1. If displacement of a particle is directly proportional to the square of time. Then particle is moving with
(a) Uniform acceleration
(b) Variable acceleration
(c) Uniform velocity
(d) Variable acceleration but uniform velocity

2. A body of mass 10 kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 sec on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is
(a) $3\ m/s^2$ (b) $-3\ m/s^2$
(c) $0.3\ m/s^2$ (d) $-0.3\ m/s^2$

3. A body starts from rest. What is the ratio of the distance travelled by the body during the 4^{th} and 3^{rd} second.
(a) 7/5 (b) 5/7 (c) 7/3 (d) 3/7

4. A very large number of balls are thrown vertically upwards in quick succession in such a way that the next ball is thrown when the previous one is at the maximum height. If the maximum height is 5m, the number of ball thrown per minute is (take $g = 10\,ms^{-2}$)
(a) 120 (b) 80 (c) 60 (d) 40

5. By which velocity a ball be projected vertically downward so that the distance covered by it in 5th second is twice the distance it covers in its 6th second ($g = 10\,m/s^2$)
(a) $58.8\,m/s$ (b) $49\,m/s$
(c) $65\,m/s$ (d) $19.6\,m/s$

6. A ball is thrown up with a certain velocity so that it reaches a height h. Find the ratio of the times in which it is a h/3.
(a) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (b) $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ (c) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ (d) $\frac{1}{3}$

7. A particle is moving eastwards with a velocity 5 ms^{-1}. In 10 s, the velocity changes to 5 ms^{-1} northwards. The average acceleration in this time is
(a) $\frac{1}{\sqrt{2}}\,ms^{-2}$NE (b) $\frac{1}{2}\,ms^{-2}$N
(c) Zero (d) $\frac{1}{\sqrt{2}}\,ms^{-2}$NW

8. A particle moves according to the equation $x = 2t^2 - 5t + 6$. Find (i) average velocity in the first 3 sec and (ii) velocity at t = 3 s.
(a) 1 ms^{-1}, 7 ms^{-1} (b) 4 ms^{-1}, 3 ms^{-1}
(c) 2 ms^{-1}, 5 ms^{-1} (d) 3 ms^{-1}, 7 ms^{-1}

9. Two cars A and B are 5 m long each. Car A is at any instant just behind B. A and B are moving at 54 km/h and 36 km/h. Find the road distance covered by the car A to overtake B.
(a) 35 m (b) 30 m (c) 32.5 m (d) 27.5 M

10. The first stage of the rocket launches a satellite to a height of 50 km and velocity attained is 6000 kmh^{-1} at which point its fuel exhausted. How high the rocket will reach?
(a) 138.9 km (b) 188.9 km (c) 88.9 km (d) 168.9 km

11. A particle moves according to the equation $t = \sqrt{x} + 3$, when the article comes to rest for the first time
(a) 3s (b) 2.5 s (c) 3.5 s (d) None of these

12. A particle is projected with a velocity $6\hat{i}+8\hat{j}$, 2m away from a vertical wall. After striking the wall it lands at …………… away from the wall. B

(a) 3 m (b) 3.3 m (c) 5.5 m (d) 6.6 m

13. Six person are situated at the corners of a hexagon of side l. They move at a constant speed v. Each person maintains a direction towards the person at the next corner. When will the person meet?

(a) l/v (b) 2l/3v (c) 3l/2v (d) 2l/v.

14. A vehicle moves west with a speed of 50 ms^{-1} and then towards north with a speed of 50 ms^{-1} only. Total time taken by the body is 5s. What is the average acceleration of the body?

(a) 0 (b) 50ms^{-2} (c) 14ms^{-2} (d) 20.4 ms^{-2}

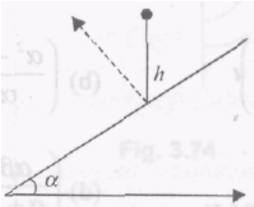
15. A particle experiences a fixed acceleration for 6s after starting from rest. It covers a distance of $s_1$in first two seconds, $s_2$in the next 2 seconds and $s_3$in the last 2 seconds then s_3: s_2: $s_1$is

(a) 1:3:5 (b) 5:3: 1 (c) 1:2:3 (d) 3 :2 :1

16. An aeroplane drops a parachutist. After covering a distance of 40 m, he opens the parachute and retards at 2 ms^{-2}. If he reaches the ground with a speed of 2 m^{-1}, he remains in the air for about

(a) 16s (b) 3s (c) 13 s (d) 10 s

17. A marble starts falling from rest on a smooth inclined plane of inclination α. After covering distance h the ball rebounds off the plane. The distance from the impact point where the ball rebounds for the second time is



(a) 8h cosα (b) 8h sin α (c) 2h tan α (d) 4h sin α

18. A particle is moving in a plane with velocity given by $\vec{u} = u_0\,\hat{i} + (a\omega\cos\omega t)\,\hat{j}$, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis, respectively. If the particle is at origin at t = 0, the distance from origin at time 3π/2 ω is

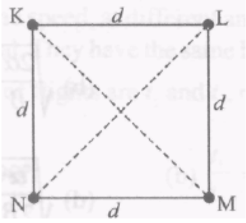
(a) $a^2 + \omega^2$ (b) $\left[(3\pi u_0/2\omega)^2 + a^2\right]^{1/2}$

(c) $\sqrt{a^2 + (2/3\pi u_0)^2}$ (d) $\sqrt{a^2 + (\pi u_0/\omega)^2}$

19. A particle in uniformly accelerated motion travels a, b and c distances in xth, yth, and zth second of its motion, respectively. Then a(y - z) + b(z - x) + c (x - y) =

(a) 1 (b) 0 (c) 2 (d) 3

20. Four persons K, L, M and N are initially at rest at four corners of a square of side d. Each person now moves with a uniform speed v in such a way that K always moves directly towards L, L directly towards M, M directly towards N and N directly towards K. Show that the four persons will meet at time t =



(a) 4d/v (b) 3d/v (c) 2d/v (d) d/v

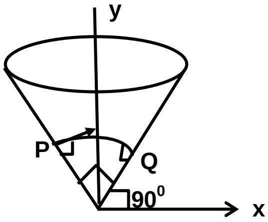
21. A particle is projected vertically upward with initial velocity 25 ms^{-1}. During third second of its motion, which of the following statement is correct?

(a) Displacement of the particle is 30 m

(b) Distance covered by the particle is 30 m

(c) Distance covered by the particle is 2.5 m
(d) None of these

22. A particle is projected from point P with velocity $5\sqrt{2}$ ms^{-1} perpendicular to the surface of a hollow right angle cone whose axis is vertical. It collides at Q normally. The time of the flight of the particle is



(a) 1 sec. (b) $\sqrt{2}$ sec. (c) 2 $\sqrt{2}$ sec (d) 2 sec

23. If a boat can have a speed of 4 km/hr in still water, for what values of speed of river flow, it can be managed to row boat right across the river, without any drift?
(a) $\geq$ 4 km/hr
(b) Greater than zero but less than 4 km/hr
(c) Only 4 km /hr
(d) None of these

24. A particle is projected horizontally from the top of a cliff of height H with a speed $\sqrt{2gH}$. The radius of curvature of the trajectory at the instant of projection will

(a) $\frac{H}{2}$ (b) H (c) 2H (d) ∞

25. Which of the following must be true for magnitude of average velocity of a body if v_1 and v_2 are magnitude of average speeds during successive time intervals t_1 and t_2 in which body covers distances d_1 and d_2 and displacements $\vec{s}_1$ and $\vec{s}_2$?

(a) $\left|\frac{v_1+v_2}{2}\right|$ (b) $\left|\frac{v_1t_1+v_2t_2}{\frac{d_1}{v_1}+\frac{d_2}{v_2}}\right|$

(c) $\left|\frac{\vec{s}_1+\vec{s}_2}{\frac{d_1}{v_1}+\frac{d_2}{v_2}}\right|$ (d) None of these

26. A car starts from rest to cover a distance s. The coefficient of friction between the road and the tyres is μ. The minimum time in which the car can cover the distance is proportional to -

(a) μ (b) $\sqrt{\mu}$ (c) $\frac{1}{\mu}$ (d) $\frac{1}{\sqrt{\mu}}$

27. A ball is dropped from top of a tower of height 'h'. It takes time 'T' to reach ground. What is height of the body from ground at time 'T/4' ?

(a) $\frac{h}{16}$ (b) $\frac{8h}{9}$ (c) $\frac{h}{4}$ (d) $\frac{15h}{16}$

28. A particle moves with a deceleration $\alpha\sqrt{v}$. Initial velocity is v_0. Find the time after which it will stop.
(a) $\sqrt{v_0}/k$ (b) $\sqrt{v_0}/2k$
(c) $2\sqrt{v_0}/k$ (d) None of these

29. A particle moves with an initial velocity v_0 and retardation kv, where v is the velocity at any time t.

(a) The particle will cover a total distance v_0/k

(b) The particle comes to rest at $t = 1/k$

(c) Particle continues to move for a long time

(d) At time $1/\alpha$, $v = v_0/2$

30. A car is travelling at a velocity of 10 kmh^{-1} on a straight road. The driver of car throws a parcel with a velocity of $10\sqrt{2}$ kmh^{-1} when car is passing by a man standing on the side of a road. If parcel just reaches the man, the direction of throw makes following angle with the direction of car

(a) 135^0 (b) 45^0 (c) $\tan^{-1}(\sqrt{2})$ (d) $\tan(1/\sqrt{2})$

1. (a)

Given that $x \propto t^2$ or $x = Kt^2$ (where K= constant)

Velocity (v) $= \frac{dx}{dt} = 2Kt$ and Acceleration (a) $= \frac{d\upsilon}{dt} = 2K$

It is clear that velocity is time dependent and acceleration does not depend on time.

So we can say that particle is moving with uniform acceleration but variable velocity.

2. (b)

Let particle moves towards east and by the application of constant force it moves towards west

$\vec{\upsilon}_1 = +10\ m/s$ and $\vec{\upsilon}_2 = -2\ m/s$.

Acceleration $= \frac{\text{Change in velocity}}{\text{Time}} = \frac{\vec{\upsilon_2} - \vec{\upsilon_1}}{t}$

$\Rightarrow$ $a = \frac{(-2)-(10)}{4} = \frac{-12}{4} = -3\ m/s^2$

3. (a)

As $S_n \propto (2n-1)$, $\frac{S_4}{S_3} = \frac{7}{5}$

4. (c)

Maximum height of ball = 5m, So velocity of projection

$\Rightarrow u = \sqrt{2gh} = \sqrt{2 \times 10 \times 5} = 10\,m/s$

time interval between two balls (time of ascent)

$= \frac{u}{g} = 1 sec = \frac{1}{60} min.$

So no. of ball thrown per min = 60

5. (c)

By formula $h_n = u + \frac{1}{2} g(2n-1)$

$\Rightarrow u - \frac{10}{2}[2 \times 5 - 1] = 2\{u - \frac{10}{2}[2 \times 6 - 1]\}$

$\Rightarrow u - 45 = 2 \times (u - 55) \Rightarrow u = 65\,m/s.$

6. (b)

$u^2 = 2gh$; $h/3 = \sqrt{2gh}\ t - 1/2\ gt^2$ or $gt^2 - 2$

$\sqrt{2gh}\,t + 2h/3 = 0$

$t = \frac{2\sqrt{2gh} \pm \sqrt{8gh - (8gh)/3}}{2g}$

or $\frac{t_1}{t_2} = \frac{2\sqrt{2gh} - 2\sqrt{2gh/3}\left(\sqrt{3}-1\right)}{2\sqrt{2gh} + 2\sqrt{2gh/3}\left(\sqrt{3}-1\right)}$

$= \frac{\sqrt{3} - \left(\sqrt{3}-1\right)}{\sqrt{3} + \left(\sqrt{3}-1\right)} = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$

7. (d)

$a_{av} = \frac{v_f - v_i}{t} = \frac{5i - 5\hat{i}}{10} = a = \frac{1}{\sqrt{2}} ms^{-2}NW$

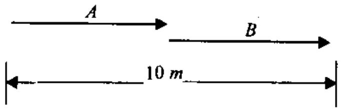
8. (a)

$x(3) = 2(3)^2 - 5(3) + 6 = 93x\ (0) = 6$

$v_{av} = \dfrac{x(3) - x(0)}{3 - 0} = \dfrac{9 - 6}{3} = 1\ ms^{-1}$

$\left.\dfrac{dx}{dt}\right|_{t=3} = 4t - 5 = 4(3) - 5 = 7\ ms^{-1}$

9. (a)



$v_{AB} = 15 - 10 = 5\ ms^{-1}$

$x_{AB} = 10$ m; $t = x_{AB}/v_{AB} = 2s$.

Road distance covered = v_As t + length of car A

= 15 × 2 + 5 = 35 m.

10. (b)

$h = (v^2/2g) + 50$ km

$= \dfrac{(5000/3)^2}{20 \times 1000} + 50 = 188.9 km$

11. (a)

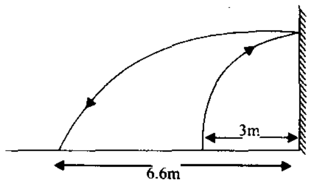
$x = (t - 3)^{2h}$

v = dx/dt = -2(t - 3) = 0 or t = 3 s.

12. (d)

$T = \dfrac{2u_y}{a_y} = \dfrac{2 \times 8}{10} = 1.6s$

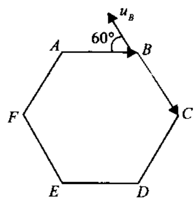
t = 3/6 = 0.5 s



$x = u_x (T - t)$

= 6(1.6 – 0.5) = 6.6 m

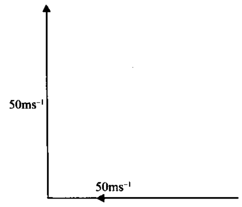
13. (d)



$t = \dfrac{1}{v_{AB}} = \dfrac{1}{v_A - v_B \text{ in the direction of A}}$

$= \dfrac{1}{v - v\cos 60} = \dfrac{21}{v}$

14. (c)



Change in velocity

$= \sqrt{50^2 + 50^2} = \sqrt{5000} = 70.7 ms^{-1}$

$\therefore$ acceleration = change in velocity/time

= 70.7/5 = 14.14 ms^{-2}.

15. (b)

$S_1 = 1/2\ at^2 = 1/2\ a \times 2^2 = 2a$ .... (i)

$S_1 + S_2 = 1/2a \times (2 + 2)^2 = 8a$ .... (ii)

$S_1 + S_2 + S_3 = 1/2a \times (2 + 2 + 2)^2 = 18\ a$ .... (iii)

Total time = 32 + time required to cover last 5 steps

= 32 + 5 = 37 s.

16. (a)

Using $h = 1/2\ gt^2$, we get, $t_1 = \sqrt{2h/g}$.

Let t_1 be the time taken from instants of jumping to the opening of parachute, then

$t_1 = \sqrt{\frac{2 \times 40}{9.8}} = 2.86$ s

His velocity at this point is given by,

$v_1^2 = 2gh_1 = 2 \times 9.8 \times 40$

784 or $v_1 = 28\ ms^{-1}$

For the remaining journey ,

$v = v_1 + at_2$

or $t_2 = \frac{v - v_1}{a} = \frac{2-28}{-2} = 13s$

$\therefore$ total time = $t_1 + t_2$ = 2.86 + 13

= 15.86 = 16s

17. (b)

Velocity before strike $u = \sqrt{2gh}$

Component of acceleration along the inclined plane = g sin α and the perpendicular component = g cos α

Using $S = ut + 1/2\ at^2$

For vertical direction we get,

$0 = v \cos \alpha t - 1/2\ g \cos\alpha t^2$ and

For horizontal direction

$x = u \sin\alpha t + 1/2\ g \sin \alpha t^2$

$= u \sin \alpha\ \frac{2u}{g} + \frac{1}{2} g \sin\alpha \left(\frac{2u}{g}\right)^2 \left(Qt = \frac{2u}{g}\right)$

$= \frac{2u^2 \sin\alpha}{g} + \frac{2u^2 \sin\alpha}{g} = \frac{4u^2 \sin\alpha}{g}$

$= 4 \times \frac{2gh \times \sin\alpha}{g} = 8h \sin \alpha$

18. (b)

Given, $u = u_0\hat{i} + (a\omega \cos \omega t)\hat{j}$

Thus velocity along y axis, $U_y = a \cos \omega t$ and velocity along x axis, $vx = u_0$.
Displacement at time t in horizontal direction,

$$x = \int u_0 dt = u_0 t \left(Qv = \frac{dx}{dt} \right)$$

and $y = \int a\omega \cos \omega t dt = a \sin \omega t$

Eliminating t, $y = a \sin (\omega x/u_0)$
At time $3\pi/2\omega$, $x = u_0(3\pi/2\omega)$
and $y = a \sin 3\pi/2 = -a$
Thus distance of particle from origin

$$S = \sqrt{\left[\frac{3\pi\mu_0}{2\omega}\right]^2 + a^2} \left(QR = \sqrt{x^2 + y^2} \right)$$

19. (b)

Using $S_n + u + \frac{a}{2}(2n - 1)$ we get

$a = u + \frac{a'}{2}(2x - 1)$ …………… (i)

[d = uniform acceleration]

$b = u + \frac{a'}{2}(2y - 1)$…………… (ii)

$c = u + \frac{a'}{2}(2z - 1)$…………… (iii)

or $a = dx + \left(u - \frac{a'}{2}\right)$ …………….. (iv)

From (iv) $ay = dxy + \left(u - \frac{a'}{2}\right)y$

and $az = dxy + \left(u - \frac{a'}{2}\right)z$

Subtracting, $a(y - z)$

$= d(xy - xz) + \left(u - \frac{a'}{2}\right)(y - z)$

Similarly, $b(z - x)$

$= a'(yz - yx) + \left(u - \frac{a'}{2}\right)(x - y)$

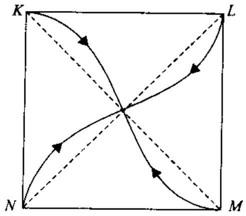
and $c(x - y) = d(zx - yz) + \left(u - \frac{a'}{2}\right)(x - y)$

Adding above 3 equations
$a(y - z) + b(z - x) + c(x - y)$

$= a'(xy - xz + yz - yx + xz - yz) + \left(u - \frac{a'}{2}\right)$

$(y - z + z - x + x - y) = 0$

20. (d)
Initial distance between any two person = d



Considering KL,
Velocity component of L along LK,
$v \cos 90^0 = 0$
Thus speed between K and L is v
$\therefore$ time t = d/v.

21. (c)
Displacement of the particle during third second of the motion (i.e. between t = 2s and t = 3s) is zero. Hence t = 2.5 sec is the turning point of the motion.

For distance $S_{t=2} = 25 \times 2 - \frac{1}{2} \times 10 \times 2^2 = 30$ m

and $S_{t=2.5} = 25 \times 2.5 - \frac{1}{2} \times 10 \times 2.5^2 = 31.25$ m

Hence distance covered by the particle during third second of motion = 2 (31.25 – 30) = 2.5 m,
Hence (C) is correct.

22. (a)
$t = \frac{u}{g \sin\theta} = \frac{5\sqrt{2} \times \sqrt{2}}{10} = 1$ sec. Hence (A) is correct.

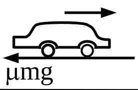
23. (b)
Drift $(\Delta x) = (v_{b,x})\Delta t$
$= (v_{br} \cos\theta + v_r)\Delta t$
for $\Delta x = 0$,
$v_r = -v_{br} \cos\theta$
$\Rightarrow (v_r)_{max} = v_{br}$
For, $v_r > v_{br}$ we can not have zero drift. Hence (B) is correct.

24. (c)
Since, $\vec{g} \perp \vec{v}$
Radial acceleration $a_r = g$
$\Rightarrow \frac{v_0^2}{r} = g$ where r is the radius of curvature.
$\Rightarrow \frac{2gH}{r} = g \quad (\because v = \sqrt{2gH})$
$\Rightarrow r = 2H$, Hence (C) is correct.

25. (c)
Conceptual.

26. (d)
Max. retardation

$a = \frac{\mu mg}{m} = \mu g$



$\because\ S = \frac{1}{2}at^2 \Rightarrow\ t = \sqrt{\frac{2S}{a}}$

$\therefore\ t_{min} = \sqrt{\frac{2S}{a_{max}}} = \sqrt{\frac{2S}{\mu g}}\ \Rightarrow t_{min} \propto \frac{1}{\sqrt{\mu}}$

27. (d)

$\because\ h = \frac{1}{2}gT^2$ ....(1)

$\therefore\ T = \sqrt{\frac{2h}{g}}$

Displacement of ball in time T/4

$S = \frac{1}{2}g(T/4)^2 = \frac{h}{16}$

$\therefore$ Height from ground $= h - \frac{h}{16} = \frac{15}{16}h$

28. (c)

$dv/dt = -k\sqrt{v}$

or $\int_{v_0}^{0}\frac{dv}{\sqrt{v}} = \int_0^t -k\,dt$ or $t = \frac{2\sqrt{v_0}}{k}$.

29. (c)

$\frac{vdv}{dx} = -kv$ or $\int_{v_0}^{0}dv = -k\int_0^{x_p}dx$

or $x_0 = v_0/k$.

$\frac{dv}{dt} = -kv$ or $\int_{v_0}^{v}\frac{dv}{v} = -\int_0^t k\,dt$

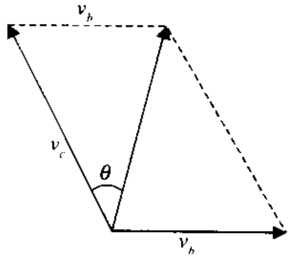
or $v = v_0e^{-kt}$ $\therefore$ $v \to 0$ when $t \to \infty$.

30. (a)

When the car is exactly opposite, the man at least distance, the bag will reach him when thrown with velocity v_0.

$\sin\theta = \frac{v_b}{v_c} = \frac{10}{10\sqrt{2}} = \frac{1}{\sqrt{2}}$

or $\theta = 45^0$



$\therefore$ total angle between v_c and v_b is 90 + 45

$= 135^0$