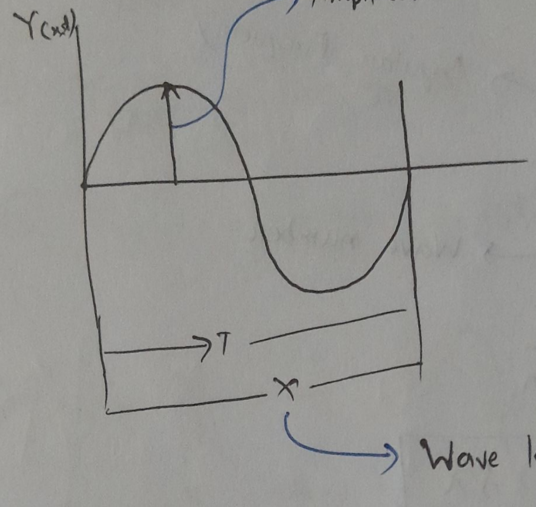
Wave Equation :

Amplitude — Wave Number — Angular Frequency

$$Y_{(x,t)} = Y_m \sin(\underbrace{kx - \omega t}_{\text{Not changable phase}} + \phi)$$



Wave length, λ

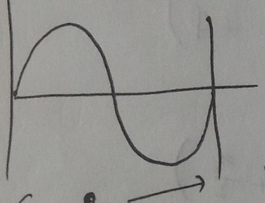
$T \dots 2\pi$

$1 \dots \frac{2\pi}{T} = \omega$

$\lambda \dots 2\pi$

$1 \dots \frac{2\pi}{\lambda} = k$

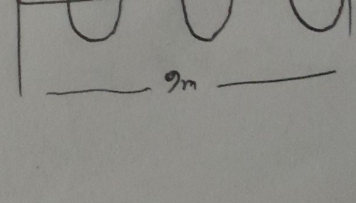
unit length



$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{2} = \pi$$

$$k = \pi$$

$$\Rightarrow k = 0.5 = \frac{1}{2} \left[\pi / 2\pi \right]$$



$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{3} = \frac{2}{3}\pi = \frac{1}{3}$$

* Phase is not changeable in wave.

$$(kx - \omega t) = \text{constant}$$

$$k \frac{dx}{dt} - \omega = 0$$

$$\frac{dx}{dt} = \frac{\omega}{k}$$

$$v = \frac{\omega}{k}$$

ω → Angular Frequency

k → Wave number

$$v = \frac{\omega}{k} = \frac{2\pi}{T} \cdot \frac{\lambda}{2\pi}$$

$$\boxed{v = \frac{\lambda}{T} = f\lambda}$$

$$Y_{(x,t)} = Y_m \sin(kx - \omega t + \phi)$$

$$Y_{(x,t)} = 10 \sin\left(x - 2t + \frac{\pi}{2}\right)$$

Amplitude = 10 m

Wave Number, $k = 1$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{1} = 2\pi$$

$\omega = 2$

$$f = \frac{\omega}{2\pi}$$

$$v = f\lambda$$

$$f = \frac{v}{\lambda} = \frac{\omega/k}{\frac{2\pi}{k}} = \frac{\omega}{2\pi}$$

$$v = \frac{\omega}{k} = \frac{2}{1} = 2\,ms^{-1}$$

L-21 / 14.12.2022 /

$$Y_{(x,t)} = Y_m \sin(kx - \omega t)$$

→ Amplitude

→ Wave Number

→ Angular Frequency

→ Moving Left to Right →

⊛

(i) $Y_{(x,t)} = 2\sin(4x - 2t)$

(ii) $Y_{(x,t)} = \sin(3x - 4t)$

(iii) $Y_{(x,t)} = 2\sin(3x - 3t)$

$$v_1 = \frac{\omega}{k} = \frac{2}{4} = 0.5$$

$$v_2 = \frac{4}{3} = 1.33$$

$$v_3 = \frac{3}{3} = 1$$

Direction to wave

Wave velocity

$v_2 > v_3 > v_1$

direction y-axis

particle Velocity

$$v_1 = \frac{dY_{(x,t)}}{dt} = -4\cos(4x - 2t)$$

$$v_2 = -4\cos(3x - 4t)$$

$$v_3 = -6\cos(3x - 3t)$$

maximum velocity

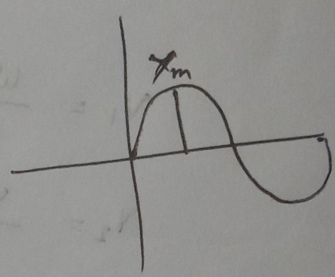
$v_3 > v_1 = v_2$

(i) Same amplitude

(ii) Same Wave Length / Frequency

(iii) Same direction → Constructive interference → Can create a big wave

(iv) Different direction opposite → Then they will cancelled each other → Standing Wave



$$Y_1(x,t) = y_m \sin(kx - \omega t)$$

$$Y_2(x,t) = y_m \sin(kx - \omega t + \phi)$$

$$Y = Y_1 + Y_2$$

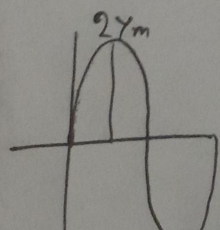
$$= y_m \sin(kx - \omega t) + y_m \sin(kx - \omega t + \phi)$$

$$= 2y_m \sin\left(kx - \omega t + \frac{\phi}{2}\right) \cos\left(\frac{\phi}{2}\right)$$

$$= \underbrace{2y_m \cos\frac{\phi}{2}} \cdot \sin\left(kx - \omega t + \frac{\phi}{2}\right)$$

→ Amplitude

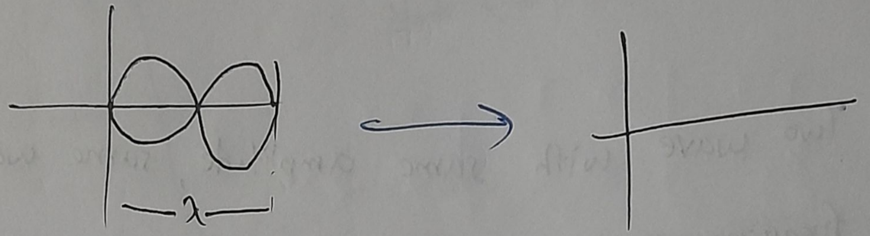
→ Time independent



→ Constructive Interference

⊛ if, $\phi = 0$, then amplitude max
and it two times than before.

⊛ if there is a phase differenence of π. opposite direction.
then amplitude will be 0.



Distructive
Wave

⊛

Degree	Radians	Wavelength	Amplitude	Type of Interference
0	0	0	$2y_m$	fully constructive
120	$\frac{2\pi}{3}$	0.33	y_m	intermediate
180	π	0.5	0	fully Distructive
240	$\frac{4\pi}{3}$	0.67	y_m	Intermediate
360	2π	1	$2y_m$	fully constructive
865	15.1	2.4	$0.60\ y_m$	Intermediate

⊛

$0.2 \rightarrow C$

$0.4 \rightarrow D$

$0.8 \rightarrow C$

Fully Intermediate $\begin{cases} 0.75 \rightarrow I \\ 0.25 \rightarrow I \end{cases}$

Possibilities

$\lambda \approx 0 \rightarrow C$

$\lambda \approx 0.5 \rightarrow D$

$\rightarrow I$

⊛ Two wave with same amplitude, same wave, same frequency, same direction.

Phase Difference, $\phi = 50$ / $y_m = 0.5$

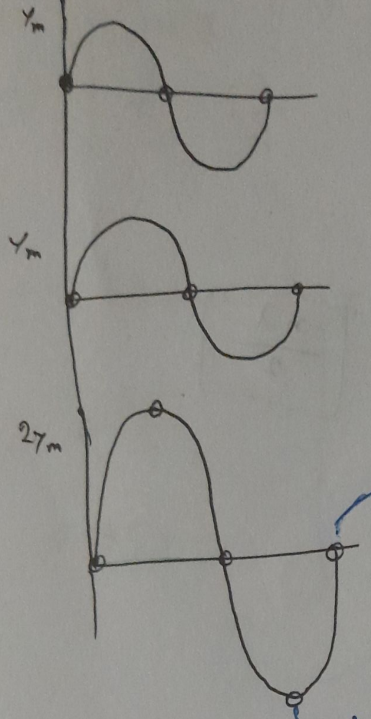
$Y = ? \longrightarrow \left|2y_m \cos\frac{\phi}{2}\right|$

⊛ $y_m = 0.5$ m

$Y = 0.8$ m

$\phi = ?$

$Y = \left|2y_m \cos\frac{\phi}{2}\right|$



Standing Wave

$$Y_1 = Y_m \sin(kx - \omega t)$$

$$Y_2 = Y_m \sin(kx + \omega t)$$

$$Y = Y_1 + Y_2$$

$$= Y_m \sin(kx - \omega t) + Y_m \sin(kx + \omega t)$$

$$Y = \underbrace{2Y_m \sin(kx)}_{\text{Amplitude : Time independent.}} \cos(\omega t)$$

Node,

$$\sin kx = 0$$

$$\sin kx = \sin n\pi$$

$$kx = n\pi$$

$$x = \frac{n\pi}{k} = \frac{n\pi}{\frac{2\pi}{\lambda}} = \boxed{\frac{n\lambda}{2}}$$

$n=0$	$n=1$	$n=2$
$x=0$	$x=\frac{\lambda}{2}$	$x = \cancel{o}\lambda$

Anti node

$$\sin kx = \sin\frac{\pi}{2} = \sin\frac{3\pi}{2} = \sin\frac{5\pi}{2}$$

$$= \sin\frac{(2n+1)\pi}{2}$$

$$kx = (2n+1)\frac{\pi}{2}$$

$$x = \frac{(2n+1)\frac{\pi}{2}}{k}$$

$$= \frac{(2n+1)\frac{\pi}{2}\cdot\lambda}{2\pi}$$

$$x = \left(n+\frac{1}{2}\right)\frac{\lambda}{2}$$

$n=0$ | $n=1$

$x = \frac{\lambda}{4}$ | $x = \frac{3\lambda}{4}$

⊛ Two red light crossing each other, $\lambda = 650$ nm. Find out node position.

⊛ $\lambda = 650$ nm

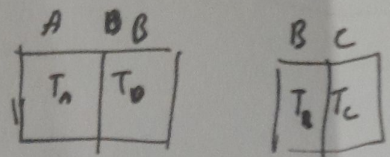
$\therefore x = n\frac{650}{2}$

$= 325n$

PHY 107 / L-22 / 17.12.2022

Tempanature Conversion.:

$T_A = T_B$



Zenoth Law of thermodyn..

$T_A = T_C$

First Law of thermodynamics

→ represent energy conservation

$$Q = W + \Delta u$$

→ Internal Energy

20J <20J

System gain energy → +Q

System Loss " → -Q

Work done by the system → +W

Work done on the system → -W

$$Q = -100 + 74 = -26\,J$$

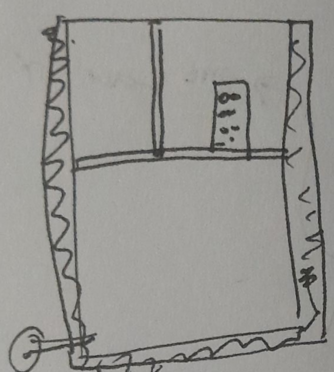
$W = -100\,J$

$\Delta u = 74\,J$

Comment:

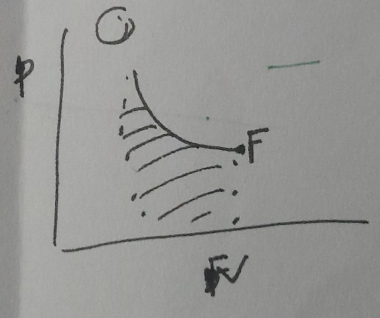
System is losing energy 26 jul as heat.

$$PV = \frac{F}{A} V$$

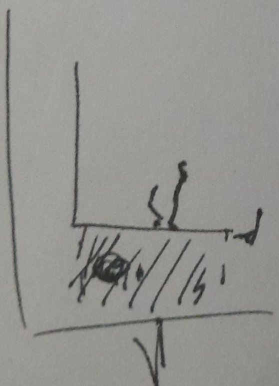


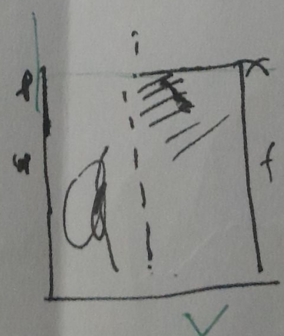
$$W = P\Delta V$$

$$\int dW = \int p\,dV$$



P





2nd Law

~~N-Trapi~~ N-Topi

N-topi enercase in irreversal process

decrease in reversical process

irreverse $\Delta S > 0$

reverse = $\Delta S = 0$

~~$\Delta S \geq 0$~~

$\boxed{\Delta S \geq 0}$ → 2nd Law of thermodynamics

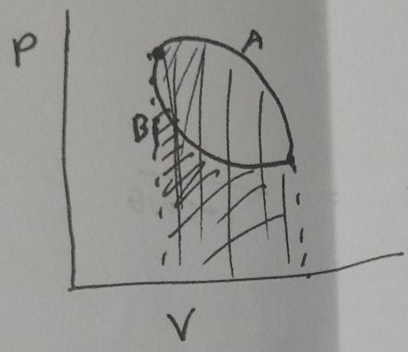
⊛ De

⊛ ...

1

PHY-107 / L-23 / 21.12.2024

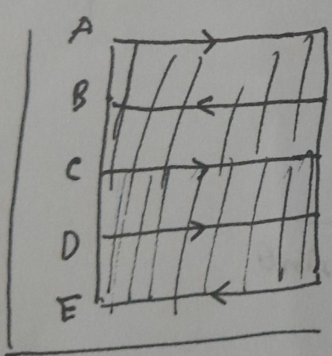
$W = P \; \Delta V$



Way of A > Way of B

(Work Done)

(under the curve)



$\boxed{A \to E}$ → maximum positive work done.

$\boxed{A \to E} > \boxed{C \to E} > \boxed{A \to B} = \boxed{D \to E}$

according to positive work done

Rotation

$\theta(t) = t^2 + 2t + 1$

$\omega(t) = \frac{d\theta}{dt} = 2t + 2$

$\alpha(t) = 2$

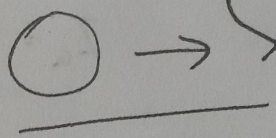
$t = 2$ sec.

$a_t = \alpha r$

$a_r = \frac{v^2}{r}$

$= \omega^2 r$

$\alpha = \frac{d\omega}{dt}$



$\omega = 5$ rad/se

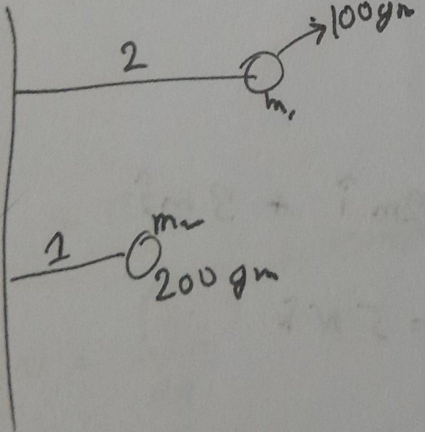
$\omega = 3$ rad/sec

a_r = defined

$a_t = \frac{d\omega}{dt} \to 0$

changing then

$a_r = a_t$ = defined



$I = mr^2$

$I_1 > I_2$

i j k

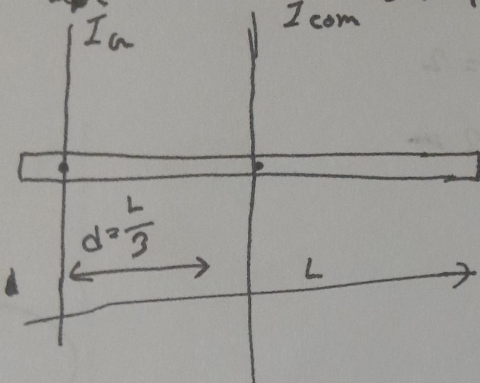
$-j \times k = -i$

⊛ Previous Object,

$k = 10\ J$ $\qquad k = \frac{1}{2} m v^2$

$\omega = ?$ $\qquad k = \frac{1}{2} I \omega^2$

$I_{com} = \frac{1}{12} m L^2$



$$\boxed{I_a = I_{com} + m d^2}$$

$$= \frac{1}{12} m L^2 + m \left(\frac{L}{3}\right)^2$$

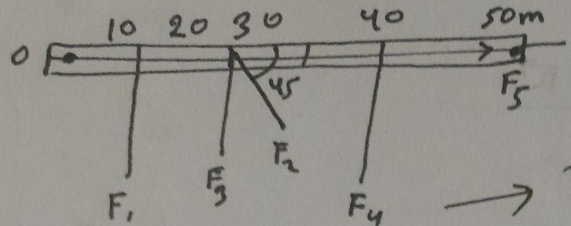
$$= \frac{1}{12} m L^2 + m \frac{L^2}{9}$$

⊛ Torque

$\bar{\tau} = \bar{r} \times \bar{F}$ $\qquad r = 2m\,\hat{i} + 3m\,\hat{j}$

$x \quad \boxed{z} \quad -y$ $\qquad \bar{F} = 5N\,\hat{k}$

$$\bar{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 0 \\ 0 & 0 & 5 \end{vmatrix}$$



$\rightarrow \tau = 400$ Nm

$$F_4 > F_3 > F_1 > F_2 > \overset{\rightarrow 0}{F_5}$$

$$\tau_4 > \tau_3 > \tau_1 > \tau_2 > \tau_5$$

$\tau = 10\,Nm$

$F = ma$

$\alpha = 2\,rad/sec^2$

$\tau = I\alpha$

$I = ?$

$F = 0$

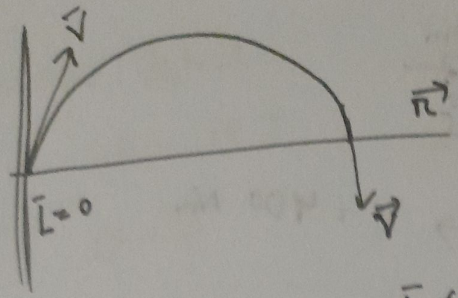
$\rightarrow$ constant if $F = 0$

$\vec{P} = ?$ $\boxed{\frac{d\bar{P}}{dt} = F}$

$\boxed{\bar{L} = \bar{r} \times \bar{p}}$

$\rightarrow$ constant

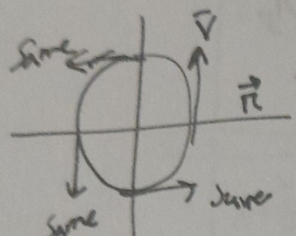
$\bar{\tau} = 0 = \frac{d\bar{L}}{dt}$



$\bar{L} \neq 0$

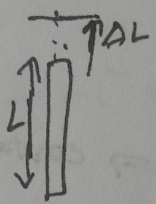
$L = \bar{r} \times \bar{p}$

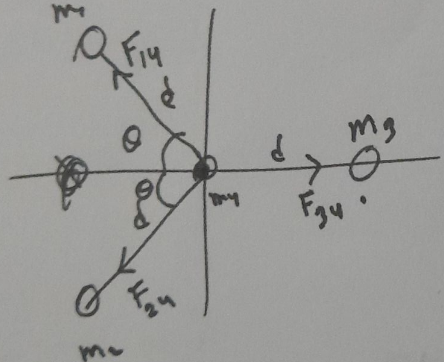
$= \bar{r} \times m\vec{v}$



direction but changing and Angular Momentum not changing

$\frac{F}{A} = E\frac{\Delta L}{L}$ (Find out formula which is applicable)





$F_{34} = G\frac{m_3 m_4}{d^2}$

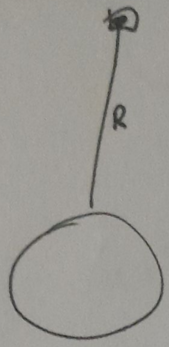
$F_{net} = F_{34} - F_{14}\cos\theta - F_{24}\cos\theta$

$= 0000$

$\frac{Nm^2}{kg^2}\frac{kg \cdot kg}{m^2}$

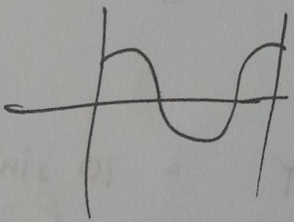
$F = N$

$$u = \frac{-G\overset{\text{Earth}}{M}\,\overset{\text{my}}{m}}{\underset{\text{from surface}}{R}}$$



$$V_{Escape} = \sqrt{\frac{2G\overset{\text{kg}}{M}}{\underset{\text{meter}}{R}}}$$

$$x_{(t)} = x_m \cos(\omega t + \phi)$$



$t = 0, \phi = 0$

$x_{(t)} = x_m$

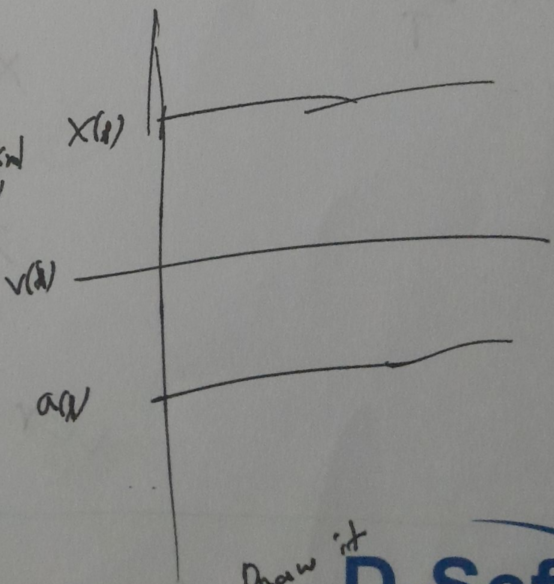
$$\omega = \sqrt{\frac{k}{m}}$$

$v: ?$

$= \omega x_m$

$$|v(t)| = |\omega x_m|$$

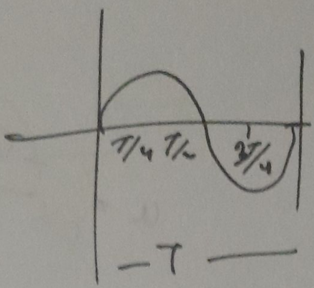
$$|a_{(t)}| = |\omega^2 x_m|$$



Draw it

$t = 0$

$x(t) = 0$



$t = 0.75\,T$

$x(t) = -x_m$

$$\boxed{E = \frac{1}{2} k x_m^2}$$ Total Energy

$$\cancel{y}\; Y_{(x,t)} = y_m \sin(kx - \omega t + \phi)$$

$k = \frac{2\pi}{\lambda}$

$\omega = \frac{2\pi}{T}$

$$Y = 10 \sin\left(2x - t + \frac{\pi}{2}\right)$$

$x_m = 10$

$k = 2$

$\lambda = ?\quad \frac{2\pi}{k} = \frac{2\pi}{2} = \pi = \frac{\pi}{2\pi} = \frac{1}{2}$

$= 0.5$

$$v = \frac{\omega}{k}$$

Find V in both axis

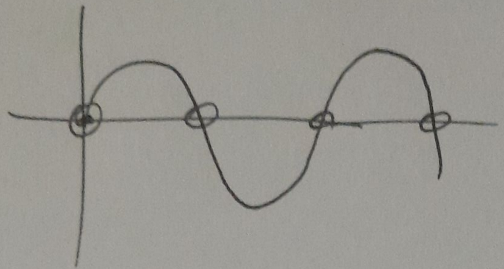
$Y' = 2y_m \sin kx \cos\frac{\phi}{2}$

$|Y'| = 2y_m \cos\frac{\phi}{2}$ $\qquad y_m = 0.5\,m$ $\quad |Y'| = ?$ amplitude

$\phi = 200^\circ$

$\eta = 0$

$x = 0$



$$x = \frac{n\lambda}{2}$$

$$x = \frac{n\,600}{2} = n\,300 \text{ Nm}$$

$n = 0$	$n = 1$	$n = 2$
$x = 0$	$x = 300$	$x = 600$

Temperature converde

Q.

$$Q = W + \Delta U$$

by the system positive
on the system negative
} work done

Calculate Q;

$\boxed{\text{Today Notes}}$