Question 1

Question: (i) Define the following terms:
(a)speed (b) velocity (c) uniform velocity (d) non uniform velocity
(e) acceleration (f) retardation.
(ii) Distinguish between:
(a) Speed and Velocity
(b) Uniform acceleration and Variable acceleration

Answer: (a) Speed
Speed is the distance travelled by a body in one second and is measured in metre per second (m s^{-1})
(b) Velocity
Velocity is the distance travelled by a body in a particular direction in unit time
Or
Velocity is defined as the rate of change of displacement. It is measured in metre per second (m s^{-1})
(c) Uniform Velocity
A body is said to travel with uniform velocity if it undergoes equal displacement in equal intervals of time, however small in a given direction
(d) Non-uniform Velocity
A body is said to be moving with non-uniform or variable velocity if

- it covers unequal distances in equal intervals of time or
- it covers equal distances in unequal intervals of time or
- it covers equal distances in equal intervals of time, but its direction is changing.

(e) Acceleration
Acceleration is defined as the rate of change of velocity
Or
Acceleration is the change in velocity in unit time. Its unit is m s^{-2}
(f) Retardation
Retardation or deceleration is negative acceleration. If the velocity of a body is decreasing then the acceleration is negative and it is called retardation.
(ii)
(a) Speed and Velocity

Speed	Velocity
It is the distance travelled by a body in one second or unit time	It is the distance travelled by a body in a particular direction in unit time.
It is a scalar quantity	It is a vector quantity.

(b) Uniform acceleration and Variable acceleration

Uniform acceleration	Variable acceleration
A body has uniform acceleration when the velocity of the body is increasing at the same rate. Example: Acceleration due to gravity.	Variable acceleration occurs when the velocity of the body does not increase at the same rate. Example: The motion of a vehicle on a busy road.

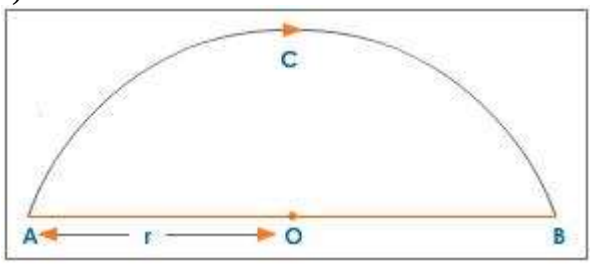
Question 2

Question: Define Displacement.

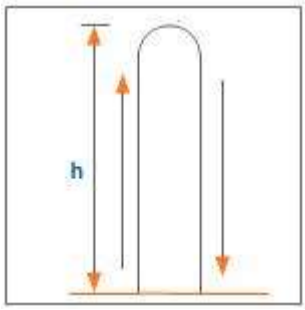
Answer: Displacement is the distance travelled in a fixed direction.
Or
The shortest distance from the initial position to the final position of the body is called displacement.

Question 3

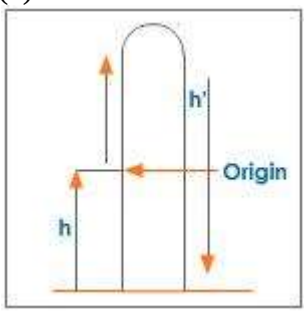
Question: Calculate the distance covered and displacement of an object following the path as shown in the figure below.
a)



(b)



(c)



Answer: a) ACB is a semicircular path of radius r.
Distance covered = circumference of the hemisphere = pr
displacement = diameter = 2r. (i.e., the shortest distance between A and B)

b) Here the body is thrown vertically up to a height 'h' and the body returns back to the ground level.
Distance = h + h = 2h
Displacement = h - h = 0
(-ve to show the change in direction)
(c) In this case the body is thrown vertically up from a height h above the ground.
It travels an additional distance h' and comes back to the ground
distance = $h^1 + h^1 + h$
$= h + 2h^1$

displacement = $h^1 - h^1 - h = - h$
(-ve sign to show change in direction)

Question 4

Question: Convert 1 km/h to m/s.

Answer: $1\,km = 1000\,m, 1\,h = 60\,s \times 60\,s = 3600\,s$

$$1\,km/h = \frac{1000\,m}{3600\,s} = \frac{10\,m}{36\,s} = \frac{5m}{18\,s}$$

i.e.,

$$1\,km/h = \frac{5}{18}\,m/s$$

Question 5

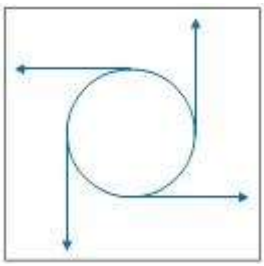
Question: What is the relationship between the distance (S) and time(t) for a body moving with uniform velocity(v)?

Answer: S = vt

Question 6

Question: Draw a diagram to show the motion of a body whose speed remains constant but velocity changes continuously.

Answer:



If a body moves along a circle with uniform speed, though the speed is constant its velocity changes continuously as the velocity of the body at any point is along the tangent to the circle at that point as shown in figure.

Question 7

Question: A scooter travels a distance of 600 m in 20 seconds southwards.
(a) What is the speed of the scooter?
(b) What is the velocity of the scooter?

Answer: (a) Speed = $\frac{\text{Distance}}{\text{time}}$

$$= \frac{600\,m}{20\,s}$$

= 30 m/s
(b) Velocity of the scooter = 30 m/s due south.

Question 8

Question: Give an example of a body moving with a uniform speed but variable velocity.

Answer: A body moving along the circumference of a circle.
e.g., Revolution of the earth around the sun.

Question 9

Question: A train moving with a uniform speed covers a distance of 1200 m in 20 s. Calculate (i) the velocity of the train (ii) the time taken to cover 3000 m.

Answer: (i) Velocity $= \frac{1200}{20}$
$= 60 \text{ m s}^{-1}$
(ii) Time $= \frac{3000}{60}$
$= 50 \text{ s}$

Question 10

Question: A body travels from A to B in 10 seconds with a speed of 50 km/h and returns with a speed of 100 km/h in 5 s. Find the average speed. Also find the average velocity for the whole journey.

Answer: Distance from A to B = Speed x time
= 50 km/h x 10 s
$= 50 \times \frac{5}{18} \times 10 \text{ metres}$
$= \frac{1250}{9} \text{ metres}$
Total distance from A to B both ways $= \frac{1250}{9} \times 2 = \frac{2500}{9} \text{ m}$
Total time taken = 10 + 5
= 15 s
$\therefore$ Average speed $= \frac{\text{Total distance}}{\text{Total time}}$
$= \frac{2500}{9} \times \frac{1}{15}$
$= 18.5 \text{ m s}^{-1}$
Average velocity $= \frac{\text{Displacement}}{\text{Time}}$
$= \frac{0}{2}$
= 0 km/h
Displacement is zero, because the body has come back to its initial position.
Note :
To convert km/h to m/s, multiply by 5/18 and to convert m/s to km/k, multiply by 18/5

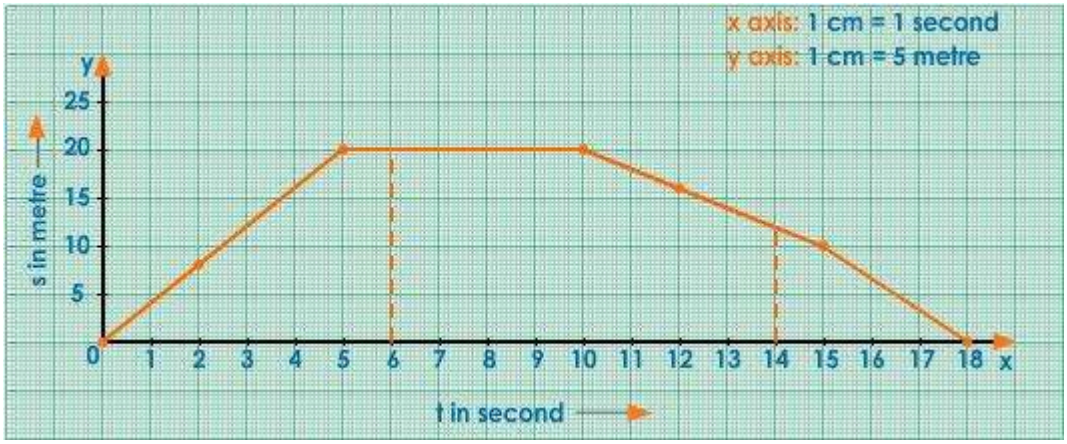
Question 11

Question: An object covers a distance of 'S' metres in 't' seconds as follows:

S (metres)	0	8	20	20	16	10	0
t (secs)	0	2	5	10	12	15	18

Plot a graph, taking 't' on X-axis and 'S' on Y axis.

Answer:



Question 12

Question: A car travels a certain distance with a speed of 50 km/h and returns with a speed of 40 km/h. Calculate the average speed for the whole journey.

Answer: Let the distance = d km

∴ Total distance travelled by car = 2d

$$\text{Time taken to travel d km at 50 km/h} = \frac{\text{distance}}{\text{speed}}$$

$$= \frac{d}{50}\ \text{h}$$

$$\text{Time taken to travel d km at 40 km/h} = \frac{d}{40}\ \text{h}$$

∴ Total time taken $= \frac{d}{50} + \frac{d}{40}$

$$= \frac{40d + 50d}{2000}$$

$$= \frac{9d}{200}$$

Average speed $= \frac{\text{Total distance}}{\text{Total time}}$

$$= \frac{2d}{9d/200}$$

$$= \frac{400}{9}$$

= 44.44 km/h.

Question 13

Question: An artificial satellite is moving in a circular orbit of radius nearly 42,250 km. Calculate its linear velocity, if it takes 24 hour to revolve round the earth.

Answer: Linear velocity, $v = \frac{\text{Distance travelled}}{\text{Time taken}}$

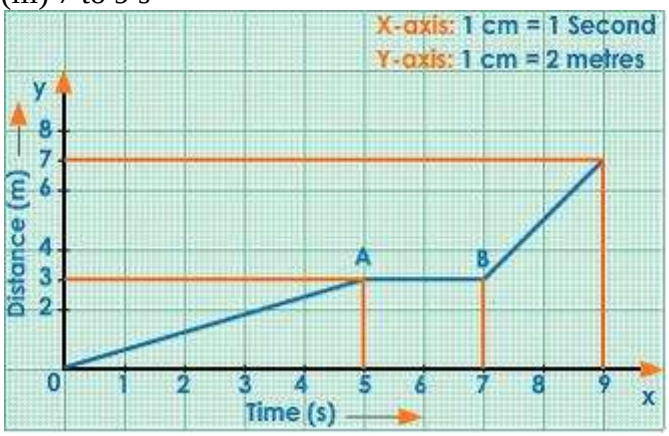
$= \frac{2\pi r}{t}$

$= 2 \times \frac{22}{7} \times \frac{42250}{24 \times 60 \times 60}$

$= 3.07 \text{ kms}^{-1}$

Question 14

Question: The given figure shows the position of a body at different times. Calculate
(i) the speed of the body as it moves for 0 to 5 s
(ii) 5 to 7 s
(iii) 7 to 9 s



Answer: (i) Speed of the body as it moves from 0 to 5 s = Slope of OA

$= \frac{3-0}{5-0}$

$= 0.6 \text{ m s}^{-1}$

(ii) Speed from 5 to 7 s = Slope of AB

$= \frac{3-3}{7-5}$

$= 0 \text{ m s}^{-1}$

(iii) Speed from 7 to 9 s $= \frac{7-3}{9-7}$

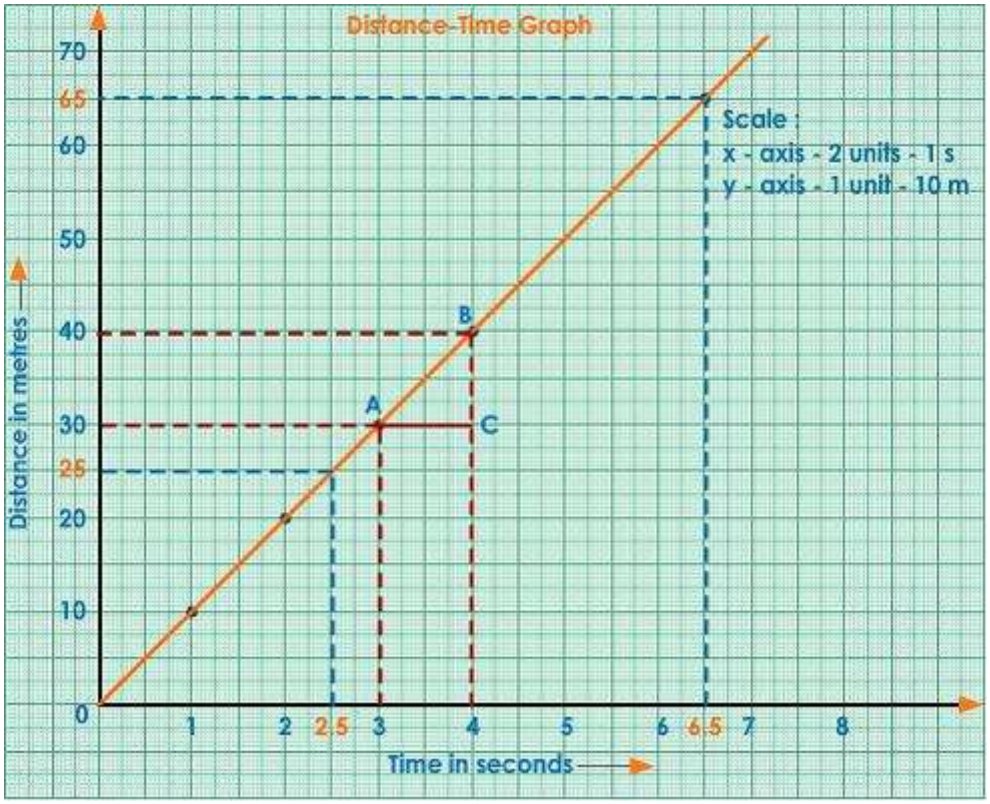
$= 2 \text{ m s}^{-1}$

Question 15

Question: Plot a distance-time graph for the given data and calculate
(a) the corresponding physical quantity and,
(b) the distance covered by the car at the end of 2.5 s and 6.5 s.

Time in Seconds	0	1	2	3	4	5	6
Distance in metres	0	10	20	30	40	50	60

Answer:



The physical quantity, which we get from the distance-time graph, is speed.

$$\text{Speed} = \text{slope of the graph} = \frac{BC}{AC} = \frac{40-30}{4-3} = \frac{10}{1}$$

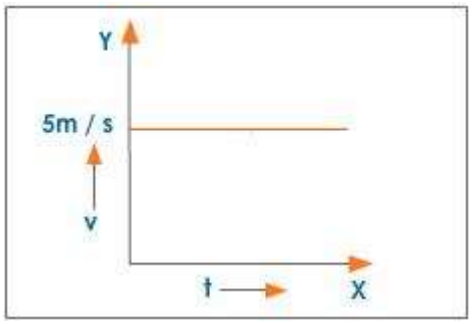
$$\text{Speed} = 10 \text{ m/s}$$

To calculate the distance covered at the end of 2.5 s draw a line vertically up from 2.5 s till it meets the distance-time graph. From that point draw a line to the y-axis. Check where the line meets. The corresponding reading on the y-axis gives the distance travelled. Similarly we can find distance covered at the end of 6.5 s.
The distance covered by the car at the end of 2.5 s = 25 m
The distance covered by the car at the end of 6.5 s = 65 m

Question 16

Question: What is the nature of the velocity - time graph of a body moving with uniform velocity of 5 m/s.

Answer:



Question 17

Question: A body moving with a velocity of 40 ms^{-1} is brought to rest in 5 seconds. Calculate the retardation.

Answer: Given, velocity u = 40m/s
v = 0
t = 5 s
Retardation = ?

$$\text{Acceleration} = \frac{v - u}{t}$$

$$= \frac{0 - 40}{5}$$

$= -8 m/s^2$ (negative acceleration)
∴ Retardation = 8 m/s^2

Question 18

Question: State the three equations of motion.

Answer:

- v = u + at
  - $S = ut + \frac{1}{2} at^2$
  - $v^2 - u^2 = 2aS$

  (where u = initial velocity, v = final velocity, t = time,
  S = displacement and a = acceleration.

Question 19

Question: Write the equation of motion connecting t u, v and a where the symbols have their usual meanings.

Answer: v = u + at

Question 20

Question: Write the equation of motion connecting s, u, v and a where the symbols have their usual meanings.

Answer: $v^2 - u^2 = 2aS$

Question 21

Question: The distance (S) in metres travelled by a particle is related to time(t) in seconds by the equation of motion $S = 5 t^2$. What is the initial velocity of the particle?

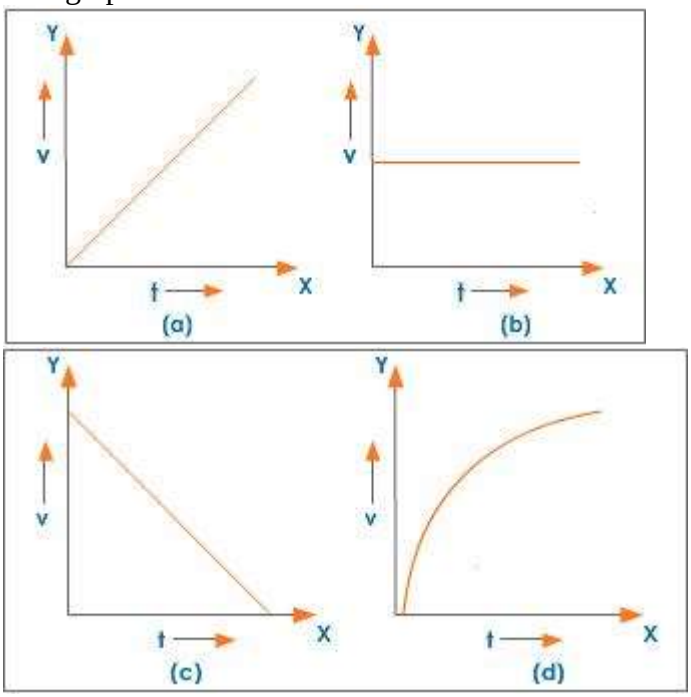
Answer: The second equation of motion is $S = ut + \frac{1}{2} at^2$.

In this case ut = 0

$S = 0 + 5 t^2$
∴ Initial velocity = 0 [because t is not 0]

Question 22

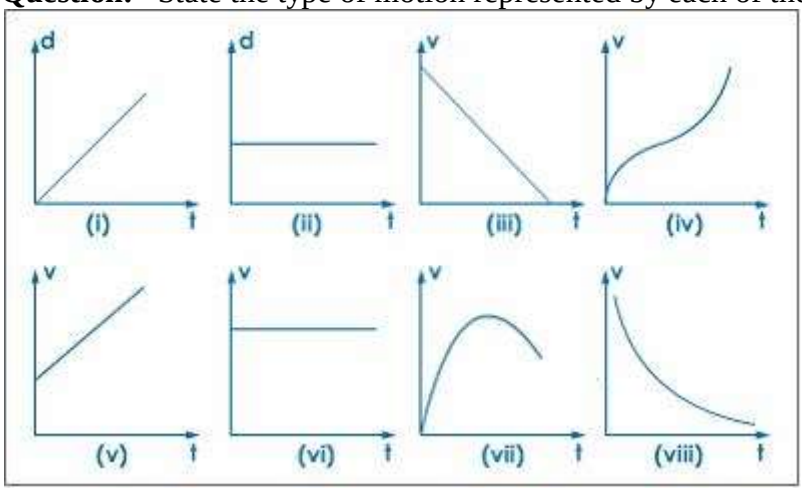
Question: What conclusions do you draw about the nature of motion of the body from the following velocity-time graph?



Answer: a) The object is moving with uniform acceleration (since the graph is a straight line. Straight line graph means change in velocity in equal intervals of time)
b) The object is having zero acceleration (since the object is moving with uniform velocity)
c) The object is moving with negative acceleration or retardation (since the velocity decreases and finally becomes zero)
d) The object is moving with variable acceleration (since the change in velocity is not equal)

Question 23

Question: State the type of motion represented by each of the following graphs:

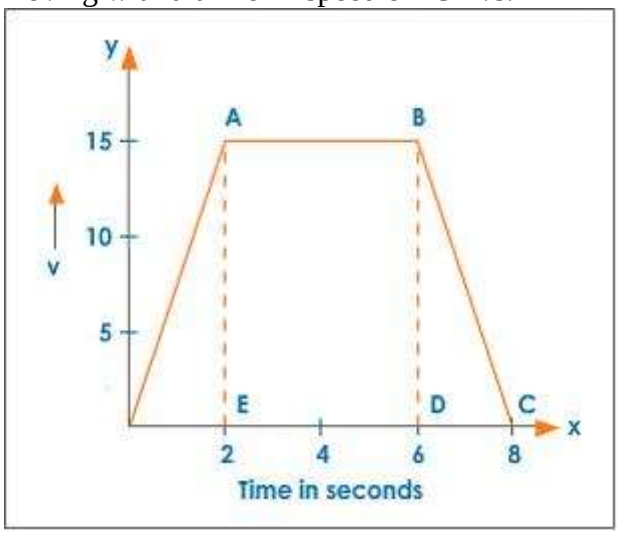


Answer: (i) Body is moving with uniform velocity
(ii) Body is stationary (at rest)
(iii) Body is moving with uniform retardation (velocity is decreasing uniformly)
(iv) Body is having variable acceleration

(v) Body is travelling with a uniform acceleration but not starting from rest
(vi) Body is moving with uniform velocity
(vii) Body is moving with variable acceleration
(viii) Body is moving with variable acceleration

Question 24

Question: The figure below gives the v-t graph of a car. What is the distance covered by the car when it is moving with a uniform speed of 15 m/s.



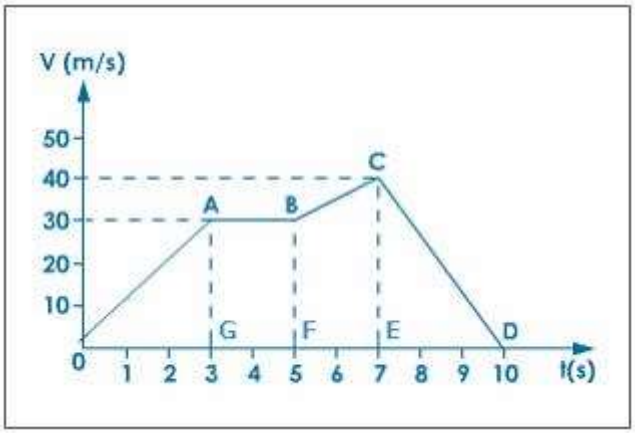
Answer: The distance covered by the car when it is moving with a uniform speed of 15 m/s = area of the rectangle ABDE

$= l \times b = AE \times DE$

$= 15 \times 4 = 60\ m.$

Question 25

Question: Figure shows the velocity time graph of the motion of a body.



(a) State the type of motion in each of the following cases:
(i) OA
(ii) AB
(iii) CD
(b) What is the maximum velocity reached by the body?
(c) State the interval during which the body is moving with a uniform velocity
(d) Calculate the acceleration in the first 3 seconds.

(e) Calculate the retardation.
(f) Calculate the distance travelled in the first 5 seconds.

Answer: (a)
(i) OA $\rightarrow$ uniform acceleration
(ii) AB $\rightarrow$ constant velocity (no acceleration)
(iii) CD $\rightarrow$ uniform retardation
(b) Maximum velocity attained by the body= 40 m/s.
(c) The body has uniform velocity from t = 3 s to t = 5 s.
(d) Acceleration in the first 3 seconds = slope of the line OA

$$= \frac{30}{3}$$

$= 10\ m/s^2$
(e) Retardation = slope of the line CD

$$= \frac{(40-0)\ m/s}{(10-7)\ s}$$

$$= \frac{40}{3}\ m/s^2$$

$$= 13.33\ m/s^2$$

(f) Distance travelled in the first 5 seconds
= Area of the triangle OAG + Area of the rectangle ABFG

$$= \left[\frac{1}{2} \times 3 \times 30\right] + (30 \times 2)$$

= 45 + 60
= 105 m

Question 26

Question: A body travelling with a velocity of 200 ms^{-1} is brought to rest in 10 s. Calculate the retardation.

Answer: u = 200 m/s
v = u + at
0 = 200 + (a x 10)
10 a = -200

$$a = \frac{-200}{10}$$

$$= -20\ m/s^2$$

$\therefore$ Retardation = 20 m/s^2 (-ve sign shows retardation)

Question 27

Question: A body travelling with a velocity of 120 ms^{-1} accelerates uniformly at the rate of 20 m s^{-2} for a period of 40 s. Calculate the velocity and the distance travelled in 40 s.

Answer: Given u = 120 m/s,
a = 20 m/s^2
t = 40 s
Velocity v = u + at

= 120 + (20 x 40)
= 120 + 800
v = 920 m/s

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

= $(120 \times 40) + \left[\frac{1}{2} \times 20 \times 40^2\right]$

= 4800 + 16000
S = 20800 m

Question 28

Question: A car starting from rest acquires a velocity of 36 km/h in 5 seconds. Calculate:
(i) its acceleration and (ii) the distance moved by it.

Answer: Initial velocity = 0
Final velocity v = 36 km/h

$= 36 \times \frac{5}{18}$

= 10 m s^{-1}

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

$= \frac{10-0}{5}$

= 2 m s^{-2}

$v^2 - u^2 = 2aS$

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

$= \frac{10^2 - 0^2}{2 \times 2}$

= 25 m
(i) Acceleration = 2 m s^{-2}
(ii) Distance = 25 m

Question 29

Question: A body moving with an initial velocity of 36 km/h accelerates uniformly at the rate of 5 m/s^2 for 20 seconds. Calculate the total distance travelled in 20 s and the final velocity.

Answer: u = 36 km/h

= 36 x $\frac{5}{18}$ = 10 m s^{-1}
a = 5 m/s^2
t = 20 s.

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

$= 10 \times 20 + \frac{1}{2} \times 5 \times 20 \times 20$

= 200 + 1000
= 1200 m
= 1.2 km
v = u + at
= 10 + 5 x 20
= 10 + 100
= 110 m s^{-1}
= 396 km/h
Distance travelled = 1.2 km, final velocity = 396 km/h.

Question 30

Question: A car travels at a uniform velocity of 60 m s^{-1} for 10 s and is brought to rest in 5 s. Calculate the retardation of the car and the distance travelled in 15 s.

Answer: Uniform velocity = 60 m s^{-1}
Time = 10 s.
∴ distance travelled in 10 s = velocity x time
= 60 x 10
= 600 m.
v = 0, u = 60 m s^{-1}, t = 5 s

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

$$= \frac{0-60}{5}$$

= -12 m s^{-2}
Retardation = 12 m s^{-2}
Since $v^2 - u^2 = 2aS$
$0^2 - 60^2 = 2 \times -12 \times S$

$$\therefore S = \frac{60 \times 60}{2 \times 12}$$

The car travels 150 m in 5 s
∴ Distance travelled in 15 s = (600 + 150)
= 750 m.

Question 31

Question: A body starting from rest acquires a velocity of 200 m s^{-1} in 10 seconds. Calculate the acceleration and the distance travelled by the body in 10 seconds.

Answer: u = 0, v = 200 m s^{-1}, t = 10 s.

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

$$= \frac{200-0}{10}$$

= 20 m s^{-2}

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

= 0 x 10 + $\frac{1}{2}$ x 20 x 10 x 10
= 1000 m.
∴ Acceleration = 20 m s^{-2} and distance travelled = 1000 m.

Question 32

Question: A body starts with a velocity of 40 m s^{-1} and moves with an acceleration of 10 m s^{-2}. Find the distance travelled by the body in 15 seconds and the velocity at the end of the 15th second.

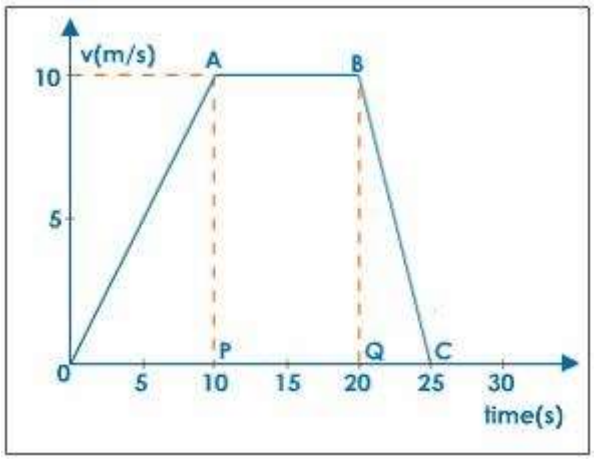
Answer: u = 40 m s^{-1} , a = 10 m s^{-2}, t =15 s

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

= 40 x 15 + $\frac{1}{2}$ x 10 x 15 x 15
= 600 + 1125
= 1725 m.
v = u + at
= 40 + 10 x 15
= 40 + 150
= 190 m s^{-1}
Distance = 1725 m.
Velocity at the end of the 15th second = 190 m s^{-1}

Question 33

Question: Figure represents the velocity - time graph of a lift, whose velocity increases uniformly as it starts to move. When the lift has achieved a velocity of 10 m s^{-1}, this velocity is maintained for a while. Finally the velocity decreases uniformly until it comes to rest. What is the acceleration of the lift during each stage of motion?



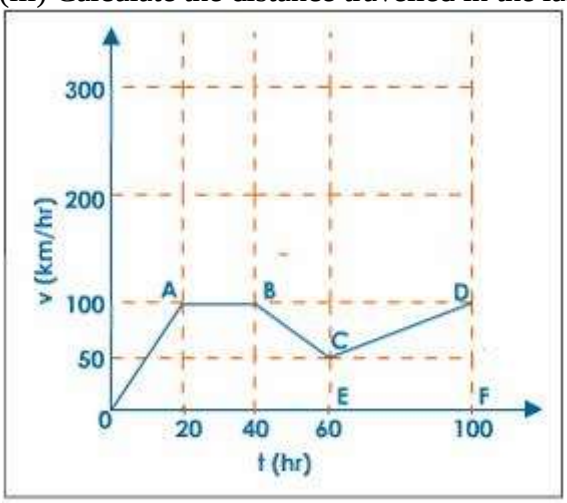
Answer: (i) Acceleration of the lift in the first 10 seconds = $\frac{10-0}{10}$
= 1 m s^{-2}
(ii) Acceleration of the lift when it is moving with uniform velocity is equal to zero as there is no change in its speed.

(iii) Acceleration of the lift in the last five seconds $= \frac{0-10}{5}$

$= -2\ m\ s^{-2}$

Question 34

Question: Figure represents graphically the velocity of a car moving along a straight road over a period of 100 hours.
(i) How long is the body travelling with a uniform velocity?
(ii) Calculate the acceleration along AB and the retardation along BC
(iii) Calculate the distance travelled in the last 40 hours.



Answer: (i)The body is travelling with uniform velocity from A to B i.e.,for 20 h.
(ii) Acceleration along AB is zero since velocity is constant.

$$\text{Retardation along BC} = \frac{(50-100)}{20}$$

$$= -\frac{50}{20}$$

$= 2.5\ km\backslash h^{-2}$

(iii) Acceleration from C to D

$$= \frac{100-50}{40}$$

$$= \frac{50}{40} = 1.25\ km\backslash h^{2}$$

Distance covered in the last 40 hours can be calculated using the equation

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

$$= 50 \times 40 + \frac{1}{2} \times 1.25 \times 40 \times 40$$

$= 2000 + 1000$
$= 3000$ km.
Or
Distance covered in the last 40 hours = area of trapezium CDFE

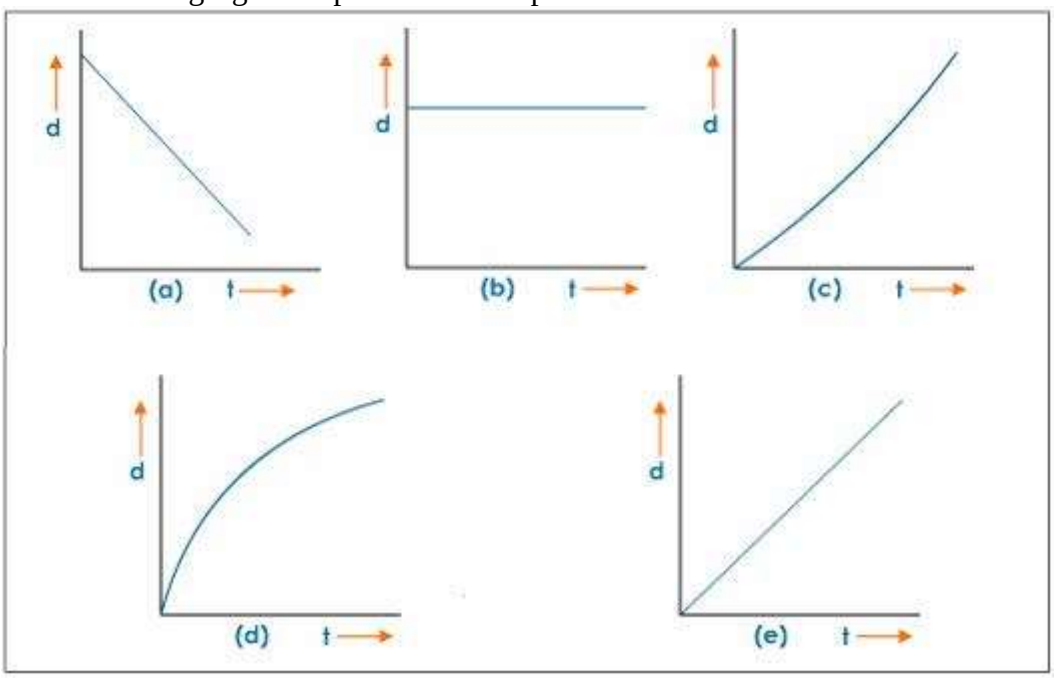
$$= \frac{1}{2} \times (CE + DF) \times EF$$

$= \frac{1}{2} \times (50 + 100) \times 40$

Distance covered in the last 40 hours $= \frac{1}{2} \times 150 \times 40$
= 3000 km

Question 35

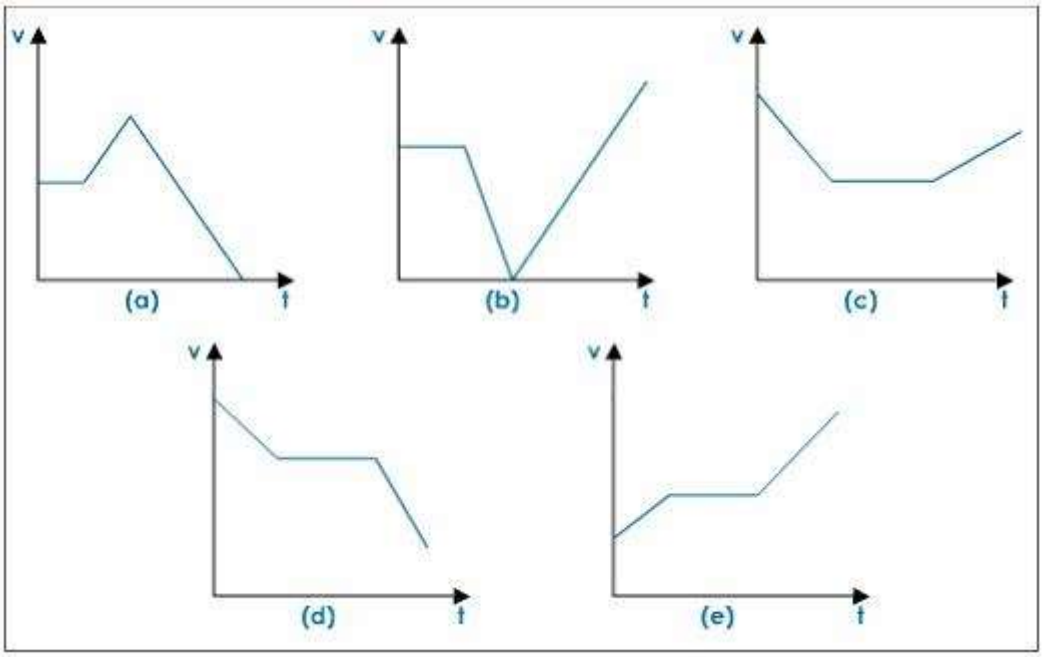
Question: A train undergoes retardation at a constant rate during a period, coming to rest in t seconds. Which of the following figures represents the displacement of the train?



Answer: Graph (d)

Question 36

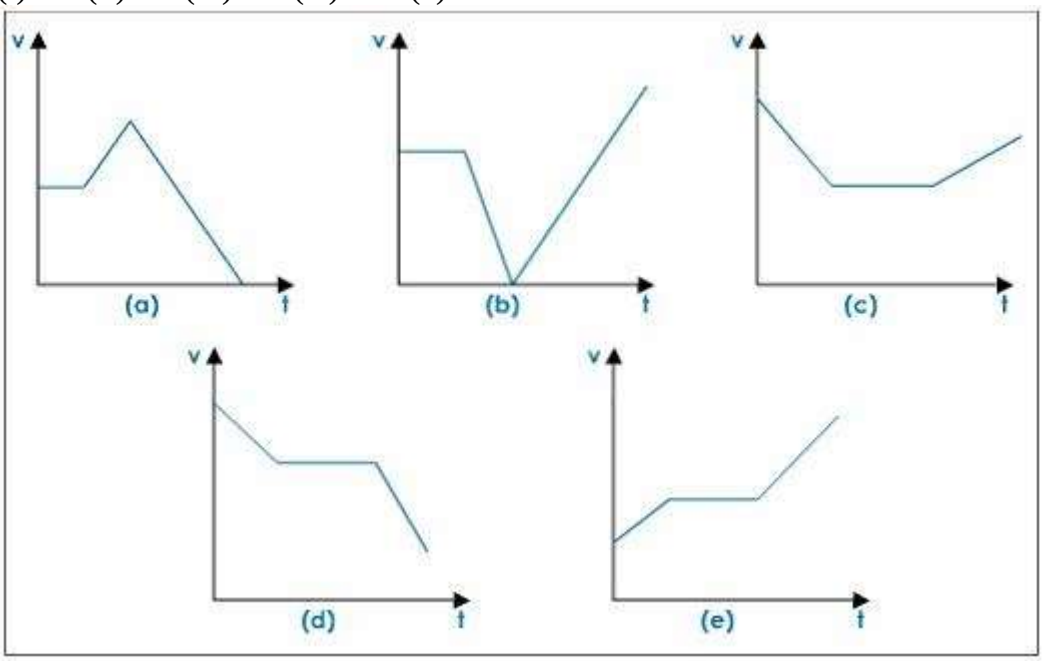
Question: Which graph represents the motion of a body initially moving with uniform deceleration (retardation) then a constant speed followed by uniform acceleration?



Answer: Graph (c)

Question 37

Question: The graph shows how the speed of a car is found to vary with time after starting at a speed of 30 ms^{-1}. When is the acceleration of the car maximum?
(i) AB (ii) BC (iii) CD (iv) at D (v) DE



Answer: Acceleration of the car when it travels from A to B = $\frac{v-u}{t}$

$= \frac{120-30}{3} = 30\ m\ s^{-2}$

Acceleration of the car when it travels fromB to C = 0, because velocity is constant.

Acceleration of the car when it travels from C to D

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

$$= \frac{210 - 120}{1}$$

$= 90 \text{ m s}^{-2}$

Acceleration of the car when it travels from D to E is negative.

∴ Acceleration is maximum from C to D.

Question 38

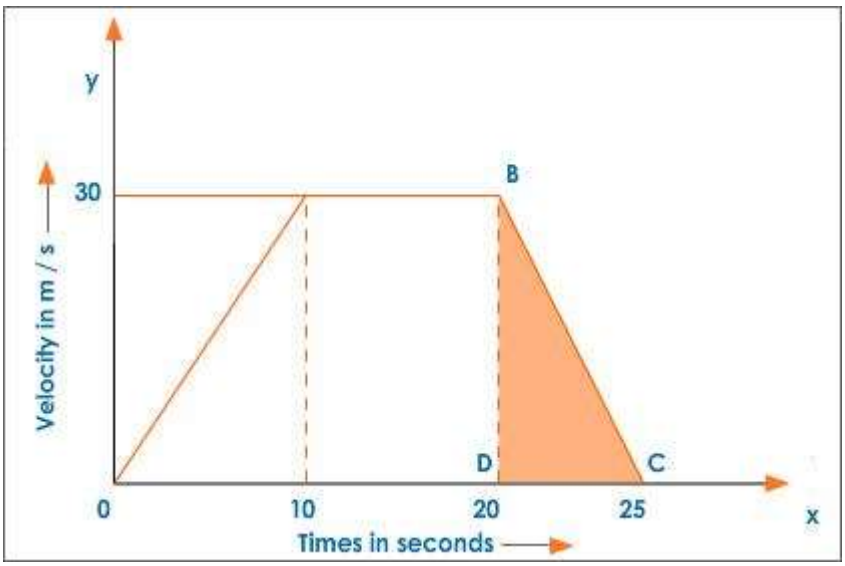
Question: What do you infer, if the distance-time graph is a straight line?

Answer: The straight line graph indicates that the speed is uniform.

Question 39

Question: A car is moving with a uniform acceleration for the first ten seconds and then it moves with a uniform velocity of 30 m/s for the next ten seconds. The brakes are applied and the car comes to rest with a uniform acceleration in 5 seconds. Draw a v-t graph to show the nature of motion. How far does the car travel after the brakes are applied?

Answer:



Here, you have to calculate the distance travelled by the car after the brakes are applied. i.e., the distance travelled between the time interval 20 s - 25 s.

The area of the shaded part gives the distance travelled.

$$\text{Distance covered} = \text{area of } \Delta BDC = \frac{1}{2}bh$$

$$= \frac{1}{2} \times DC \times BD$$

$$= \frac{1}{2}(25 - 20)30$$

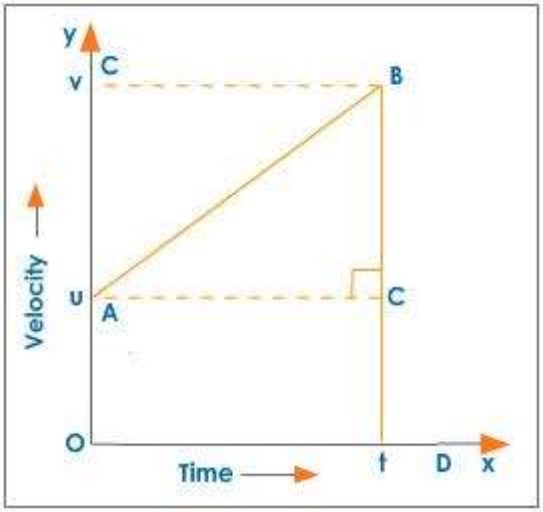
$$= \frac{1}{2} \times 5 \times 30$$

$$= 5 \times 15$$

Distance covered after the application of brakes = 75 m.

Question 40

Question: Derive the first equation of motion from a v-t graph.



Answer:

Graphical Derivation of First Equation

Consider an object moving with a uniform velocity u in a straight line. Let it be given a uniform acceleration a at time t = 0 when its initial velocity is u. As a result of the acceleration, its velocity increases to v (final velocity) in time t and S is the distance covered by the object in time t.

The figure shows the velocity-time graph of the motion of the object.

Slope of the v - t graph gives the acceleration of the moving object.

Thus, acceleration = slope = AB = $\frac{BC}{AC} = \frac{v-u}{t-0}$

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

v - u = at

v = u + at **I equation of motion**

Question 41

Question: An electron accelerates in a straight line at 4 x 10^{10}m/s^2 in a cathode ray tube. If its initial speed is 2 x 10^4 m/s what is its speed after 3 x 10^{-6} s?

Answer: $\text{Acceleration } (a) = 4 \times 10^{10} m/s^2$

$\text{Initial velocity } (u) = 2 \times 10^4 m/s$

Final velocity (v) = ?

Time (t) = 3 x 10^{-6} s

Applying v = u + at

$v = 2 \times 10^4 + 4 \times 10^{10} \times 3 \times 10^{-6}$

$= 2 \times 10^4 + 4 \times 3 \times 10^4$

$= 2 \times 10^4 + 12 \times 10^4$
$= 10^4 (2 + 12)$
Final Velocity $= 14 \times 10^4 m/s$

Question 42

Question: Give an expression for the distance covered in the nth second by a body which is initially moving with a velocity 'u' and has a constant acceleration 'a'.

Answer: $S_n = u + \frac{a}{2}(2n - 1)$

Question 43

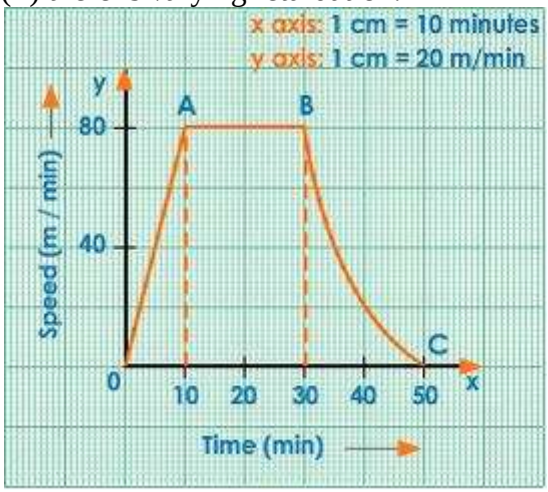
Question: A ball starting from rest slides down an inclined plane of length 10 m with a speed of 10 m/s. What is the acceleration produced in the ball?

Answer: Initial velocity (u) = 0 (the ball is starting from rest)
Length of the inclined plane = distance covered by the ball = S = 10 m.
Final velocity (v) = 10 m/s.
Acceleration produced in the ball = a
Acceleration is calculated using III equation of motion

$v^2 - u^2 = 2aS$
$10^2 - 0^2 = 2 \times a \times 10$
$100 = 20a$
$a = \frac{100}{20}$
Acceleration produced in the ball = 5 m/s^2.

Question 44

Question: The diagram given below is the speed-time graph of a particle moving in a straight line. State the interval during which
(i) There is no acceleration
(ii) there is varying retardation.



Answer: (i) There is no acceleration from the 10th minute to the 30th minute because the speed is constant.
(ii) There is varying retardation from the 30th to the 50th minute.

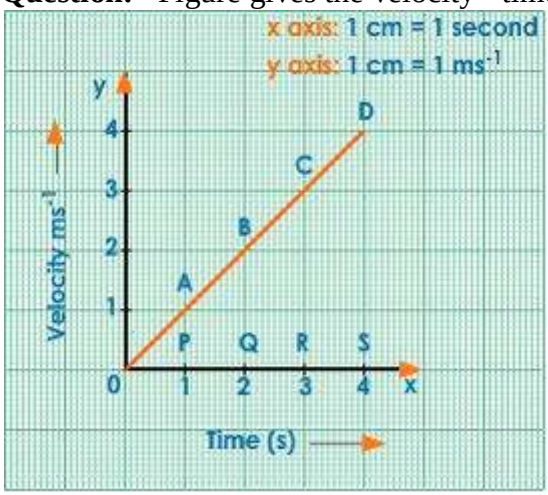
Question 45

Question: A stone of mass 2 kg takes 4 s to reach the ground when it is dropped from a tower. What time will another stone of mass 4 kg, take for the same fall?

Answer: It will also take 4 seconds because acceleration produced in a freely falling body is independent of its mass.

Question 46

Question: Figure gives the velocity - time graph of a body. Draw the displacement time graph for it.



Answer: Displacement of the body at the end of first second = Area of ΔOAP

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

= 0.5 m

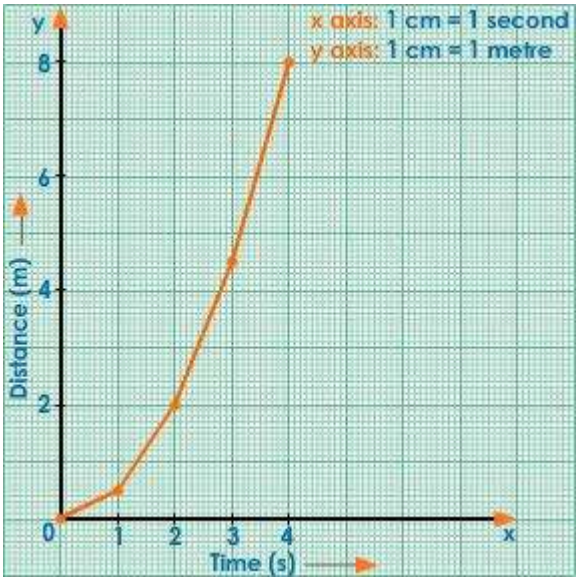
Similarly displacement in 2, 3, and 4 seconds is calculated.

Displacement of the body at the end of 2nd second = $\frac{1}{2} \times 2 \times 2 = 2\,m$

Displacement of the body at the end of 3rd second = $\frac{1}{2} \times 3 \times 3 = 4.5\,m$

Displacement of the body at the end of 4th second = $\frac{1}{2} \times 4 \times 4 = 8\,m$

Hence, the displacement - time graph will be a curve as shown in figure below.



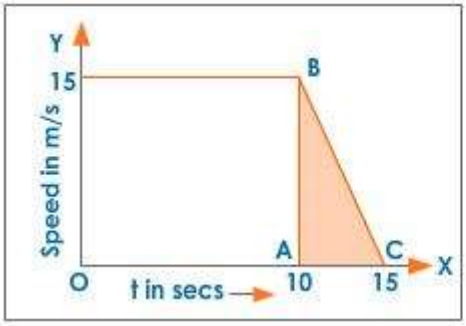
Question 47

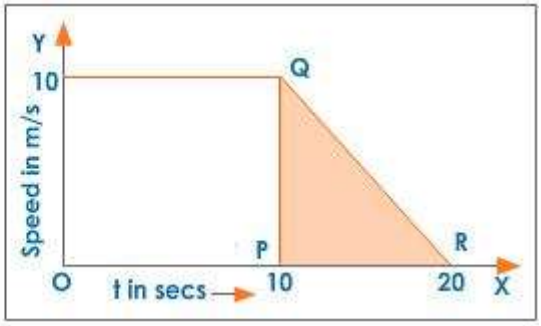
Question: A driver of a car A travelling at a uniform speed of 54 km/h for 10 s applies the brakes and decelerates uniformly. The car stops in 5 s. Driver of car B going at 36 km/h for 10 s applies the brakes slowly and stops after 10 seconds. Plot the speed-time graph of both cars and find out which of the two cars travelled further after the brakes were applied.

Answer: Since the time is given in seconds, the speed is converted to m/s.

$$54\,km/h = 54 \times \frac{5}{18} = 15\,m/s$$

$$36\,km/h = 36 \times \frac{5}{18} = 10\,m/s$$





Speed - Time Graph (Car A) Speed - Time Graph (Car B)

Here we have to find out which of the two cars travelled more distance after the brakes were applied. For that we calculate the area of the shaded part and compare.

Distance covered by car A after the brakes were applied = area of DABC

$$= \frac{1}{2}bh$$

$$= \frac{1}{2} \times AC \times AB = \frac{1}{2} \times 5 \times 15$$

$$= \frac{75}{2} = 37.5\,m$$

Distance covered by car B after the brakes were applied = area of DPQR

$= \frac{1}{2}bh$

$= \frac{1}{2} \times PR \times PQ = \frac{1}{2} \times 10 \times 10$

$= \frac{100}{2} = 50\ m$

Hence car B covers more distance.

Question 48

Question: The table below shows the distance travelled by objects A, B and C during each second.

Time in Second	Distance covered by		
	A in cm	B in cm	C in cm
1	20	20	20
2	20	36	60
3	20	24	100
4	20	30	140
5	20	48	180

(i) Which object is moving with constant speed? Give a reason for your answer.
(ii) Which object is moving with constant acceleration? What is the value of this acceleration?
(iii) Which object is moving with an irregular acceleration?
(iv) What is the distance covered by each of the objects A,B and C in 5 seconds?

Answer: (i) Object A is moving with a constant speed because it is covering equal distances (20 cm) in equal intervals of time (1s).
(ii) Object C is moving with constant acceleration because:-

in the 1st sec. $v = \frac{20}{1} = 20\ m\ s^{-1}$

2nd sec. $v = \frac{60}{1} = 60\ m\ s^{-1}$

3rd sec. $v = \frac{100}{1} = 100\ m\ s^{-1}$

4th sec. $v = \frac{140}{1} = 140\ m\ s^{-1}$

5th sec. $v = \frac{180}{1} = 180\ m\ s^{-1}$

Acceleration is the rate of change of velocity, the velocity is changing at the rate of 40 m s^{-2}. Since the rate is constantly 40 m s^{-2} acceleration is constant.
(iii) The object B is moving with irregular acceleration
(iv)
Distance covered by the object A in 5 seconds = 20 x 5 = 100 cm = 1 m
Distance covered by the object B in 5 seconds = 20 + 36 + 24 + 30 + 48
= 158 cm
= 1.58 m
Distance covered by the object C in 5 seconds = 20 + 60 + 100 + 140 + 180
= 500 cm
= 5 m.

Question 49

Question: A body starting with a velocity of 60 m s^{-1} moves with an acceleration of 5 m s^{-2}.
(a) What will be the velocity of the body after 10 seconds?
(b) Calculate the distance travelled during 10 s.

Answer: (a) Given data:

$u = 60\ ms^{-1}\ ;\ a = 5\ ms^{-2}\ ;\ t = 10\ s$

Velocity of the body after 10 s = u + at
= 60 + (5 x 10)
= 60 + 50

$v = 110\ m\ s^{-1}$

(b) Distance travelled = S

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

$$= \left(\frac{110+60}{2}\right)\times 10$$

$$= \frac{170}{2}\times 10$$

S = 850 m

Question 50

Question: A body starting from rest accelerates uniformly at the rate of 100 m s^{-2} for 10 seconds. Calculate the final velocity at the end of 10 seconds and the distance travelled during this interval.

Answer: Final velocity, v = u + at
Given: u = 0

a = $100\ m\ s^{-2}$ and
t = 10 s

$\therefore\ v = 0 + 100\times 10$

= 1000 m/s
v = 1000 m/s.

$$\text{Distance travelled, } S = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2}\times 100\times (10)^2$$

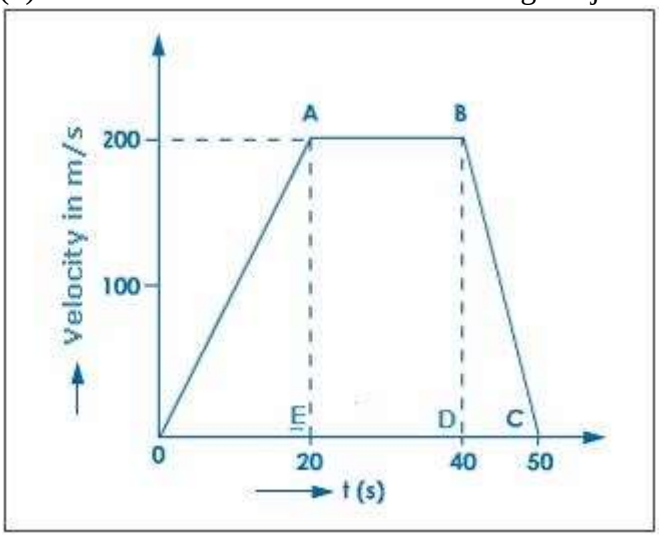
$$= \frac{1}{2}\times 100\times 100$$

S = 5000 m

Question 51

Question: Figure shows a velocity - time graph of a body starting from rest. Study the graph and answer the following questions:
(a) Describe the journey along
OA, AB, BC

(b) Calculate the acceleration during the first 20 seconds.
(c) How long does the body has zero acceleration for?
(d) Calculate the distance travelled during the journey



Answer: (a) OA → Velocity of the body increases at a uniform rate, i.e. the body is moving with positive acceleration.
AB → Body is moving with uniform velocity, i.e. the body is moving with zero acceleration.
BC → Velocity of the body decreases at a uniform rate, the body is moving with negative acceleration.

(b) Acceleration of the body during the first 20 seconds = $\frac{\text{change in velocity}}{\text{time}}$

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

$= \frac{200-0}{20}$

$= 10\ m\ s^{-2}$

(c) The body moves with zero acceleration for 20 seconds i.e., during its journey from A to B.

(d) Distance travelled during the journey = Area of the v-t graph OABC
= Area of the trapezium OABC

$= \frac{1}{2} AE(AB + OC)$

$= \frac{1}{2} \times 200(20 + 50)$

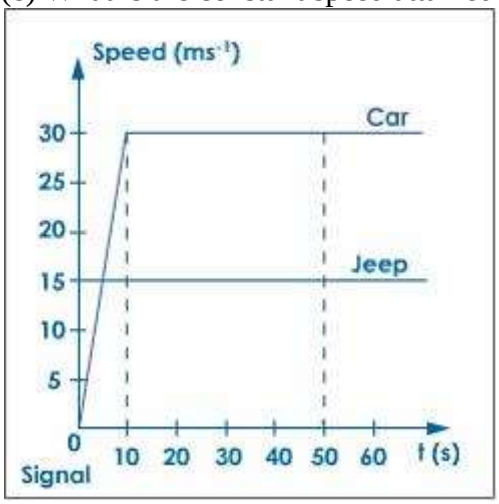
$= 100 \times 70$

\ Distance travelled = 7000 m

Question 52

Question: Figure shows the motion of two vehicles near a traffic signal. The car is stopped at the signal. The light turns green and just as the car starts to accelerate, a jeep passes it moving at a constant speed.
(a) How long does it take the car to reach the same speed as the jeep?
(b) How far has the car travelled from the signal to gain the speed?
(c) At that time how far the jeep travelled from the signal?
(d) Calculate the acceleration of the car in the first 10 seconds?

(e) What is the constant speed attained by the car?



Answer: (a) 10 s

(b) Acceleration of the car, a = $\frac{v-u}{t}$

= $\frac{15-0}{10}$

= 1.5 m/s^2

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

= $0+\frac{1}{2}\times 1.5\times 10^2$

S = 75 m

(c) distance travelled by the jeep = speed x time

= 15 m/s x 10s

= 150 m

(d) acceleration a = $\frac{v-u}{t}$

= $\frac{(30-0)\,m/s}{20\,s}$

a = 1.5 m/s^2

(e) 30 m/s.

Question 53

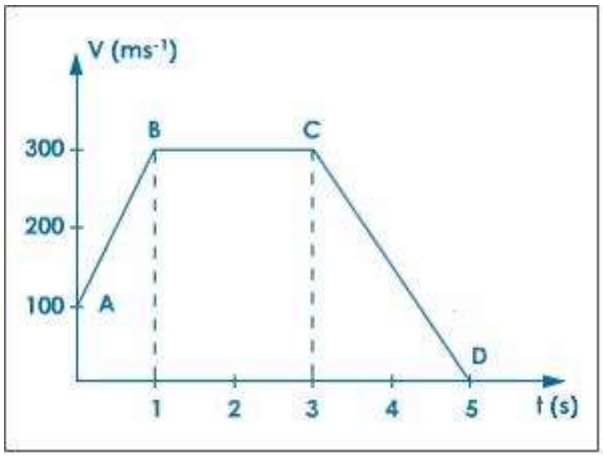
Question: The graph shows the relationship between velocity and time for a moving body.

(a) What kind of motion is represented by -

(i) AB

(ii) BC

(iii) CD



(b) Calculate the acceleration along CD.

Answer: (a) (i) AB → uniform acceleration (not starting from rest)
(ii) BC → constant velocity (no acceleration)
(iii) CD → uniform retardation.

(b) acceleration along CD = $\frac{v-u}{t}$

$= \frac{(0-300)\ m/s}{2\ s}$

acceleration = 150 m/s^2

∴ Retardation = 150 m/s^2

Question 54

Question: The following table gives the distance moved by a body against time:

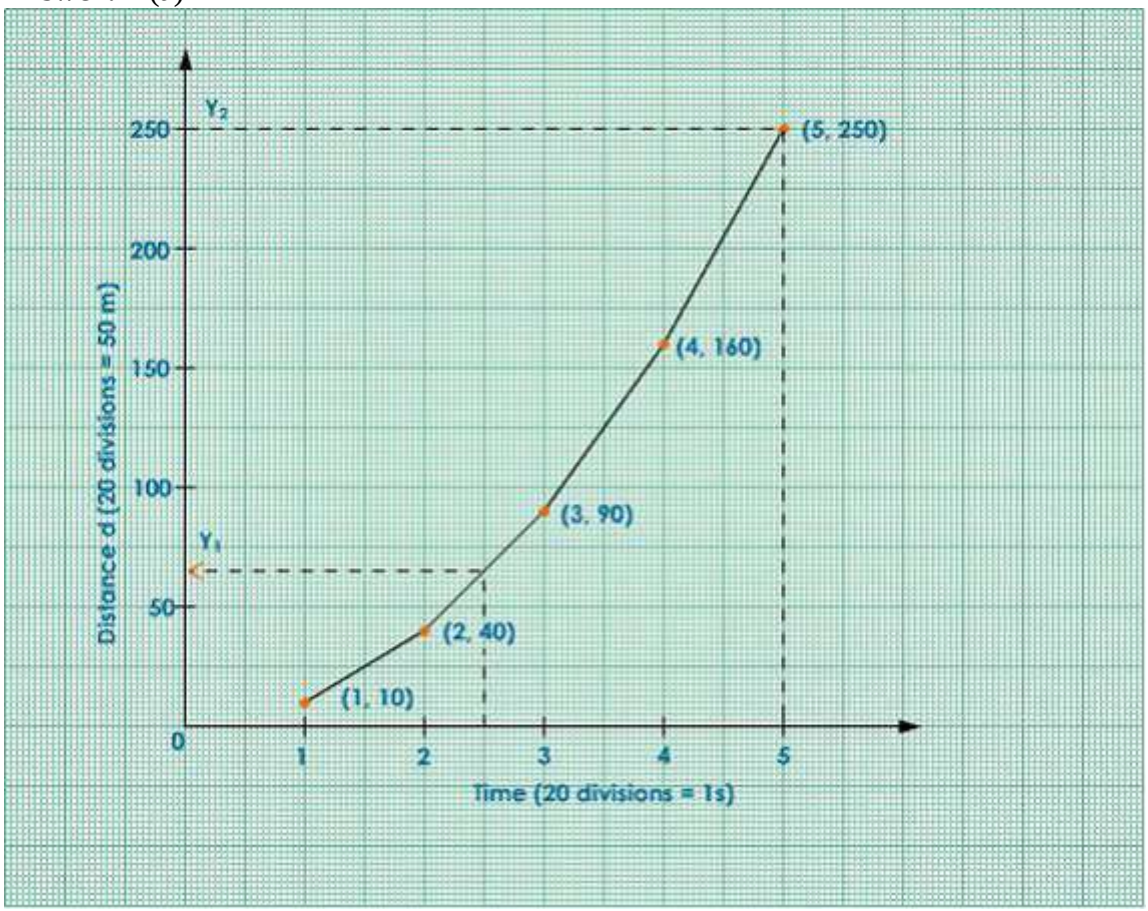
Time (s)	1	2	3	4	5
Distance (m)	10	40	90	160	250

(a) Plot a distance-time graph and find the distance travelled after 2.5 seconds.
(b) Draw a velocity time graph for the motion of the body in the above questions.

Vel. (m/s)				
Time (s)				

(c) Calculate the acceleration of the body.
(d) Calculate the total distance travelled.

Answer: (a)

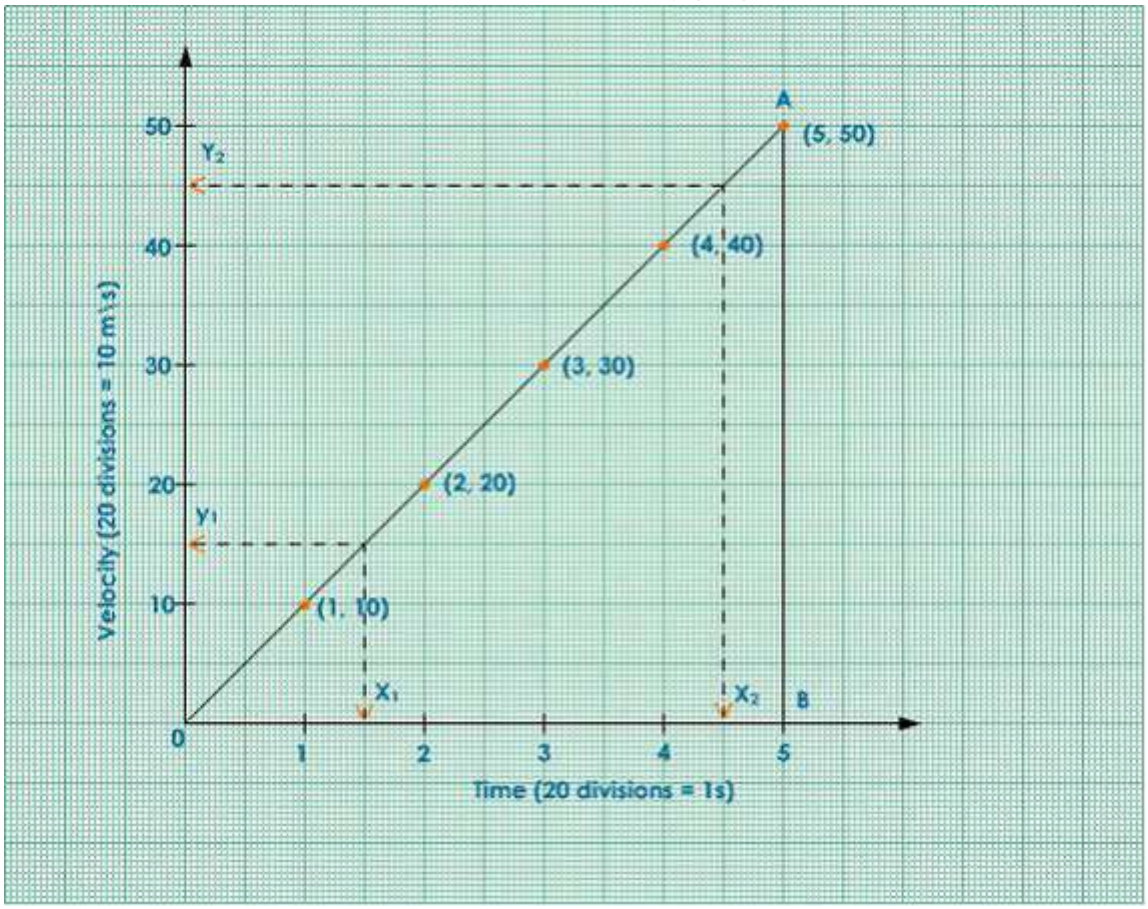


Distance travelled after 2.5 s = $y_2 - y_1$
= 250 - 65
= 185 m

(b)

$$v = \frac{d}{t}$$

t (s)	1	2	3	4	5
v (m/s)	10	20	30	40	50



(c) acceleration of the body = slope of the graph

$$= \frac{v_2 - v_1}{x_2 - x_1}$$

$$= \frac{(45 - 15)\,m/s}{(4.5 - 1.5)s}$$

$$= \frac{30}{3}\,m/s^2$$

$a = 10\ m/s^2$

(d) Total distance travelled = Area of triangle OAB

$$= \frac{1}{2} \times AB \times BO$$

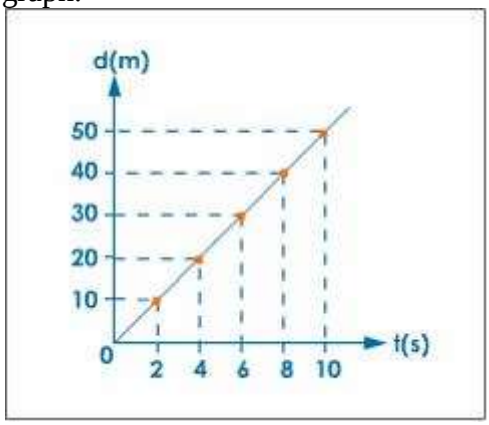
$$= \frac{1}{2} \times 50\ m\,s^{-1} \times 5s$$

$$= \frac{250}{2}\,m$$

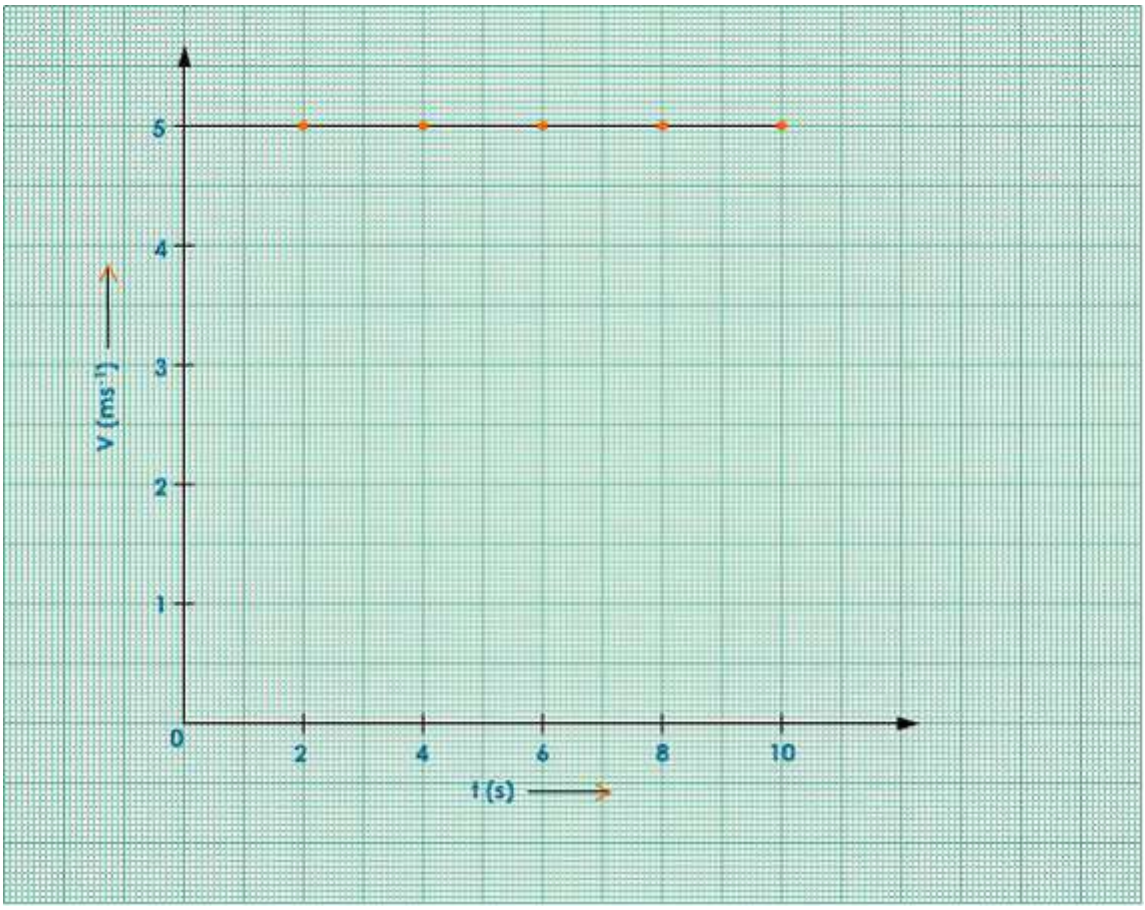
$= 125$ m

Question 55

Question: Figure below shows the distance - time graph of the motion of the body. Draw a velocity - time graph.

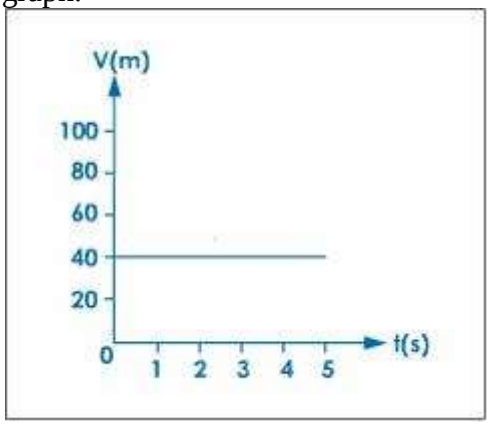


Answer:

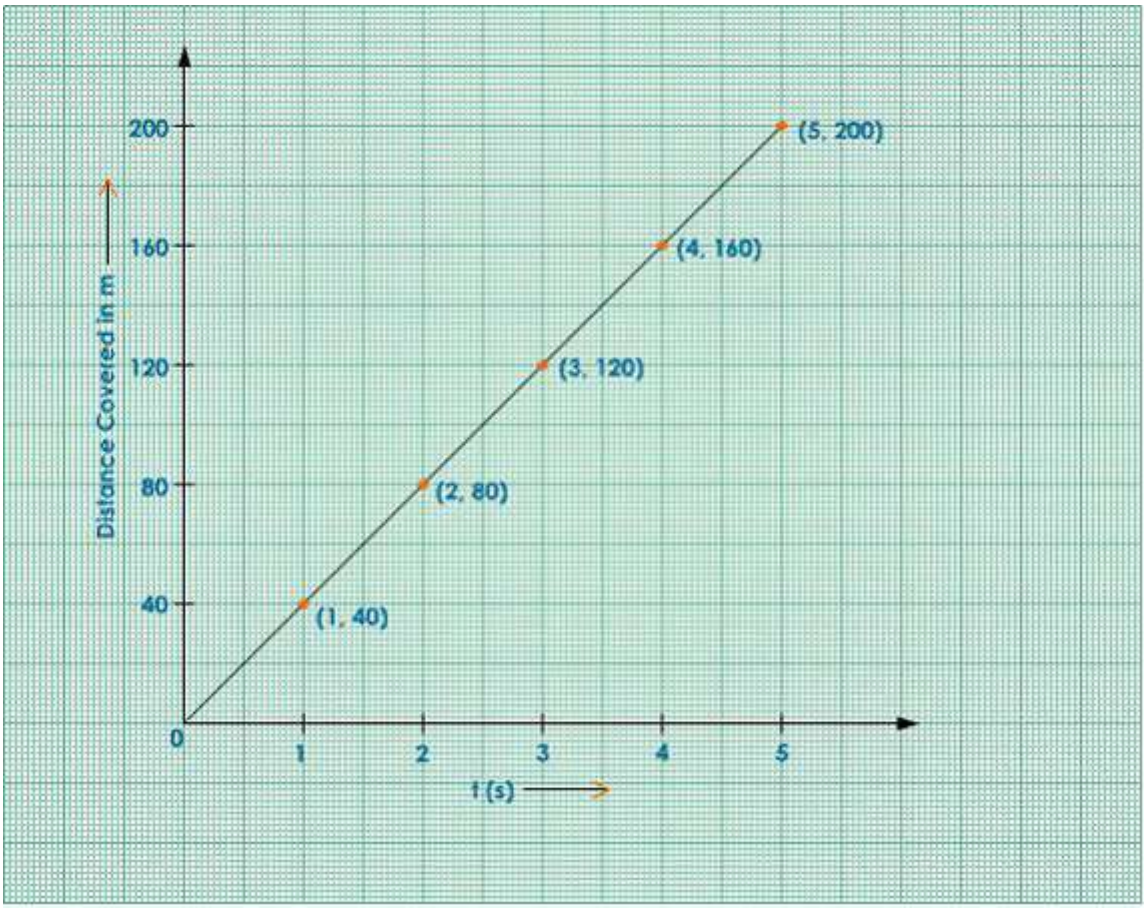


Question 56

Question: Figure below shows the velocity - time graph of the motion of the body. Draw a distance - time graph.



Answer:



Question 57

Question: A stone dropped from the top of a tower reaches the ground in 8 seconds (a = 10 ms^{-2}). Calculate
(a) the height of the tower
(b) The distance travelled by the stone in the 8^{th} second.

Answer: Given t = 8 s
g = 10 ms^2
u = 0
(a) Height of the tower = ?

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

h = $0 + \frac{1}{2} gt^2$

= $\frac{1}{2} \times 10 \times 8^2$

h = 320 m

(b) Distance travelled by the stone in the 8th second,

$S = u + \frac{1}{2} a(2t - 1)$

= $0 + \frac{1}{2} \times 10(2 \times 8 - 1)$

= $\frac{1}{2} \times 10 \times 15$

S = 75 m

Question 58

Question: A cricket ball is thrown upwards with a velocity of 60 ms^{-1} (a= -10 ms^{-2}). Calculate
(a) the time taken by the ball to reach the maximum height.
(b) the maximum height reached by the ball.
(c) the total time taken to return to the ground.

Answer: Given u = 60 m/s
v = 0
a = -10 m/s^2.
(a) v = u + at
v = 60 - 10 x t
0 = 60 - 10t

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

= 6 s

(b) $v^2 = u^2 - 2gh$

$2gh_{max} = u^2$

$h_{max} = \frac{u^2}{2g}$

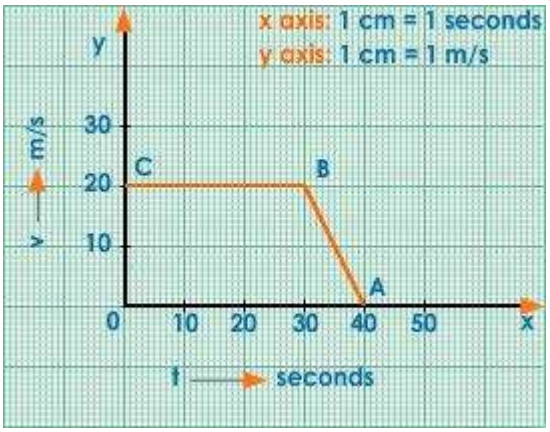
= $\frac{60^2}{2 \times 10}$

= 180 m

(c) Total time taken to return to ground = 6 + 6
= 12 s
(time of ascent = time of descent)

Question 59

Question: A cyclist is cycling at a uniform speed of 20 m/s for 30 seconds. He then stops pedalling and comes to a halt in next 10 s. Draw a velocity time graph and hence find (i) The total distance travelled (ii) The average retardation.



Answer:

(i) Total distance travelled = Area of trapezium OABC.

$$= \frac{1}{2} \times OC\,(OA + BC)$$

$$= \frac{1}{2} \times 20\,(40 + 30)$$

= 700 m

(ii) Average retardation = negative acceleration

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

$$= \frac{0 - 20}{10}$$

$= -2\ m\ s^{-2}$

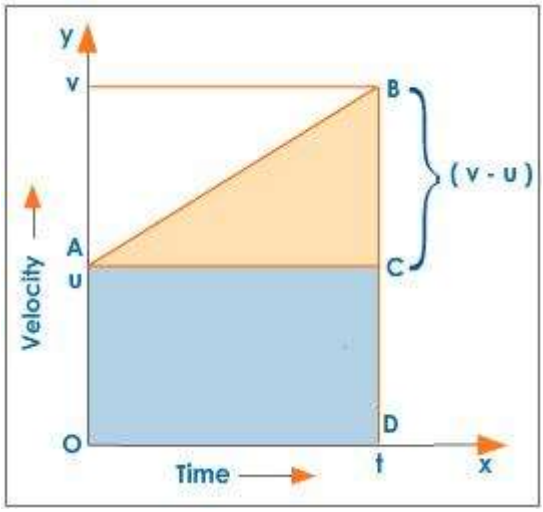
∴ retardation = $2\ m\ s^{-2}$

Question 60

Question: Derive II and III equations of motion graphically.

Answer: **Second Equation of Motion**

Let u be the initial velocity of an object and 'a' the acceleration produced in the body. The distance travelled S in time t is given by the area enclosed by the velocity-time graph for the time interval 0 to t.



Graphical Derivation of Second Equation

Distance travelled S = area of the trapezium ABDO

= area of rectangle ACDO + area of DABC

$$= OD \times OA + \frac{1}{2} BC \times AC$$

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

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

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

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

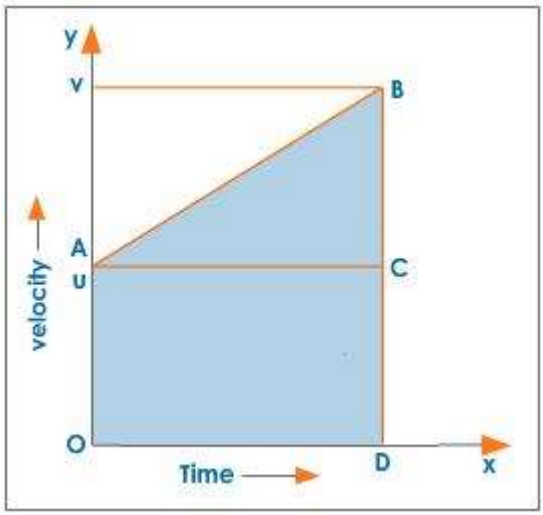
(v = u + at I eqn of motion; v - u = at)

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

$S = ut + \frac{1}{2} at^2$ **II equation of motion**

Third Equation of Motion

Let 'u' be the initial velocity of an object and a be the acceleration produced in the body. The distance travelled 'S' in time 't' is given by the area enclosed by the v - t graph.



Graphical Derivation of Third Equation

S = area of the trapezium OABD.

$= \frac{1}{2}(b_1 + b_2)h$

$= \frac{1}{2}(OA + BD)AC$

$= \frac{1}{2}(u + v)t \quad \ldots (1)$

But we know that $a = \frac{v - u}{t}$

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

Substituting the value of t in equation (1) we get,

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

2aS = (v + u) (v - u)

(v + u)(v - u) = 2aS [using the identity $a^2 - b^2 = (a+b)(a-b)$]

$v^2 - u^2 = 2aS$ **III Equation of Motion**

Question 1

Question: 1 km/h = _____ m/s

1. $\frac{5}{18}$
2. $\frac{18}{5}$
3. $\frac{50}{3}$
4. $\frac{3}{50}$

Answer: 1

Question 2

Question: The distance (s) in metres travelled by a particle is related to time (t) in seconds by the equation of motion -S = $10t + 4t^2$. What is the initial velocity of the body?

1. 10 m/s
2. 6 m/s
3. 4 m/s
4. 10 m/s^2

Answer: 1

Question 3

Question: For the equation - S = $10t + 4t^2$ what is the acceleration of the body?

1. 8 m/s^2
2. 10 m/s^2
3. 4 m/s^2
4. 8 m/s

Answer: 1

Question 4

Question: A body moving along a straight line at 20 m/s decelerates at the rate of 4 m/s^2. After 2 seconds its speed will be equal to

1. 8 m/s
2. 12 m/s
3. 16 m/s
4. - 12 m/s

Answer: 2

Question 5

Question: Give the equation of motion connecting u, v, a and s where the symbols have their usual meaning

1. v = u + at
2. $S = ut + \frac{1}{2}at^2$
3. $v^2 - u^2 = 2aS$
4. $a = \frac{v - u}{t}$

Answer: 3

Question 6

Question: An object moving with a speed of 5 m/s comes to rest in 10 s, after the brakes are applied. What is the initial velocity?

1. zero
2. 5 m/s
3. 15 m/s
4. 50 m/s

Answer: 2

Question 7

Question: A body moving along a straight line at 40 m/s undergoes an acceleration of 4 m/s^2. After 10 seconds its speed will be

1. 20 m/s
2. 28 m/s
3. 16 m/s
4. 80 m/s

Answer: 4

Question 8

Question: SI unit of acceleration is _____.

1. m/s^2
2. km/h^2
3. cm/s^2
4. km/min^2

Answer: 1

Question 9

Question: Retardation is _____.

1. negative acceleration
2. positive acceleration
3. uniform acceleration
4. variable acceleration

Answer: 1

Question 10

Question: When an object is moving with uniform velocity, what is its acceleration?

1. zero
2. uniform
3. non-uniform
4. negative

Answer: 1

Question 11

Question: In the case of a rectilinear uniform motion, distance-time graph is a

1. parabola
2. straight line
3. curved line
4. rectangle

Answer: 2

Question 12

Question: Speed of 90 km/h when expressed in m/s is .

1. 2.5
2. 25
3. 250
4. 90000

Answer: 2

Question 13

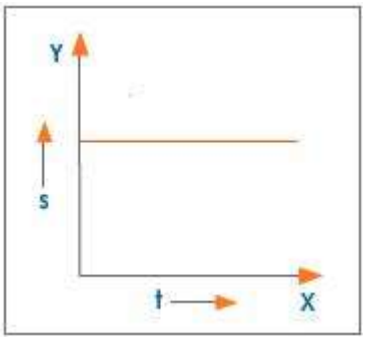
Question: When a graph of one quantity versus another results in a straight line, the quantities are .

1. directly proportional
2. constant
3. inversely proportional
4. independent of each other

Answer: 1

Question 14

Question: What does the following S-t graph indicate?



1. uniform speed
2. body is at rest
3. non-uniform speed
4. variable speed

Answer: 2

Question 15

Question: What do you infer, if S-t graphs of two cyclists meet at a point?

1. They collide
2. They pass each other
3. They are at rest
4. They are starting from rest

Answer: 2

Question 16

Question: Name the physical quantity which we get from a S-t graph.

1. Speed
2. Displacement
3. Distance
4. Time

Answer: 1

Question 17

Question: What is the SI unit of speed?

1. km/h
2. m/s
3. m/min
4. km/s

Answer: 2

Question 18

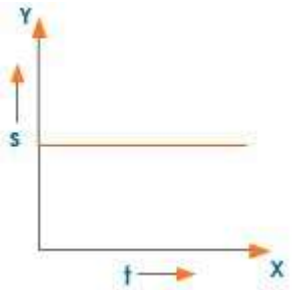
Question: What is the distance covered by a car in 5 h if it is moving with a speed of 35 km/h?

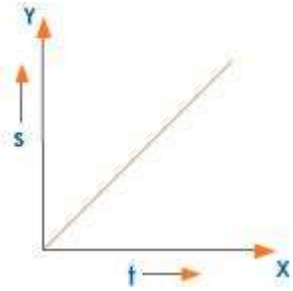
1. 175 km
2. 150 km
3. 7 km
4. 1750 km

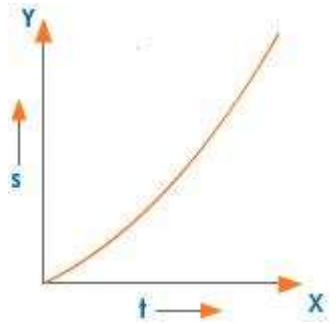
Answer: 1

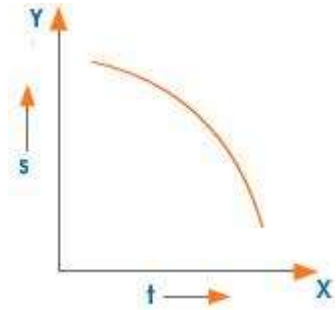
Question 19

Question: The S-t graph for uniform speed is

1. 

2. 

3. 

4. 

Answer: 2

Question 20

Question: The average speed of a car which covers half the distance with a speed of 20 m/s and other half with a speed of 30 m/s in equal intervals of time is _____.

1. 25 m/s
2. 0 m/s
3. 24 m/s
4. 2.4 m/s

Answer: 1

Question 21

Question: Displacement is a _____ quantity.

1. scalar
2. vector
3. derived
4. linear

Answer: 2

Question 22

Question: km / h^2 is a unit of _____ .

1. velocity
2. speed
3. acceleration
4. distance

Answer: 3

Question 23

Question: The speed-time graph for a particle moving at constant speed is a straight-line _____ to the time axis.

1. parallel
2. perpendicular
3. aligned
4. inclined

Answer: 1

Question 24

Question: When an object moves in a fixed direction with uniform acceleration, the speed-time graph is a _____.

1. parabola
2. straight line
3. ellipse
4. curve

Answer: 2

Question 25

Question: The area under the speed-time graph gives the _____.

1. distance
2. velocity

3. time
4. acceleration

Answer: 1

Question 26

Question: A speed of 90 km/h, expressed in cm s^{-1} is _____.

1. 2.5
2. 2500
3. 300
4. 90

Answer: 2

Question 27

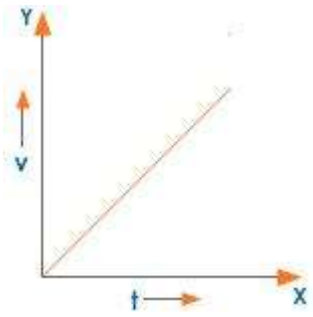
Question: When an object of mass 5 kg starts from rest, what is its initial velocity?

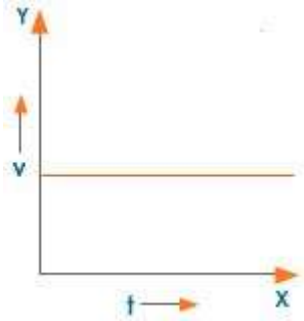
1. 0
2. - 5 m/s
3. variable
   5
4. 1 m/s

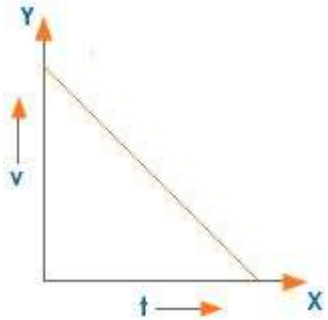
Answer: 1

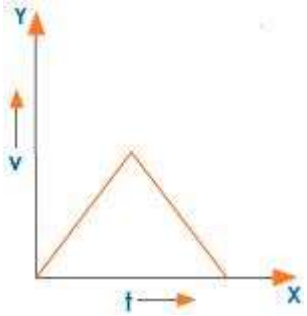
Question 28

Question: Identify the v- t graph representing uniform velocity.

1. 

2. 

3. 

4. 

Answer: 2

Question 29

Question: Name the physical quantity that is defined as the rate of change of displacement.

1. velocity
2. acceleration
3. distance
4. speed

Answer: 1

Question 30

Question: An object moves with a constant velocity of 9.8 m/s, its acceleration in m s^{-2} is _____.

1. 9.8 m/s^2
2. zero
3. 0.98 m/s
4. 98 m/s^2

Answer: 2

Question 31

Question: In 12 minutes a car whose speed is 35 km/h travels a distance of

1. 7 km
2. 3.5 km
3. 14 km
4. 28 km

Answer: 1

Question 32

Question: A body moving along a straight line at 20 m/s undergoes an acceleration of 4 m/s^2. After two seconds its speed will be _____.

1. 8 m/s
2. 12 m/s
3. 16 m/s
4. 28 m/s

Answer: 4

Question 33

Question: A car increases its speed from 20 km/h to 50 km/h in 10 seconds. Its acceleration is _____.

1. 30 m/s^2
2. 3 m/s^2
3. 18 m/s^2
4. 0.83 m/s^2

Answer: 4

Question 34

Question: When the distance covered by an object is directly proportional to time, it is said to travel with _____.

1. zero velocity
2. constant speed
3. constant acceleration
4. uniform acceleration

Answer: 2

Question 35

Question: Negative acceleration means an object is moving with _____ .

1. increasing speed
2. decreasing speed
3. uniform speed
4. constant speed

Answer: 2

Question 36

Question: Motion along a straight line is called _____ motion.

1. rectilinear motion
2. circular motion
3. oscillatory motion
4. parabolic

Answer: 1

Question 37

Question: Distance-time graph is a straight line for _____ motion.

1. variable

2. non uniform
3. rectilinear
4. circular

Answer: 3

Question 38

Question: A car is moving with a speed of 36 km/h. Its speed in m/s is _____.

1. 10
2. 100
3. 2
4. 1

Answer: 1

Question 39

Question: A car starts from rest and covers a distance of 100 m in one second with uniform acceleration. Its acceleration is _____.

1. 100 m/s^2
2. 50 m/s^2
3. 200 m/s^2
4. 100 m/s

Answer: 1

Question 40

Question: Which of the following is a vector quantity?

1. area
2. length
3. distance
4. displacement

Answer: 4

Question 41

Question: The slope of a v-t graph gives _____.

1. acceleration
2. velocity
3. speed
4. distance

Answer: 3

Question 42

Question: The physical quantity describing motion and whose measure is the product of distance travelled and the time taken to travel that distance is _____.

1. speed
2. mass
3. weight
4. displacement

Answer: 1

Question 43

Question: If you are travelling with a velocity of 25 m/s, how long will you take to travel 700 m?

1. 25 s
2. 28 s
3. 25 min
4. 2.8 s

Answer: 2

Question 44

Question: Name the instrument used to measure instantaneous speed of a vehicle.

1. accelerator
2. speedometer
3. ammeter

4. multimeter

Answer: 2

Question 45

Question: A body covers a distance S in time t. What is its speed?

1. S/t
2. t/S
3. S x t
4. Zero

Answer: 1