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Section:- BSCS-1F

Ap Assignment 1

Q1 a) Avg velocity = $\frac{\text{Total displacement}}{\text{time}} = \frac{80}{2} = 40$ km/hr

$s = vt$ $\quad$ $s = vt$

$40 = 30 \times t$ $\quad$ $40 = 60 \times t$

$t = \frac{4}{3}$ hours $\quad$ $t = \frac{2}{3}$ hours

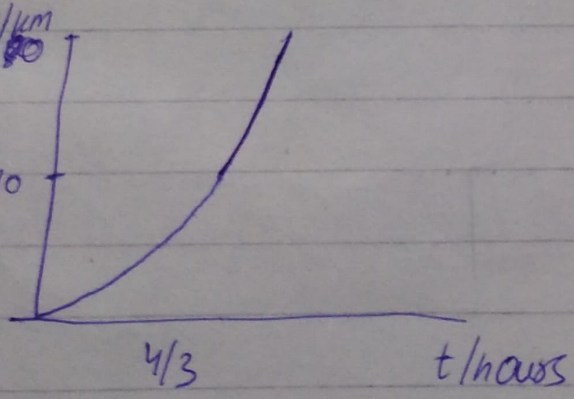
total time = $\frac{4}{3} + \frac{2}{3} =$ 2 hours

b) Avg speed = $\frac{\text{Total distance}}{\text{time}}$

$\text{avge} = \frac{80}{2} = 40$

avg speed = 40 km/hr

c)



Q2) $v = u + at$

$0 = 30 + 9.81t$

$\boxed{t = 3.1 \text{ seconds}}$ → to reach max height

$\boxed{t = 6.12 \text{ seconds}}$ → the time it remains in air.

Q3) $x = 3t - 4t^2 + t^3$

a) $t = 1s \rightarrow x = 0\,m$

b) $t = 2s \rightarrow x = -2\,m$

c) $t = 3s \rightarrow x = 0\,m$

d) $t = 4s \rightarrow x = 12\,m$

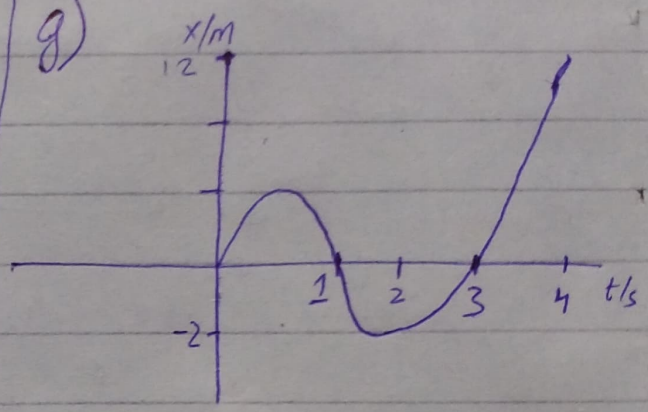
e) Objects displacement b/w time $t=0$ and $t=4$

$s = 12 - 0 = \boxed{12\,m}$

f) avg velocity = $\frac{\text{Total displacement}}{\text{time}}$

$= \frac{12 - (-2)}{4 - 2} = \boxed{7\,m/s}$

g)



Using graph, find the gradient of the curve at $t=2$ & $t=4$

(Q4) Integrate $\vec{v}$ with respect to time

$\int 3 = 3t \rightarrow$ displacement in x-direction

$30\ m \rightarrow$ displacement in y-direction

$a_x = a\sin\theta$ $\qquad$ $a_y = a\cos\theta$

$\int a_x = a_x t \longrightarrow \int a_x t = \frac{a_x t^2}{2} \rightarrow$ displacement in x-direction

$\int a_y = a_y t \longrightarrow \int a_y t = \frac{a_y t^2}{2} \rightarrow$ displacement in y-direction

$\frac{a_x t^2}{2} = 3t$ $\qquad$ $\frac{a_y t^2}{2} = 30$

$\Rightarrow \frac{1}{2} a_x t^2 = 3t$ $\qquad$ $\Rightarrow \frac{1}{2} a_y t^2 = 30$

$\frac{1}{2}(a\sin\theta)t^2 = 3t$ $\qquad$ $\Rightarrow \frac{1}{2}(a\cos\theta)t^2 = 30$

$t = \frac{6}{0.4\sin\theta}$ $\qquad$ $\Rightarrow \frac{1}{2} \times 0.40\cos\theta \times t^2 = 30$

$t = \frac{15}{\sin\theta}$ $\qquad$ $\boxed{t^2 = \frac{150}{\cos\theta}}$

$t^2 = \left(\frac{15}{\sin\theta}\right)^2$ $\qquad$ $t^2 = t^2$

$t^2 = \frac{225}{\sin^2\theta}$ $\qquad$ $\frac{225}{\sin^2\theta} = \frac{150}{\cos\theta}$

$$\frac{225}{\sin^2\theta} = \frac{150}{\cos\theta}$$

$$\cos\theta = \frac{150\sin^2\theta}{225} = \cos\theta = \frac{2}{3}\sin^2\theta$$

$$\cos\theta = \frac{2}{3}(1-\cos^2\theta)$$

$$\cos\theta = \frac{2}{3} - \frac{2}{3}\cos^2\theta$$

$$\frac{2}{3}\cos^2\theta + \cos\theta - \frac{2}{3} = 0$$

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

$\theta = 60^\circ$ Ans

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

a) $\vec{r} = 6i - 106j$

b) $\frac{d}{dx}(2t^3 - 5t) = 6t^2 - 5$ $\frac{d}{dx}(6 - 7t^4) = -28t^3$

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

$\vec{v} = 19i - 224j$

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

$\frac{d}{dt}(6t^2 - 5) = 12t$

$\frac{d}{dt}(-28t^3) = -84t^2$

$a(t) = 12t\,i - 84t^2 j$

substitute $t = 2$

$\vec{a} = 24i - 336j$

d) Tangent to particle's path at $t = 2$ is equal to velocity as it is equal to gradient $\vec{v} = 19i - 224j$

$\tan\theta = \frac{224}{19} \Rightarrow \theta = 85.7$

$360 - \theta \Rightarrow 360 - 85.7 = 274.8$

$274.8 \approx 275^\circ$

Q6) $s = ut + \frac{1}{2}at^2$

$2 = \frac{1}{2} \times 9.81 \times t^2$

$t = 0.64$

$s = vt$

$v = \frac{10}{0.64}$

$v = 15.7\ m/s$

$ac = \frac{v^2}{r} = \frac{15.7^2}{1.5} = 163.5\ m$

Past b continued

Q7) $a(t) = At - Bt^2$

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

$V = \frac{At^2}{2} - \frac{Bt^3}{3} + C$

a) $V=0$ at $t=0$ so $\boxed{C=0}$

$V = \frac{1.5t^2}{2} - \frac{0.12t^3}{3} + 0$

$\boxed{V = 0.75t^2 - 0.04t^3}$

$\int \frac{At^2}{2} - \frac{Bt^3}{3} = \frac{At^3}{6} - \frac{Bt^4}{12}$

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

$x = \frac{1.5t^3}{6} - \frac{0.12t^4}{12}$

$\boxed{x = 0.25t^3 - 0.01t^4}$

b) max vel at $a=0$

$a = 1.5t - 0.12t^2$

$0 = 1.5t - 0.12t^2$

$t(1.5 - 0.12t) = 0$

$1.5 - 0.12t = 0 \quad | \quad t=0$

$t = 12.5$

$V = 0.75t^2 - 0.04t^3$ at $t = 12.5$

$V = 0.75(12.5)^2 - 0.04(12.5)^3$

$\boxed{V = 39.1 \text{ m/s}}$

Q9) a) avg velocity = $\frac{\text{total dis}}{\text{total time}}$

$\frac{25}{20} = \boxed{\frac{5}{4} \text{ m/s}}$

b) avg velo = $\frac{\text{total dis}}{\text{toto time}} = \frac{25}{15} = \boxed{\frac{5}{3} \text{ m/s}}$

c) total displacement is 0 so avg velocity is zero

d) avg speed = $\frac{\text{total distance}}{\text{total time}}$

$\frac{50}{35} = \frac{10}{7} = \boxed{1.4 \text{ m/s}}$

total time = $20 + 15 = 35$

Q8) a) $v = u + at = v = 6 + 9.81 \times 2$

$\boxed{V = 25.6 \text{ m/s}}$

b) $s = ut + \frac{1}{2}at^2 \quad s = 6 \times 2 + \frac{1}{2} \times 9.81 \times 2^2$

$\boxed{s = 31.6 \text{ m}}$

c) $v^2 - u^2 = 2as \quad v^2 - 6^2 = 2 \times 9.81 \times 10$

$\boxed{V = 15.2 \text{ m/s}}$

Q10) 1) $\frac{d}{dx} \cdot -3t^2+4t-2$ $\frac{d}{dy}\ 6t^2-4t$

$\frac{d}{dx} \cdot -6t+4$ $\frac{dy}{dy}\ 12t-4$

$\boxed{a_x = -6}$ $\boxed{a_y = 12}$

2) $\frac{d}{dx}\ -3t^3-4t$ $\frac{d}{dy}\ -5t^2+6$

$\frac{d}{dx}\ -9t^2-4$ $\frac{d}{dy} \cdot -10t$

$\boxed{a_x = -18t}$ $\boxed{a_y = -10}$

3) $\frac{d}{dx}\ 2t^2$ $\frac{d}{dy}\ -(4t+3) \rightarrow -4t-3$

$\frac{d}{dx} = 4t$ $\frac{d}{dy} \cdot (-4)$

$\boxed{a_x = 4}$ $\boxed{a_y = 0}$

4) $\frac{d}{dx}\ (4t^3-2t)$ $\frac{d}{dy}\ (3)$

$\frac{d}{dx}\ 12t^2-2$

$\boxed{a_x = 24t}$ $\frac{d}{d} = 0$ $\boxed{a_y = 0}$

for (1) both x & y components of acceleration are constants so acceleration is constant. for (2) x-component is not constant while y-component is constant so acceleration is not constant. for (3) both x & y components are constants so acceleration is constant. for (4) x-component is not const. but y-component is, so acceleration is not constant.

Q11) $v_i = 60$ km/h $\quad 60 \times \frac{1000}{3600} = 16.67$ m/s $\quad \boxed{v_i = 16.67\hat{i}}$

$v_f = 50$ km/h $\quad 50 \times \frac{1000}{3600} = 13.89$ m/s $\quad \boxed{v_f = 13.89\hat{j}}$

$\Delta v = (13.89\hat{j}) - (16.67\hat{i})$

$\Delta v = -16.67\hat{i} + 13.89\hat{j}$

$a_{avg} \quad \frac{\Delta v}{\Delta t} = \frac{-16.67\hat{i} + 13.89\hat{j}}{2} \quad \boxed{\Delta t = 2}$

$\boxed{a_{avge} = -8.33\hat{i} + 6.95\hat{j}}$

$|a_{avg}| = \sqrt{(-8.33)^2 + (6.95)^2} = \sqrt{117.63} = 10.84$

$\boxed{a_{avg} = 10.84 \text{ m/s}^2}$

Q12) a) avg speed $= \frac{15}{30} = \boxed{0.5 \text{ km/min}}$

b) avg speed $= \frac{15}{20} = \boxed{0.75 \text{ km/min}}$

c) avg velocity $= 0$ as total displacement is zero

Date:

Q13) $x = -4t + 2t^2$

$t = 0s \quad x = 0m$

$t = 1s \quad x_2 = 2m$

$t = 3 \quad x = 6m$

a) $-2 - 0 = \boxed{-2m}$

$6 - (-2) = \boxed{8m}$

b) avg velocity $= \frac{-2}{1} = \boxed{-2 m/s}$ avg velocity $= \frac{8}{2} = \boxed{4 m/s}$

c) $\frac{d}{dx} -4t + 2t^2 = -4 + 4t$ at $t = 2.5$

instant velocity $= -4 + 4(2.5) = \boxed{6 m/s}$

Q14) $v = u + at \quad 0 = 20 + (-9.81) \times t \quad t = \frac{-20}{-9.81}$

a) $\boxed{t = 2.04 s}$

b) $v^2 - u^2 = 2as \quad 0^2 - 20^2 = 2 \times (-9.81)(s) \Rightarrow \frac{-400}{-9.81 \times 2} = s$

$\boxed{s = 20.4 m}$

c) $2.04 \times 2 = 4.08 \quad \boxed{t = 4.08 s}$

Q15) $s = ut + \frac{1}{2} at^2 \quad 100 = (0)t + \frac{1}{2} \times 9.81 \times t^2$

$\boxed{t = 4.5 s} \quad s = vt \quad s = 4.5 \times 40 \quad \boxed{s = 180.6 m}$

So it strikes the ground after travelling 180.6m horizontally.