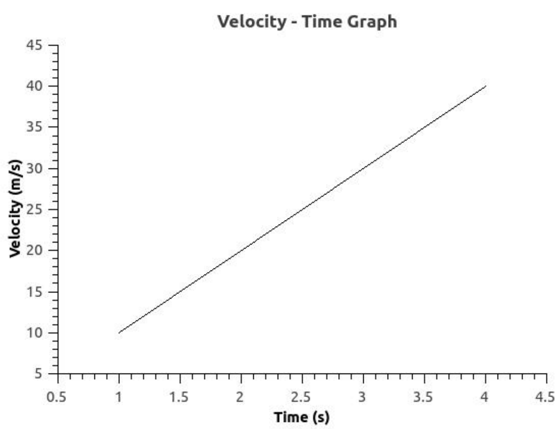
MOTION IN A STRAIGHT LINE

Que.1. Positions of an object with time is shown in the table given below. Complete the table. Plot a velocity – time graph. Using the graph, Determine acceleration of the object

[Marks :(3)]

t	x	v
0	0	
1	5	
2	20	
3	45	
4	80	
5	125	

Ans.



Slope of the Graph = Acceleration

= 10 m/s2

Que.2. Three pairs of initial and final positions along an x axis are given below. Which pair gives a positive displacement:

A] -10 m, +15 m   B] -5 m, -12 m   C] 2 m, -5 m?

[Marks :(1)]

Ans. A] -10 m, +15 m

Que.3. Ramesh observes the motion of an insect in a circle. He finds that it travels 6 revolutions in

an anti-clockwise direction for a time of 31.4 sec.

a. Find the angular velocity of the insect

b. Ifthe insect travels 4 revolutions in the clockwise direction for a time of 8.6 sec, what will

be the angular speed averaged over the total time?

c. Obtain the expression for centripetal acceleration (a) in terms of angular speed

[Marks :(5)]

Ans.

a. Angular velocity $\omega = \frac{2\pi n}{t} = \frac{2\pi \times 6}{31.4}$

$= 1.2$ rad/s

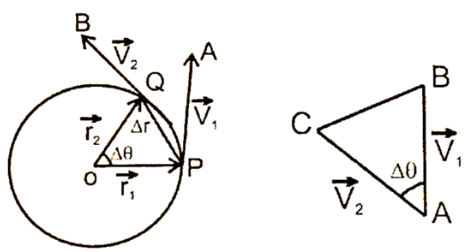
b. Period of rotation in clockwise,

$t = \frac{8.4}{4} = 2.1$

$\omega = \frac{2\pi}{T} = \frac{2\pi \times 4}{8.6} = 2.92$ rad/s

c. Centripetal acceleration

When a particle moves in a circle with uniform speed, the direction of the velocity varies with time. Hence it experiences an acceleration directed along the radius towards the centre and it is centripetal acceleration. Consider a particle moving in a circle with the centre at O and radius r, with uniform speed v and angular velocity



Suppose the particle moves from P to Q in an interval of time At. During the interval theposition vector

varies from r, tor, and velocity varies from $v_1$to v_2.

$|\vec{v}_1| = |\vec{v}_2| = v$ and $|\vec{r}_1| = |\vec{r}_2| = r$

From similar triangles OPQ and ABC

$$\frac{BC}{PQ} = \frac{AB}{OP}$$

When $\Delta t \to 0$ $\frac{\Delta v}{\Delta t} = a$ $\frac{\Delta r}{\Delta t} = v$

So $a = v^2$ But $v = r\omega$

$a = v\omega = r\omega^2$

$a = r\omega^2$

In vector form $\vec{a} = \vec{v} \times \vec{\omega}$

The acceleration of a particle excluding uniform circular motion at any point on the circular path is directed

along the radius towards the center.

Que.4. A food packet is dropped from a plane falling horizontally.

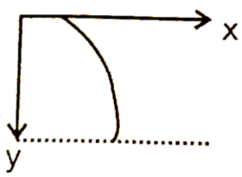
a. Sketch the path of the falling food packet

b. If the time taken by the packet to reach the earth's surface is '6' seconds, calculate the height from which the packet is dropped. (Take $g = 10 m/s^2$)

[Marks :(3)]

Ans.

a.



b. Initial velocity in downward direction u = 0, a = 10, and t = 6 sec. Substituting these values in this equation.

$S = ut + \frac{1}{2} at^2$

$S = 0 + \frac{1}{2} \times 10 \times 6^2$

$S = 180$ m = height

Que.5. Identify the correct statement in the case of a moving body.

a) Pathlength is greater than or equal to the displacement.

b) Displacement is less than the path length.

c) Displacement is greater than or equal to the pathlength.

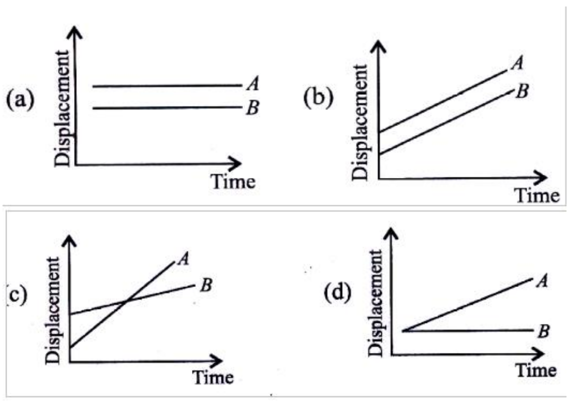
d) Pathlength is greater than the displacement.

[Marks :(3)]

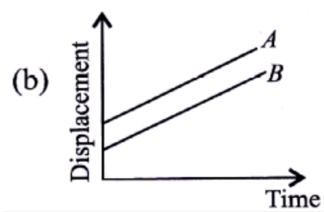
Ans. a) Pathlength is greater than or equal to the displacement.

Que.6. Which one of the following represents displacement – time graph of two objects A and B moving with zero relative velocity?

[Marks :(2)]



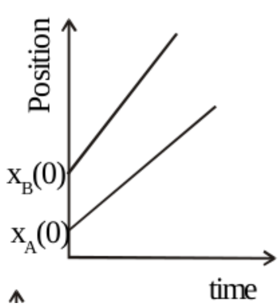
Ans.



Que.7. Consider two objects A and B moving with uniform velocities VA and VB. Draw the position time graph for objects A and B having velocities VA < VB but XA ≠ XB .(XA and XB are the position of A and B)

[Marks :(2)]

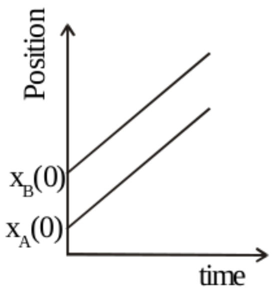
Ans.



Que.8. Consider two objects A and B moving with uniform velocities V_A and V_B. Draw the corresponding position time graph for objects A and B having velocities $V_A = V_B$ but $X_A \neq X_B$

[Marks :(2)]

Ans.



Que.9. Give the kinematic equations for uniform acceleration

[Marks :(3)]

Ans. v = u+ a t

$$S = ut + \frac{1}{2}at^2$$ OR

$$S = v_0 T + \frac{1}{2}aT^2$$

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

OR

$$v_t^2 = v_0^2 + 2as$$

Que.10. Derive

a. Velocity - time relation.

b. Position - time relation

c. Position velocity relation

[Marks :(8)]

Ans. a. Velocity – time relation.

Consider a particle moving with uniform acceleration along a straight line. Let v (t_1) and v (t_2) be the velocities of the particle at instants t_1 and t_2 respectively.

Then acceleration

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

$$a \times t_2 - t_1 = v(t_2) - v(t_1)$$

$$v(t_2) = v(t_1) + a(t_2 - t_1)$$

OR v = u + a t

b. Position – time relation

Consider a particle moving along a straight line with uniform acceleration a. Let x (t_1) and x (t_2) be the position vectors and v (t_1) and v (t_2) be the velocities at instants t_1 and t_2 respectively.

Then average velocity =

$$average\ velocity = \frac{total\,displacement}{total\,time} = \frac{x(t_2)-x(t_1)}{t_2-t_1}$$

also

$$average\ velocity = \frac{v(t_2)+v(t_1)}{2}$$

from these two equations

$$\frac{x(t_2)-x(t_1)}{t_2-t_1} = \frac{v(t_2)+v(t_1)}{2}$$

$$\frac{x(t_2)-x(t_1)}{t_2-t_1} = \frac{v(t_2)+v(t_1)}{2}$$

$$x(t_2)-x(t_1) = \frac{v(t_2)+v(t_1)}{2} \times t_2 - t_1$$

$$.= v(t_1) \times (t_2-t_1) + \frac{1}{2} a (t_2-t_1)^2$$

$$ie.\ x(t_2)-x(t_1) = v(t_1) \times (t_2-t_1) + \frac{1}{2} a (t_2-t_1)^2$$

let x(t_2) – x(t_1) = S, displacement, v(t_1) = u : initial velocity, and (t_2 – t_1) = t , then

$$S = ut + \frac{1}{2} at^2$$

c. Position velocity relation

from the velocity time relation

$$v(t_2) = v(t_1) + a(t_2 - t_1)$$

squaring on both side

$$v^2(t_2) = v^2(t_1) + 2v(t_1)a(t_2-t_1) + a^2(t_2-t_1)^2$$

$$v^2(t_2) = v^2(t_1) + 2a[(v(t_1)(t_2-t_1)) + \frac{1}{2} a (t_2-t_1)^2]$$

$$v^2(t_2) = v^2(t_1) + 2a[x(t_2) - x(t_1)]$$

from position time relation

let $v(t_1) = u$, initial velocity. $v(t_2) = v$, final velocity. $x(t_2) – x(t_1) = S$, displacement

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

Que.11. A ball is thrown vertically up with an initial velocity u.

a. What is the force acting on the ball after being projected?

b. What is the acceleration of the ball?

c. What is the velocity of the ball at the highest position?

d. What is the acceleration of the ball at the highest position?

[Marks :(4)]

Ans. a. $F = - mg$

b. $a= -g$

c. $v = 0$

d. $a= - g$

Que.12. Can a body have acceleration without velocity. Justify your answer.

[Marks :(2)]

Ans. Yes. For a ball thrown vertically up at its highest point of its path the velocity is zero but still it has an acceleration ($a = - g$)

Que.13. Define uniform motion along a straight line

[Marks :(1)]

Ans. If an object moving on a straight line covers equal distance in equal intervals of time, it is said to be in uniform motion along a straight line.

Que.14. The speedometer (odometer) of a vehicles shows _____________

a. Instantaneous speed b. Instantaneous velocity c. Instantaneous acceleration

Ans. a. Instantaneous speed

Que.14. Define with example : one dimensional motion, two dimensional motion and three dimensional motion.

[Marks :(1)]

Ans. a. Instantaneous speed

Que.15. Define with example : one dimensional motion, two dimensional motion and three dimensional motion.

[Marks :(6)]

Ans. a. One dimensional motion is the motion of an object along a straight line.

example: motion of a train along a straight rai.

b. Two dimensional motion is a motion of an object in a plane

example: a car moving on a plane Road

c. Three dimensional motion is the motion of an object in space

example: motion of gas molecules

a kite flying on a windy day

motion of aeroplane

Que.16. To describe the motion of a body we require a frame of reference. What do you mean by frame of reference?

[Marks :(2)]

Ans. a co-ordinate system used to specify position of an object along with the clock to measure time constitutes a frame of reference.

Que.17. Which of the following statements is incorrect?

a) Path length is scalar quantity whereas displacement is a vector quantity

b) The magnitude of displacement is always equal to the path length traversed by an object over a given time interval.

c) The displacement depends only on the end points whereas path length depends on the actual path followed.

d) The path length is always positive whereas displacement can be positive, negative and zero

[Marks :(1)]

Ans. b) The magnitude of displacement is always equal to the path length traversed by an object over a given time interval.

Que.18. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km h –1 , and train B moves south with a speed of 90 km h –1 . What is the

(a) velocity of B with respect to A?

(b) velocity of ground with respect to B?

[Marks :(1)]

Ans. a. the direction from south to north is taken as positive

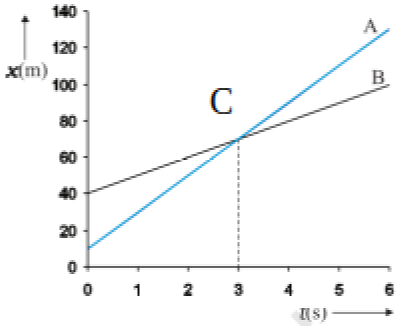
then VA = +54 m/s = 15 m/s

VB = - 90 m/s = 25 m/s

relative velocity of B with respect to A = VA – VB = 15 - (-25) = 40 m/s

b. relative velocity of ground with respect to B = 0 – VB = 0-25 = 25 m/s

Que.19. Position-time graphs of two objects with unequal velocities is given.



The point C stands for ___________

[Marks :(1)]

Ans. the time of meeting.

Que.20. A stone is thrown vertically upward with a velocity 9.8 metre per second. Find the maximum height reached by the stone, time taken to reach the maximum height, the velocity with which it touches the ground and the time taken to reach the ground. 4X2=8

Ans. v_0 = 9.8 m/s

a = -g = - 9.8 m/s^2

let S=h, maximum height

a. at maximum height v_t = 0

$v_t^2 = v_0^2 + 2ah$

$h = \frac{0 - 9.8^2}{2 \times -9.8}$ = 4.9 m

b. we have $v_t = v_0 + a\,t$

$$t = \frac{v_t - v_0}{a}$$

$\frac{0 - 9.8}{-9.8}$ = 1 sec

c. If v_t is the velocity acquired by the stone on reaching ground.

H = 4.9 m

$$v_t^2 = v_0^2 + 2as$$
$$0 + 2 \times 9.8 \times 4.9$$

v_t = 9.8 m/s

d.
let T be the total time by the stone to reach the ground. For its entire displacement S = 0

t= T,

v_0 = 9.8 m/s,

a = -g = - 9.8 m/s^2

$$S = v_0 T + \frac{1}{2} a T^2$$

$$0 = v_0 T + \frac{1}{2} a T^2$$

$$-v_0 T = \frac{1}{2} a T^2$$

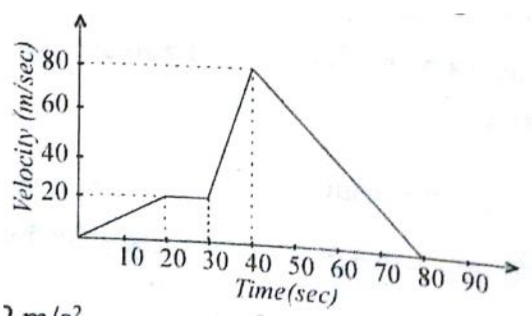
$$-v_0 = \frac{1}{2} a T$$

$$-9.8 = \frac{1}{2} - 9.8 T$$

$$T = 2\, sec$$

Que.21. the velocity time graph of a moving object is given below. Find the maximum acceleration from the graph.

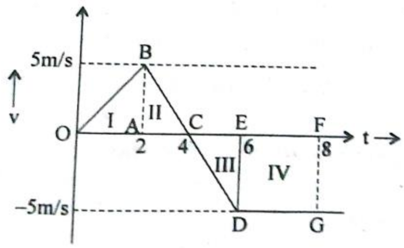
[Marks :(1)]



Ans. 2 m/s^2

Que.22. The velocity time graph of a body moving along a straight line is given below. Find the distance and displacement of the particle in 8 second.

[Marks :(5)]



Ans. Total area under graph gives distance covered by the body = Area I + Area II + Area III + Area IV

= Area of ▲OAB + Area of ▲ABC + Area of ▲CED + Area of ▬ DEFG

= $\frac{1}{2}\times2\times5+\frac{1}{2}\times2\times5+\frac{1}{2}\times2\times5+5\times2=25m$

displacement is obtained by taking the area of v-t graph by considering direction

Displacement = Area I + Area II - (Area III + Area IV)

= $\frac{1}{2}\times2\times5+\frac{1}{2}\times2\times5-(\frac{1}{2}\times2\times5+5\times2)=-5m$

Que.23. The slope of velocity time graph gives ________________ of particle.

[Marks :(1)]

Ans. acceleration

Que.24. For uniformly accelerated body the velocity time graph is a ________________

[Marks :(1)]

Ans. straight line with positive slope.

Que.25. The variation of velocity with time of a vehicle is tabulated below

Time (second)	**0**	**1**	**2**	**3**	**4**
Velocity (m/s)	**0**	**5**	**10**	**15**	**20**

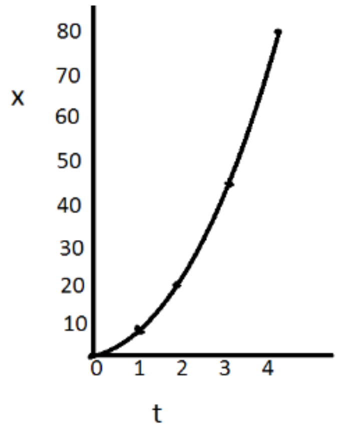
a) What type of motion does this indicate? (1)

b)Draw the corresponding position time graph (2)

c)The shape of corresponding acceleration time graph is ------------ (1)

[Marks :(4)]

Ans. a. uniformly accelerated motion



c. Straight line parallel to time axis

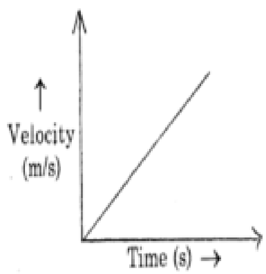
Que.26. Area under velocity time graph gives ________

[Marks :(1)]

Ans. Displacement

Que.27. The variation of velocity time graph of a body is shown below.

[Marks :(1)]

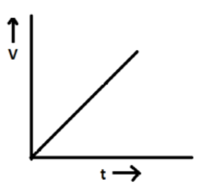


Slope of the graph will give __________

Ans. Acceleration.

Que.28. Velocity – time graph of an object is given below.

[Marks :(3)]



a. What type of motion is indicated by the above graph? (1)

b. Derive a relation connecting the displacement and time for this type of motion. (2)

Ans. a. object with constant acceleration

b. derivation $S = v_0 T + \frac{1}{2} a T^2$

Que.29. What are the uses of v-t graph?

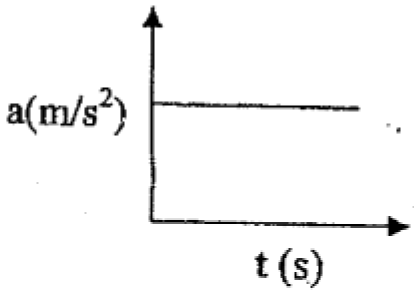
[Marks :(3)]

Ans. a. v-t graph gives velocity of object at different instant of time.

b. Area under velocity time graph gives displacement

c. Slope of the graph will give Acceleration

Que.30. Acceleration – time graph of a body is shown below:



a) Drawn the corresponding velocity-time graph. (1)

b) What does the area under the velocity – time graph represent? (1)

c) Arrive at a relation connecting velocity (v) and time (t) for a uniformly accelerated body. (3)

Que.31. The position time graph for a particle in uniform motion is parabola. Which of the following graph represents the position time graph for a particle in uniform motion with

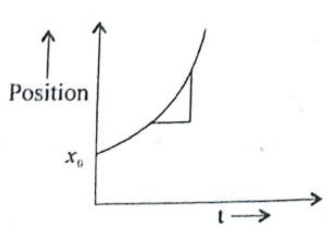
a. positive acceleration.

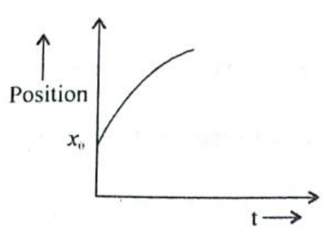
b. Negative acceleration.

[Marks :(4)]

Ans. a. positive acceleration.

b. Negative acceleration.





Que.32. The position time graph for a particle in uniform motion is _________

[Marks :(1)]

Ans. parabola.

Que.33. The slope of position time graph gives __________

[Marks :(1)]

Ans. Velocity

Que.34. A car travels at a speed of 30 kilometre per hour for 10 minutes and then with a speed of 40 km per hour for 5 minutes. Find

a. the total distance travelled

b. the average speed of car.

[Marks :(4)]

Ans. Given v1 = 30km/hr, v2 = 40 km/hr, t1 = 10 min, t2 = 5 min

a. distance covered at the speed 30 km/hr S1 = v1 t1 = 30 X 10/60 = 5 km

distance covered at the speed 40 km/hr S2 = v2 t2 = 40 X 5/60 = 3.33 km

total distance S = S1 +S2 = 5+ 3.33 = 8.33 km

b. $Average\ speed = \frac{total\ distance}{total\ time} = 8.33/0.25 = 33.32\ km/hr$

Que.35. Velocity is defined as the rate of change of displacement. Distinguish between average velocity and instantaneous velocity.

[Marks :(4)]

Ans. Average velocity of an object during an interval of time is the ratio of its total displacement during that interval to the total time taken.

Average Velocity = $\frac{Total\ Displacement}{time\ taken}$

v = $\frac{x_2 - x_1}{t_2 - t_1}$

The velocity of an object at a particular instant of time is called instantaneous velocity.

Let dx be the displacement of a particle in a small time dt, then

v =

$\frac{dx}{dt}$

OR

Instantaneous velocity is the time derivative of displacement.

Que.36. What do you mean by relative velocity

[Marks :(2)]

Ans. Relative velocity is the velocity of a body with respect to another body. It is measured as a rate of change of position of a body with respect to another body.

Que.37. State true or false

"in uniform motion the velocity of a particle remains same"

[Marks :(1)]

Ans. True

Que.38. What are the uses of position time graph?

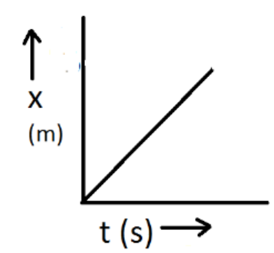
[Marks :(2)]

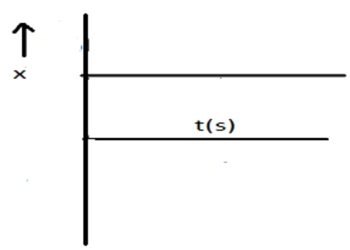
Ans. From the position time graph we get the position of object at different instance of time.

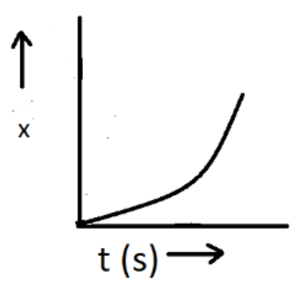
The slope of position time graph gives the velocity.

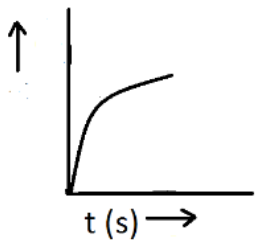
Que.39. A graph with Position along Y axis and time along X axis is called Position –time graph. Identify the following graphs.

[Marks :(2)]









Ans. i) Position –time graph of an object with Zero acceleration (under uniform velocity)

ii) Position –time graph of an object at rest

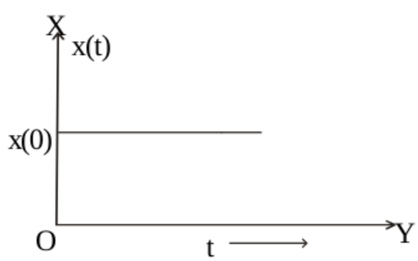
iii) Position –time graph of an object in non uniform motion with increasing speed

iv) Position – time graph of an object in non uniform motion with decreasing speed

Que.40. Draw the position- time graph for a stationary object.

[Marks :(1)]

Ans.



Que.41. when a body is said to be a stationary object?

[Marks :(1)]

Ans. An object is said to be stationary if its position does not change with time.

Que.42. An aeroplane flying from India to USA is said to be a point object.

Why it is said to be a point object.

What is a point object.

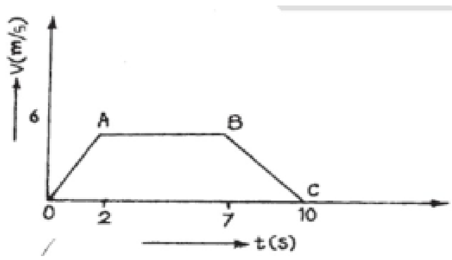
[Marks :(2)]

Ans. The size of plane is negligible in comparison with the distance covered. So it is called a point object.

An object is said to be a point object if its dimensions are negligible in comparison with the distance covered by it.

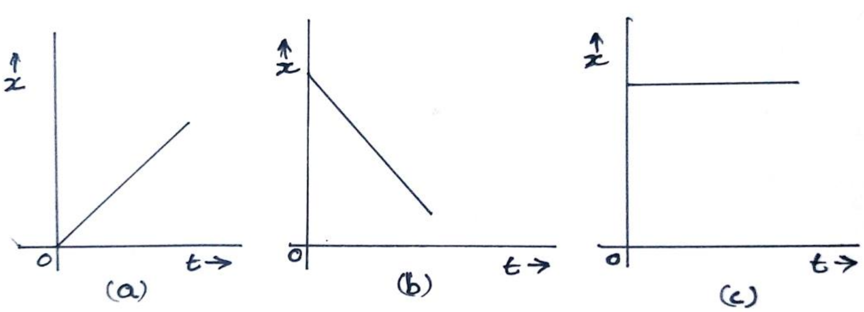
Que.43. Velocity – time graph of a body is given below. Which portion of the graph represents uniform retardation? (i) OA (ii)AB (iii) BC (iv) OC

[Marks :(1)]

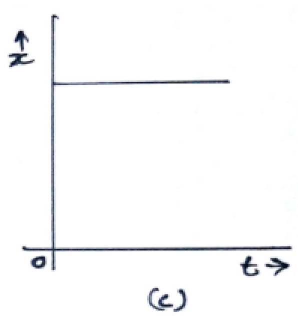


Que.44. Which one of the following graph represents the position time graph for a particle at rest.

[Marks :(1)]



Ans.



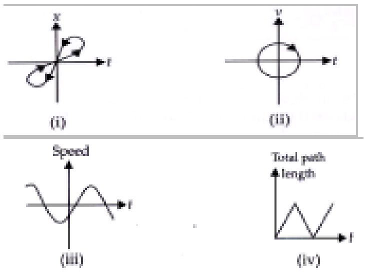
Que.45. Free fall of the object in vacuum is a case of motion with

a) Uniform velocity b) Uniform acceleration c) variable acceleration d) uniform speed

[Marks :(1)]

Ans. b) Uniform acceleration

Que.46. Which of the following graphs cannot possibly represent one dimensional motion of a particle?



a) (i) and (ii) b) (ii) and (iii) c) (i), (ii) and (iii) d) all four

[Marks :(1)]

Ans. (iii) d) all four

Que.47. Which of the following paramter get changed, when a particle is moving with uniform velocity?

a) Position b) Speed c) Velocity d) Acceleration

[Marks :(1)]

Ans. a) Position

Que.48. when a ball throws vertically upwards with velocity u. At highest point,

a) both the velocity and acceleration of the ball are zero.

b) the velocity of the ball is u but its acceleration is zero

c) the velocity of the ball is zero but its acceleration is g.

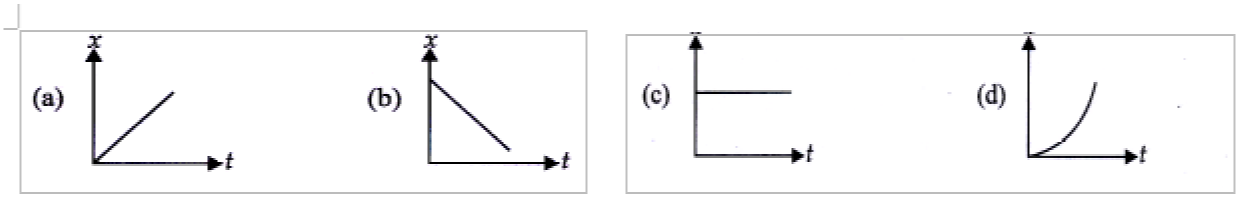
d) the velocity of the ball is u but its acceleration is g

[Marks :(1)]

Ans. c) the velocity of the ball is zero but its acceleration is g.

Que.49. Which of the following graphs represents the position – time graph of a particle moving with negative velocity?

[Marks :(1)]



Ans.