 m/s got the maximum range measured in the atmosphere as 225m. The decrease in range due to atmosphere is
1) 0 m 2) 245 m 3) 225 m 4) 20 m

51. A bomb at rest is exploded and the pieces are scattered in all directions with a maximum velocity of $20ms^{-1}$. Dangerous distance from that spot is ($g = 10\ m/s^2$)
1) 10 m 2) 20 m 3) 30 m 4) 40 m

52. A ball is projected, with a K.E. = E at an angle 'θ' with the horizontal. At the highest point of parabola, KE is
1) E Cosθ 2) E Cos$^2\theta$
3) E Sinθ 4) E Sin$^2\theta$

53. If K.E. = P.E. at the highest point of parabolic path, angle of projection is
1) 30^0 2) 45^0 3) 60^0 4) 70^0

54. A bomb is dropped from an aeroplane flying horizontally with a velocity of 720 kmph at an altitude of 980m. Time taken by the bomb to hit the ground is
1) 1 s 2) 7.2 s 3) 14.14 s 4) 0.15 s

55. A gun with a muzzle velocity of 500 m/s shoots a bullet at a bird 50m away. To hit the bird, the gun should be aimed ($g = 10\ m/s^2$)
1) directly towards the bird along the line joining the gun and bird.
2) 10 cm high above the bird.
3) 5 cm high above the bird
4) 5 cm below the bird

56. In between two hills of heights 100m and 92m, there is a valley of breadth 16m. If a vehicle jumps from the first hill to the second one, the minimum velocity of the vehicle is (assume $g = 9\ m/s^2$)
1) 16 m/s 2) 12 m/s 3) 9 m/s 4) 10 m/s

57. A skier starts from rest down an incline with uniform acceleration and attains a speed of 2.7 m/s in 3s. Its acceleration is
1) 9.8 m/s^2 2) 4.9 m/s^2
3) 0.9m/s^2 4) 1.9 m/s^2

58. A body is sliding down a smooth inclined plane which makes 30^0 with the horizontal. Acceleration of the body is
1) 9.8 m/s^2 2) 4.9 m/s^2
3) 2.45 m/s^2 4) 0 m/s^2

KEY

1) 3	2) 3	3) 1	4) 4	5) 3
6) 3	7) 1	8) 2	9) 2	10) 4
11) 2	12) 1	13) 2	14) 1	15) 2
16) 1	17) 2	18) 2	19) 1	20) 2
21) 4	22) 2	23) 2	24) 2	25) 1
26) 3	27) 1	28) 4	29) 3	30) 3
31) 4	32) 2	33) 2	34) 2	35) 2
36) 1	37) 2	38) 3	39) 3	40) 2
41) 2	42) 3	43) 1	44) 1	45) 1
46) 2	47) 4	48) 2	49) 2	50) 4
51) 4	52) 2	53) 2	54) 3	55) 3
56) 2	57) 3	58) 2		

HINTS

1. $2R : \pi R$ (or) $2 : \pi$
2. $S_1 : S_2 : S_3 = 1:3:5$
3. $S_1 = \frac{1}{2}at^2$ & $S_2 = v(2t)$
4. $S_n = u + a\left(n - \frac{1}{2}\right)$
5. no. of planks $= \frac{n^2}{2n-1}$
6. $V = u+at$
7. $v^2 - u^2 = 2as$
9. $S = \sqrt{R^2 + R^2} = \sqrt{2}R$
10. $V_{avg} = \frac{u+v}{2}$
11. $V_{avg} = \frac{2v_1v_2}{v_1 + v_2}$
12. $V_{avg} = \frac{v_1t_1 + v_2t_2}{t_1 + t_2}$
13. $V_{avg} = \frac{2v_1v_2}{v_1 + v_2}$
14. $S = vt$
15. $a = \frac{v-u}{t}$
16. v-u = 30 and v+u = 60
17. $s = ut + \frac{1}{2}at^2$
18. $s_1 = \frac{1}{2}at^2, s_2 = \frac{1}{2}a(t-2)^2$ and $s_2 = \frac{s_1}{9}$
19. $v = \frac{ds}{dt}$ and $a = \frac{d^2s_1}{dt^2}$
20. $s = \frac{1}{2}an^2; s_n = a\left(n - \frac{1}{2}\right)$
21. $\sqrt{2gh} = h, v = h$
22. $h = \frac{1}{2}gt^2$
23. $s = ut + \frac{1}{2}at^2$ and $v^2 - u^2 = 2as$
24. $v_1 - v_2 = gt$
25. $t_a = \frac{u}{g}$
27. $T = \frac{2u}{g}$
28. $h\alpha\frac{1}{g}$
29. $h\alpha u^2$
31. $t = \frac{h}{u}$ and $v = u + at$
32. $v = gt$
33. $T = \frac{2u\sin\theta}{g}$
34. $R_{max} = \frac{u^2}{g}$
35. $R = 4h\cot\theta$
36. $R = u\sqrt{\frac{2h}{g}}$
37. $y = (\tan\theta)x - \left(\frac{g}{2u^2\cos^2\theta}\right)x^2$
38. $H_{max} = \frac{u^2\sin^2\theta}{2g}$

40. $T = \frac{2u\sin\theta}{g}$

41. $h_1 + h_2 = \frac{u^2}{2g} h_1 - h_2 = 50$

43. $x = (u\cos\theta)t$

44. $v = \sqrt{v_x^2 + u_y^2}$

45. $x\alpha t^3, \frac{d^2x}{dt^2}\alpha 6t$

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

48. $R = 2h$

49. $T = \frac{2u\sin\theta}{g}$

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

51. $d = R_{max} = \frac{u^2}{g}$

52. $K.E. = \frac{1}{2}mu^2\cos^2\theta$

54. $t = \sqrt{\frac{2h}{g}}$

56. $R = u\sqrt{\frac{2h}{g}}$

57. $S = \frac{1}{2}at^2$

58. $a = g\sin\theta$

LEVEL - II

MOTION IN HORIZONTAL PLANE

1. A body moves with a velocity of 3m/s due east and then turns due north to travel with the same velocity. If the total time of travel is 6s, the acceleration of the body is
   1) $\sqrt{3}$ m/s^2 towards north west
   2) $\frac{1}{\sqrt{2}}$ m/s^2 towards north west
   3) $\sqrt{2}$ m/s^2 towards north east
   4) all the above

2. Distance travelled by a body is given by 2S=(10t+5t^2)m. The acceleration of the body is
   1) 2.5 m/s^2 2) 5 m/s^2
   3) 10 m/s^2 4) 0.5 m/s^2

3. A body starting with a velocity 'v' returns to its initial position after 't' second with the same speed, along the same line. Acceleration of the particle is
   1) $\frac{-2v}{t}$ 2) $\frac{2v}{t}$ 3) $\frac{v}{2t}$ 4) $\frac{t}{2v}$

4. Two cars are travelling towards each other on a straight road at velocities 15 m/s and 16 m/s respectively. When they are 150m apart, both the drivers apply the brakes and the cars decelerate at 3 m/s^2 and 4 m/s^2 until they stop. Separation between the cars when they come to rest is
   1) 86.5 m 2) 89.5 m 3) 85.5 m 4) 80.5 m

5. A body moving with uniform acceleration travels a distance $s_n = (0.4n + 9.8)$m in nth second. Initial velocity of the body is (in m/s)
   1) 0.4 2) 10 3) 3.5 4) 4

6. A train is running at full speed when brakes are applied. In the first minute it travels 8 km, and in the next minute it travels 3 km. Initial speed of the train is
   1) 150 m/s 2) 175 m/s 3) 200 m/s 4) 225 m/s

7. A car travelling at 60 kmph overtakes another car travelling at 42 kmph. Assuming each car to be 5.0m long, the time taken for the over taking is
   1) 6 s 2) 4 s 3) 3 s 4) 2 s

8. Two particles move along x-axis in the same direction with uniform velocities 8 m/s and 4 m/s. Initially the first particle is 21m to the left of the origin and the second one is 7m to the right of the origin. The two particles meet from the origin at a distance of
   1) 35 m 2) 32 m 3) 28 m 4) 56 m

9. A particle is moving with uniform acceleration along a straight line ABC. Its velocity at 'A' and 'B' are 6 m/s and 9 m/s respectively. If AB:BC = 5:16 then its velocity at 'C' is
   1) 9.6 m/s 2) 12 m/s 3) 15 m/s 4) 21.5 m/s

10. A body starts with velocity 'u' and moves on a straight path with constant acceleration. When its velocity becomes '5u' the acceleration is reversed in direction without change in magnitude. When it returns to starting point its velocity becomes.
    1) -u 2) -3u 3) -7u 4) -5u

11. A body covers 30m and 40m during 10th and 15th second respectively. The acceleration and initial velocity of the body are respectively
    1) 2 m/s^2, 35 m/s 2) 2 m/s^2, 11 m/s
    3) 11 m/s^2, 2 m/s 4) 1 m/s^2, 10 m/s

12. A body travels 200m in the first two second and 220m in the next four second. The velocity at the end of the seventh second from the start will be
    1) 10 m/s 2) 15 m/s 3) 220 m/s 4) 5 m/s

13. The velocity of body moving along the x-axis is given by v = 4t-2.5t^2. Its acceleration after 3s is
    1) 1.5 cm/s^2 2) -11 cm/s^2
    3) 4 cm/s^2 4) 5 cm/s^2

14. A bus starts from rest and moves with a uniform acceleration of $1ms^{-2}$. A boy 10m behind the bus at the start runs at a constant speed and catches the bus in 10s. Speed of the boy is
1) 10 m/s 2) 1 m/s 3) 6 m/s 4) 4 m/s

15. A car moving with a constant acceleration covers the distance between two points 180m apart in 6s. If its speed as it passes the second point is 45 m/s, its speed at the first point is
1) 10 m/s 2) 15 m/s 3) 30 m/s 4) 45 m/s

16. While moving with uniform acceleration, a body has covered 550m in 10 second and attained a velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are
1) $10\ ms^{-1}$, $5\ ms^{-2}$ 2) $10\ ms^{-1}$, $-5\ ms^{-2}$
3) $5\ ms^{-1}$, $10\ ms^{-2}$ 4) $10\ ms^{-1}$, $0\ ms^{-2}$

17. While moving with uniform acceleration, a body has covered 100m in 10^{th} second and attained a velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are
1) $10\ ms^{-1}$, $5\ ms^{-2}$ 2) $10\ ms^{-1}$, $-5\ ms^{-2}$
3) $5\ ms^{-1}$, $10\ ms^{-2}$ 4) $10\ ms^{-1}$, $0\ ms^{-2}$

18. A particle moving with velocity equal to 0.4 m/s is subjected to an acceleration of $0.15\ m/s^2$ for 2s in a direction at right angle to its direction of motion. The magnitude of resultant velocity is
1) 0.3 m/s 2) 0.5 m/s 3) 0.27 m/s 4) 0.55 m/s

19. Two cars are travelling in the same direction with a velocity of 60 kmph. They are separated by a distance of 5 km. A truck moving in opposite direction meets the two cars in a time interval of 3 minute. The velocity of the truck is (in kmph)
1) 20 2) 30 3) 40 4) 60

20. When two bodies approach each other with different uniform speeds, the distance between them decreases by 120m per every 1 minute. If they move in the same direction, the distance between them increases by 90m per every 1 minute. The speeds of the bodies are respectively.
1) 2 m/s, 0.5 m/s 2) 3 m/s, 2 m/s
3) 1.75 m/s, 0.25 m/s 4) 2.5 m/s, 0.5 m/s

21. A point moves in a straight line so that its displacement 'x' metre at a time 't' second is such that $t = (x^2-1)^{1/2}$. Its acceleration in m/s^2 at time 't' second is
1) $\frac{1}{x}$ 2) $\frac{1}{x^3}$ 3) $\frac{-t}{x^2}$ 4) $\frac{t}{x^2}$

MOTION UNDER GRAVITY

22. A stone dropped from the top of a tower covers 24.5m in the last second of its fall. Height of the tower is
1) 24.5 m 2) 44.1 m 3) 78.4 m 4) 122.5 m

23. A body dropped freely has covered half of he total distance in the last second. The total journey time is
1) $\left(2+\sqrt{2}\right)$ s 2) $\left(2-\sqrt{2}\right)$ s
3) 2 s 4) $\left(2+\sqrt{3}\right)$ s

24. A ball is dropped from a bridge 122.5m above a river. After 2s, a second ball is thrown down after it. What must its initial velocity be so that both hit the water at the same time ?
1) 49 m/s 2) 55.5 m/s 3) 26.1 m/s 4) 9.8 m/s

25. A ball dropped from a height of 10m, rebounds to a height of 2.5m. If the ball is in contact with the floor for 0.01 second, its acceleration during contact is ($g = 9.8m/s^2$)
1) $20\ m/s^2$ 2) $21\ m/s^2$ 3) $210\ m/s^2$ 4) $2100\ m/s^2$

26. A sharp stone of mass 2kg falls from a height of 10m on sand and buries into the sand. It comes to rest in a time of 0.029 second. The depth through which it buries into sand is
1) 0.2 m 2) 0.15 m 3) 0.25 m 4) 0.30 m

27. The splash of sound was heard 5.35s after dropping a stone into a well 122.5m deep. Velocity of sound in air is
1) 350 cm/s 2) 350 m/s 3) 392 cm/s 4) 0 cm/s

28. Two balls are dropped on to the ground from different heights. One ball is dropped 2s after the other ball but both strike the ground at the same time, 5s after the first is dropped. Difference in the heights at which they were dropped is
1) 44.1 m 2) 122.5m 3) 78.4 m 4) 166.6 m

29. Two stones are thrown vertically upwards with the same velocity of 49m/s. If they are thrown one after the other with a time lapse of 3 second, height at which they collide is
1) 58.8 m 2) 111.5 m 3) 117.6 m 4) 122.5 m

30. In the above problem, the time at which they collide after the projection of the first ball is
1) 3.5 s 2) 6.5 s
3) 4.5 s 4) 4.0 s

31. A body released from a height falls freely towards the earth. Another body is released from the same height exactly a second later. Then the separation between the two bodies two second after the release of the second body is
1) 4.9 m 2) 9.8 m 3) 19.6 m 3) 24.5 m

32. A body dropped freely has covered $(16/25)^{th}$ of the total distance in the last second. Its total time of fall is
1) 2.5 s 2) 5 s 3) 7.5 s 4) 1 s

33. A freely falling body takes 't' second to travel first $(1/x)^{th}$ distance. Then, time of descent is
1) $\frac{t}{\sqrt{x}}$ 2) $t\sqrt{x}$ 3) $\frac{\sqrt{x}}{t}$ 4) $\frac{1}{t\sqrt{x}}$

34. A body released from the top of a tower of height 'h' takes 'T' second to reach the ground. At (T/2) s it is
1) at $\frac{h}{16}$ from the ground
2) at $\frac{h}{4}$ below the top of the tower
3) at $\frac{15h}{16}$ from the ground
4) at $\frac{3h}{16}$ below the top of the tower

35. A particle is projected vertically up and another is let fall to meet at the same instant. If they have velocities equal in magnitude when they meet, the distances travelled by them are in the ratio
1) 1:1 2) 1:2 3) 3:1 4) 2:2

36. A body released from the top of a tower of height 'h' takes 'T' second to reach the ground. The position of the body at (T/4) second is
1) at $\frac{h}{16}$ from the ground
2) at $\frac{3h}{4}$ above the ground
3) at $\frac{15h}{16}$ from the ground
4) at $\frac{3h}{16}$ below the top of the tower

37. The distance travelled by a body during last second of its upward journey is 'd', when the body is projected with certain velocity vertically up. If the velocity of projection is doubled, the distance travelled by the body during the last second of its upward journey is
1) 2d 2) 4d 3) d/2 4) d

38. A stone thrown vertically up with a velocity v reaches three points A, B and C with velocities $\frac{v}{2}, \frac{v}{4}, \frac{v}{8}$ respectively. Then AB : BC is
1) 1:1 2) 2:1 3) 4:1 4) 1:4

39. From an elevated point 'P', a stone is projected vertically upwards. When it reaches a distance 'd' below P, its velocity is doubled. The greatest height reached by it above 'P' is
1) d/3 2) 3d 3) 2d 4) d/2

40. A stone projected upwards with a velocity 'u' reaches two points 'P' and 'Q' separated by a distance 'h' with velocities u/2 and u/3. The maximum height reached by it is
1) $\frac{9h}{5}$ 2) $\frac{18h}{5}$ 3) $\frac{36h}{5}$ 4) $\frac{72h}{5}$

41. A stone is dropped from a balloon at an altitude of 280m. If the balloon ascends with a velocity of 5m/s and descends with a velocity of 5 m/s, times taken by the stone to reach the ground in the two cases respectively are ($g=10m/s^2$)
1) 8 s and 9 s 2) 9 s and 8 s
3) 3 s and 4 s 4) 8 s and 7 s

42. A ball is thrown vertically upwards with a speed of 10 m/s from the top of a tower 200m height and another is thrown vertically downwards with the same speed simultaneously. The time difference between them on reaching the ground is ($g=10m/s^2$)
1) 12s 2) 6s 3) 2s 4) 1s

43. A body is thrown vertically up with certain velocity. If 'h' is the maximum height reached by it, its position when its velocity reduces to $(1/3)^{rd}$ of its velocity of projection is at
1) 8h/9 from the ground
2) 8h/9 below the top-most point
3) 4h/9 from the ground
4) h/3 below the top-most point

44. A stone of mass 200g is thrown up with certain velocity reaches a maximum height of 30m. Another body of double the mass is thrown up with half the velocity of the first. Maximum height reached by it is
1) 30 m 2) 15 m 3) 7.5 m 4) 3.5 m

45. A ball is dropped from the top of a building. The ball takes 0.5s to fall past the 3m length of a window at certain distance from the top of the building. Speed fo the ball as it crosses the top edge of the window is ($g=10m/s^2$)
1) 3.5 ms^{-1} 2) 8.5 ms^{-1} 3) 5 ms^{-1} 4) 12 ms^{-1}

46. In the above problem, how fast was the ball going as it passed the bottom of the window ?
1) 3.5 m/s 2) 8.5 m/s 3) 5 m/s 4) 12 m/s

47. In the above problem, how far is the top of the window from the point at which the ball was dropped ?
1) 0.5 m 2) 0.5225m 3) 0.6125m 4) 0 m

48. In the above problem, time of travel above the window is
1) 0.5 s 2) 0.25 s 3) 0.35 s 4) 0.75 s

49. Two balls, A and B are thrown simultaneously. A, vertically upwards at a speed of $15ms^{-1}$ from the ground and B, vertically downwards from a height of 30m at the same speed along the same line of motion. They meet after a time of
1) 1 s. 2) 2 s 3) 3 s 4) 4 s

50. A shot fired vertically upwards is known to be at 'P' at the end of two second and also again after six more second. Height of 'P' above the point of projection.
1) 44.1 m 2) 78.4 m 3) 122.5 m 4) 19.6 m

51. A body thrown vertically up with a velocity 'u' reaches the maximum height 'h' after 'T' second. Correct statement among the following is
1) at a height h/2 from the ground its velocity is u/2
2) at a time 'T' its velocity is 'u'
3) at a time '2T' its velocity is '-u'
4) at a time '2T' its velocity is '-6u'

52. A stone projected vertically up with a velocity of 10m/s reaches the highest point after 2s. If it is thrown with a velocity of 20 m/s, it reaches the highest point after a time of
1) 2 s 2) 4 s 3) 6 s 4) 1s

53. If a body projected up with a velocity 'u' rises to a height 'h', a body of double the mass projected with a double the velocity rises to a height of
1) 8h 2) 4h 3) 2h 4) h

54. A balloon is rising vertically with a velocity of 9.8 m/s. A packet is dropped from it when it is a height of 39.2 m. Time taken by the packet to reach the ground is
1) 1s 2) 2s 3) 3s 4) 4s

55. A bag is dropped from a helicopter rising vertically at a constant speed of 2m/s. The distance between the two after 2s is
1) 4.9m 2) 19.6m 3) 29.4m 4) 39.2m

56. In the above problem the velocity of bag after 2s is
1) 17.6 m/s 2) -17.6 m/s
3) 19.6 m/s 4) -19.6 m/s

57. A stone is dropped from a rising balloon at a height of 300m above the ground and it reaches the ground in 10s. The velocity of the balloon when it was dropped is
1) 19 m/s 2) 19.6 m/s 3) 29 m/s 4) 0 m/s

58. A stone is dropped from the 16th store of a multistoried building reaches the ground in 4 seconds. The no. of stores travelled by the stone in 2nd second is
1) 4 2) 3 3) 5 4) 2

59. If the ratio of distances travelled by freely falling body in the last and last but one second of its motion is 7:5 The velocity with which the body strikes the ground is ______
1) 29.4 ms^{-1} 2) 39.2 ms^{-1}
3) 19.6 m^{-1} 4) 49 m^{-1}

60. From the top of a tower 36 m high, a body is dropped and at the same time another body is projected vertically upward from the ground. If they meet midway find the initial velocity of the projected body and its velocity when the two bodies come together.
1) $5\sqrt{6}m,\ 0$ 2) $\frac{42}{\sqrt{5}}m,\ 0$
3) $6\sqrt{6}m,\ 2m/s$ 4) $8\sqrt{6}m,\ 4.5m/s$

61. A balloon starts rising from the ground with an acceleration of 1.25 ms^{-2}, After 8 seconds, a stone is released from the balloon, The stone will ($g=10\ ms^{-2}$)
1) cover a distance of 40 m
2) having a displaceent of 50 m
3) reach the ground in 4 s
4) begin to move down after being released

62. A paper weight is dropped from the roof of a block of multistorey flats each storey being 3 meters high. It passes the ceiling of the 20th storey at 30m/s. If (g = 10 m/s^2), how many storey does the flat have?
1) 25 2) 30 3) 35 4) 40

63. A ball of mass 100 gm is projected vertically upwards from the ground with a velocity of 49 m/s. At the same time another identical ball is dropped from a height of 98 m. After some time the two bodies collide. When they collide, their velocities are
1) 29.4 m/s upwards; 29.4 m/s downwards
2) 29.4 m/s upwards; 19.6 m/s downwards.
3) 19.6 m/s upwards; 19.6 m/s downwards
4) None

64. A stone is dropped from a height h. Simultaneously another stone is thrown up from the ground which reaches the height 4h. The two stones cross each other after a time.
1) $\sqrt{\frac{h}{2g}}$ 2) $\sqrt{\frac{h}{8g}}$ 3) $\sqrt{8hg}$ 4) $\sqrt{2hg}$

65. A ball is projected vertically upwards with a velocity of 25 ms^{-1} from the bottom of a tower. A boy who is standing at the top of a tower is unable to catch the ball when it passes him in the upward direction. But the ball again reaches him

after 3 sec when it is falling. Now the boy catches it Then the height of the tower is ($g=10ms^{-2}$)

1) 5 m 2) 10 m 3) 15 m 4) 20 m

66. A body is thrown verticaly upwards with an initial velocity u reaches maximum height in 6 seconds. The ratio of the distance travelled by body in the first second and the eleventh second is______

1) 1:1 2) 11:9 3) 1:2 4) 9:11

PROJECTILE MOTION

67. A ball is thrown with a velocity of 'u' making an angle 'θ' with the horizontal. Its velocity vector is normal to initial velocity vector (u) after a time interval of

1) $\frac{u\sin\theta}{g}$ 2) $\frac{u}{g\cos\theta}$ 3) $\frac{u}{g\sin\theta}$ 4) $\frac{u\cos\theta}{g}$

68. The maximum height reached by a projectile is 'h'. Its time of flight is

1) $\sqrt{\frac{4h}{g}}$ 2) $\frac{8h}{g}$ 3) $\sqrt{\frac{8h}{g}}$ 4) $\sqrt{\frac{16h}{g}}$

69. Two paper screens A and B are separated by a distance of 100 m. A bullet pierces A and then B. The hole in B is 10 cm below the hole in A. If the bullet is travelling horizontally at A, velocity of the bullet at A is ($g=9.8\ m/s^2$)

1) 500 m/s 2) 700 m/s 3) 800 m/s 4) 900 m/s

70. Two tall buildings are 80 m apart. The velocity with which a ball should be thrown horizontally from a window 95 m above the ground in one building so that it will enter a window 15 m above the ground in the second building is ($g=10\ m/s^2$)

1) 15 m/s 2) 5 m/s 3) 10 m/s 4) 20 m/s

71. A particle projected from the level ground just clears in its ascent a wall 30 m high and $120\sqrt{3}$ away measured horizontally. The time since projection to clear the wall is two second. It will strike the ground in the same horizontal plane from the wall on the other side at a distance of

1) $150\sqrt{3}$ m 2) $180\sqrt{3}$ m

3) $120\sqrt{3}$ m 4) $210\sqrt{3}$ m

72. A person projects a bottle into a dustbin at the same height as he is 2m away at an angle of 45^0. The velocity of projection is (in m/s)

1) g 2) $\sqrt{g}$ 3) 2g 4) $\sqrt{2g}$

73. A ball of mass 'm' is thrown vertically upwards. Another ball of mass '2m' is thrown up making an angle 'θ' with the vertical. Both of them stay in air for the same time. Their maximum heights are in the ratio

1) 2:1 2) 1:1 3) $1:\cos\theta$ 4) $1:\sec\theta$

74. From the top of a building 80 m high, a ball is thrown horizontally which hits the ground at a distance. The line joining the top of the building to the point where it hits the ground makes an angle of 45^0 with the ground. Initial velocity of projection of the ball is($g=10\ m/s^2$)

1) 10 m/s 2) 15 m/s 3) 20 m/s 4) 30 m/s

75. A stone is projected from the top of a tower with velocity 20 m/s making an angle of elivigation of 30^0 with the horizontal. If the total time of flight is 5s and $g = 10\ ms^{-2}$, then

1) the height of the tower is 75m

2) the maximum height of the stone from the ground is 80m

3) both the above are true

4) the height of the tower is 120m

76. A stone is projected with velocity 80 m/s making an angle of 30^0 with the horizontal. The horizontal component of its velocity after 2 second is ($g=10ms^{-2}$)

1) 40 m/s 2) $40\sqrt{3}$ m/s

3) 20 m/s 4) $20\sqrt{3}$ m/s

77. A body is projected at an angle of 30^0 to the horizontal with a speed of 30 m/s. The angle made by the velocity with the horizontal after 1.5 s is ($g=10\ m/s^2$)

1) 0^0 2) 60^0 3) 45^0 4) 90^0

78. A grass hopper can jump a maximum horizontal distance of 0.3 m. If it spends negligible time on the ground, its horizontal component of velocity is ($g=10\ m/s^2$)

1) 3/2 m/s 2) $\sqrt{\frac{3}{2}}$ m/s 3) 1/2 m/s 4) $\sqrt{\frac{2}{3}}$ m/s

79. A ball is thrown with a velocity of 8 m/s making an angle of 60^0 with the horizontal. Its velocity will be perpendicular to the initial velocity of projection after a time of ($g=10\ m/s^2$)

1) $\frac{1.6}{\sqrt{3}}$ s 2) $\frac{4}{\sqrt{3}}$ s 3) 0.6 s. 4) $1.6\sqrt{3}$ s

80. The minimum and maximum velocities of a projectile are 10 m/s and 20 m/s respectively. The horizontal range and maximum height are respectively ($g = 10\ m/s^2$)

1) $10\sqrt{3}$ m, 20 m 2) $20\sqrt{3}$ m, 15 m

3) 20 m, 15 m 4) $10\sqrt{3}$ m, 10 m

81. A gun mounted on the top of a moving truck is aimed in the backward direction at angle of 30^0 to the vertical. If the muzzle velocity of the gun is 4 m/s, the speed of the truck to send the bullet vertically up is

1) 1 m/s 2) $\frac{\sqrt{3}}{2}$ m/s 3) 0.5 m/s 4) 2 m/s

82. A body is projected with the same speed at two different angles such that the horizontal range is same in both the cases. If the maximum height attained are 20m and 80m respectively in the above two cases, then the range is
1) 120 m 2) 20 m 3) 160 m 4) 40 m

83. Two second after projection, a projectile is moving at 30^0 above the horizontal. After one more second it is moving horizontally. Angle of projection is ($g = 10\ m/s^2$)
1) 0^0 2) 45^0 3) 60^0 4) 90^0

84. A ball is projected at an angle of 30^0 and 60^0 to the horizontal with the same initial velocity in each case. Ratio of their times of flight is
1) 1:1 2) 1:3 3) $1:\sqrt{3}$ 4) $2:\sqrt{3}$

85. In the above problem, ratio of maximum height is
1) 1:1 2) 1:3 3) $1:\sqrt{3}$ 4) $2:\sqrt{3}$

86. In the above problem, ratio of ranges is
1) 1:1 2) 1:3 3) $1:\sqrt{3}$ 4) $2:\sqrt{3}$

87. A particle of mass 1 kg is projected at an angle 45^0 to the horizontal with an initial velocity of 20 m/s. Change in momentum during its time of flight is
1) $10\sqrt{2}$ kg m/s 2) $20\sqrt{2}$ kg m/s
3) $30\sqrt{2}$ kg m/s 4) $40\sqrt{2}$ kg m/s

88. A bullet is fired with a velocity of 196 ms^{-1} at an angle of 30^0 with horizontal. Time of flight of the bullet is
1) 10s 2) 20s 3) 30s 4) 40s

89. A player kicks a foot ball obliquely at a speed of 20 m/s so that its range is maximum. Another player at a distance of 24m away in the direction of kick starts running at that instant to catch the ball. Before the ball hits the ground to catch it, the speed with which the second player has to run is ($g=10\ ms^{-2}$)
1) 4 m/s^{-1} 2) $4\sqrt{2}$ m/s^{-1}
3) $8\sqrt{2}$ m/s^{-1} 4) 8 m/s^{-1}

90. For a projectile the range and maximum height are equal. The angle of projection is
1) 45^0 2) 0^0 3) 76^0 4) 90^0

91. A bullet fired at an angle of 15^0 with the horizontal hits the ground 6 km away. Keeping the same velocity of projection for the bullet to attain a range of 12 km, the angle of projection is
1) 15^0 2) 30^0 3) 45^0 4) 60^0

92. If 4 seconds be the time in which a projectile reaches a point P of its path and 5 seconds the time from P till it reaches the horizontal plane through the point of projection. The height of P from the horizontal plane is
1) 78.4 m 2) 98 m 3) 122.5m 4) 220.5 m

93. The speed of a projectile at the maximum height is half of its initial speed. Its horizontal range is
1) $\frac{u^2}{\sqrt{3g}}$ 2) $\frac{2u^2}{\sqrt{3g}}$ 3) $\frac{\sqrt{3}}{2}.\frac{u^2}{g}$ 4) $\frac{\sqrt{3}u^2}{g}$

94. A healthy young man standing at distance of 7 m from a 11.8 m high building sees a kid slipping from the top floor. His uniform speed of run to catch the kid at the arms height of 1.8 m is
1) 4.9 m/s 2) 9.8 m/s 3) 3.5 m/s 4) 7 m/s

95. A marble travelling at 100 cm/s rolls of the edge of a level table. It hits the floor 30 cm away from the spot directly below the edge of the table. Height of the table is
1) 44 cm 2) 100cm 3) 30 cm 4) 70 cm

96. A body is projected downwards at an angle of 30^0 with the horizontal from the top of a building of height 300m. Its initial speed is 40 m/s. Time taken by it to hit the ground is
($g = 10\ m/s^2$)
1) 2s 2) 4s 3) 6s 4) 8s

97. A ball rolling off the top of a staircase of each step with height H and width W, with an initial velocity U will just hit n^{th} step. Then n =
1) $\frac{2U^2H^2}{gW}$ 2) $\frac{2U^2H^2}{gW^2}$ 3) $\frac{2U^2H}{gW^2}$ 4) $\frac{2UH^2}{W^2}$

98. In the above problem, if H = 20cm, W = 30cm, U = 18 kmph, then n = ($g = 10\ m/s^2$)
1) 11.1 2) 6.5 3) 8.3 4) 12.8

99. A body of mass 'm' is projected horizontally with a velocity 'v' from the top of a tower of height 'h' and it reaches ground at a distance 'x' from the top of a tower. If a second body of mass '2m' is projected horizontally from the top of a tower of height 2h, it reaches the ground at a distance '2x' from the tower. The horizontal velocity of second body is
1) v 2) 2v 3) $\sqrt{2v}$ 4) $v/2$

100. From the top of a tower of height 78.4 m two stones are projected horizontally with 10 m/s and 20 m/s in opposite directions. On reaching the ground, their separation is
1) 120 m 2) 100 m 3) 200 m 4) 150 m

101. An aeroplane is flying horizontally at a height of 980 m with velocity 100 ms^{-1} drops a food packet. A person on the ground is 414 m ahead horizontally from the dropping point. At what velocity should he move so that he can catch the food packet.
1) $50\sqrt{2}ms^{-1}$ 2) $\frac{50}{\sqrt{2}}ms^{-1}$
3) $100ms^{-1}$ 4) $200ms^{-1}$

102. A body is projected horizontally from the top of a high tower with a speed of $20ms^{-1}$. After 4 seconds, the displacement of the body is ($g = 10\ ms^{-2}$)

1) 40m 2)80m 3) $80\sqrt{2}$ m4) $\frac{80}{\sqrt{2}}m$

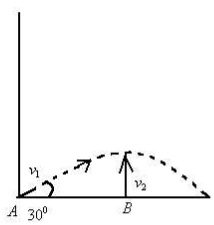
103. A fighter plane flying horizontally at an attitude of 2 km with speed of 540 kmph passes directly over head an anti aircraft gun. If the gun can fire a bullet at the muzzles speed of 500 ms^{-1}. at what angle with the vertical the gun should fire the bullet so that the bullet hits the plane ?

1) $\cos^{-1}\left(\frac{3}{10}\right)$ 2) $\sin^{-1}\left(\frac{3}{10}\right)$

3) $\tan^{-1}\left(\frac{3}{10}\right)$ 4) 45^o

104. A body is projected with velocity v_1 from the point A as shown in Fig. 3.39. At the same time another body is thrown vertically upward from with velocity v_2. The point B lies vertically below the highest point.

For both the bodies to collide, $\frac{v_2}{v_1}$ should be



1) $\frac{1}{2}$ 2) $\sqrt{\frac{3}{2}}$ 3) 2 4) 1

105. A hose pipe lying on a ground shoots a stream of water upward at an angle of 60^o to the horizontal. The speed of water is $20ms^{-1}$ as it leaves the hose. It will strike a wall 10m away at a height of $\left(g = 10ms^{-2}\right)$

1) 10.5m 2) 12.32m 3) 10m 4) 20m

106. A particle having a mass of 0.5kg is projected with a speed of 98 ms^{-1} at an angle of 60^0. The magnitude of change of momentum of th particle after 10 seconds in N-S is

1) 0.5 2) 49 3) 98 4) 490

107. If the velocity of a particle at greatest height is $\sqrt{2/5}$ times of its velocity when it is at half of the greatest height. The angle of projection is

1) 30^0 2) 37^0 3) 60^0 4) 45^0

108. A projectile has initial the same horizontal velocity as it would acquired if it had moved from rest with uniform acceleration of $3ms^{-2}$ of 0.5 min. If the minimum height reached by it is 80m, then the angle of projection is $\left(g = 10ms^{-2}\right)$

1) $\tan^{-1}(3)$ 2) $\tan^{-1}(3/2)$

3) $\tan^{-1}(4/9)$ 4) $\sin^{-1}(4/9)$

109. A body is projected horizontally from the top of a hill with a velocity of 9.8m/s. What time elapses before the vertical velocity is twice the horizontal velocity ?

1) 0.5sec 2) 1 sec 3) 2 sec 4) 1.5 sec

110. A javelin thrown into air at an angle with the horizontal has range of 200m. If the time of flight is 5 second, then the horizontal component of velocity of the projectile at the highest point of the trajectory is

1) 40 m/s 2) 0 m/s 3) 9.8 m/s 4) infinite

111. The horizontal range of a projectile is $4\sqrt{3}$ times the maximum height achieved by it, then the angle of projection is

1) 30^0 2) 45^0 3) 60^0 4) 90^0

112. A ball is rolled off along the edge of table(horizontal) with velocity 3m/s. It hits the ground after time 0.4s. Which one of the following is wrong ?

1) The height of the table is0.8 m

2) It hits the ground at an angle of 60^0 with the verticle.

3) It covers a horizontal distance 1.6m from the table.

4) It hits the ground with verticle velocity 4m/s.

KEY

1) 2	2) 2	3) 1	4) 4	5) 2
6) 2	7) 4	8) 1	9) 3	10) 1
11) 2	12) 1	13) 2	14) 3	15) 2
16) 3	17) 3	18) 2	19) 3	20) 3
21) 2	22) 2	23) 1	24) 3	25) 4
26) 1	27) 2	28) 3	29) 2	30) 2
31) 4	32) 1	33) 2	34) 2	35) 3
36) 3	37) 4	38) 3	39) 1	40) 3
41) 4	42) 3	43) 1	44) 3	45) 1
46) 2	47) 3	48) 3	49) 1	50) 2
51) 3	52) 2	53) 2	54) 4	55) 2
56) 2	57) 1	58) 2	59) 2	60) 2
61) 3	62) 3	63) 2	64) 2	65) 4
66) 2	67) 3	68) 3	69) 2	70) 4
71) 2	72) 4	73) 2	74) 3	75) 3
76) 2	77) 1	78) 2	79) 1	80) 2
81) 4	82) 3	83) 3	84) 3	85) 2
86) 1	87) 2	88) 2	89) 2	90) 3
91) 3	92) 2	93) 3	94) 1	95) 1
96) 3	97) 3	98) 1	99) 3	100) 1
101) 1	102) 3	103) 2	104) 3	105) 2
106) 2	107) 3	108) 3	109) 3	110) 1
111) 1	112) 2			

HINTS

1. $a = \frac{\sqrt{v_x^2 + v_y^2}}{t}$

2. $a = \frac{d^2s}{dt^2}$ 3. $a = \frac{\Delta v}{\Delta t}$

4. Use $v^2 - u^2 = 2as$ twice.

5. $S_n = u + a\left(n - \frac{1}{2}\right)$

6. Apply $S = ut + \frac{1}{2}at^2$ twice

7. $S_{rel} = V_{rel}t$

8. relative displacement $= v_{rel}t + \frac{1}{2}a_{rel}t^2$

9. $v^2 - u^2 = 2as$

10. $v^2 - u^2 = 2as$

11. $S_n = u + a\left(n - \frac{1}{2}\right)$

12. Apply $S = ut + \frac{1}{2}at^2$ twice

13. $a = \frac{dv}{dt}$

14. $S_{bus} = \frac{1}{2}at^2 \quad S_{bus} + 10 = S_{boy} = ut$

16. $v + u = \frac{2S}{t}$

17. $S_n = u + a\left(n - \frac{1}{2}\right)$ and, $v = u + at$

18. $v = \sqrt{v_x^2 + v_y^2}$

19. $S = V_{rel}t$ 20. $S = V_{rel}t$

22. $\frac{S_t}{S} = \frac{2t-1}{t^2}$

24. $t = \sqrt{\frac{2h}{g}}$; $h = u(t-2) + \frac{1}{2}g(t-2)^2$

25. $a = \frac{v-u}{t}$ 26. $S = \frac{v+u}{2}t$

27. $t = \sqrt{\frac{2h}{g}} + \frac{S}{V_{sound}}$

28. $\Delta h = \frac{1}{2}g(t_2^2 - t_1^2)$

29. $x = \frac{4u^2 - g^2t^2}{8g}$

30. $t = \frac{u}{g} + \frac{\Delta t}{2}$ 32. $\frac{S_t}{S} = \frac{2t-1}{t^2}$

33. $h = \frac{1}{2}gt^2$ 34. $h = \frac{1}{2}gt^2$

35. $h = \frac{1}{2}gt^2$ and $h = ut - \frac{1}{2}gt^2$

36. $h = \frac{1}{2}gt^2$ 37. conceptual

38. v^2-u^2=2as 39. v^2-u^2=2as

40. v^2-u^2=2as and $h = \frac{u^2}{2g}$

41. $h = -ut + \frac{1}{2}gt^2$ and $h = ut + \frac{1}{2}gt^2$

42. $t = \frac{2u}{g}$ 43. v^2-u^2=2as

44. $h \alpha u^2$ 45. $s = \frac{v+u}{2}t$

49. Apply $S = ut + \frac{1}{2}at^2$ twice

50. $h = \frac{1}{2}gt_1t_2$ 51. $h = \frac{1}{2}gt^2$

52. $t_a \alpha u$ 53. $h \alpha u^2$

54. $h = -ut + \frac{1}{2}gt^2$ 57. $h = -ut + \frac{1}{2}gt^2$

58. $H = \frac{1}{2}gt^2$

$S_n = \frac{g}{2}(2n-1)$

59. $S_n \alpha (2n-1); V = gt$

60. $u^2 = 2g\frac{h}{2}$

61. $u = u + at$; $s = ut + \frac{1}{2}at^2$; $h = -ut + \frac{1}{2}gt^2$

$x = \frac{1}{2}gt^2$

62. $t=\frac{V}{g}$

63. $V_1=u-gt$

64. $u=\sqrt{2gh}$

65. $t=\frac{2u}{g}$; $H=\frac{g}{8}\left(t_1^2-t_2^2\right)$

66. use $s_n=u+g\left(n-\frac{1}{2}\right)$ twice

67. $t=\frac{v}{g\sin\theta}$

68. $h=\frac{u^2\sin^2\theta}{2g}$; $T=\frac{2u\sin\theta}{g}$

69, 70. $R=u\sqrt{\frac{2h}{g}}$ $R=u\sqrt{\frac{2h}{g}}$

71. $x=(u\cos\theta)t$ and $y=(u\sin\theta)t-\frac{1}{2}gt^2$

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

73. $h_1=\frac{u^2}{2g}, h_2=\frac{u_2^2\sin^2\theta}{2g}$

74. $R=h$ and $R=\sqrt{\frac{2h}{g}}$

75. $h=(u\sin\theta)t-\frac{1}{2}gt^2$

76. $v_x=u\cos\theta$

77. $\tan\theta=\frac{u\sin\theta-gt}{u\cos\theta}$

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

79. $t=\frac{v}{g\sin\theta}$

80. $R=\frac{u^2\sin2\theta}{g}$

81. use vector resolvation

82. $R=4\sqrt{h_1h_2}$

83. $\tan\theta=\frac{u\sin\theta-gt}{u\cos\theta}$

84. Apply $T=\frac{2u\sin\theta}{g}$ twice

85. Apply $h=\frac{u^2\sin^2\theta}{2g}$ twice

86. $R=\frac{u^2\sin2\theta}{g}$ is same

87. $\Delta P=2mu\sin2\theta$

88. $T=\frac{2u\sin\theta}{g}$

89. 24 - R = ut

90. $R=4h\cot\theta$

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

92. $y=(u\sin\theta)t-\frac{1}{2}gt^2$ and $T=\frac{2u\sin\theta}{g}$

93. $u\cos\theta=\frac{u}{2}1$

94. $h=\frac{1}{2}gt^2$ and $s=ut$

95. $R=u\sqrt{\frac{2h}{g}}$

96. $h=(u\sin\theta)t+\frac{1}{2}gt^2$

97, 98. $R=u\sqrt{\frac{2h}{g}}$

99. Use $h=\frac{gx^2}{2u^2}$ twice

100. $S=\left(u_1+u_2\right)\sqrt{\frac{2h}{g}}$

101. $t=\sqrt{\frac{2h}{g}},\ x=ut$

102. $x=ut$, $y=\frac{1}{2}gt^2$; $s=\sqrt{x^2+y^2}$

103. $u=v\sin\theta$

104. $\frac{u_2}{u_1}=\frac{1}{\sin\theta}$

106. $\Delta p=p_2-p_1$

107. $V_{\frac{h}{2}}=u\sqrt{\frac{1+\cos^2\theta}{2}}$; $u\cos\theta=ut$

108. $h=\frac{u^2\sin^2\theta}{2g}$

109. $\frac{1}{2}gt^2=2u$

110. $R=u\cos\theta t$

111. $R=nH$

$\tan\theta=\frac{4}{n}$

112. $x=4\sqrt{\frac{2h}{g}}$

LEVEL - III

MOTION IN HORIZONTAL PLANE :

1. If the velocity of a body moving with uniform acceleration is doubled in t_1 seconds and tripled in next t_2 seconds then
1) $t_2 = 2t_1$ 2) $t_1 = 2t_2$ 3) $t_1t_2 = 2$ 4) $t_1 = t_2$

2. The position of a body is given as a function of time by the relation, $x = 2t^3-6t^2+12t+6$. The acceleration of the body is zero after a time
1) 1s 2) 2s 3) $2\sqrt{2}$ s 4) 3s

3. The velocity of a car decreases from 30m/s to 15m/s, when it travels a distance of 100m. The distance travelled from this position before it comes to rest is
1) 100m 2) $\frac{100}{3}$ m 3) $\frac{200}{3}$ m 4) $\frac{100}{9}$ m

4. A proton in a uniform electric field moves along a straight line with constant acceleration starting from rest. If it attains a velocity $4\text{x}10^3$ km/s in a distance of 2cm, the time required to reach the given velocity is
1) 10^{-3}s 2) 10^{-6}s 3) 10^{-8}s 4) 10^{-5}s

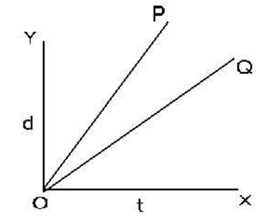
5. Three persons A, B and C at the corners of an equilateral triangle of side 'x' move at a constant speed 'v'. Each person maintains a direction towards the person at the next corner. The time, the persons will take to meet each other is
1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{4x}{3v}$

6. In the above problem if it is a square with four persons A,B,C and D at the corners, their time of meeting is
1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{3x}{4v}$

7. In the above problem, if six persons are at the corners of a regular hexagon, the time of meeting is
1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{5x}{6v}$

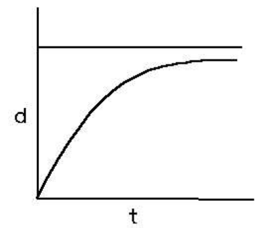
8. The driver of an express train travelling at a speed of v_1 sees on the same track at distance 'd' in front of him a goods train travelling in the same direction at a speed v_2. Immediately he applies brakes to his express train producing retardation 'a' to avoid collision. Then
1) $a < \frac{v_1^2 - v_2^2}{2d}$ 2) $a < \frac{(v_1 - v_2)^2}{2d}$
3) $a > \frac{(v_1 - v_2)^2}{2d}$ 4) $a > \frac{v_1^2 - v_2^2}{2d}$

9. The displacement - time graphs of two bodies A and B are OP and OQ respectively. If $\angle$ POX is 60^0 and $\angle$ QOX is 45^0, the ratio of the velocity of A to that of B is



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

10. The distance of a particle as a function of time is shown below. The graph indicates that



1) The particle starts with certain velocity, but the motion is retarded and finally the particle stops
2) The velocity of the particle is constant throughout
3) The acceleration of the particle is constant throughout
4) The particle starts with a constant velocity the motion is in acceleration and finally the particle moves with another constant velocity.

11. A particle starts with a velocity 200 cm/s and moves in a straight line with a retardation of 10 cm/s^2. Its displacement will be 1500 cm
1) Only once after 30s from start
2) Only once after 10s
3) Twice after 10s and 30s
4) Always

MOTION UNDER GRAVITY

12. A body falls from a height of 200m. If gravitational attraction ceases after 2s, further time taken by it to reach the ground is($g=10\ ms^{-2}$)
1) 5s 2) 9s 3) 13s 4) 17s

13. A ball after having fallen from rest under the influence of gravity for 6s, crashes through a horizontal glass plate, thereby losing two-third of its velocity. If it then reaches the ground in 2s, height of the plate above the ground is
1) 19.6m 2) 39.2m 3) 58.8m 4) 78.4m

14. A stone is dropped from the top of a tower of height 49m. Another stone is thrown up vertically with velocity of 24.5 m/s from the foot of the tower at the same instant. They will meet in a time of
1) 1s 2) 2s 3) 0.5s 4) 0.25s

15. A ball is dropped from the top of a tower. Another ball thrown up vertically with a velocity of 20 m/s from the ground level at the same instant meets the first after 1.5s. Height of the tower is
1) 20m 2) 30m 3) 40m 4) 50m

16. A juggler throws up balls at regular intervals of time. Each ball takes 2s to reach the highest position. If the first ball is in the highest position by the time the fifth one starts, then the separation between the first and the second balls is
1) 1.225m 2) 2.45m 3) 4.9m 4) 3.8m

17. A person sitting on the top of a tall building is dropping balls at regular intervals of one second. When the 6th ball is being dropped, the positions of the 3rd, 4th, 5th balls from the top of the building are respectively
1) 4.9m, 19.6m, 44.1m 2) 4.9m, 14.7m, 24.5m
3) 44.1m, 19.6m, 4.9m 4) 24.5m, 14.7m, 4.9m

18. A rocket is fired and ascends with constant vertical acceleration of $10m/s^2$ for 1 minute. Its fuel is exhausted and it continues as a free particle. The maximum altitude reached is ($g=10m/s^2$)
1) 18 km 2) 36 km 3) 72 km 4) 108km

19. A parachutist after bailing out falls for 10s without friction. When the parachute opens he descends with an acceleration of $2\ m/s^2$ against his direction and reached the ground with 4 m/s. From what height he has dropped himself? ($g = 10m/s^2$)
1) 500m 2) 2496m 3) 2996m 4) 4296m

20. In the above problem the total journey time is
1) 10s 2) 48s 3) 38s 4) 58s

21. A parachutist after bailing out falls 50m without friction. When the parachute opens, he decelerates downwards with $2m/s^2$. He reaches the ground with a speed of 3 m/s. How long is the parachute in the air? ($g = 10\ m/s^2$)
1) 14.2s 2) 15.3s 3) 20.5s 4) 40.5s

22. At what height did he bail out?
1) 50m 2) 247.75m
3) 297.75m 4) 197.75m

23. A ball is dropped from the top of a building. The ball takes 0.2s to fall past the 3m length of a window some distance from the top of the building. Speed of the ball as it crosses the top edge of the window is ($g = 10ms^{-2}$)
1) 3.5 m/s 2) 8.5 m/s 3) 5 m/s 4) 14 m/s

24. A ball is projected vertically upwards with a velocity of 100 m/s. After 2 second, a second ball is projected vertically upwards from the same point with a velocity 110 m/s. When they meet, time taken by the first ball to meet the second one is ($g = 10ms^{-2}$)
1) 6s 2) 8s 3) 10s 4) 12s

25. Two bodies are projected vertically upwards with a velocity of 49 m/s. They are projected with a time gap of 2s. After the projection of the first body, they will meet in a time of
1) 5s 2) 3s 3) 6s 4) 7s

26. A loose nut from a bolt on the bottom of an elevator which is moving up the shaft at 3m/s falls freely. The nut strikes the bottom of the shaft in 2s. Distance of the elevator from the bottom of the shaft when the nut fell off is
1) 19.6m 2) 13.6m 3) 9.8m 4) 3.8m

27. A body thrown up with a velocity of 98 m/s reaches a point 'P' in its path 7 second after projection. Since its projection it comes back to the same position after
1) 13s 2) 14s 3) 6s 4) 22s

28. A body is thrown up with velocity 'u' to reach a height 'h'. When the velocity is half the initial velocity, its height from the top point of projection is
1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{3h}{4}$ 4) h

29. A stone projected vertically up from the top of a cliff reaches the foot of the cliff in 8s. If it is projected vertically downwards with the same speed, it reaches the foot of the cliff in 2s. Then its time of free fall from the cliff is
1) 16s 2) 8s 3) 2s 4) 4s

30. A ball is thrown vertically up with a velocity of 14.7 m/s from the top of a tower of height 49m. On its return, it misses the tower and finally strikes the ground. The time that elapsed from the instant the ball was thrown until it passes the edge of the tower is
1) 1.5s 2) 3s 3) 6s 4) 0.5s

31. A body is thrown with a velocity of $\left(4\hat{i}+3\hat{j}\right)$ m/s. The maximum height attained by the body is ($g = 10ms^{-2}$)
1) 2.5m 2) 0.8m 3) 0.9m 4) 0.45m

PROJECTILE MOTION

32. The launching speed of a certain projectile is five times the speed it has at its maximum height. Its angle of projection is
1) $\theta = \cos^{-1}(0.2)$ 2) $\theta = \sin^{-1}(0.2)$
3) $\theta = \tan^{-1}(0.2)$ 4) $\theta = 0^0$

33. A projectile shot at an angle of 45^0 above the horizontal strikes the wall of a building 30m away at a point 15m above the point of projection. Initial velocity of the projectile is

1) 14 m/s 2) $14\sqrt{2}$ m/s

3) $14\sqrt{3}$ m/s 4) $14\sqrt{5}$ m/s

34. The parabolic path of a projectile is represented by $y = \frac{x}{\sqrt{3}} - \frac{x^2}{60}$ in MKS units : Its angle of projection is ($g = 10ms^{-2}$)

1) 30^0 2) 45^0 3) 60^0 4) 90^0

35. A body is projected with a velocity of 20 m/s making an angle 45^0 with the horizontal. Its path is represented by ($g = 10ms^{-2}$)

1) $y = x - \frac{x^2}{20}$ (m) 2) $y = x - \frac{x^2}{40}$ (m)

3) $\sqrt{3}x - \frac{x^2}{40}$ (m) 4) $\frac{x}{\sqrt{3}} - \frac{x^2}{40}$ (m)

36. The variation of horizontal and vertical distances with time are given by $y = 8t - 4.9t^2$, $x = 6t$ with MKS units. Then, the velocity of projection is

1) 8 m/s 2) 6 m/s 3) 10 m/s 4) 14 m/s

37. In the above problem, angle of projection is

1) $\tan^{-1}(3/4)$ 2) $\tan^{-1}(4/3)$

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

38. A projectile is fired with a speed 'u' at an angle 'θ' with the horizontal. Its speed when its direction of motion makes an angle 'α' with the horizontal is

1) $u\cos\theta$ 2) $u\cos\theta \sec\alpha$

3) $u\cos\theta \sin\alpha$ 4) $u\cos\theta \cos\alpha$

39. A body projected obliquely with velocity 19.6 m/s has its kinetic energy at the maximum height equal to 3 times its potential energy. Since projection from the ground, its position after 1s is (h = maximum height)

1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{h}{3}$ 4) h

40. A shell is fired vertically upwards with velocity v_1 from the deck of a ship travelling at a speed of v_2. A person on the shore observes the motion of the shell as parabola whose horizontal range is given by

1) $\frac{2v_1^2v_2}{g}$ 2) $\frac{2v_1v_2^2}{g}$ 3) $\frac{2v_1v_2}{g}$ 4) $\frac{2v_1^2v_2^2}{g}$

41. A body is projected with velocity 'u' making an angle α with the horizontal. Its velocity when it is perpendicular to the initial velocity vector 'u' is

1) $u\sin\alpha$ 2) $u\cot\alpha$ 3) $u\tan\alpha$ 4) $u\cos\alpha$

42. A car is moving horizontally along a straight line with constant speed 30 m/s. A projectile is to be fired from the moving car in such a way that it will return to the car after the car has moved through 90m. The speed and angle at which the projectile must be projected are respectively

1) 14.7 m/s, 30^0 2) 14.7 m/s, 60^0

3) 14.7 m/s, 90^0 4) 14.7 m/s, 0^0

43. A boy standing on an open car throws a ball vertically upwards with a velocity of 9.8 m/s, while moving horizontally with uniform acceleration of 1 m/s^2. The ball will fall behind the boy on the car at a distance of

1) 1m 2) 2m 3) 3m 4) 4m

44. A helicopter is flying horizontaly at an altitude H with a uniform velocity 'u'. It drops a bomb so as to hit a target on the ground. Distance of the helicopter from the target while dropping the bomb is

1) $u\sqrt{\frac{2H}{g}}$ 2) $\sqrt{\frac{2u^2H}{g} + H^2}$ 3) H 4) $\sqrt{\frac{uH}{g}}$

45. A person in lift which ascends up with acceleration $10ms^{-2}$ drops a stone from a height 10 m. The time of descent is ($g = 10\ ms^{-2}$)

1) 1 s 2) 2 s 3) 1.5 s 4) 0.5 s

46. A body projected up reaches a point A in its path at the end of 4th second and reaches the ground after 5 seconds from the start. The height of A above the ground is

1) 19.6 m 2) 30.6 m 3) 11 m 4) 20 m

47. A stone is projected vertically up from the ground with velocity $40\ ms^{-1}$. The interval of time between the two instants at which the stone is at a height of 60 m above the ground is ($g = 10\ ms^{-2}$)

1) 4 s 2) 6 s 3) 8 s 4) 12 s

48. If the distance travelled by a freely falling body in the last second of its journey is equal to the distance travelled in the first 2s, the time of descent of the body is

1) 5 s 2) 1.5 s 3) 2.5 s 4) 3 s

49. A player kicks a foot ball obliquely at a speed of $20\ ms^{-1}$ so that its range is maximum. Another player at a distance of 24 m away in the direction of kick starts running at that instant to catch the ball. Before the ball hits the ground to catch it, the speed with which the second player has to run is ($g = 10\ ms^{-2}$)

1) $4\ ms^{-1}$ 2) $4\sqrt{2} ms^{-1}$

3) $8\sqrt{2} ms^{-1}$ 4) $8\ ms^{-1}$

50. A ball is thrown with velocity $8\ ms^{-1}$ making an angle 60° with the horizontal. Its velocity will be perpendicular to the direction of initial velocity of projection after a time of ($g = 10\ ms^{-2}$)

1) $\frac{1.6}{\sqrt{3}}$ s 2) $\frac{4}{\sqrt{3}}$ s 3) 0.6 s 4) $1.6\sqrt{3}$ s

51. From an elevated point P a stone is projected vertically upwards when it reaches a distance d below *P* its velocity is doubled. The greatest height reached by it above *P* is

1) $\frac{d}{3}$ 2) 3 d 3) 2 d 4) $\frac{d}{2}$

52. From an elevated point *P* a stone is projected vertically upward. When it reaches a distance y below the point of projection its velocity is double the velocity when it was at a height y above P. The greatest height reached by it above P is

1) $\frac{2y}{3}$ 2) $\frac{5y}{3}$ 3) $\frac{y}{3}$ 4) 2 y

53. A stone projected vertically up from the ground reaches a height y in its path at t_1 seconds and after further t_2 seconds reaches the ground. The height y is equal to

1) $\frac{1}{2}g(t_1 + t_2)$ 2) $\frac{1}{2}g(t_1 + t_2)^2$

3) $\frac{1}{2}g\, t_1 t_2$ 4) $g\, t_1 t_2$

54. A ball dropped from a point P crosses a point Q in t seconds. The time taken by it to travel from Q to R, if PQ = QR

1) t 2) $\sqrt{2}$ t 3) 2 t 4) $(\sqrt{2} - 1)$t

55. In the above problem if S is a point such that PQ = QR = RS, the time taken by the ball to travel from R to S is

1) $(\sqrt{2} - 1)$t 2) $(\sqrt{3} - \sqrt{2})$t

3) $\sqrt{3}$ t 4) $(\sqrt{3} - 1)$t

56. A motor boat going down stream crosses a float at a point A. 60 minutes later it turned back and after some time passed the float at a distance of 12 km from the point A. The velocity of stream

1) 8 kmph 2) 4 kmph 3) 6 kmph 4) 10 kmph

57. Two balls of equal masses are thrown upwards along the same vertical line at an interval of 2 seconds with the same initial velocity of $39.2\ ms^{-1}$. The total time of flight of each ball, if they collide at a certain height, inelastically will be

1) 5s and 3s 2) 10 s and 6 s

3) $5\sqrt{15}$ s and $3\sqrt{15}$ s

4) $(5 + \sqrt{15})$s and $(3 + \sqrt{15})$s

58. A particle is projected vertically up and another is let fall to meet at the same instant. If they have velocities equal in magnitude when they meet, the distance travelled by them are in the ratio of

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

59. A man in a lift ascending with an upward acceleration throws a ball vertically upwards and catches it after t_1 second. Later when the lift is descending with the same acceleration, the man throws the ball up again with same velocity and catches it after t_2 second.

1) the acceleration of the elevator is $g\frac{(t_2 - t_1)}{(t_1 + t_2)}$

2) the velocity of projection of the ball relative to elevator is $\frac{t_2 t_1 g}{t_1 + t_2}$. We can conclude that.

1) only A is true 2) only B is true

3) Both A and B is true

4) Both A and B are false

60. A particle is projected with velocity $2\sqrt{gh}$ so that it just clears two walls of equal height h which are distance 2h from each other. The time interval for which the particle travels between the two walls is

1) $2\sqrt{\frac{h}{g}}$ 2) $\sqrt{\frac{h}{g}}$ 3) $\sqrt{\frac{2h}{g}}$ 4) $\sqrt{\frac{h}{2g}}$

61. A particle is aimed at a mark which is in the same horizontal plane as that of point of projection. It falls 10 m short of the target, when it is projected at an angle of 75° and falls 10 m ahead of the target when it is projected with an elevation of 45°. The angle of projection for which the particle exactly hits this target is ($g = 10\ ms^{-2}$)

1) $\frac{1}{2}\text{Sin}^{-1}\left(\frac{3}{4}\right)$ 2) $\frac{1}{2}\text{Sin}^{-1}\left(\frac{4}{5}\right)$

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

62. A ball is thrown vertically upwards with a speed of $10\ ms^{-1}$ from the ground at the bottom of a tower 200 m high. Another is dropped vertically downward simultaneously, from the top of a tower. If $g = 10ms^{-2}$ the time interval after which the projected body will be at the same level as the dropped body is

1) 20 s 2) 25 s 3) $2\sqrt{10}$ s 4) 5 s

63. A ball is projected from the bottom of a tower and is found to go above the tower and is caught by the thrower at the bottom of the tower after a time interval t_1. An observer at the top of the tower finds the same ball go up above him and then come back to his level in a time interval t_2. The height of the tower is

1) $\frac{1}{2}gt_1t_2$ 2) $\frac{gt_1t_2}{8}$

3) $\frac{g}{8}\left(t_1^2 - t_2^2\right)$ 4) $\frac{g}{2}(t_1 - t_2)^2$

64. When a body is projected from a level ground the ratio of its speed in the vertical and horizontal direction is 4 : 3. If the velocity of projection is u, the time after which, the ratio of the velocities in the vertical and horizontal directions are reversed is

1) $\frac{7u}{20g}$ 2) $\frac{35u}{10g}$ 3) $\frac{9u}{g}$ 4) $\frac{10u}{g}$

65. At a certain height a shell at rest explodes into two equal fragments. One of the fragments receives a horizontal velocity u. The time interval after which, the velocity vectors will be inclined at 120° to each other is

1) $\frac{u}{\sqrt{3}g}$ 2) $\frac{\sqrt{3}u}{g}$ 3) $\frac{2u}{\sqrt{3}g}$ 4) $\frac{u}{2\sqrt{3}g}$

Q.Nos 66-69

From a certain height two bodies are simultaneously projected horizontally in opposite directions, with velocities of $1\,ms^{-1}$ and $4\,ms^{-1}$ respectively.

66. The time taken for the velocity vectors of the two bodies to become perpendicular to each other is

1) 0.1 s 2) 0.2 s 3) 0.4 s 4) 0.8 s

67. The horizontal distance between the two bodies when their velocity vectors are perpendicular to each other is

1) 1 m 2) 0.5 m 3) 2 m 4) 4 m

68. The time taken for the displacement vectors of the two bodies to become perpendicular to each other is

1) 0.1 s 2) 0.2 s 3) 0.4 s 4) 0.8 s

69. In that above case, the horizontal distance between the two bodies is

1) 1 m 2) 0.5 m 3) 2 m 4) 4 m

70. The maximum height reached by a projectile is 4 m. The horizontal range is 12 m. Velocity of projection in ms^{-1} is : (g - acceleration due to gravity)

1) $5.\sqrt{\frac{g}{2}}$ 2) $3.\sqrt{\frac{g}{2}}$ 3) $\frac{1}{3}.\sqrt{\frac{g}{2}}$ 4) $\frac{1}{5}.\sqrt{\frac{g}{2}}$

71. A train accelerates from rest at a constant rate a_1 for distance S_1 and time t_1. After that it retards to rest at a constant rate a_2 for distance S_2 at time t_2. Then the correct relation among the following is

1) $\frac{S_1}{S_2} = \frac{a_1}{a_2} = \frac{t_1}{t_2}$ 2) $\frac{S_1}{S_2} = \frac{a_2}{a_1} = \frac{t_1}{t_2}$

3) $\frac{S_1}{S_2} = \frac{a_1}{a_2} = \frac{t_2}{t_1}$ 4) $\frac{S_1}{S_2} = \frac{a_2}{a_1} = \frac{t_2}{t_1}$

72. An elevator ascends with an upward acceleration of $0.2\ ms^{-2}$ At the instant its upward speed is $2\ m/s$, a loose bolt 5 m high from the floor drops from the ceiling of the elevator. The time taken by the bolt to strike the floor and the distance it has fallen are

1) 1 s, 1.9 m 2) 1 s, 2.9 m
3) 1 s, 4.9 m 4) 1s, 3.9 m

73. Two particles are separated by a horizontal distance R on the ground. Those two are projected simultaneously with velocities $u/\sqrt{3}$ and u at angles of projection 30° and 120° with the horizontal direction so that they approach each other in the same plane. The time after which the horizontal separation between those particles becomes zero is

1) $\frac{u}{2R}$ 2) $\frac{u}{R}$ 3) $\frac{R}{u}$ 4) $\frac{2R}{u}$

74. If two bodies are projected from the same point with speeds V and V/3, they will have same horizontal range. If the second body is thrown at an angle of 15° to the horizontal, the angle of projection of first body with horizontal is

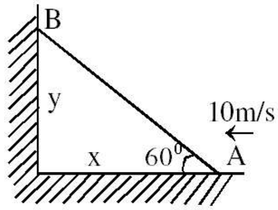
1) $\frac{1}{2}\sin^{-1}\left(\frac{1}{9}\right)$ 2) $\frac{1}{2}\sin^{-1}\left(\frac{1}{18}\right)$

3) $2\sin^{-1}\left(\frac{1}{18}\right)$ 4) $\frac{1}{2}\sin^{-1}\left(\frac{1}{8}\right)$

75. A point has equal velocities in two directions. If one of these velocities is halved, the angle which the resultant makes with the other is also halved. The angle between the velocities is

1) 60^0 2) 45^0 3) 120^0 4) 90^0

76. Two particles are connected by a light rigid rod AB. The rod slides on perpendicular rails as shown in the figure. The velocity of 'A' to the left is 10 m/s. If $\alpha = 60^0$, the velocity of 'B' then is



1) 10 m/s 2) 5.8 m/s
3) 17.3 m/s 4) 9.2 m/s

77. A stone is projected so as to pass over two walls of heights a, b at distance b, a from the point of projection. If 'θ' is the angle of projection, then tanθ is

1) $\frac{a^2+ab+b^2}{a-b}$ 2) $\frac{(a^2+ab+b^2)}{ab}$

3) $\frac{(a^2-ab+b^2)}{ab}$ 4) 3

78. A stone of mass 'm' is projected with a velocity 'u' at an angle 45^0 to the horizontal. It angular momentum about the point of projection when it is at its highest point

1) $\frac{mu^3}{4\sqrt{2g}}$ 2) $\frac{mu^2}{4g}$ 3) $\frac{mu}{\sqrt{2}}$ 4) $\frac{2mu^3}{g}$

79. The angle of incidence at which a smooth ball must strike a horizontal surface so that after impact its direction will be at right angle to its former path is

1) $\tan^{-1}e$ 2) $\tan^{-1}\sqrt{e}$ 3) $\cot^{-1}(e)$ 4) $\cot^{-1}(\sqrt{e})$

80. Two bodies were thrown simultaneously from the same point; one, straight up and the other, at angle of 'θ' to the horizontal. The initial velocity of each body is equal to v. Neglecting the air drag, the distance between the bodies 't' seconds later is

1) $vt\sqrt{2(1-\sin\theta)}$ 2) $\sqrt{v\cos\theta t - v\sin\theta}$

3) $v\sqrt{(1-\cos\theta)t}$ 4) $vt\sqrt{2(1-\cos\theta)}$

81. The angles of elevation of a particle at any time from the two ends (in the same horizontal plane) of the trajectory are 'α' and (90-α). The angle of projection 'θ' is

1) $\tan\theta = 2\,\mathrm{cosec}\alpha$ 2) $\tan\theta = 2\sec 2\alpha$
3) $\theta = \alpha$ 4) $\theta = \tan^{-1}(\cos\alpha)$

82. If the range and maximum height of a projectile are respectively 'R' and 'H', the maximum range that could be obtained with the same velocity of projection is

1) 4H 2) 2R

3) $2H+\frac{R^2}{8H}$ 4) $2R+\frac{H^2}{8R}$

83. A ball is projected with a velocity $2\sqrt{g}$ so as to clear two walls each of height 'a', distance between them being 2a. The angle of projection is

1) 60^0 2) 30^0 3) 45^0 4) $36^012'$

84. The equation of motion of a projectile is $y = Ax - Bx^2$. The horizontal range of the projectile is

1) $\frac{A}{B}$ 2) $\frac{A^2}{4B}$ 3) AB 4) $\frac{AB}{A+B}$

85. In the above problem, the greatest height reached is

1) $\frac{A^2}{4B}$ 2) $\frac{B^2}{4A}$ 3) $\frac{AB}{4}$ 4) $\frac{AB^2}{2}$

86. In the same problem, the total time of flight is

1) $\sqrt{\frac{A}{Bg}}$ 2) $\sqrt{\frac{AB}{g}}$ 3) $A\sqrt{\frac{2}{Bg}}$ 4) $B\sqrt{\frac{2}{Ag}}$

87. The trajectory of a projectile in a vertical plane is $y = ax - bx^2$ where a, b are constants and 'x' and 'y' are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection from the horizontal is

1) $\tan^{-1}(a)$ 2) $\tan^{-1}(b)$

3) $\tan^{-1}\left(\frac{a}{b}\right)$ 4) $\tan^{-1}\left(\frac{b}{a}\right)$

88. A body is at A, B, C, D after successive equal intervals of time. If 'O' is a point in the same line ABCD and distances of A, B, C, D from 'O' are respectively a, b, c, d then (a – d) is equal to (the body is moving with uniform acceleration)

1) (b – c) 2) 2 (b – c) 3) 3 (b – c) 4) 4 (b – c)

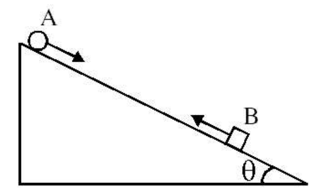
89. The velocity - time curves bisect at right angles. If the acceleration of one body is 2.5 ms^{-2}, the acceleration of the other is

1) 0.4 m/s^2 2) –0.4 ms^2
3) –2.5 ms^{-2} 4) $0.5 m/s^2$

90. A driver can stop his car from the red signal at a distance of 20m when he is driving at 36 kmph and 41.25m when he is driving at 54 kmph. His reaction time is

1) zero 2) 1 s
3) 0.5 s 4) 0.25 s

91. A mass 'A' is released from the top of a frictionless inclined plane 18m long and reaches the bottom 3 sec. later. At the instant when 'A' is released a second mass 'B' is projected upwards along the plane, from the bottom with a certain velocity. The mass travels a certain distance up the plane, stops and returns to the bottom so that it arrives simultaneously with 'A'. The two masses do not collide with each other. The initial velocity of 'B' is



1) 7 ms^{-1} 2) 2.25 ms^{-1} 3) 6 ms^{-1} 4) 3 ms^{-1}

92. Two cars start in a race with velocities u_1 and u_2 and travel in a straight line with acceleration 'α' and β. If both reach the finish line at the same time, the range of the race is

1) $\frac{2(u_1-u_2)}{(\beta-\alpha)^2}(u_1\beta-u_2\alpha)$

2) $\frac{2(u_1-u_2)}{\beta+\alpha}(u_1\alpha-u_2\beta)$

3) $\frac{2(u_1-u_2)^2}{(\beta-\alpha)^2}$ 4) $\frac{2u_1u_2}{\beta\alpha}$

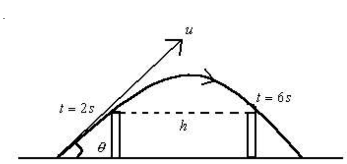
93. From top of a tower of height 40 m, a ball is projected with speed of 20m/s at angle 30° with horizontal. The ratio of the times taken by the ball to come back to the same point and that taken to hit the ground is (g=10 m/s^2)

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

94. Shots are fired simultaneously from the top and bottom of a vertical cliff at angles 30° and 60° respectively with horizontal. These shots hit an object simultaneously. If horizontal distance of the object from bottom of cliff is 10 $\sqrt{3}m$, height of cliff is

1) 10 m 2) 20 m 3) 30 m 4) 40 m

95. If a prjectile crosses two wallls of equal height h symmetrically as shown in the fig. Choose the correct statement (s) $\left(g=10m/s^2\right)$



1) The time of flight is 8 sec
2) The height of each wall is 60 m
3) The maximum height of projectile is 80m
4) All the above

96. A bomb at rest at the summit of a cliff breaks into two equal fragments. One of the fragment attains a horizontal velocity of $20\sqrt{3}$ m/s. The horizontal distance between the two fragments, when their displacement vectors are inclined at 60^0 relative to each other is $\left(g=10m/s^2\right)$

1) $40\sqrt{3}m$ 2) $480\sqrt{3}m$ 3) $120\sqrt{3}m$ 4) $160\sqrt{3}m$

97. The friction of the air causes a vertical retardation equal to 10% of the acceleration due to gravity. Take $g=10m/s^2$. The maximum height and time to reach the maximum height will be dereased by

1) 9%, 9% 2) 11%, 11%
3) 9%, 10% 4) 11%, 9%

98. The maximum height attained by a projectile is increased by 10% by increasing its speed of projection. The percentage increase in the horizontal range will be

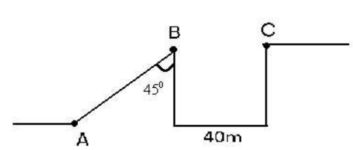
1) 20% 2) 15% 3) 10% 4) 5%

99. A particle is projected at an angle of elevation α and after t seconds it appears to have an angle of elevation β as seen from point of projection. The initial velocity will be

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

3) $\frac{\sin(\alpha-\beta)}{2gt}$ 4) $\frac{2\sin(\alpha-\beta)}{gt\cos\beta}$

100. A body is projected up a smooth inclined plane with velocity v from a point A as shown in fig. The angle of inclination is 45^0 and the top is connected to a well of diameter 40. If the body just manages to cross the well, what is the value of v? Length of the inclined plane is $20\sqrt{2}$ m.



1) 40 m/s 2) $40\sqrt{2}$ m/s
3) 20 m/s 4) $20\sqrt{2}$ m/s

KEY

1) 4	2) 1	3) 2	4) 3	5) 1
6) 3	7) 2	8) 3	9) 2	10) 1
11) 3	12) 2	13) 3	14) 2	15) 2
16) 1	17) 3	18) 2	19) 3	20) 4
21) 1	22) 3	23) 4	24) 2	25) 3
26) 1	27) 1	28) 3	29) 4	30) 2
31) 4	32) 1	33) 3	34) 1	35) 2
36) 3	37) 2	38) 2	39) 4	40) 3
41) 2	42) 3	43) 2	44) 2	45) 1
46) 1	47) 1	48) 3	49) 2	50) 1
51) 1	52) 2	53) 3	54) 4	55) 2
56) 1	57) 4	58) 3	59) 3	60) 1
61) 1	62) 1	63) 3	64) 1	65) 2
66) 2	67) 1	68) 3	69) 3	70) 1
71) 2	72) 2	73) 3	74) 2	75) 1
76) 2	77) 2	78) 1	79) 2	80) 1
81) 1	82) 4	83) 1	84) 1	85) 1
86) 3	87) 1	88) 3	89) 2	90) 3
91) 3	92) 1	93) 1	94) 3	95) 4
96) 2	97) 1	98) 3	99) 2	100) 4

HINTS

1. $v = u + at$
2. $a = \frac{d^2x}{dt^2}$
3. $v^2 - u^2 = 2as$
4. $v^2 - u^2 = 2as$ and $s = \frac{1}{2}at^2$
5. $s = \frac{x}{\sqrt{3}}, v^1 = v\cos\theta, t = \frac{s}{v}$
6. $v^2 - u^2 = 2as$
8. $v^2 - x^2 = 2as$
9. $v \alpha \tan\theta$
10. $s = \frac{1}{2}at^2$
11. $s = ut + \frac{1}{2}at^2$
12. $h = \frac{1}{2}gt^2, h = ut$
13. $v = gt, h = ut + \frac{1}{2}gt^2$
14. $t = \frac{h}{u}$
15. $t = \frac{h}{u}$
16. $h = \frac{1}{2}gt^2$
18. $S_1 = \frac{1}{2}at^2,\ S_2 = \frac{v^2}{2g}$
24. Apply $h = ut - \frac{1}{2}gt^2$ twice
25. Apply $h = ut - \frac{1}{2}gt^2$ twice
26. $h = \frac{1}{2}gt^2$
27. $h = \frac{1}{2}g(t_1 - t_2)$
28. $v^2 - u^2 = 2gh$
29. $t = \sqrt{t_1 t_2}$
30. $t = \frac{2u}{g}$
31. $u\cos\theta = 4, u\sin\theta = 3$
32. $u\cos\theta = \frac{u}{5}$
33. $y = (\tan\theta)x - \frac{g}{2u^2\cos^2\theta}x^2$
34. $y = (\tan\theta)x - \frac{g}{2u^2\cos^2\theta}x^2$
36. compare with the equations

    $y = (u\sin\theta)t - \frac{1}{2}gt^2, x = (u\cos\theta)t$
37. $u\cos\theta = v\cot\alpha$
39. $K.E. = \frac{1}{2}mu^2\cos^2\theta, P.E. = \frac{1}{2}mu^2\sin^2\theta$
41. $t = \frac{v}{g\sin\theta}, v = \sqrt{v_x^2 + v_y^2}$
42. time of flight $= \frac{90}{30} = 3$ second
44. distance $= \sqrt{R^2 + h^2}$
45. $g^1 = a + g$

46. $t=\frac{2u}{g}$

$s=ut^1-\frac{1}{2}gt^{1^2}$, $t^1=1s$

47. $s=ut-\frac{1}{2}gt^2$

48. $g\left(n-\frac{1}{2}\right)=\frac{1}{2}gt^2$

49. $R_{\max}=\frac{u^2}{g}$; $T=\frac{2u\sin\theta}{g}$; $V=\frac{R_{\max}-x}{T}$

50. $t=\frac{u}{g\sin\theta}$

51. $v^2-u^2=2as$

52. $v^2-u^2=2as$

53. $\frac{t_1+t_2}{2}=\frac{2u}{g}$

54. $t=\sqrt{\frac{2h}{g}}$, $h=PQ$; $t^{-1}=\sqrt{2\times\frac{2h}{g}}$

$\Delta t=t^1-t$

55. $t_n=\sqrt{nh}$; $h=PQ$

n- Number of equal distance

58. $v=u-gt=gt$

$u=2gt$; $S_1=ut-\frac{1}{2}gt^2$

$S_1=ut-\frac{1}{2}gt^2$

59. $t_1=\frac{u}{2(g+a)}$; $t_2=\frac{u}{2(g-a)}$

$\frac{t_1}{t_2}=\frac{g-a}{(g+a)}$

60. Speed at height 'h' = $\sqrt{2gh}$ (by law of conservation of energy $2h=\frac{v^2\sin 2\alpha}{g}$

$\Rightarrow \alpha=45^0$

$\sqrt{2gh}.\frac{1}{\sqrt{2}}=\upsilon\cos\theta$

$t=\frac{2h}{\sqrt{gh}}=2.\sqrt{\frac{h}{g}}$

61. Let R be the range of the point

$$R-10=\frac{u^2\sin 2\theta_1}{g}$$

$$R+10=\frac{u^2\sin 2\theta_2}{g}$$

62. $t=\frac{h}{u}$

70. $\frac{\tan\theta}{4}=\frac{h}{R}$; $\sin\theta=\frac{4}{5}$

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

76. $x^2+y^2=l^2$

$2x\frac{dx}{dt}+2y\frac{dy}{dt}=0 \Rightarrow xv_x=-yv_y$

$v_y=v_x\frac{x}{y}$

78. $L=r\times p=\frac{u^2\sin^2\theta}{2g}\times mu\cos\theta$

93. $T_1=\frac{2u\sin\theta}{g}$

$T_2=\frac{u\sin\theta+\sqrt{u^2\sin^2\theta+2gH}}{g}$

94. $R=\frac{u^2\sin 2\theta}{g}$; $t=\frac{2u\sin\theta}{g}=\sqrt{\frac{2h}{g}}$

96. $u_1=u_2$

$t=\frac{2u}{g\sin\frac{\theta}{2}}$

$d=t(u_1+u_2)$

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

$h=l\sin\theta$

$u_1^2-u^2=-2gh$

LEVEL - IV

Comprehensive Questions

A. A body projected with certain velocity 'u' at angle θ with horizontal describes a parabolic path. It is represented by an equation $y = Ax - Bx^2$, where 'x'and 'y'are the horizontal and vertical displacements,'A' and 'B' are constants.Then answer the following questions.

1. Angle of projection is

   1) $\theta = \tan^{-1}(A)$ 2) $\theta = \sin^{-1}(A)$

   3) $\theta = \cos^{-1}(A)$ 4) $\theta = \cot^{-1}(A)$

2. The maximum height reached is

   1) $\frac{2A^2}{B}$ 2) $\frac{A^2}{2B}$ 3) $\frac{A^2}{4B}$ 4) $\frac{2A^2}{3B}$

3. Time of flight is

   1) $\sqrt{\frac{A^2}{2Bg}}$ 2. $\sqrt{\frac{2A^2}{Bg}}$ 3) $\sqrt{\frac{2B^2}{Ag}}$ 4. $\sqrt{\frac{B^2}{4Ag}}$

4. Horizontal range is

   1) $\frac{B}{A}$ 2) $\frac{A}{B}$ 3) $\frac{4A}{B}$ 4) $\frac{B}{2A}$

5. Initial velocity of the body is

   1) $\sqrt{\frac{g(1+A)}{2B}}$ 2) $\sqrt{\frac{g(1+A^2)}{B}}$

   3) $\sqrt{\frac{g(1+A^2)}{2B}}$ 4) $\sqrt{\frac{g(1+B^2)}{2A}}$

B). Two bodies are projected with angles of projection 30^0 *and* 60^0 with an initial velocity 19.6 m/s from the same point. Then answer the following questions.

6. The ratio of maximum heights attained is

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

7. Ratio of horizontal ranges is

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

8. Ratio of the time of flights is

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

9. The sum of the maximum heights attained by them is

   1) 9.8 m 2) 19.6 m 3) 39.2 m 4) 78.4m

C)If the horizontal displacement of a projectile is $x = 6t\,(m)$ and vertical displacement is $y = 8t - 5t^2\,(m)$. Then answer the following questions.

10. The angle of projection is in $\left(ms^{-1}\right)$

    1) 14 2) 10 3) 2 4) **5**

11. Angle of projection is

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

    3) 45^0 4) $\tan^{-1}\left(\frac{4}{5}\right)$

12. Horizontal range is

    1) 9.6 m 2) 4.8m 3) 3.2m 4) 19.6m

13. Maximum height reached is

    1) 6.4m 2) 3.2m 3) 1.6m 4) 4.8m

KEY

1. 1	2. 3	3. 2	4. 2	5. 3
6. 4	7. 1	8. 2	9. 2	10. 2
11. 2	12. 1	13. 3		

PREVIOUS EAMCET QUESTIONS

1. Two bodies are projected simultaneously in the same verticle plane from the same point with velocities v_1 and v_2 with angles θ_1 and θ_2 respectively with the horizantal. If $v_1 \cos\theta_1 = v_2 \cos\theta_2$, the path of one ball from the position of other ball is **(EAMCET - 2005M)**

   1) Parabola

   2) Horizantal straight line

   3) Vertical straight line

   4) straight line making 45^0 with the vertical

2. A body projected vertically upwards crosses a proint twice its journey at a height 'h' just after t_1 and t_2 seconds. Maximum height reached by the body is **(EAMCET - 2005 E)**

   1) $\frac{g}{4}(t_1+t_2)^2$ 2) $g\left(\frac{t_1+t_2}{4}\right)^2$

   3) $2g\left(\frac{t_1+t_2}{4}\right)^2$ 4) $\frac{g}{4}(t_1 t_2)$

3. The equation of trajectory of a projectile is $y = 10x - \left(\frac{5}{9}\right)x^2$ (m), The maximum height reached is **(EAMCET - 2005 E)**
1) 36m 2) 24m 3) 18m 4) 9m

4. The horizontal and vertical displacements x and y of a projectile at given time t are given by $x = 6t$ (m) and $y = 8t - 5t^2$ (m). The range projectile in metres is **(EAMCET - 2004 E)**
1) 9.6 2) 10.6 3) 19.2 4) 38.4

5. The maximum height reached by projectile is 4 metres. The horizontal range is 12m. Velocity of projection in m/s is (g - acceleration due to gravity) **(EAMCET- 2004 M)**
1) $5\sqrt{\frac{g}{2}}$ 2) $3\sqrt{\frac{g}{2}}$ 3) $\frac{1}{3}\sqrt{\frac{g}{2}}$ 4) $\frac{1}{5}\sqrt{\frac{g}{2}}$

6 Two stones are projected with the same speed but making different angles with the horizontal. Their horizontal ranges are equal. The angle of projection of one is $\pi/3$ and the maximum height reached by it is 102m. Then the maximum height reached by the other in metres is **EAMCET- 2003M**
1) 336 2) 224 3) 56 4) 34

7. The equation of motion of a projectile are given by x=36t metre and $2y = 96t - 9.8t^2$ metre. The angle projection is **(EAMCET -2003 E)**
1) $\sin^{-1}(4/5)$ 2) $\sin^{-1}(3/5)$
3) $\sin^{-1}(4/3)$ 4) $\sin^{-1}(3/4)$

8. A projectile has initially the same horizontal velocity as it would acquire if it had moved from rest with uniform acceleration of 3m/s^2 for 0.5 minute. If the maximum height reached by it is 80m, then the angle of projection is (g=10m/s^2) **(EAMCET-2002M)**
1) $\tan^{-1}(3)$ 2) $\tan^{-1}(3/2)$
3) $\tan^{-1}(4/9)$ 4) $\sin^{-1}(4/9)$

9. The horizontal and vertical displacements of a projectile at a time 't' are x = 36t, y = 48t - 4.9t^2 respectively. Initial velocity of the projectile is (in m/s) **(EAMCET-2002M)**
1) 15 2) 30 3) 45 4) 60

10. An object is projected with a velocity of 20 ms^{-1} making an angle of 45^0 with horizontal. The equation of the trajectory is h = Ax-Bx^2(m) where 'h' is the height, 'x' is the horizontal distance, A and B are constants. The ratio A to B is (g = 10m/s^2) **(EAMCET-2001E)**
1) 1:5 2) 5:1 3) 1:40 4) 40:1

11. The initial velocity of a particle $\vec{u} = 4\vec{i} + 3\vec{j}$. It is moving with uniform acceleration $\vec{a} = 0.4\vec{i} + 0.3\vec{j}$. Its velocity after 10 seconds is **(EAMCET-2001M)**
1) 3 units 2) 4 units 3) 5 units 4) 10 units

12. It is possible to project a particle with a given speed in two possible ways so that it has the same horizontal range R. The product of the times taken by it in the two possible ways is **(EAMCET-2001M)**
1) $\frac{R}{g}$ 2) $\frac{2R}{g}$ 3) $\frac{3R}{g}$ 4) $\frac{4R}{g}$

13. A body of mass m$_1$, projected vertically upwards with an initial velocity 'u' reaches a maximum height 'h'. Another body of mass m$_2$ is projected along an inclined plane making an angle 30^0 with the horizontal with a velocity 'u'. The maximum distance travelled along the incline is **(EAMCET-2001M)**
1) 2h 2) h 3) $\frac{h}{2}$ 4) $\frac{h}{4}$

14. Four bodies P,Q,R and S are projected with equal velocities having angles of projections 15^0, 30^0, 45^0 and 60^0 with the horizontal respectively. The body having shortest range is **(EAMCET-2000)**
1) P 2) Q 3) R 4) S

15. A body is thrown horizontally from the top of a tower of 5m height. It touches the ground at a distance of 10m from the foot of the tower. The initial velocity of the body is (g=10ms^{-2}) **(EAMCET-2000)**
1) 2.5 m/s 2) 5.0 m/s 3) 10 m/s 4) 20 m/s

16. A body is thrown vertically upwards with an initial velocity 'u' reaches a maximum height in 6s. The ratio of the distance travelled by the body in the first second to the seventh second is **(EAMCET-2000)**
1) 1:1 2) 11:1 3) 1:2 4) 1:11

17. A stone projected with a velocity u$_1$ at an angle θ with the horizontal reaches maximum height H$_1$. When it is projected with the same velocity at an angle $\left(\frac{\pi}{2} - \theta\right)$ with the horizontal reaches the maximum height H$_2$. The relation between the horizontal range R of the projectile H$_1$ and H$_2$ is **(EAMCET-2000)**
1) $R = 4\sqrt{H_1H_2}$ 2) $R = 4(H_1-H_2)$
3) $R = 4(H_1+H_2)$ 4) $R = \frac{H_1^2}{H_2}$

18. For a projectile, the ratio of maximum height reached to the square of flight time is (g=10ms^{-2}) **(EAMCET-2000)**
1) 5:4 2) 5:2 3) 5:1 4) 10:1

19. The average velocity of a body moving with uniform acceleration after travelling a distance of 3.06 m is 0.34 m/s. If the change in velocity of the body is 0.18 ms^{-1} during this time, its uniform acceleration is **(EAMCET-2000)**
1) 0.01 ms^{-2} 2) 0.02 ms^{-2}
3) 0.03 ms^{-2} 4) 0.04 ms^{-2}

20. The angle of projection of a projectile for which the horizontal range and the maximum height are equal is **(EAMCET-2000)**
1) $\tan^{-1}\left(\sqrt{3}\right)$ 2) $\tan^{-1}(4)$
3) $\tan^{-1}\left(\sqrt{2}\right)$ 4) $\tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$

21. The distances travelled by a body starting from rest and travelling with uniform acceleration, in successive intervals of time of equal duration will be in the ratio **(EAMCET-1999)**
1) 1:2:3 2) 1:2:4 3) 1:3:5 4) 1:5:9

22. The speed of a projectile at its maximum height is $\sqrt{3}$ /2 times its initial speed. If the range of the projectile is 'p' times the maximum height attained by it, then p = **(EAMCET-1999)**
1) 4/3 2) $2\sqrt{3}$ 3) $4\sqrt{3}$ 4) 3/4

23. Water drops fall from a tap on to the floor 5.0m below at regular intervals of time. The first drop strikes the floor when the fifth drop beings to fall. The height at which the third drop will be from ground, at the instant when the first drop strikes the ground is (Take g = 10ms^{-2}) **(EAMCET-1999)**
1) 1.25m 2) 2.15m 3) 2.75m 4) 3.75m

24. A car starts from rest and travels with uniform acceleration α for some time and then with uniform retardation β and comes to rest. If the total time of travel of the car is 't', the maximum velocity attained by it is given by **(EAMCET-1998)**
1) $\frac{\alpha\beta}{(\alpha+\beta)}t$ 2) $\frac{1}{2}\frac{\alpha\beta}{(\alpha+\beta)}t^2$
3) $\frac{\alpha\beta}{(\alpha-\beta)}t$ 4) $\frac{1}{2}\frac{\alpha\beta}{(\alpha-\beta)}t^2$

25. A gun mounted on the top of a moving truck is aimed in the backward direction at an angle of 30^0 to the vertical. If the muzzle velocity of the gun is 4 m/s, the value of the speed of the truck that will make the bullet come out vertically is **(EAMCET-1998)**
1) 1 m/s 2) $\frac{\sqrt{3}}{2}$ m/s 3) 0.5 m/s 4) 2 m/s

26. A person standing on the edge of a well throws a stone vertically upwards with an initial velocity 5 ms^{-1}. The stone gone up, comes down and falls in the well making a sound. If the person hears the sound 3 second after throwing, then the depth of water (neglect time travel for the sound and take g = 10ms^{-2}) **(EAMCET-1998)**
1) 1.25 m 2) 21.25 m 3) 30m 4) 32.5 m

27. A bomb is dropped from an aircraft travelling horizontally at 150 m/s at a height of 490 m. The horizontal distance travelled by the bomb before it hits the ground is **(EAMCET-1998)**
1) 1000m 2) 1200m 3) 1500m 4) 1800m

28. A stone thrown vertically up from the ground reaches a maximum height of 50m in 10s. Time taken by the stone to reach the ground from maximum height is **(EAMCET-1996)**
1) 5s 2) 10s 3) 20s 4) 25s

29. A bus accelerates uniformly from rest and acquires a speed of 36kmph in 10s. The acceleration is **(EAMCET-1996)**
1) 1 m/s^2 2) 2 m/s^2 3) 1/2 m/s^2 4) 3 m/s^2

30. A body thrown up with some initial velocity reaches a maximum height of 50m. Another body with double the mass thrown up with double the initial velocity will reach a maximum height of **(EAMCET-1996)**
1) 100m 2) 200m 3) 400m 4) 50m

31. A bomb is dropped from an acceleration moving horizontally at constant speed. When air resistance is taken into consideration, the bomb **(EAMCET-1995)**
1) falls to the earth exactly below the aeroplane.
2) falls to the earth behind the aeroplane.
3) falls to the earth ahead of the aeroplane.
4) flies with the aeroplane.

32. A body projected up with a speed 'u' took 'T' seconds to reach the maximum height 'H'. Pick out the correct statement **(EAMCET-1995)**
1) It reaches H/2 in (T/2)s
2) It acquires velocity u/2 in (T/2)s
3) Its velocity is u/2 at H/2
4) Same velocity at 2Ts

33. The displacement is given by $x=2t^2+t+5$(m). The acceleration at t=2s is **(EAMCET-1995E)**
1) 4 m/s^2 2) 8 m/s^2 3) 10 m/s^2 4) 15m/s^2

34. A person sitting in an open car moving at constant velocity throws a ball vertically up into air. The ball falls **(EAMCET-1995E)**
1) Outside the car
2) In the car ahead of the person
3) In the car to the side of the person
4) Exactly in the hand which threw it up.

35. Velocity time curve for a body projected vertically upwards is **(EAMCET-1995E)**
1) Parabola 2) Ellipse
3) Hyperbola 4) Straight Line

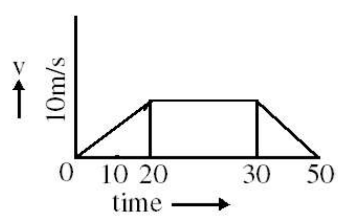
36. Two bodies are projected with the same velocity. One body is projected at an angle of 30^0 and the other at an angle of 60^0 to the horizontal. The ratio of the maximum heights reached is
(EAMCET-1995E)
1) 3:1 2) 1:3 3) 1:2 4) 2:1

37. A gun is fired aiming at a target. At the moment of firing, the target is released and freely falls under gravity. Then the bullet**(EAMCET-1995E)**
1) will miss the target by passing above it.
2) hits the target.
3) will miss the target by passing below it.
4) may or may not hit.

38. An aeroplane is flying horizontally at 98 m/s and releases an object which reaches the ground in 10s. The angle made by it while hitting the ground is **(EAMCET-1994)**
1) 55^0 2) 45^0 3) 60^0 4) 75^0

39. A starts from rest and moves with acceleration a_1. Two seconds later, B starts from rest and moves with an acceleration a_2. If the displacement of A in the 5^{th} second is the same as that of B in the same interval, the ratio of a_1 to a_2 is **(EAMCET-1994)**
1) 9:5 2) 5:9 3) 1:1 4) 1:3

40. The velocity time graphs of a body is as shown. The displacement suffered by it is**(EAMCET-1994E)**



1) 300m 2) 400m 3) 250m 4) 200m

41. A passenger in a moving train tossed a coin vertically upwards. The coin falls ahead of him in the direction of motion of the train. Then, the train must be moving with **(EAMCET-1994)**
1) Deceleration 2) Acceleration
3) Moving with uniform velocity
4) At rest

42. A ball is thrown vertically upwards with a speed of 10 m/s from the top of the tower 200m high and another is thrown vertically downwards with the same speed simultaneously. The time difference between them in reaching the ground is ($g=10\ m/s^2$) **(EAMCET-1994)**
1) 12s 2) 6s 3) 2s 4) 1s

43. A body travels 200cm in the first two seconds and 220cm in the next 4 seconds with deceleration. The velocity of the body at the end of the 7^{th} second is **(EAMCET-1994)**
1) 20 cm/s 2) 15 cm/s 3) 10 cm/s 4) 0 cm/s

44. A bomb travelling in a parabolic path under the effect of gravity, explodes in mid-air. The centre of mass of the fragments will**(EAMCET-1993)**
1) move vertically upwards and then vertically downwards
2) move vertically downwards
3) move in irregular path
4) move in the parabolic path, the unexplored bomb would have travelled

45. A particle starts moving from rest under uniform acceleration. It travels a distance 'x' in the first two seconds and a distance 'y' in the next two seconds. If y = nx, then n= **(EAMCET-1993)**
1) 1 2) 2 3) 3 4) 4

46. The distance moved by a freely falling body (starting from rest) during the 1st, 2nd and 3rd ... nth second of its motion, are proportional to
(EAMCET-1992)
1) (n-1) 2) (2n-1) 3) (n^2-1) 4) $(2n-1)/n^2$

47. An aeroplane moving horizontally with a speed of 180 kmph drops a food packet while flying at a height of 490m. The horizontal range is
(EAMCET-1992)
1) 180m 2) 980m 3) 500m 4) 670m

48. A body freely falling from rest has a velocity 'v' after it falls through a distance 'h'. The distance it has to fall down further, for its velocity to become double ...... is times h.**(EAMCET-1992)**
1) 4h 2) 3h 3) h 4) 16h

49. A boat is moving with a velocity (3i+4j) with respect to ground. The water in the river is moving with a velocity (-3i-4j) with respect to ground. The relative velocity of boat with respect to water is **(EAMCET-1991)**
1) 6i+8j 2) zero 3) 6i 4) 8j

50. A body of mass 'm' thrown horizontally with a velocity 'v' form the top of a tower of height 'h' touches the level ground at a distance of 250m from the foot of the tower. A body of mass 2m, thrown horizontally with a velocity v/2 from the top of a tower of height 4h will touch the level ground at a distance of .... m from the foot of the tower**(EAMCET-1991)**
1) 250m 2) 500m 3) 125m 4) 1000m

51. A wooden block of mass 10 gm is dropped from the top of a cliff 100 m high. Simultaneously a bullet of mass 10 gm is fired from the foot of the cliff upward with a velocity 100 m/s. The bullet and the wooden block will meet each other after a time of **(EAMCET-1991)**

1) 10s 2) 0.5s 3) 1s 4) 7s

KEY

1) 3	2) 3	3) 3	4) 1	5) 1
6) 4	7) 1	8) 3	9) 4	10) 4
11) 4	12) 2	13) 1	14) 1	15) 3
16) 2	17) 1	18) 1	19) 2	20) 2
21) 3	22) 3	23) 4	24) 1	25) 4
26) 3	27) 3	28) 2	29) 1	30) 2
31) 2	32) 2	33) 1	34) 4	35) 4
36) 2	37) 2	38) 2	39) 2	40) 1
41) 1	42) 3	43) 3	44) 4	45) 3
46) 2	47) 3	48) 2	49) 1	50) 1
51) 3				

HINTS

2. $t_1+t_2=\frac{2u}{g};\quad u=\frac{g(t_1+t_2)}{2}$

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

3. $\tan\theta=10$

$\sin\theta=1,\ \cos\theta=\frac{1}{10}$

$\frac{g}{2u^2\cos^2\theta}=\frac{5}{9}$

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

4. $u\cos\theta=6;\ u\sin\theta=8$

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

5. $\frac{\tan\theta}{4}=\frac{h}{R};\ h=\frac{u^2\sin^2\theta}{2g}$

6. $h\,\alpha\sin^2\theta$

7. $\tan\theta=\frac{u\sin\theta}{u\cos\theta}=\frac{48}{36}=\frac{4}{3}$

$\therefore\sin\theta=\frac{4}{5}$

8. $u\cos\theta=\frac{1}{2}at^2$

9. $x=(u\cos\theta)t,\ y=(u\sin\theta)t-\frac{1}{2}gt^2$

10. $y=(\tan\theta)x-\frac{g}{2u^2\cos^2\theta}x^2$

11. $v=u+at$

12. $T=\frac{2u\sin\theta}{g}$

13. $h_1=h_2$

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

15. $R=u\sqrt{\frac{2h}{g}}$

17. $R=4h\cot\theta$

18. $R=\frac{u^2\sin 2\theta}{g},\ T=\frac{2u\sin\theta}{g}$

19. $v^2-u^2=2as$

22. $u\cos\theta=\frac{\sqrt{3}}{2}u$

23. $h=\frac{1}{2}gt^2$

24. $v=\alpha t_1$ and $v=\beta t_2$

25. vector addition

26. $t=\sqrt{\frac{2h}{g}}+\frac{s}{v_{sound}}$

27. $R=u\sqrt{\frac{2h}{g}}$

28. $t_a=t_d$

29. $v=u+at$

30. $h=\frac{u^2}{2g}$

33. $a=\frac{d^2s}{dt^2}$

38. $R=u\sqrt{\frac{2h}{g}}$

42. $t=\frac{2u}{g}$

43. Apply $S=ut+\frac{1}{2}at^2$ twice

48. $v^2\,\alpha\,h$

49. $v=v_1-v_2$

OTHER COMPETITIVE EXAMINATION QUESTIONS :

1. A person travels along a straight road for the first half length with constant speed v_1 and the second half length with a constant speed v_2. Average speed v is **(CPMT 92)**

1) $\frac{v_1 v_2}{2(v_1+v_2)}$ 2) $\frac{2(v_1+v_2)}{v_1 v_2}$

3) $\frac{2(v_1 v_2)}{v_1+v_2}$ 4) $\frac{v_1+v_2}{2(v_1 v_2)}$

2. A motorist travels from A to B at a speed of 40 kmph and returns back at a speed of 60 kmph. His average speed will be **(CBSE 1990)**

1) 40 kmph 2) 48 kmph
3) 50 kmph 4) 60 kmph

3. Velocity of a body in time 't' is according to the equation ($v=20+0.1t^2$). The body is undergoing **(MNR 95)**

1) Uniform acceleration
2) Uniform retardation
3) Non uniform acceleration
4) Zero acceleration

4. A point moves with uniform acceleration v_1, v_2 and v_3 denote the average velocities in three successive intervals of time t_1, t_2 and t_3. Correct relation among the following is **(NCERT 82)**

1) $(v_1-v_2) : (v_2-v_3) = (t_1-t_2) : (t_2-t_3)$
2) $(v_1-v_2) : (v_2-v_3) = (t_1+t_2) : (t_2+t_3)$
3) $(v_1-v_2) : (v_2-v_3) = (t_1-t_2) : (t_2+t_3)$
4) $(v_1-v_2) : (v_2-v_3) = (t_1+t_2) : (t_2-t_3)$

5. An election starting from rest has a velocity that increases linearly with time that is v=kt where $k=2m/s^2$. Distance covered in first 3s will be **(NCERT 82)**

1) 9m 2) 16m 3) 27m 4) 36m

6. A car moving at a speed of 20 m/s is subjected to a uniform retardation of 5 m/s^2. It stops in a time of **(NCERT 67)**

1) 100s 2) 4s 3) 3s 4) 5s

7. Initial velocity of a particle moving along a straight line is 10 m/s and its retardation is 2 m/s^2. Distance covered by the particle in the 5th 's' of its motion is **(CPMT 76)**

1) 1m 2) 19m 3) 50m 4) 75m

8. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a certain distance with velocity of 30 kmph and 40 kmph respectively. Velocity of the car exactly midway between P and Q is **(CBSE 93)**

1) 33.3 kmph 2) 20 kmph
3) 25 kmph 4) 35 kmph

9. A particle starts moving from the position of rest under a constant acceleration. It travels a distance 'x' in the first 10s, a distance 'y' in the next 10s then **(NCERT 72)**

1) y = 3x 2) y = 2x 3) y = x 4) y = 4x

10. Tripling the speed of a motor car multiples the distance needed for stopping it by **(NCERT78)**

1) 3 2) 6 3) 9 4) some other number

11. A car travelling at a speed of 30 kmph is brought to rest in 8m by applying brakes. If the same car is travelling at 60 kmph, it can be brought to halt with the same breaking force in a distance **(CPMT 71)**

1) 8m 2) 16m 3) 24m 4) 32m

12. A body sliding on a smooth inclined plane requires 4s to reach the bottom starting from rest at the top. Time taken by it to cover one fourth of the distance starting from rest at the top is **(NCERT 77)**

1) 1s 2) 2s 3) 4s 4) 16s

13. A body, freely falling under gravity will have uniform **(NCERT 69)**

1) speed 2) velocity
3) momentum 4) acceleration

14. Two bodies of different masses m_a and m_b are dropped from two different heights viz 'a' and 'b'. Ratio of times taken by the two, to drop through these distances is **(NCERT 72)**

1) a : b 2) $\sqrt{b} : \sqrt{a}$ 3) $\sqrt{a} : \sqrt{b}$ 4) $a^2 : b^2$

15. A body let fall from the top of a building reaches the ground in 3s. Height of the building is **(CPMT 84)**

1) 14.7m 2) 24.4m 3) 44.1m 4) 66.2m

16. A ball released from a height 'h' touches the ground in 't's. After $\frac{t}{2}$ s since dropping, the height of the body from the ground **(NCERT 81)**

1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{3h}{4}$

4) Depends upon mass and volume of ball.

17. A body is released from certain height and falls freely towards the earth. Exactly 1s later another body is released. Distance between the two bodies 2s after the release of the second body is **(CPMT 83)**

1) 4.9m 2) 9.8m 3) 24.5m 4) 50m

18. Distances covered by a freely falling body (starting from rest) during 1st, 2nd, 3rd .... nth of its motion are proportional to **(CPMT 91)**

1) even numbers 2) odd numbers
3) all integral numbers
4) square of integral numbers

19. A body throws balls vertically upwards. He throws one, while the previous one is at its highest point. Maximum height reached by a ball if he throws one ball each per second at uniform speed is **(NCERT 69)**
1) 19.6m 2) 9.8m 3) 4.9m 4) 2.45m

20. A pebble is thrown vertically upwards from a bridge with an initial velocity of 4.9 m/s. It strikes the water after 2s. Height of the bridge is **(NCERT 69)**
1) 19.6m 2) 14.7m 3) 9.8m 4) 4.9m

21. A bullet is fired horizontally with a velocity 400 m/s from the top of a tower. At the same time a stone is dropped from the same point. Then **(CPMT 85)**
1) Stone will reach the ground first
2) Bullet will reach the ground first
3) Both will reach the ground at same time
4) Their times of fall depend on 'g'

22. A stone is dropped into a lake from a lower 500m high. The sound of the splash will be heard by a man on the tower after a time of (velocity of sound in air=350 m/s) **(CPMT 92)**
1) 21s 2) 10s 3) 11.4s 4) 1s

23. A lead sphere of mass 20 kg has the same diameter as an aluminium sphere of mass 72 kg. The spheres are simultaneously dropped from a lower. When they are 10m from the ground, they have identical **(CPMT 77)**
1) Kinetice energy 2) Potential energy
3) Momentum 4) Acceleration

24. The displacement time graph for two particles A and B are straight lines inclined at angles of 30^0 and 60^0 with the time axis. The ratio of the speeds V_A and V_B is **(CPMT 90)**
1) 1:2 2) $1:\sqrt{3}$ 3) $\sqrt{3}:1$ 4) 1:3

25. Height 'y' and distance 'x' along horizontal plane of a projectile on a certain plane are given by x = 6t(m) and y = 8t-5t^2(m). Velocity of projection of the projectile is **(CPMT 81)**
1) 8 m/s 2) 6 m/s 3) 10 m/s 4) 0 m/s

26. In the above problem the direction of velocity of projection with respect to x-axis is **(CPMT 81)**
1) $\tan^{-1}(3/4)$ 2) $\tan^{-1}(4/3)$
3) $\sin^{-1}(3/4)$ 4) $\cos^{-1}(3/4)$

27. In the above problem, acceleration due to gravity is **(CPMT 81)**
1) -10 m/s^2 2) 5 m/s^2
3) 20 m/s^2 4) 2.5 m/s^2

28. A bomb is released by a horizontally flying aeroplane. The trajectory of the bomb is **(CPMT 93)**
1) straight line 2) parabola
3) hyperbola 4) circle

29. A ball is thrown upwards and returns to the ground describing a parabolic path. The quantity remaining constant among the following **(NCERT 73)**
1) Kinetic energy of the ball
2) The speed of the ball
3) The vertical component of velocity
4) The horizontal component of velocity

30. If a body of mass 'M' is thrown with a velocity 'v' at an angle of 30^0 to the horizontal and another body 'B' of the same mass is thrown at an angle of 60^0 to the horizontal. The ratio of range of 'A' to that of 'B' will be **(CBSE 92)**
1) 1:2 2) 2:1 3) 1:3 4) 1:1

31. It was calculated that a shell when fired from a gun with certain velocity and at an angle of elevation $\frac{5\pi}{36}$ radian should strike a given target in actual practice, it was found that a hill just intervened the trajectory. The angle of elevation at which the gun should be fired in order to hit the target is **(CBSE 92)**
1) $\frac{5\pi}{36}$ radian 2) $\frac{7\pi}{36}$ radian
3) $\frac{11\pi}{36}$ radian 4) $\frac{13\pi}{36}$ radian

32. A cricket ball is hit for a six leaving the bat at an angle of 45^0 to the horizontal with kinetic energy 'k'. At the top, K.E. of the ball is **(NCERT 84)**
1) Zero 2) k 3) $\frac{k}{2}$ 4) $\frac{k}{\sqrt{2}}$

33. A person standing at some distance from a high tree, throws a stone taking aim at a fruit hanging from that tree. The fruit begins to fall freely at the time, when the person throws the stone. Correct statement among the following is **(CPMT 91)**
1) The stone moves above the falling fruit.
2) The stone strikes the fruit if the stone is thrown with a definite velocity.
3) The stone moves below the falling fruit.
4) The stone always hit the fruit.

34. 150m long train is moving towards north at a speed of 10 m/s. A parrot flying towards south with a speed of 5 m/s crossed the train. The time taken by the parrot to cross the train would be **(CBSE 92)**
1) 30s 2) 15s 3) 8s 40 10s

35. A cricket ball is hit at 45^0 to the horizontal with a kinetic energy K. The kinetic energy at the highest point is **(CBSE 92)**
1) K 2) K/2 3) $K\sin 45^0$ 4) 0

36. A bus accelerates uniformly from rest and acquires a speed of 75 km/hr in 20seconds. The accelearation of the bus is **(AIEEE 2002)**
1) 10 m/s^2 2) 5 m/s^2
3) 2 m/s^2 4) 1 m/s^2

37. A car moves along a straight line whose motion is given by $S=12t+3t^2-2t^3$, where s is in meters and 't' is in seconds. The velocity of the car at the start will be **(AIEEE 2002)**
1. 7 m/s 2) 9 m/s 3) 12 m/s 4) 16 m/s

38. Two cars 1 & 2 starting from rest are moving with speeds V_1 *and* V_2 m/s $(V_1>V_2)$. Car 2 is ahead of car '1' by s meter when the driver of the car '1' sees car '2'. What minimum retardation should be given to car '1' to avoid collision.
(AIEEE 2002)
1) $\frac{V_1-V_2}{S}$ 2) $\frac{V_1+V_2}{S}$
3) $\frac{(V_1+V_2)^2}{2S}$ 4) $\frac{(V_1-V_2)^2}{2S}$

39. From a building two balls A & B are thrown such that A is thrown upwards and B downwards (both vertically). If V_A and V_B are their respective velocities on reaching the ground then
(AIEEE - 2002)
1) $V_B<V_A$ 2) $V_A=V_B$ 3) $V_A>V_B$
4) Their velocities depends on their masses.

40. If a body looses half of its velocity on penetrating 3cm in a wooden block, then how much will it penetrate more before coming to rest **(AIEEE - 2002)**
1) 1 cm 2) 2cm 3) 3cm 4) 4cm

41. Speeds of two identical cars are U and 4U at a specific instant. The ratio of the respective deistance in which the two cars are stopped from that instant is **(AIEEE - 2002)**
1) 1:1 2) 1:4 3) 1:8 4) 1:16

42. A car moving with a speed of 50km/hr can be stopped by brakes after atleast 6m. If the same car is moving at a speed of 100km/hr, the minimum stopping distance is **(AIEEE - 2003)**
1) 12m 2) 18m 3) 24m 4) 6m

43. A boy playing on the roof a of a 10m high building thrown a ball with a speed of 10m/s at an angle 30^0 with horizontal. How far from the throwing piont will the ball be at the height of 10m from the ground $\left(g=10m/s^2\right)$ **(AIEEE 2003)**
1) 5.20m 2) 4.33m 3) 2.60m 4) 8.66m

44. 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 **(AIEEE - 2003)**
1) $3t\sqrt{\alpha^2+\beta^2}$ 2) $3t^2\sqrt{\alpha^2+\beta^2}$
3) $t^2\sqrt{\alpha^2+\beta^2}$ 4) $\sqrt{\alpha^2+\beta^2}$

45. A ball is released from the top of a tower of height h metre. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds.
(AIEEE - 2004)
1) h/9 metres from the ground
2) 7h/9 metres from the ground
3) 8h/9 metres from the ground
4) 17h/18 metres from the ground

46. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two time of flights is directely proportional to **(AIEEE - 2004)**
1) $1/R^2$ 2) $1/R$ 3) R 4) R^2

47. An automobile travelling with a speed of 60km/h. can brake to stop with in a distance of 20m. If the car is going twice as fast i.e., 120km/h the stopping distance will be **(AIEEE - 2004)**
1) 20 m 2) 40 m 3) 60 m 4) 80 m

48. A ball is thrown from a point with a speed V_0 at an angle of projection θ. From the same point and at the same instant a person starts running with a constant speed $V_0/2$ to catch the ball . Will the person be able to catch the ball ? If yes, what should be the angle of projection ?**(AIEEE - 2004)**
1) $yes, 60^0$ 2) $yes, 30^0$
3) no 4) $yes, 45^0$

49. The relation between time t and distance x is $t=ax^2+bx$, where a and b are constants. The acceleration is : **(AIEEE - 2005)**
1) $-2abv^2$ 2) $2bv^3$ 3) $-2av^3$ 4) $2av^2$

50. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerate at the rate $\frac{f}{2}$ to come to rest. If the total distance travelled is 15 S, then **(AIEEE - 2005)**
1) $S=ft$ 2) $S=\frac{1}{6}ft^2$
3) $S=\frac{1}{72}ft^2$ 4) $S=\frac{1}{4}ft^2$

$5ms^{-1}$. In 10 seconds the velocity changes to

$5ms^{-1}$ northwards. The average acceleration in this time is : **(AIEEE - 2005)**

1) $\frac{1}{\sqrt{2}}ms^{-2}$ N-W 2) $\frac{1}{2}ms^{-2}$ North

3) zero 4) $\frac{1}{2}ms^{-2}$ N-E

52. A parachutist after bailig out falls 50m without friction. When parachute opens, it decelerates at $2m/s^2$. He reaches the ground with a speed of $3m/s^2$. At what height, did he bail out ? **(AIEEE - 2005)**

1) 91m 2) 182m 3) 293m 4) 111m

KEY

1) 3	2) 2	3) 1	4) 2	5) 1
6) 2	7) 1	8) 4	9) 1	10) 3
11) 4	12) 2	13) 4	14) 3	15) 3
16) 3	17) 3	18) 2	19) 2	20) 3
21) 3	22) 4	23) 4	24) 3	25) 3
26) 2	27) 1	28) 2	29) 4	30) 4
31) 4	32) 3	33) 4	34) 4	35) 2
36) 4	37) 3	38) 4	39) 2	40) 1]
41) 2	42) 3	43) 4	44) 2	45) 3
46) 3	47) 4	48) 1	49) 3	50) 3
51) 1	52) 2			

NEW MODEL QUESTIONS

TRUE OR FALSE TYPE QUESTIONS

1. A particle constrained to move on a straight line path. It returns to the starting point after 10 s. The total distance covered by the particle during this time is 30m. Which of the following statements about the motion of the particle is false ?
a) displacement of the particle is zero
b) average speed of the particle is $3ms^{-1}$
c) displacement of the particle is 15m
d) Average velocity is $3ms^{-1}$
1) a 2) b 3) c 4) d

2. Consider the following statements A and B and identify the correct answer
A) A body falling freely under the action of gravity does not have one dimensional motion.
B) A body moving uniformly in one frame may be accelerating in some other frame of reference.
1) both A & B are true 2) A is true but B is false
3) B is true but A is false4) both A & B are false

3. Consider the following statements A and B and identify the correct answer.
A) The speed acquired by a body when falling in a vacuum for a given time is dependent on the mass of the falling body.
B) A stone falls freely from rest and the total distance covered by it in the last second of its motion equals the distance covered by it in the first three seconds of its motion. The stone remains in the air for 5s. [$g=10ms^{-2}$]
1) both A & B are true 2) A is true but B is false
3) B is true but A is false 4) both A & B are false

4. Consider the following statements A and B and identify the correct answer.
A) Two balls of different masses are thrown vertically upwards with the same initial velocity. They rise to the same maximum height above the ground.
B) Two balls of different masses are thrown vertically upwards with the same speed. They pass through the point of projection in their downward motion with the same speed. (neglect air resistance)
1) both A & B are true 2) A is true but B is false
3) B is true but A is false 4) both A & B are false

5. A man standing at the top of a tower has two spheres A and B. He drops sphere A downwards and throws sphere B horizontally at the same time. Which of the following is correct ?
a) both the spheres will reach the ground simultaneously
b) A will reach the ground first
c) B will reach the ground first
1) a is correct 2) b is correct
3) c is correct 4) none

6. A body is projected up with a speed 'u' and the time taken by it is 'T' to reach the maximum height 'H'. Pick out the correct statement.
a) It reaches H/2 in T/2 s.
b) It acquires velocity u/2 in T/2 s.
c) Its velocity is u/2 at H/2
d) same velocity at 2T
1) a is correct 2) b is correct
3) c is correct 4) d is correct

7. Consider the following statements A and B and identify the correct answer
A) The speed of the oblique projectile is minimum at the top of the path.
B) In case of a projectile motion, if the range 'R' is 'n' times the maximum height 'H' then the angle of projection 'θ' is equal to $\tan^{-1}(4/n)$
1) both A & B are true 2) A is true but B is false
3) B is true but A is false 4) both A & B are false

8. The position of a particle moving in the XY-plane at any time 't' is given by $x = (3t^2 - 6t)m$; $y = (t^2 - 2t)m$. Select the correct statement about the moving particle from the following
a) The acceleration of the particle is zero at t = 0 second
b) The velocity of the particle is zero at t = 0 second
c) The velocity of the particle is zero at t = 1 second
d) The velocity and acceleration of the particle are never zero

9. Consider the following statements A and B and identify the correct answer

A) The maximum range 4 times the maximum height attained during its flight in the case of a projectile.

B) In the case of a projectile the range 'R' is related to the time of flight 'T' as $R = 5T^2$. If $g = 10ms^{-2}$, the angle of projection is 45^0

1) both A & B are true 2) A is true but B is false
3) B is true but A is false 4) both A & B are false

MATCHING TYPE QUESTIONS

10. Study the following

List - I	List - II
a)A body covers first	e)Average velocity is half of distance with $\sqrt{\frac{gh}{2}}$ a speed V_1 and second half of distance with a speed V_2.
b)A body covers first	f) Average speed is half of a time with $\frac{V_1+V_2}{2}$ a speed V_1 and second half of a time with a speed V_2.
c)A body is projected	g) Average speed is vertically up from $\frac{2V_1V_2}{V_1+V_2}$ ground with certain velocity. Considering its total motion.
d)A body freely	h) Average velocity is released from zero a height 'h'.

The correct match is

1) $a \to f; b \to g; c \to e; d \to h$
2) $a \to g; b \to f; c \to h; d \to e$
3) $a \to h; b \to g; c \to h; d \to e$
4) $a \to e; b \to f; c \to h; d \to g$

11. Study the following.

List - I	List - II
a) Constant speed and varying velocity	I) At height point of body projected vertically up
b) Zero displacement and finite distance	II)Uniform circular motion
c)Zero velocity and finite acceleration	III) At any intermediate point of freely falling body.
d)Non-zero velocity and non-zero	IV)Body on reaching point of projection acceleration.

The correct match is

	a	b	c	d
1)	IV	II	III	I
2)	II	IV	I	III
3)	III	I	IV	II
4)	I	III	II	IV

12. Angle between velocity and acceleration vectors in the following cases.

List - I	List - II
a) Vertically projected body	e) 90^0
b) For freely falling body	f) changes from point to point
c) For projectile	g) zero
d) In uniform circular motion	h) 180^0

The correct match is

1) $a \to h; b \to g; c \to f; d \to e$
2) $a \to f; b \to g; c \to h; d \to e$
3) $a \to e; b \to f; c \to h; d \to g$
4) $a \to g; b \to h; c \to e; d \to f$

13. Study the following

List - I	List - II
a) Horizontal motion of a projectile	e) zero velocity
b) Freely falling body	f)retarded motion from a small height
c) Parachutist	g) uniform descending down acceleration from an aeroplane
d)Maximum height of	h) uniform velocity a body thrown vertically up

The correct match is

1) $a \to g; b \to f; c \to h; d \to e$
2) $a \to h; b \to g; c \to f; d \to e$
3) $a \to e; b \to h; c \to f; d \to g$
4) $a \to f; b \to e; c \to g; d \to h$

14. Study the following

List - I	List - II
a) One dimensional motion with uniform	e) $Y = kx^2$ where 'k' is a constant acceleration
b) Equation of trajectory of horizontal projection	f)$Y = Bx - Cx^2$ where B & C are constants
c)Equation of projection	g)Velocity= trajectory of oblique $k\sqrt{\text{displacement}}$ where 'k' is a constant
d) Relation between	h) $R = 4H\tan\theta$ maximum height

Range (R) and angle of projection (θ)

i) $R = 4H \cot\theta$

The correct match is

1) $a \to e; b \to g; c \to f; d \to i$

2) $a \to e; b \to g; c \to f; d \to h$

3) $a \to g; b \to e; c \to f; d \to i$

4) $a \to g; b \to e; c \to f; d \to h$

15. Match List I with List II for a projectile

List - I	List - II
a) For two angles θ and $(90-\theta)$ with same magnitude of velocity of projection	e) $\frac{P\vec{i}.P\vec{i}}{g}$
b) Equation of parabola of a projectile $y = Px - Qx^2$	f) Maximum height = 25% of $\frac{P^2}{Q}$
c) Radius of curvature of a body projected with velocity $(P\vec{i}+Q\vec{j})\,ms^{-1}$ at highest point	g) Range = Maximum height
d) Angle of projection $\theta = \tan^{-1}(4)$	h) Range is same

The correct match is

1) $a \to f; b \to h; c \to g; d \to e$

2) $a \to h; b \to f; c \to e; d \to g$

3) $a \to e; b \to g; c \to f; d \to h$

4) $a \to e; b \to g; c \to h; d \to f$

ORDER ARRANGING TYPE QUESTIONS

16. The velocity of a body as a function of time is $V = t^3 - 6t^2 + 10t + 4$. Set the accelerations of a body in increasing order at given times
a) t = 0 sec b) t = 1 sec c) t = 5 sec
1) b, a, c 2) a, b, c 3) c, b, a 4) c, a, b

17. Three bodies are projected in three ways with same speed from top of a tower. Set the times of reaching ground by them in increasing order
a) vertically up b) vertically down
c) horizontally
1) b, a, c 2) c, a, b 3) b, c, a 4) a, b, c

18. From the top of a tower two bodies are projected with the same initial speed of $40ms^{-1}$, first body vertically upwards and second body vertically downwards. A third body is freely released from the top of the tower. If their respective times of flights are T_1, T_2 and T_3, identify the correct descending order of the times of flights.
1) T_1, T_2, T_3 2) T_2, T_3, T_1
3) T_2, T_1, T_3 4) T_1, T_3, T_2

19. Set the ranges for following projectiles in increasing order for same velocity of projection.
a) $\theta = 15^0$ b) $\theta = 45^0$ c) $\theta = 55^0$ d) $\theta = 85^0$
1) d, a, c, b 2) a, b, c, d
3) d, c, b, a 4) b, c, a, d

20. A body is projected from a point with different angles of projections $20^0, 35^0, 45^0, 60^0$ with the R_1, R_2, R_3 and R_4. Identify the correct order in which the horizontal ranges are arranged in increasing order
1) R_1, R_4, R_2, R_3 2) R_2, R_1, R_4, R_3
3) R_1, R_2, R_4, R_3 4) R_4, R_1, R_2, R_3

ASSERTION AND REASON TYPE QUESTIONS

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

21. **A:** If the distance travelled by body is directly proportional to the square of time taken, then its speed is increasing with time.
R: The speed is equal to the time rate of change of distance.
1) A 2) B 3) C 4) D

22. **A :** The displacement time graph of a body moving with uniform velocity is a straight line.
R : The displacement is proportional to time.
1) A 2) B 3) C 4) D

23. **A :** Average velocity of the body may be equal to its instantaneous velocity.
R : The body having uniform motion in one dimension.
1) A 2) B 3) C 4) D

24. **A :** The relative velocity between the bodies is equal to sum of the velocities of two bodies.
R: Some times, relative velocity between two bodies is equal to difference in velocities of the two
1) A 2) B 3) C 4) D

25. **A:** A body can have acceleration even if its velocity is zero at a given instant of time.
R : A body is momentarily at rest when it reverse its direction of motion.
1) A 2) B 3) C 4) D

26. **A:** In retarded motion the displacement and acceleration are in opposite directions.
R: Acceleration is rate of change of velocity
1) A 2) B 3) C 4) D

27. **A:** A hydrogen filled balloon stops rising after it has attained a certain height in the sky.
R: The atmospheric pressure decreases with height and becomes zero when maximum height is attained.
1) A 2) B 3) C 4) D

28. **A** : The size of a hydrogen balloon increases as it rises in air.
R : The material of the balloon can be easily stretched.
1) A 2) B 3) C 4) D

29. **A:** A ball is projected with $60ms^{-1}$ at 60^0 with the horizontal simultaneously a toy car starts moving with $30ms^{-1}$ from the same point and in the same horizontal direction as the ball moves. The ball always lies above the toy car.
R : Bodies moving with same uniform velocity cover equal displacements in equal intervals of time.
1) A 2) B 3) C 4) D

30. **A:** For a body projected horizontally from the top of a tower, the velocity on reaching the ground depends both on velocity of projection and height of the tower.
R: For a projectile velocity varies both in horizontal and vertical directions.
1) A 2) B 3) C 4) D

31. **A:** If a bomb is dropped from an aeroplane moving horizontally with constant velocity then the bomb appears to move along a vertical straight line for the pilot of the plane.
R: Horizontal component of velocity of the bomb remains constant and same as the velocity of the plane during the motion under gravity.
1) A 2) B 3) C 4) D

32. **A:** Time taken by the bomb to reach the ground from a moving aeroplane depends on height of aeroplane only.
R: Horizontal component of velocity of the bomb remains constant and vertical component of vertical of bomb changes due to gravity.
1) A 2) B 3) C 4) D

33. **A:** Only vertical component of velocity of a projectile is known, time of flight can be calculated but horizontal range cannot be calculated.
R: Time of flight depends on horizontal component and range depends on vertical component of velocity projection.
1) A 2) B 3) C 4) D

34. **A:** In case of projectile the angle between velocity and acceleration changes from point to point.
R: Because its horizontal component of velocity remains constant while vertical component of velocity changes from point to point due to acceleration due to gravity.
1) A 2) B 3) C 4) D

35. **A:** In projectile motion, the angle between the instantaneous velocity and acceleration at the height point is 180^0.
R: At the highest point, velocity of projectile will be in horizontal direction only.
1) A 2) B 3) C 4) D

36. **A:** The path followed by one projectile as observed by another projectile is a straight line.
R: The relative velocity between two projectiles at a given place does not change with time.
1) A 2) B 3) C 4) D

37. **A:** When range of a projectile is maximum, its angle of projection may be 45^0 or 135^0.
R: Horizontal range $= \dfrac{u^2 \sin 2\theta}{g}$. When $\theta = 45^0$ or 135^0 the range is same.
1) A 2) B 3) C 4) D

38. **A:** When a body is projected at an angle 45^0, its maximum height is half than that of horizontal range.
R: Horizontal range $= \dfrac{u^2 \sin 2\theta}{g}$ and maximum height $= \dfrac{u^2 \sin^2 \theta}{2g}$
1) A 2) B 3) C 4) D

39. **A:** The horizontal displacement of a projectile varies linearly with time.
R : Projectile motion is uniform motion along horizontal and accelerated motion along vertical.
1) A 2) B 3) C 4) D

40. **A:** If a body is projected obliquely at angle 'θ' above horizontal with initial speed 'u' then its speed at the instant when its velocity makes an angle 'α' above the horizontal is $\left(\dfrac{u\cos\theta}{\cos\alpha}\right)$
R: Horizontal component of velocity of projectile remains constant.
1) A 2) B 3) C 4) D

KEY

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