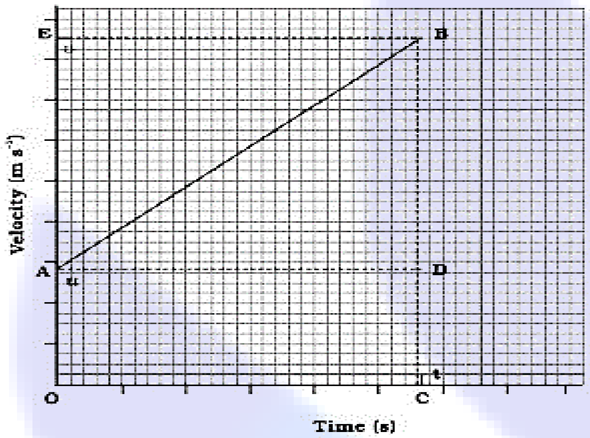
1. Derive $v^2 = u^2 + 2as$ where symbols have their usual meaning.

Ans.



The distance s travelled by the object in time t is given by s = area of the trapezium OABC

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

But OA=u, BC=V and OC=t

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

From velocity – time relation v =u+ at,

We have,

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

Substituting value of time 't' from equation (2) into (1) we get

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

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

2. A scooter initially at rest picks up a velocity of 20 m/s over a distance of 40 m. Calculate acceleration and time in which it attains the velocity of 20 m/s.

Ans. Initial velocity u = 0

Final velocity v = 20 m /s

Distance s = 40 m

Using third equation of motion to obtain acceleration

To obtain time, we use first equation of motion

v = u + at

t = (v - u)/a

t = 20/ 5 = 4 s

3. Derive the first equation of motion.

Ans. Let a body be moving with initial velocity 'u'. After time 't', its velocity becomes 'v' and during this journey, uniform acceleration is 'a.'

We know that, $a = \frac{v - u}{t}$

v = u + at

4. (a) Define the term acceleration.

(b) When is acceleration (i) Positive? (ii) Negative?

(c) State the unit of acceleration in C.G.S. and S.I. systems.

Ans.

(a) Acceleration: The rate of change of velocity (when velocity is increasing), is called acceleration

(b) (i) When the velocity is increasing with time, acceleration is positive.

(ii) When the velocity is decreasing with time, acceleration is negative.

(c) cms^{-2} in C.G.S. system and ms^{-2} in S.I. system are units of acceleration.

5. What is the relation between distance and time, when :

(i) Body is moving with a uniform velocity?

(ii) Body is moving with variable velocity?

Ans. (i) The distance covered by a body is directly proportional to time.

(ii) The distance covered by a body is not directly proportional to time.

6. What do you understand by the terms (i) rest (ii) motion? Support your answer by giving two examples each.

Ans. (i) When a body does not change its position with respect to the surrounding, the body is said to be at rest.

Examples: A lamp post, a table in a room.

(ii) When a body changes its position with respect to the surroundings, the body is said to be in motion.

Examples: Running horse, speeding car.

7. How can you calculate the following?

(i) Velocity from displacement-time graph.

(ii) Acceleration from velocity-time graph.

(iii) Displacement from velocity-time graph.

(iv) Velocity from acceleration-time graph.

Ans. (i) By finding the slope of graph, i.e.

$v = \frac{\Delta S}{\Delta t} \times \frac{\text{Change in displacement}}{\text{Time}}$

(ii) By finding the slope of graph, i.e.

$a = \frac{\Delta v}{\Delta t} \times \frac{\text{Change in velocity}}{\text{Time}}$

(iii) By finding area under the graph line i.e.

$S = \Delta v \times \Delta t = \text{Change in velocity} \times \text{Time}.$

(iv) By finding the area under the graph line, i.e. $V = \Delta a \times \Delta t$

= Change in acceleration × Time.

8. A train starting from rest, picks up a speed of 20 ms^{-1} in 200 s. It continues to move at the same rate for the next 500 s and then brought to rest in another 100 s.

(i) Plot a speed-time graph.

(ii) From the graph calculate:

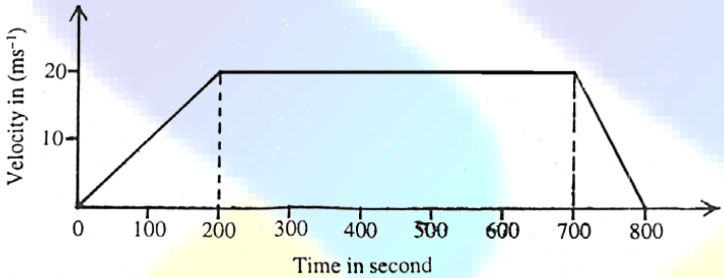
(a) Uniform rate of acceleration

(b) Uniform rate of retardation

(c) Total distance covered before stopping

(d) Average speed.

Ans. (i) The graph is shown below:



$$\text{(ii) (a) Acceleration } = \frac{V_f - V_i}{t} = \frac{(20-0)\ ms^{-1}}{200s} = 0.1\ ms^{-2}.$$

$$\text{(b) De} - \text{acceleration } = \frac{V_f - V_i}{t} = \frac{(20-0)\ ms^{-1}}{100\ s} = -0.2\ ms^{-2}.$$

$$\text{(c) Total distance } = \frac{1}{2}\left(200 \times 20 \times 500 + \frac{1}{2}\ (100 + 20)\right)$$

$$= 2000 + 10000 + 1000 = 13{,}000\ m.$$

$$\text{(d) Average speed } = \frac{13{,}000\ m}{800\ s} = 16.25\ ms^{-1}.$$

9. The table above shows the velocity of a motor bike at various intervals of time.

(i) Plot the velocity-time graph.

(ii) Calculate de-acceleration between 5 s – 7 s.

(iii) Calculate acceleration between 7 s and 10 s.

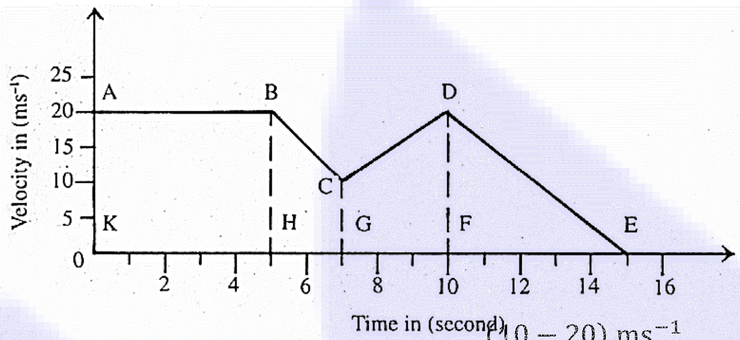
(iv) Calculate de-acceleration between 10 s and 15 s.

(v) Total distance travelled by motor-bike.

(vi) Average velocity of motor bike.

Velocity in (ms^{-1})	20	20	10	20	0
Time in (seconds)	0	5	7	10	15

Ans. (i) The graph is shown below.



(ii) De − acceleration between 5 s – 7 s $= \frac{(10-20)\ ms^{-1}}{2\ s} = -5\ ms^{-2}$.

(iii) Acceleration between 7s − 10s $= \frac{(10-20)\ ms^{-1}}{3s} = 3.33\ ms^{-2}$.

(iv) Deacceleration between 10s15s $= \frac{(0-20)\ ms^{-1}}{5s} = -4\ ms^{-2}$.

(i)Total distance travelled = Area of ABHK + Area of trapezium BCGH + Area of trapezium CGFD + Area of ΔDFE.

$= 20\ ms^{-1} \times \frac{1}{2}\ 5s + (20+10)\ ms^{-1} \times 2s + \frac{1}{2} + (10+20)\ ms^{-1} \times 3s + \frac{1}{2} \times 20\ ms^{-1} \times 5s$

$= 100\ m + 30\ m + 45\ m + 50\ m = 225m.$

(vi) Average velocity of motor bike $= \frac{\text{Total distance}}{\text{Total time}} = \frac{225}{15s} = 15\ ms^{-1}$

10. A spaceship is moving in space with a velocity of 60 kms^{-1}. It fires its retro-engines for 20 s and the velocity is reduced to 55 kms^{-1}. Calculate the distance travelled by spaceship in 40 s, from the time of firing retro-engines.

Ans. Case I:

Time for which ship is de-acceleration = 20 s.

$u = 60\ kms^{-1}; v = 55\ kms^{-1}; t = 20s; a = ?; S = ?$

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

$S = 60 \times 20 + \frac{1}{2} \times (-0.25) \times\times 20 \times 20$

$= 1200 - 50 = 1150\ km.$

Case II:

Time for which ship is moving with uniform velocity of

$55kms^{-1} = (40-20) = 20\ s$

∴ Distance travelled by ship $= 55 \times 20 = 1100\ km$

∴ Total distance travelled by ship $= 1150 + 1100 = 2250\ km$