Chapter 14 : Fluids :-

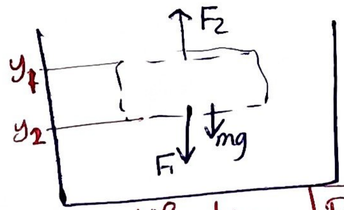
14.1

$$P = \frac{\Delta m}{\Delta V}$$

$$P = \frac{\Delta F}{\Delta A} \rightarrow \text{Pascal (Pa)} \rightarrow 1\,atm \rightarrow 1.01\times10^5\,Pa = 760\,torr = 14.7\,lb/in^2$$

14.2

Fluids at rest



$F_{net} = 0$

$-F_1 + F_2 - mg = 0$

$F_2 = F_1 + mg$

$P_2 A_2 = P_1 A_1 + mg$

$P_2 \cancel{A} = P_1 \cancel{A} + (\rho(\cancel{A}h))g$

$P_2 = P_1 + \rho g (y_1 - y_2)$

$$\boxed{P_2 = P_1 + \rho g h}$$

$P = \boxed{P_0} + \rho g h$ → مدى العمق فقط

P_0 → Pressure at surface وبالعادة يكونه الضغط الجوي

لأعطاني نقطة في الشكل

by difinction $\boxed{P = \frac{F}{A}}$

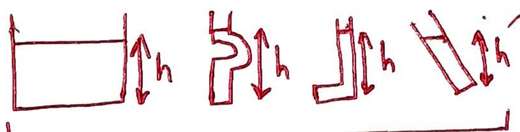
$\rho = \frac{m}{V}$

gauge Pressure $= P - P_0 = \rho g h$

اذا اردنا نحسب الضغط فوق سطح الارض سيصبح السائل هو الهواء ← $P = P_0 - \rho_{air} g d$

كل ما ارتفعنا عن سطح الارض قلّه الضغط فأصبح الهواء يقل

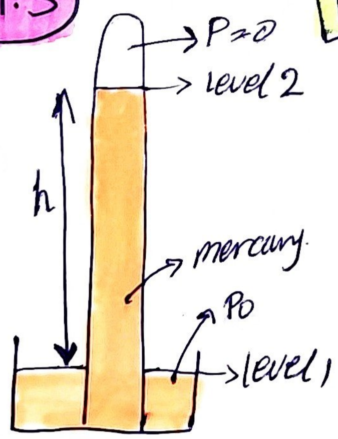
* اذا كانت الانابيب بنفس العمق والارتفاع (h) سوف يكونون نفس الضغط مهما اختلف الشكل اذا كانوا في حالة الاتزان



all this tube the same Pressure

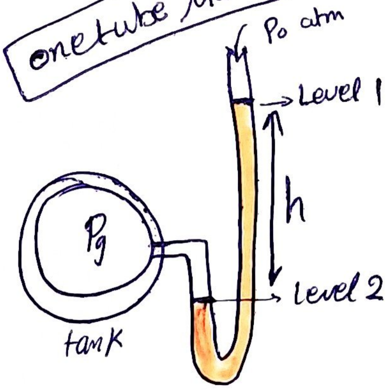
14.3

Barometer



$$\boxed{P_0 = \rho g h}$$

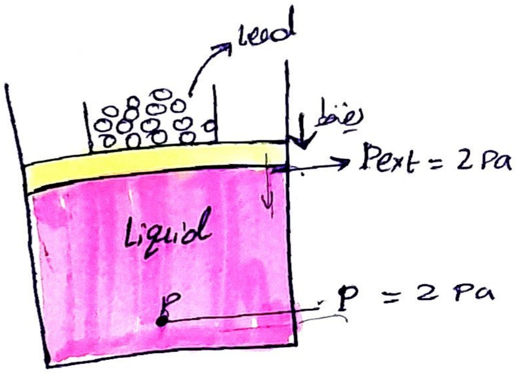
one tube Manometer



$P_g = P - P_0 = \rho h g$

ممكن طلع + او -

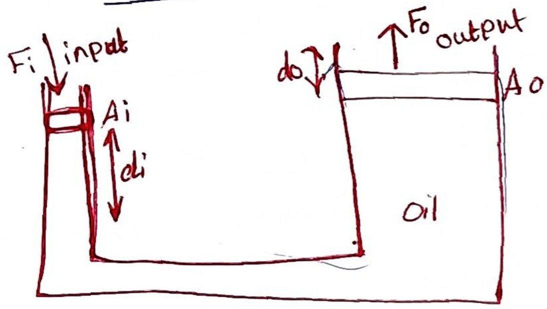
14.4 Pascal's Principle :-



$\Delta P = \Delta P_{ext}$ independent of (h)

لا يعتمد على العمق

يتوزع الضغط بنفس المقدار عند أي نقطة .



$\Delta P_i = \Delta P_o$

$\frac{F_i}{A_i} = \frac{F_o}{A_o}$

$\boxed{F_i = F_o \left(\frac{A_i}{A_o}\right)}$

- يعني القوة التي اضغط بها المساحة الصغيرة تساوي نصف القوة التي تخرج من المساحة الكبيرة .
- حجم السائل المضغوط سوف يساوي حجم السائل الخارج لذلك :

$V_i = V_o$

$A_i d_i = A_o d_o$

$\boxed{d_i = d_o \left(\frac{A_o}{A_i}\right)}$

المسافة التي ضغطت بها المساحة الصغيرة راح تكون أكبر من المسافة التي تخرج

$W = F d$

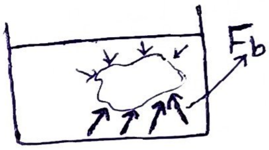
$F_i d_i = F_o \left(\frac{A_i}{A_o}\right) \cdot d_o \left(\frac{A_o}{A_i}\right)$

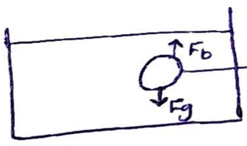
$\boxed{F_i d_i = F_o d_o}$

$W_i = W_o$

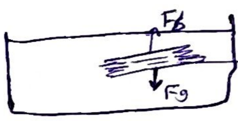
الطاقة محفوظة .

14.5 Archimedes Principle





rock / stone $F_g > F_b$
So it's downward.



wood $F_b > F_g$ So it's upward.

* $F_b = m_f g$
  - m_f : كتلة السائل المزاح
  - g : تسارع الجاذبية
  - F_b : قوة الطفو

* إذا كانت الجسم في حالة الاتزان مثل .

$\boxed{F_b = F_g}$

$F_b = F_g$

$\boxed{m_f g = m g}$

$\boxed{F_g = m_f g}$ floating يطفو

$W_{app} = W_{act} - F_b$ الوزن الظاهري = الوزن الحقيقي - قوة الطفو

مثل الوزن في الماء عند حمل الشئ في الماء فيكون الوزن قليل ولكن هذا هو الوزن الظاهري بسبب قوة الطفو التي تدفع معي .

$W = \underset{\text{water}}{\rho}\, V g$

وزن السائل المزاح

حجم السائل المزاح

14.6 Equation of Continuity

$A_1V_1 = A_2V_2$

$V = $ ~~volume~~ (speed)

$R_V = A\overset{\text{speed}}{V} = \text{constant}$

Rate volume of flow $\left(\frac{V}{t}\right)$ → volum

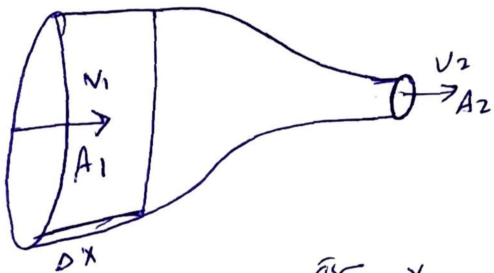
$R_m = \rho R_V = \rho A V = \text{constant}$.

ρR_V

$R_V = R_V$

للمساحة الأولى — للمساحة الثانية

دائماً نفسها



$\Delta V_1 = \Delta V_2$

$A_1X_1 = A_2X_2$

$A_1V_1\cancel{t} = A_2V_2\cancel{t}$

$\boxed{A_1V_1 = A_2V_2}$

$\boxed{R_V = AV} = \text{cons.}$

as سرعة $V = \frac{X}{t}$

$R_m \Rightarrow \frac{\rho V}{t} = \rho R_V$

$\rho AV = \text{const.}$

14.7 Bernoulli's Equation

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g y_2$$

$$\boxed{P + \frac{1}{2}\rho V^2 + \rho g y = \text{Constant}}$$

العلاقة عكسية بين السرعة والمسافة (الارتفاع) والضغط

$P + \frac{1}{2}\rho v^2 + \rho g h$

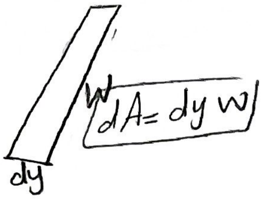
$P = \frac{1}{2}\rho(v_2^2 - v_1^2)$

اذا كانت السرعة عالية والارتفاع عالي

فإن الضغط يقل

والعكس صحيح

Chapter 14:
(3, 8, 18, 24, 51)



Q3:-

$dA = W\,dy$

a) $dF = P(dA) = (\rho g y)(W dy)$
$= \rho g y W dy$

$F = \int_0^D \rho g y\, w dy \Rightarrow \rho g W \int_0^D y dy$

$= \frac{1}{2}\rho g w (D^2 - 0^2) =$

$= \frac{1}{2}(1000)(10)(250)(30)^2 = \boxed{1.1 \times 10^9}$

b) $d\tau = dF(D-y)$

$\tau = \int (D-y) dF$

$\tau = \rho g W \int_0^D y(D-y) dy \Rightarrow \tau = \rho g W \left(\frac{Dy^2}{2} - \frac{y^3}{3}\right)\Big|_0^D$

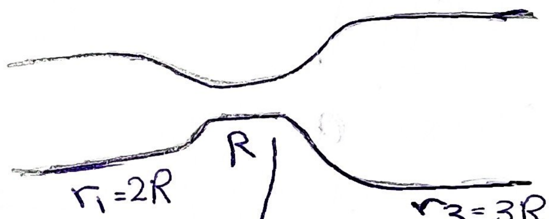
$\tau = \rho g W \left(\frac{D^3}{2} - \frac{D^3}{3}\right) = \rho g w \left(\frac{D^3}{6}\right)$

$= (1000)(10)(250)\left(\frac{(30)^3}{6}\right) = \boxed{1.125 \times 10^{10}}$

c) $\tau = rF$

$r = \frac{\tau}{F} = \boxed{\frac{D}{3}} = \frac{30}{3} = \boxed{10m}$

Q8



$A_1V_1 = A_2V_2 = A_3V_3$

$\pi(2R)^2 V_1 = \pi(R)^2 V_2 = \pi(3R)^2 V_3$

$\boxed{4V_1 = V_2 = 9V_3}$

$V_1 = \frac{V_2}{4} = \frac{0.62}{4} = 0.155$

$W = F.d = P\Delta V$

$\Delta P = \frac{1}{2}\rho \Delta v^2$

$\Delta P = \frac{1}{2}\rho(V_2^2 - V_1^2)$

$\Delta P = \frac{1}{2}(1000)((0.62)^2 - (0.155)^2)$

$= 180.187$ Pa

$W = PV$

$= (180.2)(0.7) = \boxed{126.13}$

Q18 $m_f = 501\,kN$

$F_b = F_g$

$F_g = m_f g$

$F_b = m_f g$

$W = \rho V g \Rightarrow (1000)\, V_f\, (10) = 501\,kN$

وزن السائل المزاح — water — سائل المزاح

$V_f = \frac{501 \times 10^3}{10000} = 5.01\ m^3$

$W = \rho V g$
$= (1.1\times10^3)(5.01)(10)$
$= 55.1 \times 10^3\,kN \rightarrow 55$

$\Delta V = V_w - V_s$
$= 5.01 - 5.17 = 0.08$

Q24 :- <u>Pascal Principle</u>

$\frac{F}{A} = \frac{f}{a}$

a) $\boxed{F = f\left(\frac{A}{a}\right)}$

b) $R_1 = \frac{3.5}{2} = r_1 \quad a = \pi\left(\frac{R}{2}\right)^2$

$R_2 = \frac{60}{2} = r_2 \quad A = \pi\left(\frac{R}{2}\right)^2$

$f = 20N \quad F = 20\left(\frac{A}{a}\right) = \square\ N$

Q51

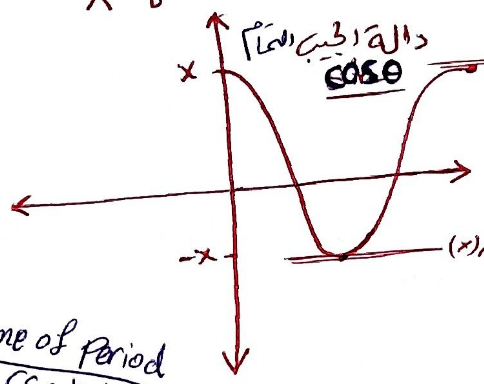
a) $P = \rho g h = Pa$

b) $P \rightarrow torr$
$P \rightarrow 1.1\times10^5\,Pa \rightarrow 760\ torr$

Chapter 15 Oscillations التذبذبات

15.1 Simple harmonic motion

الحركة التوافقية البسيطة
- كتلة في نهاية زنبرك → مثل
- كتلة تتأرجح يمين وشمال → مثل



عند الاشتقاق يعطينا السرعة تكون بتساوي نقطة السرعة تساوي صفر (المماس أفقي).

* f = frequency = $\boxed{\frac{1}{T}}$ s^{-1} / Hz

T → time of Period
زمن الدوري

عدد المرات التي يتذبذب فيها في الدورة الكاملة

SHM
نوع من أنواع الحركة الاهتزازية والتي تكون فيها الجسم متذبذب حول موضع اهتزازه
- مثل حركة البندول (θ small)
- الشاحنة ذات العدة والزنبرك.

$F = -x$
تتناسب طرديًا وعكسيًا مع الإزاحة

Simple Harmonic motion

* (Sinsoudl function)

$x(t) = x_m \cos(\omega t + \phi)$

- $x(t)$ → desplacment at time
- x_m → Amplitude
- t → time
- ω → Angular frequncy
- $(\omega t + \phi)$ → (Phase)
- ϕ → Phase constant or angle

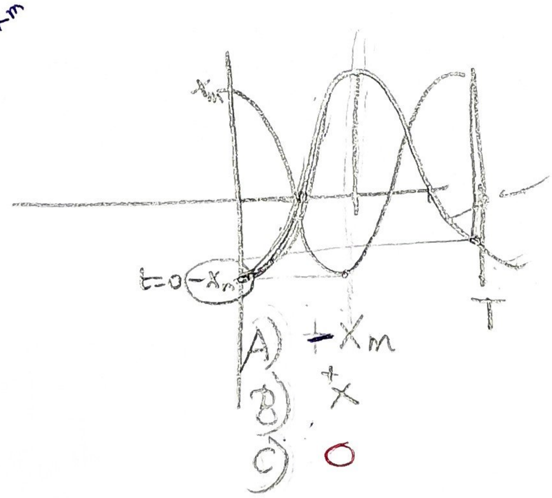
$\omega = 2\pi f = \frac{2\pi}{T}$

Check Point 1-1 :-

At $t=0$ $x \to -x_m$

$2T = ?$
$3.5T = ?$
$5.25T = ?$

- T → دورة كاملة
- 2T → راح يرجع نفس النقطة عدد صحيح
- 3.5 → راح يطلع لفوق
- 5.25 → راح يرجع صفر



A) $+x_m$
B) $+x$
C) 0

* Velocity can be found by derivative of Position function

$x(t) = x_m \cos(\omega t + \phi)$

$\dot{x}(t) = -x_m \sin(\omega t + \phi)\ \omega$

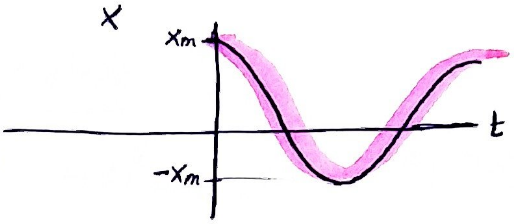
$v(t) = -\omega x_m \sin(\omega t + \phi)$

$(\omega x_m) \to v_m \to$ (velocity amplitude)

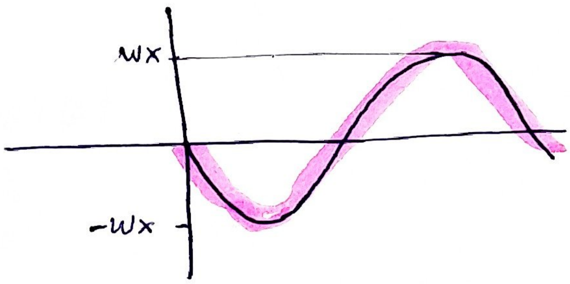
$a(t) = -\omega^2 x_m \cos(\omega t + \phi)$

$(\omega^2 x_m) \to a_m \to$ (acceleration amplitude)

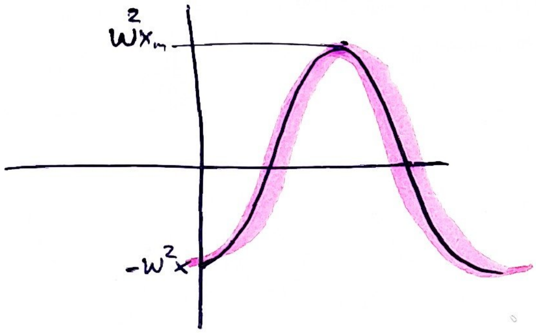
* $x(t) = x_m \cos(\omega t + \phi)$



* $v(t) = -\omega x_m \sin(\omega t + \phi)$



* $a(t) = -\omega^2 x_m \cos(\omega t + \phi)$



Check Point 2:-

A) $a = 3x^2$
B) $a = 5x$
C) $a = -4x$
D) $a = -2/x$

Who the relationships between (a) and (x) SHM? → $a(t) = -\omega^2 x(t)$

$\boxed{a = -4x}$

$\omega = 2$ A

* $F = ma = m(-\omega^2 x) = \boxed{-m\omega^2 x}$

هوكي لو

$F = \underbrace{-K}_{-m\omega^2} x$

$\boxed{\omega = \sqrt{\frac{k}{m}}}$ → حالة خاصة → السرعة الزاوية دال فقط ثابت السبرنك spring K

$\boxed{T = 2\pi\sqrt{\frac{m}{k}}}$

15.2 Energy in simple harmonic Motion

$F = ma$, $k = \omega^2 x$, $\frac{k}{\omega^2}$

$K(t) = \frac{1}{2}mv^2 \rightarrow \frac{1}{2}m(-\omega x \sin(\omega t+\phi))^2 \rightarrow \frac{1}{2}m\omega^2 x^2 \sin^2(\omega t+\phi) \Rightarrow \frac{1}{2}kx^2\sin^2(\omega t+\phi)$

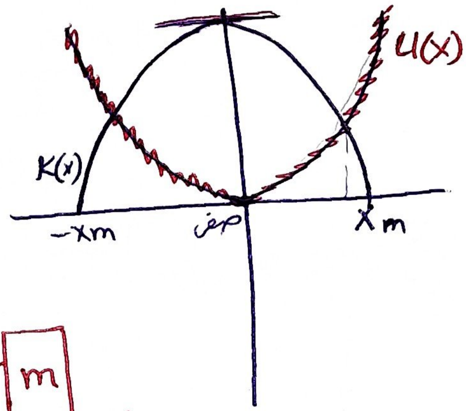
$U(t) = \frac{1}{2}kx^2 \rightarrow \frac{1}{2}k(x\cos(\omega t+\phi))^2 \rightarrow \frac{1}{2}kx^2\cos^2(\omega t+\phi) \Rightarrow \frac{1}{2}kx^2\cos^2(\omega t+\phi)$

$E = U + K$

$= \frac{1}{2}kx^2\cos^2(\omega t+\phi) + \frac{1}{2}kx^2\sin^2(\omega t+\phi)$

$= \frac{1}{2}kx^2 \underbrace{(\cos^2(\omega t+\phi) + \sin^2(\omega t+\phi))}_{1}$

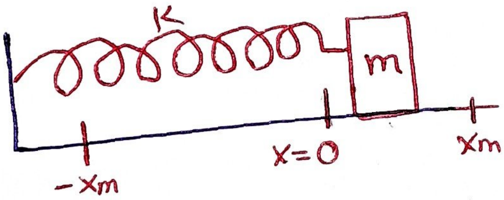
$E \boxed{= \frac{1}{2}kx_m^2}$



Check Point :

$K = 3J$
$U = 2J$
$x = 2cm$

What K? $x = 0$
U? $x = -2$
$x = -x_m$



a) $U = \frac{1}{2}kx^2 \rightarrow 2 = \frac{1}{2}k(2)^2$ $\boxed{k = 10000}$
$= 0$
$E = U + K$
$= 2 + 3 = 5J$
$K = 5J$ in $x = 0$

b) $U = \frac{1}{2}kx^2$
$= \frac{1}{2}(10000)(-2)^2$
$= 2J$

$U = \frac{1}{2}k(-x_m)^2$
$= \frac{1}{2}(10000)(x_m)^2$
$= \frac{1}{2}kx_m^2 = E = 5J$

F
C
F

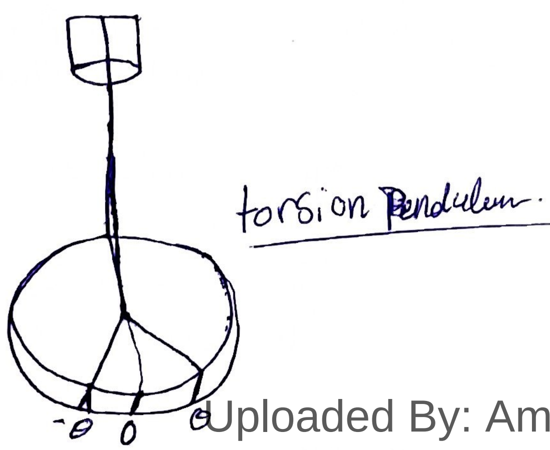
15.3 An Angular SHMO?

$F = -kx \leftarrow \tau = -k\theta$

ma, $\omega^2 x$

k: torsion constant

$T = 2\pi\sqrt{\frac{I}{k}}$ → replace (m)

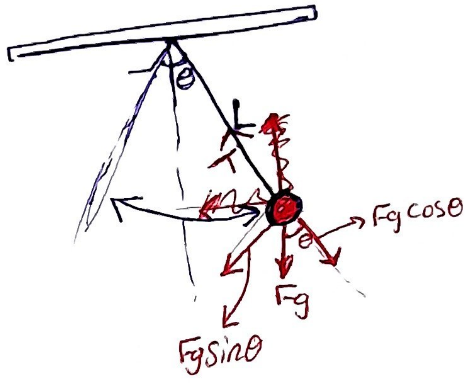


15.4 Pendulums, Circular motion

* Simple Pendulum

$\tau = F r$

$\tau = I\alpha$



$F r = I\alpha$

القوة المسؤولة عن التذبذب

$F_g\sin\theta\; r = I\alpha$

$r \to L$

$-L F_g \sin\theta = I\alpha \Rightarrow \alpha = \dfrac{-L F_g\sin\theta}{I}$

$-$ → x السالب

$\sin\theta = \theta$

$\alpha = \dfrac{-L\, mg\,\theta}{I}$

rememple

$a = -w^2 x$

$w^2 \to \dfrac{Lmg}{I}$, $x \to \theta$

$\alpha = -\dfrac{Lmg}{I}\theta$

$w = \sqrt{\dfrac{mgL}{I}} \Rightarrow T = 2\pi\sqrt{\dfrac{I}{mgL}} \Rightarrow 2\pi\sqrt{\dfrac{mL^2}{mgL}} = \boxed{2\pi\sqrt{\dfrac{L}{g}}}$

$x_m - \frac{1}{2}x_m$

$x_m e^{-\frac{bt}{2m}}$

$E = \frac{1}{2}kx e^{...}$

* Physical Pendulums غلطنا مش عليكم

15.5 Damped Simple H.M

$w' = \sqrt{\dfrac{k}{m} - \dfrac{b^2}{4m^2}}$

w' → Angular frequency of Damped

$F_d = -bV$

$-$ → عكس اتجاه

b → ثابت التخميد

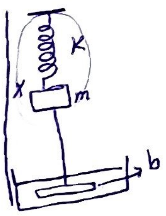
V → سرعة

$\sum F = ma$

$-bV - kx = ma$

but $V = \dfrac{dx}{dt}$ $\quad a = \dfrac{d^2x}{dt^2}$

$\Rightarrow \boxed{m\dfrac{dx^2}{dt^2} + b\dfrac{dx}{dt} + kx = 0}$



$x(t) = x_m e^{-\frac{bt}{2m}}\cos(w't + \phi)$

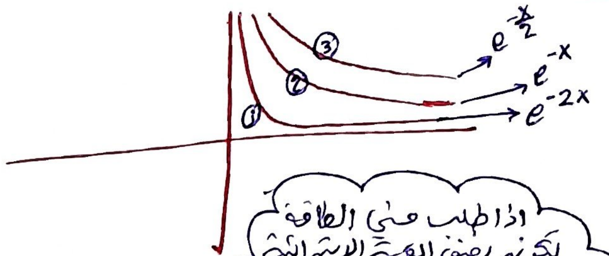
$E(t) = \frac{1}{2}kx_m^2 e^{-\frac{bt}{m}}$ → الطاقة تعتمد بنقصانها على $e^{-\frac{bt}{m}}$ فقط
فقط المقدار لذلك اذا كانت القوة K

15.6

$w' = w$

A/x_m أكبر ما يمكن

Resonance
رنين
مثل الزلازل
جسر عليه جنود



① تقل بسرعة هائلة لذلك الزمن أقل

② تقل بسرعة أقل من ①

③ تقل بسرعة قليلة جداً زمن أكبر ..

اذا طلب مني الطاقة تكون نصف القيمة الابتدائية

$E = \frac{1}{2}kx^2 e^{-\frac{bt}{m}} = \frac{1}{4}kx^2$

4

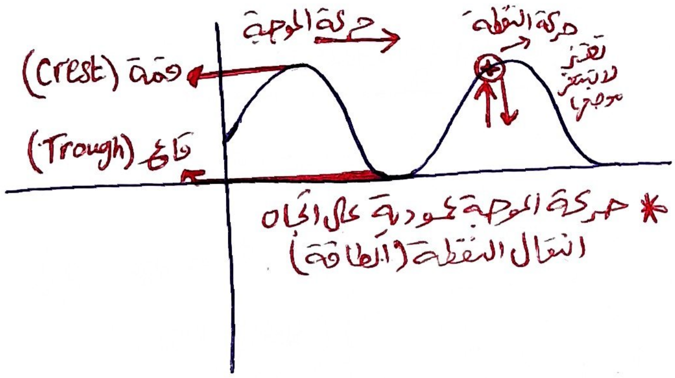
Chapter 16 Waves I

16.1 Transverse wave (

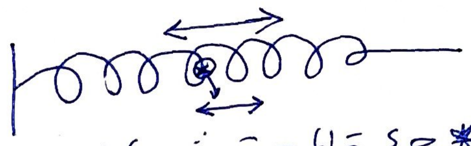
Three type of waves :-
- (Mechanical waves) → حبل / الصوت / ماء → تحتاج وسط للانتقال
- Electromagnetic waves. → التلفاز / الضوء / جوال / الراديو → لا تحتاج وسط → تنتقل في الفراغ
- Matter waves. → الالكترونات / بروتونات / ... → لا تحتاج وسط

We to Learn Mechenical wave :

Transverse waves : (الامواج مستعرضة) / Longitudinal waves (الطولية)

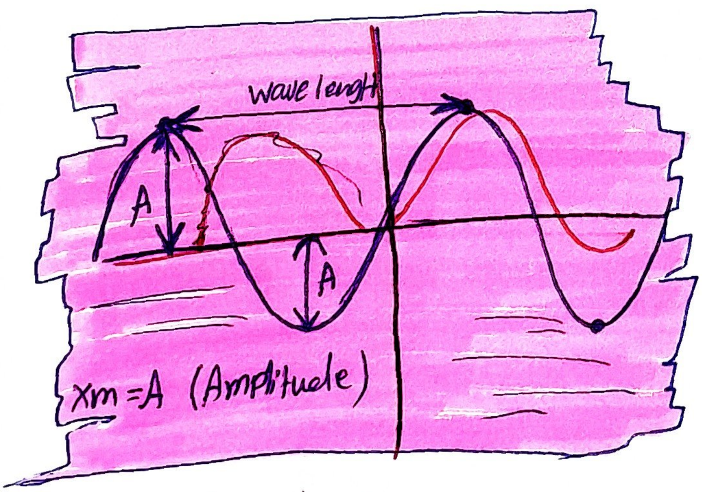


* حركة الموجة عمودية على اتجاه انتقال النقطة (الطاقة)



* حركة الموجة نفس حركة النقطة
same dirction

*

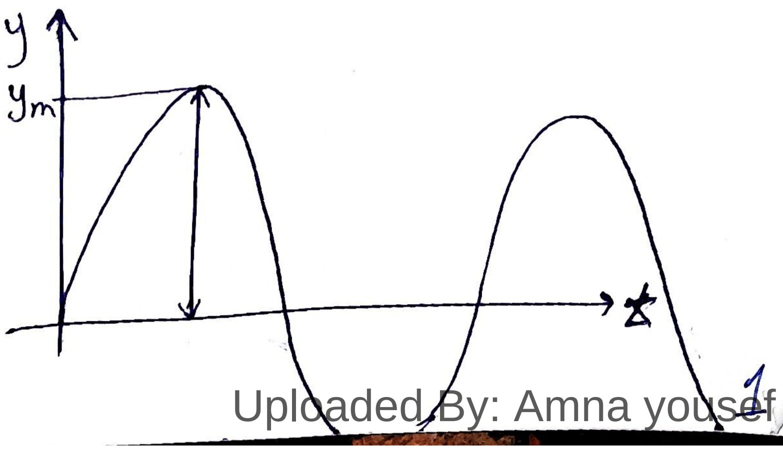


* $A = x_m =$ Amplitude → من المحور للقمة أو للقاع

* $\lambda =$ wave length → المسافة بين قمتين أو قاعين

المعادلة الرياضية التي تصف الامواج المستعرضة :-

$$\boxed{y(x,t) = y_m \sin(kx - \omega t)}$$

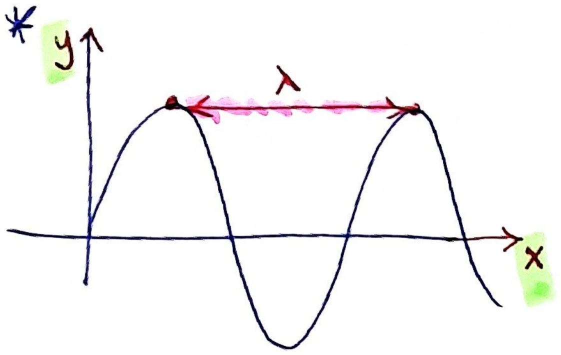


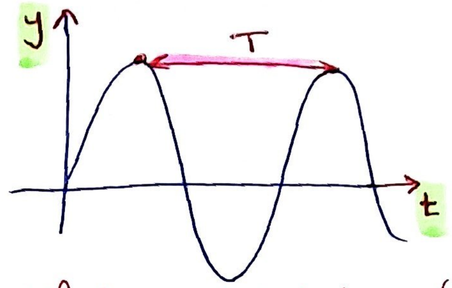
* $(kx - \omega t) \rightarrow$ Phase

K : angular wave number (m^{-1} / rad/m)

$K = 2\pi/\lambda$

W : angular frequney $= 2\pi f = \frac{2\pi}{T}$





* if the graph is between (y–x) the distance between two peaks or throughs is the (wave length) λ

* if the graph is between (y-t) the distance between two Peaks and two troagh is called the (time Period) (T)

- The speed of a Traveling wave :-

$kx - wt = \text{Constant}$

$k\frac{dx}{dt} - w = 0 \Rightarrow kv - w = 0$

(wave speed) $\boxed{V = \frac{w}{k}} = \boxed{\frac{\lambda}{T}} = \boxed{\lambda f}$

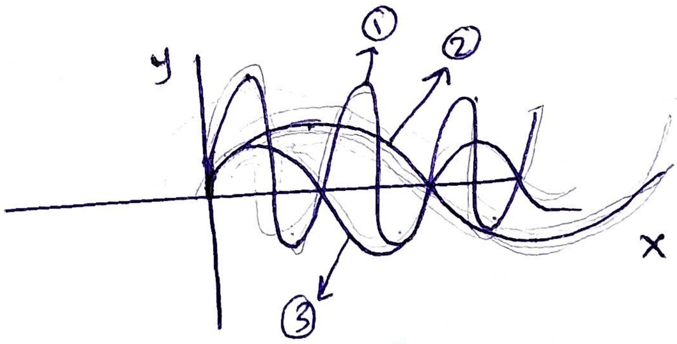
Checkpoint 1

$\lambda\downarrow \; k\uparrow \; \uparrow f$

a- $2x-4t \rightarrow 2$

b- $4x-8t \rightarrow 3$

c- $8x-16t \rightarrow 1$



Check Point 2

$Q_1 \rightarrow$ rank according wave speed and transvers speed ?

1) $y(x,t) = 2\sin(\overset{k}{4}x - \overset{w}{2}t)$

2) $y(x,t) = \sin(3x-4t)$

3) $y(x,t) = 2\sin(3x-3t)$

$-V = \frac{W}{K} = \frac{\lambda}{T}$

$2 > 3 > 1$

$A \cdot w \rightarrow \max(t.s)$

$\rightarrow u_1 = -4\cos(4x-2t)$

$\rightarrow u_2 = -4\cos(3x-4t)$

$\rightarrow u_3 = -6\cos(3x-3t)$

1

$u_3 > u_1 = u_2$

$6 > 4 = 4$

Cos اكبر قيمة لـ ← (1)

2

16. ملخص

* $y(x,t) = y_m \sin(kx - \omega t + \phi) \longrightarrow$ الموجة تمشي باتجاه +x لان السرعة موجبة

* $y(x,t) = y_m \sin(kx + \omega t + \phi) \longrightarrow$ الموجة تمشي باتجاه -x لان السرعة سالبة

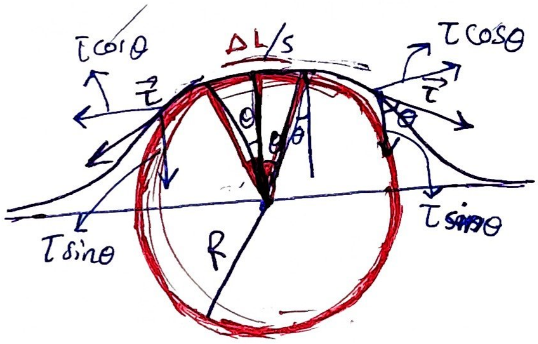
$\boxed{V = +\frac{\omega}{k}}$ $V = \boxed{-\frac{\omega}{k}}$

16.2 Wave speed on a stretched string

هناك سرعة موجة مستمرة خاصة بالحبل

$V = \sqrt{\frac{\tau}{\mu}}$ → τ: tention شد ; μ: Linear density

$\mu = \frac{m}{\Delta L}$



$\sum F_x = 0$

$\sum F_y = \tau\sin\theta + \tau\sin\theta$

$= 2\tau\sin\theta \longrightarrow \theta$ is very small

$= 2\tau\theta$

$S/\Delta L = r\Delta\theta$

$= R(2\theta) \rightarrow \Delta L = 2R\theta$

$\theta = \frac{\Delta L}{2R}$

$F = \cancel{2}\tau\left(\frac{\Delta L}{\cancel{2}R}\right)$

$\boxed{F = \frac{\Delta L\,\tau}{R}}$ $\longleftrightarrow$ $F = ma_c$, $F = m\frac{V^2}{r}$ → لانها حركة دورانية

$F = F$

$\frac{\Delta L\,\tau}{\cancel{R}} = \frac{mV^2}{\cancel{R}}$

$\Delta L\,\tau = mV^2$

$V^2 = \frac{\Delta L\,\tau}{m}$

$V = \sqrt{\frac{\tau}{\mu}}$

$\mu = \frac{m}{L}$

Checkpoint 3: String:

- $f \uparrow$
  - V? Same
  - λ? $\downarrow$
  - $V = \lambda f\uparrow$ → Same

- $\tau \uparrow$
  - V? $\uparrow$
  - λ? $\uparrow$
  - $V = \sqrt{\frac{\tau}{\mu}}$
  - $V = \frac{\lambda}{T}$

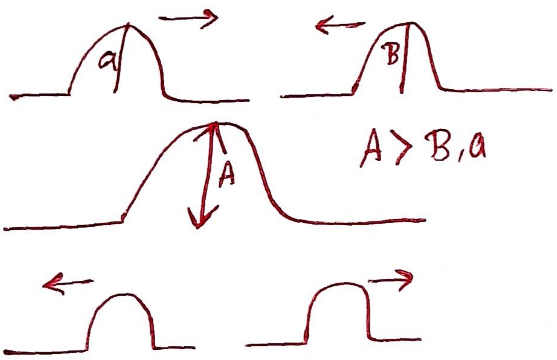
16.4: The wave Equation

$$\boxed{\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}}$$

16.5) Interfernee: التداخل

three type of interfernee

Constractive interfernee:- تداخل البناء



A > B, a

Distractive Interferne: تداخل هدام

القمة تتقدم القاع / القاع يتقدم القمة

intermedeb interfauee

موجة تبدأ قبل موجة
فلا تدمر أو تضاعف

example:-

$y_1 = y_m \sin(kx - wt)$
$y_2 = y_m \sin(kx - wt + \phi)$] Superposition Principle

$$\acute{y}(x,t) = y_1 + y_2$$
$$= y_m \sin(kx - wt) + y_m \sin(kx - wt + \phi)$$
$$= y_m \left(\sin(kx - wt) + \sin(kx - wt + \phi) \right)$$
$$= y_m \left(2 \sin\left(kx - wt + \frac{\phi}{2}\right) \cos\frac{\phi}{2} \right)$$

$$\boxed{\acute{y} = 2 y_m \cos\frac{\phi}{2} \sin\left(kx - wt + \frac{\phi}{2}\right)}$$

$$\sin\alpha + \sin\beta = 2 \sin\left(\frac{\alpha+\beta}{2}\right) \cos\left(\frac{\alpha-\beta}{2}\right)$$

معادلة رياضية

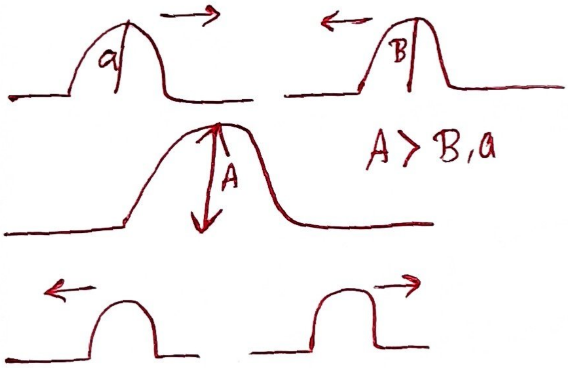
16.4: The wave Equation

$$\boxed{\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}}$$

16.5 Interfernce: التداخل

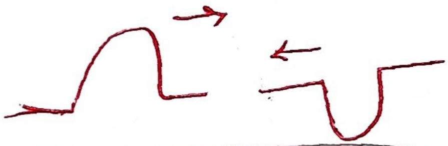
three type of interfernce

Constractive interfernce:- تداخل البناء



A > B,a

Distractive Interferne: تداخل هدام



القمة تصادم القاع / القاع يلاقي القمة

intermedet interfance

موجة تبدأ قبل موجة فلا تهدم أو تضاعف

example:-

$y_1 = y_m \sin(kx - wt)$
$y_2 = y_m \sin(kx - wt + \phi)$
] Superposition Principle

$$\grave{y}(x,t) = y_1 + y_2$$
$$= y_m \sin(kx - wt) + y_m \sin(kx - wt + \phi)$$
$$= y_m\left(\sin(kx-wt) + \sin(kx-wt+\phi)\right)$$
$$= y_m\left(2\sin\left(kx - wt + \frac{\phi}{2}\right)\cos\frac{\phi}{2}\right)$$

$$\boxed{\grave{y} = 2y_m \cos\frac{\phi}{2}\,\sin\left(kx - wt + \frac{\phi}{2}\right)}$$

$$\sin\alpha + \sin\beta = 2\sin\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right)$$

معادلة رياضية ♡

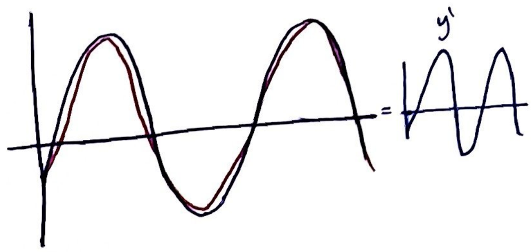
4

if $\phi = 0$

$\boxed{y' = 2y_m \sin(kx - \omega t)}$ Contractive interferenc

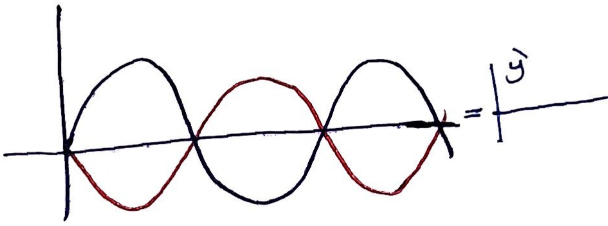
$\boxed{y'_m = 2y_m}$

$\phi = 0$



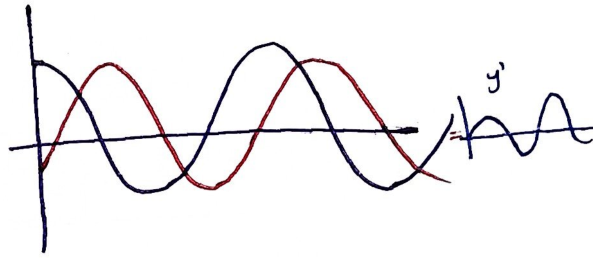
if $\phi = \pi$

$y' = 0$ No wave Distractive interfernce



if ϕ any ---

$2y_m > y'_m > 0$ intermedieal interfernce



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

$\frac{2\pi}{3} = \frac{\lambda}{3} = 0.33$ wavelength

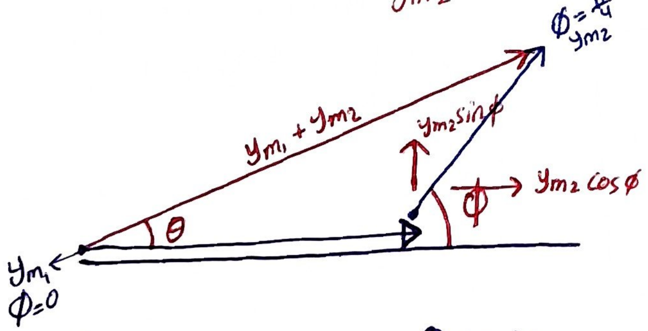
~~example~~

16.6 Phasors:

$y_1 = y_m \sin(kx - \omega t)$ → $\phi = 0$ → magnetude

$y_2 = y_{m_2} \sin(kx - \omega t + \phi)$ → dirction $= \frac{\pi}{4}$

$y_1 + y_2$ → Resultant $y_{m_1} = 3$, $y_{m_2} = 7$



$\sum y'_m x = y_{m_1} \hat{i} + y_{m_2}\cos\phi$

$\sum y'_m y = y_{m_2}\sin\phi$

$y'_m = (y_{m_1}\hat{i} + y_{m_2}\cos\phi) + y_{m_2}\sin\phi\,\hat{j}$

$y'_m = \sqrt{(y_{m_1} + y_{m_2}\cos\phi)^2 + (y_{m_2}\sin\phi)^2}$

$\theta = \tan^{-1}\left(\frac{y_{m_2}\sin\phi}{y_{m_1} + y_{m_2}\cos\phi}\right)$ → radian

$\theta = +$

يعني الموجة الأولى متأخرة عن الثانية.

$\theta = -$

يعني الموجة الأولى متقدمة عن الثانية

16.7 Standing waves and Resonance

$y_1 = y_m \sin(kx - \omega t)$

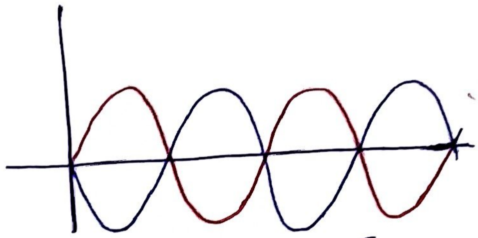
$y_2 = y_m \sin(kx + \omega t)$

$y' = y_1 + y_2$

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

$= y_m \left(2 \sin kx \cos \omega t\right)$

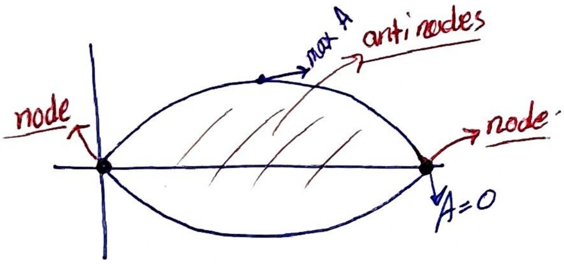
$= 2y_m \sin(kx) \cos(\omega t)$



وحدة تمشي لليمين ووحدة تمشي للشمال منعكسات .

$\sin\alpha + \sin\beta \Rightarrow 2 \sin\frac{\alpha+\beta}{2} \cos\frac{\alpha-\beta}{2}$

$\boxed{2y_m \sin kx} \rightarrow$ Amplitude of standing waves



At nodes Amplitude = 0

$\sin kx = 0$

$kx = n\pi \quad n = 0, 1, 2 \ldots$

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

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

At antinodes Amplitude is the maximum

$|\sin kx| = 1$

$kx = n\pi + \frac{\pi}{2} \quad n = 0, 1, 2 \ldots$

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

$v = \lambda f$

$v = \frac{2L}{n} f$

$\boxed{f = \frac{nv}{2L}}$

عدد العقد L عدد البطون
antinode < Node .

$L = \frac{n\lambda}{2} \rightarrow n$: antinode

first harmonic $\frac{\lambda}{2}$
second harmonic λ
third harmonic $\frac{3\lambda}{2}$

Check Point:

$y_{m1} = y_{m2} \quad \lambda_1 = \lambda_2$

① $y'(x,t) = 4\sin(5x - 4t)$

② $y'(x,t) = 4\sin(5x)\cos(4t)$

③ $y'(x,t) = 4\sin(5x + 4t)$

السؤال بيد أي موجة الموجتين كانوا ماشيين كان x^+ / x^- / عكس بعض ؟

① x^+

② عكس بعض

③ x^-

$\sin 5x \cos 4t$

$= \frac{1}{2}\left(\underbrace{\sin(5x - 4t)}_{x^+} + \underbrace{\cos(5x + 4t)}_{x^-}\right)$

عكس بعض ماشيو

Check Point 2

one frequency (lower than 400 Hz) is missing ? and what the (f) of the 7^{th} harmonic?

150 Hz
225 Hz
300 Hz
375 Hz

$225 - 150 = 75$

$300 - 225 = 75$

$375 - 300 = 75$

$75 < 400$

$150 - 75 = 75$

75 Hz is missing

$f_n = 75n$

$= 75(7)$

$= 525\text{ Hz}$

$7\pi \rightarrow 3\pi,\ 3\pi,\ \pi$

$\frac{3\lambda}{2} + \frac{3\lambda}{2} + \frac{\lambda}{2}$

$\boxed{\frac{7}{2}\lambda}$

$f = \frac{v}{\frac{7}{2}\lambda}$

Chapter 17: Waves II:

17.1 Speed of Sound

Sound wave is longitudinal mechanical wave that Propagate in medium
طولية ميكانيكية

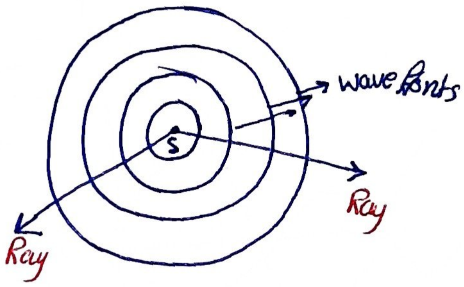
$$V_s = \sqrt{\frac{B}{\rho}}$$ (air)(gas)(liquid)

$$B = -\frac{\Delta P}{\frac{\Delta V}{V}}$$

$B > 1000\rho$

B: Balk modalals (معامل الحجم)

ρ: density (الكثافة الحجمية)



17.2 travelling Sound:

$$S(x,t) = S_m \cos(kx - \omega t)$$

$\Delta P = \Delta P_m \sin(kx - \omega t) \rightarrow$ ⊖ تخلخل ⊕ تضاغط

$S_m = max$	$\Delta P_m = 0$
$\Delta P_m = max$	$S_m = 0$

بالرسمة ص 428 بالكتاب

$\Delta P_m = B\, S_m\, k \longrightarrow V = \frac{\omega}{k}$

$\Delta P_m = V \rho \omega S_m$

17.3 Interference:-

$S_1 = S_m \cos(kx - \omega t)$

$S_2 = S_m \cos(kx - \omega t + \phi)$

$S_1 + S_2 = (S_m \cos(kx - \omega t) + S_m \cos(kx - \omega t + \phi))$

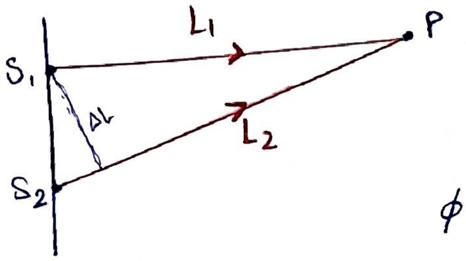
$= 2S_m \cos(kx - \omega t + \frac{\phi}{2}) \cos\frac{\phi}{2}$

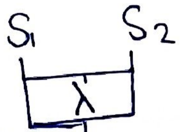
$= 2 S_m \cos\frac{\phi}{2} \cos(kx - \omega t + \frac{\phi}{2})$

$$\boxed{S_m' = 2 S_m \cos\frac{\phi}{2}}$$

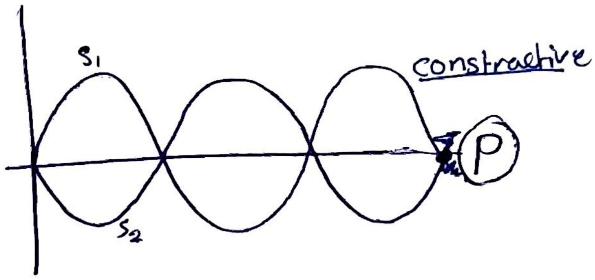
$\cos\alpha + \cos\beta$

$2\cos\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2}$





وصلنا إلى النقطة P
لطرق مختلفة احسب ϕ
عن طريق ΔL و λ



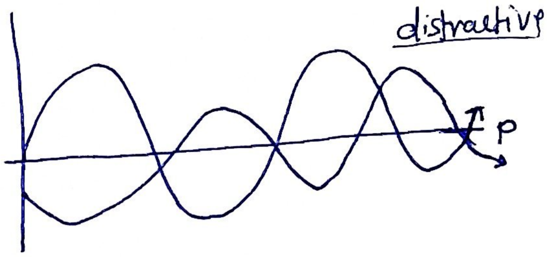
$\boxed{\phi = \Delta L} = |L_2 - L_1|$ depend to path defrence

if $L_1 = L_2$ (Idintecal source) no ϕ

$\Delta L = 0 \quad \phi = 0$ (constractive interfernce)

if $L_1 \neq L_2$

$\Delta L \neq 0 \quad \phi \neq 0$ (Distractive interfernce)



ex; $\Delta L = \frac{\lambda}{2} \quad \phi = \pi$

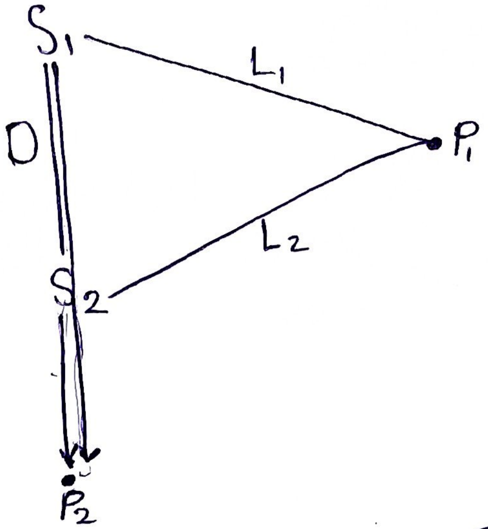
$$\frac{\phi}{2\pi} = \frac{\Delta L}{\lambda} \Rightarrow \boxed{\phi = \frac{2\pi \Delta L}{\lambda}}$$

$\Delta L = n\lambda \quad n = 0, 1, 2 \ldots$ fully constrative interfernce

$\phi = (2n+1)\pi \quad n = 0, 1, 2, 3 \ldots$

$\Delta L = (n + \frac{1}{2})\lambda$ distractive Interfernce

Example: S_1, S_2 idintical $\quad D = 1.5\lambda$



a) $P_1 \quad \Delta L = 0 \quad L_1 = L_2$

the interfernce is constractive

b) $P_2 \quad L_1 = 1.5\lambda + L_2$

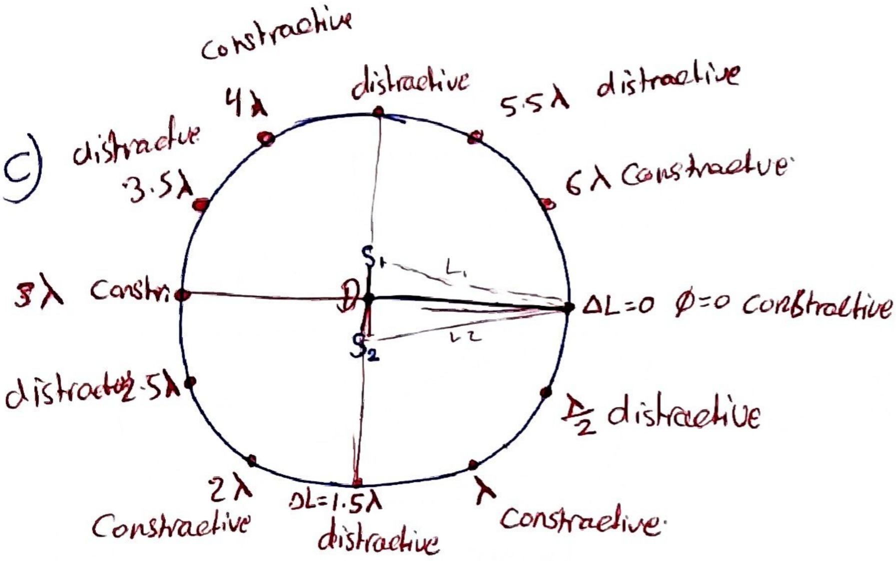
$\Delta L = L_2 - L_1$

$= \cancel{L_2} - 1.5\lambda - \cancel{L_2}$

$\Delta L = 1.5\lambda$

$\phi = 3\pi$ distractive interfernce

c)



6 Point is constractive

6 Point is distractive

17.4 Intensity and sound level : حدة الصوت وشدته

$I = \frac{P}{A}$ $[W/m^2]$

P: Power

A: Area

$\boxed{P = \frac{E}{t}}$ → $\boxed{I = \frac{E}{A \cdot t}}$

$\boxed{I = \frac{1}{2}\rho v \omega^2 S_m^2}$

Sphere

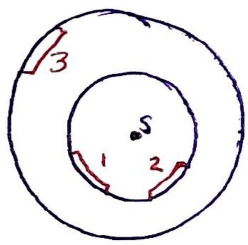
$A = \boxed{4\pi r^2}$

مثلاً كل ما بعدنا r ا تقل الصوت

Check Point

① and ② same area → greatest I

③ greatest area → smallest



* Sound Level, (B) [DB] ديسبل

* The Lowest sound Intensity that a human can hear is $10^{-12}\ W/m^2$

$B = 10dB \log\left(\frac{I}{I_0}\right)$

- I : Intensity $[W/m^2]$
- $I_0 = 10^{-12}\ [W/m^2]$
- B : sound level [dB]

if $I = I_0$

$B = 10dB \log 1$

$= \boxed{0}$

معلومة جانبية

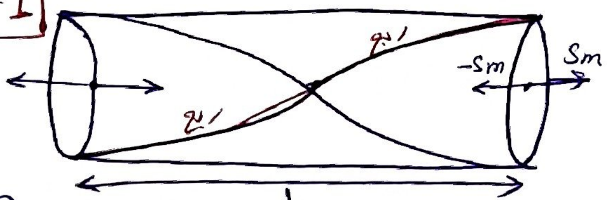
f larg الترددات ← المرأة

f small الصوت خشن ← الرجل

17.5 Sources of Musical Sound

Standing wave $\boxed{S = S_m \cos(kx - \omega t)}$

$\boxed{n=1}$ من الجهتين مفتوح



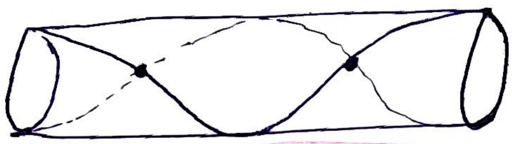
L

findimental wave $\quad L = $ نص موجة

$$L = \frac{\lambda}{2}$$

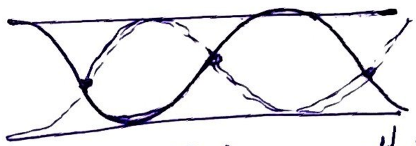
$$\boxed{\lambda = 2L}$$

$\boxed{n=2}$



$$L = \lambda \Rightarrow \boxed{\lambda = \frac{2L}{2}} \quad \text{second}$$

$\boxed{n=3}$



$$L = \frac{3}{2}\lambda \quad \text{third}$$

$$\boxed{\lambda = \frac{2L}{3}}$$

$$\boxed{\lambda = \frac{2L}{n} \qquad n = 1, 2, 3 \ldots}$$

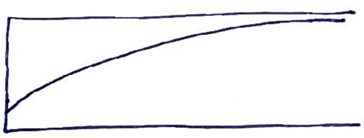
$$\lambda f = V \Rightarrow$$

$$f = \frac{V}{\lambda} \Rightarrow \lambda = \frac{V}{f} = \frac{2L}{n} \Rightarrow \boxed{f = \frac{Vn}{2L} \qquad n = 1, 2, 3 \ldots}$$

Standing waves:

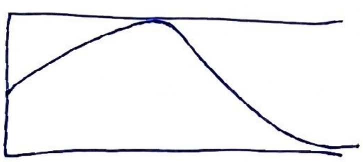
من جهة مفتوح ومن جهة أخرى مغلق .

$n=1$



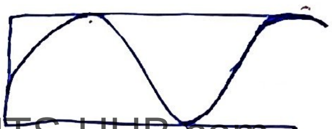
$$L = \frac{\lambda}{4} \Rightarrow \lambda = 4L$$

$n=3$



$$L = \frac{3\lambda}{4} \Rightarrow \lambda = \frac{4L}{3}$$

$n=5$



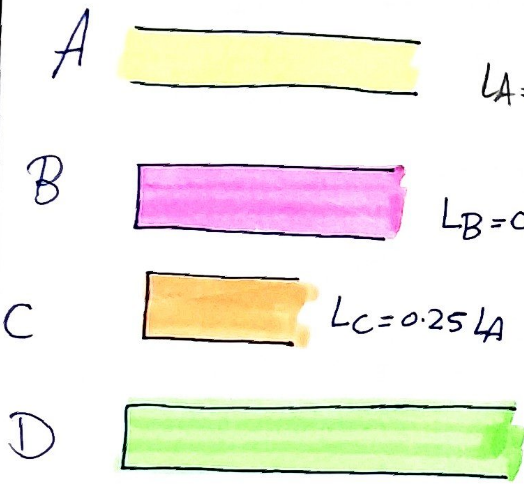
$$L = \frac{5}{4}\lambda \Rightarrow \lambda = \frac{4L}{5}$$

$$\lambda = \frac{4L}{n} \qquad n: 1, 3, 5 \ldots \text{ odd num}$$

$$\boxed{f = \frac{Vn}{4L}}$$

$f\lambda = v$
$f\frac{2L}{n} = v$

Examples:-



$L_A = 0.343$

$L_B = 0.5 L_A$

$L_C = 0.25 L_A$

$L_D = 2 L_A$

$V_{sound} = 343\ m/s$

a) $f_A = \frac{nV}{2L} = \frac{n_A(343)}{2(0.343)} = 500 n_A \qquad n_A = 1, 2, 3 \ldots$

$f_B = \frac{n_B V_s}{4L_B} = \frac{n_B(343)}{4(0.5(0.343))} = 500 n_B \qquad n_B = 1, 3, 5, 7 \ldots$

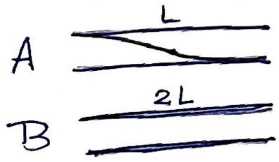
$f_C = \frac{n_c V_s}{4L_c} = \frac{n_c(343)}{4(0.25(0.343))} = 1000 n_c \qquad 500$

$f_D = \frac{n_D V_s}{4L_D} = \frac{n_D(343)}{4(2(343))} = 125 n_D$

لازم تكون قيم (n) في الموجات
متشابهة مع الموجة الاصلية
$n_A = 2n_c \qquad n_A = n_B$

كل قيم B موجودة في A
كل قيم C موجودة في A
أما D لا توجد $\frac{1}{4}$ أو 4 في قيم D

Checkpoint



first $L = \frac{\lambda}{2}$

$L = \boxed{\lambda} \downarrow 2L$

two open end

$f_A = \frac{V}{2L}$ second

$\frac{V}{2L} = \frac{Vn}{4L}$

$\frac{1}{2} = \frac{n}{4}$

$n = 2$

17.6 Beats:- (النضبات)

- ظاهرة تنشأ عندما يكون هناك فرق في التردد -

$f_{Beat} = f_1 - f_2 \longrightarrow$ Wavering beats

$f_{avg} = \frac{f_1 + f_2}{2} =$ الذي نسمعه (صوتين ذو ترددين مختلفين مع بعض)

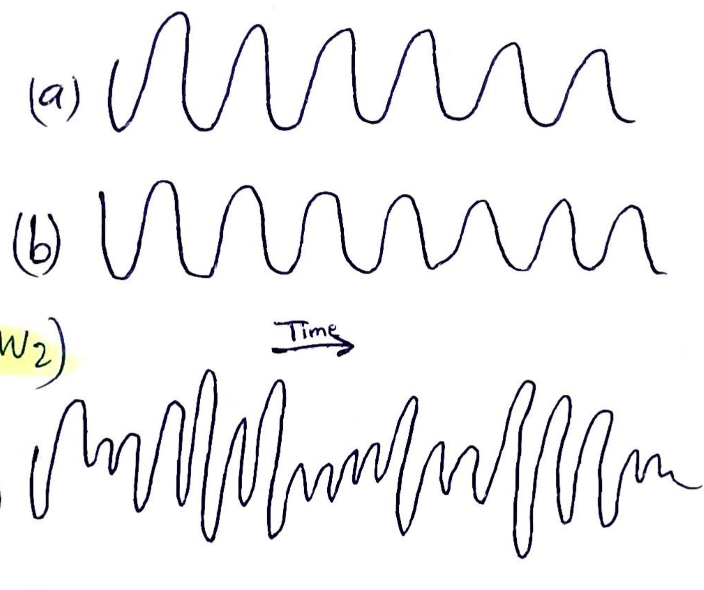
$S_1 = S_m \cos w_1 t \qquad S_2 = S_m \cos w_2 t, \qquad (W_1 > W_2)$

time dependent
أي $x=0$

$S_1 + S_2 = S_m \cos w_1 t + S_m \cos w_2 t$

$= S_m (\cos w_1 t + \cos w_2 t)$ جمع الكوساينات

$$\boxed{= 2S_m \cos\left(\frac{W_1 - W_2}{2}\right)t \cos\left(\frac{W_1 + W_2}{2}\right)t}$$



* $w' = \frac{1}{2}(w_1 - w_2)$ and $w = \frac{1}{2}(w_1 + w_2)$

this reslut :-

$$S(t) = [2S_m \cos w't] \cos wt$$

if $\boxed{w_1 = w_2}$ then $w \ggg w'$

if $w_1 = 5$ $w_2 = 5.1$ $W = 10.1$, $w' = 0.1$] $w \gg w'$

$$w_{Beat} = 2w'$$

$$f_{Beat} = f_1 - f_2$$

17.7 Doppler effect :-

General Equation is

$$f' = f \frac{V \pm V_D}{V \pm V_S}$$

D S

- تحدث تغيير في التردد الذي نسمعه نتيجة الحركة النسبية بين مصدر الصوت والمتلقي للصوت .

V_D : Speed of the Detector

V_S : Speed of the source

V : Speed of the sound

* هلأ بالنسبة للاشارات :- ركزو معي :- ♡

موجب عكس حالة [⊕] V_D بالنسبة للبسط $\xrightarrow{V_S}$ $\xleftarrow{V_D}$

على عكس موجب [⊖] V_D / / / / $\xrightarrow{V_S}$ $\xrightarrow{V_D}$

دائماً من المصدر إلى المتلقي $\xrightarrow{V}$

⊖ V_S بالنسبة للمقام $\xrightarrow{V_S}$ $\xrightarrow{V}$

⊕ V_S / / / / $\rightarrow$ $\leftarrow$

Example : للتوضيح

حالات المراقب والمصدر في العلاقة الرياضية :

$\boxed{f_d > f_s}$ ←

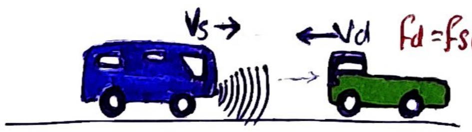
$$f'_d = f_s \left(\frac{V - 0}{V - V_s}\right)$$

* مراقب ثابت $V_d = 0$
مصدر متحرك باتجاه المراقب V_s

$\boxed{f_d > f_s}$ ←

$$f_d = f_s \left(\frac{V + V_d}{V + 0}\right)$$

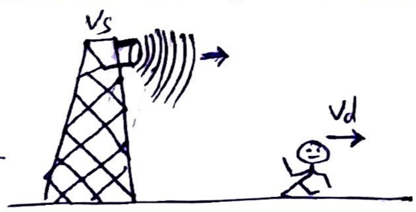
* مراقب متحرك في اتجاه المصدر
مصدر ثابت $V_s = 0$



$$f_d = f_s \left(\frac{V + V_d}{V - V_s}\right)$$

* مراقب متحرك في اتجاه المصدر
مصدر متحرك في اتجاه المراقب

$\boxed{f_d < f_s}$ ←

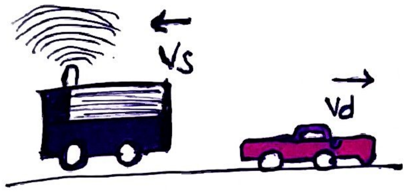


* مراقب متحرك مبتعداً عن المصدر
مصدر ثابت $V_s = 0$

$$f_d = f_s \left(\frac{V - V_d}{V - 0}\right)$$

* مراقب متحرك ومصدر متحرك على نفس الاتجاه .

$$f_d = f_s\left(\frac{V - V_d}{V - V_s}\right)$$



* مراقب متحرك ومصدر متحرك في اتجاهين متعاكسين

$$f_d = f_s\left(\frac{V - V_d}{V + V_s}\right)$$

Cheack point: 4

	Source	Detector
a	→	• 0 speed
b	←	• 0 speed
c	→	→
d	←	←
e	→	←
f	←	→

a) $f_D = f_s\left(\frac{V \pm 0}{V - V_s}\right) \Rightarrow f_D > f_s$

b) $f_D = f_s\left(\frac{V \pm 0}{V + V_s}\right) \Rightarrow f_D < f_s$

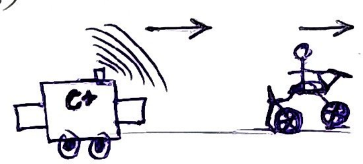
c) $f_D = f_s\left(\frac{V - V_D}{V - V_s}\right) \Rightarrow$

d) $f_D = f_s\left(\frac{V + V_D}{V + V_s}\right)$

e) $f_D = f_s\left(\frac{V + V_D}{V - V_s}\right)$

f) $f_D = f_s\left(\frac{V - V_D}{V + V_s}\right)$

example:



$f_s = 1620\ Hz$

$V_D = 2.44\ m/s$

$f_D = 1590\ Hz$

$V_s = ??$

$$f_D = f_s\left(\frac{V + V_D}{V + V_s}\right)$$

$$1590 = 1620\left(\frac{343 + 2.44}{343 + V_s}\right)$$

$$0.98 = \frac{345.44}{343 + V_s}$$

$$343 + V_s = 352.48$$

$$\boxed{V_s = 9.48}$$

Chapter 18:

Temperature, Heat, and First Law of thermodynamics:

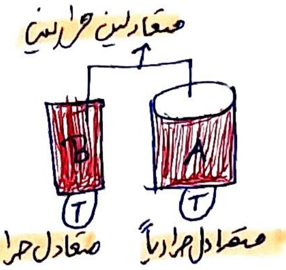
18.1) Temprature:-

it's measured with **a thermometer**

SI System (K) وحدة قياسها الكلفن

thermal equilibrium

الاتزان الحراري



تنتقل الحرارة ← من الجسم الاسخن الى الابرد.

* The zeroth Law of thermodinamic

" if bodies A and B are each in thermal equilibrium with the third body (T) then A and B are in thermal equiliberium with each other "

18.2

* The Celsius and Fahrenheit scales

① $T_C = T_K - 273.15 \quad (C^\circ)$

② $T_F = \frac{9}{5} T_C + 32 \quad (F)$

Checkpoint 1

Rank according size?

$70 - (-20) = 90^\circ$

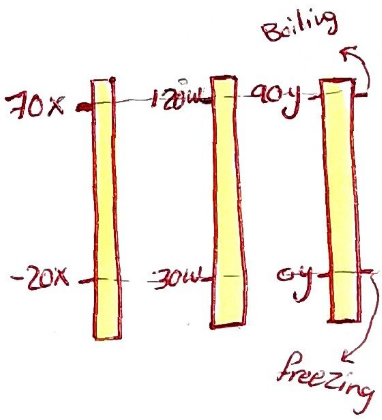
$120 - 30 = 90^\circ$

$90 - 0 = 90^\circ$

Degree $\frac{90^\circ}{90^\circ} = 1^\circ$

$1^\circ = 1^\circ = 1^\circ$ same size

$50 = 50 = 50$



18.3) Thermal Expansion التمدد الحراري

- when heat is added to most materials, the averge amplitude of the atoms vibrating within the material increases. متوسط سعة الذرات التي تهتز داخل المادة تزيد (تمدد الحراري).

- Three type of thermal Expansion:-

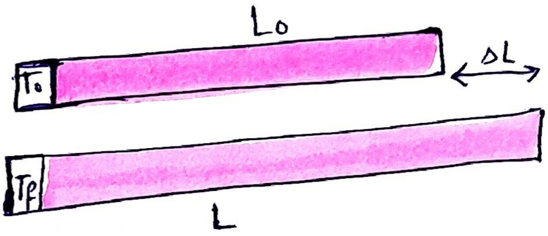
1- Linear thermal Expansion تمدد حراري طولي

2- Surface thermal Expansion تمدد حراري سطحي

3- Volume thermal Expansion تمدد حراري حجمي

① Linear thermal Expansion

$$L = L_o + \Delta L = L_o + \alpha L_o (T_f - T_o) = L_o(1 + \alpha \Delta T)$$



L_o : Initial length

L : final length

α : Linear coefficient

ΔL : Change of length

$\Rightarrow \alpha = \dfrac{\Delta L}{L_o \Delta T}$ [1/c]

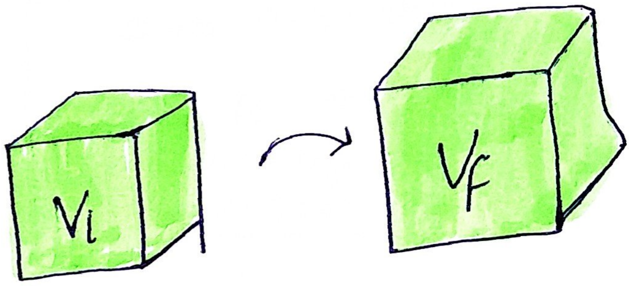
$\Rightarrow \Delta L = \alpha L_o \Delta T$ [m]

$\Rightarrow \Delta L = L - L_o$

② Volume thermal Expansion

$\Delta V = \beta V_o \Delta T \Rightarrow \beta = \dfrac{\Delta V}{V_o \Delta T}$ Liquid

سوائل



β : Coefficent volume

$$\boxed{\beta = 3\alpha}$$

المادة صلبة

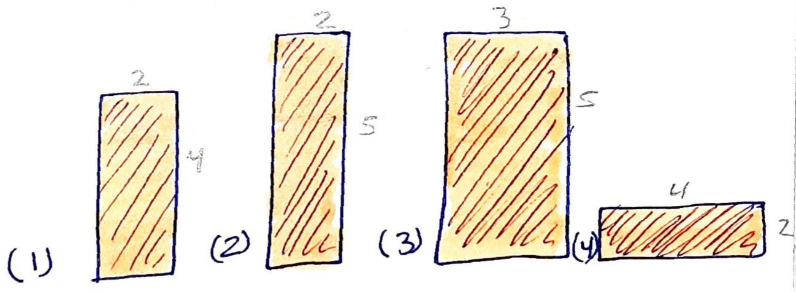
Solid

* Check Point 2

$2 = 3 > 1 > 4$ (vertical height)

$3 > 2 > 1 = 4$ (area)

(from 1) → [ΔT the same, α the same]



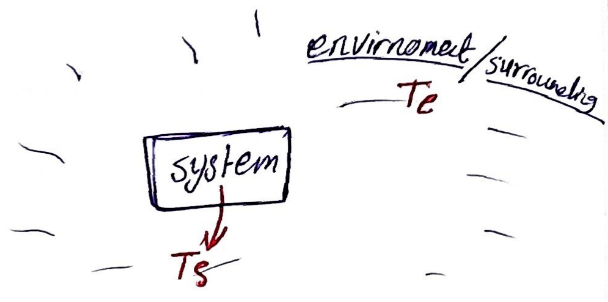
18.4 ABSorPtion of Heat

Heat → Q

كمية الحرارة اللازمة لرفع درجة حرارة جرام واحد من الماء

[J] [cal]

$\boxed{1\ Cal = 4.1868\ J}$ $\boxed{Q = C\Delta T}$



① if $Ts > Te$ energy is transferred from system to surrounding so Q is negative (−)

② if $Ts = Te$ energy no transfere $Q = 0$ neither release nor opsorbed

③ if $Ts < Te$ energy is tranferee from surrounding to system so Q is positive.

* Heat capacity : السعة الحرارية

(C) كمية الحرارة اللازمة لرفع درجة حرارة الجسم درجة واحدة

$\boxed{C = \frac{Q}{\Delta T}}$ [J/K] (depend on mass)

* Specific Heat : الحرارة النوعية

$\boxed{(c) = \frac{C}{m}}$ [J/k.kg] (depend on the material)

[cal/g.c°] نستخدمه عند تغير درجة الحرارة بمقدار ΔT مع ثبات شكل (نوع) المادة

* Heat of transformation . الحرارة الكامنة

(L) Phase to phase هي الحرارة التي نستخدمها عند تحويل المادة بالكامل من Solid → Liquid

two type of Heat transformation :-

① Melting : Solid → liquid

L_f → (L) fusion

$\boxed{Q = \pm m L_f}$

تسخين صلبة ← سائل ⊕

تبريد سائل ← صلب ⊖

من صلب ← سائل (تفكك) والتفكك يحتاج طاقة ⊕
من سائل إلى صلب (تركيب) يعطي طاقة . ⊖

نفس الحاجة

② Vaporizing : Liquid → gas

L_v → L vaporizing

$Q = \mp m L_v$

⊕ سائل ← غاز

⊖ غاز ← سائل

Checkpoint:

A certain amount of Heat Q will warm 1g of material (A) by 3C° and 1g of material (B) by 4C°? Which material has the greater specific heat?

$\boxed{A}$ $m = 1g$, $T = 3C°$

$\boxed{B}$ $m = 1g$, $T = 4C°$

$c = \frac{C}{m}\uparrow$

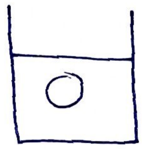
$Q = c\,m\,\Delta T$

- ثابت

$\boxed{A > B}$

Sample problem:-

Copper slug whose mass $m_c = 75g$ heated on Lab a T of 312C°
$m_{water} = 220g$ $C_b = 45\ cal/K$ $T_{iw} = T_{ib} = 12C°$ (Isolated system)
water doesn't vaporaize find the final T_f of the system?



Isolated System

$$\Sigma Q = 0 \Rightarrow Q_b + Q_w = -Q_c$$

$$(cm)\Delta T + cm\Delta T = -cm\Delta T$$

$$(45)(T_f - 12) + (1)(220)(T_f - 12) = -(0.0923)(75)(T_f - 312)$$

$$45T_f - 540 + 220T_f - 2640 = -6.9225T_f + 2159.82$$

$$271.922\,T_f = 5339.82$$

$$\boxed{T_f = 19.637C°}$$

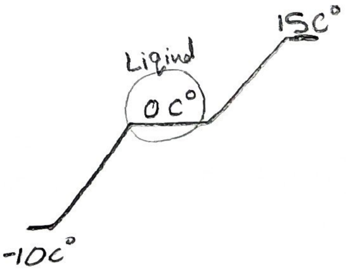
Sample Problem 2:-

How much heat must be apsorbed by ice of mass = 720g at -10C° to take it to the liquid state at 15C°?

720 g ↓ 0.72 Kg

$\boxed{\begin{matrix} -10 \rightarrow 0 \\ 0 \rightarrow 15 \end{matrix}}$

$$Q_1 = cm\Delta T = (2220)(0.72)(0 - -10) = 15984\ J$$



$$Q_2 = L_f m = (333)(0.72) = 239760\ J$$

$$Q_3 = cm\Delta T = (4187)(0.72)(15 - 0) = 45219.6\ J$$

$$Q_{net} = Q_1 + Q_2 + Q_3 = 3009636\ J$$

1 KJ = 1000 J
333 →

4

18.5 The first Law of thermodinmic

* Heat and Work done

$dw = F \cdot ds = PA \cdot ds = P(A\,ds)$

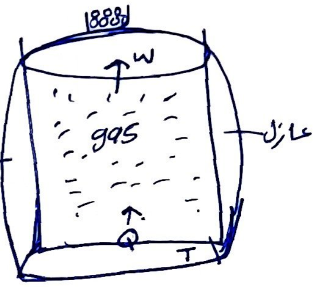
$dw = \boxed{P\,dV}$

⊕ النظام ← الخزانة

⊖ الخزانة ← النظام

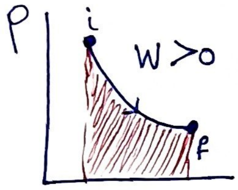
~~work done by~~ expasion ← ⊕ عازل يتمدد

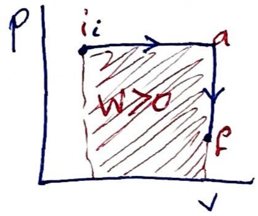
~~work done on~~ compresson ← ⊖ منضغط/ينقلص

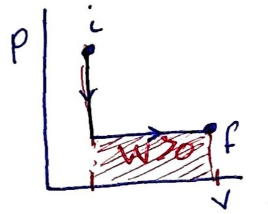


$\int dw = \int P\,dV$

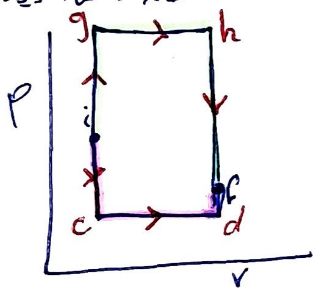
$W = P \int_{V_i}^{V_f} dV$

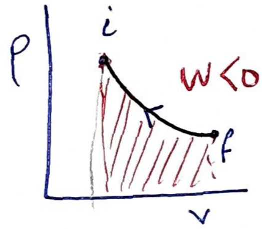


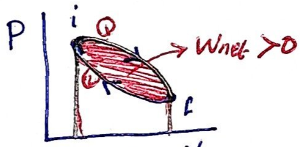




V لانه V من الكبير إلى الصغير







$A_1 - A_2 > 0$

W ⊖ compression

W ⊕ expansion

* The first of thermodinamic

$$\boxed{\Delta E_{int} = E_{int\,f} - E_{int\,i} = Q - W}$$

ΔE_{int} ↓ الطاقة الداخلية — depends only on the materials' state (temprature, Key Ideal Pressure, Volume)

[Q and W are Path dependent , Eint is Path indepenelent]

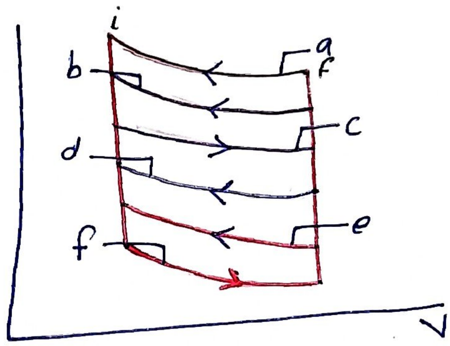
$\underbrace{\text{Q and W}}_{\text{يعتمدون على المسار}}$; Eint: E_i , E_f

* the first Law of thermodinamics find application in several special cases:-

- adiabatic Processes $Q = 0$ $E_{int} = -W$ (no heat transfere into or out the system)
- Constant volume Prosesses $W = 0$ $\Delta E_{int} = Q$
- cyclical Processes $\Delta E_{int} = 0$ $Q = W$
- free expansion $Q = W = \Delta E_{int} = 0$ → irreversible عكسية

Checkpoint: 1

a compression
b ------
c expansion
d compression
e compression
f expansion



(c - d, e - f) closed cycle

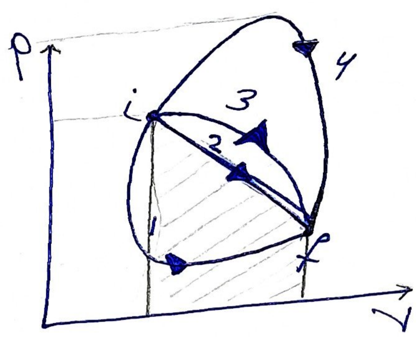
X qusition to Shimaa

Checkpoint 2 Rank according ΔE_{int} / W / Q

ΔE_{int} the same becaus it path indepedent

W → 4 > 3 > 2 > 1

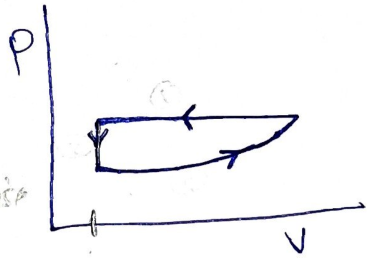
Q → 4 > 3 > 2 > 1



Checkpoint 3 ΔE_{int} and Q Positive/negative/zero

ΔE_{int} Cycle = 0

Q = negative beceaus W counterclockwise



Chapter 19
The Kinetic Theory of Gases

19.1 Avogadro's Number:-

$N_A = 6.02 \times 10^{23}\ m^{-1}$

$N = n \times N_A$

- N → number of Moleculs
- n → numbe of mole
- N_A → Avogadro number

$n = \frac{m}{M}$

m: mass
M = Molermass
n = numberof mole

$$\boxed{M = m N_A} \Rightarrow n = \frac{m}{m N_A} = \boxed{\frac{1}{N_A}}$$

19.2 Ideal Gases

الغاز المثالي

$$\boxed{PV = nRT}$$
$$\boxed{PV = NKT}$$

$R = 8.31\ J/mol \cdot K$

K = Boltzman $= 1.38 \times 10^{-23}$

$K = \frac{R}{N_A}$

① At Constant temprature

$W = PV = \int P\,dV = \int \frac{nRT}{V}\,dv$

$$\boxed{W = nRT \ln \frac{V_f}{V_i}}$$

② At Constant Volume:

$W = 0$

③ At constant Pressure

$W = P \int 1\,dv$

$W = PV \Big|_i^f$

$$\boxed{W = P\,\Delta V}$$

example:-

$V_i = 12\,L \quad V_f = 8.5\,L$

$T_i = 20C° \quad T_f = 35C°$

$P_i = 15\,atm \quad P_f = ??$

$P_i V_i = nRT_i$.

$(15)(12) = nR(20+273.15)$

$n = n$

$\frac{P_i V_i}{\cancel{R} T_i} = \frac{P_f V_f}{\cancel{R} T_f}$

$0.6 = \frac{P_f(8.5)}{(35+273.15)}$

$\boxed{P_f = 22.2}$ atm

19.3 Pressure and temprature and RMS speed

$$P = \frac{nMV_{rms}^2}{3V}$$

$V_{rms} = \sqrt{(V^2)_{avg}}$ is the root-mean-squar.speed

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

19.4 Translational Kinetic energy

$$K_{avg} = \frac{1}{2} m V_{avg}^2 = \frac{1}{2} m V_{rms}^2$$

$$K_{avg} = \frac{1}{2} m\left(\frac{3RT}{M}\right)$$

$$K_{avg} = \frac{3}{2} nRT$$

$$\boxed{= \frac{3}{2} KT}$$ تعتمد على الحرارة

Check Point :-

A gas mixture consists of molecules of type 1, 2 and 3 with molecular masses $m_1 > m_2 > m_3$. Rank the three types according to (a) ave K b) rms V?

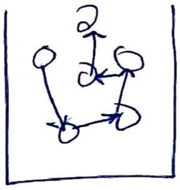
a) $K_1 = K_2 = K_3$

b) $V_3 > V_2 > V_1$

19.5 Mean free Path

$$\boxed{\lambda = \frac{1}{\sqrt{2}\pi d^2 \frac{N}{V}}}$$

معدل المسافة بين الجزيئات المتصادمة



d: diameter

$\left(\frac{N}{V}\right) = \frac{\text{number of molecules}}{\text{volume}}$

* the moler specfic heat C_v الحرارة النوعية المولية

$$C_V = \frac{Q}{n\Delta T} = \frac{\Delta E_{int}}{n\Delta T}$$

For an Ideal monatomic gas

$$\boxed{C_V = \frac{3}{2}R} \Rightarrow \text{constant } V$$

$$W = \int P\,dV = 0$$

$\Delta E_{int} = Q - 0$

$\Delta E_{int} = Q$

$\frac{3}{2}R\cancel{n}\Delta T = \cancel{n}C_V\Delta T$

$$\boxed{C_V = \frac{3}{2}R}$$

$$\boxed{\Delta E_{int} = nC_V\Delta T}$$

any Processes

depend on $\boxed{T}$ just

* The moler specfic heat at constant (P):

$$C_P = \frac{Q}{n\Delta T}$$

$$C_P = C_V + R$$

$W = \int P\,dV$

$W = P\Delta V$

$\Delta E_{int} = Q - W$

$= nC_P\Delta T - P\Delta V$

$W = \boxed{P\Delta V = nR\Delta T}$

$\Delta E_{int} = nC_P\Delta T - nR\Delta T$

$\cancel{n}C_V\cancel{\Delta T} = \cancel{n}C_P\cancel{\Delta T} - \cancel{n}R\cancel{T}$

$C_V = C_P - R$

$$\boxed{C_P = C_V + R}$$

$C_V = \frac{3}{2}R \quad C_P = \frac{5}{2}R$] for monatomic gas

19.8 Degrees of Freedom and Moler specific heat

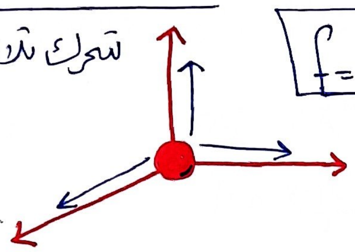
f (degrees of freedom)

عدد درجات الحرية

① monatomic gas (O, He, H)

تتحرك ثلاث حركات

$\boxed{f = 3 \text{ translition}}$



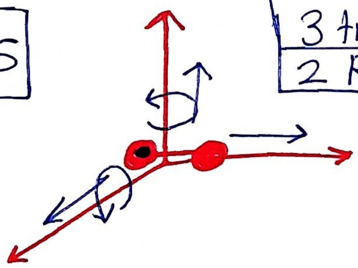
$C_v = \frac{3}{2}R$

$C_p = \frac{5}{2}R$

② Diatomic gas (O_2, H_2)

$\boxed{f = 5}$

3 translation
2 Rotation

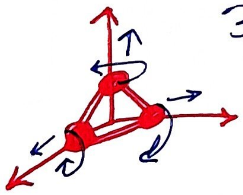


$C_v = \frac{5}{2}R$

$C_p = \frac{7}{2}R$

③ Polyatomic gas

$\boxed{f = 6}$



3 transltion

3 Rotation

$C_v = 3R$

$C_p = 4R$

★ if f is the number of freedom then:-

- $E_{int} = \left(\frac{f}{2}\right) nRT$
- $C_v = \left(\frac{f}{2}R\right)$
- $C_p = \frac{f}{2}R + R$

(19.9) The adiabatic expansion of An Ideal gas

The Adiabatic expansion (no exchange of heat)

$Q = 0 \longrightarrow \boxed{\Delta E_{int} = W}$ [العمليات السريعة أو عمليات معزولة.]

$PV^{\gamma} = Const \Rightarrow P_i V_i^{\gamma} = P_f V_f^{\gamma}$

ثابت $\gamma = \frac{C_P}{C_V}$

$PV = nRT$

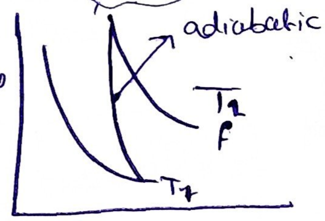
$P = \frac{nRT}{V} \Rightarrow \frac{nRT}{V} V^{\gamma} = \underline{Const}$

معلومة → (nR) const مقسم عليهم

$T V^{\gamma-1} = Const$

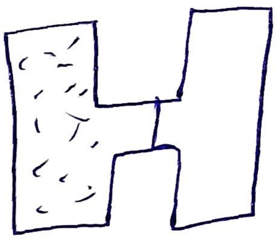
$\boxed{T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}}$

$\frac{1}{V^{\gamma}}$ منحنى



مثال عملي عليها الفتح على الريف فالهواء يصل باردًا.
أو فتح علبة كولا.

Free expansion



$Q = 0$
$W = 0$
$\Delta E_{int} = 0$
$\Delta T = 0$
$T_f = T_i$

Sample problem:

Ideal diatomic gas. $\gamma = \frac{C_P}{C_V}$

$P_i = 2 \times 10^{3}$ Pa
P
$V_i = 4 \times 10^{-6}$ m³
$V_f = 8 \times 10^{-6}$ m³

Find W? $\gamma = \frac{7/2}{5/2}$

$W = \int_{V_i}^{V_f} P\, dV$

$P_i V_i^{\gamma} = P V^{\gamma}$

$P = \frac{P_i V_i^{\gamma}}{V^{\gamma}} \Rightarrow W = \int \frac{P_i V_i^{\gamma}}{V^{\gamma}} dV$

$W = P_i V_i^{\gamma} \int \frac{1}{V^{\gamma}} dV \Rightarrow (P_i V_i^{\gamma}) \left(\frac{V^{-\gamma+1}}{-\gamma+1} \right) \Big|_{V_i}^{V_f} \Rightarrow 0.48$

Find ΔE_{int}

$\Delta E_{int} = -W$
$= -0.48$ J

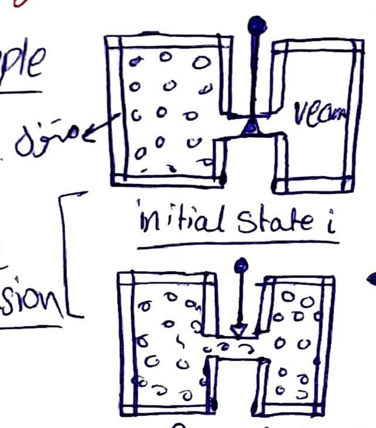
Emnah

Chapter 20

Entropy and the Second Law of thermodynamic

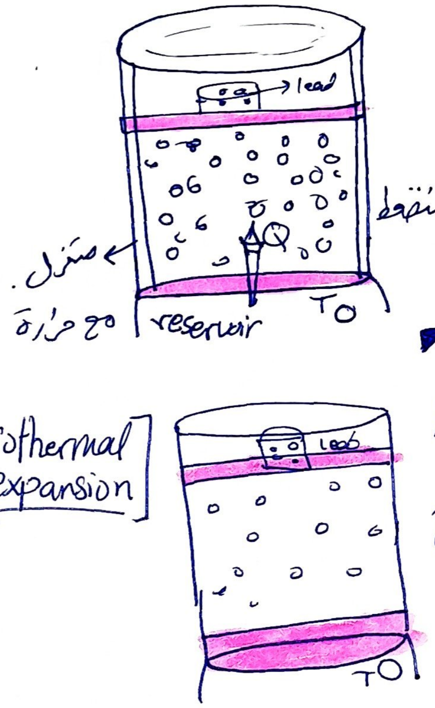
* if an irreversible Process occurs in an a closed system, the entropy (S) of the system always increases; It never decreases.

example



free expansion

T Constant → $\Delta E_{int} = 0$



Isothermal expansion

T constant

* change of entropy

$$\Delta S = S_f - S_i = \int_i^f \frac{dQ}{T}$$

because the temprature is constant then :-

$$\Delta S = S_f - S_i = \frac{1}{T}\int_i^f dQ$$

$$\boxed{\Delta S = \frac{Q}{T}}$$ (isothermal Process)

* لإيجاد قيمة التغير في الانتروبي للحالات الغير قابلة للعكس يمكننا ايجاده لحالة قابلة للعكس بنفس الحالة البدائية والنهائية وايجاده $\Delta S = \int \frac{dQ}{T}$

* Entropy as a state function:

depend in an initial state and final state

Path independent

$$\boxed{\Delta S_{irr} = \Delta S_r}$$

example :-

* الخزان الحراري يعتبر عملية عكسية لانه يمكن عكس العملية. ويكون الحرارة ثابتة لذلك العلاقة تكون

$$\Delta S = \frac{1}{T}\int dQ = \boxed{\frac{Q}{T}}$$

المأخوذة
المحيط

$\Delta E_{int} = 0 \Rightarrow Q = W \rightarrow$

$\Delta T = 0$

* using the first Law of thermodynamics in differential form:

$$dE_{int} = dQ - dW$$

$$dW = PdV$$

$$dE_{int} = nC_v dT$$

$$dQ = dE_{int} + dW$$

$$\frac{dQ}{T} = \frac{nC_v dT}{T} + \frac{PdV}{T} \quad (\text{نقسم على } T)$$

$$\frac{dQ}{T} = \frac{nC_v dT}{T} + \frac{nRdV}{V} \qquad PV = nRT \quad \boxed{\frac{P}{T} = \frac{nR}{V}}$$

$$\int \frac{dQ}{T} = \int \frac{nC_v dT}{T} + \int \frac{nRdV}{V}$$

$$\boxed{\Delta S = nC_v \ln\frac{T_f}{T_i} + nR\ln\frac{V_f}{V_i}}$$ (genral formla for ΔS for an ideal gas)

- constant T $\boxed{\Delta S = nR\ln\frac{V_f}{V_i}}$
- Constant V $\boxed{\Delta S = nC_v\ln\frac{T_f}{T_i}}$
- constant P $\boxed{\Delta S = nC_v\ln\frac{T_f}{T_i} + nR\ln\frac{V_f}{V_i}}$

example $C = 386\ J/kg\cdot K$ $m = 1.5\ kg$ $T_{iL} = 60°C$ $T_{iR} = 20°C$ $T_f = 40°C$ (Irreversible)

$\Delta S = \int \frac{dQ}{T}$ "I Cant" because its (irr.) Process

L R

L R

تنزل درجة حرارة الخزان الى T_f

علاقة تربط بين Q و T

$$Q = mC\Delta T$$

$$\frac{dQ}{T} = \frac{mC\,dT}{T}$$

$$\int \frac{dQ}{T} = mC\int \frac{dT}{T}$$

$$\boxed{\Delta S = mC\ln\frac{T_f}{T_i}}$$

ΔS_R نفس الطريقة

$$\Delta S = \Delta S_L + \Delta S_2$$

لازم يطلع اكبر من الصفر (موجب دائمًا)

* $\Delta S \geq 0$

$\Delta S = 0$ reversible

$\Delta S > 0$ irreversible

$\Delta S \to$ Surrounding

- reversible $\to \Delta S \to -\Delta S_{gas}$
- irreversible $\to \Delta S = 0$

* Second law of thermodynamics

"If a process in a closed system, the entropy of the system increase for the irreversible and remain constant for reversible, its never decreas"

$\Delta S \geq 0$ $\boxed{\text{forever}}$ ♡

20.2 Entropy in real world: Engines:

heat engines: extracts energy from it's environment in the form of heat and does useful work.

الترجمة: المحرك الحراري: يستخرج الطاقة من بيئته على شكل حرارة ويقوم بشغل مفيد.

- Working substance :- المادة العاملة التي تحتوي كل محرك

example:

المحرك البخاري يحتوي الماء

(mixture) محرك السيارة يحتوي بنزين وهواء

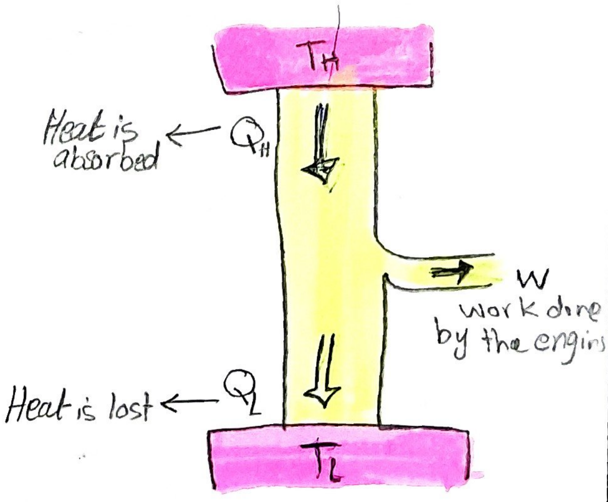
note:- if the engines it to do work on a sustained basis the working substans must be operate in a cycle

يجب أنه تدخل في سلسلة من العمليات الديناميكية

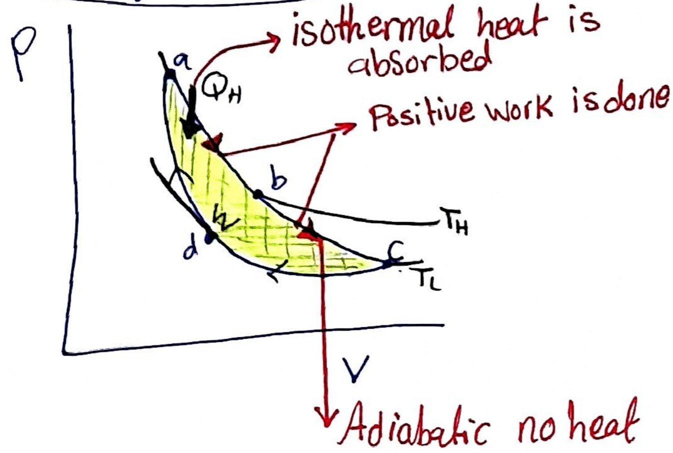
* Carnot Engines

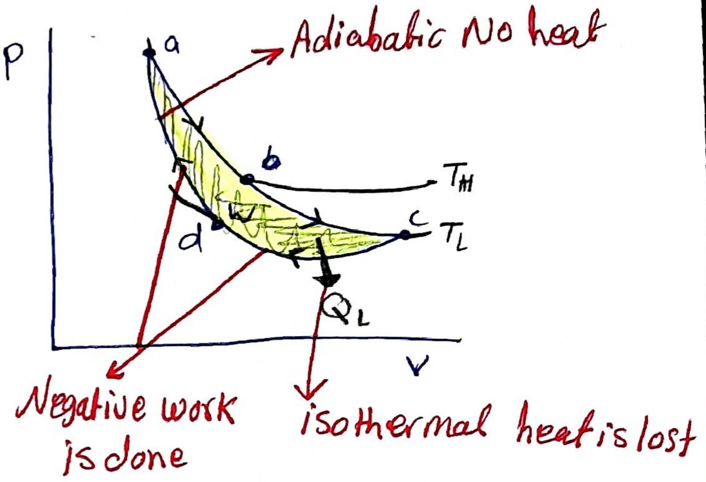
* In Ideal engins all Processes are reversible and No wasteful energy transfers occur due to (friction, turbulence).

مبدأ عمله:- يقوم بامتصاص حرارة من خزان حراري بدرجة حرارة ثابتة وتفرغها على شكل حرارة أخرى إلى خزان حراري آخر بدرجة حرارة منخفضة ثابتة.



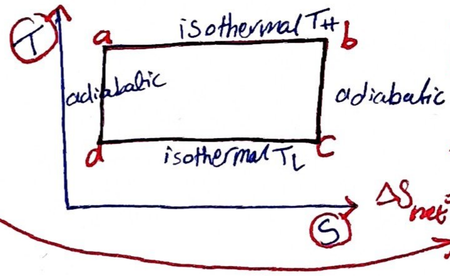
* Stages of Carnot engins





- Work $= |Q_H| - |Q_L|$ becaus this is cycle $\Delta E_{int} = 0$ $W = Q$

- $\Delta S = \Delta S_H + \Delta S_L \Rightarrow \frac{|Q_H|}{T_H} - \frac{|Q_L|}{T_L} \rightarrow$



$\Delta S_{a\to b} = \frac{Q_H}{T_H}$
$\Delta S_{b\to c} = 0$
$\Delta S_{c\to d} = -\frac{Q_L}{T_L}$
$\Delta S_{d\to a} = 0$
$\Delta S_{net} = S_1 + \cancel{S_2} + S_3 + \cancel{S_4}$
$\frac{Q_H}{T_H} + -\frac{Q_L}{T_L}$

$T_H > T_L$ so $Q_H > Q_L$
for full cycle $\Delta S = 0$ so $\boxed{\frac{|Q_H|}{T_H} = \frac{|Q_L|}{T_L}}$

* Efficiency of a Carnot Engine.

$$\varepsilon = \frac{\text{energy we get}}{\text{energy we pay for}} = \frac{|W|}{|Q_H|}$$ (efficiency in any engines)

$$\frac{|Q_H| - |Q_L|}{|Q_H|} \Rightarrow 1 - \frac{|Q_L|}{|Q_H|}$$ we know $\frac{Q_H}{T_H} = \frac{Q_L}{T_L}$

$$\Rightarrow 1 - \frac{T_L}{T_H} < 100\%$$

(K)

$T_H > T_L$

Cheakpoint:

$\varepsilon_1 = 1 - \frac{T_C}{T_H} = 20\%$

$\varepsilon_2 = 1 - \frac{T_C}{T_H} = 25\%$

$\varepsilon_3 = 1 - \frac{T_C}{T_H} = 33.3\%$

$\varepsilon_3 > \varepsilon_2 > \varepsilon_1$

20.3 REFRIGERATORS And Real engin

$$K = \frac{\text{What we want}}{\text{What we pay for}} = \frac{|Q_L|}{|W|}$$

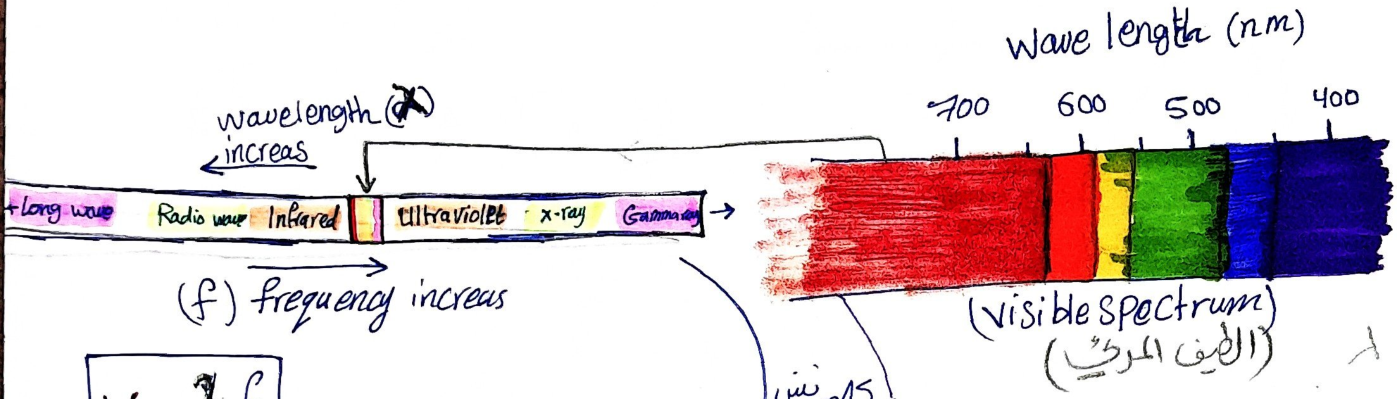
$$\Rightarrow \frac{Q_L}{Q_H - Q_L} \rightarrow \frac{T_L}{T_H - T_L}$$

$$\Delta S = \frac{-Q}{T_L} + \frac{Q}{T_H}$$ $T_H > T_C$

Chapter 33: Electromagnetic Waves

* Maxwell's Rainbow :

Maxwell's show that the beam of Light is a travling wave of electric and magnetic fields — an (electromagnetic waves)



- $\boxed{V = \lambda f}$
- $C = 3 \times 10^8 \ m/s$ (speed of light)

$$V = \frac{w}{k} = \frac{2\pi f}{\frac{2\pi}{\lambda}} = 2\pi f \cdot \frac{\lambda}{2\pi} = \boxed{\lambda f}$$

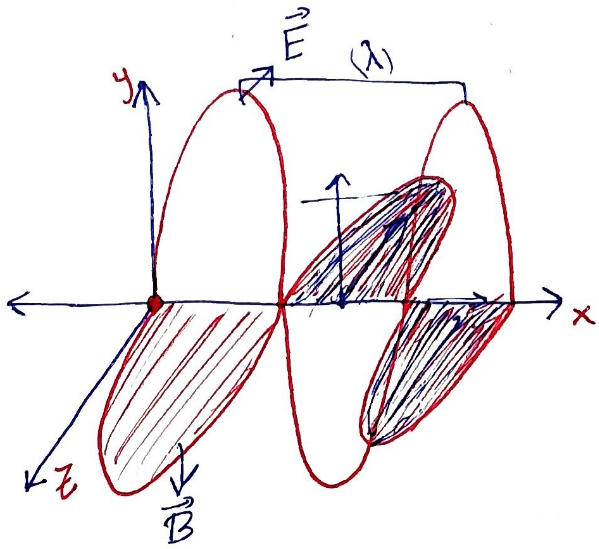
* $\vec{E} \perp V$ and $\vec{B} \perp V$
* $\vec{E} \perp \vec{B}$
* $\vec{E} \times \vec{B} \Rightarrow$ dirction of the wave

- الاتجاه عمودي عالمجال لذلك نأخذ الكروس برودكت.

$$E = E_m \sin(kx - wt)$$

$$B = B_m \sin(kx - wt)$$

$$\boxed{V = \frac{w}{k}}$$



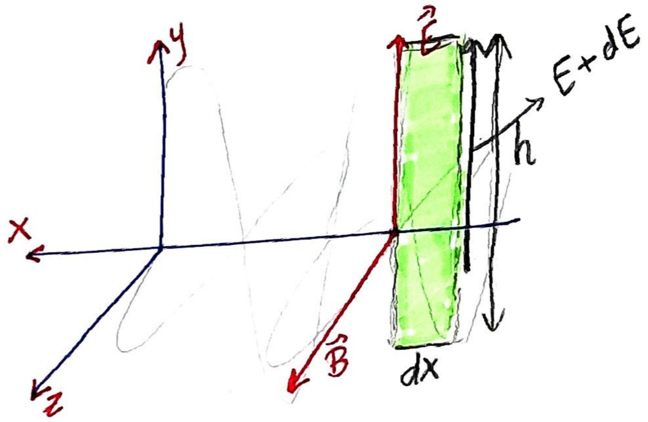
- اتجاه سير الموجة عمودي على ~~...~~ جبهة الموجة

wave front

* the Induced Electric feild :-

→ Fardays Law of Induction :

$$\oint \vec{E}\cdot ds = -\frac{d\Phi_B}{dt} \quad \Phi_B \to B\cdot A \to (dx)(h)$$



$$(\vec{E}+dE)h - Eh = -\frac{d(Bdxh)}{dt}$$

$$\cancel{h}\, dE = -dx\,\cancel{h}\frac{dB}{dt}$$

$$\frac{dE}{dx} = \frac{-dB}{dt} \Rightarrow \frac{\partial E}{\partial x} = -\frac{\partial B}{\partial t}$$

$$E = E_m \sin(Kx - wt)$$

$$B = B_m \sin(Kx - wt)$$

we know $\frac{\partial E}{\partial x} = -\frac{\partial B}{\partial t}$

$$K E_m \cancel{\cos(Kx-wt)} = w B_m \cancel{\cos(Kx-wt)}$$

$$K E_m = w B_m$$

$$\boxed{\frac{E_m}{B_m} = \frac{w}{K}}$$

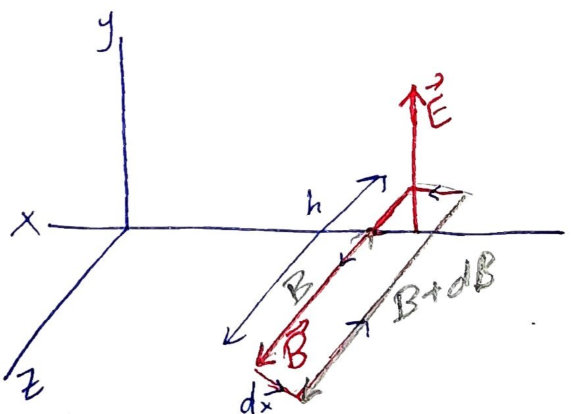
we know $V = \frac{w}{K}$

$$\text{So } \boxed{\frac{E_m}{B_m} = V} = \boxed{\frac{E}{B}}$$

C

* Induced Magnatic feild :

→ Maxwells Law :- $\boxed{\text{wavespeed}}$



$$\oint \vec{B}\cdot ds = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}$$

$$-(B+dB)h + Bh = \mu_0 \varepsilon_0 \frac{d\vec{E}\,dx\,h}{dt}$$

$$-\cancel{h}\, dB = \mu_0 \varepsilon_0 \frac{d\vec{E}\,\cancel{h}\,dx}{dt}$$

$$-\frac{dB}{dx} = \mu_0 \varepsilon_0 \frac{dE}{dt}$$

$$E = E_m \sin(Kx - wt)$$

$$B = B_m \sin(Kx - wt)$$

$$-KB_m \cancel{\cos(Kx-wt)} = -\mu_0 \varepsilon_0 w E_m \cancel{\cos(Kx-wt)}$$

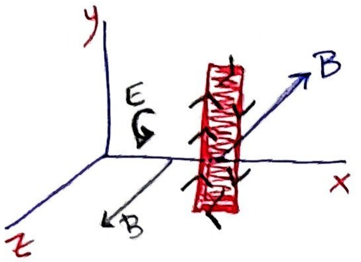
$$K B_m = \mu_0 \varepsilon_0 w E_m$$

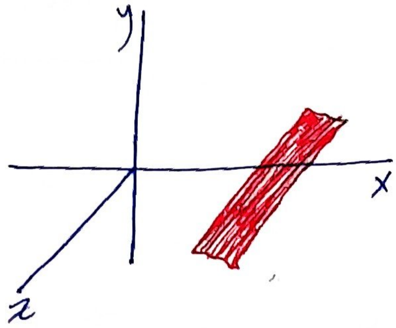
$$\frac{B_m}{\mu_0 \varepsilon_0 E_m} = \frac{w}{K} = C = \frac{E_m}{B_m} = \boxed{\frac{1}{\mu_0 \varepsilon_0 C}} = C^2 = \frac{1}{\mu_0 \varepsilon_0}$$

$$\boxed{C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}}$$

Cheack Point:-

سؤال الدكتورة





if B increasing
So E must Be counterclockwise
aroud z

33.2 Energy transport and Poynting ~~Poss~~ (vector)

$\vec{S}$: the rate of energy transport Per unit areee

$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B} \quad E \perp B$$

$$S = \frac{1}{\mu_0} EB \Rightarrow S = \frac{\text{energy / time}}{\text{area}} = \boxed{\frac{P}{A}} \quad \frac{\text{Power}}{\text{Area}} = \left[\frac{\text{Watt}}{m^2}\right]$$

$$\langle S \rangle = I \text{ (Intensity)}$$

averg valu

$$S = \frac{1}{\mu_0} EB$$

$$S = \frac{1}{\mu_0 c} E^2$$

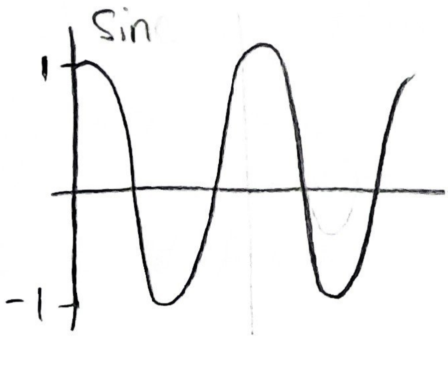
$$E = E_0 \sin(kx - \omega t)$$

$$S = \frac{1}{\mu_0 c} \left(E_0 \sin(kx - \omega t)\right)^2$$

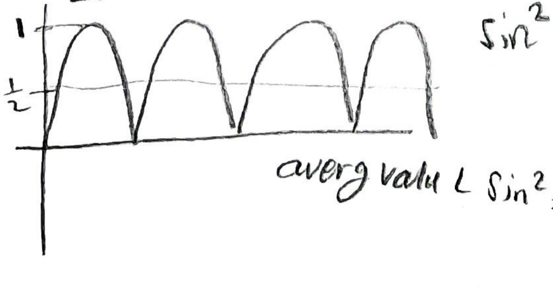
$$S = \frac{E_0^2}{\mu_0 c} \sin^2(kx - \omega t)$$

$\frac{1}{2}$

$$I = \frac{E_0^2}{2\mu_0 c}$$



$\rightarrow$



averg valu L $\sin^2 = \frac{1}{2}$

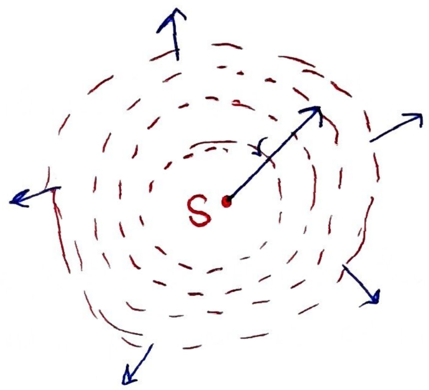
$$\ast\ I = \frac{E_m^2}{2\mu_0 c}$$

$$\boxed{- E_{rms} = \frac{E_m}{\sqrt{2}} \Rightarrow I = \frac{1}{c\mu_0} E_{rms}^2}$$

$$- I = \frac{\text{Power}}{\text{area}}$$

$$I = \frac{P}{4\pi r^2} \qquad r^2 \frac{1}{\propto} I$$

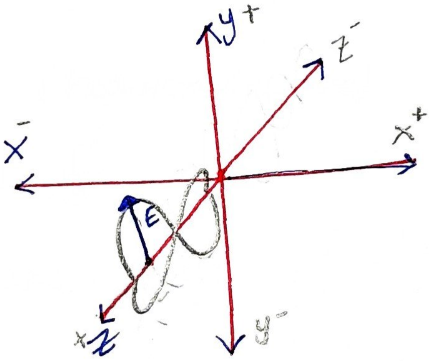
تقل شدة الضوء مع المسافة

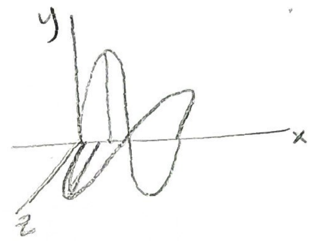


Cheack Point

$S \to z^-$
$E \to y^+$
$B \to -x$

$i \to j \to k$



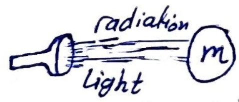


$$\begin{vmatrix} i & j & k \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{vmatrix} \quad i: -x$$

33.3 Radiation Pressure ضغط اشعاعي

Electromagnetic waves have Linear momentum as well as energy by shining on it. but this Pressure very small becaus for example you don't fell a punch during a camra flash.

$$\Delta P = \frac{\Delta U}{c} \quad \text{(total absorption)}$$



الجسم بعد فترة من الزمن سيتحرك الاشعة المقابلة وباتجاهه.

P: Linear momentum
U: energy absorbed
c: speed of Light

We know

* $F = \frac{\Delta P}{\Delta t}$ → Linear momentum

* $I = \frac{P}{A}$ → Power $\Rightarrow I = \frac{\Delta U / t}{A} = I = \frac{\Delta U}{A t} \Rightarrow \boxed{\Delta U = I A \Delta t}$

$$F = \frac{\frac{\Delta U}{c}}{\Delta t} \Rightarrow \frac{I A \Delta t}{c \Delta t} = \boxed{\frac{IA}{c}}$$ (total absorpation)

- if the radiation is totally reflected back along its' orignal Path

so:

$$\Delta P = \frac{2 \Delta U}{\Delta t}$$

$$F = \frac{2 I A}{c}$$

Note: if the radiation is Partlly absorped or reflected the magnitude of the force or area is between the value of IA/c and $2IA/c$

* Pressure → we can find it (Radiation pressure)

$F = \frac{IA}{c}$ we know $P = \frac{F}{A}$

$P = \frac{F}{A}$

So $\boxed{P_r = \frac{I}{c}}$ (total absorpation)

$F \propto A$

$\boxed{P_r \text{ independent of the } A}$

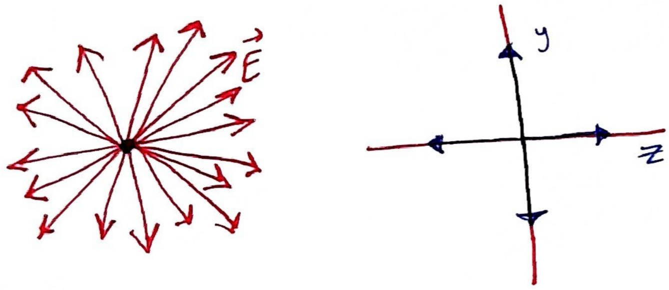
$\boxed{P_r = \frac{2I}{c}}$ (total reflected)

33.4) Polaraization استقطاب

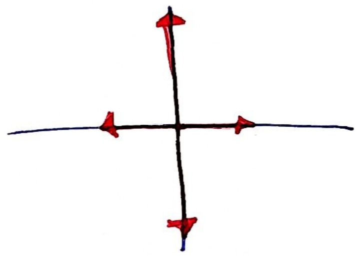
~~(VHF) very high freqency~~ - تجي ملهاش دخل -

Types of Polarization

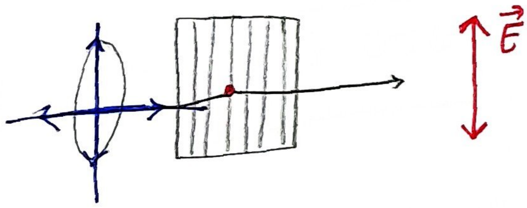
① unpolarizeed / randomlly



② Partielly Polarized



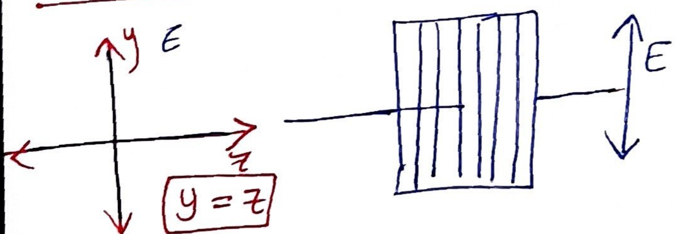
③ Polarized :-



Note
(Polarizing sheet) (can be the transform unpolarized to Polarized.)

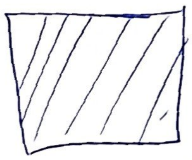
* Intensity of transmitted Polarized light

① for unpolarized light :



$$I = \frac{I_0}{2}$$

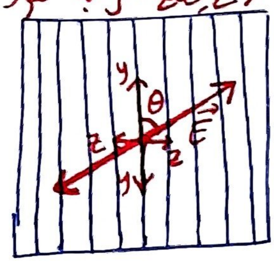
خذي شكل للورقة



راح يطلع $\frac{1}{2}$

② Polarized Light

راح يطلع المركبة العمودية



$$\boxed{E_y = E_0 \cos\theta}$$

هسسه هالله

ناتج الموجة حسب شكل الورقة

we know

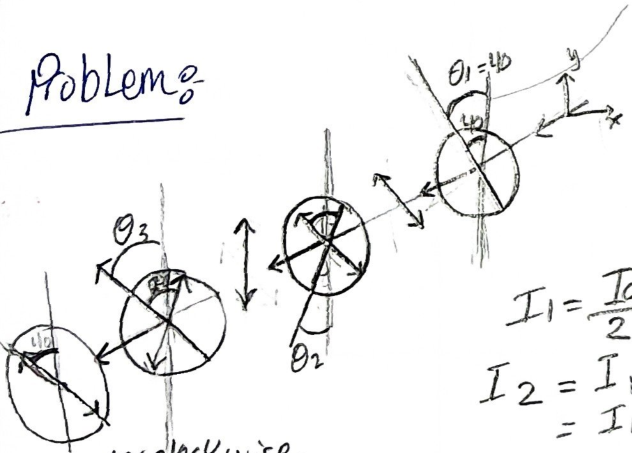
$$I = \frac{E_{rms}^2}{\mu_0 C} \Rightarrow \cancel{\frac{I}{I_0} = \frac{E_{rms}^2}{\mu_0 C} \Big/ \frac{E_{0rms}^2}{\mu_0 C} \Rightarrow \frac{E_{rms}^2}{E_y^2}}$$

$$\cancel{\Rightarrow \frac{E_{rms}^2}{E_{rms}^2 \cos\theta}} \qquad \cancel{\frac{E_{rms}^2}{\mu_0 C} \cdot \frac{E_{rms}^2}{\mu_0 C} \Rightarrow \frac{E_{rms}^2}{\mu_0 C} \cdot \frac{\mu_0 C}{E_{rm}^2}}$$

$$I = \frac{E_{rms}^2}{\mu_0 C} \Rightarrow \text{بدنا} \quad \frac{I}{I_0} = \frac{E_{rms}^2}{\cancel{\mu_0 C}} \cdot \frac{\cancel{\mu_0 C}}{E_{0rms}^2} \Rightarrow \frac{E_{rms}^2}{E_{0rms}^2} \Rightarrow \frac{\cancel{E_{rms}^2} \cos^2\theta}{\cancel{E_{rms}^2}}$$

$$\boxed{\frac{I}{I_0} = \cos^2\theta} \qquad \boxed{I = I_0 \cos^2\theta} \text{ (cosin squer rule)}$$

Problem:



$\theta_1 = \theta_2 = \theta_3 = 40°$

q_1: $\frac{I}{I_0}$?? and

$$I_1 = \frac{I_0}{2} \rightarrow ①$$

$$I_2 = I_1 \cos^2(\theta_1 + \theta_2) = I_1 \cos^2 80$$

$$I_3 = I_2 \cos^2(\theta_2 + \theta_3) = I_2 \cos(80)$$

$$I_3 = \frac{I_0}{2} \cos^2 80 \cos^2 80$$

$$\frac{I_3}{I_0} = 4.5 \times 10^{-2} \%$$

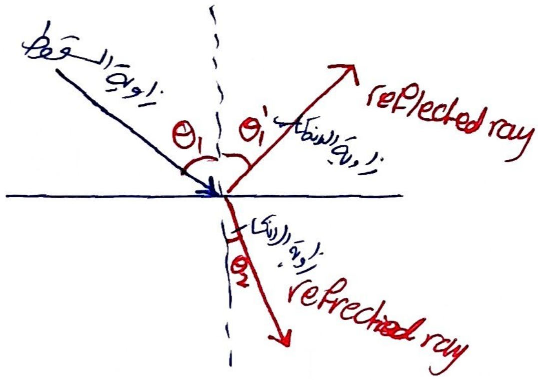
② dirction is $\theta = 40$ counterclockwis

33.5 Reflection ~~and~~ Refraction

الانعكاس والانكسار

① Law of reflection

$\theta_1 = \theta_1'$



② Law of refraction

Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$

n : index of refraction.

$$\boxed{n = \frac{c}{v}} \geq 1$$

تكون تساوي 1 لما $v = c$

دائمًا $c > v$ أكبر من 1

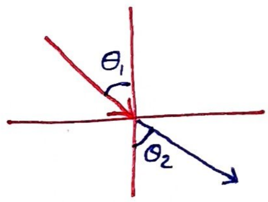
c : speed of Light in the vacuum.

v : speed of Light in the medium.

$$\sin\theta_2 = \frac{n_1}{n_2} \sin\theta_1$$

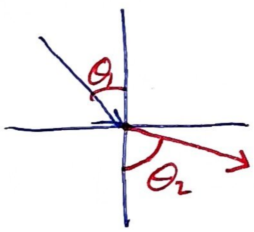
① $n_1 = n_2$

so $\theta_1 = \theta_2$



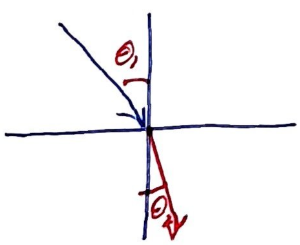
② $n_1 > n_2$

$\theta_2 > \theta_1$



③ $n_1 < n_2$

$\theta_2 < \theta_1$



"كل فكرة عظيمة تبدأ بحلم
وكل نجاح يبدأ بخطوة ..."

لا تتوقف إلا أن تصبح فخور بنفسك ♡

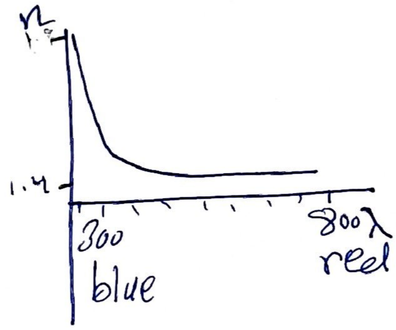
"وإن بدا لك الأمر معقد
فلطف الله ممتد ♥ ..."

تفاءل
فإن ثمار الصبر
أوشكت أن تجنى ♥

- Chromatic Dispersion

fig 33-18

$\boxed{n \propto \frac{1}{\lambda}}$



$\Downarrow$

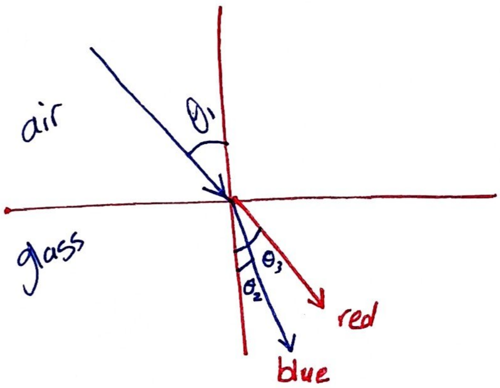
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_{air} = 1$

$\sin\theta_1 = n_2 \sin\theta_2$

$\boxed{\sin\theta_2 = \frac{\sin\theta_1}{n_2}}$

$\theta_{red} > \theta_{blue} \Rightarrow n_{blue} > n_{red}$

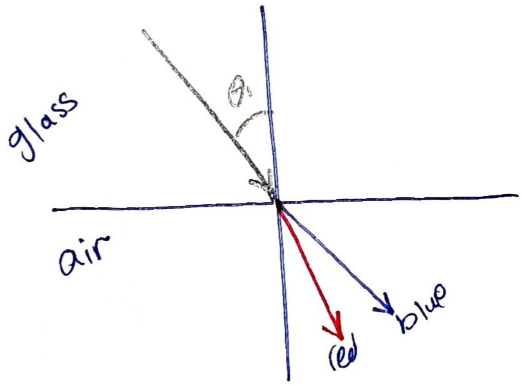


$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_1 \sin\theta_1 = \sin\theta_2$

$n_b > n_r \leftarrow \boxed{\lambda_b < \lambda_r}$

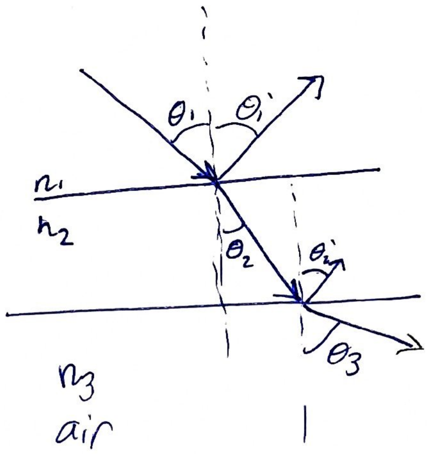
$\theta_b \cancel{>} \theta_r$



Sample Problem:-

$n_1 = 1.33$
$n_2 = 1.77$
$\theta_1 = 40^\circ$

find θ_1' ?
find θ_2 ?
find θ_3 ?



1- $\theta_1' = \theta_1 = 40$

2- $n_1 \sin\theta_1 = n_2 \sin\theta_2$
$(1.33)\sin 40 = (1.77)\sin\theta_2$
$\theta_2 = 28.8$

3- $n_2 \sin\theta_2 = n_3 \sin\theta_3$
$(1.77)(\sin 29) = (1)\sin\theta_3$
$\theta_3 = 59.1^\circ$

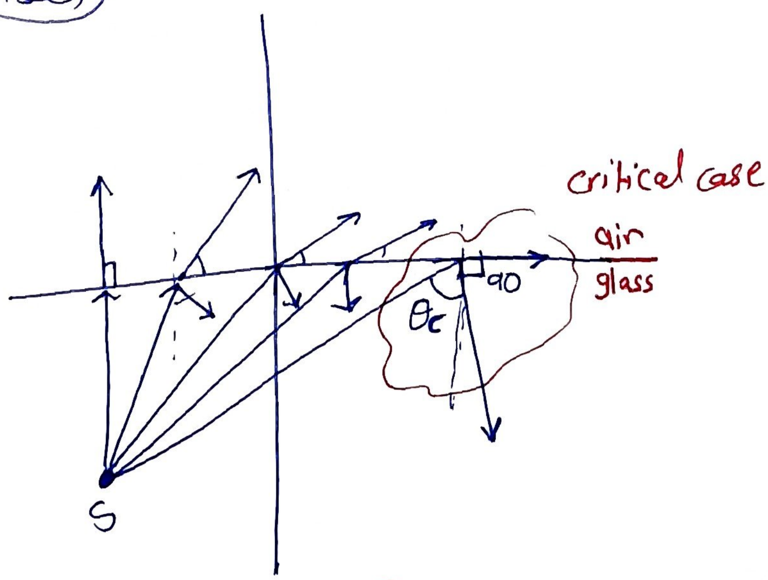
33.6 Total Internal reflaction.

$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$n_1 \sin\theta_? = n_2 \sin 90$

$$\boxed{\theta_c = \sin^{-1}\frac{n_2}{n_1}}$$

اذا الزاوية هي نقطة عملت زاوية انعكاس 90 فانه زاوية السقوط تسمى θ_c

$n_2 < n_1 \rightarrow$ critical refraction عشان نصير total لازم



Chapter 35

Interfarence

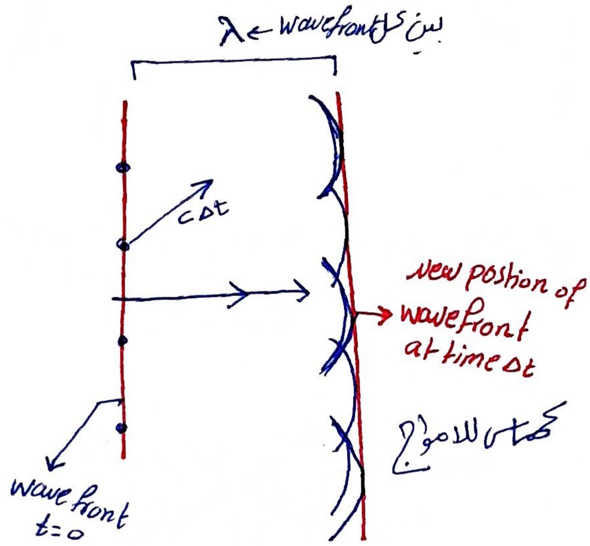
35-1 Light as a wave

Huygen's Prenciple

* Refraction :-

$$n = \frac{c}{v}$$

$$v_1 = \frac{c}{n_1} \qquad v_2 = \frac{c}{n_2}$$

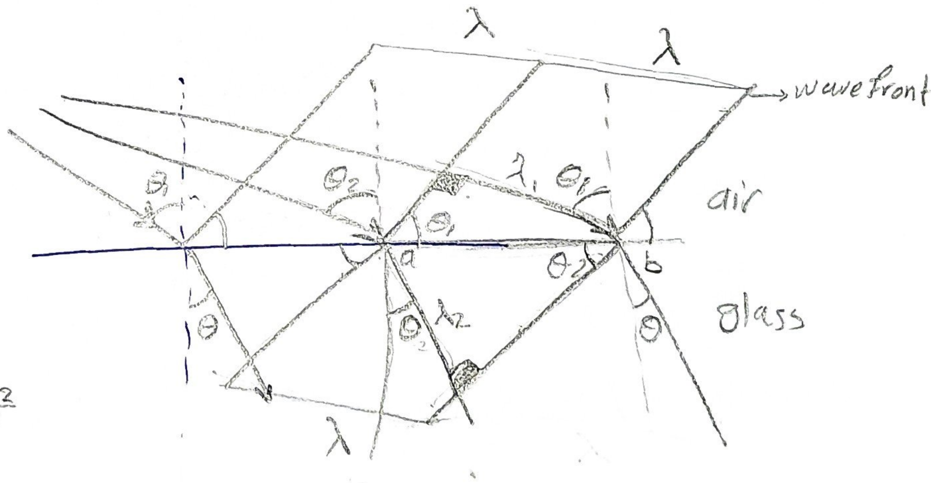


$$\Delta t = \frac{\lambda_1}{v_1} = \frac{\lambda_2}{v_2}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} \quad - (1)$$

$$\sin\theta_1 = \frac{\lambda_1}{ab} \qquad \sin\theta_2 = \frac{\lambda_2}{ab}$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} \rightarrow (2)$$



$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} \Rightarrow \frac{\sin\theta_1}{\sin\theta_2} = \frac{\cancel{c}}{n_1}\cdot\frac{n_2}{\cancel{c}}$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} \Rightarrow \boxed{n_1\sin\theta_1 = n_2\sin\theta_2}$$

Snill's Law...

$$\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$

$$n_1 = n_{air} \qquad v_1 = c$$

$$\lambda_2 = \lambda_n$$

$$\frac{\lambda}{\lambda_n} = \frac{c}{v} = n$$

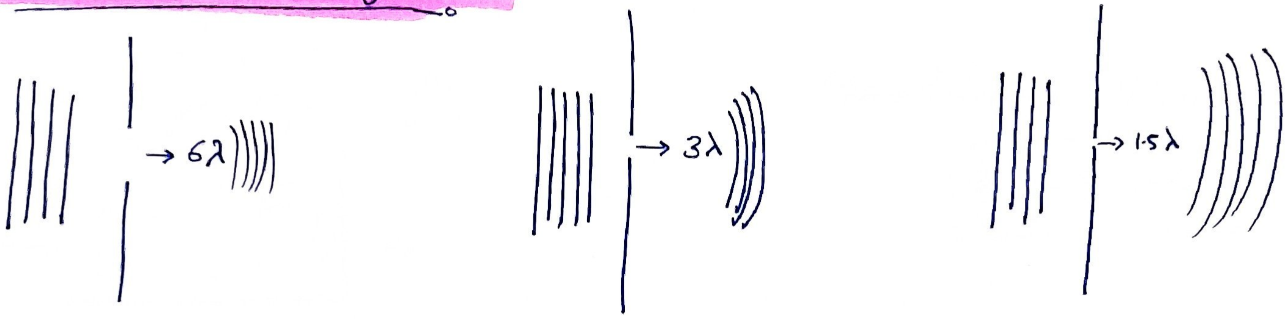
$$\Rightarrow \frac{\lambda}{\lambda_n} = n \Rightarrow \boxed{\lambda_n = \frac{\lambda}{n}}$$

$$f_n = \frac{v}{\lambda_n}$$

$$f_n = \frac{c/n}{\lambda/n} = \frac{c}{\lambda} = f$$

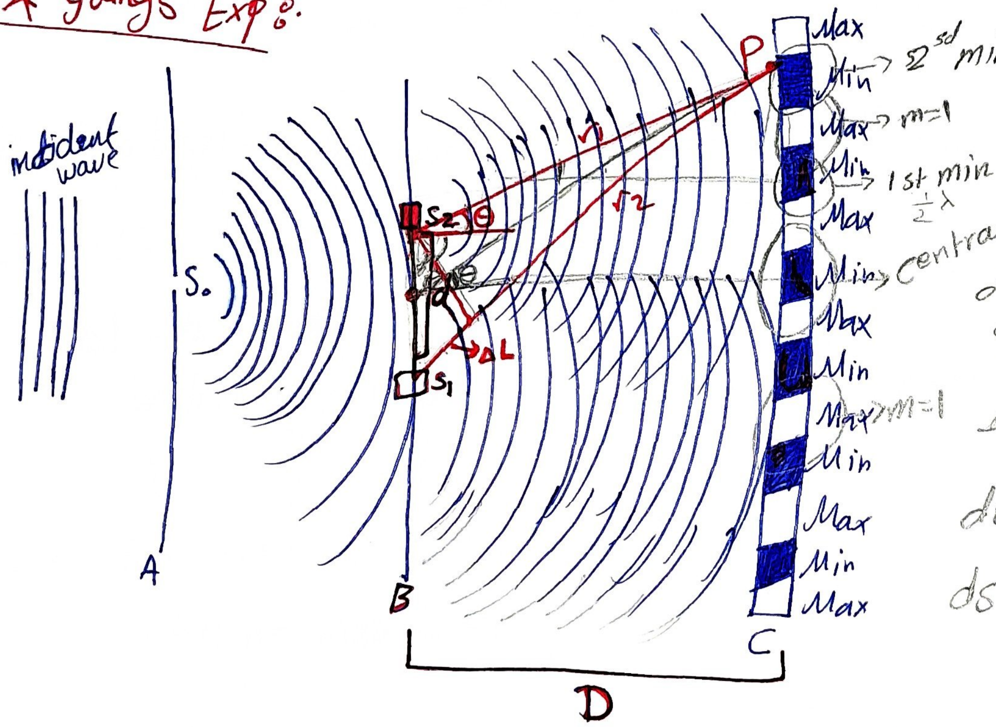
(the frequncy of the light in the medium is the same as it is in vacuum)

diffraction of the light



Note مثال من الواقع : عندما نشاهد ضوء الشارع وإغلاق العين أي اصغر فتحة نرى أنه الضوء قد انتشر .

* youngs Exp :



$d <<< D$

$\sin\theta = \frac{\Delta L}{d}$

$\Delta L = d\sin\theta$

$d\sin\theta = m\lambda$ → constractiv

$d\sin\theta = (n+\frac{1}{2})\lambda$ → distractive

Max

$\frac{y}{D} = \frac{\lambda}{d}$ 1st ← c من

$\tan\theta = \frac{y}{D}$

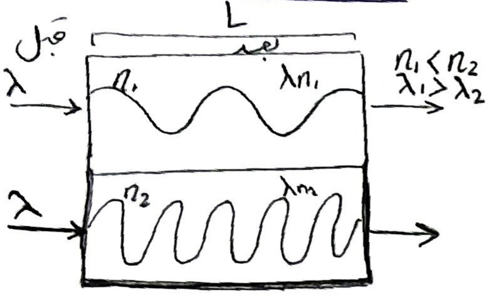
$d\sin\theta = (n+\frac{1}{2})\lambda$

$\theta = \theta$

$\frac{\frac{1}{2}\lambda}{d} = \frac{y}{D}$

$\boxed{y = \frac{\frac{1}{2}\lambda D}{d}}$

* Phase differnce



عدد الموجات

$$N_1 = \frac{L}{\lambda n_1} \qquad N_2 = \frac{L}{\lambda n_2}$$

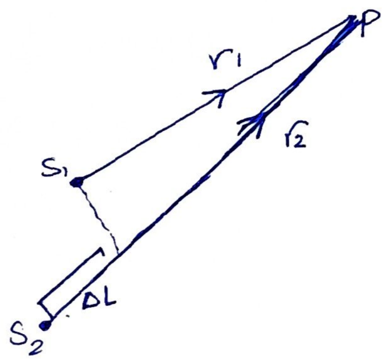
Phase differnce : $|N_1 - N_2| = \frac{n_1 L}{\lambda} - \frac{n_2 L}{\lambda}$

$$\boxed{\Rightarrow \frac{L}{\lambda}(n_1 - n_2)}$$

we know

$$\lambda n = \frac{\lambda}{n} \Rightarrow N_1 = \frac{n_1 L}{\lambda} \qquad N_2 = \frac{n_2 L}{\lambda}$$

* Path length difference



ΔL = Path length differenee

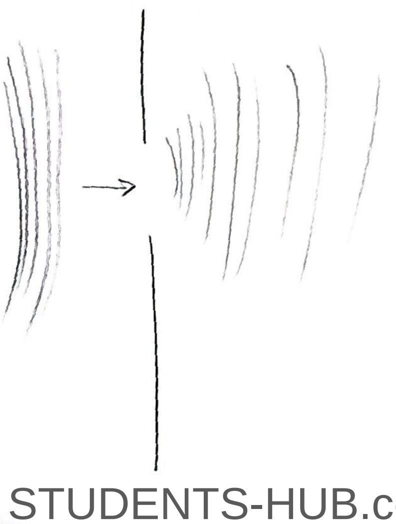
if $\Delta L = m\lambda$ $\quad m = 0, 1, 2, \ldots$

Constractive interfernce

if $\Delta L = (n + \frac{1}{2})\lambda$ $\quad n: 0, 1, 2 \ldots$

distractive interfernee

35.2 young's Interferene Exp.



diffraction

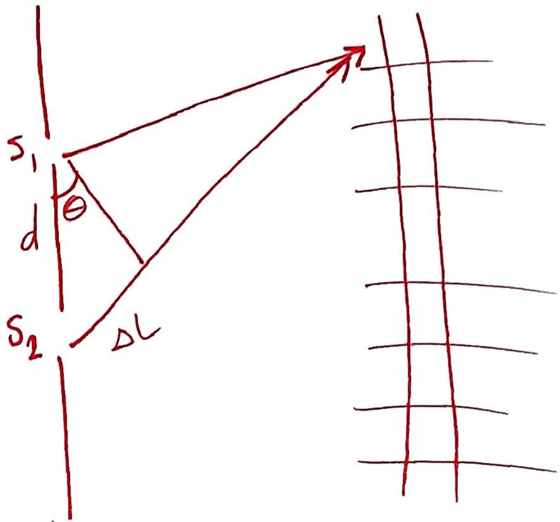
انتشار

عند دخول موجة
على فتحة صغيرة .

35.3 Interference - Double slit Intinsity

→ Coherent Source ϕ constant
example: Laser

→ In Coherent Source ϕ varibales
لانستطيع رؤية الاختلاف في التداخل (البناء، الهدام)
example: Sunlight تكون الاشعة بشكل عشوائي وسريعة جداً.



$$E_1 = E_0 \sin(\omega t)$$
$$E_2 = E_0 \sin(\omega t + \phi)$$

$$I = 4 I_0 \cos^2 \frac{\phi}{2}$$
$$\phi = \frac{2\pi d}{\lambda} \sin\theta$$

Maximum I: $\frac{\phi}{2} = m\pi$

$$\frac{\cancel{2}\cancel{\pi} d}{\cancel{2}\lambda} \sin\theta = m\cancel{\pi}$$

$$\boxed{d\sin\theta = m\lambda}$$

minimum I: $\frac{\phi}{2} = (m+\frac{1}{2})\pi$

$$\frac{\cancel{2}\cancel{\pi} d \sin\theta}{\cancel{2}\lambda} = (m+\frac{1}{2})\cancel{\pi}$$

$$\boxed{d\sin\theta = (m+\frac{1}{2})\lambda}$$

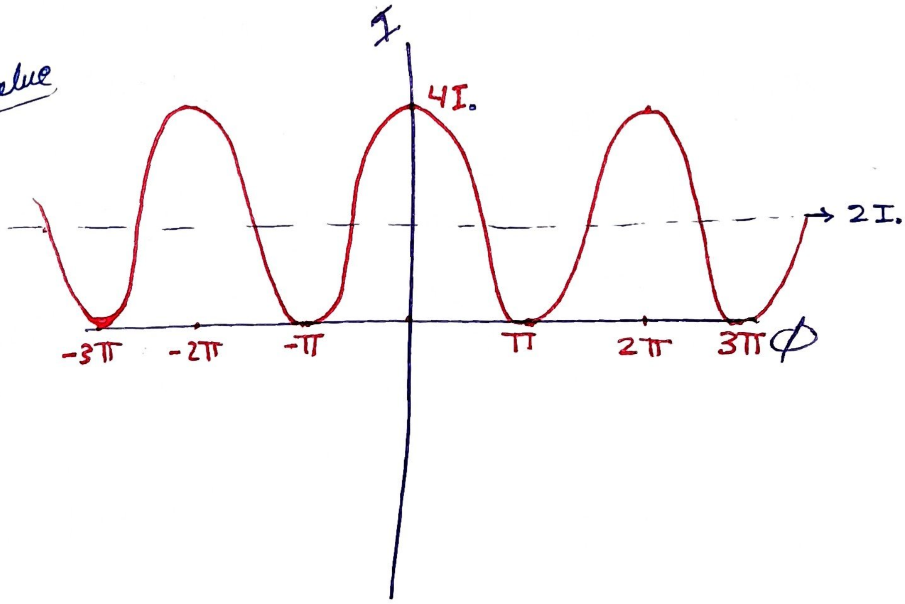
$0 < I < 4I_0$

$\langle I \rangle = \langle 4 I_0 \cos^2 \frac{\phi}{2} \rangle$ → averge value

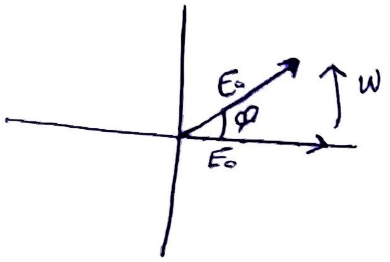
$= 4 I_0 \langle \cos^2 \frac{\phi}{2} \rangle$

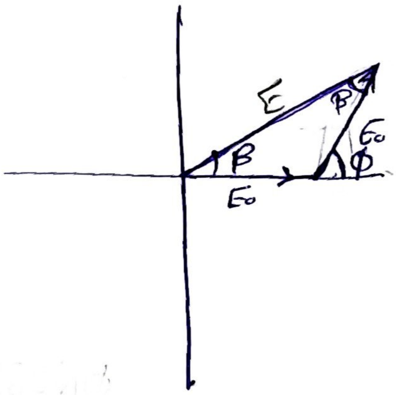
$= 4 I_0 \langle \cos^2 \frac{\phi}{2} \rangle$

$\boxed{= 2 I_0}$



$E_1 = E_0 \sin \omega t$ / $E_2 = E_0 \sin \omega t + \phi$





$E = E_1 + E_2$

$= E_0 \cos\beta + E_0 \cos\beta$

$= 2E_0 \cos\beta$ $\qquad \phi = 2\beta \qquad I \propto \frac{E}{0}$

$E^2 = \left(2E_0 \cos\frac{\phi}{2}\right)^2 = 4E_0^2 \cos^2\frac{\phi}{2}$

$\frac{I}{I_0} = \frac{E^2}{E_0^2} = 4\cos^2\frac{\phi}{2}$

$$\boxed{I = 4 I_0 \cos^2\frac{\phi}{2}}$$

*** Phase diff.**

$\phi = \pi \rightarrow \Delta L = \frac{\lambda}{2}$ (min)

$\phi = 2\pi \rightarrow \Delta L = \lambda$ (max)

$\phi = \frac{2\pi}{\lambda}\Delta L \Rightarrow \phi = \frac{2\pi d \sin\theta}{\lambda}$

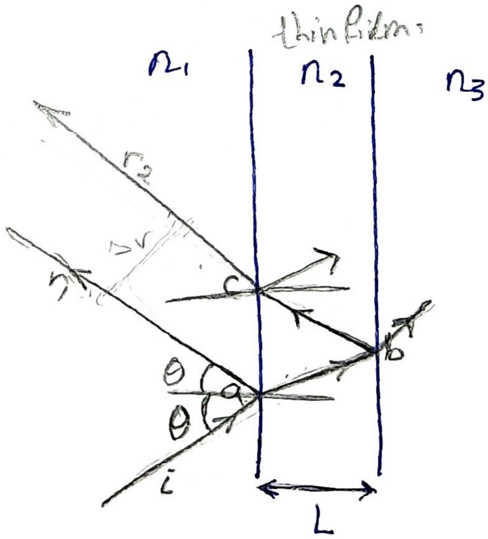
35.4 Interfernce from thin films

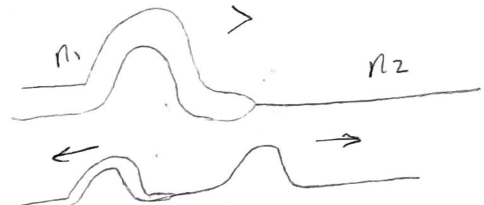
constrcative بناء
distractive هدم

$\phi = \Delta r = \overline{r_2} - \overline{r_1}$

$= (L + L + \overline{r_1}) - \overline{r_1}$

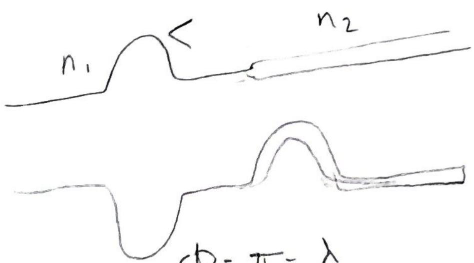
$\phi = \Delta r = 2L$





soft refl.

$\varphi = 0$



hard refl

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

* $2L = \left(m + \frac{1}{2}\right) \lambda_{n_2}$ (max)

$$2L = \left(m + \frac{1}{2}\right) \frac{\lambda}{n_2}$$

$$\lambda = \frac{2 n_2 L}{m + \frac{1}{2}} \longrightarrow \text{max}$$

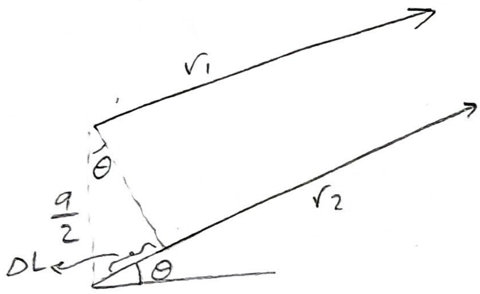
min : $2L = m \lambda_{n_2}$

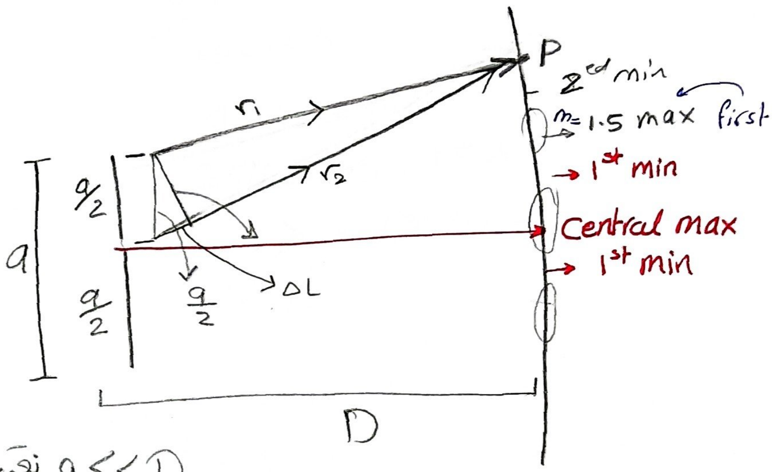
Chapter 36

Diffraction

36.1 Single-slit diffraction

$r_1 \parallel r_2$





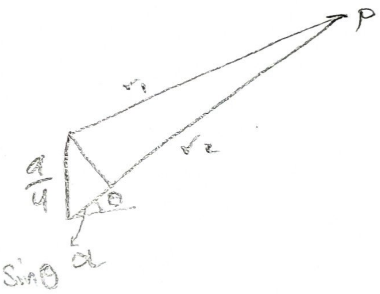
$\Delta L = \frac{a}{2}\sin\theta$ $a << D$ نعتبر r_1, r_2 متوازيان

$\Delta L = \frac{\lambda}{2} \Rightarrow \frac{\lambda}{2} = \frac{a}{2}\sin\theta \Rightarrow \lambda = a\sin\theta$

first minima $\boxed{a\sin\theta = \lambda} \rightarrow (1)$

3^{ed} minima $\boxed{a\sin\theta = 3\lambda}$

$\Delta L = \frac{3}{2}\lambda$



$\Delta L = \frac{\lambda}{2} = \frac{a}{4}\sin\theta$

$\boxed{a\sin\theta = 2\lambda}$ 2^{ed} min

$\boxed{a\sin\theta = m\lambda}$ $m = 1, 2, 3, 4 \ldots$

$a\sin\theta = \lambda$

$\boxed{\sin\theta = \frac{\lambda}{a}}$ $a \rightarrow \lambda$

$\sin\theta = 1$

$\boxed{\theta = 90}$

Sample Problem

a) $a = ??$

$\lambda_r = 650\,nm$, $\theta = 15°$?

$a \sin\theta = m\lambda$ 1^{st} min $= m = 1$

$a = \frac{\lambda_r}{\sin\theta}$

$= \frac{650 \times 10^{-9}}{\sin 15} = \boxed{2511\,nm}$

b) find λ' 1^{st} max $\theta = 15°$

$m = 1.5\lambda$

$a \sin\theta = m\lambda$

$2511 \sin 15 = 1.5\lambda'$

$\lambda = 430\,nm$

36.2 Intensity in single-slit diff.

$I(\theta) = I_m \left(\frac{\sin\alpha}{\alpha}\right)^2$, $I(\theta) = 0$ min

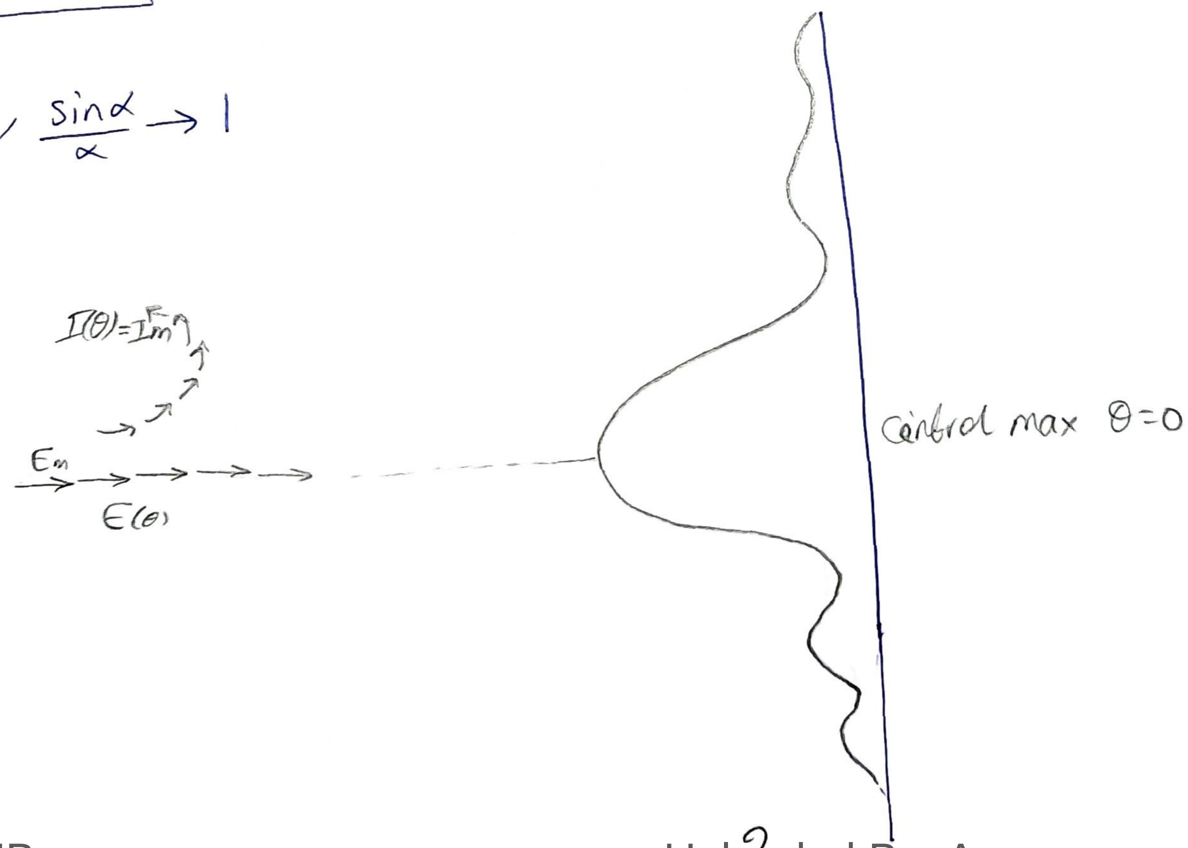
$\alpha = m\pi$ $m = 1, 2, 3 \ldots$

$\alpha = \frac{\pi a}{\lambda} \sin\theta \Rightarrow \cancel{m}\cancel{\pi} = \frac{\cancel{\pi} a \sin\theta}{\lambda}$

$\boxed{m\lambda = a\sin\theta}$

$\theta = 0 \Rightarrow \alpha = 0$, $\frac{\sin\alpha}{\alpha} \to 1$

$\boxed{I(\theta) = I_m}$



qusition:-

find $I(\theta)$ for $1^{st}, 2^{ed}, 3^{ed}$ max

$\alpha = m\pi$

1^{st} max $\quad m = 1.5 \longrightarrow \alpha = 1.5\pi$

2^{ed} max $\quad m = 2.5 \longrightarrow \alpha = 2.5\pi$

3^{ed} max $\quad m = 3.5 \longrightarrow \alpha = 3.5\pi$

$$I(\theta) = I_m \left(\frac{\sin\alpha}{\alpha}\right)^2$$

$\frac{I_1}{I_m}$ بنعوض α وبتطلع

النسبة ؟

36.4 Diffraction by double slit.

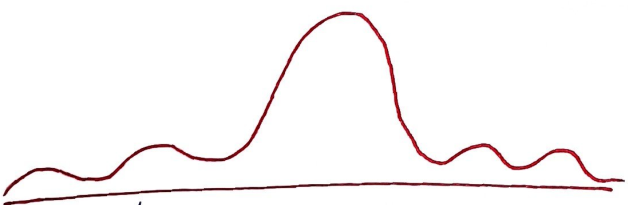
$$I(\theta) = I_m \cos^2\beta \left(\frac{\sin\alpha}{\alpha}\right)^2$$

$\beta = \frac{\pi d}{\lambda}\sin\theta \quad , \quad \alpha = \frac{\pi a}{\lambda}\sin\theta$

if $a \to 0 \qquad I(\theta) = I_m \cos^2\beta$

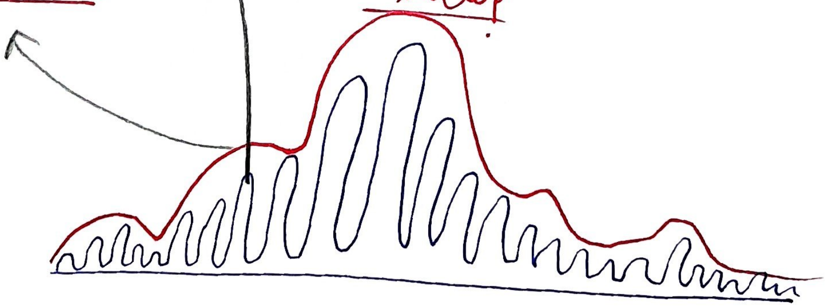
if $d \to 0 \qquad I(\theta) = I_m \left(\frac{\sin\alpha}{\alpha}\right)^2$

interfernce



Intenstiy

invelop



Sample Problem

$\lambda = 405\ nm$
$a = 4.05\ \mu m$
$d = 19.44\ \mu m$

a) Find # of maximam of Centra peak.

$a\sin\theta = m_1\lambda$

1st min $\rightarrow m_1 = 1$

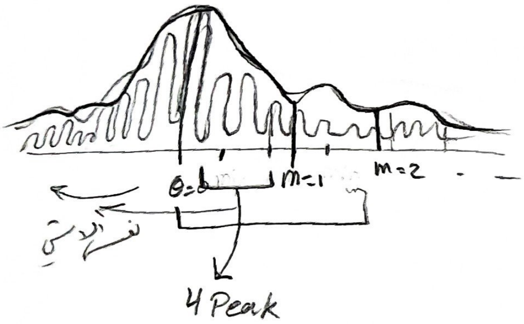
$\boxed{a\sin\theta = \lambda} \rightarrow (1)$

$d\sin\theta = m_2\lambda$

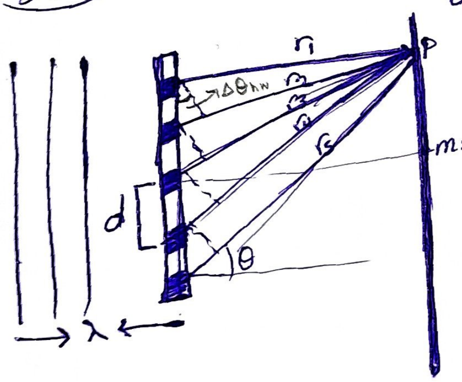
$m_2 = \frac{d\sin\theta}{\lambda}$

$m_2 = \frac{d\sin\theta}{a\sin\theta}$

$\boxed{m_2 = \frac{d}{a}}$ $m_2 = 4.8$



36.5 Diffraction Gratings



$\Delta L = d\sin\theta = m\lambda$ (maximum)

$\sin\theta = \frac{m\lambda}{d}$

$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right)$

$\Delta\theta_{hw} \Rightarrow width = 2\Delta\theta_{hw}$

عدد الفتحات ، طول فتحة واحدة

$a = Nd$

$a\sin\theta = \lambda m$

$Nd\sin\theta = m\lambda \rightarrow m = 1$

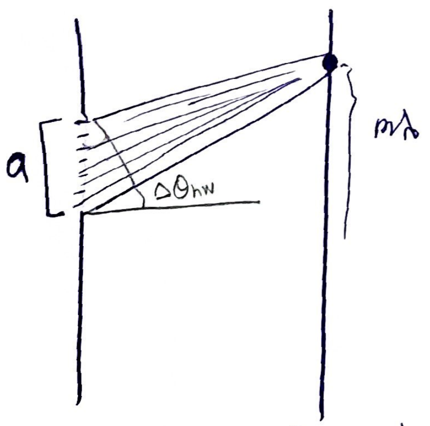
$Nd\sin\theta = \lambda$

$Nd\sin\Delta\theta_{hw} = \lambda$

$\boxed{Nd\,\Delta\theta_{hw} = \lambda}$

$\Delta\theta_{hw}$ is small
So $\sin\Delta\theta_{hw} = \Delta\theta_{hw}$

$\boxed{\Delta\theta_{hw} = \frac{\lambda}{Nd}} \rightarrow$ (Cintral line)



$a\sin\theta = m\lambda$, 1st min , $m = 1$
$a\sin\theta = m\lambda$

* for high order

$$\boxed{\Delta\theta_{hw} = \frac{\lambda}{N d \cos\theta}}$$

$$d = \frac{w}{N}$$

Sample Problem

350 line/mm (N/w) , (400 - 700) nm

How many orders (m) ?

$d \sin\theta = m\lambda$

$d = \frac{w}{N}$

$\theta < 90$

$d = \frac{1}{350}$

$$\sin\theta = \frac{m\lambda}{d} < 1 \Rightarrow \frac{m(700 \times 10^{-9})}{d}$$

$$m < \frac{d}{\lambda} = \frac{28 \times 10^{-8}}{700 \times 10^{-9}} = 4$$

تعليقات:

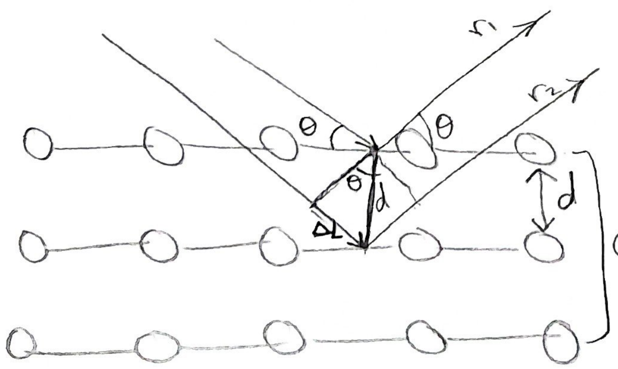
- اخترنا $\theta < 90$ لانو لو $\theta = 90$ تكون معتمة ولا نرى شيء
- واخترنا 700 نانومتر لاننا نريد اعلى رتبة لنرى كم عددهم واي أين يصل الضوء
- ولانه $\sin\theta$ اكبر قيمة له واحد نحل المعادلة هيك

36.7 X-Ray diffraction

X-ray → electromagnetic radiation whose wavelengths (1 Å) → 10^{-10} m   550 nm

$d = 3000$ nm

$$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right) \Rightarrow \sin^{-1}\left(\frac{(1)(0.1\,nm)}{3000\,nm}\right) = 0.0019^\circ$$



$\Delta L = d\sin\theta + d\sin\theta$

$= 2d\sin\theta = m\lambda$ $\boxed{\text{Bragg's law}}$

$$\boxed{d = \frac{a_0}{2}}$$