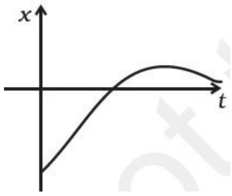
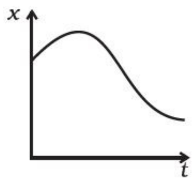
SECTION – A (single choice)

1. Among the four graphs, there is only one graph for which average velocity over the time intervel (*0, T*) can vanish for a suitably chosen *T*. Which one is it?

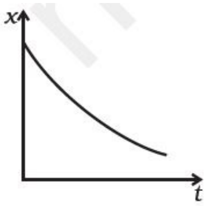
(a)



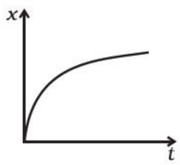
(b)



(c)



(d)



2. A lift is coming from 8th floor and is just about to reach 4th floor. Taking ground floor as origin and positive direction upwards for all quantities, which one of the following is correct?

(a) $x < 0$, $v < 0$, $a > 0$ (b) $x > 0$, $v < 0$, $a < 0$
(c) $x > 0$, $v < 0$, $a > 0$ (d) $x > 0$, $v > 0$, $a < 0$

3. In one dimensional motion, instantaneous speed v satisfies $0 \le v < v_0$.
(a) The displacement in time T must always take non-negative values.
(b) The displacement x in time T satisfies $-v_0 T < x < v_0 T$.
(c) The acceleration is always a non-negative number.
(d) The motion has no turning points.

4. A vehicle travels half the distance L with speed $V1$ and the other half with speed V_2, then its average speed is

(a) $\frac{V_1+V_2}{2}$ (b) $\frac{2V_1+V_2}{V_1+V_2}$
(c) $\frac{2V_1V_2}{V_1+V_2}$ (d) $\frac{L(V_1+V_2)}{V_1V_2}$

5. The displacement of a particle is given by $x = (t-2)^2$ where x is in metres and t in seconds. The distance covered by the particle in

(a) 4 m (b) 8 m
(c) 12 m (d) 16 m

6. At a metro station, a girl walks up a stationary escalator in time t_1. If she remains stationary on the escalator, then the escalator take her up in time $t2$. The time taken by her to walk up on the moving escalator will be

(a) $\frac{(t_1+t_2)}{2}$ (b) $\frac{t_1 t_2}{(t_1-t_2)}$
(c) $\frac{t_1 t_2}{(t_1+t_2)}$ (d) t_1-t_2

7. A person travelling on a straight line moves with a uniform velocity v_1 for some time and with uniform velocity v_2 for the next equal time. The average velocity v is given by

(a) $v=\frac{v_1+v_2}{2}$ (b) $v=\sqrt{v_1v_2}$
(b) $\frac{2}{v}=\frac{1}{v_1}+\frac{1}{v_2}$ (d) $\frac{1}{v}=\frac{1}{v_1}+\frac{1}{v_2}$

8. Average velocity of a particle moving in a straight line, with constant acceleration a and initial velocity u in first t second is

(a) $u+\frac{1}{2}at$ (b) $u+at$
(c) $\frac{u+at}{2}$ (d) $\frac{u}{2}$

9. A particle is released from rest from a tower of height $3h$. The ratio of times to fall equal heights h . i.e. $t_1 : t_2 : t_3$ is

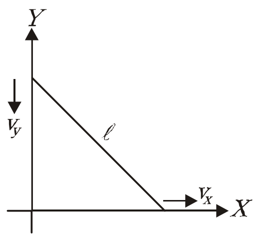
(a) $\sqrt{3}:\sqrt{2}:1$ (b) $3:2:1$
(c) $9:4:1$ (d) $1:(\sqrt{2}-1):(\sqrt{3}-\sqrt{2})$

10. Two particle are released from the same height at an interval of 1s. How long after the first particle begins to fall will the two particles be 10 m apart. $(g = 10 \text{m/s}^2)$

(a) 1.5 s (b) 2 s

(c) 1.25 s (d) 2.5 s

11. A rod of length ℓ leans against a smooth vertical wall, with its lower end resting on the floor. The end that leans against the wall moves downward with uniform speed. Then



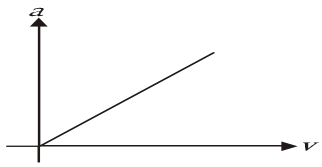
(a) the other end also moves uniformly
(b) the speed of other end goes on decreasing
(c) the speed of the other end goes on increasing
(d) the speed of other end first decreases and then Increases

12. A swimmer crosses a flowing stream of width ω to and fro in time t_1. The time taken to cover the same distance up and down the stream is t_2. If t_3 is the time the swimmer would take to swim a distance 2ω in still water, then

(a) $t_1^2 = t_2 t_3$ (b) $t_2^2 = t_1 t_3$

(c) $t_3^2 = t_1 t_2$ (d) $t_3 = t_1 + t_2$

13. Acceleration-velocity graph of a particle moving in a straight line is as shown in figure. Then slope of velocity displacement graph



(a) increases linearly (b) decreases linearly

(c) is constant (d) increases parabolically

14. A ball is thrown vertically upwards. It was observed at a height *h* twice with a time interval Δt. The initial velocity of the ball is

(a) $\sqrt{8gh + g^2(\Delta t)^2}$ (b) $\sqrt{8gh + \left(\frac{g^2 \Delta t}{2}\right)^2}$

(c) $\frac{1}{2}\sqrt{8gh + g^2(\Delta t)^2}$ (d) $\sqrt{8gh + 4g^2(\Delta t)^2}$

15. An express elevator can accelerate or decelerate by a maximum of 0.4g. The elevator attains a maximum vertical speed of 400 metre per minute. The minimum time required by the elevator to start from rest from the 10th floor and to stop at the 30th floor, a distance 100m apart is

(a) 1.67 s (b) 16.7 s

(c) 167 s (d) 1670 s

16. The position of a particle moving along *x*-axis is given by $x = 3t^2 - t^3$ where *x* is in m and *t* is in s. Consider the following statements :

(i) Displacement of the particle after 4 *s* is 16 m.
(ii) Distance traveled by the particle upto 4 *s* is 24 m.
(iii) Distance of the particle after 4 *s* is –16 m.
(iv) Distance covered by the particle upto 4 *s* is 22 m.
Select the correct alternative

(a) statements (i) and (ii) only are correct

(b) statements (ii) and (iii) only are correct

(c) statements (i) and (iii) only are correct

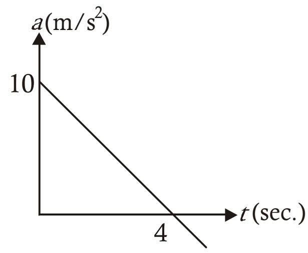
(d) none of these

17. A bullet loses $\frac{1}{20}$ of its velocity in passing through a plank. The least number of planks required to stop the bullet is

(a) 10 (b) 11

(c) 12 (d) 23

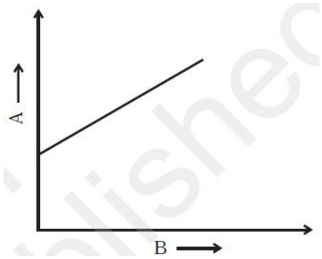
18. The acceleration-time graph of particle moving along a straight line is as shown in figure. At what time the particle acquires its initial velocity ?



(a) 12 sec (b) 5 sec
(c) 8 sec (d) 16 sec

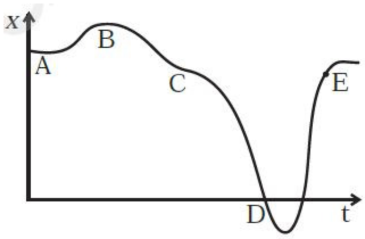
SECTION – B (Multiple Choice)

1. The variation of quantity A with quantity B, plotted in Fig. describes the motion of a particle in a straight line.



(a) Quantity B may represent time.
(b) Quantity A is velocity if motion is uniform.
(c) Quantity A is displacement if motion is uniform.
(d) Quantity A is velocity if motion is uniformly accelerated.

2. A graph of *x* versus *t* is shown in Fig. Choose correct alternatives from below.



(a) The particle was released from rest at $t = 0$.
(b) At B, the acceleration $a > 0$.
(c) At C, the velocity and the acceleration vanish.
(d) Average velocity for the motion between A and D is positive.
(e) The speed at D exceeds that at E.

3. For the one-dimensional motion, described by $x = t - \sin t$
(a) $x(t) > 0$ for all $t > 0$.
(b) $v(t) > 0$ for all $t > 0$.
(c) $a(t) > 0$ for all $t > 0$.
(d) $v(t)$ lies between 0 and 2.

4. A spring with one end attached to a mass and the other to a rigid support is stretched and released.
(a) Magnitude of acceleration, when just released is maximum.
(b) Magnitude of acceleration, when at equilibrium position, is maximum.
(c) Speed is maximum when mass is at equilibrium position.
(d) Magnitude of displacement is always maximum whenever speed is minimum.

5. A ball is bouncing elastically with a speed 1 m/s between walls of a railway compartment of size 10 m in a direction perpendicular to walls. The train is moving at a constant velocity of 10 m/s parallel to the direction of motion of the ball. As seen from the ground,
(a) the direction of motion of the ball changes every 10 seconds.
(b) speed of ball changes every 10 seconds.
(c) average speed of ball over any 20 second interval is fixed.
(d) the acceleration of ball is the same as from the train

6. Following are four different relations about displacement, velocity and acceleration for the motion of a particle in general. Choose the incorrect one (s) :
(a) $v_{av} = \frac{1}{2}[v(t_1) + v(t_2)]$
(b) $v_{av} = \frac{[r(t_2) + r(t_1)]}{t_2 - t_1}$
(c) $r = \frac{1}{2}[v(t_2) - v(t_1)](t_2 - t_1)$
(d) $a_{av} = \frac{v(t_2) - v(t_1)}{(t_2 - t_1)}$

7. Rain appears to fall vertically to a man walking at 3 kmh^{-1} but when he changes his speed to double, the rain appears to fall at 45°.
(a) velocity of rain is $2\sqrt{3}$ kmh^{-1}
(b) the angle of fall of rain is 60°
(c) the angle of fall of rain is 45°
(d) velocity of rain is $3\sqrt{2}$ kmh^{-1}

8. A man throws a stone vertically up with a speed of 20 ms^{-1} from top of high rise building. Two seconds later, an identical stone is thrown vertically downward with the same speed 20 ms^{-1}. Then:
(a) The relative velocity between the two stones remains constant till one hits the ground
(b) both will have the same kinetic energy, when they hit the ground.
(c) the relative acceleration between two is equal to zero, till one hits the ground.
(d) the time interval between their hitting the ground is 2 seconds

SECTION – C (Subjective)

1. A uniformly moving cricket ball is turned back by hitting it with a bat for a very short time interval. Show the variation of its acceleration with time. (Take acceleration in the backward direction as positive).

2. An object falling through a fluid is observed to have acceleration given by $a = g - bv$ where g = gravitational acceleration and b is constant. After a long time of release, it is observed to fall with constant speed. What must be the value of constant speed?

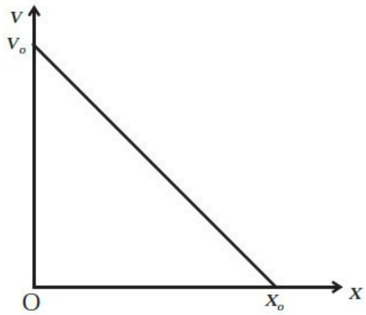
3. A particle executes the motion described by $x(t) = x_0(1 - e^{-\gamma t}); t \geq 0,$
   (a) Where does the particle start and with what velocity?
   (b) Find maximum and minimum values of *x (t), v (t), a(t).* Show that *x (t)* and *a (t)* increase with time and *v (t)* decreases with time.

4. A bird is tossing (flying to and fro) between two cars moving towards each other on a straight road. One car has a speed of 18 m/h while the other has the speed of 27 km/h. The bird starts moving from first car towards the other and is moving with the speed of 36 km/h and when the two cars were separated by 36 km. What is the total distance covered by the bird? What is the total
   Displacement of the bird?

5. A man runs across the roof-top of a tall building and jumps horizontally with the hope of landing on the roof of the next building which is of a lower height than the first. If his speed is 9 m/s, the (horizontal) distance between the two buildings is 10 m and the height difference is 9 m, will he be able to land on the next building? (take $g = 10$ m/s^2)

6. A ball is dropped from a building of height 45 m. Simultaneously another ball is thrown up with a speed 40 m/s. Calculate the relative speed of the balls as a function of time.

7. The velocity-displacement graph of a particle is shown
   in Fig.
   (a) Write the relation between *v* and *x.*
   (b) Obtain the relation between acceleration and displacement and plot it.



8. A motor car moving at a speed of 72km/h can not come to a stop in less than 3.0 s while for a truck this time interval is 5.0 s. On a higway the car is behind the truck both moving at 72km/h. The truck gives a signal that it is going to stop at emergency. At what distance the car should be from the truck so that it does not bump onto (collide with) the truck. Human response time is 0.5s.

9. A monkey climbs up a slippery pole for 3 seconds and subsequently slips for 3 seconds. Its velocity at time *t* is given by $v(t) = 2t\,(3-t)$; $0 < t < 3$ and $v(t) = -(t-3)(6-t)$ for $3 < t < 6$ s in m/s. It repeats this cycle till it reaches the height of 20 m.
   (a) At what time is its velocity maximum?
   (b) At what time is its average velocity maximum?
   (c) At what time is its acceleration maximum in magnitude?
   (d) How many cycles (counting fractions) are required to reach the top?

10. A man is standing on top of a building 100 m high. He throws two balls vertically, one at $t = 0$ and other after a time interval (less than 2 seconds). The later ball is thrown at a velocity of half the first. The vertical gap between first and second ball is +15 m at $t = 2$ s. The gap is found to remain constant. Calculate the velocity with which the balls were thrown and the exact time interval between their throw.