

CBSE Class 9 Science
Important Questions
Chapter 8
Motion

1 Marks Questions

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

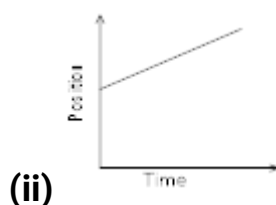
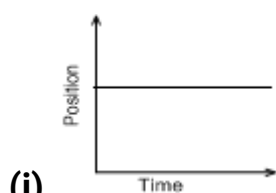
Ans. (b) speed is a scalar and velocity is a vector

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

- (a) positive
- (c) negative
- (b) zero
- (d) may be positive or negative

Ans. (b) zero

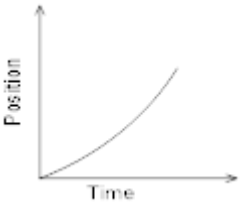
3. Which of the following is the position time graph for a body at rest?



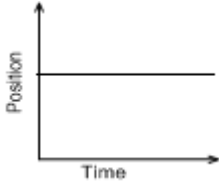
(iii)



(iv)



Ans. (i)



4. What does 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 body?

- (a) Positively accelerated
- (b) Negative accelerated
- (c) Uniform accelerated
- (d) None of the above

Ans. (a) Positively accelerated

6. What does slope of 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 remains the same

(b) its speed changes but velocity remains the same

(c) both speed and velocity changes

(d) both speed and velocity remains 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 displacement 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 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

2 Marks Questions

1. Distinguish between speed and velocity.

Ans. Speed of a body is the distance travelled by it per unit time while velocity is displacement per unit time of the body during movement.

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

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

3. What does the odometer of an auto mobile measure?

Ans. The odometer of an auto mobile measures the distance covered by that 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 i.e. look 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, $3 \times 10^8 \text{ m s}^{-1}$.

Ans. $Distance = speed \times time = 5 \text{ min} \times (3 \times 10^8 \text{ m s}^{-1})$
 $= (5 \times 60) \text{ seconds} \times (3 \times 10^8 \text{ m s}^{-1})$
 $= 300 \text{ sec} \times (3 \times 10^8 \text{ m s}^{-1})$
 $= 900 \times 10^8 \text{ m s}^{-1} = 9 \times 10^{10} \text{ m}$
 $= 9 \times 10^7 \text{ km}$

6. Which of the following is true for displacement?

- (a) It cannot be zero.
- (b) Its magnitude is greater than the distance travelled by the object.

Ans. Both (a) as well as (b) are false with respect to concept of displacement.

7. When will you say a body is in

- (i) uniform acceleration?
- (ii) non-uniform acceleration?

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

(ii) non-uniform acceleration: It 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 80 km h^{-1} to 60 km h^{-1} in 5 s. Find the acceleration of the bus.

Ans. Initial speed of bus (u) = 80 km h^{-1}
$$= \frac{80 \times 1000}{60 \times 60 \text{ seconds}}$$

$$= \frac{200}{9ms^{-1}} = 22.22ms^{-1} \quad \text{final speed of bus (v)} = 60km\ h^{-1}$$

$$= \frac{60 \times 1000}{60 \times 60seconds} = \frac{50}{3ms^{-1}} = 16.67ms^{-1} \quad \text{time (t)} = 5\ s$$

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

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 i.e. it would a straight line and if it has non uniform motion then the nature of distance time graph is 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 $0.1\ m\ s^{-2}$ for 2 minutes. Find (a) the speed acquired, (b) the distance travelled.

Ans. (a) $u=0$, $a = 0.1ms^{-2}$, $t= 2min = 120\ seconds$.

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

(a) speed acquired = $v = 12ms^{-1}$

$$\text{(b)} \quad s = ut + \frac{1}{2}at^2 = 0 \times 120 + \frac{1}{2} \times 0.1 \times 120^2 = 720\ m$$

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

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

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

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

Ans. $u = 0$, $a = 4\text{m/s}^2$, $t = 10\text{s}$

$$s = ut + \frac{1}{2}at^2 = 0 \times 10 + \frac{1}{2} \times 4 \times 10^2 = 200\text{m}$$

14. Differentiate between distance and displacement?

Ans.

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

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

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

Let V =final velocity; V_0 = initial velocity, T = time, a =acceleration.

So by definition of acceleration

$$a = \frac{V - V_0}{T}$$

$$at = V - V_0$$

$$V = V_0 + at$$

If $V_0 = u$ =initial velocity, then $[V = u + at]$

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

Ans. $u = 0$ (starts from rest) u = initial velocity

$a = ?$ a =acceleration

$T = 5$ sec, t = time

$S = 87.5\text{m}$ (S =distance)

From 2nd equation of motion –

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

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

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

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

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

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

$$\Rightarrow 7m/s^2 = a$$

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 takes 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. In first case; $t_1 = \text{time} = 2\text{hrs}$

$$v_1 = \text{speed} = 40\text{km/hr}$$

$$s_1 = \text{distance} = \text{speed} \times \text{time}$$

$$s_1 = 40 \times 2 = 80\text{km}$$

In second case, $t_2 = \text{time} = 3\text{hrs}$

$$v_2 = \text{speed} = 60\text{km/hr}$$

$$s_2 = \text{distance} = \text{speed} \times \text{time}$$

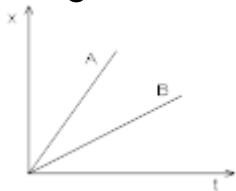
$$s_2 = 60 \times 3 = 180\text{km}$$

The total distance = $s_1 + s_2 = 80 + 180 = 260\text{km}$

Total time, $t_1 + t_2 = 2 + 3 = 5\text{hrs}$

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{260}{5} = 52\text{km/hr}$$

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



(a) Are the bodies moving with uniform acceleration?

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

Ans. (a) Yes the bodies are moving with uniform acceleration.

(b) The body A is moving with greater acceleration.

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

Ans. Let at time $t = 0$, body has initial velocity = V_o

At time 't', body has final velocity = V

S = distance traveled in time 't'

We know, total distance traveled = Average velocity \times time

$$\frac{\text{initial velocity} + \text{final velocity}}{2}$$

Average velocity =

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

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

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

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

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

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

$$2s = 2V_o t + at^2$$

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

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 = $V = 0$ (body comes to rest)

Distance = $s = ?$

Time = $t = 6$ sec

From, $V = u + at$

$$0 = 5 + a \times 6$$

$$-a \times 6 = 5$$

$$a = \frac{-5}{6}$$

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

Now,

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

$$0^2 - 25 = 2 \times \frac{-5}{6} \times s$$

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

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

$$15m = s$$

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 = $u = 12\text{m/s}$

Final velocity = $v = 0$

S = distance = 18m

A = acceleration = ?

From 3rd equation of motion;

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

$$0^2 - (12)^2 = 2 \times a \times 18$$

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

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

$$[a = -4\text{m/s}^2]$$

\Rightarrow Retardation of 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 final velocity?

Ans. Initial velocity = $u = 0$

Final velocity = $v = ?$

Acceleration = $a = 4\text{m/s}^2$

Distance = $s = 800\text{m}$

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

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

$$v = 80\text{ m/s}$$

$$v^2 = 6400$$

24. The driver of a car traveling along a straight road with a speed of 72KM ph observes a signboard which give the speed limit to be 54KM ph. 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 = $u = 72\text{ km/hr}$

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

Final speed = $v = 54\text{ km/hr}$

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

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

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

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

$225 - 400 = 140a$

$- 175 = 140a$

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

25. Differentiate between scalars and vectors?

Ans.

Vector	Scalar
(1) It has magnitude and specific direction	(1) it has magnitude but no direction.
(2) It can be positive or negative.	(2) It is always positive.
(3) e.g. - displacement, velocity.	(3) e.g. distance, speed.

3 Marks Questions

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

Ans. Yes, if an object has 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. So if an object travels from point A to B and then returns back to point A again, the total displacement is zero.

2. A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds?

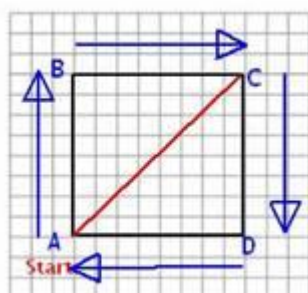
Ans. Distance covered by farmer in 40 seconds = $4 \times (10) m = 40m$

Speed of the farmer = distance/time = $40m/40s = 1 m/s$.

Total time given in the question = 2min20seconds = $60+60+20 = 140seconds$

Since he completes 1 round of the field in 40seconds so in he will complete 3 rounds in 120 seconds (2mins) or 120m distance is covered in 2minutes. In another 20seconds will cover another 20m so total distance covered in 2min20sec = $120 + 20 = 140m$.

Displacement = $\sqrt{10^2 + 10^2} = \sqrt{200} = \sqrt{100 \times 2} = 10\sqrt{2}m$ (as per diagram) = $10 \times 1.414 = 14.14 m$.



3. A train starting from a railway station and moving with uniform acceleration attains a speed 40 km in 10 minutes. Find its acceleration.

Ans. Since the train starts from rest (railway station) = $u = \text{zero}$

Final velocity of train = $v = 40 \text{ km h}^{-1}$

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

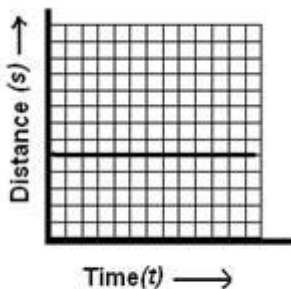
$$= 11.11 \text{ ms}^{-1}$$

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

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

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

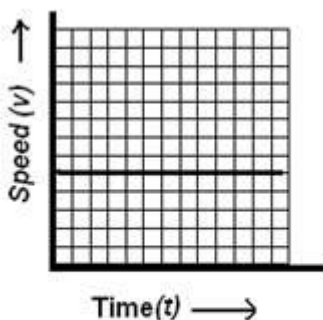
Ans. If the object's distance time graph is a straight line parallel to the time axis indicates that with increasing time the distance of that object is not increasing hence the object is at rest i.e. not moving.



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.



Speed-time graph of an object moving with uniform speed

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

Ans. $u = 90 \text{ km h}^{-1} = \frac{(90 \times 1000)}{60 \times 60} = 25 \text{ m s}^{-1}$

$a = -0.5 \text{ m s}^{-2}$, $v = 0$ (train is brought to rest)

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

$0 = 25 - 0.5t$

$0.5t = 25$, or $t = 25/0.5 = 50$ seconds

$s = ut + \frac{1}{2}at^2 = 25 \times 50 + \frac{1}{2} \times (-0.5) \times 50^2$

$= 1250 - 625 = 625 \text{ m}$

7. A stone is thrown in a vertically upward direction with a velocity of 5 m s^{-1} . If the acceleration of the stone during its motion is 10 m s^{-2} in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

Ans. $u = 5 \text{ m s}^{-1}$, $a = -10 \text{ m s}^{-2}$

$v = 0$ (since at maximum height its velocity will be zero)

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

$0 = 5 - 10t$

$10t = 5$, or, $t = 5/10 = 0.5$ second.

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

$= 2.5 - 1.25 = 1.25 \text{ m}$

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

Ans. let at time $T=0$ body moves with initial velocity u and at time ' t ' body has final velocity ' v ' and in time ' t ' it covers a distance ' s '.

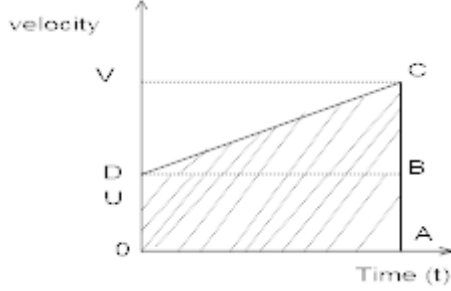
$AC=v$, $AB=u$, $OA= t$, $DB=OA=t$, $BC=AC-AB = v-u$

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

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

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

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



Area of rectangle OABD = length \times Breadth

$= OA \times BA$

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

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

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

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

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

$S = 62.5\text{m}$

$a = -5\text{m/s}^2$ (retardation)

$U = ?$

From 3rd equation of motion,

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

$0^2 - u^2 = 2 \times (-5) \times 62.5$

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

$u^2 = 625,$

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

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 50KMph in the same direction, find the magnitude and direction of

(a) Give the relative velocity of car A with respect to B

The relative velocity of car B with respect to A.

Ans. (a) Velocity of car A = 80KMph

Velocity of Car B = - 50 kmph

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

Relative velocity of car A with respect to B

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

= 80 + (-(-50))

= 80+50

=+130KMph

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

(b) Relative velocity of car B with respect to A

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

= -50 + (-80)

= -130kmph

→ 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 16m down an inclined plane in 4 s.

(a) What is the acceleration of the ball?

(b) What is the velocity of the ball at the bottom of the incline?

Ans. u = initial velocity = 0 (body starts from rest)

S = distance = 16 m

T = time = 4s

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

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

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

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

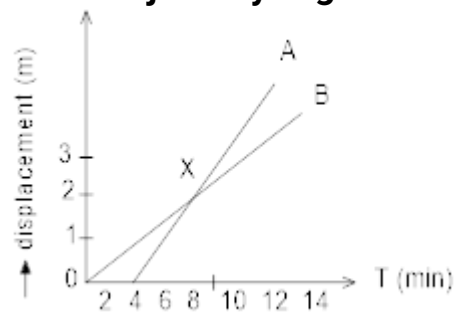
$$[2 \text{ m/s}^2 = a]$$

(ii) From, $v = u + at$

$$v = 0 + 2 \times 4$$

$$[v = 8 \text{ m/s}]$$

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



- How far down the road has B travelled when A starts the journey?
- Without calculation, the speed, state who is traveling faster A or B?
- What is the speed of A?
- What is the speed of B?
- Are the speed of A and B uniform?
- What does point X on the graph represent?
- What is the speed of approach of A towards B?

What is the speed of separation of A from B?

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

(b) A travels faster than B because A starts his journey late but crosses B and covers more distance than B in the same time as B

$$(c) \text{ Speed of A} = \frac{\text{Distance covered}}{\text{time taken}}$$

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

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

$$(d) \text{ Speed of B} = \frac{\text{distance covered}}{\text{time taken}}$$

$$V_B = \frac{3000}{12} = 214 \text{ m/min}$$

(e) Speed of approach of A towards B = 375 m/min - 214 m/min

$$= 161 \text{ m/min}$$

(f) Speed of separation of A from B = 161 m/min.

13. A body is dropped from a height of 320m. The acceleration due to the gravity is 10 m/s^2 ?

(a) How long does it take to reach the ground?

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

Ans. Height = h

Distance = $s = 320 \text{ m}$

Acceleration due to gravity = $g = 10 \text{ m/s}^2$

Initial velocity = $u = 0$

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

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

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

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

$$64 = t^2$$

$$t = 8 \text{ sec}$$

(b) from $v = u + at$

$$v = 0 + 10 \times 8$$

$$v = 80 \text{ m/s}$$

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

Ans. We know;

$$v = u + at \dots\dots(i)$$

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

Where, 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)

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

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

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

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

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

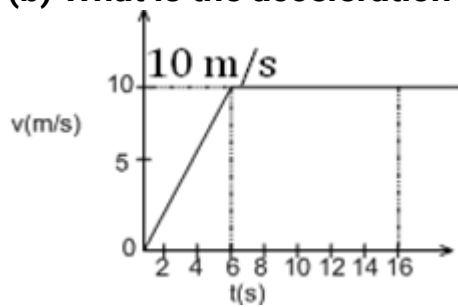
$$2as = v^2 - u^2$$

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

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

(a) What is the total distance covered by the runner in 16s?

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



Ans. (a) We know that area under v - t graph gives displacement:

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

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

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

$$= 30\text{m}$$

Area of rectangle = length \times breadth

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

$$= 10 \times 10$$

$$= 100\text{m}$$

Total area = 180m

Total distance = 180m

(b) Since at $t = 11$ sec, particles travels 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 ($g = -10\text{m/s}^2$)?

(b) What is the maximum height reached by the ball?

(c) How long will it take to reach the ground?

Ans. $u = 60\text{ m/s}$; $g = -10\text{m/s}^2$; $v=0$

(a) The time to reach maximum height is;

$$v = u + at = u + gt$$

$$0 = 60 - 10t$$

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

(b) The maximum height is;

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

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

$$= 180m$$

(c) The time to reach top is equal to time taken to reach back to ground. Thus, time to reach the ground after reaching top is 6s Or 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-

$$X = 20m + \left(\frac{12m}{s}\right) t$$

(a) draw a graph if x versus t for $t = 0$ and $t = 5$ sec

(b) What is the displacement come out of the particles initially?

(c) What is slope of the graph obtained?

Ans. $X = 20m + (12) t$

(i) At $t=0$

$$X = 20 + 12 \times 0 = 20 \text{ m}$$

(ii) At $t=1$

$$X = 20 + 12 = 32m$$

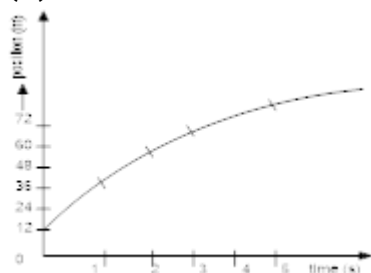
(iii) At $t = 2$

$$X = 20 + 24 = 44m$$

(iv) At $t=5$

$$X = 20 + 12 \times 5 = 72 \text{ m}$$

(a)



(b) At $T = 0$ (initially)

Displacement = 20m.

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{72 - 44}{5 - 2} = \frac{28}{3}$$

(c) Slope = $\frac{28}{3}$
= 9.3 m/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

(b) distance travelled and draw the graph.

Ans. (a) Acceleration = slope of the velocity time graph

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

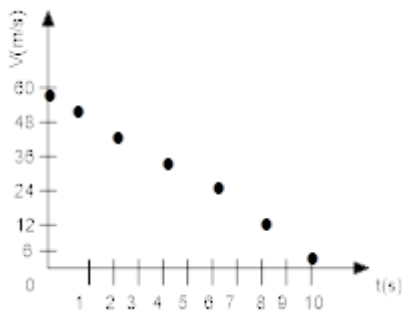
$$a = \frac{54 - 24}{1 - 6} = \frac{30}{-5} = -6 \text{ m/s}^2$$

(b) Distance $\Rightarrow S = ut + \frac{1}{2}at^2$

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

$$= 600 - 300 = 300 \text{ m}$$

(c)



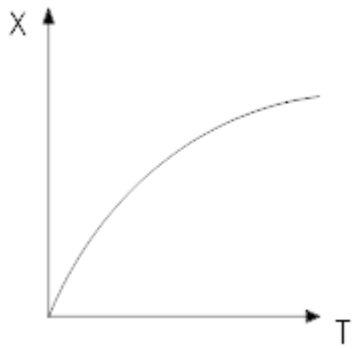
19. Draw the graph for uniform retardation –

(a) position – time graph

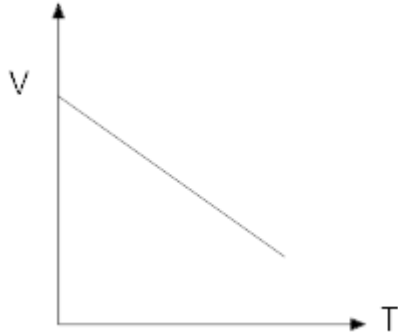
(b) velocity – time

(c) Acceleration- time

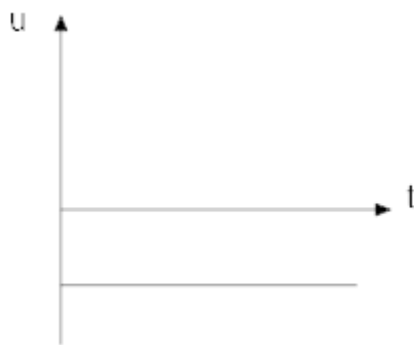
Ans. (1) Position – time



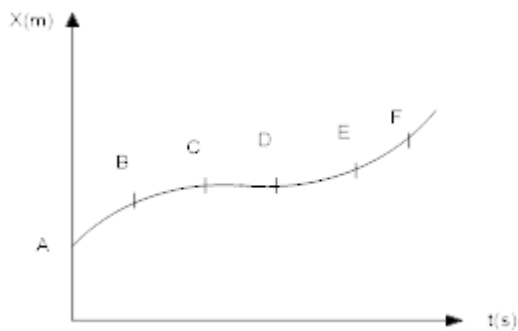
(2) Velocity – time



(3) Acceleration- time



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.



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

(ii) For BC, curve still has $+ve$ slope so, $V = +ve$ but velocity is decreasing wrt time so, $a = \text{negative}$

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

(iv) For DE, velocity is the (v is increasing wrt time) and so is acceleration is $+ve$.

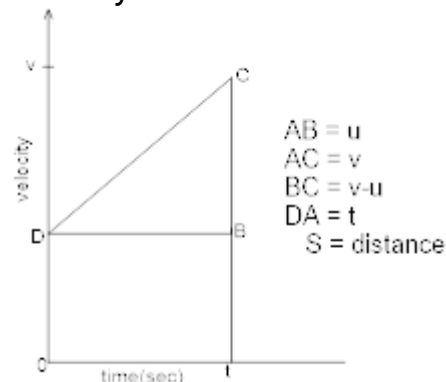
(v) For EF, velocity is $+ve$ (positive slope of $x-t$ graph) but acceleration is Zero

because velocity remains same 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 $t=0$, body moves with initial velocity u and time at ' t ' has final velocity ' v ' and in time ' t ' covers a distance ' s '



Area under v-t graph gives displacement

$S = \text{Area of } \triangle DBC + \text{Area of rectangle OABD}$

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

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

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

Now, $v-u = at$

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

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

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

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

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

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

$$2as = v^2 - u^2 \Rightarrow \text{third equation of motion}$$

5 Marks Questions

1. An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?

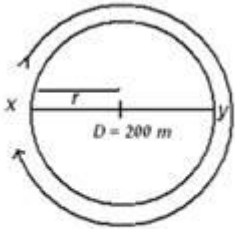
Ans. circumference of circular track = $2\pi r$

$$= 2 \times \frac{22}{7} \times \frac{\text{diameter}}{2}$$

$$= 2 \times \frac{22}{7} \times \frac{200}{2} =$$

4400/7 m
 rounds completed by athlete in 2min20sec = s = 140/40 = 3.5

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



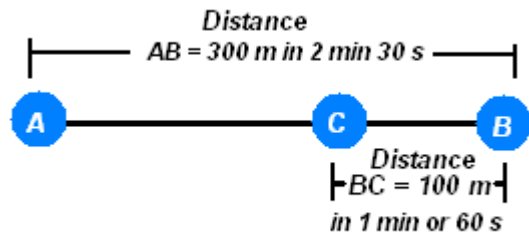
Final Position of athlete after 3 1/2 round
 -XY - Diameter of circle = 200 m

since one complete round of circular track needs 40s so he will complete 3 rounds in 2mins 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 300 m road in 2 minutes 50 seconds and then turns around and jogs 100 m back to point C in another 1 minute. What are Joseph's average speeds and velocities in jogging (a) from A to B and (b) from A to C?

Ans. (a) distance = 300m
 time = 2min30seconds = 150 seconds
 average speed from A to B = average velocity from A to B
 = 300m/150s = 2m/s

(b) average speed from A to C = $\frac{(300+100)}{400} \text{ m}/\frac{(150+60)}{210} \text{ sec} = 1.90 \text{ m/s}$



displacement from A to C = (300 - 100) m = 200 m
 time = 2min30sec + 1min = 210s
 velocity = displacement/time = 200m/210s = 0.95m/s

3. Abdul, while driving to school, computes the average speed for his trip to be 20 km h⁻¹. On his return trip along the same route, there is less traffic and the average speed is 40 km h⁻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: $speed = 20 \text{ km h}^{-1}$,

velocity = displacement/time
 $20 = x/t$, or, $t = x/20$ hr
 on his return trip: $speed = 40 \text{ km h}^{-1}$, $40 = x/t'$
 or, $t' = x/40$ hr
 total distance travelled = $x + x = 2x$
 total time = $t + t' = x/20 + x/40 = (2x + x)/40 = 3x/40$ hr
 average speed for Abdul's trip = $2x/(3x/40) = 80x/3x = 26.67 \text{ km/hr}$

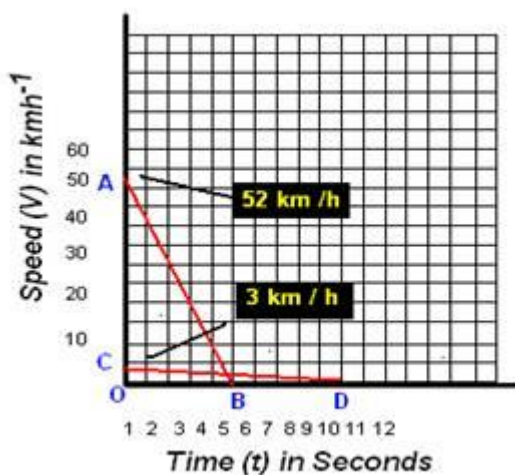
4. A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3.0 m s^{-2} for 8.0 s . How far does the boat travel during this time?

Ans. since the motorboat starts from rest so $u = 0$
 time (t) = 8 s , $a = 3 \text{ m/s}^2$

$$\text{distance}(s) = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 3 \times 8^2 = 96 \text{ m}$$

5. A driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5 s . Another driver going at 3 km h^{-1} in another car applies is brakes slowly and stops in 10 s . 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.



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 52 kmh^{-1} and 3 kmh^{-1} respectively. Distance Travelled by first car before coming to rest = Area of ΔOAB
 $= (1/2) \times OB \times OA$
 $= (1/2) \times 5 \text{ s} \times 52 \text{ kmh}^{-1}$
 $= (1/2) \times 5 \times (52 \times 1000) / 3600 \text{ m}$

$$= (1/2) \times 5 \times (130/9) \text{ m}$$

$$= 325/9$$

m

$$= 36.11 \text{ m}$$

Distance Travelled by second car before coming to rest = Area of $\triangle OCD$

$$= (1/2) \times OD \times OA$$

$$= (1/2) \times 10 \text{ s} \times 3 \text{ kmh}^{-1}$$

$$= (1/2) \times 10 \times (3 \times 1000) / 3600 \text{ m}$$

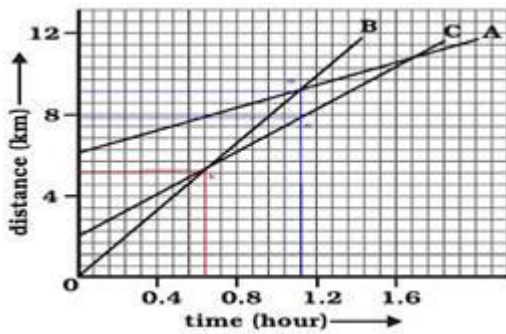
$$= (1/2) \times 10 \times (5/6) \text{ m}$$

$$= 5 \times (5/6) \text{ m}$$

$$= 25/6 \text{ m} = 4.16 \text{ m}$$

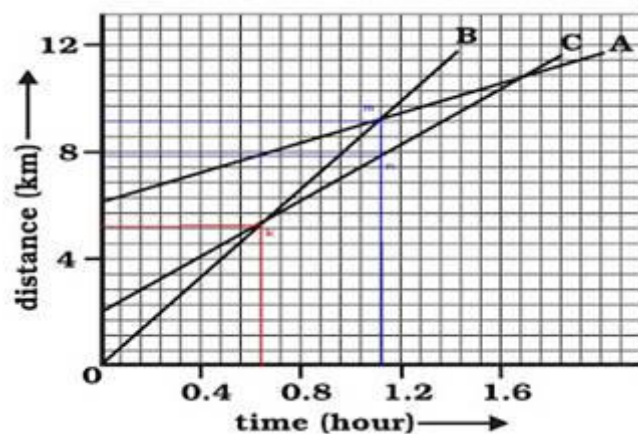
∴ Clearly the first car will travel farther (36.11 m) than the first car (4.16 m).

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



- Which of the three is travelling the fastest?
- Are all three ever at the same point on the road? Fig. 8.11
- How far has C travelled when B passes A?
- How far has B travelled by the time it passes C?

Ans.



- It is clear from graph that B covers more distance in less time. Therefore, B is the fastest.
- All of them never come at the same point at the same time.
- 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

$$9.14 - (0.57 \times 3.75) \text{ km} = 9.14 \text{ km} - 2.1375 \text{ km} = 7.0025 \text{ km} \approx 7 \text{ km}$$

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

(d) B passes C at point Q at the distance axis which is $\approx 4 \text{ km} + 0.57 \text{ km} \times 2.25 = 5.28 \text{ km}$

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

7. A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of 10 m s⁻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 $s=20 \text{ m}$

Downward acceleration $a=10 \text{ m s}^{-2}$

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

$$\text{or, } 2as = v^2 - u^2$$

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

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

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

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

$$t = (v-u)/a$$

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

$$= 20/10$$

$$= 2 \text{ seconds}$$

a car is shown in Fig. 8.12.

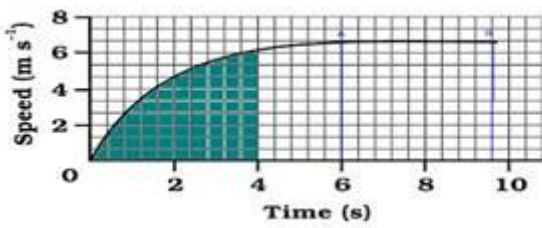
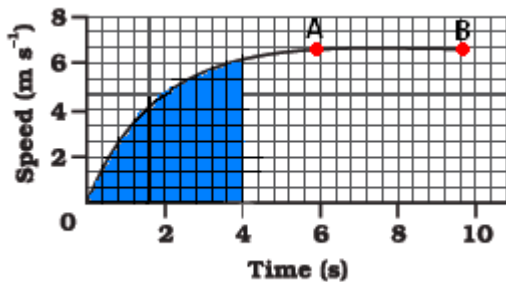


Fig. 8.12

(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.

(b) Which part of the graph represents uniform motion of the car?

Ans.



(a) 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 = $56 + 12/2 = 62$ squares

The total area of the squares will give the distance travelled by the car in 4 second.

on the time axis,

5 squares = 2seconds, therefore 1 square = $2/5$ seconds

on speed axis there are 3 squares = 2m/s

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

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

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

(b) 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

(b) an object moving in a certain direction with an acceleration in the perpendicular direction.

Ans. (a) 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) 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 42250 km. Calculate its speed if it takes 24 hours to 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.

$$= 42250 \text{ km}$$

Radius of circular orbit r

$$= 42250 \times 1000 \text{ m}$$
 Time taken by artificial satellite $t = 24$ hours

$$= 24 \times 60 \times 60 \text{ s}$$
 Distance covered by satellite $s =$ circumference of circular orbit

$$= 2\pi r$$

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

$$= \frac{[2 \times (22/7) \times 42250 \times 1000]}{(24 \times 60 \times 60)}$$

$$= \frac{(2 \times 22 \times 42250 \times 1000)}{(7 \times 24 \times 60 \times 60)} \text{ m s}^{-1}$$

$$= 3073.74 \text{ m s}^{-1}$$

$$= 3.073 \text{ km/s}$$

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

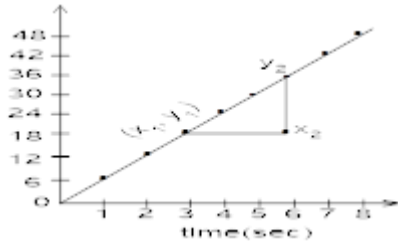
Time (s)	0	1	2	3	4	5	6	7	8
Displacement (m)	0	6	12	18	24	30	36	42	48

(a) Draw the displacement time graph for the above data?

(b) What is the slope of graph?

What is the speed of the motion?

Ans. (a)



(b) Slope of the graph = $\frac{y_2 - y_1}{x_2 - x_1}$

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

(c) Slope of the graph of a displacement-time graph = speed

Hence speed = 6m/sec