Applied Physics Assignment 01

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Section: CY-A

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Q1) Data :-

$x_1 = 40$ Km
$v_1 = 30$ Km/h
$x_2 = 40$ Km
$v_2 = 80$ Km/h
(a) Average velocity = $\vec{V}_{avg}$ = ??
(b) Average speed = V = ?
(c) x - t graph

Sol :-

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

$t = \frac{x_1 + x_2}{v_1 + v_2}$

$= \frac{40 + 40}{}$

$t_1 = \frac{x_1}{v_1} = \frac{4}{3}$ h

$t_2 = \frac{x_2}{v_2} = \frac{2}{3}$ h

$t = t_1 + t_2$

$t = \frac{4}{3} + \frac{2}{3}$

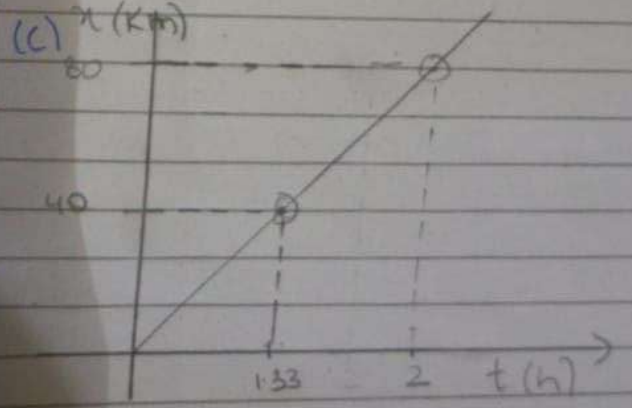
$t = \frac{6}{3}$

$t = 2$ h

(a) $V_{avg} = \frac{x_1 + x_2}{t} = \frac{80}{2} = 40$ Km/h

(b) $V = \frac{\text{Total distance}}{t} = \frac{80}{2} = 40$ Km/h

(c)



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s, v_f, t → given
v_i, a → find

Q2) V = 30 m/s
(a) time to reach maximum height = ?
(b) total time of flight = ?

(a) $v_f = v_i + gt$
$0 = 30 + (-9.8)(t)$
$9.8t = 30$
$t = 30/9.8$
$\boxed{t = 3.06\,s}$

(b) Total time = $2t = 2(3.06) = 6.12\,s$

Q3) Data :-
The car has constant acceleration.
$s = 50\,m$ (distance b/w two points)
$t = 5\,s$
After passing the second point, $v_f = 16$ m/s
(a) acceleration (a) = ?
(b) velocity as it passed the first point = ? = v_i

Sol :- (b) $v_{avg} = \frac{s}{t} = \frac{50}{5} = 10$ m/s

$v_{avg} = \frac{v_i + v_f}{2} \Rightarrow 10 = \frac{v_i + 16}{2}$

$20 = v_i + 16 \Rightarrow \boxed{v_i = 4\ m/s}$

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(a) $a = \frac{v_f - v_i}{t} = \frac{16 - 4}{5} = \frac{12}{5}$

$$\boxed{a = 2.4 \text{ m/s}^2}$$

(Q4)

Data:-

$x = 3t - 4t^2 + t^3$

Sol:-

(a) $t = 1s$

$x = 3(1) - 4(1)^2 + (1)^3$

$x = 3 - 4 + 1.$

$\boxed{x_1 = 0\,m}$

(b) $t = 2s$

$x = 3(2) - 4(2)^2 + (2)^3$

$x = 6 - 16 + 8$

$\boxed{x_2 = -2\,m}$

(c) $t = 3s$

$x = 3(3) - 4(3)^2 + (3)^3$

$x = 9 - 36 + 27$

$\boxed{x_3 = 0\,m}$

(d) $t = 4s$

$x = 3(4) - 4(4)^2 + (4)^3$

$x = 12 - 64 + 64$

$\boxed{x_4 = 12\,m}$

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(e) displacement b/w $t = 0s$ and $t = 4s$

$$X = X_4 - X_0$$
$$X = 12 - 0$$
$$\boxed{X = 12\ m}$$

(f) $V_2 = \frac{X_2}{t} = \frac{2}{2} = 1\ m/s$

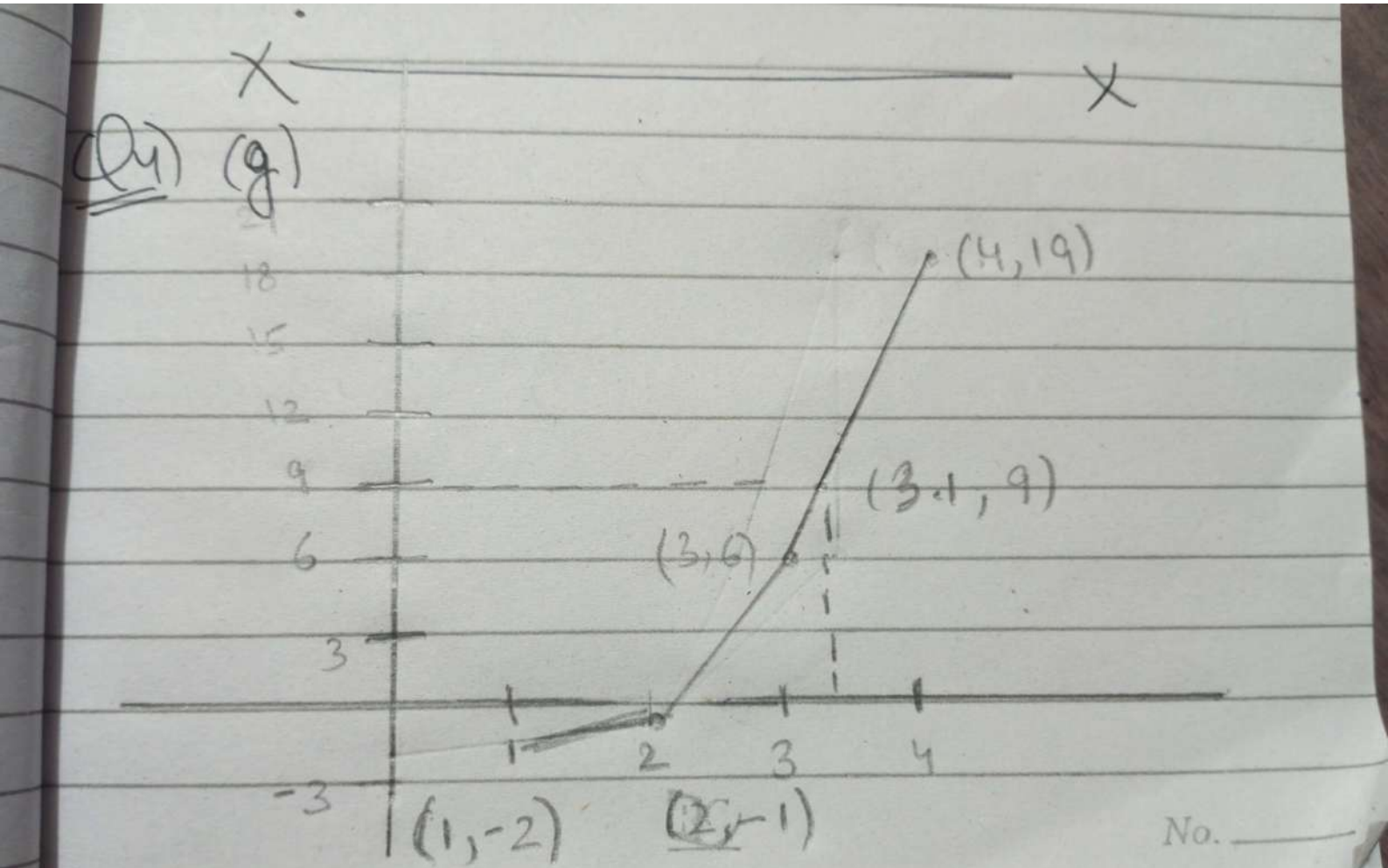
$V_4 = \frac{X_4}{t} = \frac{12}{4} = 3$ m/s

$V_{avg} = \frac{V_4 + V_2}{2} = \frac{1 + 7.25}{2} = 4.125\ m/s$

(f) $V_{avg} = \frac{(X_4 - X_2)}{(t_4 - t_2)} = \frac{12 - (-2)}{4 - 2}$

$$\boxed{V_{avg} = \frac{12 + 2}{2} = \frac{14}{2} = 7\ m/s}$$

(g) graph



(24) (9)

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Qs) Data:-

$x = 21t + 5t^2$

(b) $v = \frac{dx}{dt}(21t + 5t^2)$

$v = 21 + 10t$

v at $t = 3 = 21 + 10(3)$

v at $t = 3 = 21 + 30$

v at $t = 3 = 51$ m/s

(c) $a = \frac{dv}{dt}(21 + 10t)$

$a = 0 + 10$

$a = 10$ m/s^2

(a) For average velocity.

$\Delta v = \frac{\Delta x}{\Delta t}$.

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Let $t_1 = 0s$ and $t_2 = 3s$

$\Delta t = t_2 - t_1$

$\Delta t = 3 - 0$

$\boxed{\Delta t = 3s}$

$\Delta x = x(t_2) - x(t_1)$

$\Delta x = [21(3) + 5(3)^2] - [21(0) + 5(0)^2]$

$\Delta x = [63 + 45] - 0$

$\boxed{\Delta x = 108\ m}$

$$\boxed{\Delta v = \frac{\Delta x}{\Delta t} = \frac{108}{3} = 36\ m/s}$$

X

X

26) Data:-

$r = 5m$

$\omega = 12\ rad/s$

at $t = 0$

$x = 1.5m$

axis.

(Q 6) Data :-

radius = 5m

Angular speed = 12 rad/s

X_0 at $t = 0$

$fx(t) = ?$

Sol :-

$$fx(t) = r x \cos(\omega t) + x_0$$

$$fx(t) = 5x \cos(12t) + x_0$$

Taking derivative for velocity.

$$\frac{d}{dx} fx(t) = 5 \frac{d}{dt} \{\cos(12t) + x_0\}$$

$$\frac{d}{dx} fx(t) = -5 [\sin(12t) . 12 + 0]$$

$$\frac{d}{dx}$$

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$$\frac{d}{dx} fx(t) = -60 \sin 12t$$

Taking derivative of v for acceleration.

$$\frac{d^2 fx(t)}{dt^2} = -60 \frac{d^2}{dt^2} \sin 12t$$

$$= -60 [\cos 12t \cdot 12]$$

$$\frac{d^2 fx(t)}{dt^2} = -720 (\cos 12t)$$

Ans.

(Q7) Data:-

(a) Magnitude of $\vec{a}$ = ?

(b) Direction of $\vec{a}$ = ?

Solution:-

(a) $x - x_0 = v_0 t + \frac{1}{2} a t^2$

$0 - (-2) = v_0(1) + 1/2\ a t^2$

$2 = v_0 + 1/2\ a \rightarrow (i)$

Now,

$x - x_0 = v_0 t + 1/2\ a t^2$

$6 - (-2) = v_0(2) + 1/2\ a(2)^2$

$6 + 2 = 2v_0 + 1/2\ a(4)$

$8 = 2v_0 + 2a$

$4 = v_0 + a$

$v_0 = 4 - a$

Now eq (i) $\Rightarrow$

$2 = v_0 + 1/2\ a$

$2 = (4 - \vec{a}) + 1/2\ a$

$2 = 4 - a + \frac{a}{2}$

$2 = \frac{8 - 2a + a}{2}$

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$$4 = 8 - a$$

$$a = 8 - 4$$

$$\boxed{a = 4 \text{ m/s}^2}$$

(b) Direction of acceleration is along x-axis.

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(18) Sol :-

$$\left.\begin{aligned} r_1 &= 5i - 6j + 2K \text{ m} \\ r_2 &= -2i + 8j - 2K \text{ m} \end{aligned}\right\} \begin{aligned} t_1 &= 0s \\ t_2 &= 10s \end{aligned}$$

$$\Delta r = r_2 - r_1$$
$$\Delta r = -2i + 8j - 2K - (5i - 6j + 2K)$$
$$\Delta r = -2i + 8j - 2K - 5i + 6j - 2K$$
$$\Delta r = -7i + 14j - 4K \text{ m}$$

$$\Delta t = t_2 - t_1$$
$$\Delta t = 10 - 0$$
$$\Delta t = 10s$$

Now, for velocity.

$$V = \frac{\Delta r}{\Delta t} = \frac{-7i + 14j - 4K}{10}$$

$$\boxed{V = -0.7\hat{i} + 0.14\hat{j} - 0.4\hat{K} \text{ m/s}}$$

For acceleration:

$$a = \Delta V / \Delta t = \frac{-7\hat{i} + 14\hat{j} - 4K/10}{10}$$

$$a = -0.07\hat{i} + 0.14\hat{j} - 0.04K \frac{m}{s^2}$$

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Q9) Solution :-

$$r = (2t^3 - 5t)i - (6 - 7t^4)j$$

(a) r at $t = 2s$

$$r = [2(2)^3 - 5(2)]i - [6 - 7(2)^4]j$$
$$r = [2(8) - 10]i - [6 - 112]j$$
$$r = (16 - 10)i - (-106)j$$
$$\boxed{r = +6i + 106j \text{ m}}$$

(b) v at 2 s

$$v = \frac{dr}{dt} = \left[(2t^3 - 5t)i - (6 - 7t^4)j\right]$$

$$v = (6t^2 - 5)i - (0 - 28t^3)j$$
$$v = [6(2)^2 - 5]i - [-28(2)^3]j$$
$$v = [6(4) - 5]i - [-28(8)]j$$
$$v = [24 - 5]i + 224j$$
$$\boxed{v = 19i + 224j \text{ m/s}}$$

(c) a at 2s.

$$a = \frac{dv}{dt}\left[(6t^2 - 5)i + 28t^3 j\right]$$

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$$a = 12t\,i + 84t^2\,j$$
$$a = 12(2)\,i + 84(2)^2\,j$$
$$\boxed{a = 24i + 336j \ m/s^2}$$

(d) For The angle:-

$$\theta = \tan^{-1}\frac{V_y}{V_x}$$

$$\theta = \tan^{-1}\left(\frac{224}{19}\right)$$

$$\boxed{\theta = 83.5^\circ}$$

(Q10) Data:-

height $= h = 9.1m$

$\vec{V} = (7.6\hat{i} + 6.1\hat{j})\ m/s$

(a) max. height = ?

(b) Total horizontal distance = ?

(c) Magnitude of $\vec{V}$ = ?

(d) Angle of ball's velocity = ?

Sol :-

(a) $2as = v_f^2 - v_i^2$

$2gh = V_y^2 - V_{oy}^2$

$2(9.8)(9.1) + V_{oy}^2 = V_y^2$

$V_y^2 = 2(9.8)(9.1) + (6.1)^2$

$V_y^2 = 215.57$

$\boxed{V_y = 14.68 \text{ m/s}}$

$2gh = V_y^2 - V_{oy}^2$

$2(9.8)h = (14.68)^2 - (0)^2$

$\boxed{h = 10.99 \text{ m}}$

(b) $R = \frac{2(V_o)(V_{oy})}{g} = \frac{2(7.6)(14.68)}{9.8}$

$\boxed{R = 22.76 \text{ m}}$

(c) $|\vec{V}| = \sqrt{(7.6)^2 + (14.68)^2}$

$|\vec{V}| = 16.54 \text{ m/s}$

(d) $\theta = \tan^{-1}\left(\frac{14.68}{7.6}\right)$

$\boxed{\theta = 62.66^\circ}$