8th advanced

WS-8 → S-t, V-t e a-t

Task

1.

From the graph velocity at 0 sec is initial velocity

$u = 7$ m/sec.

we know that Acceleration = $\frac{dv}{dt}$ = $\frac{\text{Change in velocity}}{\text{time}}$

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

$\Rightarrow \frac{0-7}{11-0} = -0.64$ m/s^2

The body is in retardation.

2.

From the Graph acceleration = slope of the graph

$= + \frac{dv}{dt}$

$+ \left[\frac{0-4}{4-0}\right] = \frac{-4}{4} = -1$ m/s^2

3.

From graph Displacement = Area of the graph

$= \frac{1}{\cancel{2}} \times \cancel{4}^{2} \times 20 + \frac{1}{\cancel{2}} \times \cancel{2} \times 20 - \cancel{\frac{1}{2} \times 2 \times 10 + \frac{1}{2} \times 2 \times 10}$

$= 40 + 20 = 60$ m

Distance travelled = Area of graph

$= \frac{1}{\cancel{2}} \times 4 \times \cancel{20}^{10} + \frac{1}{\cancel{2}} \times \cancel{2} \times 20 + \frac{1}{\cancel{2}} \times \cancel{2} \times 10 + \frac{1}{\cancel{2}} \times \cancel{2} \times 10$

$= 4 \times 10 + 20 + 10 + 10$

$= 80$ m

(4)

From graph the maximum velocity = Area of the graph

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

$= \frac{1}{\cancel{2}} \times 11 \times \cancel{10}^{5}$

$= 55$ m/s

(5)

From the graph the height to which elevator takes the Passengers up = Displacement of the elevator

= Area of the graph

$= \frac{1}{\cancel{2}} \times \cancel{2} \times 3.6 + 8 \times 3.6 + \frac{1}{\cancel{2}} \times \cancel{2} \times 3.6$

$\Rightarrow 28.8\text{ m} + 7.2\text{ m}$

$= 36$ m

(6)

From graph velocity = slope of the graph

$\Rightarrow \tan\theta$.

$\therefore \frac{V_1}{V_2} = \frac{\tan\theta_1}{\tan\theta_2}$

$\Rightarrow \frac{V_1}{V_2} = \frac{\tan 30}{\tan 45^\circ}$

$\Rightarrow \frac{V_1}{V_2} = \frac{\frac{1}{\sqrt{3}}}{1}$

$\Rightarrow \frac{V_1}{V_2} = \frac{1}{\sqrt{3}}$

⑦ From the graph speed = slope of the graph

$$= \frac{dy}{dt}.$$

$\therefore$ For $0 \to 2$ sec speed $v_1 = \frac{\text{displacement}}{\text{time}} = \frac{20}{2}$

$= 10$ m/s.

For $2 \to 6$ sec speed $v_2 = \frac{20}{4} = 5$ m/sec

$$\therefore \frac{v_1}{v_2} = \frac{10}{5} = \frac{2}{1}$$

⑧

Given graph represents Projectile motion.
As the body Projected it's velocity ~~increases~~ decreases with respect to time because it is moving against gravity. After reaching maximum height, it's velocity is zero and starts falling in the direction of gravity. so velocity of the body increases gradually and becomes initial velocity at the Point of Projection but direction of velocity is reversed. so option 'c' represents correct v-t graph for given s-t graph

(10) From the graph distance covered = Area of the graph

For 7 sec distance $S_1 = \frac{1}{2} b_1 h_1 + b_2 \times h_2 + \frac{1}{2} b_3 h_3$

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

$= 10 + 20 + 10$

$= 40m$

For 2 sec distance $S_2 = \frac{1}{2} b_1 h_1 = \frac{1}{2} \times 2 \times 10 = 10m$

$\therefore$ Fraction of distance covered by the body in 2 sec out of Total distance covered by the body in 7 sec

$= \frac{S_2}{S_1} = \frac{10}{40} = \frac{1}{4}$

(11)

9

From the graph From $t = 0 \to 6$ sec

slope $m = \frac{dy}{dx} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-0}{6-0} = \frac{5}{6}$

$\Rightarrow m = \frac{\text{acceleration}}{\text{time}} = \frac{5}{6} \Rightarrow a = \frac{5}{6}t$

$\Rightarrow \frac{dv}{dt} = \frac{5}{6}t$

$\Rightarrow dv = \frac{5}{6}t\,dt$

Acceleration $a = \frac{dv}{dt}$
Velocity $v = \frac{ds}{dt}$
$\int x^n dx = \frac{x^{n+1}}{n+1}$

on integrating both sides

$\Rightarrow \int dv = \frac{5}{6}\int t\,dt$

$\Rightarrow v = \frac{5}{6}\left[\frac{t^2}{2}\right] \Rightarrow \frac{5t^2}{12}$

$\Rightarrow \frac{ds}{dt} = \frac{5}{12}t^2$

$\Rightarrow ds = \frac{5}{12}t^2\,dt$

on integrating both sides

$\Rightarrow \int ds = \frac{5}{12}\int t^2\,dt$

$\Rightarrow s = \frac{5}{12}\left(\frac{t^3}{3}\right] = \frac{5}{36}t^3$

Here t is from $0 \to 6$ sec.

$\therefore s = \frac{5}{36}\left[t^3\right]_0^6 \Rightarrow \frac{5}{36}\left[6^3 - 0^3\right]$

$\Rightarrow \frac{5}{\cancel{36}} \times \cancel{6\times6}\times 6$

$\Rightarrow 5\times6$

$s = 30m$

(11)

From graph acceleration = slope of the v-t graph

$$= \frac{dv}{dt} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{10-0}{10-0} = \frac{10}{10} = 1\,m/s^2$$

Here slope is same for any two points

$\therefore$ a = constant.

clearly from graph after 10 sec velocity is -ve ie direction of motion of the body is reversed and

Displacement = Area of v-t graph

$$= \frac{1}{2}b_1h_1 + \frac{1}{2}b_2h_2 + \frac{1}{2}b_3h_3$$

$$= \cancel{\frac{1}{2}\times 10\times 10} + \cancel{\frac{1}{2}\times 10\times(-10)} + \frac{1}{\cancel{2}}(\cancel{20}^{10})(-20)$$

$$= -100\,m$$

<speed> from $0 \to 10$ sec = $\frac{u+v}{2} = \frac{0+10}{2} = 5\,m/s$

From $10 \to 20$ sec = $\frac{0+(-10)}{2} = +5\,m/s$

(or) we can calculate avg speed by using = $\frac{\text{Total distance}}{\text{Total time}}$

From $0 \to 10$ sec <speed> = $\frac{\frac{1}{2}\times b\times h}{10} = \frac{\frac{1}{2}\times 10\times 10}{10} = 5\,m/s$

From $10 \to 20$ <speed> = $\frac{\text{Total distance}}{\text{Total time}} = \frac{\frac{1}{2}\times 10\times 10}{10} = 5\,m/s$

so $\boxed{a \,\&\, d}$ are correct.

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(15)

we know that Acceleration $= \frac{dv}{dt}$

$$\therefore a = \frac{dv}{dx} \times \frac{dx}{dt}$$

$$\Rightarrow \frac{dv}{dx} [v] \qquad \left[\because \text{velocity} = \frac{dx}{dt}\right]$$

$$\Rightarrow a = v\frac{dv}{dx} = v \times \text{slope of the graph}$$

From graph $0 \to 100m$ slope of the graph $\frac{dv}{dx} = +ve$

so $a \Rightarrow +ve$

From $100-200m$ slope of the graph $\frac{dv}{dx} = -ve$

so $a = -ve$.

option 'c' represents correct Ans

(16)

From graph velocity = slope of the graph $= \frac{dy}{dt} = \frac{y_2 - y_1}{t_2 - t_1}$

(i) From $A \to E$ velocity $= \frac{10-0}{10-0} = \frac{10}{10} = 1 \text{ cm/s}$

(ii) From $B \to E$ velocity $= \frac{10-4}{10-3} = \frac{6}{7} = 0.86 \text{ cm/s}$

(iii) From $C \to E$ velocity $= \frac{10-12}{10-5} = -\frac{2}{5} = -0.4 \text{ m/s}$

(17) From $D \to E$ velocity $= \frac{10-12}{10-8} = \frac{-2}{2} = -1 \text{ m/s}$

(18) From $C \to D$ velocity = 0 Because Both C & D are at same position $\Rightarrow$ displacement $= y_2 - y_1$
$= 0$

LTask

CUQ's

① From graph velocity = slope of the graph = $\frac{dx}{dt}$

Acceleration = $\frac{dv}{dt} = \frac{dv}{dx} \times \frac{dx}{dt}$

$a = \frac{dv}{dx} \times$ slope of the graph

From 1 → 3 sec, the slope $\frac{dx}{dt}$ is −ve.

∴ $a = -ve$ that is the body is retarded.

After 3 sec the displacement is maintained constantly

ie) dx = change in displacement = 0

$\frac{dx}{dt} = 0$

∴ $V = 0$; $a = 0$ the body is stopped.

② From the t-s graph

Initially at $t = 0$ sec, the position of the body is at 0

After 't' sec the body is at 'D' whose position = 0.

∴ displacement of the body = Final position − Initial position

$= 0 - 0$

$= 0$

∴ <velocity> = $\frac{\text{Total displacement}}{\text{Total time}} = \frac{0}{t} = 0$

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(3)

when a ball thrown vertically upwards, it's velocity decreases with respect time because the ball is moving against gravity. After reaching maximum height the ball starts falling in a direction opposite to it's motion initially, so it's velocity increases gradually and becomes equal to it's original velocity of projection as it reaches point of projection.

'D' represents the velocity of ball with respect to time.

(4)

we know that Acceleration $= \frac{dv}{dt}$

$$= \frac{dv}{dx} \times \frac{dx}{dt}$$

$$a = \frac{dv}{dx} \times \text{slope of the graph}$$

From OA $\rightarrow \frac{dx}{dt} = -ve \Rightarrow a = -ve$

AB $\rightarrow \frac{dx}{dt} = 0 \Rightarrow a = 0 \quad [dx = x_2 - x_1 = 0]$

BC $\rightarrow \frac{dx}{dt} = +ve. \Rightarrow a = +ve.$

CD $\rightarrow \frac{dx}{dt} = +ve \Rightarrow a = +ve.$

(5)

From graph velocity (or) speed = slope of the graph $= \frac{dx}{dt}$

up to 't' sec slope $= \frac{dx}{dt} = +ve.$ and is constant because the graph is straightline passing through origin.

After 't' sec $dx = 0 \Rightarrow$ slope $= \frac{dx}{dt} = 0$

(6)

From the graph velocity = slope of the graph

$$= \frac{dx}{dt}$$

At 't' slope $\frac{dx}{dt}$ = $-ve$ $\therefore$ velocity = $-ve$.

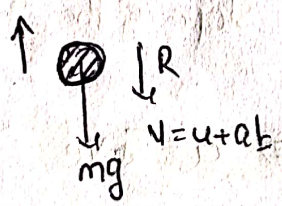
(8) If any body is in uniform motion it's velocity = constant

i.e. the body covers equal distances in equal intervals of time

so the s-t graph is a straight line passing through origin.

(10) Take same ans from 8th question

(9) correct option → c.



where 'R' is air resistance.

For upward motion

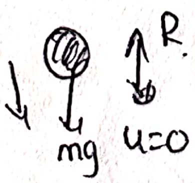
$\therefore$ $F_{net} = -(mg + R)$

$\Rightarrow ma = -[mg+R]$

$\Rightarrow a = -\left[\frac{mg+R}{m}\right]$ = slope is $-ve$.

$\therefore V = u - \left[\frac{mg+R}{m}\right]t$

For downward motion



$F_{net} = mg - R$

$\Rightarrow ma = mg - R$

$a = \frac{mg-R}{m}$ = slope is $+ve$.

$\therefore V = u + at$

$V = 0 + \left(\frac{mg-R}{m}\right)t$

$V = \left(\frac{mg-R}{m}\right)t$

From s-t graph

acceleration = slope of graph

$$= \frac{dv}{dt}$$

SAQ's

1

Between 20s to 40s, there is non-zero acceleration and retardation.

Hence distance travelled during this interval

$= \text{Area between } 20 \to 40 \text{ sec}$

$= \frac{1}{2} \times b_1 \times h_1 + \frac{1}{2} b_2 h_2 + b_3 h_3$

$= \frac{1}{2} \times 10 \times 3 + \frac{1}{2} \times 10 \times 3 + 20 \times 1$

$\Rightarrow 30 + 20 = 50m$

2

slope $\frac{dv}{dx} = \frac{30-10}{10-0} = \frac{20}{10} = 2$

$\Rightarrow dv = 2\,dx$

on integrating both sides

$\Rightarrow \int_{10}^{v} dv = \int_{0}^{1} 2\,dx$

$\Rightarrow [v]_{10}^{v} = 2[x]_0^1$

$\Rightarrow v - 10 = 2(1 - \cancel{0})$

$\Rightarrow v - 10 = 2 \Rightarrow v = 12\,m/s$

Acceleration $a = \frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt} = v\frac{dv}{dx}$

$a = 12 \times 2 = 24\ m/s^2$

(3)

slope of the graph $m = -\left[\frac{2000-1500}{100-50}\right] = -10$

$\therefore$ equation of line $y = mx + c$

$\Rightarrow v^2 = -10s + c$.

on differentiating both sides w.r.t time

$\Rightarrow \frac{d}{dt}[v^2] = -10\frac{d}{dt}s + \frac{d}{dt}c$

$\Rightarrow 2v\frac{dv}{dt} = -10v + 0$ $\quad [\frac{d}{dt}\text{ constant} = 0]$

$\Rightarrow \cancel{2}\cancel{v}(a) = -\overset{5}{\cancel{10}}\cancel{v}$ $\quad [\frac{dv}{dt} = \text{acceleration}]$

$\Rightarrow a = -5\ m/s^2$

Initially s = displacement $= 0$ there velocity $v^2 = 2500$

this will act as initial velocity $u^2 = 2500$

$\Rightarrow u = 50\ m/s$

From $v = u + at$ for entire motion

$\Rightarrow 0 = 50 - 5t \Rightarrow t = \frac{50}{5} = 10$ sec.

In the last '2' sec Displacement $= S_{10s} - S_{8s}$

use $s = ut + \frac{1}{2}at^2$ for both cases

$S = (50)(10) + \frac{1}{2}(-5)(10)^2 - [50\times 8 + \frac{1}{2}(-5)(8)^2]$

$= 500 - 250 - 400 + 160 \Rightarrow 660 - 650$

$= 10m$

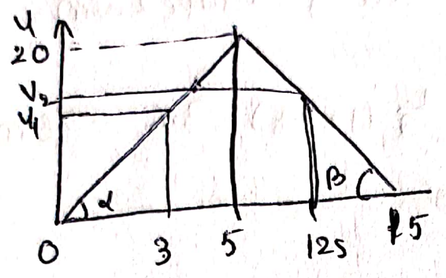
(4)

slope of v-t graph gives acceleration

$\therefore a = \frac{dv}{dt} \Rightarrow \tan\alpha = \frac{dv}{dt} = \frac{20}{5} = 4.$

Area of v-t graph gives displacement

Area = displacement $= \frac{1}{2} \times b_1 \times h_1 + \frac{1}{2} b_2 h_2$



From here $\tan\alpha$ also $= \frac{v_1}{3}$

$\Rightarrow \tan\alpha = \frac{v_1}{3}$

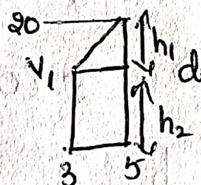
$\Rightarrow 4 = \frac{v_1}{3} \Rightarrow v_1 = 12\ m/s$

$\tan\beta = \frac{dv}{dt} = \frac{20}{15-5} = \frac{20}{10} = 2$

also $\tan\beta = \frac{v_2}{15-12} \Rightarrow 2 = \frac{v_2}{15-12} \Rightarrow 2 = \frac{v_2}{3} \Rightarrow v_2 = 6\ m/s$

From 3 sec → 5 sec

$v_1 = 12\ m/sec.$



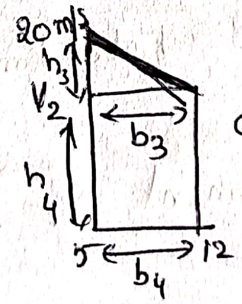
displacement $s_1 = \frac{1}{2} b_1 h_1 + b_2 h_2$

$= \frac{1}{2} \times 2 \times 8 + 2 \times 12$

$= 8 + 24 = 32\ m$

From 5 sec → 12 sec

$v_2 = 6\ m/s$



displacement $s_2 = \frac{1}{2} b_3 h_3 + h_4 \times b_4$

$= \frac{1}{2} \times \cancel{14}^{7} \times 7 + 6 \times 7$

$= 7 \times 7 + 42$

$= 49 + 42 = 91$

$\therefore$ Total displacement $= s_1 + s_2 = 32 + 91 = 123\ m$

(5)

Displacement of elevator from the starting Point to where velocity becomes 0 gives us the height of the elevator

$\Rightarrow$ Height = Area under v-t graph from $0 \to 12$ sec.

= Area of trapezium

$= \frac{1}{2}(12+8) \times 3.6 = 36 \text{ m}$

(6)

From graph area gives displacement

$\therefore$ Displacement $= \frac{1}{2} b \times h$

For OAC

$S_1 = \frac{1}{2} \times OA \times OA \times \tan 60$ [$h = OA \tan 60$]

$S_1 = \frac{1}{2}(OA)^2 \tan 60$ (or) $S_1 = \frac{1}{2} \times \frac{h}{\tan 60} \times h$

time $\to$ OA $\Rightarrow \frac{h}{\tan 60}$

$\therefore$ $\langle velocity \rangle = \frac{\text{Total distance}}{\text{total time}} = \frac{\frac{1}{2} \times \frac{\cancel{h}}{\cancel{\tan 60}} \times h}{\frac{\cancel{h}}{\cancel{\tan 60}}} = \frac{h}{2}$

For ACB

Displacement $S_2 = \frac{1}{2} \times b \times h = \frac{1}{2}(AB) \times h$

$$\boxed{\tan 30 = \frac{h}{AB} \Rightarrow AB = \frac{h}{\tan 30}}$$

$= \frac{1}{2} \frac{h}{\tan 30} \times h$

time AB $= \frac{h}{\tan 30}$

$\langle velocity \rangle = \frac{\text{Total displacement}}{\text{Total time}} = \frac{\frac{1}{2} \times \frac{\cancel{h}}{\cancel{\tan 30}} \times h}{\frac{\cancel{h}}{\cancel{\tan 30}}} = \frac{h}{2}$

$\therefore$ From OA & AB $\langle velocities \rangle$ are same $= 1:1 = 1$.

⑦

Given Particle starts from rest $u=0$

Area of a-t graph gives change in velocity

From $0 \rightarrow 2$ sec change in velocity = Area of a-t graph

$$\Rightarrow V_2 - u = (-10) \times 2 = -20 \text{ m/s}$$

$$\Rightarrow V_2 = -20 \text{ [velocity is in -ve direction]}$$

so the body is speeding up from $0 \rightarrow 2$ sec.

From $2 \rightarrow 4$ sec. change in velocity $V_4 - V_2 = 10 \times 2$

$$\Rightarrow V_4 - V_2 = 20$$

$$\Rightarrow V_4 = 20 + V_2 = 20 - 20 = 0 \text{ m/s}$$

so the body speeding down from $2 \rightarrow 4$ sec. So the body have maximum velocity at $t = 2$ sec.

⑧

Area under acceleration-time graph gives

$$\text{change in velocity} = \frac{1}{2} b_1 h_1 + b_2 h_2 + \frac{1}{2} b_3 h_3 - \frac{1}{2} b_4 h_4$$

$$= \frac{1}{\cancel{2}} \cancel{4}^{2} \times 4 + 6 \times 4 + \frac{1}{\cancel{2}} \times \cancel{2} \times 4 - \frac{1}{\cancel{2}} \cancel{2} \times 2$$

$$= 8 + 24 + 4 - 2$$

$$\Rightarrow 36 - 2$$

$$= 34 \text{ m/sec}$$

As initial velocity is zero, the velocity at 14 sec is 34 m/s

⑨

Distance = Area under v-t graph from 0→7 sec

$= \frac{1}{2} \times b_1 h_1 + b_2 h_2 + \frac{1}{2} b_3 h_3 + \frac{1}{2} b_4 h_4 + \frac{1}{2} b_5 h_5$ $\cancel{+\frac{1}{2} b_6 h_6}$

$= \frac{1}{\cancel{2}} \times \cancel{2} \times 4 + 1 \times 4 + \frac{1}{\cancel{2}} \times 1 \times \overset{2}{\cancel{4}} + \frac{1}{2} \times 1 \times (+4) + \frac{1}{2} \times 2 \times (+4)$ $\cancel{+\frac{1}{2} 1 \times 2}$

$= \cancel{4 + 4 + 2 + 2 + 4 + 1}$

$= 4 + 4 + 2 + 2 + 4$

$= 16m$

⑩

Displacement = Area under v-t graph from 0→6 sec.

$= b_1 \times h_1 + b_2 h_2 + b_3 h_3$

$= 2 \times 4 + 2 \times (-2) + 2 \times 2$

$= 8 - 4 + 4 = 8 m.$

Distance = Area under v-t graph from 0→6 sec.

$= b_1 h_1 + b_2 h_2 + b_3 h_3$

$= 2 \times 4 + 2 \times 2 + 2 \times 2$

$= 8 + 4 + 4$

$= 16m.$

(11)

From the graph

Displacement = Area under v-t graph from 2→4 sec

$= b \times h$

$= 8 \times 2 = 16m$

Acceleration at 2 sec = slope of the graph.

$= \frac{dy}{dt} = \frac{8-0}{2-0} = \frac{8}{2} = 4 m/s^2$

Total distance travelled = Area of v-t graph

$= \frac{1}{2} b_1 h_1 + b_2 h_2 + \frac{1}{2} b_3 h_3$

$= \frac{1}{2} \times 2 \times 8 + 2 \times 8 + \frac{1}{\cancel{2}} \times 3 \times \cancel{8}\,4$

$= 8 + 16 + 12 = 36 m.$

$\langle velocity \rangle = \frac{\text{Total displacement}}{\text{Total time}} = \frac{36}{7} m/s$

(17)

From graph velocity = slope of d-t graph

$= \tan \theta$

$\Rightarrow V = \tan 60$

$\Rightarrow V = \sqrt{3}$

$\Rightarrow V = 1.732 m/s$

(16)

From the graph displacement = Area of v-t graph

$$= \frac{1}{2} b_1 h_1 + \frac{1}{2} b_2 h_2 + b_3 h_3 + \frac{1}{2} b_4 h_4 + \frac{1}{2} b_5 h_5 + \frac{1}{2} b_6 h_6 + \frac{1}{2} b_7 h_7$$

$$= \frac{1}{2}(-5)(2.5) + \frac{1}{2}(2.5)(5) + 2.5 \times 5 + \frac{1}{2} \times 2.5 \times 10 + 2.5 \times 15 + \frac{1}{2} \times 2.5 \times 15 - \frac{1}{2} \times 5 \times 2.5$$

$\Rightarrow$ $81.25 - 6.25$

$\Rightarrow$ $\underline{\underline{75 \text{ m}}}$

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