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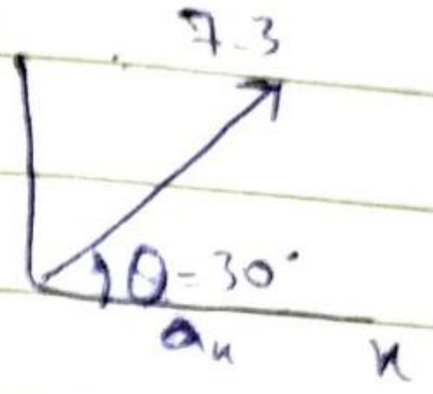
20K-1710.

Applied Physics Date

Assignment-1 (Vectors)

Q1) displacement = 7.3m, $\theta = 30^\circ$

x-component:



$$\cos\theta = \frac{B}{H}$$

$$\cos 30^\circ = \frac{a_x}{7.3}$$

$$a_x = 7.3 \times \cos 30^\circ$$

$$\boxed{a_x = 6.32\,m}$$

-component:

$$\sin\theta = \frac{P}{H}$$

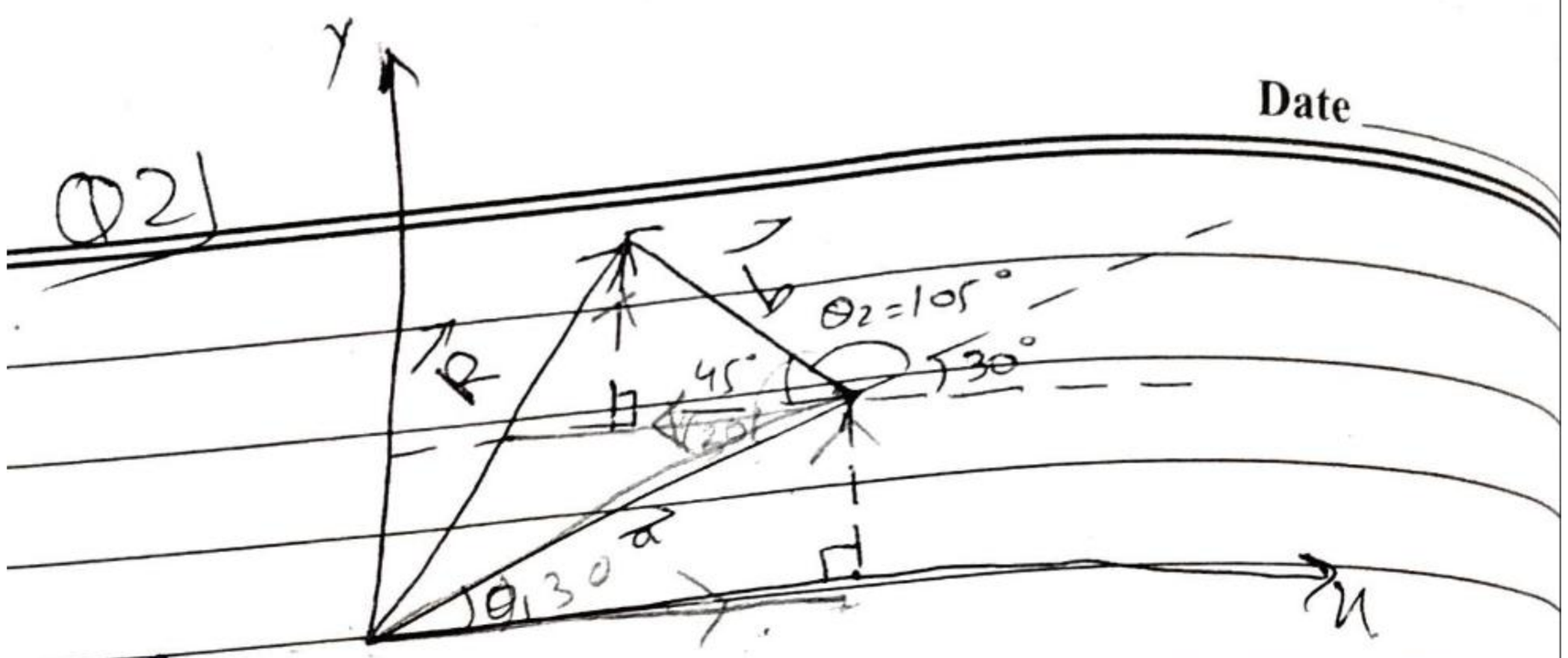
$$\sin 30^\circ = \frac{a_y}{7.3}$$

$$a_y = \sin 30^\circ \times 7.3$$

$$\boxed{a_y = 3.65\,m}$$

Date

Q21



for $\vec{a}$:-

a) $\vec{a}_x = 10 \cos(30°)$

$\cong 8.66m$

$\vec{a}_y = 10 \sin(30°)$

$\cong 5m$

for $\vec{b}$:-

$\theta = 105° + 30°$

$= 135°$

$\theta_E = 180 - 135$

$\theta = 45°$

$\vec{b}_x = 10 \cos(45°)$

$\cong 7.07m$

$\vec{b}_y = 10 \sin(45°)$

$\vec{b}_y \cong 7.07m$

$\vec{R}_x = 8.66m - 7.07m$

$\vec{R}_x = 1.59m$

$\vec{R}_y = 5m + 7.07m$

$\vec{R}_y = 12.07m$

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b) $|\vec{R}| = \sqrt{(1.59)^2 + (12.07)^2}$

$|\vec{R}| = 12.175_m$

c) $\theta = \tan^{-1}\left(\frac{\vec{R_y}}{\vec{R_x}}\right)$

$= \tan^{-1}\left(\frac{12.07}{1.59}\right)$

$= 82.495°$

$\theta = 83.5°$

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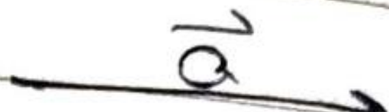
23) $a = 4, b = 3, c = 5$, $a \times b = ?$

for a_x & a_y :-



$a_x = 4\cos 0$

$a_x = 4(1)$

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

for b_x & b_y :-

$\boxed{b_x = 0}$; $b_y = 3\sin 90$

$b_y = 3(1) \Rightarrow \boxed{b_y = 3}$

$\vec{a} = 4i + 0j + 0k$

$\vec{b} = 0i + 3j + 0k$

$(\vec{a} \times \vec{b})$:-

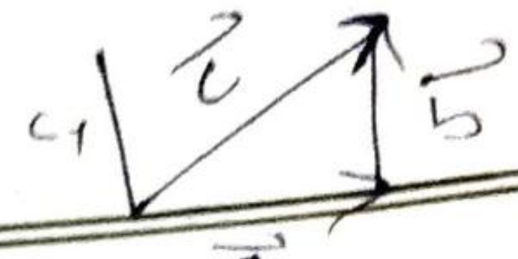
$$\vec{a} \times \vec{b} = \begin{vmatrix} i & j & k \\ 4 & 0 & 0 \\ 0 & 3 & 0 \end{vmatrix}$$

$= 0i - 0j + 12k$.

$\vec{a} \times \vec{b} = 12\hat{k}$

$|\vec{a} \times \vec{b}| = 12$

Direction will be in +ve z-axis.



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$\vec{a} \times \vec{c}$:-

$c_x = |\vec{a}|$, $c_y = |\vec{b}|$

$\vec{c} = 4i + 3j + 0k$

$$\vec{a} \times \vec{c} = \begin{vmatrix} i & j & k \\ 4 & 0 & 0 \\ 4 & 3 & 0 \end{vmatrix}$$

$= 0i - 0j + 12K$

$+\vec{a} \times \vec{c}k = 12K \Rightarrow |\vec{a} \times \vec{c}| = 12.$

Direction is in +ve z-axis.

$\vec{b} \times \vec{c}$:

$$\vec{b} \times \vec{c} = \begin{vmatrix} i & j & k \\ 0 & 3 & 0 \\ 4 & 3 & 0 \end{vmatrix}$$

$\vec{b} \times \vec{c} = -12\hat{K}$

$|\vec{b} \times \vec{c}| = 12$

Direction is in -ve z-axis.

Q4)

Date

$a.b = ?$

a) $a.b = |a||b|\cos\theta$

$= 10 \times 10 \times \cos 75 \quad (180^\circ - 105^\circ = 75^\circ)$

$\boxed{a.b = 25.88}$

b) $a \times b = ab \sin\theta$

$= 10 \times 10 \times \sin 75^\circ$

$\boxed{a \times b = 96.5925}$

c) $180^\circ - 105^\circ = 75^\circ$

The angle is 75°

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Q5)

$A_x = 25$; $A_y = 40$; $A = ?$

$$A = \sqrt{(A_x)^2 + (A_y)^2}$$

$$= \sqrt{(25)^2 + (40)^2}$$

$$\boxed{A = 97.169.}$$

$$\Theta = \tan^{-1}\left(\frac{A_x}{A_y}\right)$$

$$\Theta = \tan^{-1}\left(\frac{25}{40}\right)$$

$$\boxed{\Theta = 32.005^\circ}$$

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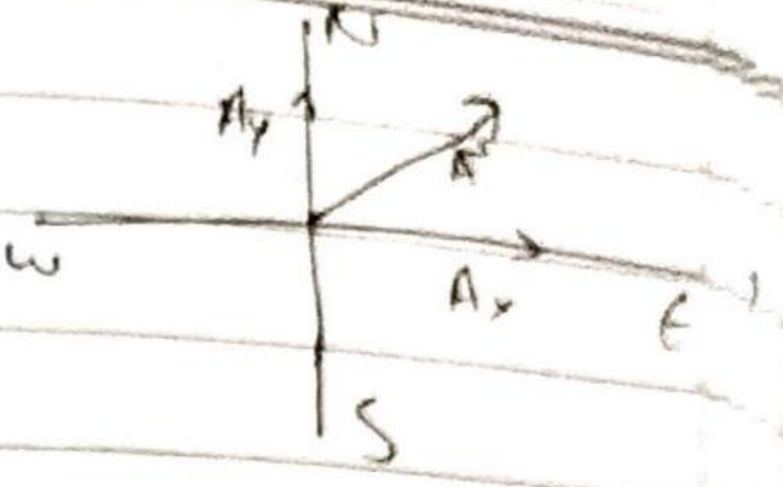
2(c) for magnitude :-

$$A = \sqrt{(A_x)^2 + (A_y)^2}$$

$$= \sqrt{(100)^2 + (120)^2}$$

$$A = 156.20$$



for direction :-

Ship should move 156.2 km is S.W direction to reach its starting point.

$\theta = \tan^{-1}\left(\frac{120}{100}\right)$ ~~$\Rightarrow \theta = \tan^{-1}(5/6) \Rightarrow$~~

3(a) $\vec{a} = 50m$, $\vec{b} = 50m$, $\vec{c} = 50m$

$\theta = 30^\circ$, $\theta = 195^\circ$, $\theta = 315^\circ$

i) for magnitude of $\vec{a}+\vec{b}+\vec{c}$

a_x & a_y :- $a_x = a\cos\theta$

$a_y = a\sin\theta$

$a_x = 50\cos 30^\circ$; $a_y = 50\sin 30^\circ$

b_x & b_y :- $b_x = b\cos\theta$

$b_y = b\sin\theta$

$b_x = 50\cos 195^\circ$ $b_y = 50\sin 195^\circ$

c_x & c_y :- $c_x = c\cos\theta$

$c_x = c\sin\theta$

$c_x = 50\cos 315^\circ$ $c_x = 50\sin 315^\circ$

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$A_x = a_x + b_x + c_x$

$A_x = 50(\cos 30° + \cos 195° + \cos 315°)$

$A_x = 30.360$

$A_y = a_y + b_y + c_y$

$A_y = 50(\sin 30° + \sin 195° + \sin 315°)$

$A_y = -23.296$

$A = \sqrt{(30.360)^2 + (-23.296)^2}$

$\boxed{A = 38.26}$

i.e

$|\vec{a} + \vec{b} + \vec{c}| = 38.26\,m.$

for Angle:

$\theta = \tan^{-1}\left(\frac{-23.296}{30.360}\right)$

$\boxed{\theta = -37.49°}$

ii) for Magnitude $|\vec{a} - \vec{b} + \vec{c}|$

$A_x = 50(\cos 30° - \cos 195° + \cos 315°)$

$A_x = 126.95°$

$A_y = 50(\sin 30° - \sin 195° + \sin 315°)$

$A_y = 2.58$

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for $R = \sqrt{(126.95)^2 + (2.58)^2}$

$R_{n.b.c} = 126.974$

$\theta = \tan^{-1}(2.58/126.95)$

$\theta = 1.12°$

$d = (a+b) - (c+d) = 0$

a+b :

$a_x + b_x \qquad a_y + b_y$

$a_x + b_x = 50(\cos 30° + \cos 195°)$

$a_y + b_y = 50(\sin 30° + \sin 195°)$

$\vec{a+b} = -4.995\,\hat{i} + 12.05\,\hat{j}$

c+d :

$c_x = 50 \cos 311° \; ; \; d_x = ?$

$c_y = 50 \sin 311° \; ; \; d_y = ?$

$(a+b) - (c+d) = 0$

$-4.995\,\hat{i} + 12.05\,\hat{j} - c - d = 0$

$d = (-4.995\,i + 12.05\,j) - (25\sqrt{2}\,i + 25\sqrt{2}\,j)$

$d = -40.34\,i + 47.40\,j$

$d_x = -40.34\,i$

$d_x = 47.40\,j$

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$$\theta = \tan^{-1}\left(\frac{47.40}{-40.34}\right)$$

$$\boxed{\theta = -49.60^\circ}$$

for Magnitude:

$$|d| = \sqrt{(-40.34)^2 + (47.40)^2}$$

$$\boxed{|d| = 62.21}$$ Ans.

Q8]

$$A = 2i - 3j + 7k$$

for A & x-axis :-

$$A_i = |A|\,|i| \cos\theta$$

$$(2i - 3j + 7k)(i) = \sqrt{4+9+49}\ \sqrt{i^2}\cos\theta$$

$$2i^x = \sqrt{38} \times \cos\theta$$

$$\theta = \cos^{-1}\left(\frac{2}{\sqrt{38}}\right)$$

$$\theta = 71.068^\circ \text{ for x-axis.}$$

for A & y-axis :-

$$A.j = |A|\,|j| \cos\theta$$

$$\frac{-3}{\sqrt{38}} = \cos\theta$$

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$$\theta = \cos^{-1}\left(\frac{-3}{\sqrt{38}}\right)$$

$\theta = 139.121$ for y-axis.

-2 A & z-axis:-

$A_z = |A||k| \cos\theta$.

$$\frac{5}{\sqrt{38}} = \cos\theta$$

$$\theta = \cos^{-1}\left(\frac{5}{\sqrt{38}}\right)$$

$\theta = 35.79$

for z-axis. ✱

Q9)

Date

$a = 5i + 4j - 6k$ $\quad c = 4i + 3j + 2k$

$b = -2i + 2j + 3k$

a+b+c :- &

$5i + 4j - 6k - 2i + 4i + 2j + 3j + 1k + 3k$

$= 7\hat{i} + 9\hat{j} - \hat{k}$.

θ b/w a & b

$a.b = |a||b| \cos\theta$

$|a| = 8.774$ $\quad |b| = 9.123$

$a.b = -20$

$\theta = \cos^{-1}\left(\frac{-20}{36.176}\right)$

$\theta = 123.56°$

for angle ~~b/w~~ at z-axis :-

$A.k = |A||k| \cos\theta$.

$(5i + 4j - 6k).(\hat{k}) = \sqrt{25+16+36}\ \sqrt{k^2} \cos\theta$

$\theta = \cos^{-1}\left(\frac{-6}{8.774}\right)$

$\theta = 133.144°$

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$A = 6$

$B = 7$

$AB = 14.$

$AB = |A||B| \cos\theta$

$14 = 6.7 \cos\theta.$

$\theta = \cos^{-1}\left(\frac{14}{42}\right).$

$\boxed{\theta = 70.528^\circ}$ #1

Motion in 1-D.

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① Data:

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

$r =$ at $t = 2$sec ?

v at $t = 2$sec ?

Sol:

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

~~at~~ at $t = 2$sec

$r = 6i - 106j$ Ans

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

$v = (6t^2 - 5)i + (-28t^3)$

at $t = 2$

$v = 19i - 224j$ Ans

Date

Q2)

Data:

$V_i = 18\ m/s$

$V_f = -30\ m/s$

$t = 2.4\ sec$

$a_{avg} = ?$

Sol:

$$a_{avg} = \left(\frac{V_f - V_i}{t}\right) m/s^2$$

$$= \left(\frac{-30 - 18}{2.4}\right)$$

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

Q3)

a) $V_f = V_i + at$

$3 \times 10^7 = 0 + 10 \times t$

$$\boxed{t = 3 \times 10^6\ sec}$$

b)

$S = V_i t + \frac{1}{2} g t^2$

$S = (0)t + \frac{10}{2} (3 \times 10^6)^2$

$$\boxed{S = 4.5 \times 10^{13}\ m}$$ Ans!

PAK

Q4)

Date

Data: $V_i = 0$

$V_f = 24$

$h = ?$

$a = g = 10 \, m/s^2$

Sol

$V_f = V_i + at$

$24 = 0 + 10t$

$t = 2.4 \quad — (1)$

$h = V_i t + \frac{1}{2} g t^2$

$h = \frac{10}{2} t^2 \quad — (2)$

put (1) in (2)

$h = \frac{10}{2} (2.4)^2$

$h = 28.8 \, m$ Ans

Q5)

Date

Data: $t = 2.25$ sec

$h = 36.8$ m

$V_f = ?$

$a = -10\ m/s^2$

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

$$36.8 = V_i (2.25) - \frac{1}{2}(10)(2.25)^2$$

$$\boxed{V_i = 27.3\ m/s}$$

$\therefore V_i = 27.3$

$g = a = -10\ m/s^2$

$t = 2.25$.

$$V_f = 27.3 - 10 \times 2.25$$

$$\boxed{V_f = 5.25\ m/s}$$

Q6)

Date

$V_1 = 60\ k/h$

$V_2 = 40\ k/h$

$D = n.m.$

Avg Speed = $\frac{\text{Total distance}}{\text{total time}}$

$= \frac{n+n}{t_1+t_2}$

$= \frac{n+n}{n/v_1+n/v_2}$

$= \frac{2v_1v_2}{v_1+v_2}$

$A.S_p = 48\ m/s$ Ans

Date

$V_f = 0$

$V_i = 27.3$ m/s

$a = g = -10$ m/s^2

$t = ?$, $S = ?$

$V_f = V_i + at$

$0 = 27.3 - 10 \times t.$

$t = 2.73$ sec

$S = V_i t + \frac{gt^2}{2}$

$S = (27.3)(2.73) - \frac{10(2.73)^2}{2}$

$S = 38$ m

H)

Date

Q7)

$V_i = 12.4$ m/s.

$h = 81.3$ m.

$g = a = 10$ m/s^2

$V_f = ?$, $t = ?$

V_f :-

$$2as = V_f^2 - V_i^2$$

$$V_f^2 = 2(10)(81.3) + (12.4)^2$$

$$\therefore$$

$$\boxed{V_f = \pm 42 \text{ m/s}}$$

t :-

$$V_f = V_i + at$$

$$42 = 12.4 + 10(t)$$

$$42 - 12.4 = 10t$$

$$\boxed{t = 2.96 \text{ sec}}$$

A

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$V_i = 0$

$V_f = 360$ k/h $\Rightarrow \frac{360 \times 1000}{3600} = 100$ m/s

$S = 1.8$ km $\Rightarrow 1800$ m.

$2as = V_f^2 - V_i^2$

$a = \frac{(100)^2 - (0)^2}{2(1800)}$

$= 2.77$

$\boxed{a = 2.8 \text{ m/s}^2}$

24.

Q9)

Date

$a = -4.92\ m/s^2$

$V_i = 24.6\ m/s$

$V_f = 0$

$s = ?$; $t = ?$

t:-

$$V_f = V_i + at.$$

$$0 = 24.6 - 4.92t.$$

$$4.92t = 24.6$$

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

s:-

$$2aS = V_f^2 - V_i^2$$

$$S = \frac{(0)^2 - (24.6)^2}{2(-4.92)}$$

$$S = \frac{+605.16}{+9.84}$$

$$\boxed{S = 61.5\ m}$$

Q10)

Date

Data:

$x = 50 + 10t^2$ [x - m, t - sec]

V_{avg} at first 3 sec = ?

V_{ins} at $t = 3$ sec = ?

a_{in} at $t = 3$ sec = ?

$x = 50 + 10t^2$

$\frac{dx}{dt} = 20t$

$\Rightarrow dx/dt = V_{ins}$

$V_{ins} = 20t$

$V_1 = 20$

$V_2 = 40$

$V_3 = 60$

$V_{avg} = \frac{V_1 + V_2 + V_3}{3}$

$= \frac{20 + 40 + 60}{3}$

for V_{avg} :-

$\boxed{V_{avg} = 40 \text{ m/s}}$

$V_t = 20t$

at $t = 3$

$V_3 = 20(3) \Rightarrow \boxed{V_3 = 60 \text{ m/s}}$

for a :-

$\Rightarrow V = 20t$

$\frac{dv}{dt} = 20$

$\Rightarrow dv/dt = a$

$\boxed{a = 20 \text{ m/s}^2}$