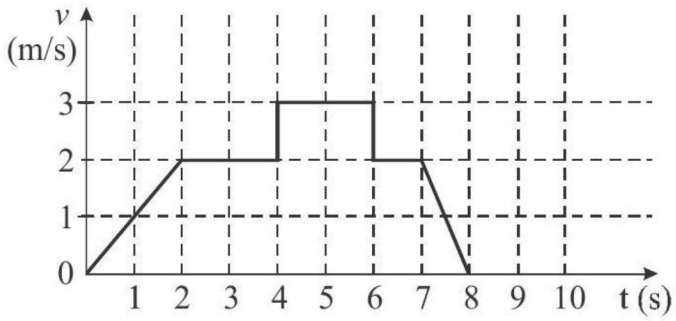
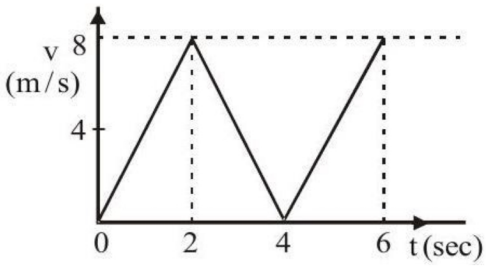
Motion in a Straight Line

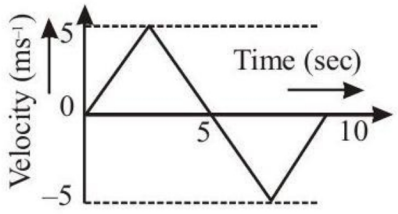
1. A particle starts from the origin at time $t = 0$ and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position (in metre) of the particle at time $\mathrm{t} = 5$ s ?



2. A car travels half the distance with constant velocity of 40 kmph and the remaining half with a constant velocity of 60 kmph. The average velocity of the car (in kmph is)
3. The position of an object moving along x-axis is given by $\mathrm{a} + \mathrm{bt}^2$, where $\mathrm{a} = 8.5$ m and $\mathrm{b} = 2.5\ \mathrm{m/s^2}$ and t is measured in seconds. The average velocity (in $\mathrm{m/s}$) of the object between $\mathrm{t} = 2$ s and $\mathrm{t} = 4$ s is
4. A car moves a distance of 200 m. It covers the first half of the distance at speed 40 km/h and the second half of distance at speed v(km/h). The average speed is 48 km/h. Find the value of v
5. A bus travelling the first one third distance at a speed of 10 km/h, the next one third at 20 km/h and the last one-third at 60 km/h. The average speed (in km/h) of the bus is
6. The $v - \mathrm{t}$ graph for a particle is as shown below. The distance (in metre) travelled in the first four seconds is



7. The $v - t$ plot of a moving object is shown in the figure. The average velocity of the object during the first 10 seconds is



8. A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10 m, its deceleration is

9. A body moves from rest with a constant acceleration of $5\ \mathrm{m/s^2}$. Its instantaneous speed (in $\mathrm{m/s}$) at the end of 10 sec is

10. A bus starts moving with acceleration $2\ \mathrm{m/s^2}$. A cyclist 96 m behind the bus starts moving simultaneously towards the bus at a speed of $20\ \mathrm{m/s}$. After what minimum time will he be able to overtake the bus?

11. The displacement x of a particle at the instant when its velocity is v is given by $\mathrm{v} = \sqrt{3\mathrm{x} + 16}$. Its initial velocity is

12. A body starts from rest, if the ratio of the distance travelled by the body during the 4 th and 3 rd second is $\frac{x}{5}$. Find the value of x.

13. If a ball is thrown vertically upwards with a velocity of $40\ \mathrm{m/s}$, then velocity (in $\mathrm{m/s}$) of the ball after two seconds will be $(\mathrm{g} = 10\ \mathrm{m/s^2})$

14. A stone falls from a balloon that is descending at a uniform rate of $12\ \mathrm{m/s}$. The displacement (in metre) of the stone from the point of release after 10 sec is

15. The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far (in metre) above the ground is the second drop at that instant? (Take $\mathrm{g} = 10\ \mathrm{m/s^2}$)

SOLUTIONS

1. **(9)** Position of the particle,
S = area under graph (time t = 0 to 5s)
$= \frac{1}{2}\times 2\times 2+2\times 2+3\times 1=9\,\text{m}$

2. **(48)** $v_{av} = \frac{2v_1v_2}{v_1+v_2} = \frac{2\times 40\times 60}{100} = 48\,\text{kmph.}$

3. **(15)**

4. **(60)** $48 = \frac{200\times 10^{-3}}{\left(\frac{100\times 10^{-3}}{40}\right)+\left(\frac{100\times 10^{-3}}{v}\right)}$
or $v = 60$ km/h

5. **(18)** Average speed $= \frac{s}{\frac{s/3}{10}+\frac{s/3}{20}+\frac{s/3}{60}} = \frac{s}{s/18} = 18\text{km/h}$

6. **(16)** The distance travelled in the first four seconds
= Area of triangle $= \frac{1}{2}\times 4\times 8 = 16\,\text{m}$

7. **(0)** Since total displacement is zero, hence average velocity is also zero.

8. **(20)** From $v^2 = u^2 + 2as \Rightarrow 0 = u^2 + 2as$
$\Rightarrow a = \frac{-u^2}{2s} = \frac{-(20)^2}{2\times 10} = -20\,\text{m/sec}^2$

9. **(50)** $v = u + at \Rightarrow v = 0 + 5\times 10 = 50$ m/s

10. **(8)** Let after a time t, the cyclist overtake the bus. Then
$96 + \frac{1}{2}\times 2\times t^2 = 20\times t$ or $t^2 - 20t + 96 = 0$
$\therefore t = \frac{20\pm\sqrt{400-4\times 96}}{2\times 1} = 8$ s and 12 sec.

11. **(4)** $v = \sqrt{3x+16} \Rightarrow v^2 = 3x+16$
$\Rightarrow v^2 - 16 = 3x$
Comparing with $v^2 - u^2 = 2ax$, we get, u = 4 units

12. **(7)** $\frac{D_4}{D_3} = \frac{0+\frac{a}{2}(2\times 4-1)}{0+\frac{a}{2}(2\times 3-1)} = \frac{7}{5}$

13. **(20)** Initial velocity (u) = 40 m/s

Acceleration (a) = –g m/s^2 = –10 m/s^2

Time (t) = 2 seconds

By Ist equation of motion,

$v = u + at$

$v = 40 - 10\,(2) = 20$ m/s

14. **(610)** u = 12m/s, g = 9.8 m/sec^2, t = 10 sec

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

$= 12 \times 10 + \frac{1}{2} \times 9.8 \times 100 = 610\text{m}$

15. **(3.75)** Height of tap = 5m and (g) = 10 m/sec^2.

For the first drop,

$5 = \text{ut} + \frac{1}{2}\text{gt}^2 = (0 \times \text{t}) + \frac{1}{2} \times 10\text{t}^2 = 5\text{t}^2$ or $\text{t}^2 = 1$ or $\text{t} = 1$.

It means that the third drop leaves after one second of the first drop. Or, each drop leaves after every 0.5 sec.

Distance covered by the second drop in 0.5 sec

$= \text{ut} + \frac{1}{2}\text{gt}^2 = (0 \times 0.5) + \frac{1}{2} \times 10 \times (0.5)^2 = 1.25\text{m}$.

Therefore, distance of the second drop above the ground = 5 – 1.25 = 3.75 m.