Applied physics Assignment:-

Name:- Yash Raj
Roll-no:- 24k-0737

Q#1:-

(a) Average velocity = $\frac{\text{Total displacement}}{\text{Total time taken}} = \frac{\vec{s}}{t}$

Total distance = 40 + 40 = 80km

$t_1 = \frac{40\,km}{30\,km/h} = \frac{40}{30} = \frac{4}{3} = 1.33 hours$

$t_2 = \frac{40km}{60\,km/h} = \frac{40}{60} = \frac{4}{6} = 0.67 hours$

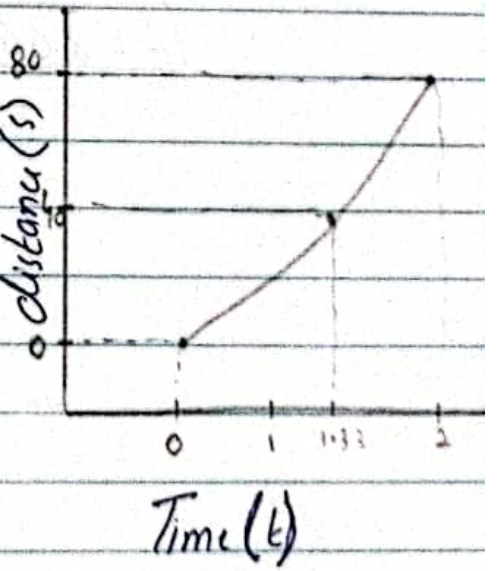
Total time = 1.33 + 0.67 = 2hours

$\boxed{\vec{V}_{av} = \frac{80}{2} = 40km/h}$

(b) Avg Speed = $\frac{\text{distance}}{\text{time}} = \frac{s}{t}$

$\boxed{V_{av} = \frac{80}{2} = 40km/h}$

(c) Graph:-



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Q#2:-

Ans:-

Given Data:-

$v_i = 30 m/s$

Required:-

$\vec{s} = 0$

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

$0 = 30t - \frac{1}{2} \times 9.8 \times t^2$

$\boxed{t = 6.122 sec}$ → Total time.

(b) Time to reach max height:-

$v_f = v_i + at$

$0 = v_i - gt$

$t = \frac{30}{9.8}$

$\boxed{t = 3.06 sec}$ Ans.

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Q#3:-

find position of the object using $x = 3t - 4t^2 + t^3$:-

(a) at $t = 1sec \Rightarrow x = 3t - 4t^2 + t^3 \Rightarrow 3(1) - 4(1)^2 + (1)^3 \Rightarrow 3 - 4 + 1 = 0$

(b) at $t = 2sec \Rightarrow x = 3t - 4t^2 + t^3 \Rightarrow 3(2) - 4(2)^2 + (2)^3 \Rightarrow 6 - 16 + 8 = -2$

(c) at $t = 3sec \Rightarrow x = 3t - 4t^2 + t^3 \Rightarrow 3(3) - 4(3)^2 + (3)^3 \Rightarrow 9 - 36 + 27 = 0$

(d) at $t = 4sec \Rightarrow x = 3t - 4t^2 + t^3 \Rightarrow 3(4) - 4(4)^2 + (4)^3 \Rightarrow 12 - 64 + 64 = 12$

(e) Displacement between $t = 0$ & $t = 4sec$:-

$\Delta s = x(4) - x(0)$ $x = 3t - 4t^2 + t^3$

$= 3(4) - 4(4)^2 + (4)^3 - 3(0) - 4(0)^2 + (0)^3$

$= 12 - 0$

$\boxed{\vec{s} = 12}$

(f) Avg velocity from $t = 2sec$ to $t = 4sec$:-

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

$3(4) - 4(4)^2 + (4)^3 = 12$

$V_{av} = \frac{s_2 - s_1}{t_2 - t_1} = \frac{12 - (-2)}{4 - 2} = \frac{12 + 2}{2} = \frac{14}{2} = 7$

$\boxed{\vec{v} = 7 m/s}$ Ans

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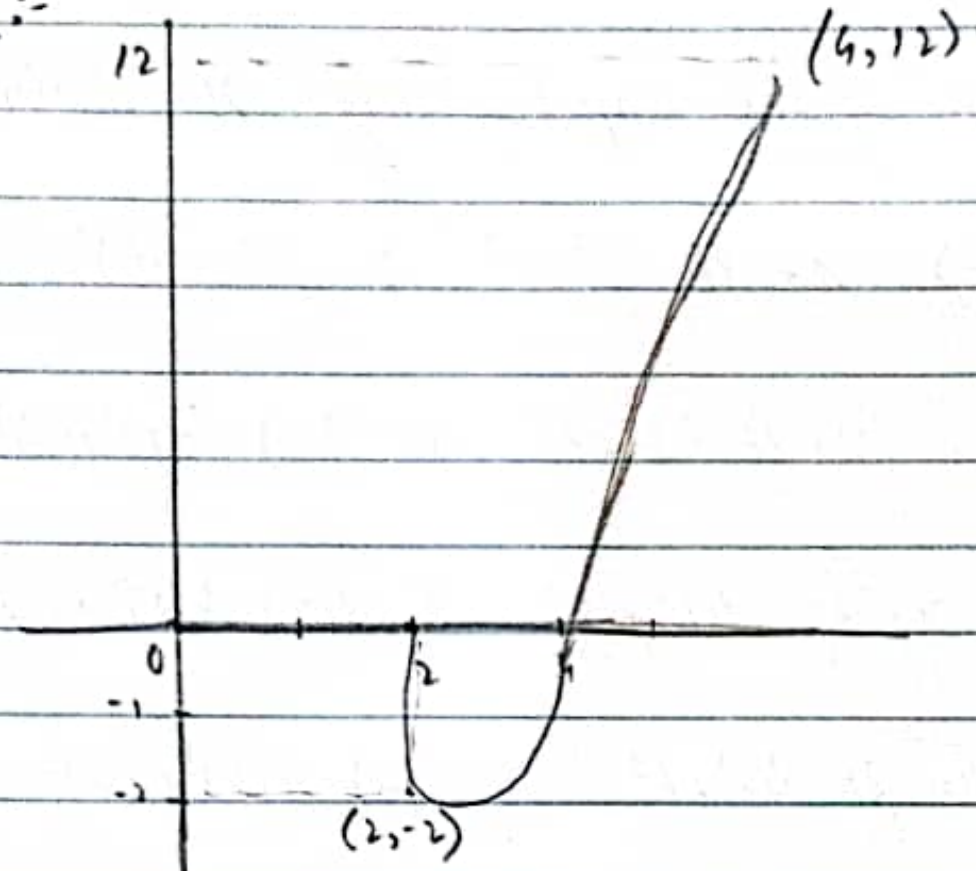
(f) Graph:-



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Q#4.. Given-Data..

$y = 30m$

$v = 3m/s$

$\vec{a} = 0.4m/s$

Required:- $\theta = ?$

Sol:-

$$\frac{1}{2}at^2\sin\theta = 3t$$

$$t = \frac{6}{a\sin\theta} = \frac{15}{\sin\theta}$$

$$\frac{1}{2}at^2\cos = 30$$

$$t^2 = \frac{60}{a\cos\theta} = \frac{150}{\cos\theta}$$

$$\frac{225}{\sin^2\theta} = \frac{150}{\cos\theta} \quad \Rightarrow \frac{3}{1-\cos^2\theta} = \frac{2}{\cos\theta} \quad \Rightarrow 2\cos^2\theta + 3\cos\theta - 2 = 0.$$

$$(2\cos\theta - 1)(\cos\theta + 2) = 0.$$

$$\cos\theta = \frac{1}{2}$$

$$\boxed{\theta = 60^\circ}$$

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Q#5:-

$$\vec{r} = (2t^3 - 5t)\hat{i} + (6 - 7t^4)\hat{j}$$

(a) Vector r:-

Sol:-

$$\vec{r} = (2t^3 - 5t)\hat{i} + (6 - 7t^4)\hat{j}$$

$$\vec{r}(2) = [(2(2)^3 - 5(2))\hat{i} + (6 - (2)^4 7))\hat{j}]$$

$$\boxed{\vec{r}(2) = 6\hat{i} - 106\hat{j}}$$

(b) Vector b & vector b at t = 2sec:-

Sol:-

$$\vec{v} = dr/dt = (2t^3 - 5t)\hat{i} + (6 - 7t^4)\hat{j}$$

$$= (6t^2 - 5)\hat{i} + (-28t^3)\hat{j}$$

$$\boxed{\vec{v} = (6t^2 - 5)\hat{i} - 28t^3\hat{j}}$$

$$\vec{v}(2) = [(6(2)^2 - 5)\hat{i} - (28(2)^3)\hat{j}]$$

$$= (6 \times 4 - 5)\hat{i} - (28 \times 8)\hat{j}$$

$$\boxed{\vec{v}(2) = 19i - 224j}$$

(c) Vector a & Vector $\vec{a}$ at t = 2sec:-

$$\vec{a} = d\vec{v}/dt = (6ti^2 - 5i) - 28t^3\hat{j}$$

$$\vec{a} = 12ti - 84t^2\hat{j}$$

$$\vec{a}(2) = 12(2)i - 84(2)^2\hat{j}$$

$$\boxed{\vec{a}(2) = 24\hat{i} - 336\hat{j}}$$

Q#5:-

(d) Slope of tangent = $d\vec{v}/dt$

So, $\tan\theta = 19i - 224j$

$\theta = \tan^{-1}(224/19) = 85.19°$ 4th.

$= 360 - 85.19°$

$\boxed{\theta = 274.8°}$ Ans

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Q#1:-

Given-Data:-

$r = 1.5m$

$h = 2m$

$S = 10m$

Required:-

Centripetal acceleration:-

For:- $S = vt$

$S_0 = vt$

$h = 2$

$d = \frac{v_i^2 \sin^2\theta}{2g}$

$t = \frac{v_i \sin\theta}{g}$

$\boxed{\sin\theta = \frac{t \cdot g}{v_i}}$

$d = \frac{v_i^2 \cdot t^2 g^2}{2g \, v_i^2}$

$t = \sqrt{\frac{4}{9.8}} = 0.64sec$

So,

$10 = v \times 0.64$

$v = 15.62 m/s$

$\boxed{a = \frac{v^2}{r}} \Rightarrow \frac{(15.62)^2}{1.5} = \boxed{162 m/s^2}$

Ans.

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Q#7:-

(a) $a(t) = At - Bt^2$

$\vec{v} = \int At - Bt^2$

$$\boxed{\vec{v} = \frac{At^2}{2} - \frac{Bt^3}{3}}$$

$$v = \int \frac{At^2}{2} - \frac{Bt^3}{3}$$

$$\boxed{y = \frac{At^3}{6} - \frac{Bt^4}{12}}$$

(b) Calculate velocity:-

$At - Bt^2 = 0$.

$+Bt^2 = +At$

$t = \frac{At}{Bt}$

$\boxed{t = A/B}$

$$\vec{v} = \frac{A(A/B)^2}{2} - \frac{B(A/B)^3}{3}$$

$$\vec{v} = \frac{A^3}{2B^2} - \frac{A^3}{3B^2} = \frac{A^3}{6B^2} \quad [\text{put } A = 1.50\,m/s^2 \quad B = 0.12.]$$

$$\frac{(1.5)^3}{6(0.12)^2} = \boxed{39.06\,m/s} \text{ Ans}$$

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Q#8:-

Given Data:-

$v_i = 6 m/s$

$g = 9.8 m/s$

$t = 2 sec$

Required Data:-

(a) Speed after falling for 2sec:-

Sol:

$v_f = v_i + gt$

$= 6 + (9.8)(2)$

$\boxed{v_f = 25.6}$

(b) How far does it fall in 2sec?

Sol:

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

$s = (6)(2) + \frac{1}{2}(9.8)(4)$

$= 12 + 19.6$

$\boxed{s = 31.6 m}$

(c) magnitude of velocity after falling 10m?

Sol:

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

$v_f^2 = 2as + v_i^2$

$= 2(9.8)(10) + (6)^2$

$v_f = \sqrt{232}$

$\boxed{v_f = 15.231 m/s}$ Ans.

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Q#9:- Given Data:-

$S_1 = 25m \quad t = 20sec$

$S_2 = 25m \quad t = 15sec.$

Required data:-

(a) magnitude of avg velocity of first 25m?

$$V = \frac{\vec{S}}{t} = \frac{25m}{20s} = \frac{5}{4} = 1.25m/s.$$

(b) magnitude of velocity at return of trip?

$$V = \frac{\vec{S}}{t} = \frac{25}{15} = \frac{5}{3} = 1.66m/s.$$

(c) Velocity of Whole trip?

$$V = \frac{\vec{S}}{t} = \frac{S_2 - S_1}{t} = \frac{25+(-25)}{35} = \frac{0}{35} = 0 \text{ (Displacement is zero).}$$

(d) Avg speed for round trip?

$$V = \frac{S}{t} = \frac{25+25}{35} = \frac{50}{35}\,7\,10 = \frac{10}{7} = 1.42\,m/s.$$

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Q#10: Whether acceleration is constant or not?

(i) $x = -3t^2 + 4t - 2$ $y = 6t^2 - 4t$.

$\vec{a} = \frac{d^2y}{dx^2}$ $\frac{dy}{dx} = \frac{12t-4}{-6t+4}$ $\frac{d^2y}{dx^2} = \frac{12}{-6} = -1/2$ ($\vec{a}$ = constant)

(ii) $x = -3t^3 - 4t$ $y = -5t^2 + 6$.

~~$\frac{dy}{dx} = \frac{-9t^2-4}{}$~~ $\frac{dy}{dx} = \frac{-10t}{-9t^2-4}$ $\Rightarrow \frac{d^2y}{dx^2} = \frac{+10}{+18t}$ = ($\vec{a}$ = not constant)

(iii) $r = 2t^2 i - (4t+3)j$

$v = \frac{dr}{dt} = 4ti - 4$ $\vec{a} = \frac{dv}{dt} = 4i$ ($\vec{a}$ = constant)

(iv) $r = (4t^3 - 2t) + 3j$

$v = \frac{dr}{dt} = 12t^2 - 2$ $\vec{a} = \frac{dv}{dt} = 24t$ ($\vec{a}$ = not constant).

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Q#11:-

find acceleration:-

$$\vec{a} = \frac{v_2 - v_1}{t_2 - t_1}$$

$t_2 - t_1$ is 2sec interval.

$$\vec{a} = \frac{60 - 50}{2}$$

$$\vec{a} = \frac{10}{2} = 5$$

$$\vec{a} = \frac{5 \times 1000}{3600}$$

$$\boxed{\vec{a} = 1.39 m/s^2}$$ Ans.

Q#12:-

Required:-

(a) Avg Speed to his College:-

$$\frac{V = S}{t} = \frac{15}{1/2} = 30 \text{ km/h} \qquad \frac{30 \times 5}{18} = 8.33 \text{ m/s}.$$

(b) Avg velocity to his College:-

$$V_{av} = \frac{\vec{s}}{t} = \frac{30}{(1/2 + 1/3)} = \frac{30 \times 6}{5} = 36 \text{ km/h} = 10 \text{ m/s}.$$

(c) Velocity of Whole trip:-

$$V = \frac{\text{displacement}}{\text{time}} = \frac{0}{5/6} = 0 \text{ m/s}.$$

→ Velocity of Whole trip is Zero because displacement is zero.

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Q#13:-

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

Q#2:-

(a) Displacement of particle:-

$\Delta x = x_2 - x_1$

$x(1) - x(0)$

$= -4(1) + 2(1)^2 - (-4(0) + 2(0)^2)$

$= -4 + 2 - 0$

$= -2m$

$\Delta x = x_2 - x_1$

$x(3) - x(1)$

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

$= -12 + 18 + 4 - 2$

$= 8m$

(b) Avg velocity = $\frac{\text{Total displacement}}{\text{Total time}}$

from $t=0$ to $t=1$:- $\frac{x(1) - x(0)}{1-0} = -2 m/s$

from $t=1$ to $t=3$:- $\frac{x(3) - x(1)}{3-1} = 4 m/s$

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(c) Instantaneous velocity at $t = 2.5$ sec.

Sol^{n}

$V_{inst} = dx/dt \,/\, t.$

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

$$\frac{dx}{dt} = -4 + 4t.$$

$t = 2.5.$

$-4 + 4(2.5) = 6.$

$V_{inst} = 6$ m/s Ans.

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Q#4 :-

Given-Data :-

$v_i = 20 m/s$

$h = 50 m$.

Required :-

(a) time taken by stone to reach max height:-

$v_f = v_i + at$.

$0 = 20 - 9.8t$.

$\boxed{t = 2.04 sec}$

(b) the maximum height.

$h = \frac{v_i^2}{2g}$

$h = \frac{(20)^2}{2(9.8)}$.

$\boxed{h = 20.4 m}$

(c) Total time of journey :-

$T = 2 \times t$

$= 2 \times 2.04$

$\boxed{T = 4 sec}$ Ans.

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Q#15:- Given Data:-

$V_i = 40 m/s$

$h = 100m.$

Required:-

Range = ?

Sol:

$h = \frac{V_i^2 \sin^2\theta}{2g}$

$t = \frac{V_i \sin\theta}{g}$

$(\sin\theta)^2 = \left(\frac{t \cdot g}{V_i}\right)^2$

$= \sin^2\theta = \frac{t^2 \cdot g^2}{V_i^2}$

$h = \frac{V_i^2 \cdot t^2 \cdot g^2}{2g \; V_i^2}$

$\sqrt{100 \times 2g} = t$

$t = \frac{\sqrt{200}}{10}$

$t = \sqrt{20}$

$\boxed{t = 4.47 \text{ sec}}$

Range = $V_0 \times t$

$= 40 \times 4.47$

$\boxed{\text{Range} = 178.8 m}$ Ans.