Study Important Questions for Class 9 Science

Chapter 7 - Motion

(Highly Expected Questions & Answers)

Very Short Answer Questions (1 Mark)

1. Which of the following statements is correct?

a. Both speed and velocity are same

b. Speed is a scalar and velocity is a vector

c. Speed is a vector and velocity is scalar

d. None of these

Ans: b) speed is a scalar and velocity is a vector

2. What is the slope of the body when it moves with uniform velocity?

a. Positive

b. Negative

c. Zero

d. May be positive or negative

Ans: b) Zero

3. Which of the following is the position time graph for a body at rest?

a.

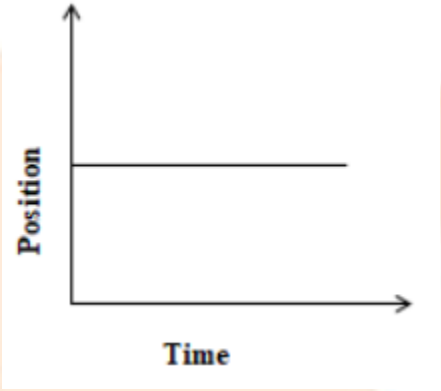

Image: Position Time Graph I

b.

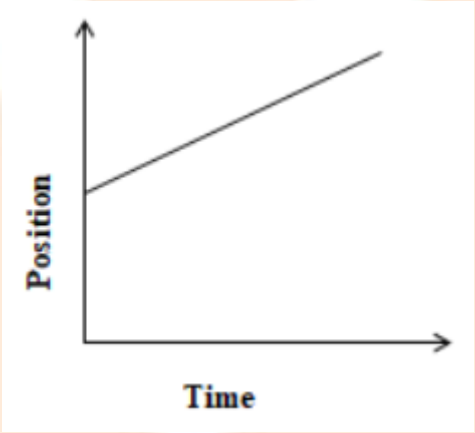

Image: Position Time Graph II

c.

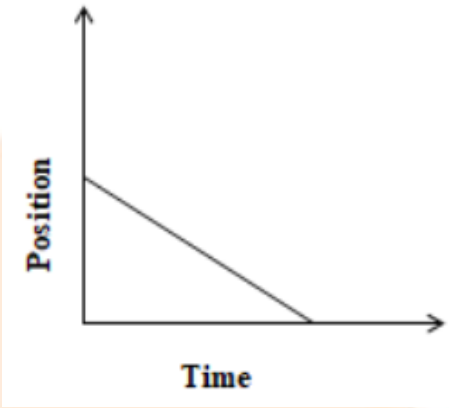

Image: Position Time Graph III

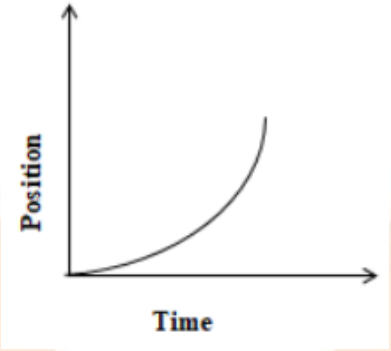

Image: Position Time Graph IV

Ans: a)

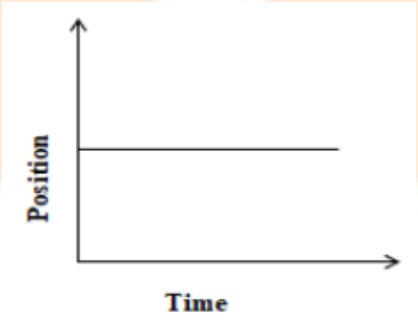

Image: Position Time Graph for a body at rest

4. What does an area velocity time graph give?

a. Distance

b. Acceleration

c. Displacement

d. None of the above

Ans: c) Displacement

5. If a body starts from rest, what can be said about the acceleration of the body?

a. Positively accelerated

b. Negative accelerated

c. Uniform accelerated

d. None of the above

Ans: a) Positively accelerated

6. What does the slope of the position-time graph give?

a. Speed

b. Acceleration

c. Uniform speed

d. Both (a) and (c) depending upon the type of graph.

Ans: a) Speed

7. When a body moves uniformly along the circle, then:

a. Its velocity changes but speed remain the same

b. Its speed changes but velocity remain the same

c. Both speed and velocity changes

d. Both speed and velocity remains the same

Ans: a) Its velocity changes but speed remains the same

8. Which of the following statements is correct?

a. Speed distance are scalar, velocity and displacement are vector

b. Speed distance are vector, velocity and displacement are vector

c. Speed and velocity are scalar, distance and velocity are vector

d. Speed and velocity are vector, distance and displacement are scalar

Ans: a) Speed distance are scalar, velocity and displacement are vector

9. What does the slope of a velocity-time graph give?

a. Distance

b. Displacement

c. Acceleration

d. Change in velocity.

Ans: c) Acceleration

10. The displacement of the body can be-

a. Positive

b. Negative

c. Zero

d. All of these.

Ans: d) All of these.

11. Which of the following gives both direction and magnitude-

a. Scalar

b. Vector

c. Both

d. None.

Ans: b) Vector

12. If a moving body comes to rest, then its acceleration is

a. Positive

b. Negative

c. Zero

d. All of these depending upon initial velocity.

Ans: b) Negative

Short Answer Questions (2 Marks)

1. Distinguish between speed and velocity.

Ans: Speed of a body is the distance travelled by a body as per unit time while velocity is the rate and direction of an object's movement.

2. Under what condition(s) is the magnitude of the average velocity of an object equal to its average speed?

Ans: If the distance travelled by a body is equal to the displacement, then the magnitude of the average velocity of an object will be equal to its average speed.

3. What does the odometer of an automobile measure?

Ans: The odometer of an automobile is used to measure the distance covered by an automobile.

4. What does the path of an object look like when it is in uniform motion?

Ans: Graphically the path of an object will be linear; it looks like a straight line when it is in uniform motion.

5. During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, $3\times 108 \mathbf{m}s^{-1}$

Ans: The given data is that time is five minutes and speed is $(3\times 10^{8} ms^{-1})$

$Distance = Speed \times Time$

$\Rightarrow 5\,\text{min} \times (3 \times 10^8\, ms^{-1})$

$\Rightarrow (5 \times 60)\,\text{sec} \times (3 \times 10^8\, ms^{-1})$

$\Rightarrow 300\,\text{sec} \times (3 \times 10^8\, ms^{-1})$

$\Rightarrow 900 \times 10^8\, ms^{-1} = 9 \times 10^{10}\, m$

$\therefore Dis\tan ce = 9 \times 10^7\, km$

6. Which of the following is true for displacement?

a. It cannot be zero.

Ans: False with respect to the concept of displacement

b. Its magnitude is greater than the distance travelled by the object.

Ans: False with respect to the concept of displacement.

7. When will you say a body is in

i. Uniform acceleration?

Ans: When an object travels in a straight line and its velocity changes by equal amount in an equal interval of time, it is said to have uniform acceleration.

ii. Non-uniform acceleration?

Ans: Non-uniform acceleration is also called variable acceleration. When the velocity of an object changes by unequal amounts in equal intervals of time, it is said to have non-uniform acceleration.

8. A bus decreases its speed from $80kmh^{-1}$ to $60kmh^{-1}$ in $5s$. Find the acceleration of the bus.

Ans: Initial speed of bus (u) $=80kmh^{-1}$

$$\Rightarrow \frac{80\times1000}{60\times60\sec}$$

$$\Rightarrow \frac{200}{9ms^{-1}} = 22.22ms^{-1}$$ Final speed of bus (v) $=60kmh^{-1}$

$$\Rightarrow \frac{60\times1000}{60\times60\sec} = \frac{50}{3ms^{-1}} = 16.67ms^{-1} time(t) = 5s$$

Acceleration (a) $= \frac{(v-u)}{t} = \frac{(16.67-22.22)}{5} = \frac{-5.55}{5} = -1.11m/s^2$

$\therefore Acceleration\ (a) = -1.11m/s^2$

9. What is the nature of the distance time graphs for uniform and non-uniform motion of an object?

Ans: If an object has a uniform motion then the nature of distance time graph will be linear, that is it would in a straight line and if it has non-uniform motion then the nature of the distance-time graph will be a curved line.

10. What is the quantity which is measured by the area occupied below the velocity-time graph?

Ans: The area occupied below the velocity-time graph measures the distance moved by any object.

11. A bus starting from rest moves with a uniform acceleration of $0.1 ms^{-2}$ for 2 minutes . Find

a. The speed acquired,

Ans: $u = 0, a = 0.1 ms^{-2}, t = 2 \min = 120 \sec$

$v = u + at = 0 + 0.1 \times 120 = 12 ms^{-1}$

Speed acquired $= v = 12 ms^{-1}$

b. The distance travelled.

Ans: $s = ut + \frac{1}{2} at^2 = 0 \times 120 + \frac{1}{2} 0.1 \times 120^2 = 720 m$

12. A trolley, while going down an inclined plane, has an acceleration of $2 cms^{-2}$. What will be its velocity 3s after the start?

Ans: Given: $u = 0, a = 2 cm/s^2, t = 3s$

$v = u + at = 0 + 2 \times 3 = 6 cm/s$

13. A racing car has a uniform acceleration of $4ms^{-2}$. What distance will it cover in 10s after start?

Ans: Given: $u = 0, a = 4m/s^2, t = 10s$

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

$$s == 0 \times 10 + \frac{1}{2} \times 4 \times 10^2$$

$$\therefore s = 200m$$

14. Differentiate between distance and displacement?

Ans: The difference between distance and displacement is as below,

	Distance	**Displacement**
	The length of the actual path travelled by the body from initial position to final position	The length of the straight line joining the initial and final position of the body
2	It is a scalar quantity, that is it has only magnitude	It is a vector quantity that is it has both magnitude and direction.
3	It is always positive.	It may be positive, negative or zero.

15. Derive mathematically the first equation of motion $\mathbf{V = u + at}$?

Ans: Acceleration is defined as the rate of change of velocity.

Let V=final velocity;

$\mathbf{V}_o$ = initial velocity, T= time, a = acceleration.

So by definition of acceleration

$$a = \frac{V - V_o}{T}$$

$$at = V - V_o$$

$$V = V_o + at$$

If $V_o = u =$ initial velocity, then $[V = u + at]$

16. Calculate the acceleration of a body which starts from rest and travels 87.5m 5sec ?

Ans: Given Data: $u = 0$ (starts from rest) u= initial velocity

a=? a=acceleration

$T = 5\text{sec}, t = time$

$S = 87.5m \ (S = distance)$

From second equation of motion

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

$$\Rightarrow 87.5 = 0 + \frac{1}{2}at^2$$

$$\Rightarrow 87.5 = \frac{1}{2}at^2 \rightarrow (i)$$

$$\Rightarrow 87.5 \times 2 = a \times (5)^2$$

$\Rightarrow \frac{87.5 \times 2}{25} = a$

$\Rightarrow \frac{175.0}{25} = a$

$\therefore S = 7m/s^2 = a$

17. Define uniform velocity and uniform acceleration?

Ans: Uniform velocity:- A body is said to move with uniform velocity if equal displacement takes place in equal intervals of time, however small these intervals may be.

Uniform acceleration:- A body is said to move with uniform acceleration if equal changes in velocity take place in equal intervals of time, however, small intervals may be.

18. A car travels at a speed of $40km/hr$ for two hour and then at $60km/hr$ for three hours. What is the average speed of the car during the entire journey?

Ans: Given: In first case; $t_1 = time = 2hrs$

$v_1 = speed = 40km/hr$

$s_1 = dis\tan ce = speed \times time$

$s_1 = 40 \times 2 = 80km$

In second case, Given $t_2 = time = 3hrs$

$v_2 = speed = 60km/hr$

$s_2 = dis\tan ce = speed \times time$

$s_2 = 60 \times 3 = 180km$

The total distance = $s_1 + s_2 = 80 + 180 = 260km$

Total time, $t_1 + t_2 = 2 + 3 = 5hrs$

Average speed = $\frac{total\ distance}{total\ time} = \frac{260}{5}$

$\therefore Average\ speed = 52km/hr$.

19. The velocity-time graph of two bodies A and B traveling along the +x direction are given in the figure

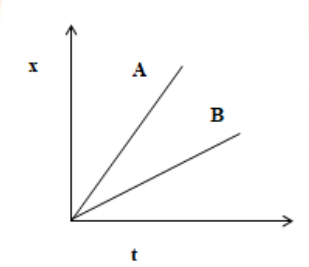

Image: Given Velocity-time graph for A and B

a. Are the bodies moving with uniform acceleration?

Ans: Yes the bodies are moving with uniform acceleration.

b. Which body is moving with greater acceleration A or B?

Ans: Body A is moving with greater acceleration.

20. Derive the second equation of motion, $\mathbf{s = ut + \frac{1}{2}at^2}$ numerically?

Ans: Let at time $\mathbf{t = 0}$, body has initial velocity $= V_o$

At time‘t’, the body has final velocity=V

S=distance traveled in time‘t’

We know, total distance traveled = Average velocity × time

$$Average\ velocity = \frac{initial\ velocity + final\ velocity}{2}$$

$$\Rightarrow \frac{V_o + V}{2}$$

$$Total\ distance = s = \frac{V_o + V}{2} \times t$$

$$\Rightarrow 2s = (V_o + V)t \rightarrow (i)$$

Now from first equation of motion, $V = V_o + at \rightarrow (ii)$

Use the value of (V) from (ii) in (i)

$$2s = (V_o + V_o + at)t$$

$$2s = 2V_o t + \frac{1}{2}at^2$$

$$Let, V_o = u$$

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

21. Calculate the acceleration and distance of the body moving with $5m/s^2$ which comes to rest after traveling for 6sec?

Ans: Acceleration=a=?

Final velocity = V =o (body comes to rest)

Distance = s =?

$Time = t = 6sec$

From, $V = u + at$

$O = 5 + a \times 6$

$-a \times 6 = 5$

$a = \frac{-5}{6} m/s^2$

Now,

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

$O^2 - 25 = 2 \times \frac{-5}{6} \times s$

$\Rightarrow -25 = \frac{-5}{3} \times s$

$\Rightarrow \frac{25 \times 3}{5} = s$

$\therefore s = 15m$

22. A body is moving with a velocity of $12m/s$ and it comes to rest in 18m, what was the acceleration?

Ans: Initial velocity $= u = 12m/s$

Find velocity =V=0

$S = distance = 18m$

A= acceleration =?

From 3rd equation of motion;

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

$O^2 - (12)^2 = 2 \times a \times 18$

$\Rightarrow \frac{-144}{36} = a$

$a = \frac{-144}{36}$

$[a = -4m/s^2]$

$\Rightarrow 4m/s^2$

23. A body starts from rest and moves with a uniform acceleration of $4m/s^2$ until it travels a distance of 800m, find the find velocity?

Ans: Initial velocity $= u = 0$

Final velocity $= v = ?$

Acceleration $= a = 4m/s^2$

Distance $= s = 800m$

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

$u^2 - (0) = 2 \times 4 \times 800$

$u = 80 m/s$

$\therefore u^2 = 6400$

24. The driver of a car traveling along a straight road with a speed of 72kmph observes a sign board which gives the speed limit to be 54kmph. The signboard is 70m ahead when the driver applies the brakes calculate the acceleration of the car which will cause the car to pass the signboard at the stated speed limit?

Ans: Initial speed $= u = 72\ km/hr$

$\Rightarrow \frac{72 \times 5}{18} = 20 m/s$

Final speed $= v = 54\ km/hr$

$\Rightarrow \frac{54 \times 5}{18} = 15 m/s$

Distance $= \mathbf{S = 70m}$

Now, $v^2 - u^2 = 2as$

$(15)^2 - (20)^2 = 2 \times a \times 70$

$\Rightarrow 225 - 400 = 140a$

$\Rightarrow -175 = 140a$

$[a = -1.25 m/s^2]$

25. Differentiate between scalars and vectors?

Ans: The difference between scalars and vectors is as below,

Vector	**Scalar**
1. It has magnitude and specific direction	It has magnitude but no direction
2. It can be positive or negative	It is always positive
3. Eg. Displacement, velocity	Eg: Distance, speed

Short Answer Questions (3 Marks)

1. **An object has moved through a distance. Can it have zero displacements? If yes, support your answer with an example.**

Ans: Yes, if an object is moved through a distance it can have zero displacement because displacement of an object is the actual change in its position when it moves from one position to the other position. So if an object travels from point A to B and then returns back to point A again, the total displacement will be zero.

2. A farmer moves along the boundary of a square field of side 10min40s. What will be the magnitude of displacement of the farmer at the end of $2\min 20\sec$ **?**

Ans: Distance covered by farmer in **40 seconds** $= 4 \times (10)m = 40m$

Speed of the farmer = distance/time

$= 40m / 40s = 1m / s.$

Total time given in the question

$= 2min20sec = 60 + 60 + 20 = 140sec$

Since he completes 1roundof the field in 40seconds so in he will complete 3rounds in $120\ seconds(2mins)or120m$ distance is covered in2min. In another 20secwill cover another 20m so total distance covered in $2min20sec = 120+20 = 140m.\ Displacement = \sqrt{10^2}+10^2$

$\Rightarrow \sqrt{200} = \sqrt{10}\sqrt{2m}$ (as per diagram)

$\Rightarrow 10\times 1.414$

$\therefore Displacement = 14.14m$

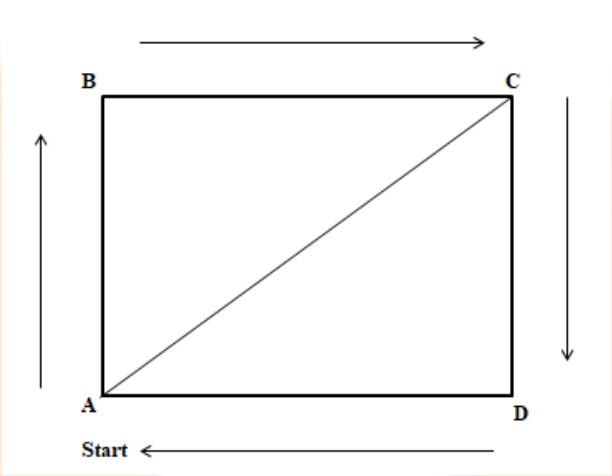

Image: Diagrammatic representation of the square field

3. A train starting from a railway station and moving with uniform acceleration attains a speed $40kmh^{-1}$ in $10\min$. Find its acceleration.

Ans: Since the train starts from rest (railway station) = u = zero

Final velocity of train $= v = 40kmh^{-1}$

$\Rightarrow \dfrac{(40\times 1000)}{60\times 60ms^{-1}} = 100/9ms^{-1}$

$\Rightarrow 11.11 ms^{-1}$

$time(t) = 10 min = 10 \times 60 = 600 \ seconds$

$Since \ a \ = \frac{(vu)}{t} = 11.11 ms^{-1} / 600 \sec = 0.018 m/s^2$

4. What can you say about the motion of an object whose distance time graph is a straight line parallel to the time axis?

Ans: If the object's distance time graph is a straight line parallel to the time axis indicates that with increasing time the distance of that object is not increasing hence the object is at rest that is not moving.

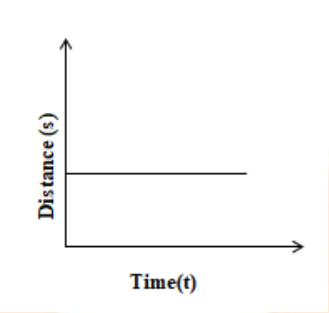

Image: Distance-time graph of an object at rest

5. What can you say about the motion of an object if its speed time graph is a straight line parallel to the time axis?

Ans: Such a graph indicates that the object is travelling with uniform velocity.

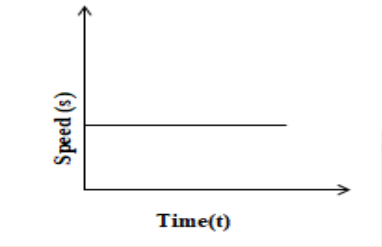

Image: Speed time graph of an object moving with uniform speed

6. A train is travelling at a speed of $90kmh^{-1}$. Brakes are applied so as to produce a uniform acceleration of $-0.5ms^{-2}$. Find how far the train will go before it is brought to rest.

Ans: $u = 90kmh^{-1} = \frac{(90\times1000)}{60\times60} = 25ms^{-1}$

$Given: a = -0.5ms^{-2}, v = 0\left(\textbf{train is brought to rest}\right)$

$v = u + at = 25 + (-0.5)\times t$

$\Rightarrow 0 = 25 - 0.5x$

$\Rightarrow 0.5t = 25, or t = \frac{25}{0.5} = 50\sec$

$s = ut + \frac{1}{2}at^2 = 25\times50 + \frac{1}{2}\times(-0.5)\times50^2$

$\Rightarrow 1250 - 625 = 625m$

$\therefore s = 625m$

7. A stone is thrown in a vertically upward direction with a velocity of $5ms^{-1}$. If the acceleration of the stone during its motion is $10ms^{-1}$ in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

Ans: Given: $u = 5ms^{-1}, a = -10ms^{-2}$

$v = 0$ **(sinceat maximum height its velocity will be zero)**

$v = u + at = 5 + (-10) \times t$

$\Rightarrow 0 = 5 - 10t \;\; 10t = 5, or, t = \frac{5}{10} = 0.5\sec$

$S = ut + \frac{1}{2}at^2 = 5 \times 0.5 + \frac{1}{2} \times (-10) \times 0.5^2$

$\Rightarrow 2.5 - 1.25 = 1.25m$

$\therefore S = 1.25m$

8. Derive the second equation of motion $S = ut + \frac{1}{2}at^2$ graphically?

Ans: Let at time $\mathbf{T = 0}$ body moves with initial velocity u and at time 't' body has final velocity 'v' and at time 't' it covers a distance's.

$\mathbf{AC = v,\ AB = u,\ OA = t,\ DB = OA = t,\ BC = AC - AB = V - u}$

Area under a $v - t$ curve gives displacement so,

$\mathbf{S = Area\ of\ \Delta DBC + Area\ of\ rectangle\ OABD \rightarrow (i)}$

$Area\ of\ \Delta DBC = \frac{1}{2} \times Base \times Height \Rightarrow \frac{1}{2} \times DB \times BC$

$\Rightarrow \frac{1}{2} \times t \times (v-u) \rightarrow (ii)$

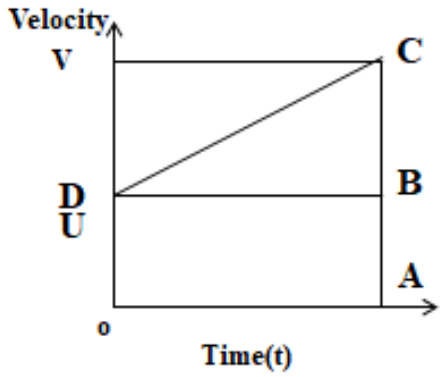

Image: Graphical representation of second equation of motion

$Area\ of\ \ rectangle\ OABD\ \ =\ \ length \times Breadth$

$\Rightarrow OA \times BA$

$\Rightarrow t \times u \rightarrow (iii)$

$S = ut + \frac{1}{2} \times t \times (v-u)$

$S = ut + \frac{1}{2} \times t \times at (\therefore use V - u = at)$

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

9. A car moving with a certain velocity comes to a halt if the retardation was $5m/s^2$ find the initial velocity of the car?

Ans: $V = 0$ (comes to rest) V = final velocity

$S = 62.5m$

$a = -5m/s^2 (retardation)$

$U = ?$

From 3^{rd} equation of motion,

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

$O^2 - u^2 = 2 \times (-5) \times 62.5$

$-u^2 = -10 \times 62.5$

$u^2 = 625$

$u = \sqrt{625} [u = 25m/s]$

10. Two cars A and B are moving along in a straight line. Car A is moving at a speed of 80kmph while car B is moving at a speed of 50kmph in the same direction, find the magnitude of Fivevtherelative of car A with respect to B. The relative velocity of car is 80kmph.

a. Velocity of Car B = $-$ 50 *kmph*

Ans: (-ve sign indicates that Car B is moving in the opposite direction to Car A)

The relative velocity of car A with respect to B

velocity of car A + (- velocity of car B)

$\Rightarrow 80+(-(-50))$

$\Rightarrow 80+50$

$\Rightarrow +130 kmph$

$+130 kmph$ shows that for a person in car B, car A will appear to move in the same direction with a speed of the sum of their individual speed.

b. Relative velocity of car B with respect to A

Ans:

$\Rightarrow$ Velocity of car B+ (- velocity of car A)

$\Rightarrow -50+(-80)$

$\Rightarrow -130 kmph$

It shows that car B will appear to move with 130~~~kmph in opposite direction to car A

11. A ball starts from rest and rolls down 16mdown an inclined plane in4s

a. What is the acceleration of the ball?

Ans: Given: **u** = **initial velocity** = **0** (body starts from rest)

$S = distance = 16\ m$

$T = time = 4s$

From, $s = ut + \frac{1}{2}at^2$

$16 = 0 \times t + \frac{1}{2} a \times (4)^2$

$16 = \frac{1}{2} \times a \times 16$

$\frac{16 \times 2}{16} = a$

$[2m/s^2 = a]$

b. What is the velocity of the ball at the bottom of the incline?

Ans: From, $v = u + at$

$v = 0 + 2 \times 4$

$[v = 8m/s]$

12. Two boys A and B, travel along the same path. The displacement – time graph for their journey is given in the following figure.

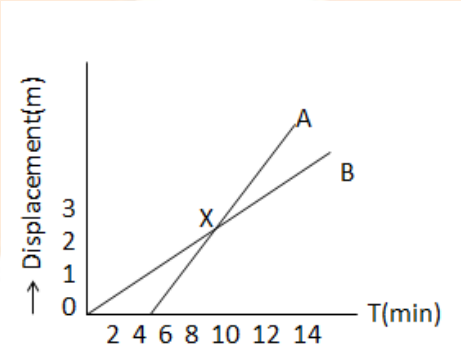

Image: Displacement Time Graph made for two boys traveling the same path

a. How far down the road has B travelled when A starts the journey?

Ans: When A starts his journey at $4\ sec$, B has already covered a distance of 857m.

b. Without calculation, the speed, state who is traveling faster A or B?

Ans: A travels faster than B because A starts his journey late but crosses B and covers more distance then B in the same time as B

c. What is the speed of A?

Ans: $Speed\ of\ A = \dfrac{Distance\ covered}{Time\ taken}$

Let at $t = 12\ min$, $distance\ covered = 3500m$

$$\Rightarrow \frac{3500}{12} = 375m/\min$$

$$\therefore Speed\ of\ A = 375m/\min$$

d. What is the speed of B?

Ans: $Speed\ of\ \mathrm{B} = \dfrac{Distance\ covered}{Time\ taken}$

$$V_B = \frac{3000}{12}$$

$$V_B = 214m/\min$$

e. Are the speed of A and B uniform?

Ans: Yes

f. What does point X on the graph represent?

Ans: X on the graph represents the point at which both A and B are at the same position

g. What is the speed of approach of A towards B? What is the speed of separation of A from B?

Ans: Speed of approach of A towards

$B = 375\ m/min - 214\ m/min$

$\Rightarrow 161\ m/min$

Speed of separation of A from $B = 161\ m/min$

13. A body is dropped from a height of320m. The acceleration due to the gravity is $10m/s^2$?

a. How long does it take to reach the ground?

Ans: Given Data: Height = h

$Distance = s = 320m$

Acceleration due to gravity $= g = 10m/s^2$

Initial velocity $= u = 0$

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

$h = ut \times \frac{1}{2}gt^2$

$320 = 0 \times t + \frac{1}{2} \times 10 \times t^2$

$\frac{320 \times 2}{10} = t^2$

$64 = t^2$

$t = 8\text{sec}$

b. What is the velocity with which it will strike the ground?

Ans: From $v = u + at$

$v = 0 + 10 \times 8$

v=80m/s

14. Derive third equation of motion $v^2 - u^2 = 2as$ numerically?

Ans: We know,

$v = u + at.....(i)$

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

When, v= final velocity

u= initial velocity

a = acceleration

t = time

s = distance

From equation (i) $t = \frac{v-u}{a}$

Put the value of t in equation (ii)

$$s = u \times \frac{v-u}{a} + \frac{1}{2} a \times \frac{v-u}{a}$$

$$s = \frac{uv-u^2}{a} + \frac{1}{2} a \times \frac{v^2+u^2-2uv}{a^2}$$

$$s = \frac{uv-v^2}{a} + \frac{1}{2} \times \frac{v^2+u^2-2uv}{a}$$

$$s = \frac{2uv-2u^2+v^2+u^2-2vu}{2a}$$

$$s = \frac{v^2-u^2}{2a}$$

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

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

15. The velocity-time graph of the runner is given in the graph.

a. What is the total distance covered by the runner in16s?

Ans: We know that area under v-t graph gives displacement:

So, Area = distance = s = area of triangle + area of rectangle

$Area\ of\ \ triangle = \frac{1}{2} \times base \times height$

$\Rightarrow \frac{1}{2} \times 6 \times 10$

$\Rightarrow 30m$

$\therefore Area\ of\ \ triangle = 30m$

$Area\ of\ \ rectangle = length \times breadth$

$\Rightarrow (16-6) \times 10$

$\Rightarrow 10 \times 10$

$\Rightarrow 100m$

Total area = 180m

Total distance = 180m

b. What is the acceleration of the runner at $t = 11s$?

Ans: Since at $t = 11sec$, particles travel with uniform velocity so, there is no change in velocity hence acceleration = zero.

16. A boy throws a stone upward with a velocity of $60m/s$.

a. How long will it take to reach the maximum height $(g = -10m/s^2)$?

Ans: $u = 60\ m/s;$ g= -10m/s^2; $v = 0$

The time to reach maximum height is $v = u + at = u + gt$

$0 = 60 - 10t$

$t = \frac{60}{10} = 6s$

b. What is the maximum height reached by the ball?

Ans: The maximum height is:

$v^2 = u^2 + 2gs$

$s = -\frac{u^2}{2g} = \frac{60^2}{2 \times 10}$

$\Rightarrow 180m$

c. How long will it take to reach the ground?

Ans: The time to reach the top is equal to the time taken to reach back to the ground. Thus, the time to reach the ground after reaching the top is6sor the time to reach the ground after throwing is $6 + 6 = 12s$.

17. The displacement x of a particle in meters along the x- axis with time 't' in seconds according to the equation- $X = 2m + \left(\frac{12m}{s}\right)t$

a. Draw a graph if x versus t for $t = 0$ **and** $t = 5\text{sec}$

Ans: $X = 20m + (12)\ t$

i. At $t = 0 \quad X = 20 + 120 = 12\ m$

ii. At $t = 1\ X = 20 + 12 = 32m$

iii. At $t = 2\ X = 20 + 24 = 44m$

iv. At $t = 5\ X = 20 + 125 = 72m$

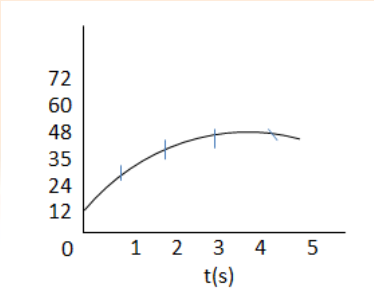

Image: Displacement Time graph for t=0 and t=5 seconds

b. What is the displacement comes out of the particles initially?

Ans: At $T = 0$ (initially)

Displacement $= 20m.$

c. What is the slope of the graph obtained?

Ans: $Slope = \frac{y_2 - y1}{x_2 - x_1} = \frac{72 - 44}{5 - 2} = \frac{28}{3}$

$\Rightarrow 9.3m/s$

18. The velocity of a body in motion is recorded every second as shown

Time(s)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Velocity(m/s)	**62**	**54**	**48**	**42**	**36**	**30**	**24**	**18**	**12**	**6**	**0**

calculate the –

a. Acceleration

Ans: Acceleration =slope of the velocity time graph

$$a = \frac{V_2 - V_1}{t_2 - t_1}$$

$$a = \frac{54-24}{1-6} = \frac{30}{-5} = -6m/s^2$$

b. Distances travelled and draw the graph.

Ans: Distance $\Rightarrow S = ut + \frac{1}{2}at^2$

$$\Rightarrow 60 \times 10 + \frac{1}{2}(-6) \times (10)^2$$

$$\Rightarrow 600 - 300 = 300m$$

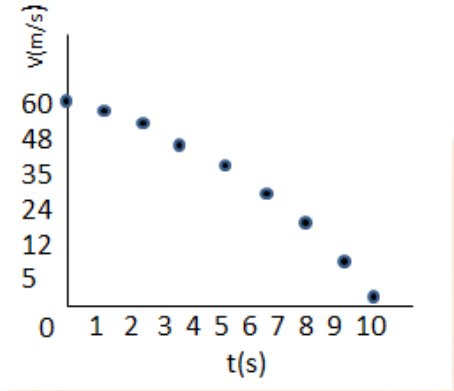

Image: Velocity Time graph for given data

19. Draw the graph for uniform retardation –

a. Position – time graph

Ans:

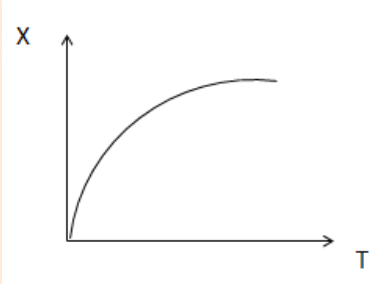

Image: Position-time graph for uniform retardation

b. Velocity – time

Ans:

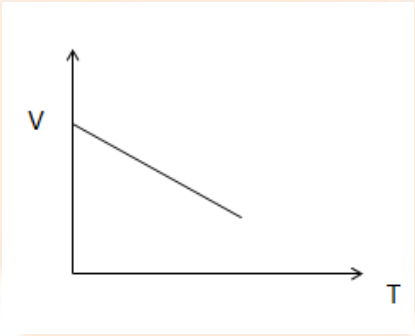

Image: Velocity-time graph for uniform retardation

c. Acceleration- time

Ans:

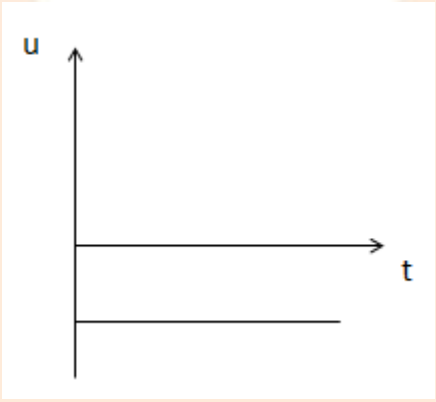

Image: Acceleration- time graph for uniform retardation

20. The displacement – time graph for a body is given. State whether the velocity and acceleration of the body in the region BC, CD, DE and EF are positive, negative or Zero.

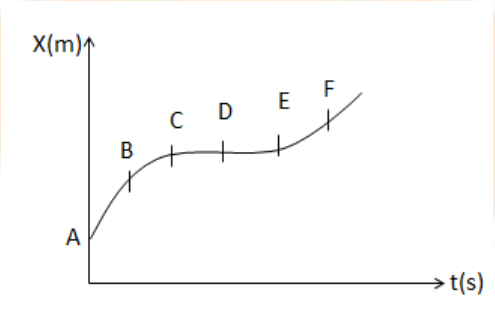

Image: Given Displacement-time graph for a body

Ans:

i. For AB, the curve is upward stopping i.e. slope is increasing so velocity is positive and remains the same so, V= +ve but $a = 0$

ii. For BC, the curve has still has +ve slope so, V= +ve but velocity is decreasing with respect to time so, a=negative

iii. For CD, both velocity and acceleration are Zero because slope is Zero.

iv. For DE, velocity is the (v is increasing with respect to time) and so is the acceleration is +ve. (v) For EF, velocity is +ve (positive slope of x-t graph) but acceleration is Zero because velocity remains some with time.

AB	BC	CD	DE	EF	
V	+ve	+ve	0	+ve	+ve
A	0	-ve	0	+ve	0

21. Derive the third equation of motion $-v^2-u^2=2as$ as graphically?

Ans: Let at time $t=0$, the body moves with initial velocity u and time at 't' has final velocity 'v' and in time 't' covers a distance 's'

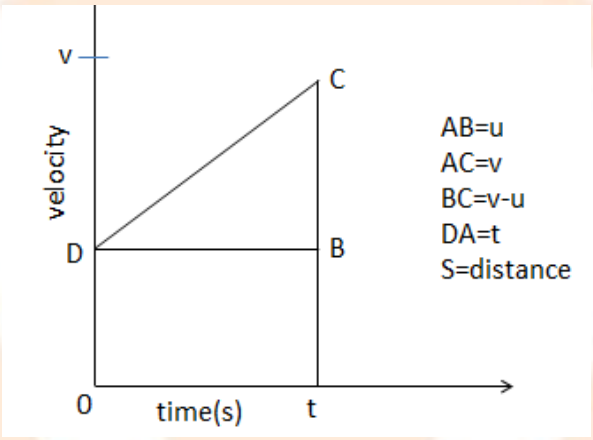

Image: Graphical representation of third equation of motion

Area under v-t graph gives displacement $\mathbf{S=Area\ of\ \Delta DBC+Area\ of\ rectangle\ OAB}D$

$$S=\frac{1}{2}\times base\times height+length\times breadth$$

$$S=\frac{1}{2}\times DB\times BC+OA\times AB$$

$$S=\frac{1}{2}\times t\times(v-u)+t\times u\rightarrow(i)$$

$$Now, v-u=at$$

$$\frac{v-u}{a}=t$$

Put the value of 't' in equation (i)

$$s=\frac{1}{2}\times(v-u)\times\frac{v-u}{a}+u\times\left(\frac{v-u}{a}\right)$$

$$s = \frac{uv - u^2}{a} + \frac{1}{2}a \times \frac{v^2 + u^2 - 2uv}{a^2}$$

$$s = \frac{(v-u)^2 2u(v-u)}{2a}$$

$$s = \frac{v^2 + u^2 - 2uv + 2vu - 2u^2}{2a}$$

$$s = \frac{v^2 - u^2}{2a}$$

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

Third equation of motion

Long Answer Questions (5 Marks)

1. An athlete completes one round of a circular track of diameter 200min 40s. What will be the distance covered and the displacement at the end of $2\,\text{min}\,20\,\text{sec}$?

Ans: circumference of circular track $= 2\pi r$

$$\Rightarrow 2 \times \frac{22}{7} \times \frac{diameter}{2}$$

$$\Rightarrow 2 \times \frac{22}{7} \times \frac{200}{2} = \frac{4400}{7} m$$

Rounds completed by athlete in $2min20sec = s = \frac{140}{40} = 3.5$

Therefore, total distance covered $= \frac{4400}{7} \times 3.5 = 2200m$

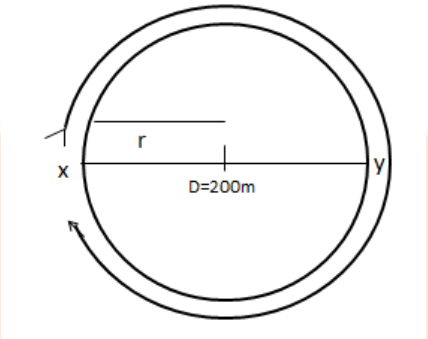

Image: Representation of circular track

since one complete round of circular track needs 40s so he will complete $3 rounds\ in\ 2 mins$

and in next 20s he can complete half round Therefore, displacement $= diameter = 200m$

2. Joseph jogs from one end A to the other end B of a straight 300mroad in $2\min 50\sec$ **and then turns around and jogs 100mback to point C in another** $1\min$ **. What are Joseph's average speeds and velocities in jogging**

a. From A to B

Ans: $Distance = 300m$

$time = 2min 30seconds = 150\ seconds$

Average speed from A to B = average velocity from A to B

$\Rightarrow 300m/150s = 2m/s$

b. From A to C?

Ans: average speed from A to C

$$= \frac{(300+100)\ m}{(150+60)\ sec}$$

$$\Rightarrow \frac{400m}{210s} = 1.90m/s$$

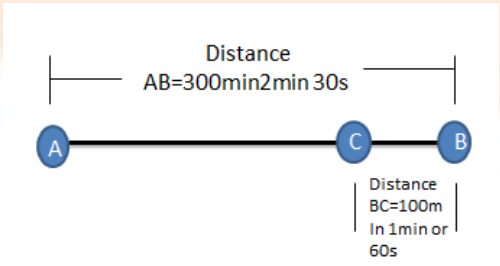

Image: Representation of distance covered by Joseph overall

Displacement from A to C $= (300100)m = 200m$

$time = 2min30sec + 1min\ = 210s$

$$velocity\ = \frac{displacement}{time} = \frac{200m}{210s} = 0.95m/s$$

3. Abdul, while driving to school, computes the average speed for his trip to be $20kmh^{-1}$. On his return trip along the same route, there is less traffic and the average speed is $40kmh^{-1}$. What is the average speed for Abdul's trip?

Ans. If we suppose that distance from Abdul's home to school = x km s

while driving to school: $speed = 20kmh^{-1}$, $velocity\ = \frac{displacement}{time}$

$$20\ = \frac{x}{t}, or,\ t = \frac{x}{20} hr$$

on his return trip: $speed = 40kmh^{-1}, 40 = x/t$

or,

$t = \frac{x}{40} hr$

$total\ distance\ travelled = x + x = 2x$

$total\ time\ = t\ +\ t = \frac{x}{20} + \frac{x}{40} = \frac{(2x\ +\ x)}{40} = \frac{3x}{40} hr$

average speed for Abdul's trip $= \frac{2x}{\left(\frac{3x}{40}\right)} = \frac{80x}{3x} = 26.67 km/hr$

4. A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of $3.0 ms^{-2}$ for 8.0s. How far does the boat travel during this time?

Ans: since the motorboat starts from rest so $u = 0$

Given data:

$time(t) = 8s, a = 3m/s^2$

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

$distacnce(s) = 0 + \frac{1}{2} \times 3 \times 8^2$

$\therefore distacnce(s) = 96m$

5. A driver of a car travelling at applies the brakes and accelerates uniformly in the opposite direction. The car stops in5s. Another driver going at $3kmh^{-1}$ in another car applies is brakes slowly and stops in10s. On the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?

Ans:

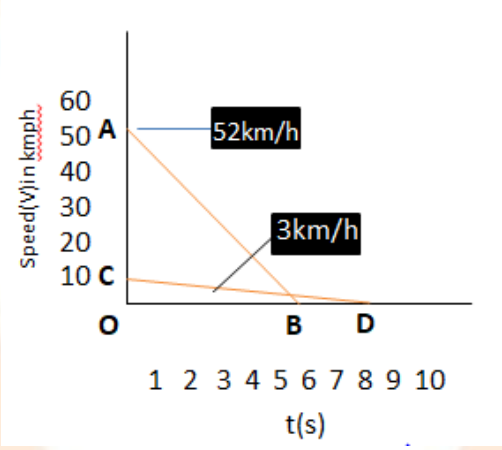

Image: Speed-time graph for two cars

As given in the figure below AB (in red line) and CD(in red line) are the Speed-time graph for given two cars with initial speeds $52kmh^{-1}$ and $3kmh^{-1}$ respectively. Distance Travelled by first car before coming to rest=Area of ΔOAB

$$\Rightarrow \left(\frac{1}{2}\right)\times OB\times OA$$

$$\Rightarrow \left(\frac{1}{2}\right)\times 5s\times 52kmh^{-1}$$

$$\Rightarrow \left(\frac{1}{2}\right)\times 5\times \left(\frac{52\times 1000}{3600}\right)m$$

$$\Rightarrow \left(\frac{1}{2}\right)\times 5\times \left(\frac{130}{9}\right)m$$

$\Rightarrow \frac{325}{9} m$

$\Rightarrow 36.11 m$

Distance Travelled by second car before coming to rest=Area of ΔOCD

$\Rightarrow \frac{1}{2} \times OD \times OA$

$\Rightarrow \frac{1}{2} \times 10 s \times 3 km h^{-1}$

$\Rightarrow \frac{1}{2} \times 10 \times \left(\frac{3 \times 1000}{3600} \right) m$

$\Rightarrow \frac{1}{2} \times 10 \times \left(\frac{5}{6} \right) m$

$\Rightarrow 5 \times \left(\frac{5}{6} \right) m$

$\Rightarrow \frac{25}{6} = 4.16 m$

$\therefore$ Clearly the first car will travel farther $\left(36.11\, m\right)$ than the first car $\left(4.16\, m\right)$.

6. Fig 8.11 shows the distance-time graph of three objects A, B and C. Study the graph and answer the following questions:

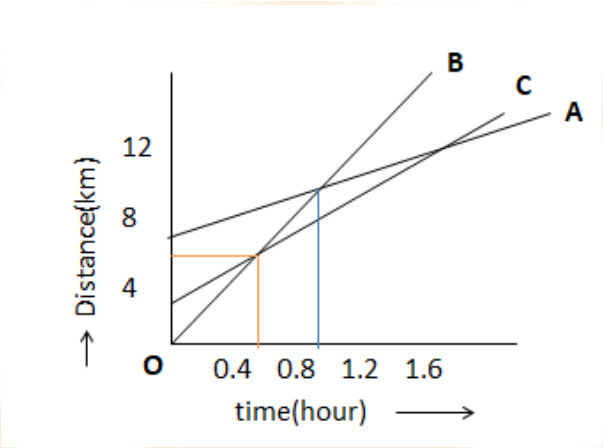

Image: Distance-time graph for objects A,B and C

a. Which of the three is travelling the fastest?

Ans: It is clear from graph that B covers more distance in less time. Therefore, B is the fastest.

b. Are all three ever at the same point on the road? Fig. 8.11

Ans: All of them never come at the same point at the same time.

c. How far has C travelled when B passes A?

Ans: According to graph; each small division shows about $0.57\ km$.

A is passing B at point S which is in line with point P (on the distance axis) and shows about $9.14\ km$

Thus, at this point C travels about $9.14\text{-}(0.57\times 3.75)\text{km}= 9.14\ km\ \ 2.1375\ km = 7.0025\ km \approx 7km$

Thus, when A passes B, C travels about $7\ km$.

d. How far has B travelled by the time it passes C?

Ans: B passes C at point Q at the distance axis which is $\approx 4km + 0.57km \times 2.25 = 5.28\ km$

Therefore, B travelled about $5.28\ km$ when passes to C.

7. A ball is gently dropped from a height of 20m. If its velocity increases uniformly at the rate of $10ms^{-2}$, with what velocity will it strike the ground? After what time will it strike the ground?

Ans: Let us assume, the final velocity with which ball will strike the ground be 'v' and time it takes to strike the ground be 't'

Initial Velocity of ball $u = 0$

Distance or height of fall $s = 20\ m$

Downward acceleration $a = 10ms^{-2}$

As we know, $v^2 = u^2 - 2as$

$or, 2as = v^2 - u^2$

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

$\Rightarrow 2 \times 10 \times 20 + 0$

$v = \sqrt{400ms^{-1}}$

$\therefore$ Final velocity of ball, $v = 20ms^{-1}$

$t = \dfrac{(v-u)}{a}$

$\therefore$ Time taken by the ball to strike $= \dfrac{(20-0)}{10}$

$\Rightarrow \dfrac{20}{10}$

$\therefore$ *Time taken by the ball to strike* $= 2\,\text{sec}$

8. The speed-time graph for a car is shown is Fig. 8.12.

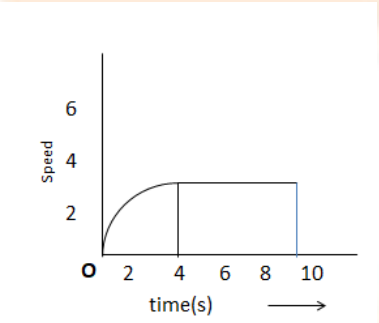

Image: Speed-time graph for a car

a. Find how far does the car travel in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.

Ans:

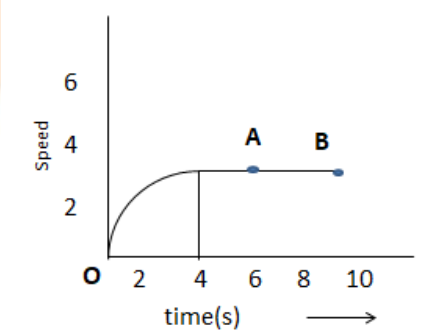

Image: Speed-time graph indicating the distance traveled by car in first 4 seconds

Distance travelled by car in the 4 *second*

The area under the slope of the speed – time graph gives the distance travelled by an object. In the given graph 56 full squares and 12 half squares come under the area slope for the time of 4 *second* .

Total number of squares $= 56 + \frac{12}{2} = 62$ squares

The total area of the squares will give the distance travelled by the car in 4 *second* . on the time axis, 5 *squares* $= 2$*seconds*, *therefore* 1 *square* $= \frac{2}{5}$ *seconds* on speed axis there are 3 *squares* $= 2m/s$

therefore, area of one square $= \frac{2}{5}s \times \frac{2}{3}m/s = \frac{4}{15}m$

so area of 62 *squares* $= \frac{4}{15}m \times 62 = \frac{248}{15}m = 16.53m$

Hence the car travels 16.53m in the first 4 *seconds*.

b. Which part of the graph represents uniform motion of the car?

Ans: The straight line part of graph, from point A to point B represents a uniform motion of car.

9. State which of the following situations are possible and give an example for each of these:

a. An object with a constant acceleration but with zero velocity

Ans: An object with a constant acceleration can still have the zero velocity. For example, an object which is at rest on the surface of earth will have zero velocity but still being acted upon by the gravitational force of earth with an acceleration of $9.81\ ms^{-2}$ towards the center of earth. Hence when an object starts falling freely can have constant acceleration but with zero velocity.

b. An object moving in a certain direction with acceleration in the perpendicular direction.

Ans: When an athlete moves with a velocity of constant magnitude along the circular path, the only change in his velocity is due to the change in the direction of motion. Here, the motion of the athlete moving along a circular path is, therefore, an example of an accelerated motion where acceleration is always perpendicular to direction of motion of an object at a given instance. Hence it is possible when an object moves on a circular path.

10. An artificial satellite is moving in a circular orbit of radius 42250km . Calculate its speed if it takes 24hrsto revolve around the earth.

Ans. Let us assume An artificial satellite, which is moving in a circular orbit of radius $42250\ km$ covers a distance 's' as it revolve around earth with speed 'v' in given time 't' of $24\ hours$.

$\Rightarrow 42250\ km$

Radius of circular orbit r

$\Rightarrow 4225\times 1000m$ Time taken by artificial satellite

$t = 24\ hours$

$\Rightarrow 24\times 60\times 60s$ Distance covered by satellite s=circumference of circular orbit

$\Rightarrow 2\pi\ r$

$\therefore$ Speed of satellite $v=\dfrac{(2\pi\ r)}{t}$

$\Rightarrow \dfrac{\left[2\times\left(\dfrac{22}{7}\right)\times 42250\times 1000\right]}{(24\times 60\times 60)}$

$\Rightarrow \dfrac{(2\times 22\times 42250\times 1000)}{(7\times 24\times 60\times 60)\,ms^{-1}}$

$\Rightarrow 3073.74ms^{-1}$

$\therefore Speed = 3.073km/s$

11. The position of a body at different times are recorded in the table given below:

a. Draw the displacement time graph for the above data?

Ans:

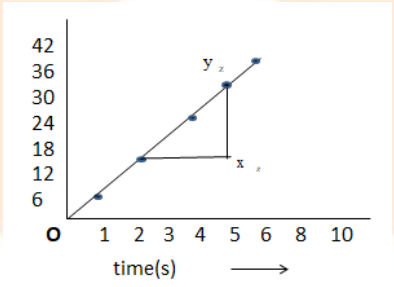

Image: Displacement-time graph for the given data

b. What is the slope of the graph?

Ans: $Slope\ of\ the\ graph = \frac{y_2 - y_1}{x_2 - x_1}$

$\Rightarrow \frac{(36-24)m}{(6-4)\sec} = \frac{12m}{2\sec}$

$\therefore Slope\ of\ the\ graph = 6m/sec$

c. What is the speed of the motion?

Ans: Slope of the graph of a displacement-time graph = speed

Hence speed $= 6m/sec$