MOTION IN ONE DIMENSION

MOTION IN ONE DIMENSION

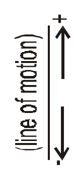
- 1-D with uniform velocity
- 1-D with uniform acceleration
- 1-D with non-uniform acc
- Relative motion in 1-D

SIGN CONVENTION

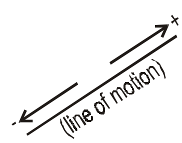
1. In straight line motion, all the vectors (position $\vec{r}$, displacement $\Delta\vec{r}$, velocity $\vec{v}$ and acceleration $\vec{a}$) will have only two possible directions, along the straight ray $\longleftrightarrow (\theta = o)$ or $\updownarrow (\theta = 90^o)$ or $\nearrow\!\!\!\swarrow$ (any θ) .
2. We designate these two directions with positive and negative signs.
3. This enables us to solve the problem mathematically without bothering about any direction reversal during the motion at any intermediate instant because final +ve or -ve sign of vectors will give the idea of direction of vectors at that final instant.
4. This also enables us to represent vectors on graph with same scalar quantity, say time just by representing magnitudes of vector on y axis (+ve y = positive direction, -ve y = negative direction)
5. Though, we can predefine any of the two directions as the +ve or -ve according to present problem, but most generally used sign convention is

horizontal θ = 0°

Vertical θ = 90°



inclined θ other than 0°, 90°



ONE DIMENSIONAL MOTION WITH CONSTANT VELOCITY

CONCEPT

Constant velocity necessarily implies that motion is *unidirectional*, but converse is not true.

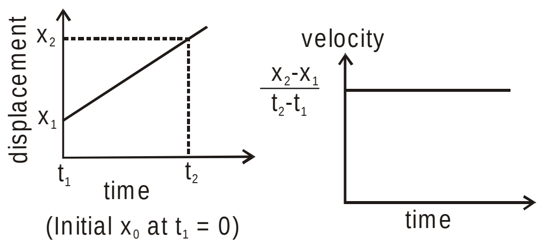
1. $\therefore$ |displacement| is always equal to distance travelled.
2. Here, average velocity is equal to instantaneous velocity.
3. Simple formula applies : distance = speed x time.

IN VECTOR FORM $\Delta\vec{r} = \vec{v}\Delta t$

i.e. $(x_2 - x_1)\ \hat{r} = \vec{v}\ (t_2 - t_1)$

4. Acceleration $\vec{a} = 0$

5. GRAPHICAL INTERPRETATION -



ONE DIMENSIONAL MOTION WITH UNIFORM ACCELERATION

(1) For uniform acceleration, instantaneous acceleration = average acceleration = $\frac{v-u}{t} = \frac{\text{change in velocity}}{\text{time}}$.

Ex. *A particle starting from rest accelerates uniformly upto 5m/sec in 5 seconds. The average acceleration of the particle can be given as :*

(A) 1 m/s² *(B) 1.2 m/s²* *(C) 1.5 m/s²* *(D) 2 m/s²*

Sol. (A)

Average acceleration = $\frac{5-0}{5}$ = 1 m/s^2.

(2) For uniform acceleration, average velocity $v_{av} = \frac{\text{initial velocity} + \text{final velocity}}{2} = \frac{u+v}{2}$.

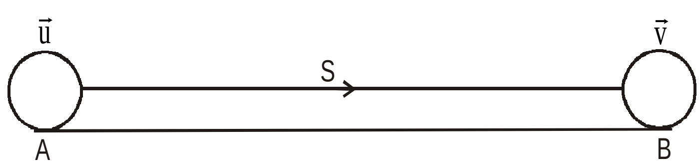
Ex. *A body starting from rest accelerates uniformly upto 6m/sec. The average velocity of the body can be given as :*

(A) 2 m/sec *(B) 3 m/sec* *(C) 3.5 m/sec* *(D) 4 m/sec*

Sol. (B)

Average velocity = $\frac{0+6}{2}$ = 3 m/sec.

DERIVATIONS OF EQUATIONS OF MOTION



Let a particle initially at A starts it's motion with some initial velocity $\vec{u}$ and after travelling a distance s in time t, reaches at B, where it's present velocity is $\vec{v}$. We can then find the relations between these parameters as :

(3) a = $\frac{dv}{dt}$ $\therefore \int_u^v dv = \int_o^t a\,dt$

If we consider $\vec{a}$ to be constant, then only it can be taken out of integration, otherwise not

so (v - u) = a$\int_o^t dt$ = at or v = u + at or a = $\frac{v-u}{t}$

in vector form $\vec{v} = \vec{u} + \vec{a}\,t$

Ex.1 *A truck is moving with constant velocity of 5m/sec. Suddenly at t = 50 sec, it starts accelerating uniformly at 1 m/s^2. The final velocity of the truck at t = 80 sec. is :*

(A) 25 m/sec *(B) 30 m/sec* *(C) 35 m/sec* *(D) 40 m/sec*

Sol. (C)

Initial velocity = 5m/sec.

Time interval considered = 30 seconds.

Acceleration = 1 m/s^2

$\therefore$ Applying, v = u + at

Final velocity = 5 + (1) × (30) = 35 m/s.

Ex.2 *A car starting from rest, accelerates at the rate of 2m/s^2 upto a final velocity of 30 m/sec. What time does the car take to reach this final velocity?*

(A) 10 sec *(B) 15 sec* *(C) 20 sec* *(D) 25 sec*

Sol. (B)

Here, u = 0, a = 2m/s^2, v = 30 m/sec.

$\therefore$ Applying, v = u + at, we get

30 = 0 + 2 × t

or t = 15 sec.

(4) a = $\frac{vdv}{dx}$

$\therefore \int_u^v v\,dv = \int_o^s a\,dx = a\int_o^s dx$ (if a = const)

$\therefore \frac{1}{2}\left[v^2\right]_u^v$ = as or $v^2 - u^2 = 2as$

or $v^2 = u^2 + 2as$.

In vector form : $\vec{v}\cdot\vec{v} = \vec{u}\cdot\vec{u} + 2\,\vec{a}\cdot\vec{s}$

Ex.1 *A sprinter, running at a uniform acceleration of 5 m/s² covers 50m race. Assuming that he started from rest, the velocity at the end of race is :*

(A) $5\sqrt{5}$ m/sec *(B) $10\sqrt{5}$ m/sec* *(C) $15\sqrt{5}$ m/sec* *(D) $20\sqrt{5}$ m/sec*

Sol. (B)

$a = 5 m/s^2$, s = 50m, u = 0

Applying $v^2 = u^2 + 2as$

$v^2 = (0)^2 + 2 \times 5 \times 50$

$\therefore$ $(v)^2 = 10 \times 50$

$\therefore$ $v = \sqrt{500} = 10\sqrt{5}$ m/sec.

Ex.2 *A vehicle, starting from rest moves with constant acceleration of (2.5) m/s² until it attains a velocity of 50m/sec. The displacement during this period is :*

(A) 350 m *(B) 400 m* *(C) 450 m* *(D) 500 m*

Sol. (D)

Here, $a = 2.5 m/s^2$, u = 0, v = 50 m/sec.

Applying $v^2 = u^2 + 2as$

$(50)^2 = (0)^2 + 2 \times 2.5 \times s$

$\therefore$ Displacement, $s = \dfrac{50 \times 50}{2 \times 2.5} = 500$ m

(5) as $v = \dfrac{dx}{dt}$ $\therefore$ $\int dx = \int v\,dt = \int (u + at)\,dt$

or $\int_0^s dx = \int_0^t u\,dt + \int_0^t at\,dt = u\int_0^t dt + a\int_0^t t\,dt$ (if a = const)

$\therefore$ $s = ut + \dfrac{1}{2}at^2$

in vector form $\vec{s} = \vec{u}t + \dfrac{1}{2}\vec{a}t^2$

Ex.1 *Carl Lewis, the famous athlete, ran through a 100 m race with constant acceleration of 2m/s² starting from rest. Can you calculate the time, this champion took to complete the race ?*

(A) 5 sec *(B) 7.5 sec* *(C) 10 sec* *(D) $10\sqrt{2}$ sec*

Sol. (C)

Here, s = 100 m, $a = 2 m/s^2$, u = 0

Applying, $s = ut + \dfrac{1}{2}at^2$

$\therefore$ $100 = (0)\,t + \frac{1}{2} \times 2 \times (t)^2$

$\therefore$ $100 = (t)^2$

or $t = \sqrt{100} = 10$ sec.

Ex.2 *A truck's motion is observed for a period of 10 sec, i.e. starting from t = 10 sec to t = 20 sec. The truck moving with constant velocity of 15 m/sec started accelerating at the rate of 2.5 m/s² at t = 10 sec. Can you calculate the displacement of truck during this time period ?*

(A) 225 m *(B) 250 m* *(C) 275 m* *(D) 300 m*

Sol. (C)

Here, u = 15 m/sec, $a = 2.5\ m/s^2$,

time period t = 10 sec

Applying $s = ut + \frac{1}{2}at^2$, we have

$$s = 15(10) + \frac{1}{2}(2.5)\,(10)^2$$

$$= 150 + \frac{100 \times 2.5}{2} = 150 + 125$$

$$= 275\ m.$$

DERIVED EQUATIONS OF MOTION

(6) Total displacement = Avg. velocity x time

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

in vector form $2\vec{s} = (\vec{v} + \vec{u})\,t$

(7) $s = ut + \frac{1}{2}at^2$

$= (v-at)\,t + \frac{1}{2}at^2$

$s = vt - \frac{1}{2}at^2$

(8) Displacement in n^{th} sec = $s_{nth} = s_{upto\ n} - s_{upto(n-1)}$

$$= \left[un + \frac{1}{2}an^2\right] - \left[u(n-1) + \frac{1}{2}a(n-1)^2\right]$$

$$s_{nth} = u + \frac{1}{2}(2n-1)\,a$$

In vector & proper dimensional form

$$\vec{s}_{nth} = \vec{u}\,(1\text{ sec}) + \frac{1}{2}\vec{a}\,(2n-1)\,(1\text{sec})$$

Ex. *A particle is travelling with uniform acceleration of 5m/s^2. Assuming that the particle starts from rest, the displacement in the 10th second is given as :*

(A) 42.5 m *(B) 45 m* *(C) 47.5 m* *(D) 50m*

Sol. (C)

Here, $a = 5\ m/s^2$ and $n = 10$ sec.

$\therefore$ $S_{nth} = 0 + \frac{1}{2}(2 \times 10 - 1) \times 5$

$= \frac{19 \times 5}{2} = 47.5$ m.

<u>MISCONCEPT</u> 1 - Equations of motion are applicable every time.

<u>CLARIFICATION</u> - Equations of motion are applicable only when $\vec{a}$ is constant.

<u>MISCONCEPT</u> 2 - In eqn of motion, s gives distance

<u>CLARIFICATION</u> - s gives displacement, not distance. So for finding distance, we must find out instant at which velocity is reversing and then break the motion in parts.

SOLVED EXAMPLES ON EQUATIONS OF MOTION

Ex.1 A particle moves in a straight line with a uniform acceleration a. Initial velocity of the particle is zero. Find the average velocity of the particle in first 's' distance.

Sol. From $s = \frac{1}{2}at^2$, $t = \sqrt{\frac{2s}{a}}$

$\therefore$ Average velocity $= \frac{s}{t} = \frac{s}{\sqrt{\frac{2s}{a}}} = \sqrt{\frac{as}{2}}$

Ex.2 An automobile moving with a velocity of 54 km/h is brought to rest in a distance of 9 m by the application of brakes. Find the retardation, assuming it to be uniform.

Sol. Initial velocity, u = 54 km/h = 54 x $\frac{5}{18}$ m/s ($\because$ 1 km/h = $\frac{5}{18}$ m/s)

= 15 m/s

Final velocity, v = 0

Displacement after the brakes are applied, S = 9m

Using the relation

$u^2 + 2aS = v^2$

$15^2 + (2 \times a \times 9) = 0$ or $18a = -225$; $a = \frac{-225}{18} = -12.5$ m/s^2

The negative sign indicates retardation.

Ex.3 An automobile can accelerate or decelerate at a maximum value of $\frac{5}{3}$ m/s^2 and can attain a maximum speed of 90 km/h. If it starts from rest, what is the shortest time in which it can travel one kilometer, if it is to come to rest at the end of the kilometer run ?

Sol. In order that the time of motion be shortest, the car should attain the maximum velocity with the maximum acceleration after the start, maintain the maximum velocity for as along as possible and then decelerate with the maximum retardation possible. Consistent with the condition, the automobile should come to rest immediately after covering a distance of 1km.

Let t_1 be the time of acceleration, t_2 be the time of uniform velocity and t_3 be the time of retardation.

Now, maximum velocity possible = 90km/ h = 90 x $\frac{5}{18}$ m/s = 25 m/s

$t_1 = \frac{v-u}{a} = \frac{25-0}{5/3} = 15$ s

Similarly, the time of retardation is also given by

$t_3 = \frac{0-25}{-\frac{5}{3}} = 15$s

During the period of acceleration, the distance covered = average velocity x time

$= \frac{25+0}{2} \times 15 = 187.5$ m

During the period of retardation, the distance covered is the same and hence = 187.5 m

$\therefore$ the total distance covered under constant velocity = 1000 – 375 = 625 m

Time of motion under constant velocity $t_2 = \frac{625}{25} = 25$ s

$\therefore$ the shortest time of motion = $t_1 + t_2 + t_3$ = 15 + 25 + 15 = 55 seconds

Ex.4 An elevator ascends with an acceleration of 0.2 m/s^2. At the instant its upward velocity is 2 m/s, a loose bolt in the ceiling of the elevator drops. The ceiling of the elevator is at a height of 2.5 m from the floor of the elevator. Find the time until the bolt strikes the floor and the distance it has fallen down.

Sol. At the time of dropping, the velocity of the bolt relative to the floor of the elevator = 0.

The acceleration of the bolt relative to the floor of the elevator = 9.8 – (– 0.2) = 10m/s^2 downward.

Let the time taken by the bolt to reach the floor be t s

Then, $S = ut + \frac{1}{2}at^2 \Rightarrow 2.5 = 0 + \frac{1}{2} \times 10 \times t^2$

or $t^2 = \frac{1}{2} \Rightarrow t = \sqrt{0.5} = 0.71$ s

The bolt takes 0.71 s to reach the floor of the elevator. During this time the actual distance travelled down by the bolt

$= 2t - \frac{1}{2} \times 9.8 \times t^2$ (2 m/s is the initial upward velocity of the bolt)

$= 2 \times 0.71 - 4.9 \times (0.71)^2$

$= 1.42 - 4.9 \times 0.5 = 1.42 - 2.45 = -1.03$ m

The distance travelled downwards by the bolt = 1.03 m

Ex.5 In a car race, car A takes a time of t s less than car B at the finish and passes the finishing point with a velocity v m/s more than the car B. Assuming that the cars start from rest and travel with constant acceleration a_1 and a_2 respectively, show that $v = t\sqrt{a_1 a_2}$.

Sol. The distance covered by both the cars is the same. Thus , $S_1 = S_2 = S$.

If the cars take times t_1 and t_2 for the race and their velocities at the finish be v_1 and v_2, then it is given that

$$\frac{v_1}{2} t_1 = S \quad \text{........ (1)}$$

$$\frac{v_2}{2} t_2 = S \quad \text{........ (2)}$$

$$\therefore \quad \frac{v_1}{t_2} = \frac{v_2}{t_1} = \frac{v_1 - v_2}{t_2 - t_1} = \frac{v}{t} \quad \text{........ (3)}$$

$$\left(\frac{v}{t}\right)^2 = \frac{v_1 v_2}{t_2 t_1} = \frac{v_1}{t_1} \cdot \frac{v_2}{t_2} = a_1 a_2 \quad \text{........ (4)}$$

$$\therefore \quad \frac{v}{t} = \sqrt{a_1 a_2} \Rightarrow v = t\sqrt{a_1 a_2}$$

Ex.6 A body, starting from rest and moving with constant acceleration, covers 10m in the first second. Find the distance travelled by it in the second second.

Sol. Using the equation for the distance travelled in the n^{th} second, viz .,

$$s_n = u + \frac{a}{2}(2n - 1)$$

we have for the first second, $10 = 0 + \frac{a}{2}(2 \times 1 - 1) = \frac{a}{2}$ $\Rightarrow$ $a = 20\ m/sec^2$

Now, the distance travelled in the second second is

$$s_2 = 0 + \frac{20}{2}(2 \times 2 - 1) = 30\ m.$$

NOTE : Following this procedure, it can be shown that the distances travelled in equal time intervals will be in the ratio 1 : 3 : 5 : 7 : ....

Ex.7 A car accelerates from rest at a constant rate α for sometime after which it decelerates at a constant rate β to come to rest. If the total time lapse is t seconds, find (i) the maximum velocity reached, and (ii) the total distance travelled.

Sol. Let υ_m be the maximum velocity and let t_1 be the time taken to attain it. Then, using $\upsilon = u + at$, we get

$$\upsilon_m = \alpha t_1 \qquad .... (1)$$

Let t_2 be the time taken by the car to stop under retardation β. Then

$$0 = \upsilon_m - \beta t_2 \quad \text{or} \quad \upsilon_m = \beta t_2 \qquad .... (2)$$

Eqns. (1) and (2) given

$$\frac{t_2}{t_1} = \frac{\alpha}{\beta} \quad \text{or} \quad \frac{t_2}{t_1} + 1 = \frac{\alpha}{\beta} + 1 \quad \text{or} \quad \frac{t}{t_1} = \frac{\alpha+\beta}{\beta} \quad \text{or} \quad \frac{\beta}{\alpha+\beta} t = t_1$$

Substituting this value of t_1 in eqn (1) , $\upsilon_m = \frac{\alpha\beta}{\alpha+\beta} t.$

Now , let s_1 be the distance travelled during acceleration and let s_2 be the distance travelled during retardation. Then, using the equation $\upsilon^2 = u^2 + 2as$, we get

$$\upsilon_m^2 = 2\alpha s_1 \qquad .... (3)$$

$$\text{and } 0 = \upsilon^2_m - 2\beta s_2 \qquad .... (4)$$

$$\therefore \quad s_1 = \frac{\upsilon^2{}_m}{2\alpha} = \frac{\alpha\beta^2}{2(\alpha+\beta)^2} t^2 \text{ and } \quad s_2 = \frac{\alpha^2\beta}{2(\alpha+\beta)^2} t^2$$

$\therefore$ Total distance, $s = s_1 + s_2$

$$= \frac{\alpha\beta t^2}{2(\alpha+\beta)^2}(\alpha + \beta) = \frac{\alpha\beta t^2}{2(\alpha+\beta)}$$

LEVEL # 1

Q.1 A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then-
(A) $S_1 = S_2$ (B) $S_1 = S_2/3$ (C) $S_1 = S_2/2$ (D) $S_1 = S_2/4$

Q.2 The displacement x of a particle along a straight line at time t is given by $x = a_0 + a_1t + a_2t^2$. The acceleration of the particle is-
(A) a_0 (B) a_1 (C) $2a_2$ (D) a_2

Q.3 the coordinates of a moving particle at any time are given by $x = at^2$ and $y = bt^2$. The speed of the particle at any moment is-
(A) $2t(a + b)$ (B) $2t\sqrt{(a^2 - b^2)}$ (C) $t\sqrt{a^2 + b^2}$ (D) $2t\sqrt{(a^2 + b^2)}$

Q.4 An electron starting from rest has a velocity that increases linearly with the time that is $v = kt$, where $k = 2m/sec^2$. The distance travelled in the first 3 seconds will be-
(A) 9m (B) 16m (C) 27m (D) 36m

Q.5 The displacement of a body is given to be proportional to the cube of time elapsed. The magnitude of the acceleration of the body is-
(A) Increasing with time (B) Decreasing with time
(C) Constant but not zero (D) Zero

Q.6 The instantaneous velocity of a body can be measured-
(A) Graphically (B) Vectorially (C) By both methods (D) None of these

Q.7 A body is moving from rest under constant acceleration and let S_1 be the displacement in the first (p – 1) sec and S_2 be the displacement in the first p sec. The displacement in $(p^2 - p + 1)^{th}$ sec. will be-
(A) $S_1 + S_2$ (B) $S_1 S_2$ (C) $S_1 - S_2$ (D) S_1 / S_2

Q.8 A body under the action of several forces will have zero acceleration-
(A) When the body is very light (B) When the body is very heavy
(C) When the body is a point body
(D) When the vector sum of all the forces acting on it is zero.

Q.9 A body starts from the origin and moves along the X-axis such that the velocity at any instant is given by $(4t^3 - 2t)$, where t is in sec and velocity in m/s. What is the acceleration of the particle, when it is 2m from the origin ?
(A) 28 m/s^2 (B) 22 m/s^2 (C) 12 m/s^2 (D) 10 m/s^2

Q.10 The relation between time and distance is $t = \alpha x^2 + \beta x$, where α and β are constants. The retardation is-
(A) $2\alpha v^3$ (B) $2\beta v^3$ (C) $2\alpha\beta v^3$ (D) $2\beta^2v^3$

Q.11 The velocity of a body depends on time according to the equation $v = 20 + 0.1t^2$. The body is undergoing-

(A) Uniform acceleration (B) Uniform retardation
(C) Non-uniform acceleration (D) Zero acceleration.

Q.12 Which of the following four statements is false ?

(A) A body can have zero velocity and still be accelerated
(B) A body can have a constant velocity and still have a varying speed.
(C) A body can have a constant speed and still have a varying velocity.
(D) The direction of the velocity of a body can change when its acceleration is constant.

Q.13 A particle moving with a uniform acceleration travels 24 m and 64 m in the first two consecutive intervals of 4 sec each. It's initial velocity is-

(A) 1 m/sec (B) 10 m/sec (C) 5 m/sec (D) 2 m/sec

Q.14 The position of a particle moving in the xy-plane at any time t is given by $x = (3t^2 - 6t)$ metres, $y = (t^2 - 2t)$ metres. 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.

Q.15 If a body having initial velocity zero is moving with uniform acceleration $8 m/sec^2$, the distance travelled by it in fifth second will be-

(A) 36 metres (B) 40 metres (C) 100 metres (D) Zero

Q.16 An alpha particle enters a hollow tube of 4m length with an initial speed of 1 km/s. It is accelerated in the tube and comes out of it with a speed of 9 km/s. The time for which it remains inside the tube is-

(A) 8×10^{-3} s (B) 80×10^{-3} s (C) 800×10^{-3} s (D) 8×10^{-4} s

Q.17 Two cars A and B are travelling in the same direction with velocities v_1 and v_2 ($v_1 > v_2$). When the car A is at a distance d ahead of the car B, the driver of the car A applied the brake producing a uniform retardation a There will be no collision when-

(A) $d < \frac{(v_1 - v_2)^2}{2a}$ (B) $d < \frac{v_1^2 - v_2^2}{2a}$ (C) $d > \frac{(v_1 - v_2)^2}{2a}$ (D) $d > \frac{v_1^2 - v_2^2}{2a}$

Q.18 A body of mass 10kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 seconds on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is-

(A) $3 m/sec^2$ (B) $-3 m/sec^2$ (C) $0.3 m/sec^2$ (D) $-0.3 m/sec^2$

Q.19 A body starts from rest from the origin with an acceleration of $6 m/s^2$ along the x-axis and $8 m/s^2$ along the y-axis. Its distance from the origin after 4 seconds will be-

(A) 56 m (B) 64 m (C) 80 m (D) 128 m

Q.20 A car moving with a velocity of 10 m/s can be stopped by the application of a constant force F in a distance of 20m. If the velocity of the car is 30 m/s, it can be stopped by this force in-

(A) $\frac{20}{3}$ m (B) 20 m (C) 60 m (D) 180 m

Q.21 The displacement of a particle is given by $y = a + bt + ct^2 - dt^4$. The initial velocity and acceleration are respectively-

(A) b, – 4d (B) – b, 2c (C) b, 2c (D) 2c, – 4d

Q.22 A car moving with a speed of 40 km/h can be stopped by applying brakes after atleast 2m. If the same car is moving with a speed of 80 km/h, what is the minimum stopping distance?

(A) 8m (B) 2m (C) 4m (D) 6m

Q.23 The motion of a particle is described by the equation $x = a + bt^2$ where a = 15 cm and b = 3 cm/s^2. Its instantaneous velocity at time 3 sec will be-

(A) 36 cm/sec (B) 18 cm/sec (C) 16 cm/sec (D) 32 cm/sec

Q.24 A body travels for 15 sec starting from rest with constant acceleration. If it travels distances S_1, S_2 and S_3 in the first five seconds, second five seconds and next five seconds respectively the relation between S_1, S_2 and S_3 is-

(A) $S_1 = S_2 = S_3$ (B) $5S_1 = 3S_2 = S_3$ (C) $S_1 = \frac{1}{3}S_2 = \frac{1}{5}S_3$ (D) $S_1 = \frac{1}{5}S_2 = \frac{1}{3}S_3$

Q.25 A body is moving according to the equation $x = at + bt^2 - ct^3$, where x = displacement and a, b and c are constants. The acceleration of the body is-

(A) a + 2bt (B) 2b + 6ct (C) 2b – 6ct (D) $3b - 6ct^2$

Q.26 A particle travels 10m in first 5 sec and 10m in next 3 sec. Assuming constant acceleration, what is the distance travelled in next 2 sec ?

(A) 8.3 m (B) 9.3 m (C) 10.3 m (D) None of above

Q.27 The distance travelled by a particle is proportional to the square of time, then the particle travels with-

(A) Uniform acceleration (B) Uniform velocity
(C) Increasing acceleration (D) Decreasing velocity

Q.28 Acceleration of a particle changes when-

(A) Direction of velocity changes (B) Magnitude of velocity changes
(C) Both of above (D) Speed changes

Q.29 The motion of a particle is described by the equation u = at. The distance travelled by the particle in the first 4 seconds is-

(A) 4a (B) 12a (C) 6a (D) 8a

Q.30 The relation $3t = \sqrt{3x} + 6$ describes the displacement of a particle in one direction where x is in metres and t in sec. The displacement, when velocity is zero, is-
(A) 24 metres (B) 12 metres (C) 5 metres (D) Zero

Q.31 A constant force acts on a body of mass 0.9 kg at rest for 10s. If the body moves a distance of 250 m, the magnitude of the force is-
(A) 3N (B) 3.5 N (C) 4.0 N (D) 4.5 N

Q.32 The average velocity of a body moving with uniform acceleration travelling a distance of 3.06 m is 0.34 ms^{-1}. If the change in velocity of the body is 0.18 ms^{-1} during this time, its uniform acceleration is-
(A) 0.01 ms^{-2} (B) 0.02 ms^{-2} (C) 0.03 ms^{-2} (D) 0.04 ms^{-2}

Q.33 Equation of displacement for any particle is $s = (3t^3 + 7t^2 + 14t + 8)$m. It's acceleration at time t = 1 sec is-
(A) 10 m/s^2 (B) 16 m/s^2 (C) 25 m/s^2 (D) 32 m/s^2

Q.34 The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will-
(A) Go on decreasing with time (B) Be independent of α and β
(C) Drop to zero when $\alpha = \beta$ (D) Go on increasing with time

Q.35 A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S, then-
(A) $S = \frac{1}{2}ft^2$ (B) $S = \frac{1}{4}ft^2$ (C) $S = \frac{1}{72}ft^2$ (D) $S = \frac{1}{6}ft^2$

Q.36 A man is 45m behind the bus when the bus starts accelerating from rest with acceleration 2.5 m/s^2. With what minimum velocity should the man start running to catch the bus ?
(A) 12 m/s (B) 14 m/s (C) 15 m/s (D) 16 m/s

Q.37 A particle moves along x-axis as $x = 4(t - 2) + a(t - 2)^2$. Which of the following is true ?
(A) The initial velocity of particle is 4 (B) The acceleration of particle is 2a
(C) The particle is at origin at t = 0 (D) None of these

Q.38 A body starting from rest moves with constant acceleration. The ratio of distance covered by the body during the 5th sec to that covered in 5 sec is-
(A) $\frac{9}{25}$ (B) $\frac{3}{5}$ (C) $\frac{25}{9}$ (D) $\frac{1}{25}$

Q.39 What determines the nature of the path followed by the particle ?
(A) Speed (B) Velocity (C) Acceleration (D) None of these

LEVEL # 2

MORE THAN ONE CHOICE MAY BE CORRECT :

Q.1 A car accelerates from rest at constant rate of 2 ms^{-2} for sometime. Then it retards at a constant rate of 4 ms^{-2} and comes to rest. It remains in motion for 3 seconds-

(A) It is accelerated for 2 seconds
(B) Maximum velocity attained is 4 ms^{-1}
(C) Total distance covered is 6m
(D) Total distance covered is 10 m

Q.2 A car accelerates from rest at constant rate of 2 ms^{-1} for sometime. Then it retards at a constant rate of 4 ms^{-1} and comes to rest. It remains in motion for 6 seconds-

(A) Its maximum speed is 8 ms^{-1}
(B) Its maximum speed is 6 ms^{-1}
(C) It travelled a total distance of 24 metre
(D) It travelled a total distance of 18 metre.

Q.3 A particle has an initial velocity of $3\hat{i} + 4\hat{j}$ and an acceleration of $0.4\hat{i} + 0.3\hat{j}$. It's speed after 10 s is

(A) 10 units
(B) 7 units
(C) $7\sqrt{2}$ units
(D) 8.5 units

Q.4 A bird flies for 4 s with a velocity of |t - 2| m/s in a straight line, where t = time in seconds. It covers a distance of

(A) 2 m
(B) 4 m
(C) 6 m
(D) 8 m

Q.5 A particle has an initial velocity of 9 m/s due east and a constant acceleration of 2 m/s^2 due west. The distance covered by the particle in the fifth second of its motion is

(A) 0
(B) 0.5 m
(C) 2 m
(D) none of these

Q.6 A particle starts moving along a straight line path with a velocity of 10 ms^{-1}. After 5 seconds, the distance of the particle from the starting point is 50 m. Which of the following statement(s) about the nature of motion of the particle is (are) correct ?

(A) The motion may be with constant acceleration
(B) The motion may be with constant velocity
(C) The motion may be continuously retarded
(D) The motion may be first accelerated and then retarded.

Q.7 Starting from rest and moving with uniform acceleration, a body acquires a velocity of 10 ms^{-1} in 5 seconds-

(A) Its acceleration is 2 ms^{-2}
(B) The distance covered is 50 m
(C) The distance covered is 25 m
(D) The distance covered is 20 m.

Q.8 Starting from rest and moving with uniform acceleration of 4 ms^{-2}, a body covers a distance of 38 m in last second-

(A) Total time of journey is 5 sec (B) Total time of journey is 10 sec

(C) Total distance covered is 50 m (D) Total distance covered is 200 m

Q.9 The initial velocity of a particle is 10 ms^{-1} and it's retardation is 2 ms^{-2}. The distance moved by the particle in 5th second of its motion is-

(A) 1m (B) 19 m (C) 50 m (D) 75 m

Q.10 A particle is moving according to the equation, $x = a + bt$

(A) Its velocity is proportional to t (B) Its velocity is constant

(C) Its acceleration is constant (D) Its acceleration is zero.

Q.11 Moving with uniform acceleration, a body covers 200 cm in first 2 seconds and 220 cm in next four seconds-

(A) The initial velocity of the body is 100 cm s^{-1}

(B) The initial velocity of the body is 115 cm s^{-1}

(C) The uniform acceleration is + 15 cm s^{-2}

(D) The uniform acceleration is – 15 cm s^{-2}.

Q.12 Moving with uniform acceleration, a body covers 10 m in 1st second, 6 m in 2nd second and 2 m in 3rd second.

(A) The acceleration of the body is 4 cm s^{-2}

(B) The acceleration of the body is – 4 cm s^{-2}

(C) The initial velocity of the body is 12 cm s^{-1}

(D) The body comes to rest after 3 sec.

Q.13 A particle goes from A to B in 10 seconds with uniform acceleration. It's velocities at A and B are 5 m/s and 25 m/s. It's acceleration in m/s^2 is-

(A) 0.5 (B) 2.5 (C) 2 (D) 3

Q.14 A particle moving with uniform acceleration is found to travel 35 m in 8th second and 51 m in the 12th second. Its velocity in m/s at the beginning of 11th second is-

(A) 49 (B) 45 (C) 47 (D) 51

Q.15 A particle moves with constant acceleration for 6 seconds after starting from rest. The distances travelled during the consecutive 2 seconds interval are in the ratio :

(A) 1 : 1 : 1 (B) 1 : 2 : 3 (C) 1 : 3 : 5 (D) 1 : 5 : 9

Q.16 A bullet fired into a fixed block of wood loses half its velocity after penetrating 60 cm. Before coming to rest, it penetrates a further distance of-

(A) 60 cm (B) 30 cm (C) 20 cm (D) 10 cm

Q.17 A train accelerating uniformly, passes three successive kilometre posts at time t = 0, t = 75 and t = 125 (all in seconds). In respect of this motion, which of the following statements are true ?

(A) The acceleration of the train is $\frac{8}{75}$ m/s^2.

(B) The speed at the last of the three posts is 22.67 m/s

(C) The initial velocity of the train is 10 m/s.

(D) The train will travel the next one kilometre in 15 s.

Q.18 The speed of a car was 50 km/hr for the first 900 s, then 40 km/hr for the next 50 km and then the car decelerated uniformly at 10 km/hr^2, till it came to rest. The average speed of the car was-

(A) 50 km/hr (B) 7.2 m/s (C) 30 km/hr (D) 9.0 m/s

Q.19 A particle moves 10 m in the first 2 s, 20 m in the next 3s and 30 m in the next 10 s. Which of the following statements are true for this motion ?

(A) The particle was uniformly accelerated.

(B) The particle had decelerating forces acting on it during the motion.

(C) The average speed of the particle was 4 m/s.

(D) The average acceleration of the particle was 3 m/s^2.

Q.20 A trolley runs down a slope from rest with constant acceleration. In the first second of it's motion, it travels 1.6 m. Its acceleration in m/s^2 is

(A) 3.2 (B) 1.6 (C) 0.8 (D) 2.4

ANSWER KEY

LEVEL # 1

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

LEVEL # 2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A,B,C	A,D	C	B	B	B,D	A,C	A,C,D	A	B,D	B,D	B,C,D	C	D	C
Que.	16	17	18	19	20										
Ans.	C	A,B	B	B,C	A										