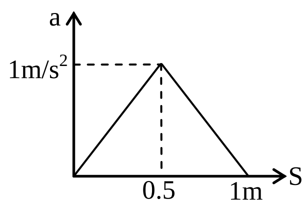
Q.1 A body initially at rest moving along x-axis in such a way so that its acceleraation Vs displacement plot is as shown in figure. What will be the maximum velocity of particle in m/sec.



Sol.[1] vdv = ads

$\Rightarrow \frac{v^2}{2}$ = Area of A-S graph

$\frac{v^2}{2} = \frac{1}{2} \Rightarrow v = 1$ m/sec

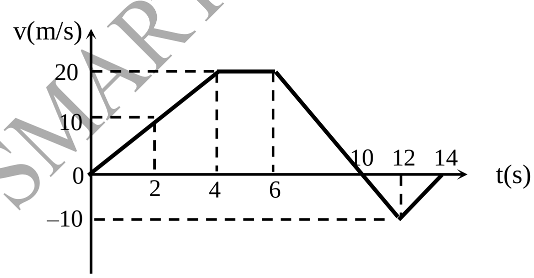
Q.2 A particle moving in a straight line covers half the distance with speed of 3 m/s. The other half of the distance is covered in two equal time intervals with a speeds of 4.5 m/s and 7.5 m/s, respectively. Find the average speed of the particle during this motion.

Sol. **[0004]** $v_{avg} = \frac{2v_0(v_1+v_2)}{2v_0+v_1+v_2}$

$= \frac{2\times3(4.5+7.5)}{6+4.5+7.5} m/s$

$= \frac{6\times12}{18} m/s = 4 m/s$

Q.3 Velocity-time graph of a particle moving in a straight line is shown in figure. In the time interval from t = 0 to t = 14 s, find:

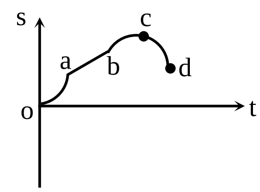


(a) average velocity and

(b) average speed of the particle

Sol. (a) $\left(\frac{50}{7}\right)$m/s **(**b)10 m/

Q.4 Displacement-time graph of a particle moving in a straight line is as shown in figure.



(a) Find the sign of velocity in regions oa, ab, bc and cd

(b) Find the sign of acceleration in the above region

Sol. (a) positive , positive, positive, negative

(b) positive , zero, negative, negative

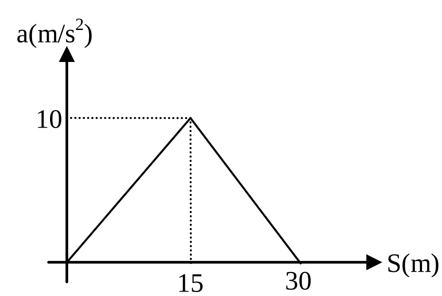
Q. 5 The speed of a motor launch with respect to the water is v = 5 m/s, the speed of stream u = 3 m/s. When the launch began travelled 3.6 km up stream, turned about and caught up with the float. How long is it before the launch reaches the float again ? (Find answer in hour).

Sol.[1] $t = \frac{2\ell}{v-u} = \frac{2\times3600}{2}$

= 3600 sec

= 1 hr.

Q.6 The particle moves with rectilinear motion given the acceleration-displacement (a-S) curve is shown in figure, determine the velocity after the particle has traveled 30 m. If the initial velocity is 10 m/s. **[0020]**



Sol. Area under curve is $= \frac{1}{2} \times 10 \times 30$

= 150 ……..(i)

Area under curve is also equal to $= \frac{v^2-u^2}{2}$ …….(ii)

From (i) and (ii)

$\frac{1}{2}(v^2 - u^2) = 150$

$v^2 = u^2 + 300$

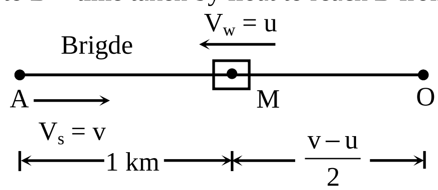
$v^2 = (10)^2 + 300$

$v = \sqrt{400} = 20$m/s.

Q.7 A swimmer jumps from a bridge over a canal and swims 1 km up stream. After that first km, he passes a floating cork. He continues swimming for half an hour and then turns around and swims back to the bridge. The swimmer and the cork reach the bridge at the same time. The swimmer has been swimming at a constant speed. How fast does the water in the canal flow in km/hr.

Sol. Let $V_w = u$ & $U_{sw} = v$

Time taken by swimmer to go from M to O and O to B = time taken by float to reach B from M.



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

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

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

$\Rightarrow$ (2v + 2) u = 2(v + u)

$\Rightarrow$ 2vu + 2u = 2v + 2u

u = 1 km/hr

Q.8 A ball is thrown upwards from the foot of a tower. The ball crosses the top of tower twice after an interval of 4 seconds and the ball reaches ground after 8 seconds, then the height of tower in meters is : ($g = 10$ m/s^2) **[0060]**

Sol. $h = ut - \frac{1}{2}gt^2$

or $gt^2 - 2ut + 2h = 0$

$t_1t_2 = \frac{2h}{g}$ and $t_1 + t_2 = \frac{2u}{g} = T$

$\therefore$ $(t_2 - t_1)^2 = (t_1 + t_2)^2 - 4t_1t_2$

$16 = 64 - 4 \times \frac{2h}{g} \Rightarrow h = 60$ m

Q.9 An insect moves with a constant velocity v from one corner of a room to other corner which is opposite of the first corner along the largest diagonal of room. If the insect can not fly and dimensions of room is $a \times a \times a$, then the minimum time in which the insect can move is $\frac{a}{v}$ times the square root of a number n, then n is equal to ? **[5]**

Sol. $(\Delta S)_{min} = \left(\sqrt{a^2 + \frac{a^2}{4}}\right) \times 2 = \sqrt{5}\,a$

Q.10 A particle is moving on a straight line with constant retardation of 1 m/s^2. what is the average speed of the particle on the last two meters betore it stops(in m/s.) **[1]**

Sol. ΔS in last two sec $= \frac{1}{2} \times 1 \times 4 = 2$m

$\therefore\ v_{av} = \frac{\Delta S}{\Delta t} = 1$ m/s

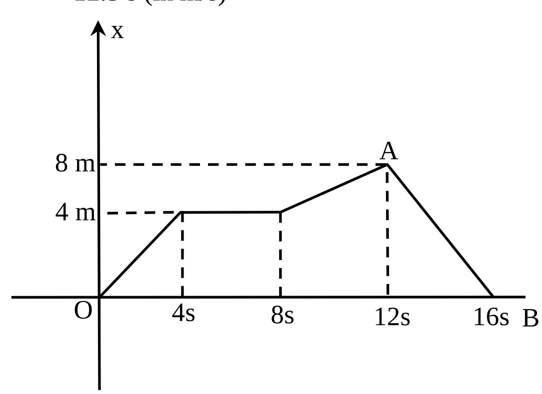
Q.11 A point moves with uniform acceleration and its initial speed and final speed are 2 m/s and 8 m/s respectively then, the space average of velocity over the distance moved is. (in m/s)

[6]

Sol. $[v_{av}]_x = \frac{\int_{x_1}^{x_2} v\,dx}{x_2 - x_1} = \frac{\int_0^x \sqrt{u^2 + 2ax}\,dx}{x}$

Q.12 A body moves with constant acceleration covers 16 m and 24 m in successive intervals of 4 sec and 2 sec. Then its acceleration in m/s^2 is. **[4]**

Q.13 Figure shows the graph of the x-co-ordinate of a particle going along the x-axis as function of time. Find the instantaneous speed of particle at t = 12.5 s (in m/s)



Sol. **[2]**

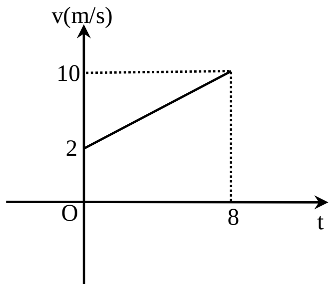
B = 2m/s

Slope of line AB = – 2m/s

Speed of particle at t = 12.5 s

$v = 2m/s$

Q.14 Figure shows the graph of velocity versus time for a particle going along x axis. Initially at t = 0, particle is at x = 3m. Find position of particle at t = 2s. (in m)



Sol. **[9]**

$v = t + 2$

$v_2 = 4$ m/s, at t_2 = s.

$x_2 - x_0 = \frac{1}{2} \times (2 + 4) \times 2$

$= 6m$

$x_2 = 9m$

Q.15 An athlete takes 2s to reach his maximum speed of 36 km/h.What is the magnitude of his average acceleration ? (in m/s)

Sol. **[5]**

5m/s

$< v > = \frac{v_i + v_f}{2}$ (for constant acceleration)

Q.16 A car travelling at 60 km/h over takes another car travelling at 42 km/h. Assuming each car to be 5.0 m long. Find the time taken during the over take. (in sec)

Sol. **[2]**

$s_{A/B} = v_{A/B}\, t + \frac{1}{2} a_{A/B}\, t^2$

Q.17 A police jeep is chasing a culprit going on a motor bike. The motor bike crosses a turning at a speed of 72 km/h. The jeep follows it a speed of 90 km/h crossing the turning ten seconds later than the bike. Assuming that they travel at constant speeds, how far from the turning will the jeep catch up with the bike ? (in km)

Sol. **[1]**

Speed of bike = $72 \times \frac{5}{18} = 20$ m/s

speed of jeep = $90 \times \frac{5}{18} = 25$ m/s.

relative velocity of jeep w. r. t. bike = 25 – 20 = 5 m/s

distance covered by bike in 10s = 20×10

= 200 m.

time taken by Jeep to cover 200 m with velocity 5 m/s.

$t = \frac{200}{5} = 40$ s.

Therefore distance covered by police jeep in40 s

$= 40 \times 25 = 1000$ m

= 1 km.

Q.18 A bullet going with speed 16 m/s enters a concrete wall and penetrates a distance of 0.4 m before coming to rest. Then the time taken during the retardation is

………… $\times 10^{-2}$ s. (in sec)

Sol. **[5]**

$0 = 16^2 - 2a\,s$ ($\because v^2 = u^2 + 2as$)

$a = \frac{16 \times 16}{2 \times 0.4} = 320$ m/s^2

$t = \frac{v}{a} = \frac{16}{320} = 5 \times 10^{-2}$ s

Q.19 A boy standing on a long railroad car throws a ball straight upwards. The car is moving on the horizontal road with an acceleration of 1m/s^2 and projection velocity in the vertical direction is 9.8m/s. How far behind the boy will the ball fall on the car ? (in m)

Sol. **[2]**

Time when velocity of ball is zero

$0 = 9.8 \times gt \Rightarrow t = \frac{9.8}{9.8} = 1s.$

$\therefore$ total time when it comes back = 2s

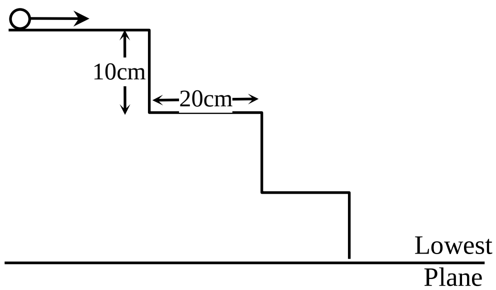
distance travelled by trolley in 2s

$s = \frac{1}{2} at^2 = \frac{1}{2} \times 1 \times 2^2 = 2m.$

ball will fall 2m behind the boy.

Q.20 A Staircase contains three steps each 10 cm high and 20 cm wide. What should be the minimum horizontal velocity of a ball rolling off the uppermost plane so as to hit directly the lowest plane. (in m/s)

Sol. **[2]**



horizontal distance travelled by ball = 3 × 0.2 = 0.6 m.

vertical distance = 3 × 0.1 = 0.3 m.

let velocity along horizontal = v m/s.

velocity along vertical = 0

therefore 0.6 = vt

$$t = \frac{0.6}{v}$$

and $$0.3 = \frac{1}{2}gt^2$$

$$0.3 = \frac{1}{2}g\left(\frac{0.6}{v}\right)^2$$

$$\Rightarrow \quad v^2 = \frac{5\times0.6\times0.6}{0.3}$$

$$v \approx 2.4 \text{ m/s.}$$