ASSIGNMENT - 2

MOTION IN 1D

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Section : E

QUESTION : 01

An automobile travels on a straight road for 40 km/h. It then continues in the same direction for another 40 Km at 60 Km/h (a) what is the average velocity of the car during the full 80 Km trip? (b) what is the average speed? (c) Graph x versus t.

Data:

$d_1 = 40$ Km $d_2 = 40$ Km

$S_1 = 30$ km/h $S_2 = 60$ Km/h

$V_{avg} = ?$ $S_{avg} = ?$

Graph x vs t?

Formula:

(i) $S = \frac{\text{distance}}{\text{time}}$ (ii) $V_{avg} = \frac{\Delta x}{\Delta t}$

(iii) $S_{avg} = \frac{\text{total distance}}{\text{total time}}$

Calculation :

$$S_1 = \frac{d_1}{t_1}$$

For t_1 ;

$$t_1 = \frac{d_1}{S_1} = \frac{40}{30}$$

$$\boxed{t_1 = 1.33\ h}$$

For t_2 ;

$$t_2 = \frac{40}{60} \boxed{= 0.67\ h}$$

For V_{avg} ;

$$V_{avg} = \frac{\Delta d}{\Delta t} \quad - eq\ (i)$$

For Δd ;

$$d = d_1 + d_2$$

$$d = 40 + 40$$

$$\boxed{d = 80\ Km}$$

For Δt ;

$$t = t_1 + t_2$$

$$t = 1.33 + 0.67$$

$$\boxed{t = 2\ h}$$

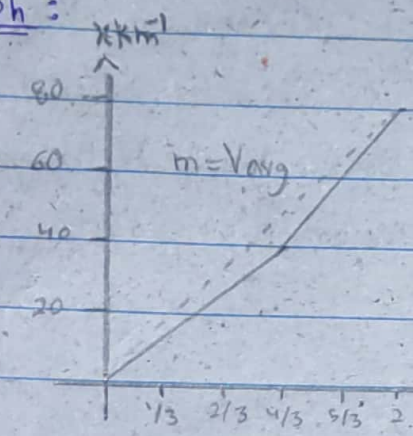
$$eq(i) \Rightarrow V_{avg} = \frac{80}{2} \boxed{= 40\ Km/h}$$

Finding S_{avg} ;

$$S_{avg} = \frac{\text{total distance}}{\text{total time}} = \frac{80}{2}$$

$$\boxed{S_{avg} = 40\ Km/h}$$

Graph :



* Average velocity can be calculated using slope of the st. line connecting 1st & last pt. on graph

QUESTION :02

A car starts from rest and accelerates uniformly to a speed of 25 m/s in 8 sec. (a) Acceleration? (b) How far in 8 sec?

Data :

$V_i = 0$ $\quad V_f = 25$ m/s

$t = 8$ sec $\quad a = ?$, $d = ?$

Formula :

(i) $V = u + at$ $\quad$ (ii) $x = v_i t + \frac{1}{2} a t^2$

Calculation :

$V = u + at$

$a = \frac{v-u}{t} = \frac{25-0}{8}$ $\boxed{= 3.125 \text{ m/s}^2}$

$x = v_i t + \frac{1}{2} a t^2 \Rightarrow x = \frac{1}{2}(3.125)(8)^2$

$\boxed{x = 100 \text{ m}}$

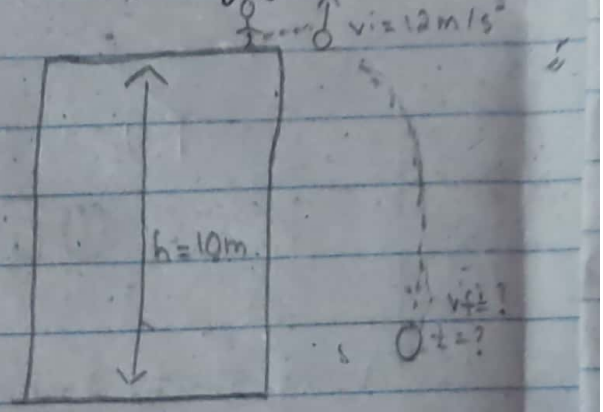
Result :

(a) acceleration = 3.125 m/sec²

(b) distance = 100 m.

QUESTION: 03

A boy stands on the edge of a building 10m above the ground and throws ball upward with an initial velocity of 12m/s. It misses the roof on the way down and falls to the ground. Find how long the ball was in the air and it's velocity just before it strikes the ground.



Data:

$v_i = 12\ m/s$

$s = -10\ m$

$v_f = v_i + gt$

$s = v_i t + \frac{1}{2} a t^2$

UPWARD MOTION:

$v_f = v_i + gt$

$v_f = 12 + (-9.8)t \quad \text{--- (i)}$

$t = 1.22\ s$

So, $s = v_i t + \left(\frac{1}{2} g t^2\right)$

$-10 = 12t - \frac{1}{2}(9.8)t^2$

$4.905t^2 - 12t - 10 = 0$

Applying Quadratic Formula:

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$t = 3.1 \text{ sec}$, $t = -0.1 \text{ s}$

(time can't be negative)

eq (i) $\Rightarrow$ $v_f = 12 + (-9.8)\, t$

$v_f = 12 - 9.8\,(3.1)$

$$\boxed{v_f = -18.4 \text{ m/sec}}$$

QUESTION : 04

At a certain time a particle had a speed of 18 m/s in the positive x direction. and 2.4s later it's speed was 30 m/s in the opposite direction. What is the average acceleration of the particle during this 2.4s interval?

Data:

$v_i = 18\ m/s$

$t = 2.4\ sec$ $\qquad a_{avg} = ?$

$v_f = 30\ m/s$

Formula:

$$a_{avg} = \frac{\text{Change in Velocity}}{\text{time taken}}$$

Calculation:

$$a_{avg} = \frac{-30 - 18}{2.4}$$

$$a_{avg} = \frac{-48}{2.4}$$

$$\boxed{a_{avg} = -20\ m/s^2}$$

QUESTION : 05

A car moving with constant acceleration covers a distance of 50 m between two points in 5 sec. It's velocity as it passes the 2nd point is 16 m/sec. (a) What is it's acceleration? (b) what was it's velocity as it passed the first point?

Data :

$x = 50\,m$, $a = ?$

$t = 5\,sec$, $v_i = ?$

$v_f = 16\,m/sec$

Formula :

$$v = u + at$$

$$2as = v_f^2 - v_i^2$$

Calculation :

$$16 = v_i + a(5) \Rightarrow v_i = 16 - 5a \quad -(i)$$

$$2a(50) = (16)^2 - v_i^2$$

$$120a = 256 - v_i^2$$

put eq (i)

$$120a = 256 - (16 - 5a)^2$$

$$120a = 256 - [256 - 160a + 25a^2]$$

$$120a = 256 - 256 + 160a - 25a^2$$

$$-25a^2 + 160a - 120a = 0$$

$$-25a^2 + 40a = 0$$

$$-5a(5a - 8) = 0$$

$$5a - 8 = 0$$

$$\boxed{a = +\frac{8}{5}\ m/sec^2}$$

For v_i ;

eq (i) $\Rightarrow$ $v_i = 16 - 5a$

$v_i = 16 - 5\left(\frac{8}{5}\right)$

$$\boxed{v_i = 8\ m/sec}$$

QUESTION: 06

A ball thrown straight up takes 2.25 sec to reach a height of 36.8 m (a) what was it's initial speed? (b) what is it's speed at this height? (c) How much higher will the ball go?

Data:

$t = 2.25$ sec $\quad V_i = ?$

$h = 36.8$ m $\quad V_f = ?$

total $h = ?$

Formula:

$$v_f = v_i + at \Rightarrow a = g$$

$$h = v_i t - \frac{1}{2} g t^2$$

$$2as = v_f^2 - v_i^2$$

Calculation:

Calculation:

a)

$$s = v_i t - \frac{1}{2} g t^2$$

$$36.8 = (2.25) v_i - 0.5 (9.8)(2.25)^2$$

$$\boxed{v_i = 27.4 \text{ m/s}}$$

b)

$$v_f = v_i + at$$

$$v_f = 27.4 - 9.8 (2.25)$$

$$\boxed{v_f = 5.3 \text{ m/s}}$$

c)

$$2as = v_f^2 - v_i^2$$

$$2(-9.8)(s) = (0)^2 - (5.3)^2$$

$$\boxed{s = 1.4 \text{ m}}$$

QUESTION: 07

A particle moves along the x-axis according to the equation;

$$x = 21t + 5t^2$$

(a) the average velocity of particle during first 3sec.

(b) the instantaneous velocity of particle at t=3sec.

(c) the instantaneous acceleration of particle at t=3sec.

Data:

$$X = 21t + 5t^2$$

Formula:

$$\frac{dx}{dt}\left[\text{derivative w.r.t } 't'\right]$$

Calculation:

a)

$$V_{avg} = \frac{x(t_3) - x(t_0)}{t}$$

$$V_{avg} = \frac{21(3) + 5(3)^2 - 21(0) - 5(0)^2}{3}$$

$$\boxed{V_{avg} = 36\ m/s}$$

b) For instantaneous velocity:

$$X = 21 + 10t \quad \text{--- (i)}$$

put $t = 3$

$$V_{int} = 21 + 10(3)$$

$$V_{int} = 51 \text{ m/s}$$

c) For instantaneous acceleration :

$$x' = 21 + 10t \quad \text{— (i)}$$

Again derivative O.B.S w.r.t 't'

$$\boxed{x = 10} \ m/s^2$$

a) instantaneous velocity at $t=3$ = 51 m/s.
b) average velocity during first 3sec = 10 m/s.
c) instantaneous acceleration at $t=3$ = 10 m/s^2.

QUESTION: 08

A particle rotates counterclockwise in a circle of radius 5m with a constant angular speed of 12rad/s. At $t=0$, the particle has an x co-ordinate of 1.5m & is moving to the right (a) Determine x coordinate as a function of time. Find the x component of particle's velocity & acceleration at any time t.

Data:

$$r = 5\,m$$
$$w = 12\ rad/s$$
$$t = 0 \quad , \quad x = 1.5\,m$$

Formula:

$$V = r\,w$$
$$a = \frac{v^2}{r}$$

$$V = \gamma w$$

$$V = 5 \times 12$$

$$\boxed{V = 60 \text{ m/s}}$$

$$a = \frac{v^2}{\gamma} = \frac{(60)^2}{5}$$

$$\boxed{a = 720 \text{ m/s}^2}$$

$$V_x = 60 \sin\theta \text{ m/s}$$

$$x = \int 60 \sin\theta \, dt$$

$$\boxed{x = 60 \sin(\theta) t + c}$$

at $t = 0$, $x = 1.5'$

$$c = 1.5$$

$$\boxed{x = 60 \sin(\theta) t + 1.5}$$