PHYSICS

" Optics "

light → wave-particle duality
→ electromagnetic wave

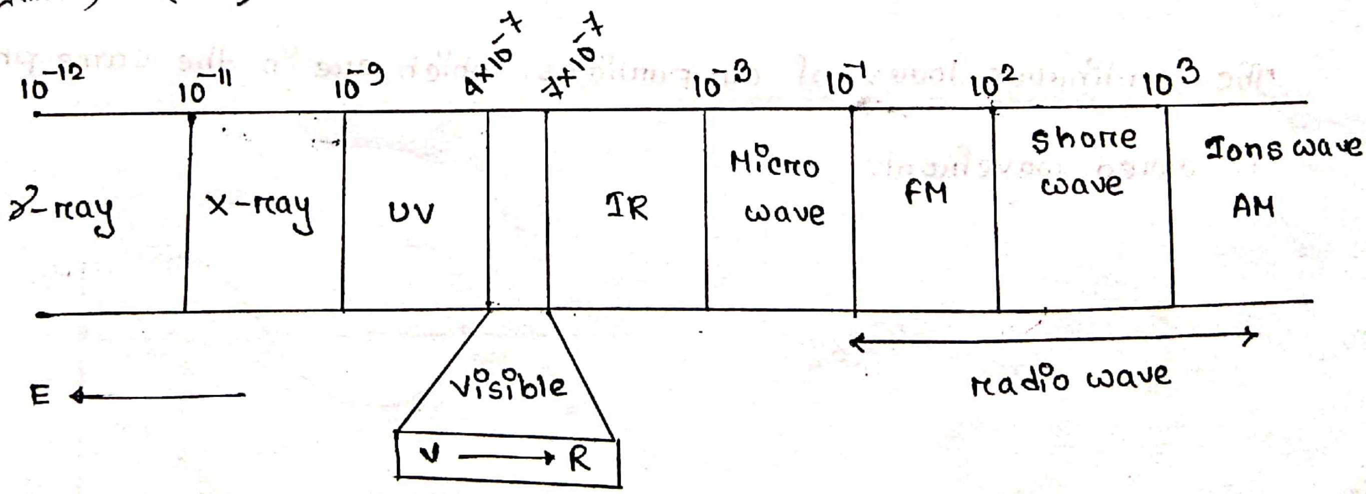
Light

- wave nature
  - Reflection
  - Refraction
  - interference (ব্যতিচার)
  - Diffraction (বিচ্ছুরণ)
  - polarization
- particle nature
  - photo electric effect
  - black body rediation etc.

particle → photon $\left(E = h\nu, = \frac{hc}{\lambda}\right)$
↓
quanta of light

$I \propto A^2$

wave → amplitude (বিস্তার), frequency, wavelength, Intensity (প্রবলতা), phase (দশা).



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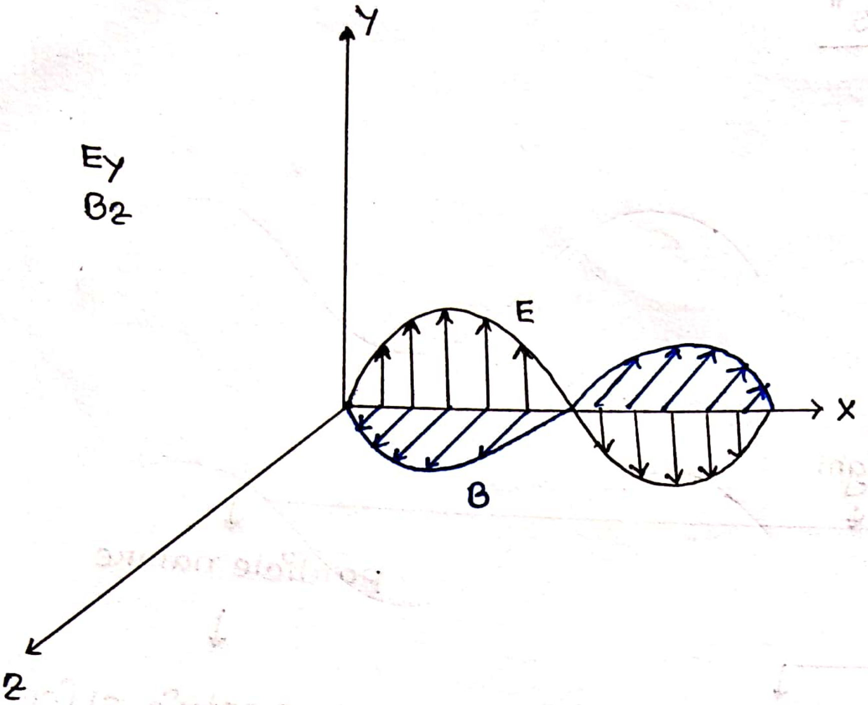
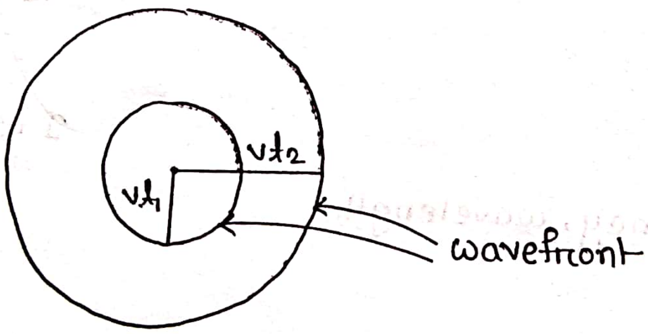
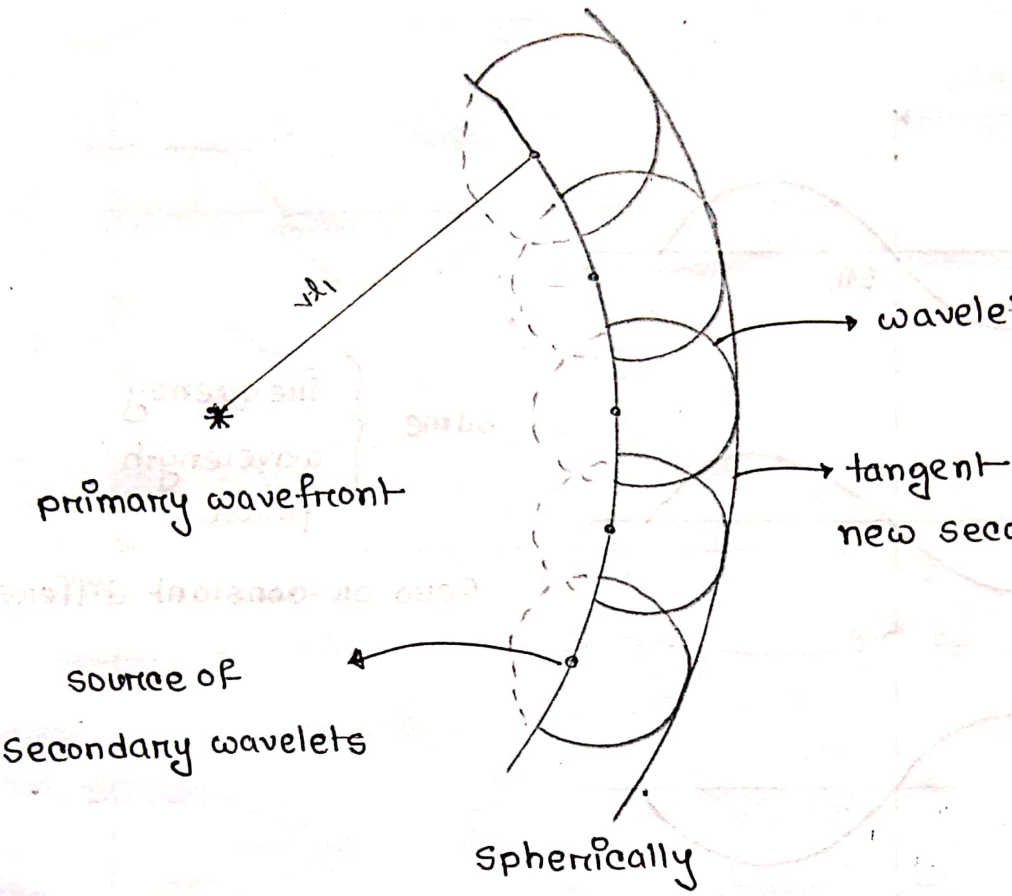


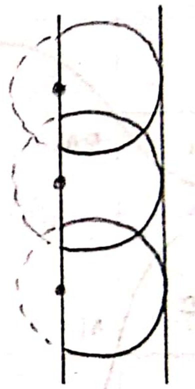
Wave fronts



The continuous locus of all particles, which are in the same phase, is called wavefront.

Huygen's principle:

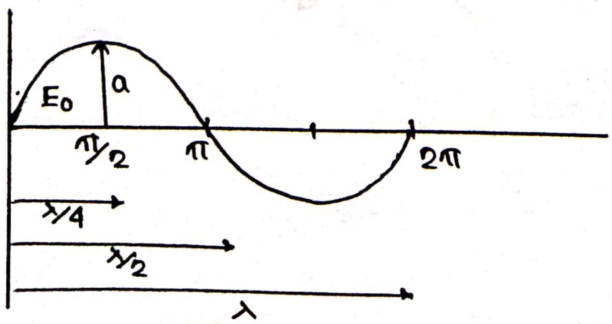




Every point of a wavefront may be considered as a source of secondary wavelets which spread out in forward direction with a speed equal to the speed of propagation of the wave.

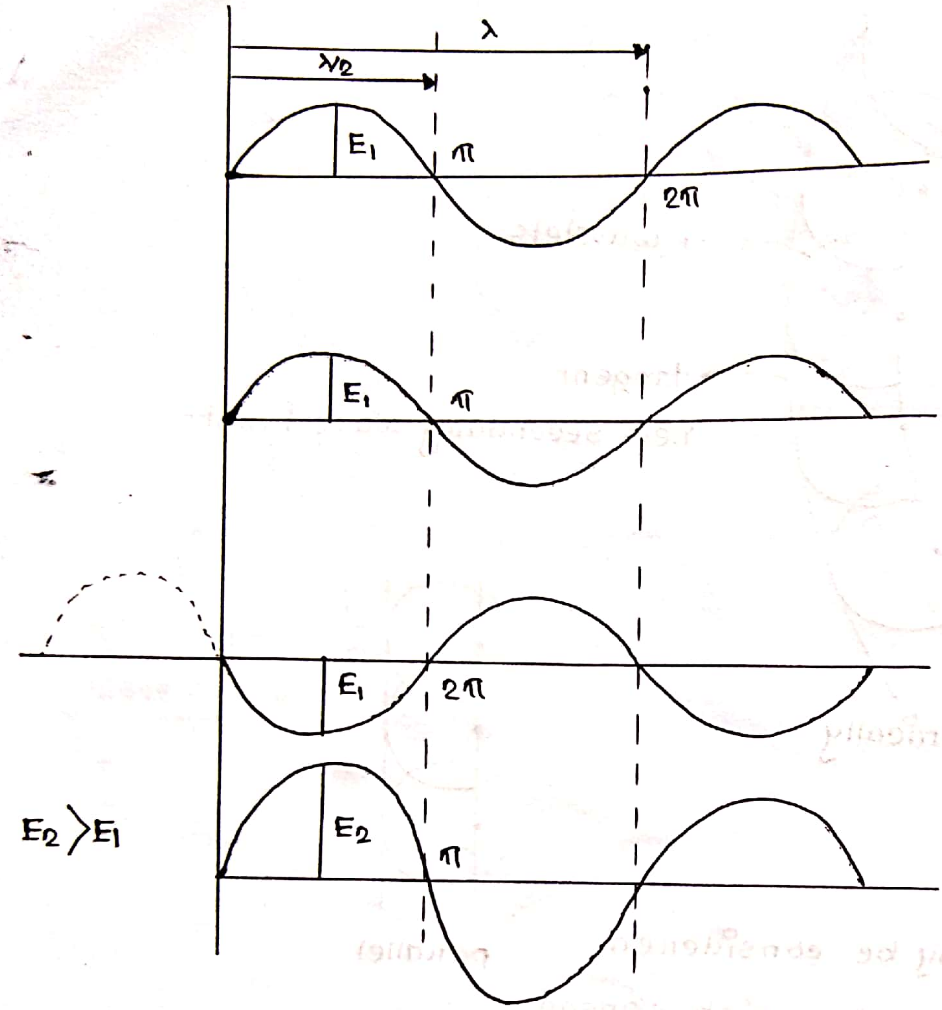
The new wavefront is the tangential surface to all of these secondary wavelets.

अन्वालोप



$I \propto E^2$

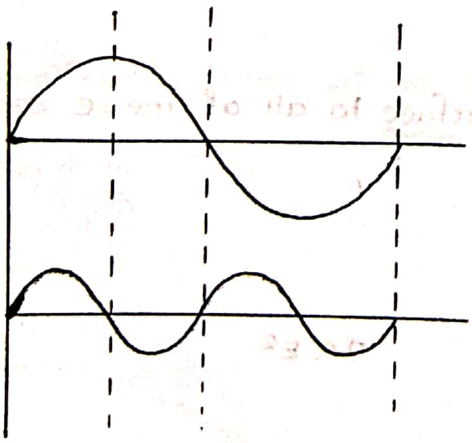
① Coherent source: (સુસંબદ્ધ ઉદગમ)



same { frequency, wavelength, phase

zero or constant difference

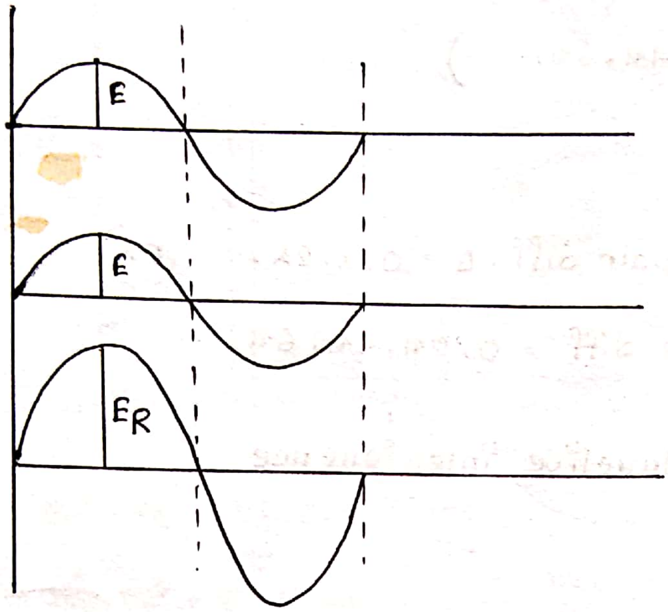
② Incoherent source:



f → different

change in the phase

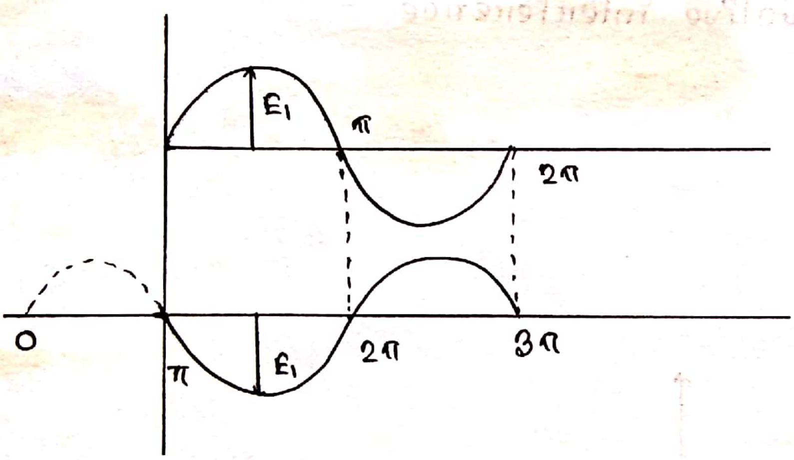
Superposition of light waves:

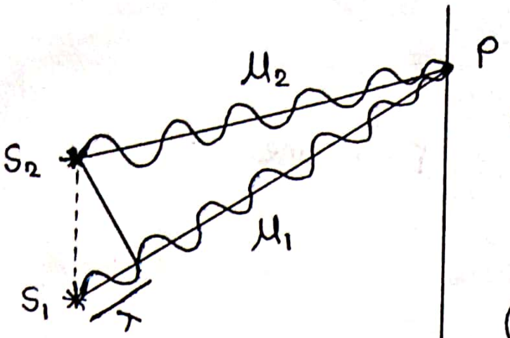


$f \longrightarrow$ same

$I \propto \frac{1}{2} c\epsilon_0 E_R^2$

$I \propto E_R^2$





উজ্জ্বল (সমদশা)

$(0, 2\pi, 4\pi, 6\pi, \dots)$

If path diff, $\Delta = 0, \lambda, 2\lambda, \dots \; n\lambda$

phase diff $= 0, 2\pi, 4\pi, 6\pi, \dots$

→ constructive interference

let,

$S_1P = r_1$

$S_2P = r_2$

Path difference.

$\Delta = r_1\mu_1 - r_2\mu_2$

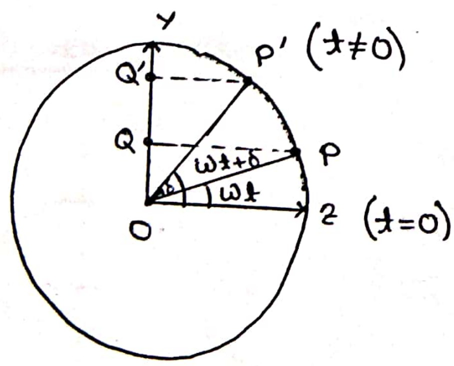
If path diff, $\Delta = \lambda/2, 3\lambda/2, \dots \; (2n+1)\lambda/2$

→ distructive interference.

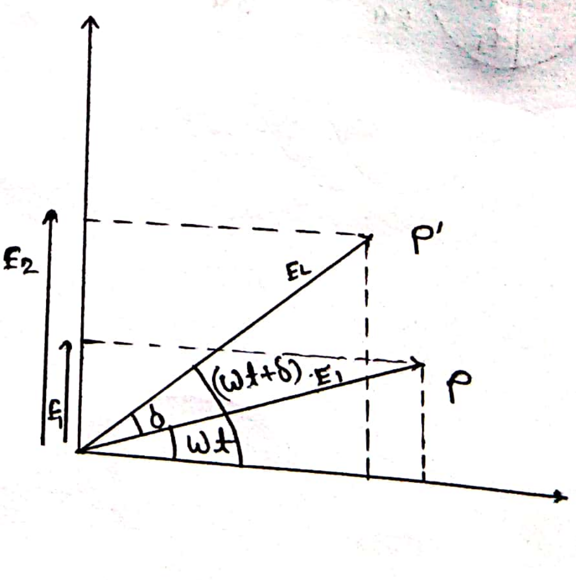
(i) side wave view → $\lambda, 2\pi$

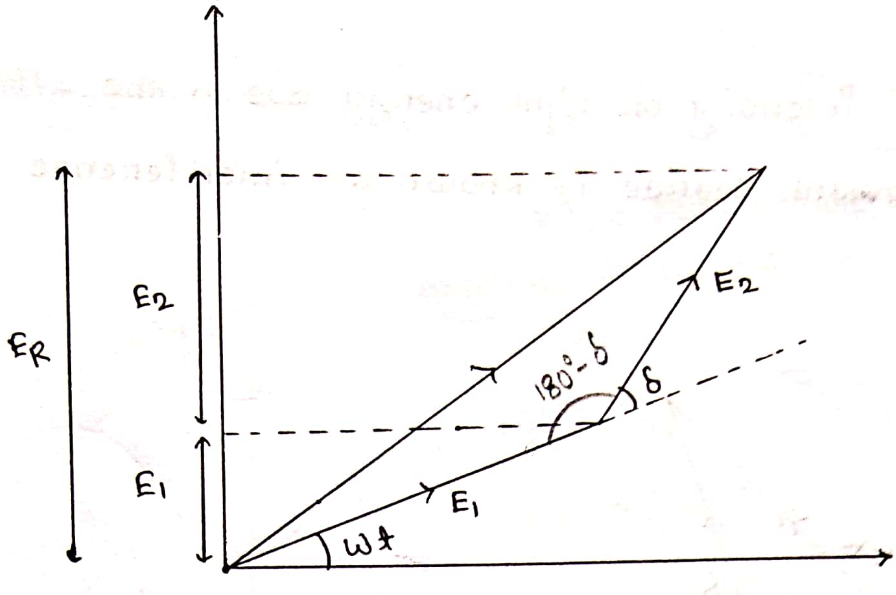
(ii) End wave view

$\theta = \omega t$



OP ∝ amplitude

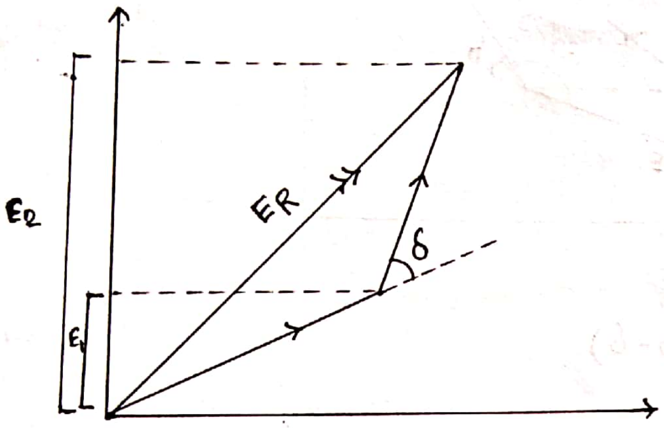




$$E_R^2 = E_1^2 + E_2^2 - 2E_1E_2\cos(180-\delta)$$

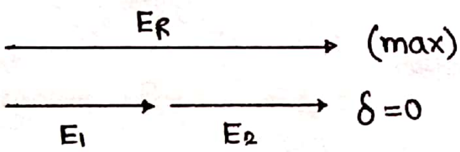
$$= E_1^2 + E_2^2 + 2E_1E_2\cos\delta$$

The redistribution of intensity of light energy due to the superposition of two or more coherent source is known as interference.

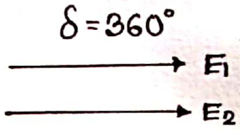


$$E_R^2 = E_1^2 + E_2^2 + 2E_1E_2\cos\delta$$

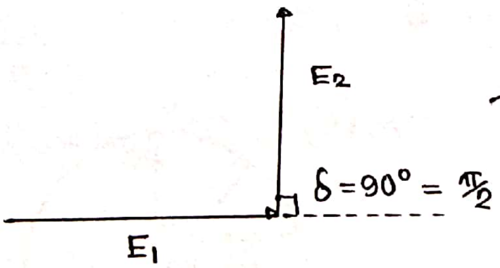
(I)

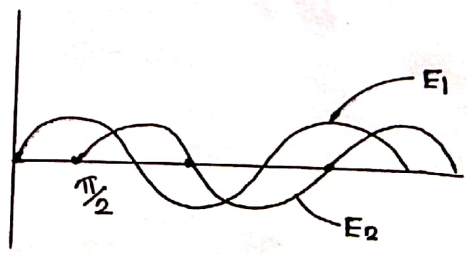


(V)

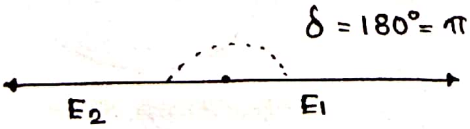


(II)

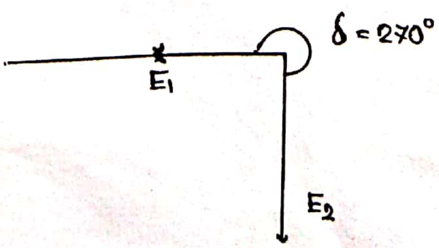




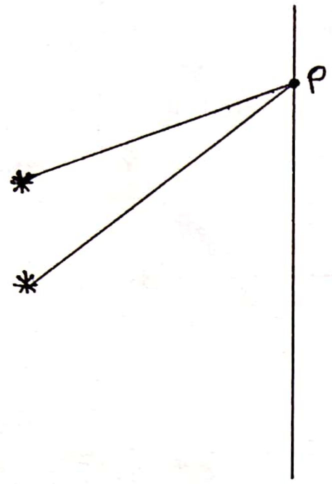
(III)



(IV)



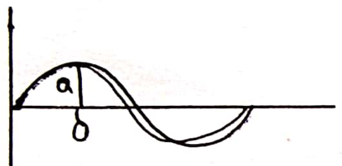
Theory of interference:



The electric field vector components of two waves arriving at the point p.

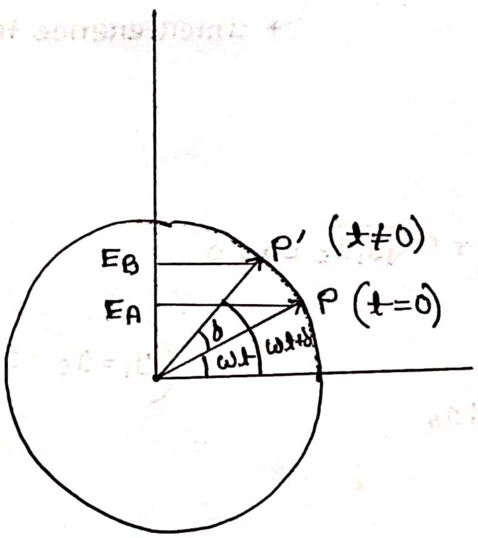
$E_A = E_1 \sin \omega t$

$E_B = E_2 \sin (\omega t + \delta)$



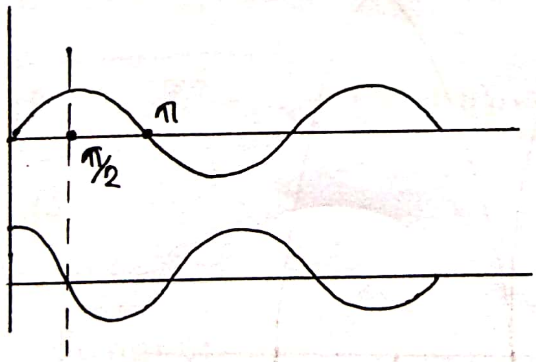
$y_1 = a \sin \omega t$

$y_2 = a \sin (\omega t + \delta)$



$E_R = E_A + E_B$

$= (E_1 + E_2 \cos \delta) \sin \omega t + E_2 \sin \delta . \cos \omega t$



let;

$$E_1 + E_2 \cos\delta = E\cos\phi \quad \text{—(i)}$$

$$E_2 \sin\delta = E\sin\phi \quad \text{—(ii)}$$

(i)^2 + (ii)^2 $\Rightarrow$

$$(E_1 + E_2\cos\delta) + E_2 \sin^2\delta = E\,(\cot\phi + \sin^2\phi)$$

$$\therefore\ E^2 = E_1^2 + E_2^2 + \underline{2E_1E_2\cos\delta}$$

Interference term

$$I \propto E^2$$

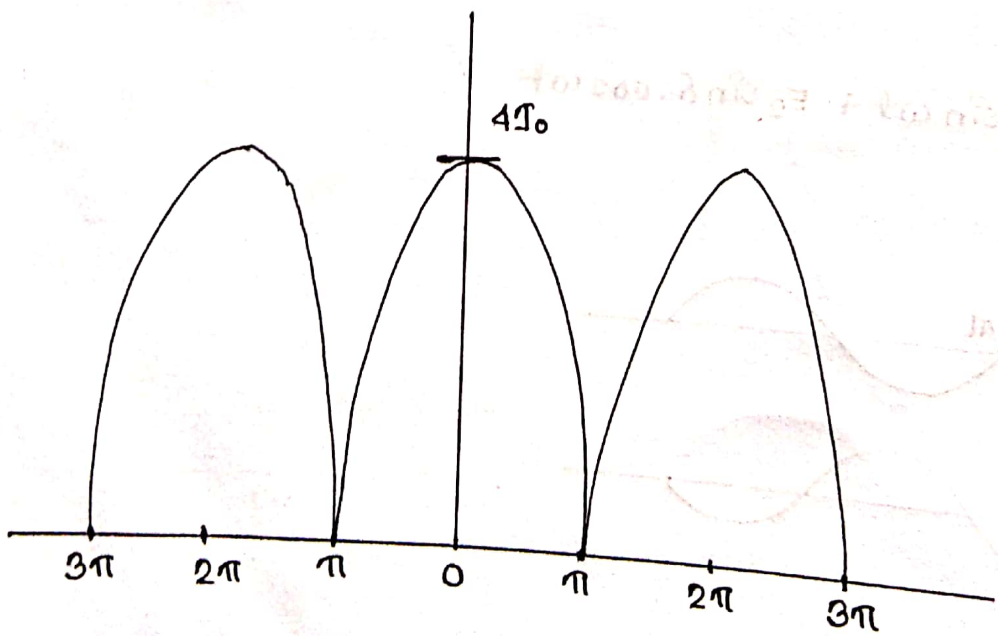
$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\delta$$

If $\delta = 0$ ($I_1 = I_2 = I_0$ হলে)

$$I_{max} = 4I_0$$

If $\delta = 180^\circ$ or π

$$I_{min} = 0$$



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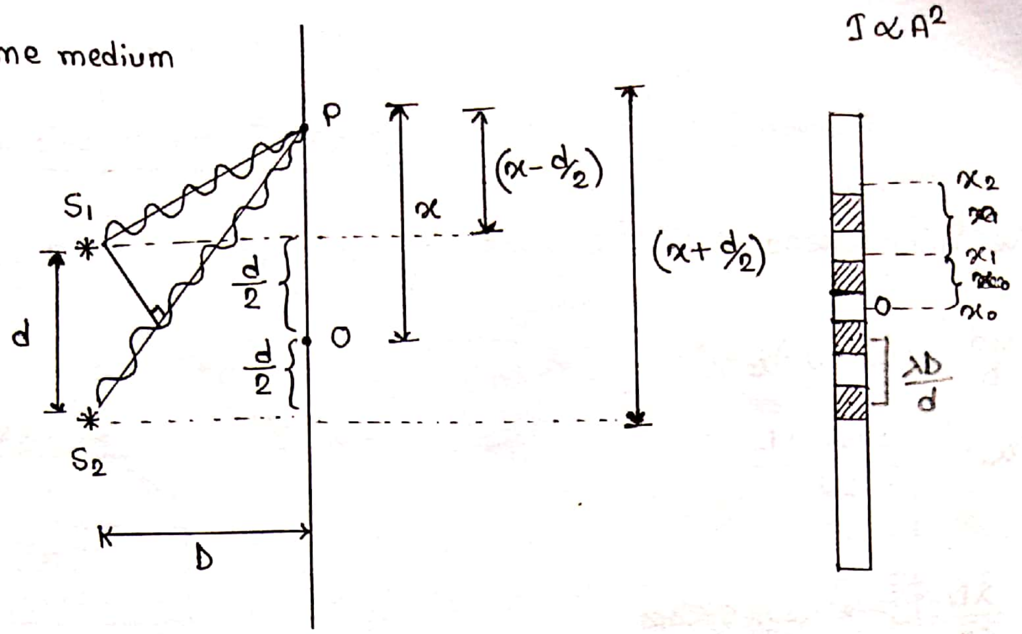
Same medium

$I \propto A^2$

#



path difference, $\Delta = \mu\,(S_2P - S_1P)$

$$\Delta \approx S_2P - S_1P$$

$$\Rightarrow S_2P^2 = D^2 + \left(x+\frac{d}{2}\right)^2$$

$$\Rightarrow S_1P^2 = D^2 + \left(x-\frac{d}{2}\right)^2$$

$$\therefore S_2P^2 - S_1P^2 = 2xd$$

$$\Rightarrow S_2P - S_1P = \frac{2xd}{S_2P + S_1P}$$

$S_1P = S_2P = D$ [খুব কাছাকাছি অবস্থায়]

$$\Rightarrow \Delta = \frac{2xd}{2D}$$

$$\therefore \boxed{\Delta = \frac{xd}{D}} \longrightarrow \text{পথপার্থক্য}$$

$$\therefore \beta \cancel{=} \cancel{\frac{xd}{D}}$$

Bright fringes:

$x_2 - x_1 = \frac{\lambda D}{d}$

$$\frac{xd}{D} = n\lambda$$

$$\therefore \boxed{x_n = \frac{n\lambda D}{d}}$$ কেন্দ্রীয় উজ্জ্বল থেকে n তম উজ্জ্বল ডোরার মধ্যবর্তী দূরত্ব

$x_0 = 0$,

For dark,

destructive interference :

$$\frac{xd}{D} = (2n+1)\,\lambda/2$$

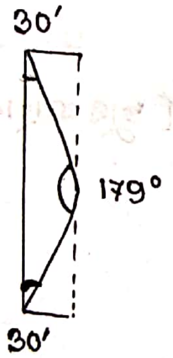
$$\therefore x_n = \frac{(2n+1)\,\lambda D}{2d}$$

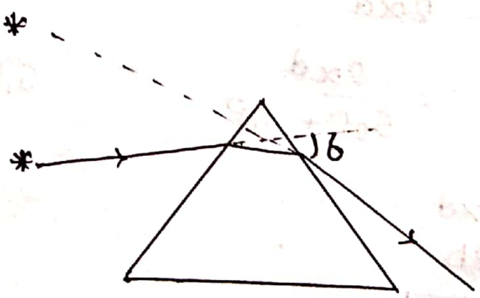
$$\therefore x_2 - x_1 = \frac{\lambda D}{d}$$ → ডোরা ব্যবধান

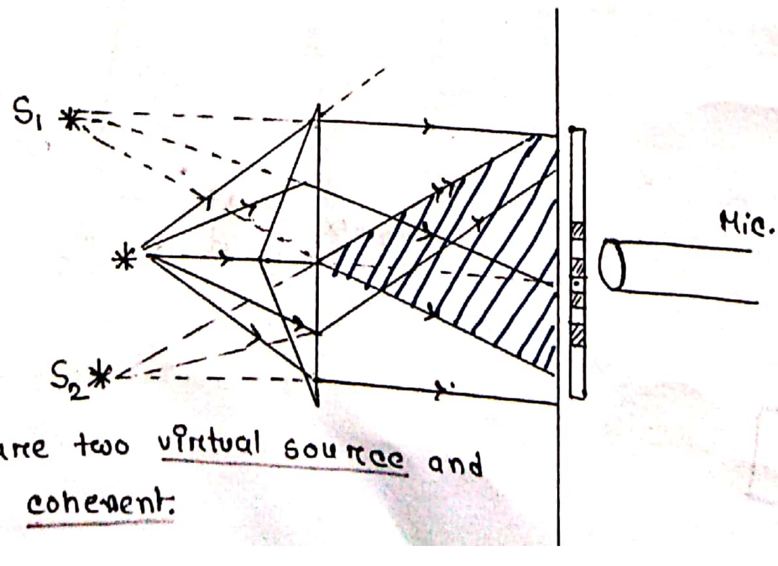
$$\therefore \beta = \frac{\lambda D}{d}$$

Fresnel's biprism:

Two prisms are very small refracting angles joined base to base.





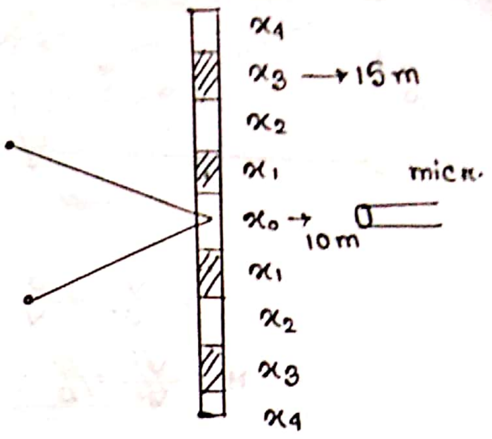


$$\beta = \frac{\lambda D}{d}$$

S_1 and S_2 are two virtual source and they produce coherent.

Determination of wave length:

① Fringess width: $\beta = \frac{\lambda D}{d}$



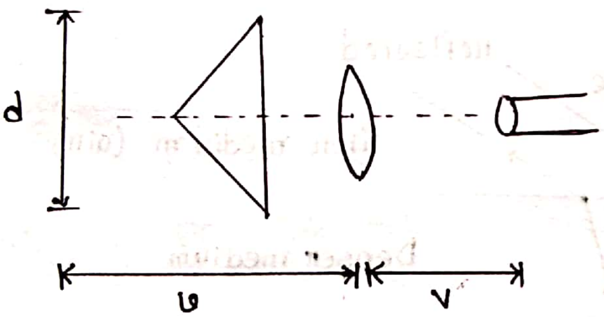
$$\beta = \frac{x_3 - x_0}{3} = \frac{15-10}{3}$$

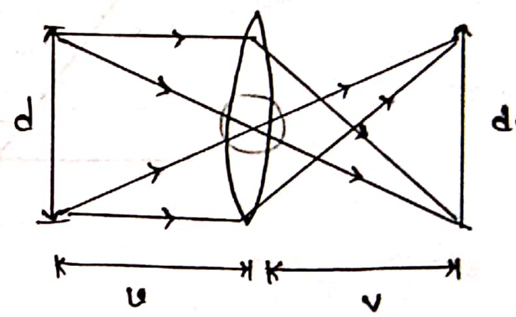
$$\boxed{\beta = \frac{x_N - x_0}{N}}$$

$$x = \frac{n\lambda D}{d}$$

$n \rightarrow 0$ হলে, $x \rightarrow 0$

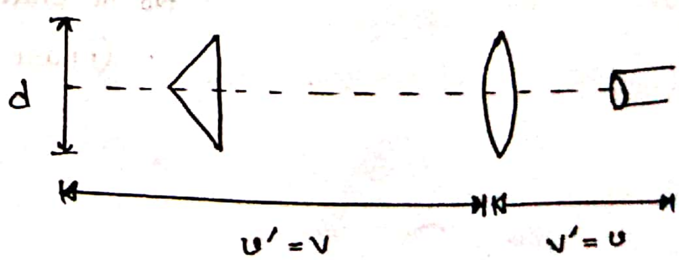
⑪ Determination of d:

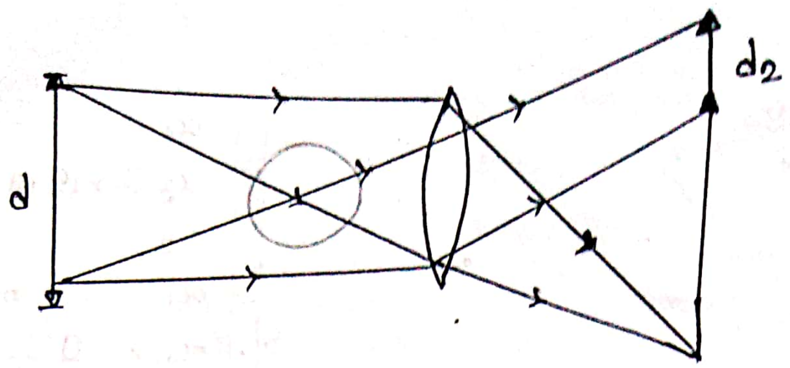




Sharp ~~mass~~ image are ~~same~~. seen

Magnification, $M = \frac{v}{u} = \frac{d_1}{d}$ —①





$$= \frac{v'}{u'} = \frac{u}{v}$$

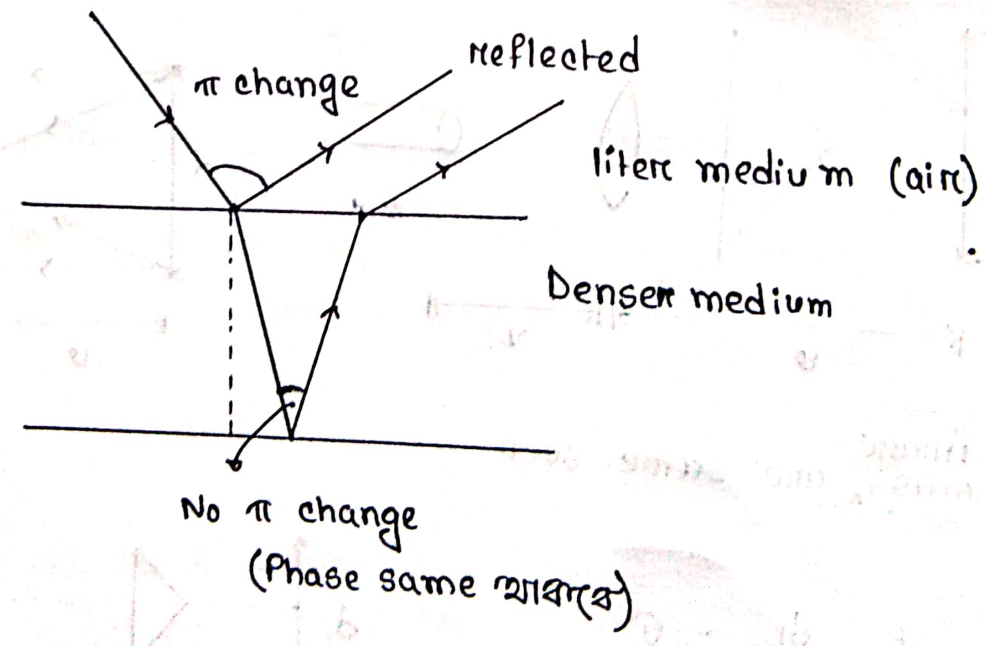
$$M = \cancel{\frac{v'}{u'}} = \cancel{\frac{u}{v}} = \frac{d_2}{d} \quad \text{———— (ii)}$$

(i) × (ii) ⇒

$$\frac{d_1 d_2}{d^2} = 1$$

$$\Rightarrow d^2 = d_1 d_2$$

$$\Rightarrow \boxed{d = \sqrt{d_1 d_2}}$$



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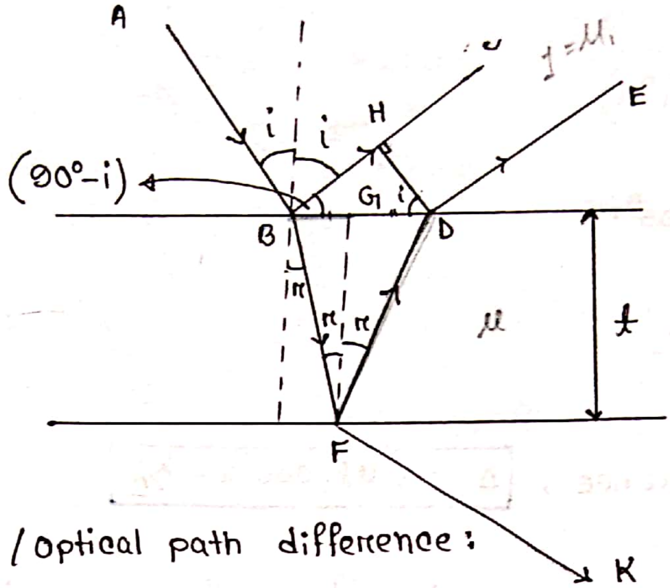
Interference due to reflected Light :



Geometrical / optical path difference :

$$\Delta = \mu(BF + FD) - BH \cdot 1 \longrightarrow \mu_0$$

$\Delta BGF \Rightarrow$

$$\cos r = \frac{FG}{BF}$$

$$\therefore BF = \frac{FG}{\cos r} = \frac{t}{\cos r}$$

$$\therefore FD = \frac{t}{\cos r}$$

$BG = GD$, $BD = BG + GD$

$$\tan r = \frac{BG}{\cancel{FGD}\, FG}$$

$$\Rightarrow BG = FG \cdot \tan r$$

$$= t \tan r \qquad \therefore BD = 2t \tan r$$

$\Delta BDH \Rightarrow$

$$\sin i = \frac{BH}{BD}$$

$$\Rightarrow BH = 2t \tan r \cdot \sin i = 2\mu t \tan r \cdot \sin r.$$

From snel's low,

$$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin i = \mu \sin r$$

$$\Delta = \frac{2\mu t}{\cos r} - 2\mu t \frac{\sin^2 r}{\cos r}$$

$$= \frac{2\mu t}{\cos r}\left(1 - \sin^2 r\right)$$

$$= \frac{2\mu t}{\cos r} \cdot \cos^2 r$$

$$\boxed{\Delta = 2\mu t . \cos r.}$$

corrected path difference, $\boxed{\Delta = 2\mu t . \cos r - \lambda/2}$

when a ray is reflected at a boundary of a rarer denser medium a path change of $\lambda/2$ or π (phase change) occurs for BC.

For constructive inteference,

$$2\mu t \cos r - \lambda/2 = n\lambda$$

$\therefore$ $2\mu t \cos r = (2n+1)\lambda/2$ $\longrightarrow$ condition for brightness.

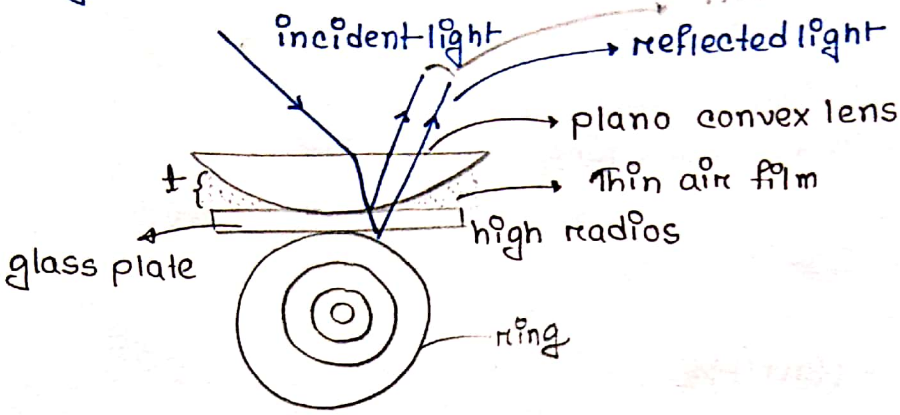
For distructive interference,

$$2\mu t \cos r - \lambda/2 = (2n+1)\lambda/2$$

$\therefore$ $2\mu t \cos r = n\lambda$ $\longrightarrow$ condition for dark.

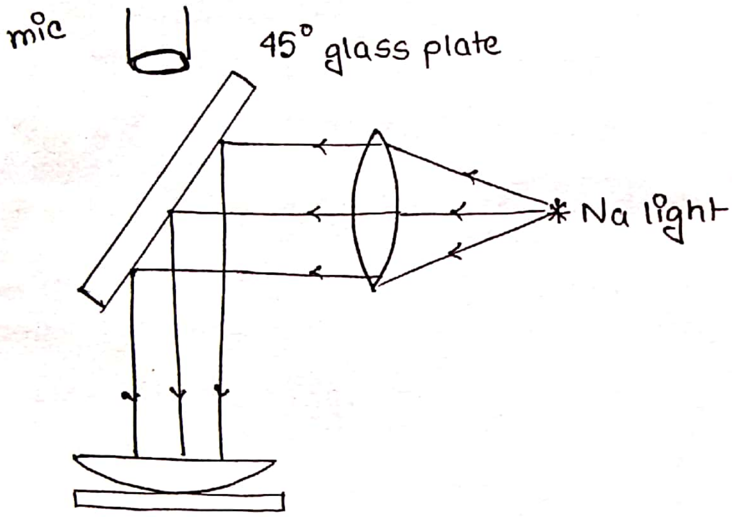
interference due to transmited light.

Newton's ring:



* Na light (Monocrometic colour) — 5890 - 5896 Å

→ 5893 Å



Newton's ring is found when a plano convex lens is placed on the glass plate

The part of the incident light is reflected from the lower portion of the plano ~~convex~~ lens.

glass to air boundary.

Remeinder of the is transmitted to the and reflected from the upper portion of the glass plate. or air to glass boundary.

$$\Delta = 2\underbrace{\mu}_{1\ (\text{for air})} t \cos \underbrace{r}_{=0} - \lambda/2$$

$$\Rightarrow \quad \Delta = 2t - \lambda/2 \longrightarrow (2n+1) - \text{dark ring}$$

For Dark ring,

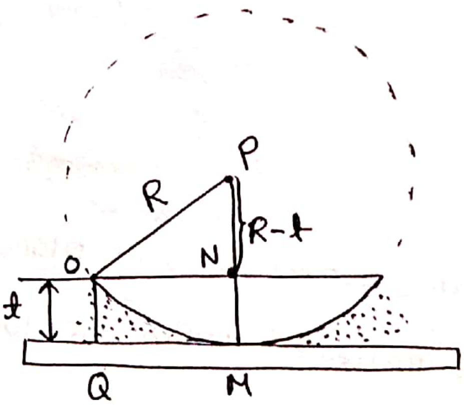
$$2t - \lambda/2 = (2n+1)\lambda/2$$

$$\Rightarrow 2t = n\lambda$$

For bright ring,

$$2t - \lambda/2 = n\lambda$$

$$\Rightarrow 2t = (2n+1)\lambda/2$$



$\Delta PON \Rightarrow$

$$R^2 = (R-t)^2 + r_m^2$$

$r = \alpha r$

$$\therefore r_m^2 = 2Rt - t^2$$

$$R \gg t \rightarrow 2Rt \gg t^2$$

$$\therefore r_m^2 = 2Rt$$

$$\therefore \boxed{t = \frac{r_m^2}{2R}}$$

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For dark ring:

$$2\mu t\cos r - \lambda/2 = (2n+1)\lambda/2$$
$$\downarrow \quad \downarrow$$
$$1 \quad 1$$

$$\Rightarrow 2t - \lambda/2 = (2n+1)\lambda/2$$

$$\Rightarrow 2t = n\lambda$$

$$\Rightarrow \frac{r_m^2}{R} = n\lambda$$

$$\rightarrow r_m^2 = n\lambda R$$

$$\Rightarrow \boxed{r_m = \sqrt{n\lambda R}}$$

$r_m \propto \sqrt{n}$

$r_m \propto \sqrt{1}$ ⟶ center ring is dark

Diameter of the ring:

$$D_m = 2r_m$$

$$\therefore \boxed{D_m^2 = 4nR\lambda}$$

Central dark spot:

$$\Delta = 2t - \lambda/2$$

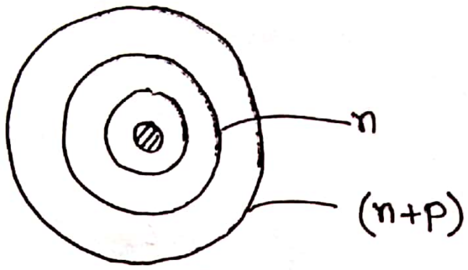
No air film
contact point
$t = 0$
$$\Delta = \lambda/2$$

Determination of wavelength (λ) of light:

center a Dark (কেন্দ্ৰ আন্ধাৰ)

$$D_n^2 = 4\lambda n R$$

Diameter of the dark ring



For $(n+p)^{th}$ ring:

$$D_{(n+p)}^2 = 4(n+p)\lambda R$$

$$\therefore D_{(n+p)}^2 - D_n^2 = 4RP\lambda$$

let,

$n = 3$

$n+p = 5$

$\therefore p = 2$

$$\therefore \lambda = \frac{D_{(n+p)}^2 - D_n^2}{4PR}$$

$$\Rightarrow \underbrace{D_{(n+p)}^2 - D_n^2}_{y} = \underbrace{4R\lambda}_{m}\,\underbrace{P}_{x}$$

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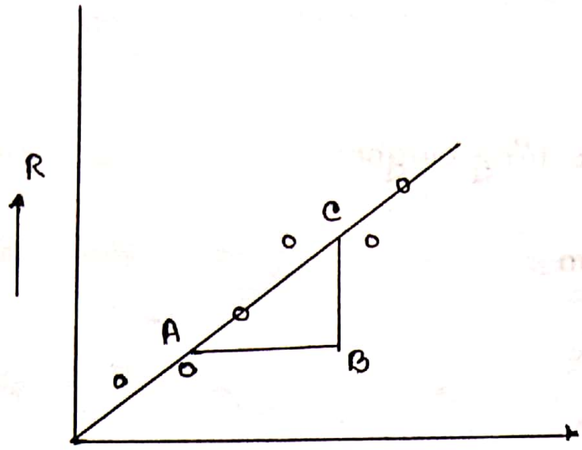
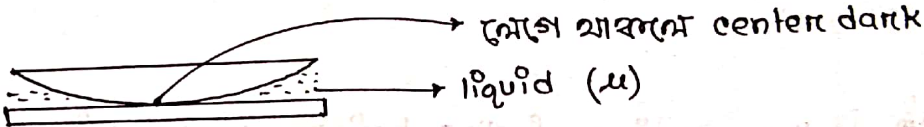


No. of ring, P →

$$\text{slope} = \frac{BC}{AB} = 4R\lambda$$

$$\therefore \lambda = \frac{\text{slope}}{4R}$$

Determination of μ of liquid:



path difference,

$$\Delta = 2\mu t\cos r - \lambda/2$$

For dark,

$$2\mu t\cos r - \lambda/2 = (2n+1)\lambda/2$$

$$\Rightarrow 2\mu t\cos r = n\lambda$$

$\cos r = 1$ হলে, $\quad 2\mu t = n\lambda$ ——— (1)

$$r_n^2 = 2tR$$

আবার,

$$D^2 = \frac{4n\lambda R}{\mu}$$

$$\Rightarrow (D_n)^2_{\text{liquid}} = \frac{4\lambda nR}{\mu}$$

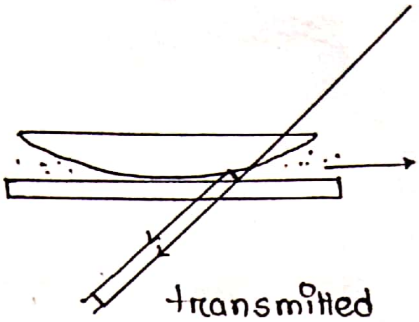
$$\therefore (D_{n+p})^2_{\text{liq}} = \frac{4(n+p)\lambda R}{\mu}$$

$$(D_n)^2_{\text{air}} = 4n\lambda R$$

$$(D_{n+p})^2_{\text{air}} = 4(n+p)\lambda R$$

$$\boxed{\therefore \mu = \frac{(D_{n+p})^2_{\text{air}} - (D_n)^2_{\text{air}}}{(D_{n+p})^2_{\text{liq}} - (D_n)^2_{\text{liq}}}}$$

Newton's ring in transmitted light:



For dark $\Rightarrow$

$$2\mu t \cos r = (2n+1)\lambda/2$$

$$\downarrow \qquad \downarrow$$

$$2t = (2n+1)\lambda/2$$

For bright $\Rightarrow$

$$2t = n\lambda$$

$\therefore t = \frac{r_m^2}{2R}$, the radius of the bright ring, $r_n^2 = n\lambda R$.

The radius of the dark ring, $r_n^2 = (2n+1)\lambda R/2$.

$$\begin{pmatrix} 5.5 - 5.8 \\ 14.1 - 14.5 \end{pmatrix}$$ — Math

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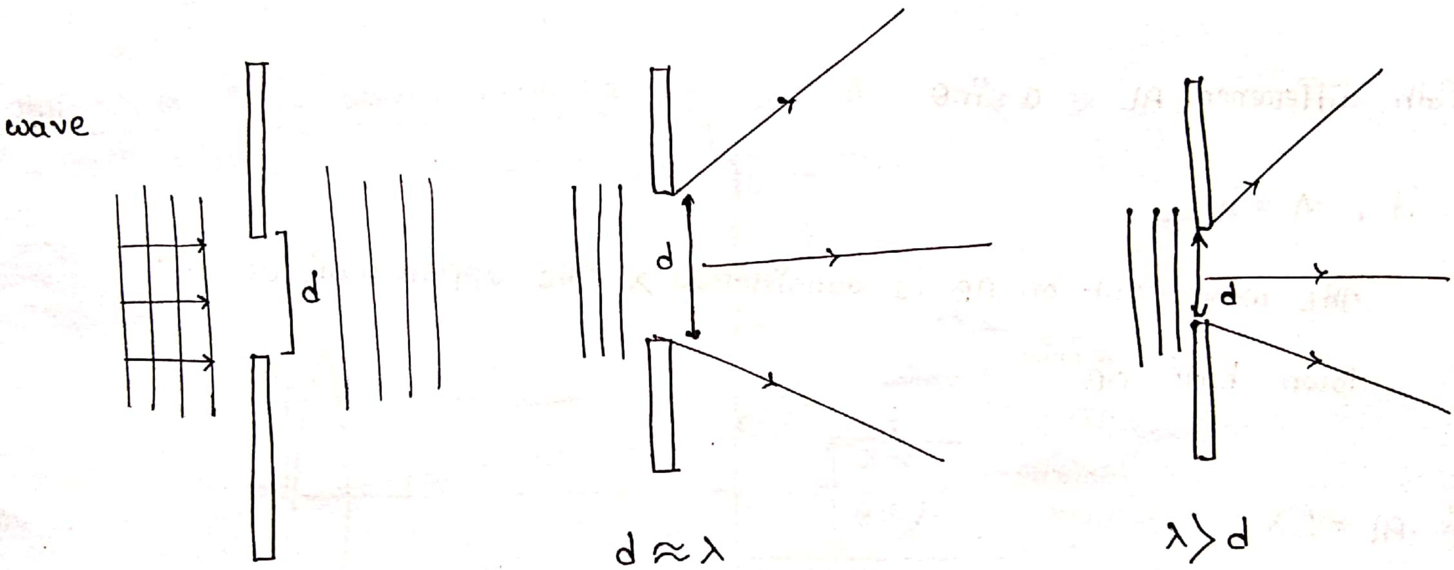
Deffraction: (wave properly)

The bending of waves around the sharp edges of an obstacle is called deffraction.

The deffraction is occured the diamansion of the obstacles are comparaeable to the wavelength of the waves.



$d \gg \lambda$ | $d \approx \lambda$ | $\lambda > d$

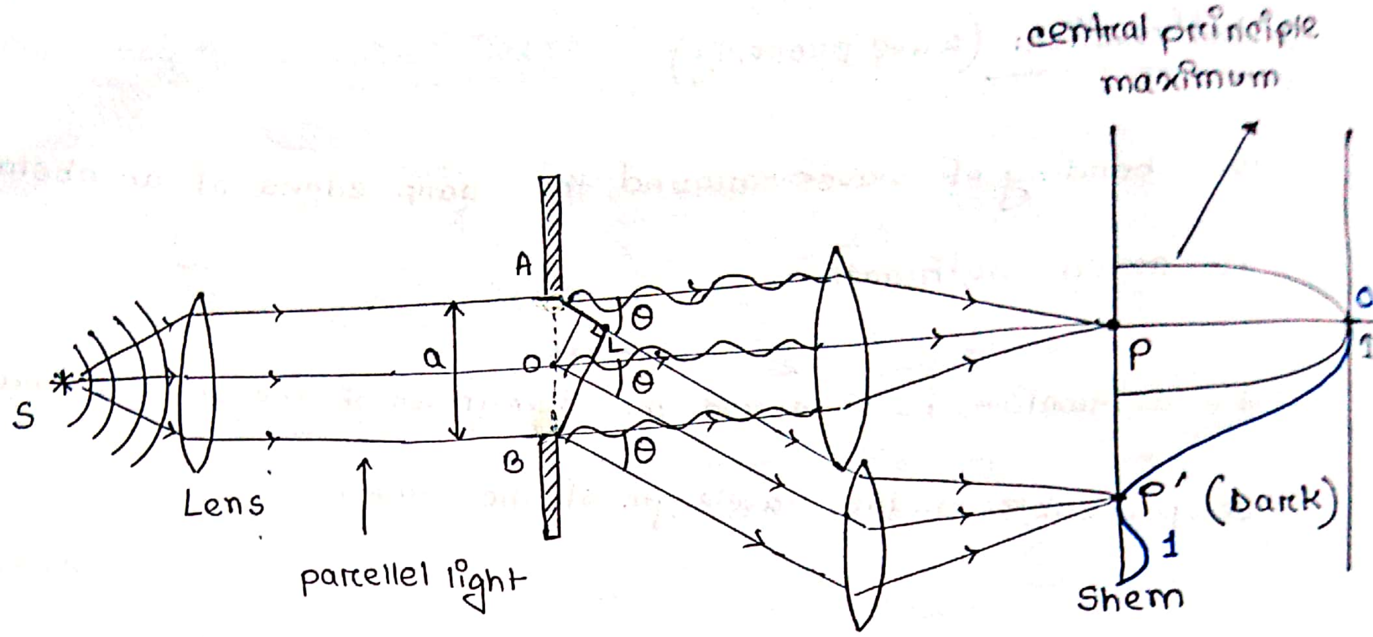
(i) No bending

(ii) The diffraction effect is obsarvel.

(iii) The diffraction effect is observed at large distance from the slit.

(i) parellal diffraction → source and slit are at finite distance.

(ii) Fraunhaffer diffraction → source and slit are at infinite distance.



• Path difference, $AL = a\sin\theta = \Delta$.

if, $\Delta = \lambda$ . . .

The wavefront on AB is considered λ. The upper half OA and lown half OB.

if $AL = 2\lambda$

The wave front 2λ

The lower and upper half are differ by $\lambda/2$.

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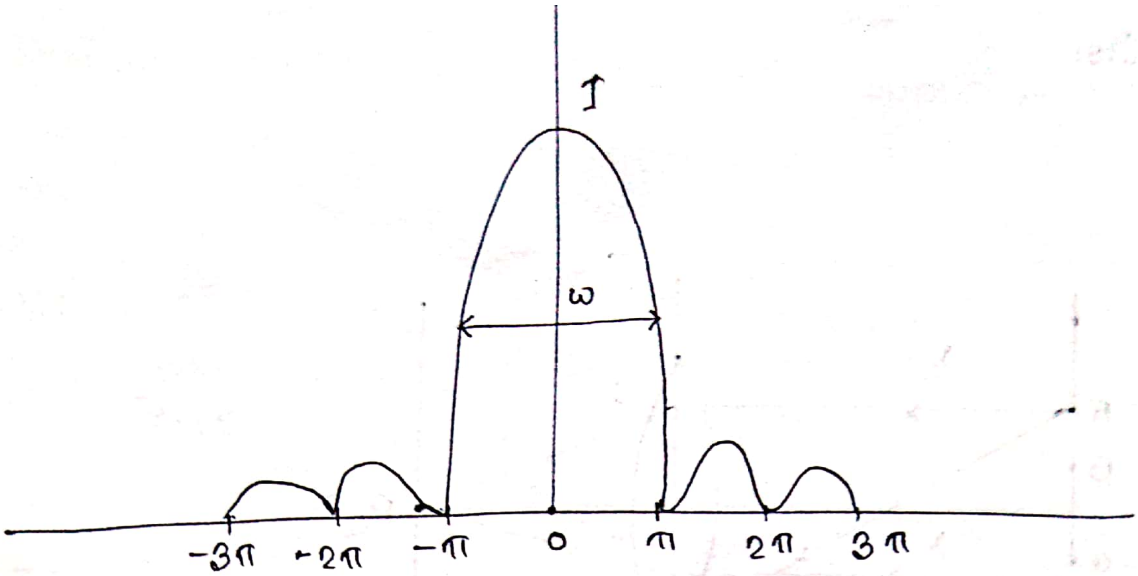
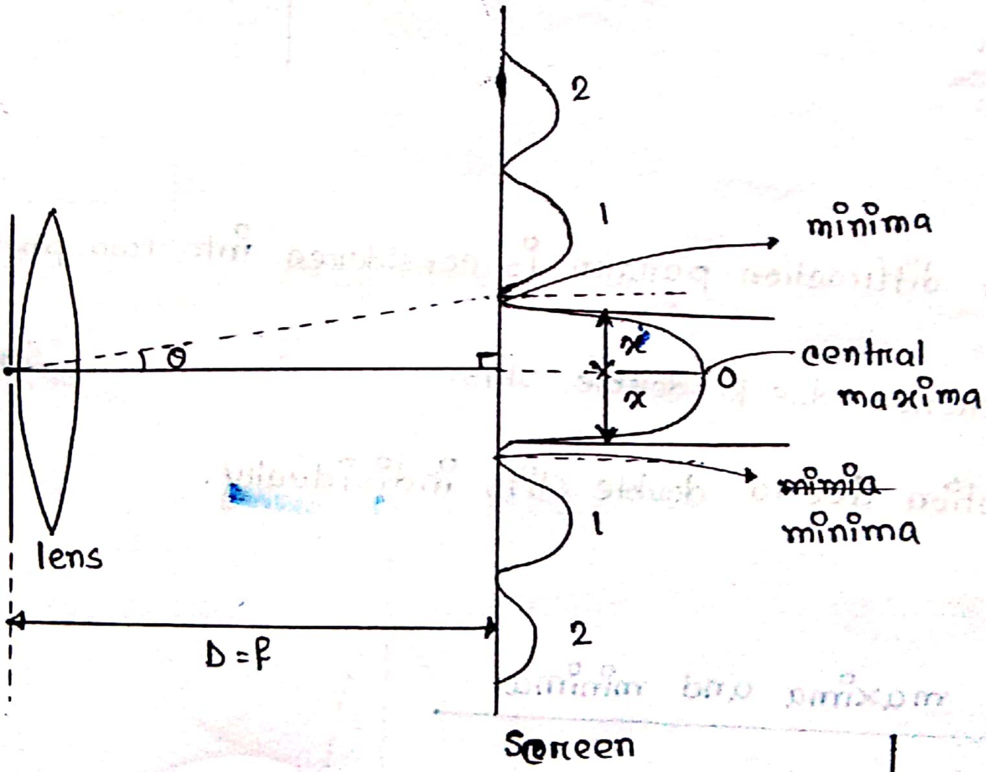


The width of the central maxima:



$\tan\theta = \frac{x}{f}$

$\Rightarrow \frac{\sin\theta}{\cos\theta} = \frac{x}{f}$

$\Rightarrow \sin\theta = \frac{x}{f}$ $[\theta \approx 0°]$

\# $a\sin\theta = \lambda$

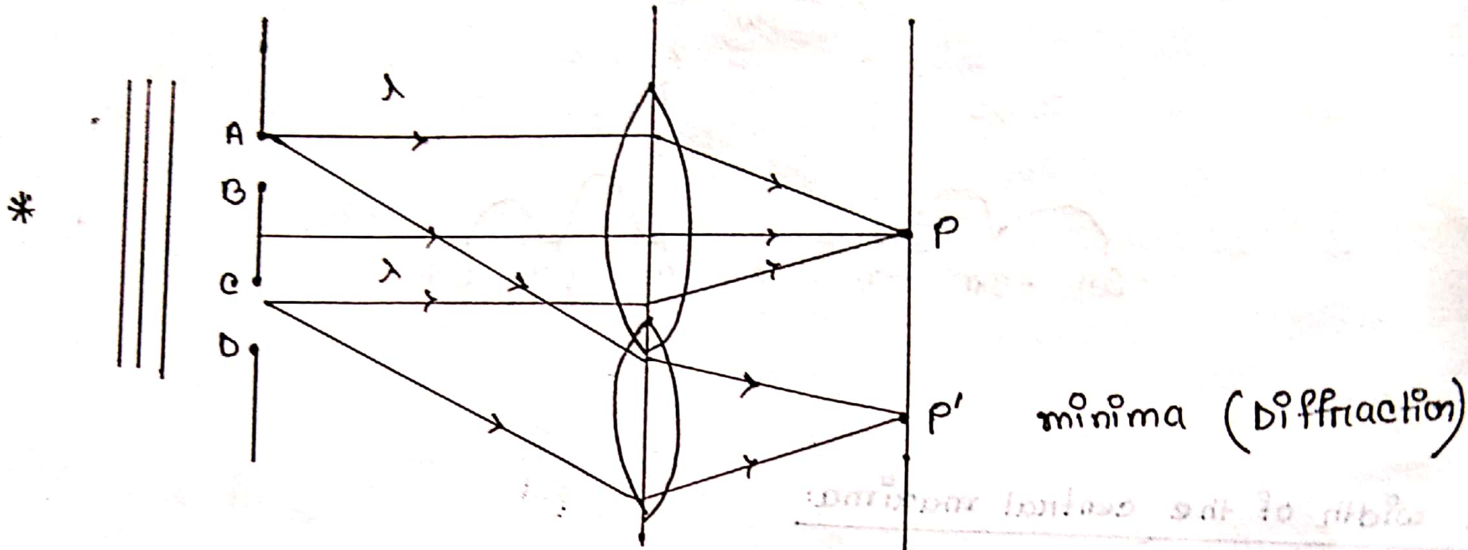
$\Rightarrow \sin\theta = \lambda/a$

$x = \frac{f\lambda}{a}$

width, $\omega = 2x$

$$\boxed{\omega = \frac{2f\lambda}{a}}$$

Double slits:



AB = a

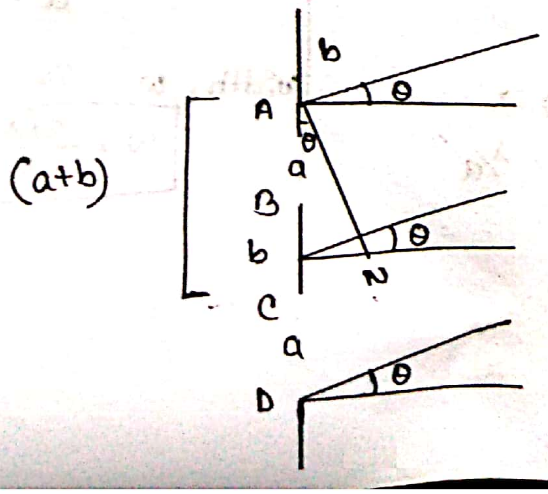
CD = a

Double slit diffraction pattern is considered into two phenomenon

① Interference due to double slits.

⑪ Diffraction due to double slits individually.

① Interference maxima and minima:



path difference, $CN = (a+b)\sin\theta$

For maxima,

$$(a+b)\sin\theta_n = n\lambda$$

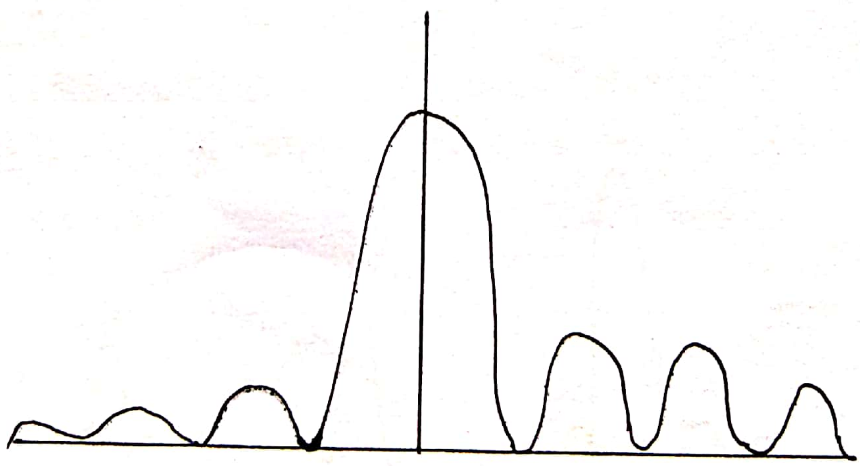
$$\Rightarrow \sin\theta_n = \frac{n\lambda}{(a+b)}$$

For minima,

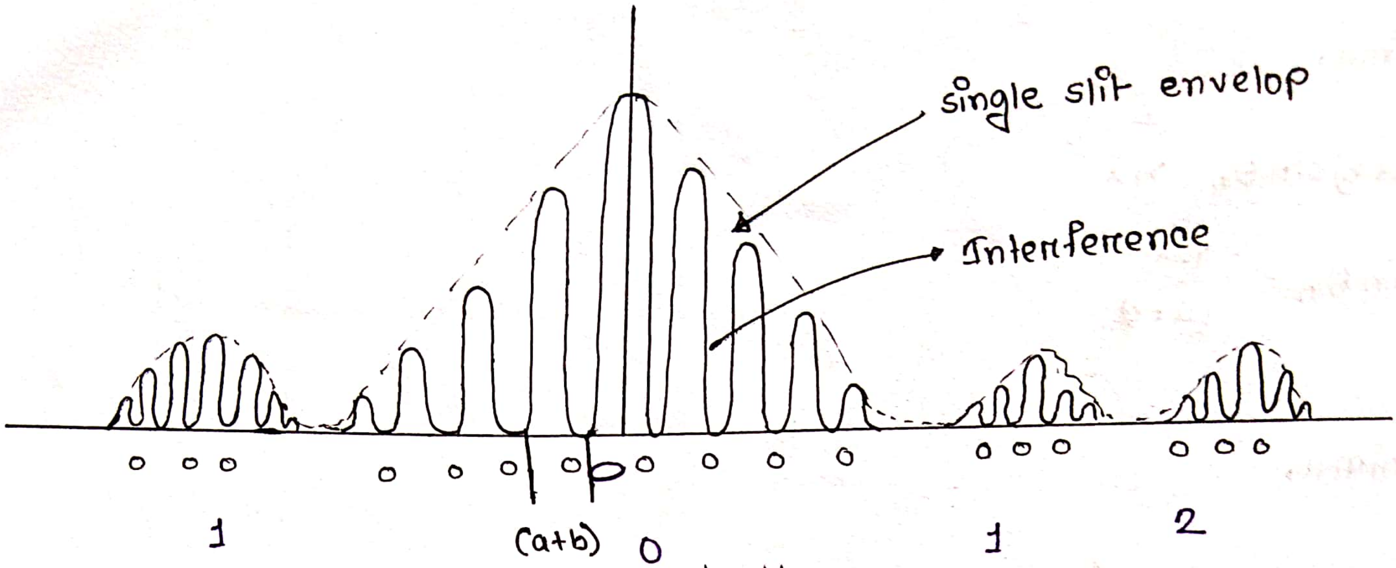
$$(a+b)\sin\theta'_n = (2n+1)\lambda/2$$

$$\Rightarrow \sin\theta'_n = \frac{(2n+1)\lambda}{2(a+b)}$$

$$\left.\begin{aligned} \sin\theta_1 &= \frac{3\lambda}{2(a+b)} \\ \sin\theta_2 &= \frac{5\lambda}{2(a+b)} \end{aligned}\right\} \therefore \sin\theta_2 - \sin\theta_1 = \frac{\lambda}{a+b}$$



① single



Double
Gratting (Multiple slit)

(ii) Diffraction maxima and minima:

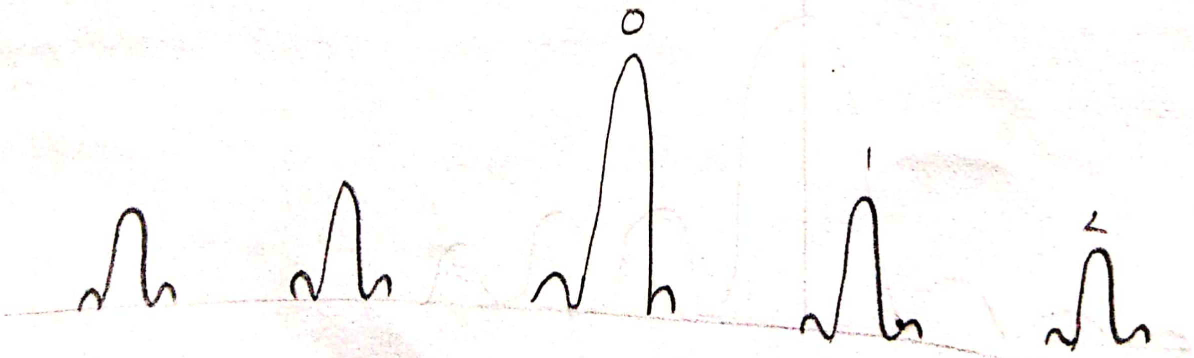
path difference, = a sinθ

For minima,

$$a\sin\theta = n\lambda$$

Diffraction gratting:

optical device.



Gratting (multiple slit)

multiple slit:

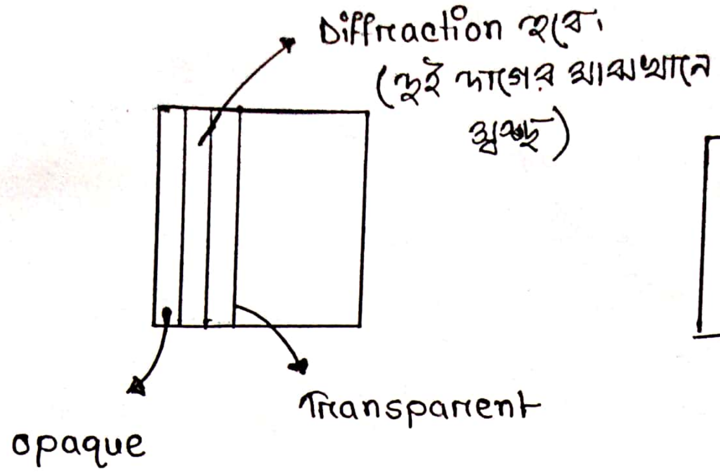
The grattings are prepared by roling equal distance parallel lines on the glass surface. The lines are drawn with a fine diamond point.

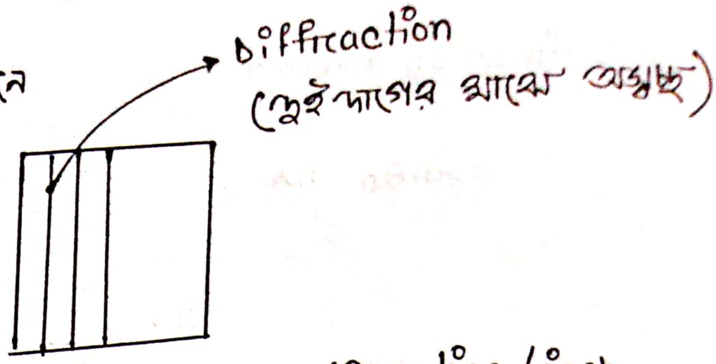
→ Transmission gratting

→ Reflection gratting

The space in between the new two lines is transparent and the line portion is such transmission such gratting act as...

On the other hand,
The lines are drawn on a silver surface, the light is reflected between any two lines. such ...

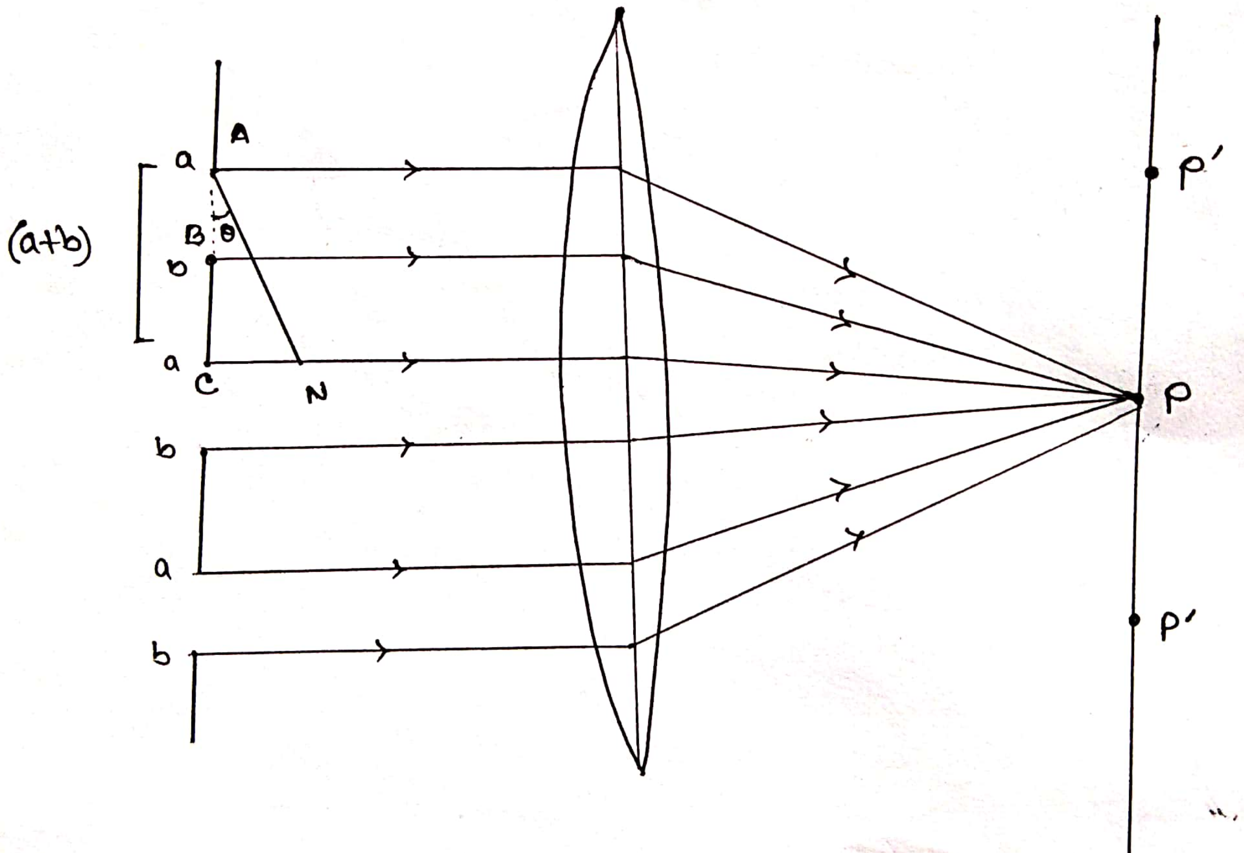




15000 line/inch

$(a+b) = \frac{2.54}{15000}$ line/cm.

(i) Transmission Gratting (ii) Reflected Gratting



(i) Interference phenomenon due to more than one slits.

path difference,

$$CN = (a+b)\sin\theta$$

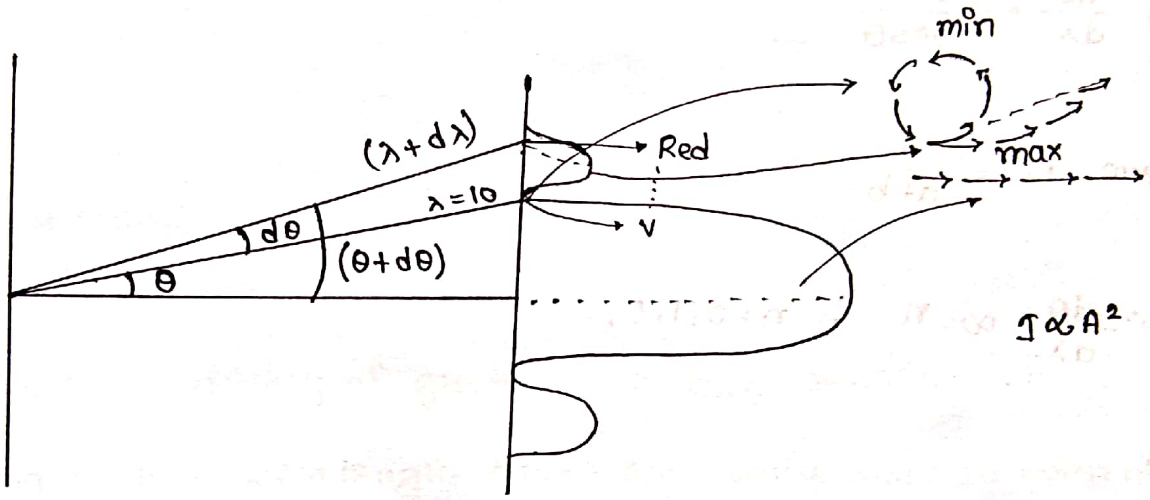
$\therefore (a+b)\sin\theta = n\lambda$ [For interference max]

$(a+b)\sin\theta = (2n+1)\lambda/2$ [for interference min]

(ii) Diffraction minima,

$$a\sin\theta = n\lambda$$

Mixed Wavelength:



$$(a+b)\sin\theta = n\lambda$$

$$\downarrow$$

$$1$$

$$(a+b)\sin(\theta+d\theta) = n(\lambda+d\lambda)$$

Dispersive power: $\frac{d\theta}{d\lambda}$

... of grating is a ratio of the difference in the angle of diffraction Diffraction of any two neighbouring spreator lines to the difference the wavelength of the two spreator lines.

$$(a+b)\sin\theta = n\lambda$$

$$(a+b)\cos\theta \, d\theta = n \, d\lambda$$

$$\therefore \frac{d\theta}{d\lambda} = \frac{n}{(a+b)\cos\theta}$$

$$\Rightarrow \frac{d\theta}{d\lambda} = \frac{nN'}{\cos\theta}$$

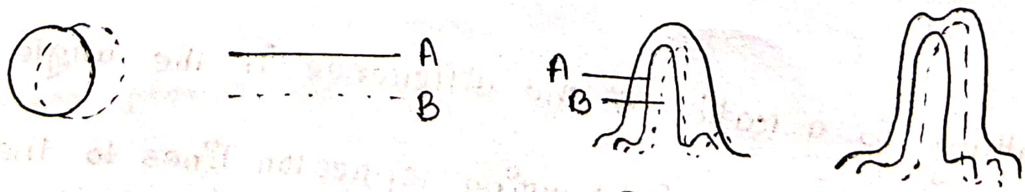
Where $N' = \frac{1}{a+b}$

$$\therefore \frac{d\theta}{d\lambda} \propto n \quad , \quad n = 0, 1, 2, \ldots$$

Distinguis between dispersive power

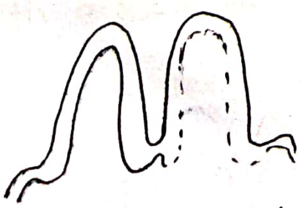
Resolving power:

The ability of an opticle instrument to produce distinctly separate images of two objects located very close to each other is called resolving power.



① unresolved

⑪ Rayleigh criteion



⑪ Resolved

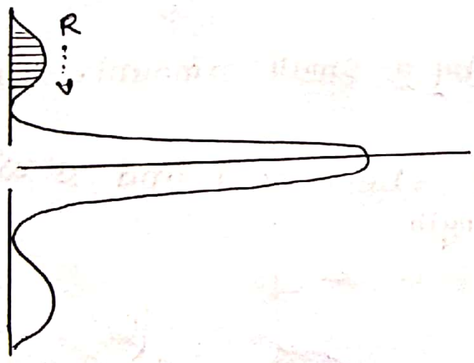
Rayleigh Criteion: With the cenlal maximum of one ~~false~~ falls of the first minimum of the other, in others words. When the central bright images of one falls on the first dark of the other. Then the two images are said to be just resolved. This called Rayleigh criteion of resolution.

Resolving power of gratting:

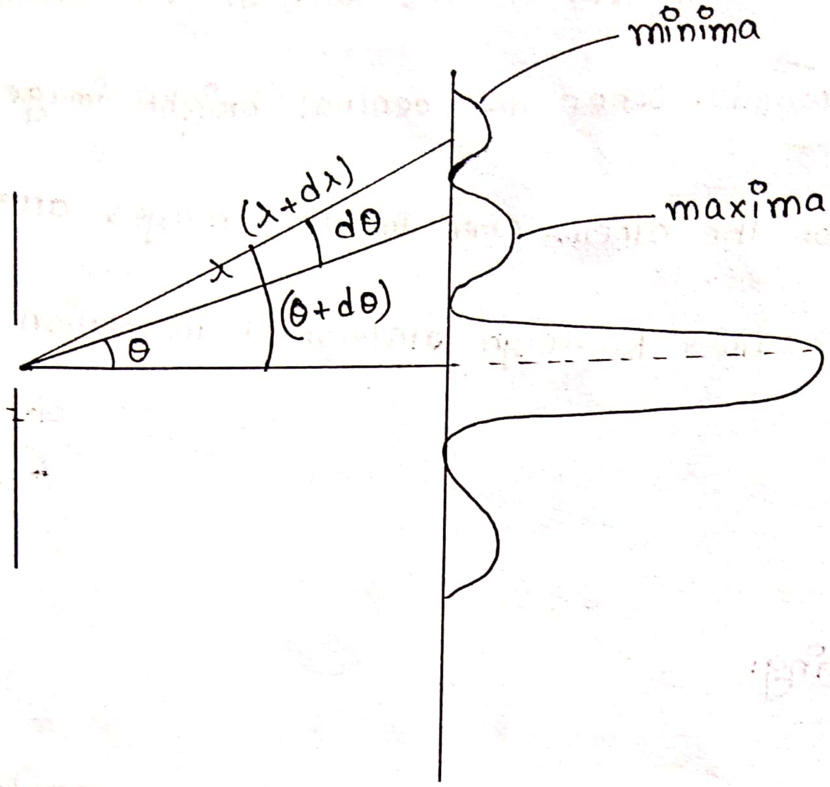
It is defined as the capasity of gratting to form separate of diffraction maxima of two wavelength which are very close to each other.

$$(a+b)\sin\theta = n\lambda$$

$$\theta \propto \lambda$$



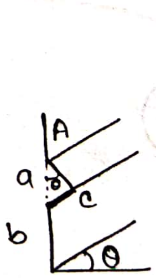
$\lambda, \lambda + d\lambda$



$(a+b)\sin\theta_n = n\lambda$

$(a+b)\sin(\theta_n + d\theta) = n(\lambda + d\lambda)$

If diffraction angle is increased by a small amount $(d\theta)$, then the path difference of secondary wave-length between A and C will increased λ/N.



$\therefore (a+b)\sin(\theta_n + d\theta) = n\lambda + \lambda/N$

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$$n(\lambda+d\lambda) = n\lambda + \frac{\lambda}{N}$$

$$\therefore \boxed{\frac{\lambda}{d\lambda} = nN}$$

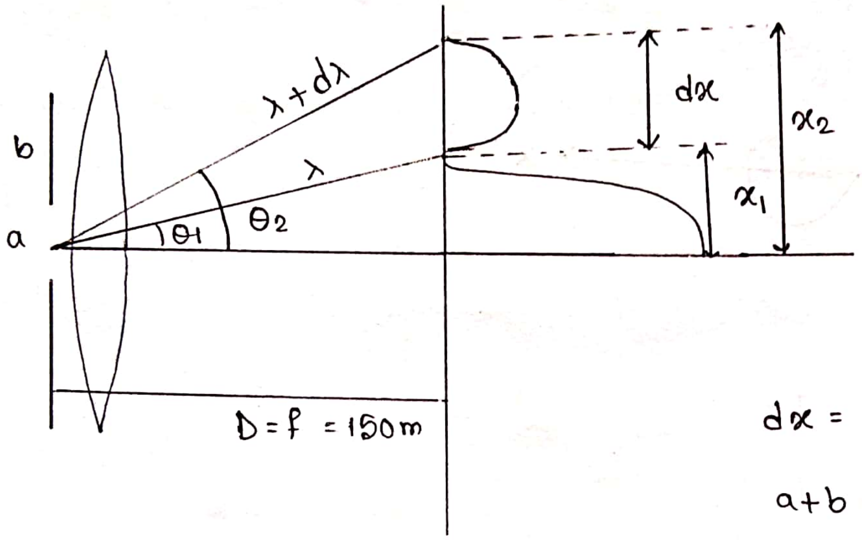
↓

resolving power.

Diffraction

18·1 – 18·7

Ex: 18·7



$\lambda = 5000$

$\lambda + d\lambda = 5200$

$dx = x_2 - x_1$

$a+b = 1000$ lines/cm

$$(a+b)\sin\theta_n = n\lambda$$

$$(a+b)\sin\theta_1 = \lambda_1$$

$$\Rightarrow \theta_1 = 30°$$

similarly,

$$(a+b)\sin\theta_2 = \lambda_2$$

$$\Rightarrow \theta_2 = 31·3°$$

$$\tan\theta_1 = \frac{x_1}{f}$$

$$\Rightarrow x_1 =$$

$$\tan\theta_2 = \frac{x_2}{f}$$

$$\Rightarrow x_2 =$$

$$\therefore x_2 - x_1 = f(\tan\theta_2 - \tan\theta_1)$$

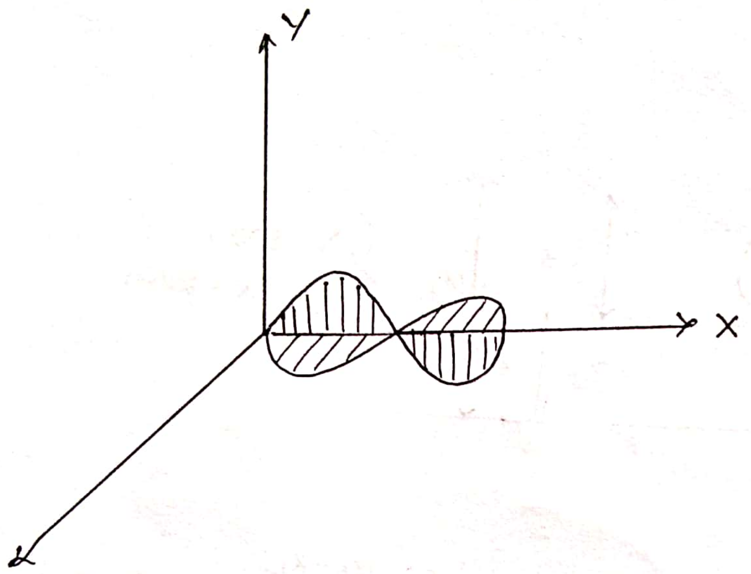
$$= 4·7 \text{ cm}$$

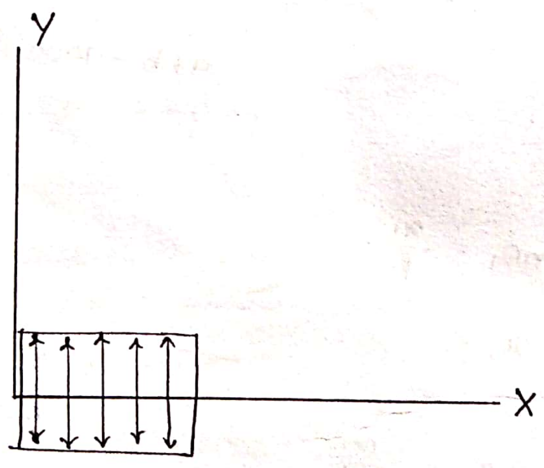
(Ans)

Ex: 19·1 , 19·6

$c = f\lambda$

Polarization:



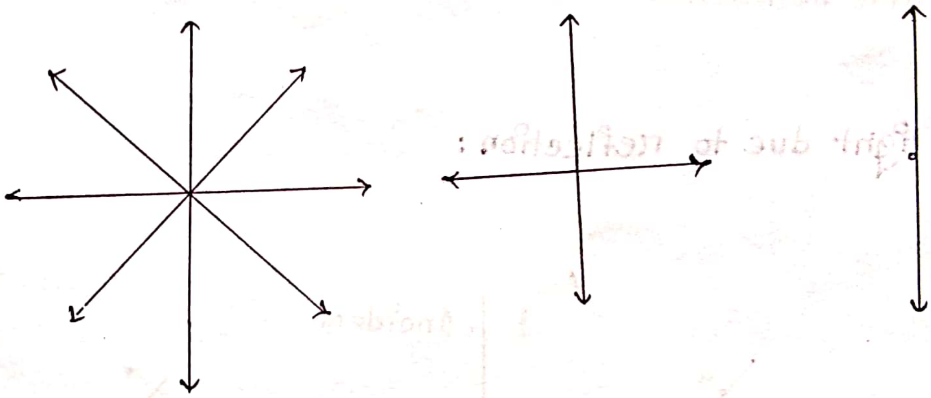


The vibrating electric field vector and the direct of propagation of the wave constitute a plane. There is an infinite number of such planes around the direction of propagation. In an ideal light-wave the vibration of electric field vector are confined to a single plane.

Unpolarised light : A light wave in which $\bar{E}$-vector oscillates in more than one plane, is refered to as unpolarized light. Ex - sun, candle, Na light

polarized light: Polarized light is the light wave that only fluctuate in one specific plane.

The plane created by the direction of ~~propagation~~ oscillation of $\bar{E}$-vector and the direction of propagation, this is known as plane of polarization.



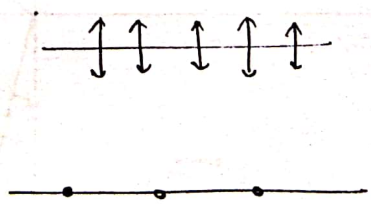
unpolarized light

• ⟶ polarization to the plane of paper

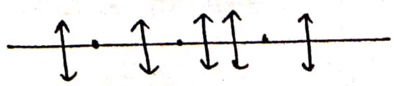
↕ ⟶ parallel " " "

• ⟶ s-compomant

↕ ⟶ p-componant



polarized light



partial polarized light

plane polarized light: Oscillation occur in a single ~~frame~~ plane.

The oscillation of $\vec{E}$ vector are strictly confined to a single plane.

production of plane polarized light:

(i) Reflection

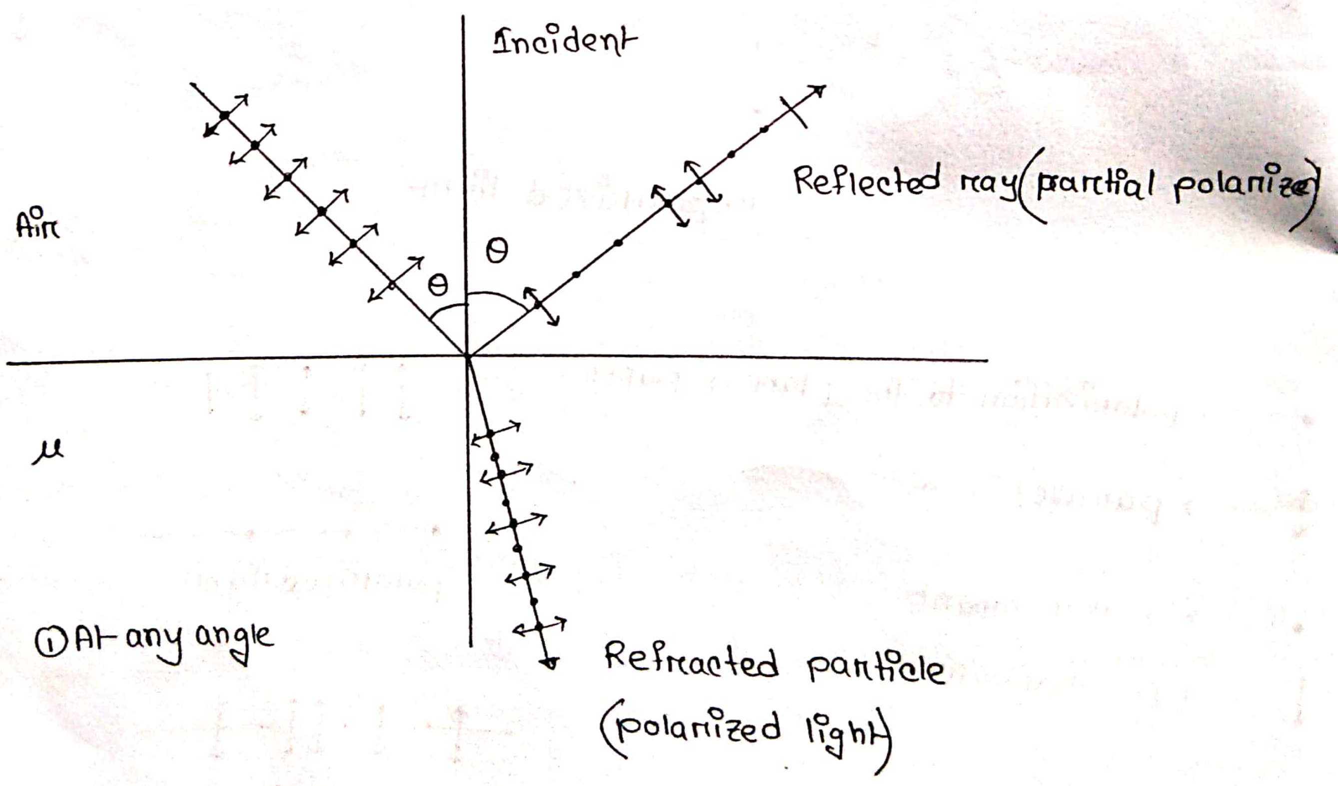
(ii) Refraction

(iii) Scattering

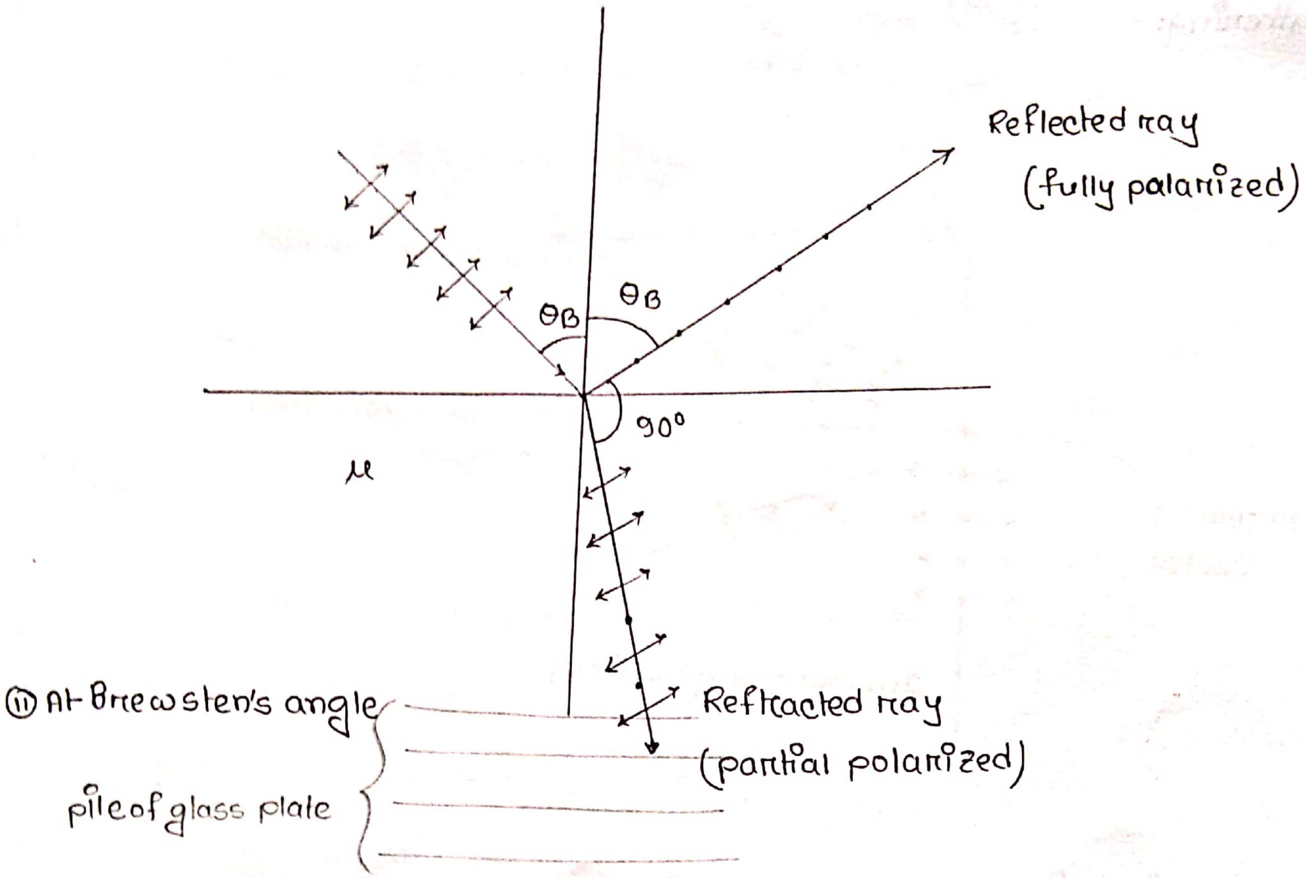
(iv) Selective absorbtion

(v) Double refraction.

polarized light due to reflection:



(i) At any angle



Brewster's law:

$$\mu = \tan\theta_B = \frac{\sin\theta_B}{\cos\theta_B} \quad \text{——— (i)}$$

From snell's eqn

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\theta_B}{\sin r} \quad \text{——— (ii)}$$

$$\therefore \cos\theta_B = \sin r = \cos\left(\pi/2 - r\right)$$

$$\Rightarrow \theta_B + r = \pi/2$$

At ~~an~~ Brewster's angle a reflected and a refracted ray are perpendicular to each other.

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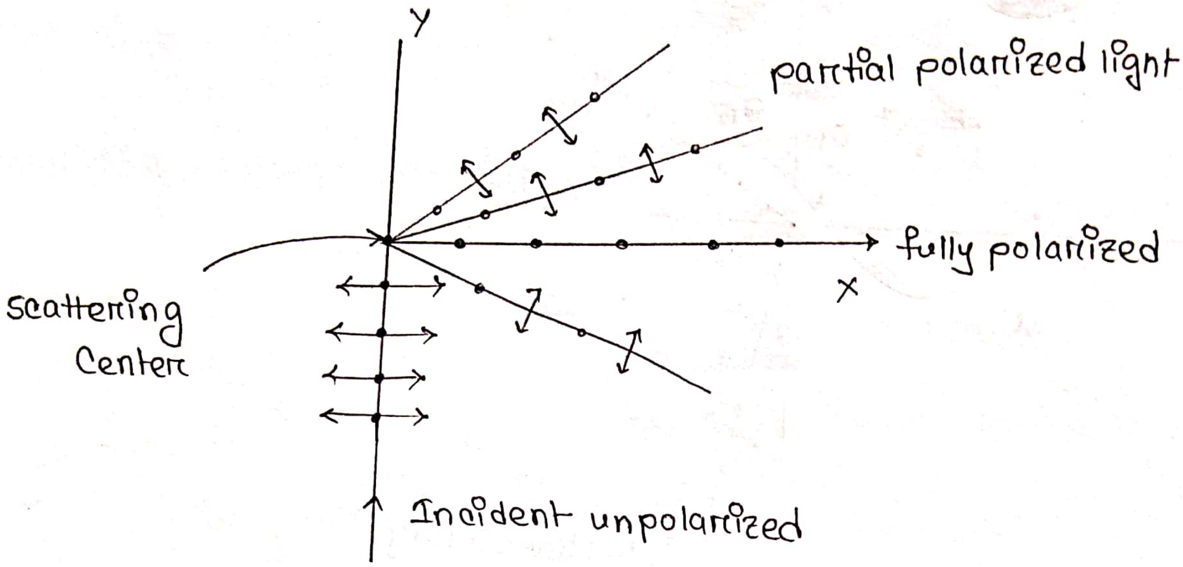
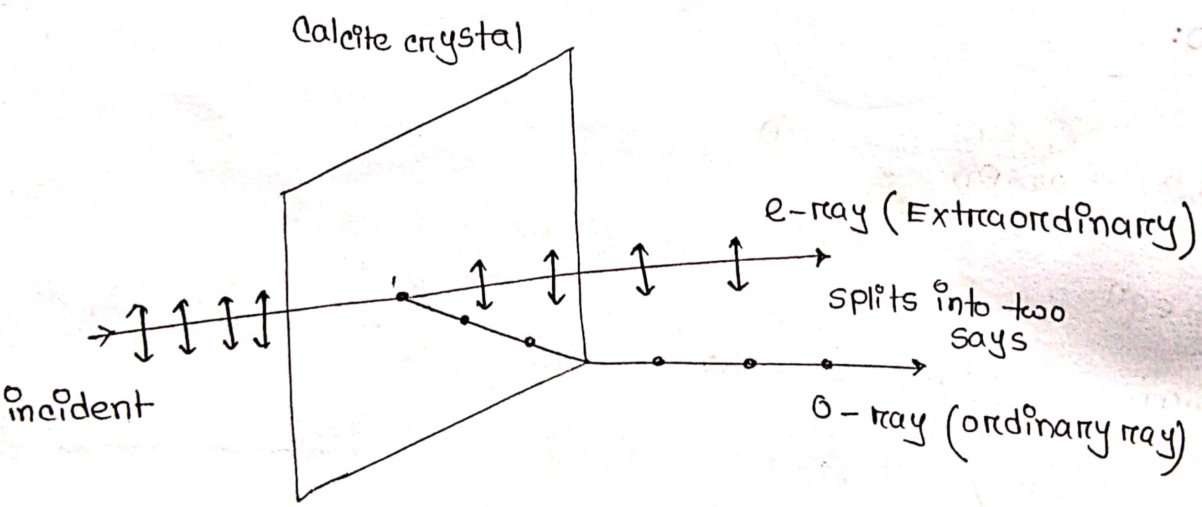
Scattering: (বিচ্ছুরণ)



Double refructive:

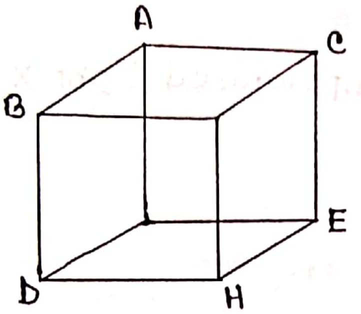


It is also known as bi-refringes

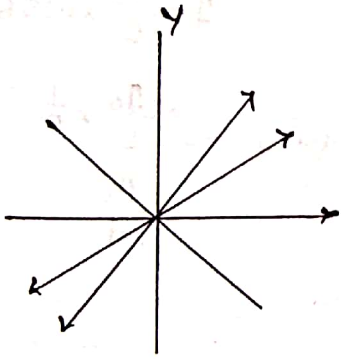
↳ Different refractive angle of different polarization.

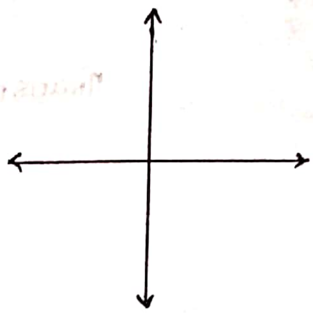
Polarizer: A polarizer is an optical element which utilize the phenomenon of selective absorbtion or double defraction and transform unpolarized light into polarized light. Plane polarized light is obtained by eleminating one of the two components in the unpolarized light.

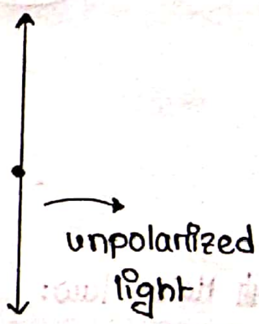
Optic axis:



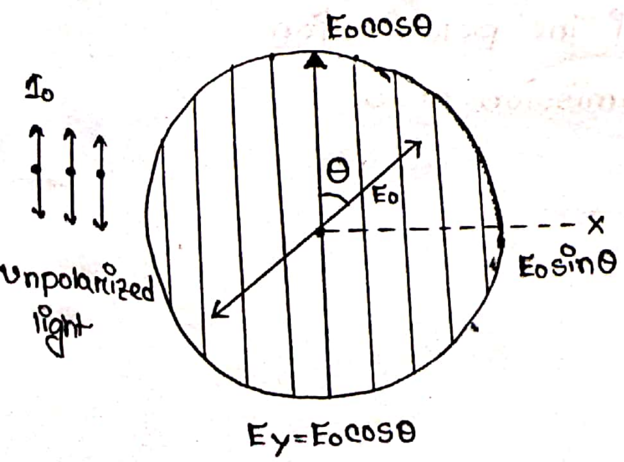
Calcite crystal ($CaCO_3$)

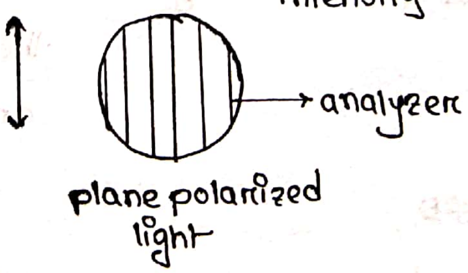






$I = \frac{1}{2} I_0 \rightarrow$ unpolarized intensity





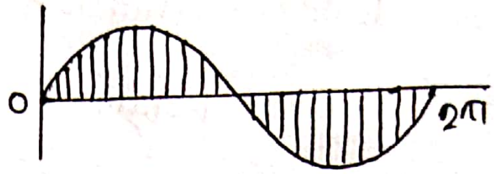
[plarized করার সময় light এর একটি component বাদ যাচ্ছে, কারণ light টা plane-এ আসবে, তাই sin component বাদ যাবে।]

$I \propto E_y^2$

$I = E_0^2 \cos^2\theta$

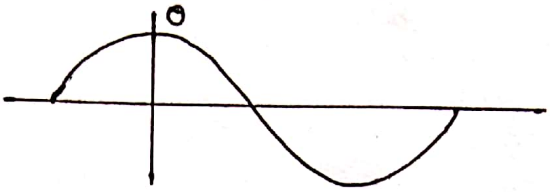
$I = I_0 \cos^2\theta$

I = polarized light এর intensity

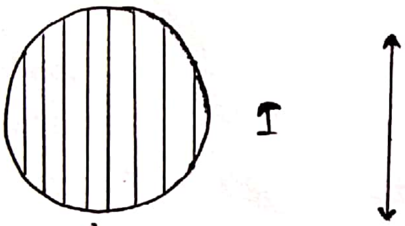


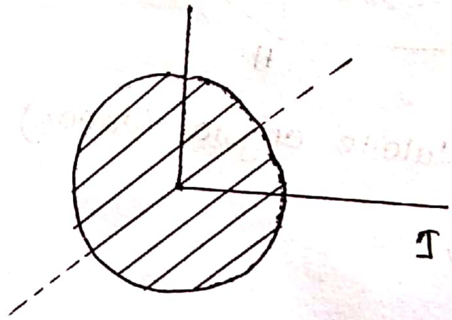
$$I = \frac{I_0}{2\pi}\int_0^{2\pi} \cos^2\theta$$

$$= \frac{1}{2} I_0$$



Intensity of polarized light = Intensity of unpolarized light $\times \frac{1}{2}$





Transmission 60° axis

$$I = \frac{I_0}{2} \times \cos 60^\circ$$

$$= \frac{I_0}{2} \times \frac{1}{2}$$

$$= \frac{I_0}{4}$$

Malus law:

The insensity of polarized light $\propto$ the squrre cosine angle between the plane of the polarization and transmission axis.

$I = \frac{1}{2} I_0 \cos^2\theta$

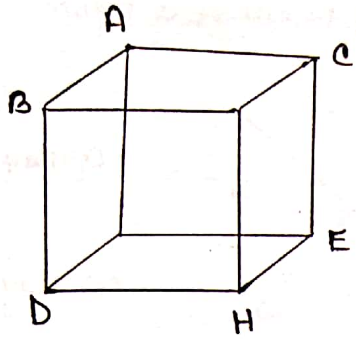
If $\theta = 0^\circ$, $I = \frac{1}{2} I_0$

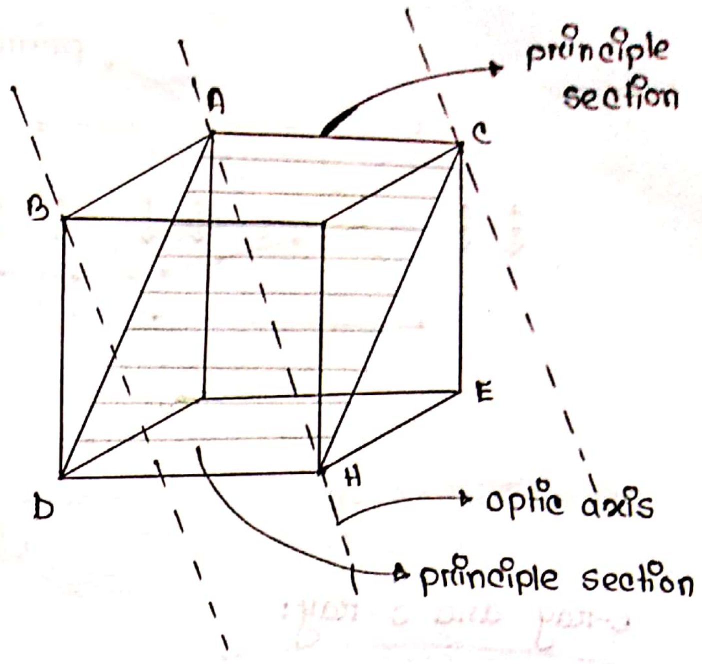
$\theta = 90^\circ$, $I = 0$

$\theta = 180^\circ$, $I = \frac{1}{2} I_0$

$\theta = 270^\circ$, $I = 0$

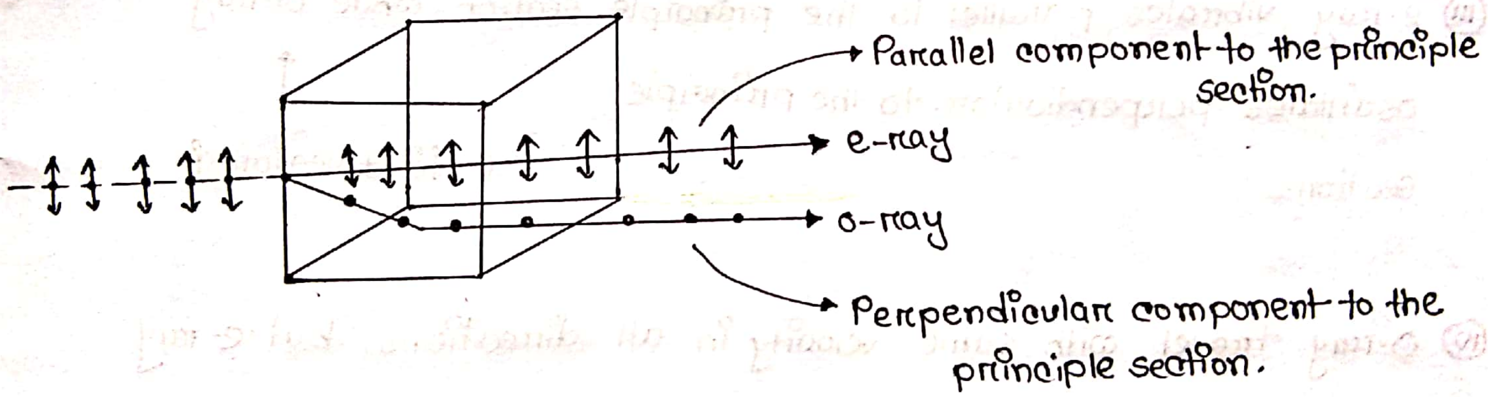
Optic axis:





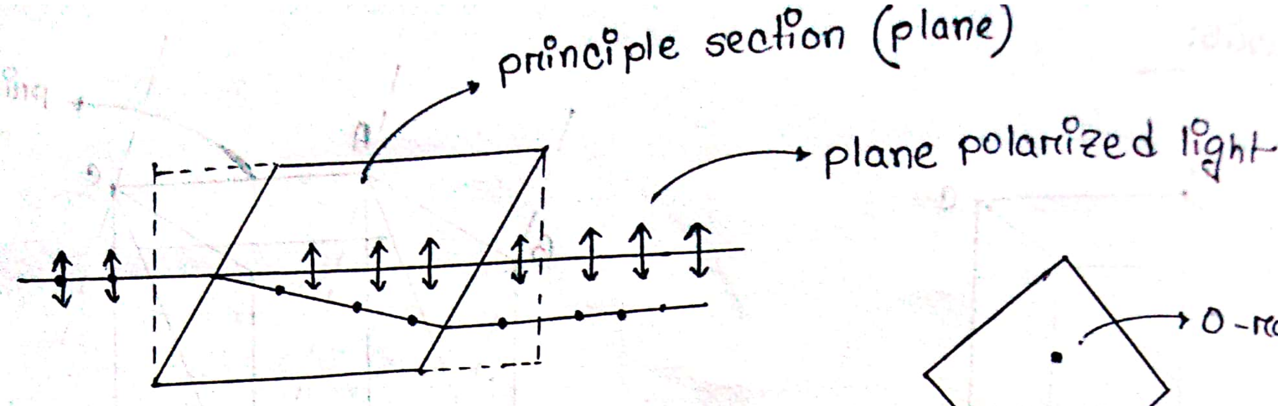
[plane টা optic axis এর parallel]

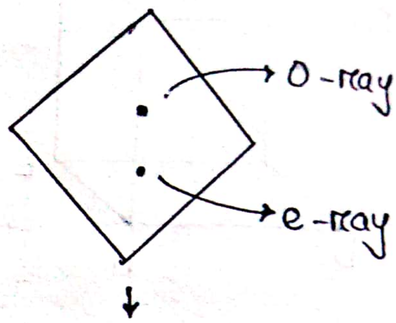
Double refraction:

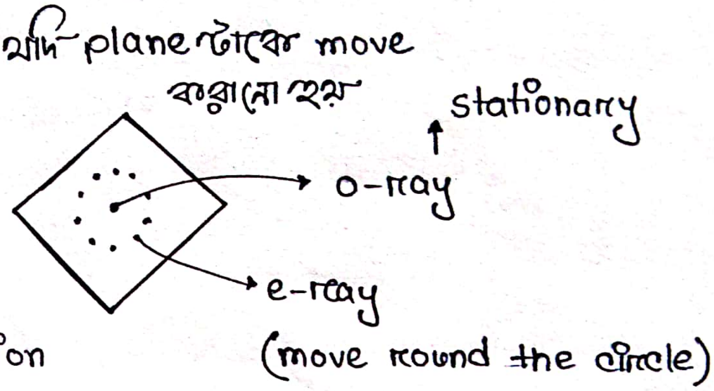


Anisotopic ⟶ Different Physical Values.
Different direction / axis.

Physical value ⟶ Heat, conductance, resistance
পরিবর্তন হবে না







e-ray and o-ray:

(i) Both rays are plane polarized.

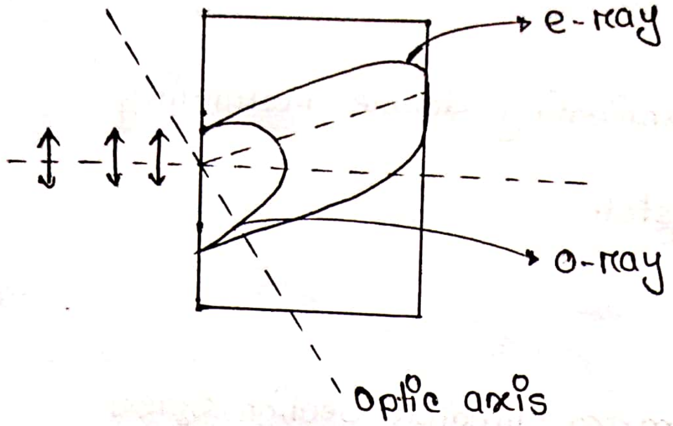
(ii) O-ray follow the law of refraction but e-ray doesn't follow the law of refraction.

(iii) e-ray vibrates parallel to the principle section while o-ray oscillates perpendicular. to the principle section.

e-field vector of

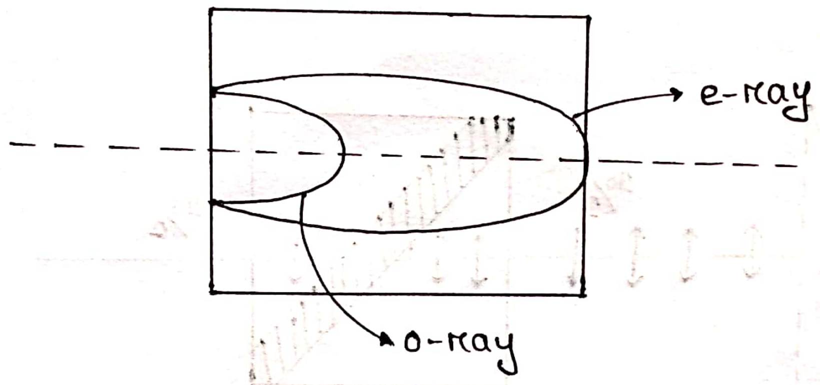
(iv) O-ray travel with same velocity in all directions, but e-ray travel with different velocity in different directions.

(i)



At any angle θ, o-ray and e-ray have different velocity and different direction.

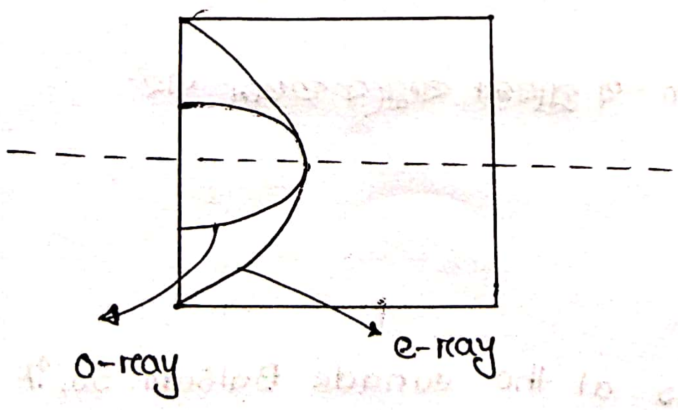
(ii)



⊥

Different velocity same direction.

(iii)



$V = f\lambda$

same velocity
same directions

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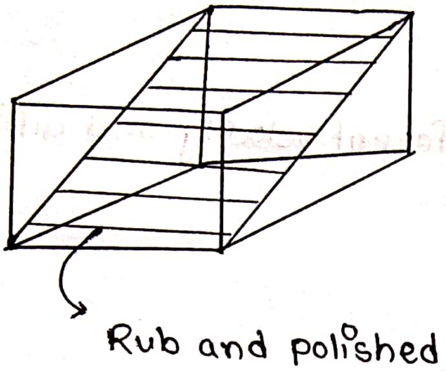
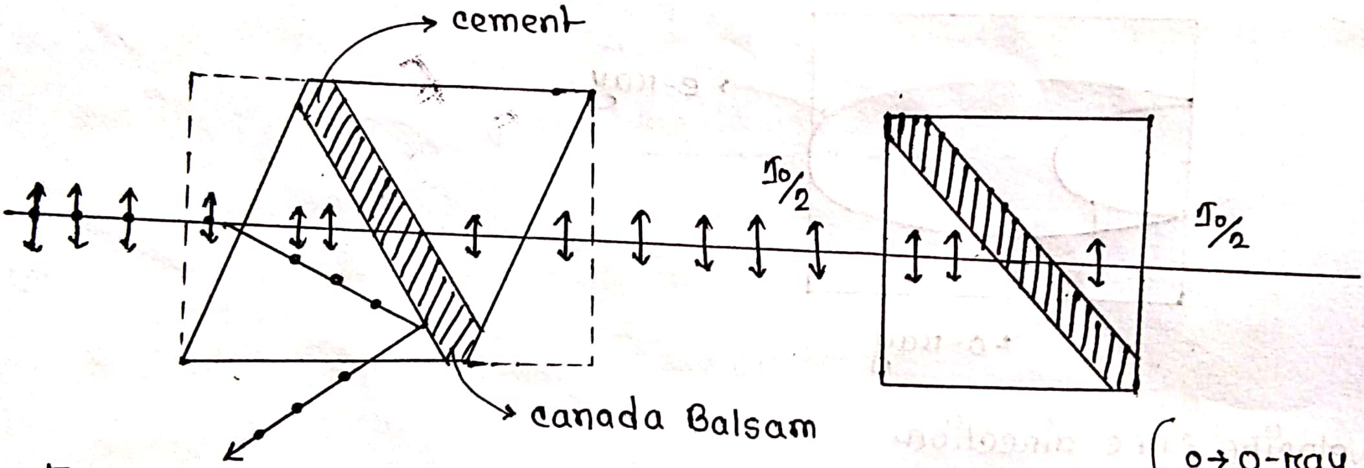
Nicol Prism:

Nicol prism is a polarizing device fabricating double refracting crystal. It is made for calcide crystal.



→ prism এর principle section বরাবর কর্তন করলে 2টি prism পাওয়া যাবে। যাদের তলকে rub and polished করা হয়।



$\mu_o = 1.66$ $\qquad$ $\mu_c = 1.55$

$\mu_e = 1.486$

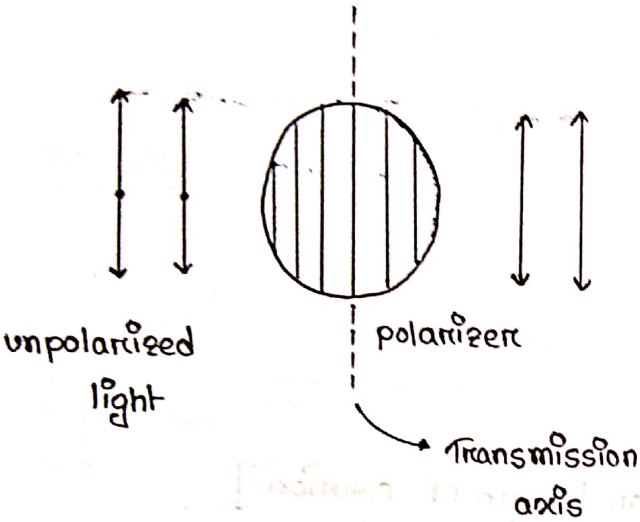
o → o-ray
e → e-ray
c → cement

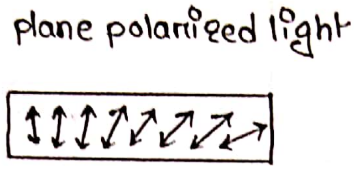
→ o-ray and e-ray যখন prism-এ প্রবেশ করবে তখন এই index show করবে।

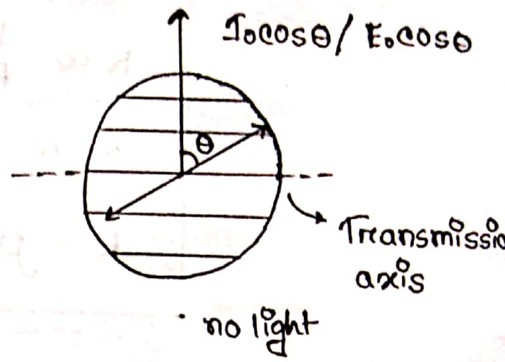
As, $\mu_o > \mu_c$

The total internal reflection occurs at the canada Balsam, so, it reflects at canada balsm. Hence nicol prism acts as a polarizer and an analyzer.

Optical Activity:







crossed position of polarizer and analyzer.

Optical active substance:

Quate, solution of suger, fruit solution, Tartarik suger.

The ability to rotate the plane of polarization of plane polarized light by optically active substance is called optical activity.

Two types of rotation:

I) Dextorotatory substance: Rolation of plane polarized light toward Right side.

II) Laevorotatory substance: " " " " " Left hand side.

Super solution ⟶ Dextorotatory substance.

Fruit " ⟶ Laevorotatory "

Specific rotation:

Rotation of plane polarized light:

$$\boxed{\begin{array}{l} R \propto l \\ R \propto \frac{l}{A} \\ R_i \propto \frac{l}{A} \\ R = \rho \frac{l}{A} \end{array}}$$

1) $\theta \propto l$ [Thickness of the substance or length of solution.]

$\theta \propto c$ [Concentration of solution or density of substance.]

$\theta \propto$ depends on λ

$\theta \propto$ Temperature T.

At a given λ and T [constant]

$\theta \propto lc$

$\theta = Slc$

└→ rotation constant (specific rotation)

$S = \frac{\theta}{lc}$

└→ dm

$l \rightarrow 1\,dm$

$c \rightarrow 1\,gm/cc$

$S = \frac{100\theta}{lc}$

└→ cm

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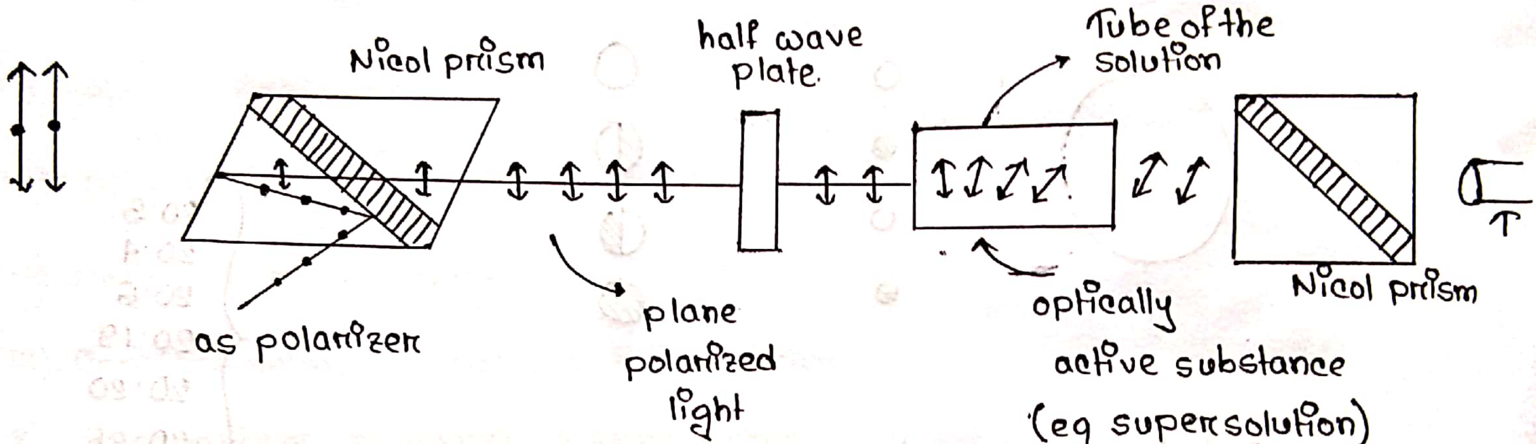
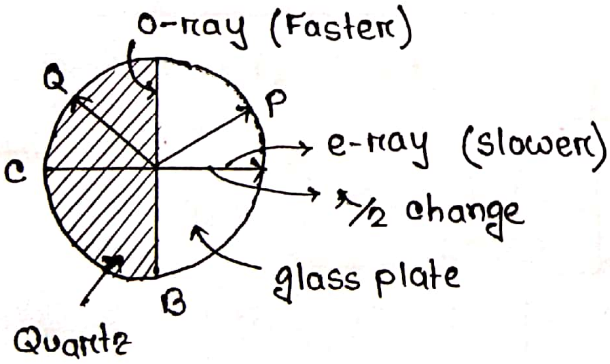
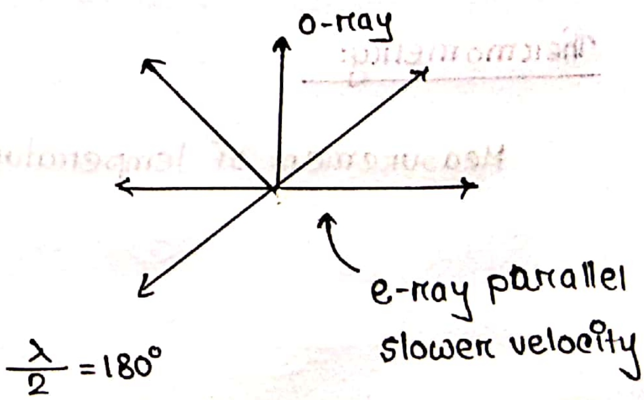
A specific rotation for a given wavelength or given temperature is defined as the rotation produce by 1 dm length of the solution containing 1 g of optically active metarial per cc solution.

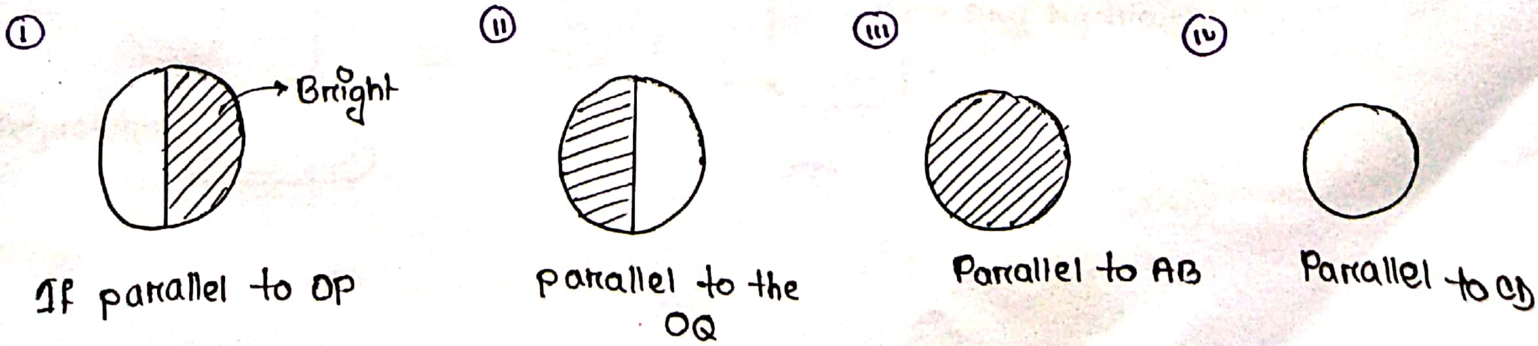
Laurents half shade polarimeter:



The plane of vibration of plane polarized light are rotated by solution.



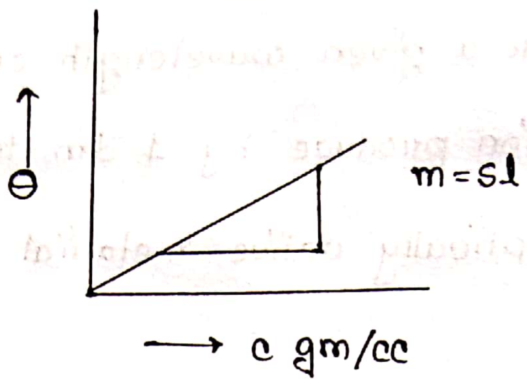




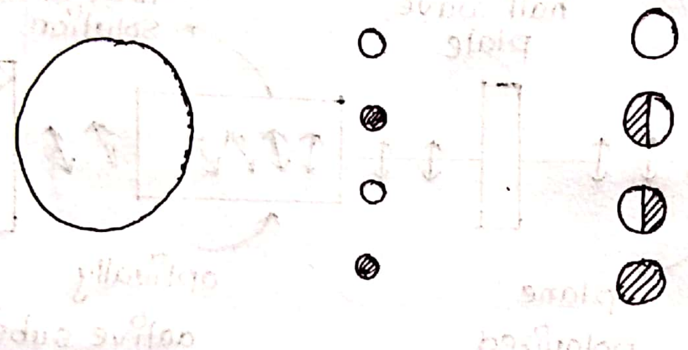
$\theta = slc$

m

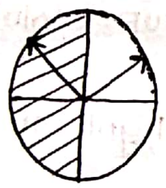
y c



half shade device কেন use করা হয় ?



20·3
20·4
20·6
20·19
20·20
20·25



Thermometry:

Measurement of temperature:

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Types of thermometry:

I) liquid thermometer.

II) Gas thermometer.

III) Resistance "

IV) Thermo- electric "

V) Radiation "

VI) Vapour pressure

VII) Bimetallic "

VIII) Magnetic susaphtibity

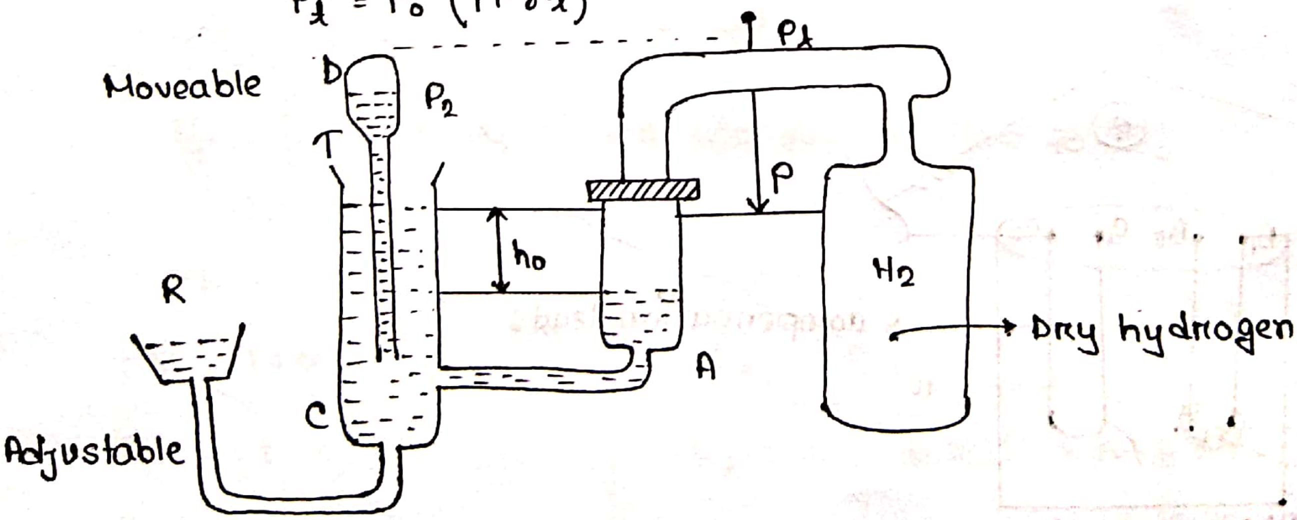
IX) Constant volume hydrogen thermometer.

X) International standard thermometer.

XI) Volume constant "

Change in pressure with temperature:

$$P_t = P_o (1 + \gamma t)$$



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i) $P_0 = h_0 + P$

$\hookrightarrow$ atmospheric pressure

P_0 = 0° temperature & pressure

ii) $P_{100} = P_0 (1 + 100\gamma)$

$P_t = P_0 (1 + \gamma t)$

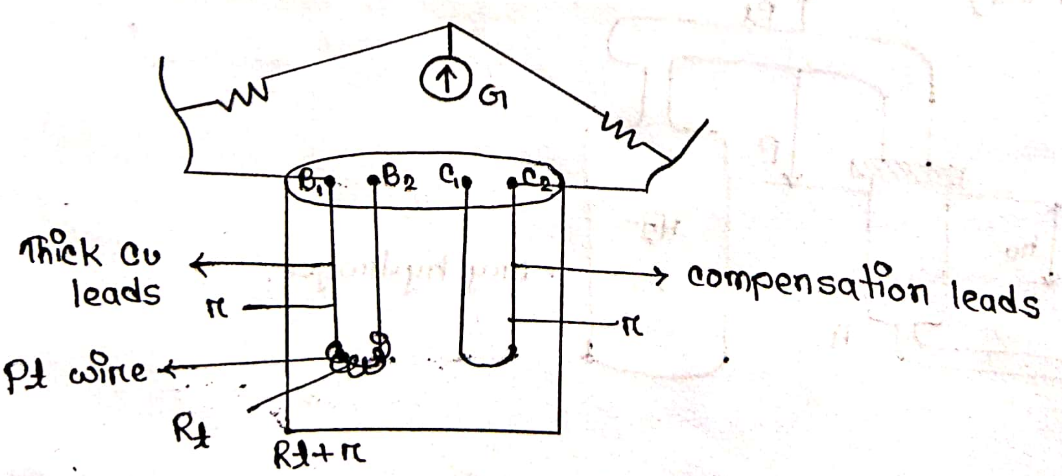
$$P_t - P_0 = P_0 \gamma t$$

$$P_{100} - P_0 = P_0 \gamma 100$$

$$t = \frac{P_t - P_0}{P_{100} - P_0} \times 100$$

Pt Resistance thermometer:

Change in resistance with termometer.



$R_t = R_0 (1 + \alpha t + \beta t^2)$

$R_t = R_0 (1 + \alpha t)$

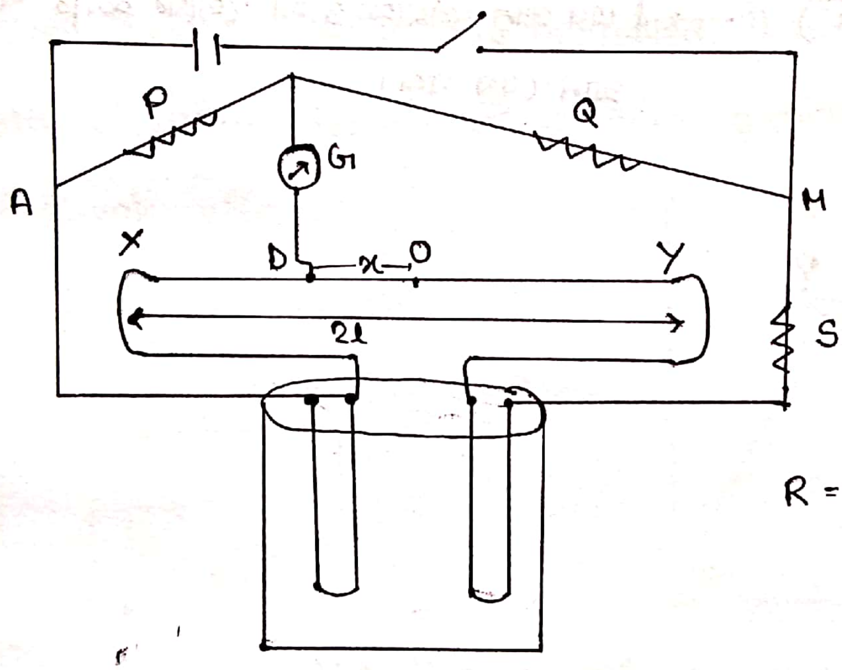
$$R_{100} = R_0(1+100\gamma)$$

$$R_t = R_0(1+\alpha t)$$

$$\rightarrow \quad t = \frac{R_t - R_0}{R_{100} - R_0} \times 100$$

Callender and Griffith bridge:

wheatstone's bridge used to measure resistance.



R = A থেকে D

$\frac{P}{Q} = \frac{R}{S}$ [যদি G এর মধ্যে current flow না হয়]

$xD = l - x$

$DY = l + x$

$R_{XD} = (l-x)\rho$

$R_{DY} = (l+x)\rho$

$P = Q$

$R_{AD} = R_{MD}$

$R_t + r + (l-x)\rho = r + S + (l+x)\rho$

$$\boxed{R_t = S + 2x\rho}$$

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Advantage and disadvantage of platinum resistance thermometer:

$R_t = S + 2xp$

The resistance of P_t wire of $0°C \longrightarrow R_0 = 5{\cdot}5\,\Omega$

" " " " at $100°C \longrightarrow R_{100} = 7{\cdot}5\,\Omega$

" " " " at $444{\cdot}6°C \longrightarrow R_{444{\cdot}6} = 14{\cdot}5\,\Omega$

$R_t = R_0(1+\alpha t+\beta t^2)$ $\longrightarrow$ t এর মান বসিয়ে ৩ সমী. থেকে α, β এর মান বের কর।

$$\left.\begin{array}{l} 3{\cdot}62\times10^{-3}\ /°C \\ 1{\cdot}28\times10^{-7}\ /°C \end{array}\right\} \begin{array}{l} \alpha = ? \\ \beta = ? \end{array}$$

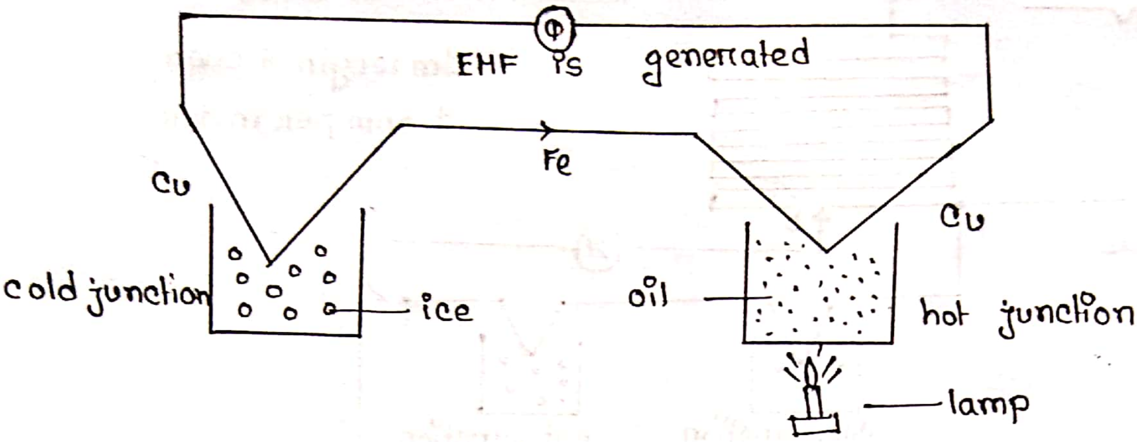
Thermocouple:

Two dissimilar metals

Two junctions

One junction is kept at cold and other junction is kept at hot.

current flows

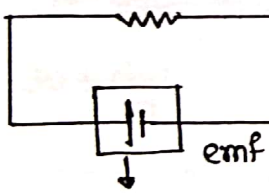


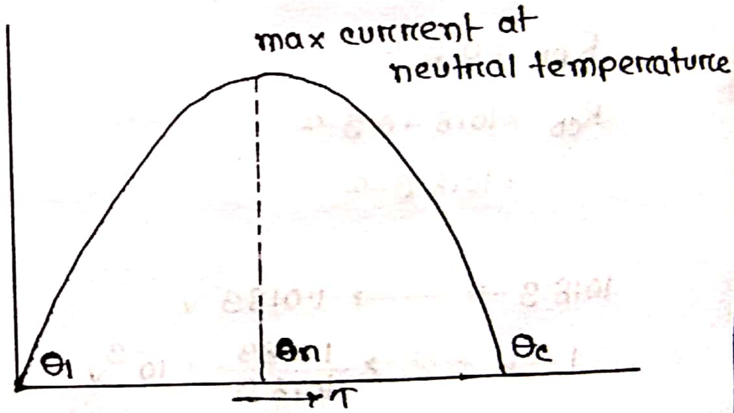
at cold junction current flows from Cu to Fe.

at hot " " " " Fe to Cu.

The current flows in this way is called thermo electricity.

Thermoelectromotive force - এই current generate করে। এই effect এর নাম Seebeck effect.

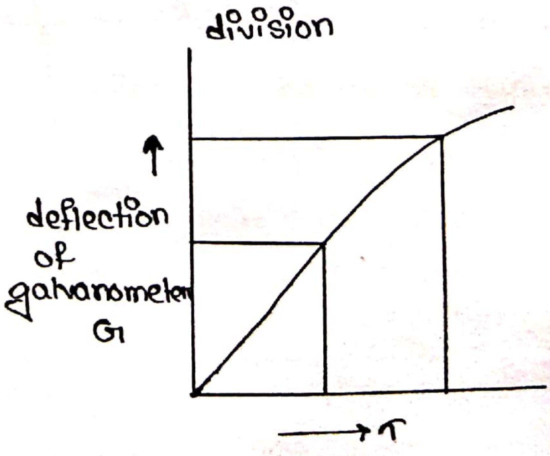




Higher voltage থেকে deflection or emf or current lower voltage এর দিকে আসে

+10 .... 0 .... −10

Neutral temp. $\theta_n = \dfrac{\theta_1 + \theta_c}{2}$



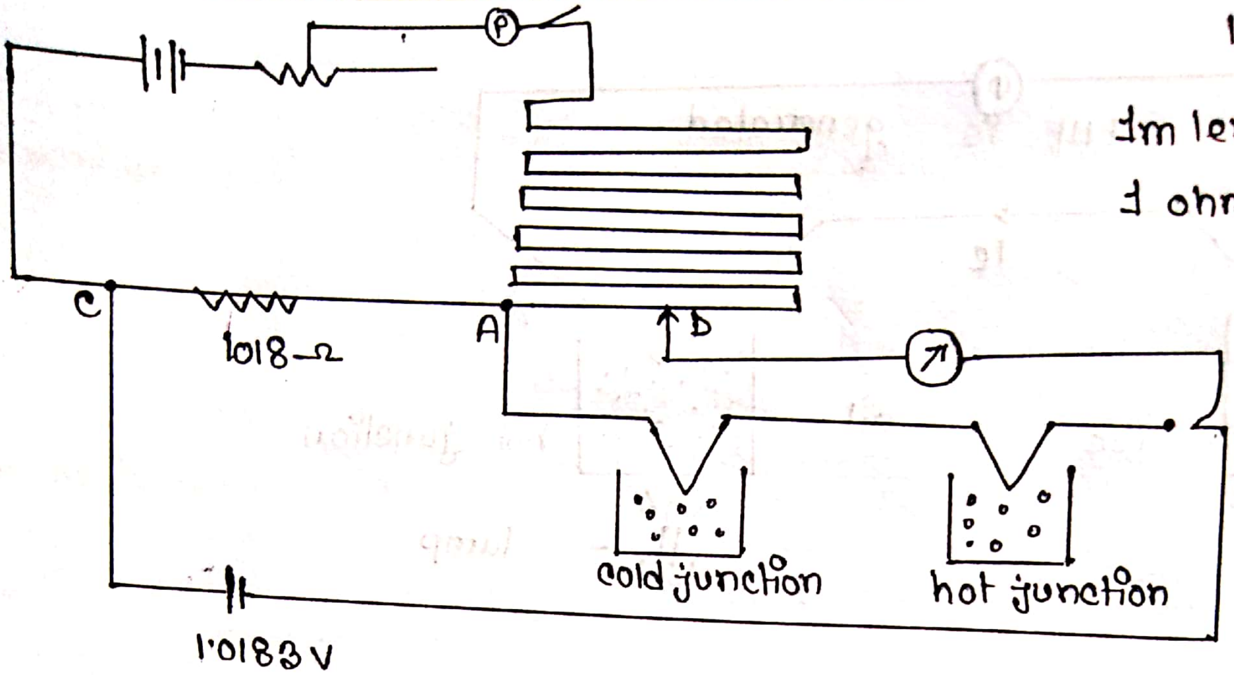
i) using galvanometer

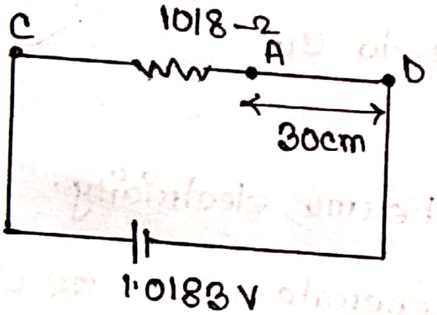
ii) using potentiometer.

10 wires

1m length of each

1 ohm per meter.





100 cm → 1 Ω

30 cm → 0.3 Ω

$R_{AD} = 0.3\,\Omega$

$R_{CD} = 1018 + 0.3\,\Omega$

$= 1018.3\,\Omega$

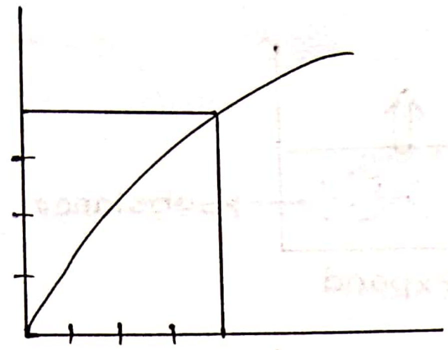
1m wire এর volt 10^{-3} V

1mm → 10^{-6} V

$1018.3\,\Omega \longrightarrow 1.0183$ V

$1\,\Omega \longrightarrow \frac{1.0183}{1018.3} = 10^{-3}$ V

2nd Case:



Zeroth law of thermo dynamics:

↳ Deals with transpering of heat from one place to another place.

equilibrium Systems: A B C

A → B - equilibrium.

Joule law: First law of thermodynamics,

$N = JH$

$dH = dU + dw$

dw ↳ work

dU → Increase the internal energy.

dH ↓ Applied heat

$W = F \cdot dx$

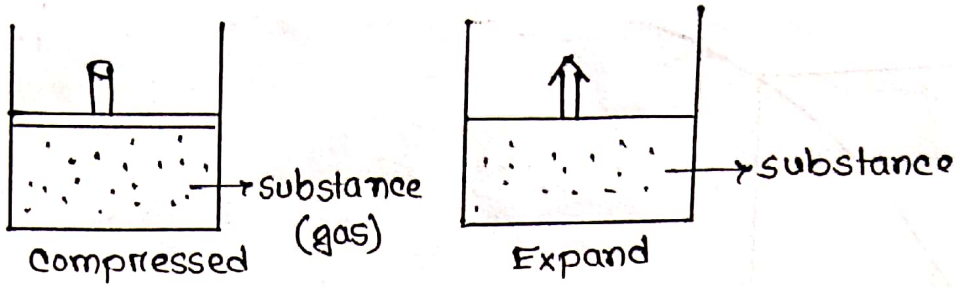
$= P \cdot A dx$

$= PdV$

$P = \frac{F}{A} \; Nm^{-2}$

A ↳ Area of the cross section.

$$dw = \int_{V_1}^{V_2} Pdv$$



Work done on the system. Work done by the system.

Isothermal Process:

The system is perfactly conduction to the surroundings.

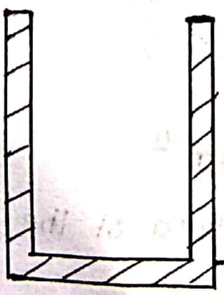
Temperature remain constant when pressure is increased.

When the pressure is increased, temperature increases.

Since the system is perfactly conducting to the surrounding, ~~So,~~ the system rejects heat to the surrounding. So, the tempercature remain constant through the process.

Adiabatic process:

No heat is transfered



$$dH = dU + dw$$

i) PV^{γ} = constant

ii) $TV^{\gamma-1}$ = constant

iii) $\frac{P^{\gamma-1}}{T^{\gamma}}$ = constant

$\gamma \rightarrow$ constant

Slope of isothermal and adiabatic:

$pv = \text{constant} = K$

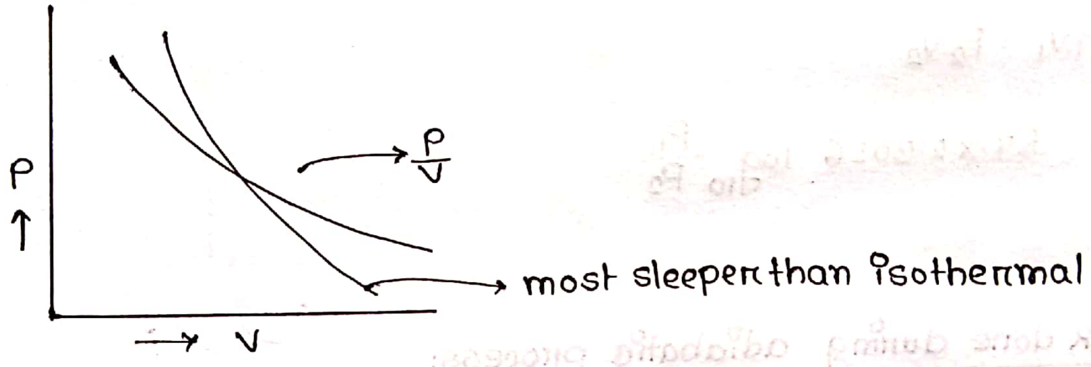
$pdv + vdp = K$

$$\frac{dp}{dv} = -\frac{p}{v}$$

$pv^{\gamma} = K$

$\gamma p v^{\gamma-1} dv + vdp = 0$

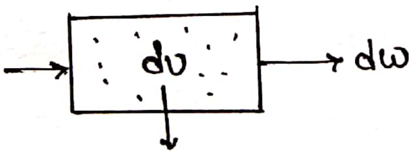
$$\frac{dp}{dv} = -\gamma \frac{p}{v} \quad [\gamma > 1]$$



6·1 → assignme

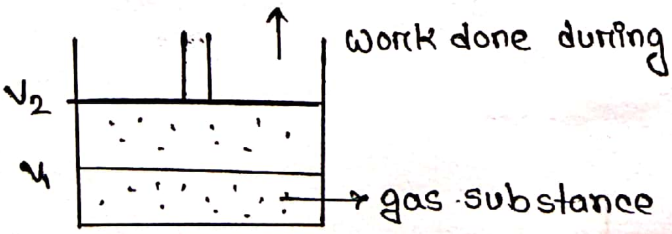
1st law of Thermodynamics:

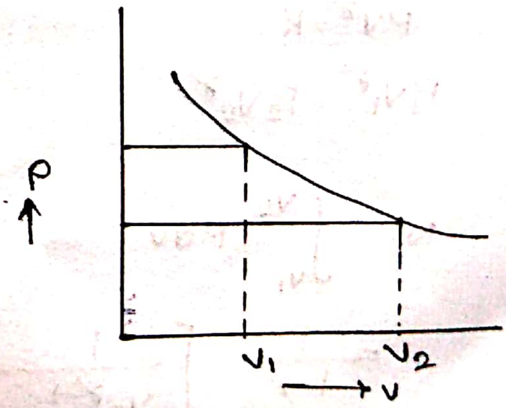
$$dH = du + \int_{v_1}^{v_2} pdv$$



change in internal energy

work done during





$dH = du + Pdv$

$0 \leftarrow$ $du = -pdv$

$= -dw$

$$w = \int_{v_1}^{v_2} Pdv$$

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$PV = RT$

$$\Rightarrow P = \frac{RT}{V}$$

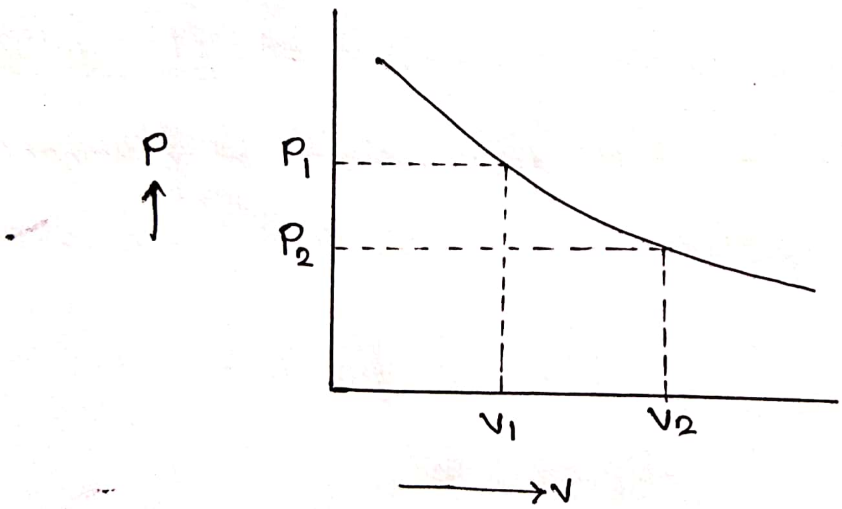
$N = RT \ln \frac{V_2}{V_1}$

$$= RT \times 2{\cdot}303 \log_{10} \frac{V_2}{V_1}$$

$P_1 V_1 = P_2 V_2$

$$W = RT \times 2{\cdot}3026 \log_{10} \frac{P_1}{P_2}$$

<u>Work done during adiabatic process:</u>



$$PV^{\gamma} = K$$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

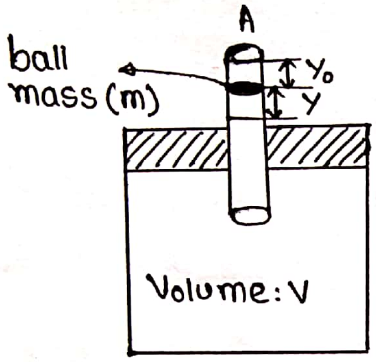
$$N = \int_{V_1}^{V_2} P\,dv$$

$$= \frac{1}{1-\gamma}\left[\frac{1}{V_2^{\gamma-1}} - \frac{1}{V_1^{\gamma-1}}\right]$$

$$= \frac{1}{1-\gamma}\left[P_2V_2 - P_1V_1\right]$$

$$= \frac{1}{1-\gamma} R\,(T_2 - T_1)$$

Rachhard's experiment:



to find γ

$$P = P_0 + \frac{mg}{A}$$

$$dv = yA$$

$$dp = F/A$$

simple harmonic motion.

$$PV^{\gamma} = K$$

$$\gamma V^{\gamma-1} P dV + V^{\gamma} dP = 0$$

$$\therefore \gamma P dV + V dP = 0$$

$$\gamma P y A + \frac{VF}{A} = 0$$

$$F = \frac{\gamma P A^2}{V} y$$

$$F = m\frac{d^2y}{dt^2}$$

$$\frac{d^2y}{dt^2} + \frac{\gamma P A^2}{Vm} y = 0$$

here,

$$\omega^2 = \frac{\gamma P A^2}{Vm}$$

$$\Rightarrow \frac{4\pi^2}{T^2} = \frac{\gamma P A^2}{Vm}$$

$$\Rightarrow \gamma = \frac{4\pi^2 Vm}{t^2 P A^2}$$

Second law of thermodynamics:

↳ heat transferred

Reversible process:

→ There should not be any loss of heat due to friction or radiation.

→ System may slow rater.

→ The system retraced back.

Irreversible process:

→ Heat lose due to friction or conductor.

→ fast rates

→ cannot retrace back.

↱ high temp. — low temp.

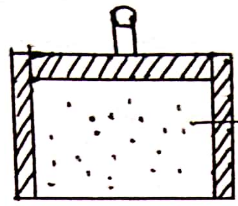
Kelvin-planck:

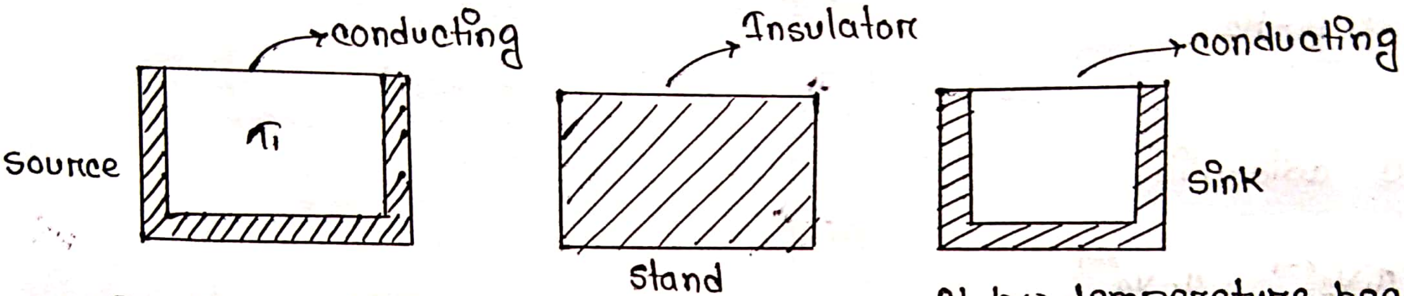
According to kelvin-planck, It is impossible to continue supply of heat... (বই)

(heat supply হবে না)

Crosious:

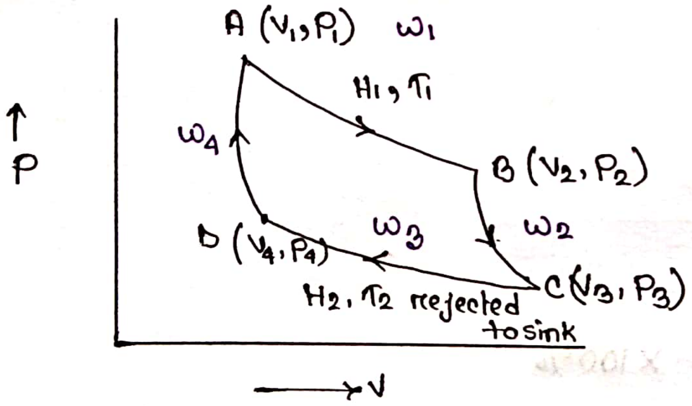
Carnot's reversible engine:





At high temperature engine absorbs heat

At low temperature heat rejects to the sink.



I) Work done during Isothermal (A to B) $\longrightarrow$ $W_1 = RT_1 \log \frac{V_2}{V_1}$

II) " " " adiabatic (B to C) $\longrightarrow$ $W_2 = \frac{R[T_1 - T_2]}{1-\gamma}$

$$W = \int_{V_1}^{V_2} P\,dv$$

III) Work done during Isothermal (C to D) $\longrightarrow$ $W_3 = -RT_2 \log \frac{V_3}{V_4}$

IV) " " " adiabatic (D to A) $\longrightarrow$ $W_4 = -\frac{R(T_1 - T_2)}{1-\gamma}$

The net work during cycle, $W = W_1 + W_2 + W_3 + W_4$

$$\therefore W = RT_1 \log \frac{V_2}{V_1} - RT_2 \log \frac{V_3}{V_4}$$

$$= R[T_1 - T_2] \log \frac{V_2}{V_1}$$

$$= H_1 - H_2$$

B to C adiabatic,

$$T_1 V_2^{\gamma-1} = T_2 V_3^{\gamma-1}$$

and A to D,

$$T_1 V_1^{\gamma-1} = T_2 V_4^{\gamma-1}$$

$$\therefore \frac{V_2}{V_1} = \frac{V_3}{V_4}$$

efficiency, $\eta = \frac{\text{Output}}{\text{Input}}$

$$= \frac{H_1 - H_2}{H_1} \times 100\%$$

$$= \frac{R(T_1 - T_2) \log \frac{V_2}{V_1}}{RT_1 \log \frac{V_2}{V_1}}$$

$$= 1 - \frac{T_2}{T_1}$$

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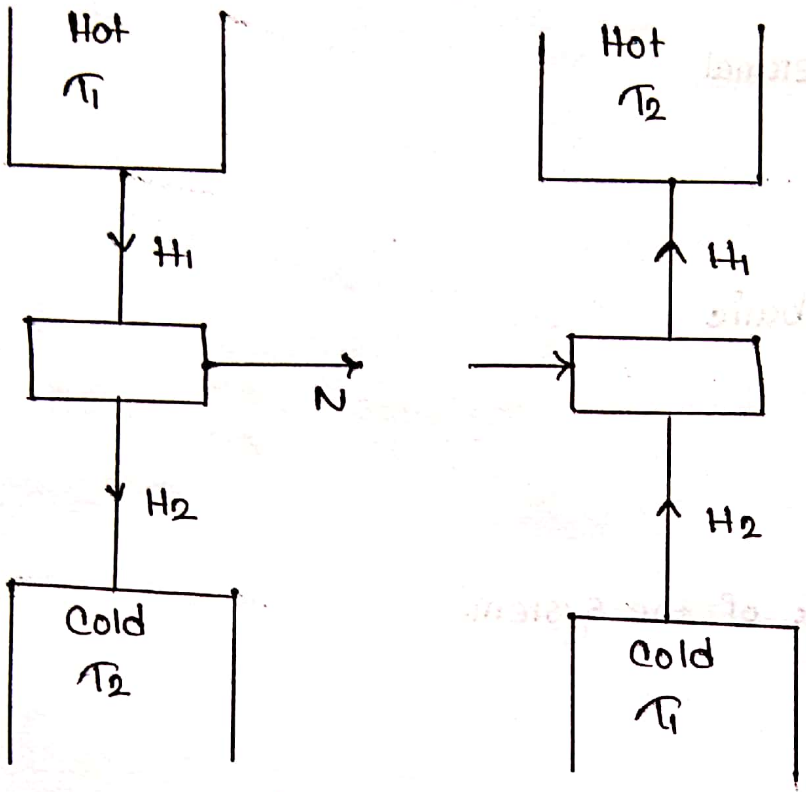
Carnot's engine and refrigerator:



Heat engine

refridgerator.

$dw = \int_{v_1}^{v_2} \underbrace{P\,dv}_{\to 0} = 0$

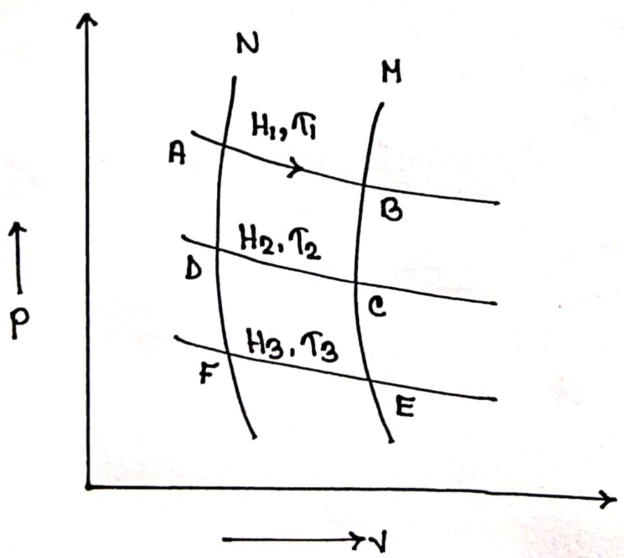
$dH = dw + du \longrightarrow$ Isothermal

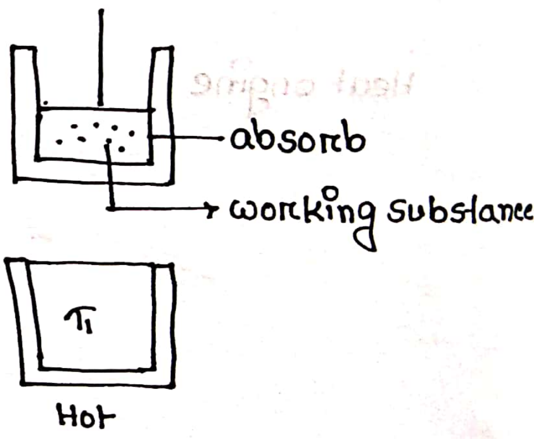
$PV = K$

$dH = dw + 0 \longrightarrow$ Adiabatic

$PV^{\gamma} = K$

Entropy measuring disorder of the system.





For ABCD →

$$\frac{H_1}{T_1} = \frac{H_2}{T_2}$$

For CDEF →

$$\frac{H_2}{T_2} = \frac{H_3}{T_3}$$

$$\therefore \frac{H_1}{T_1} = \frac{H_2}{T_2} = \frac{H_3}{T_3} = \text{constant}$$

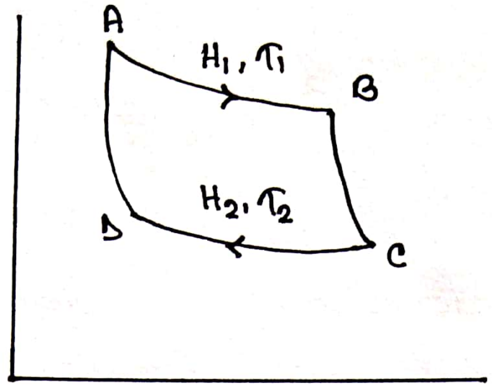
The quantity H/T bet adiabatic process is constant and this is called the change in entropy.

$$S_2 - S_1 = \frac{\delta H}{T}$$

$$\text{change in entropy } \oint ds = \frac{\delta H}{T} = \int_{T_1}^{T_2} \frac{\delta H}{T}$$

Thus entropy remains constant is during an adiabatic reversable process. When heat is absorbed during a process, there is increase in entropy. when heat is rejected .... there is decrease in entropy.

Changing entropy in a reverseable process:



The gain in entropy by working substance (A to B)

$$\frac{H_1}{T_1}$$

The lose in entropy (C→D) by working substance

$$\frac{H_2}{T_2}$$

$$\oint ds = \frac{H_2}{T_2} = \frac{H_1}{T_1} = 0$$

Changing entropy in a irreverseable process:

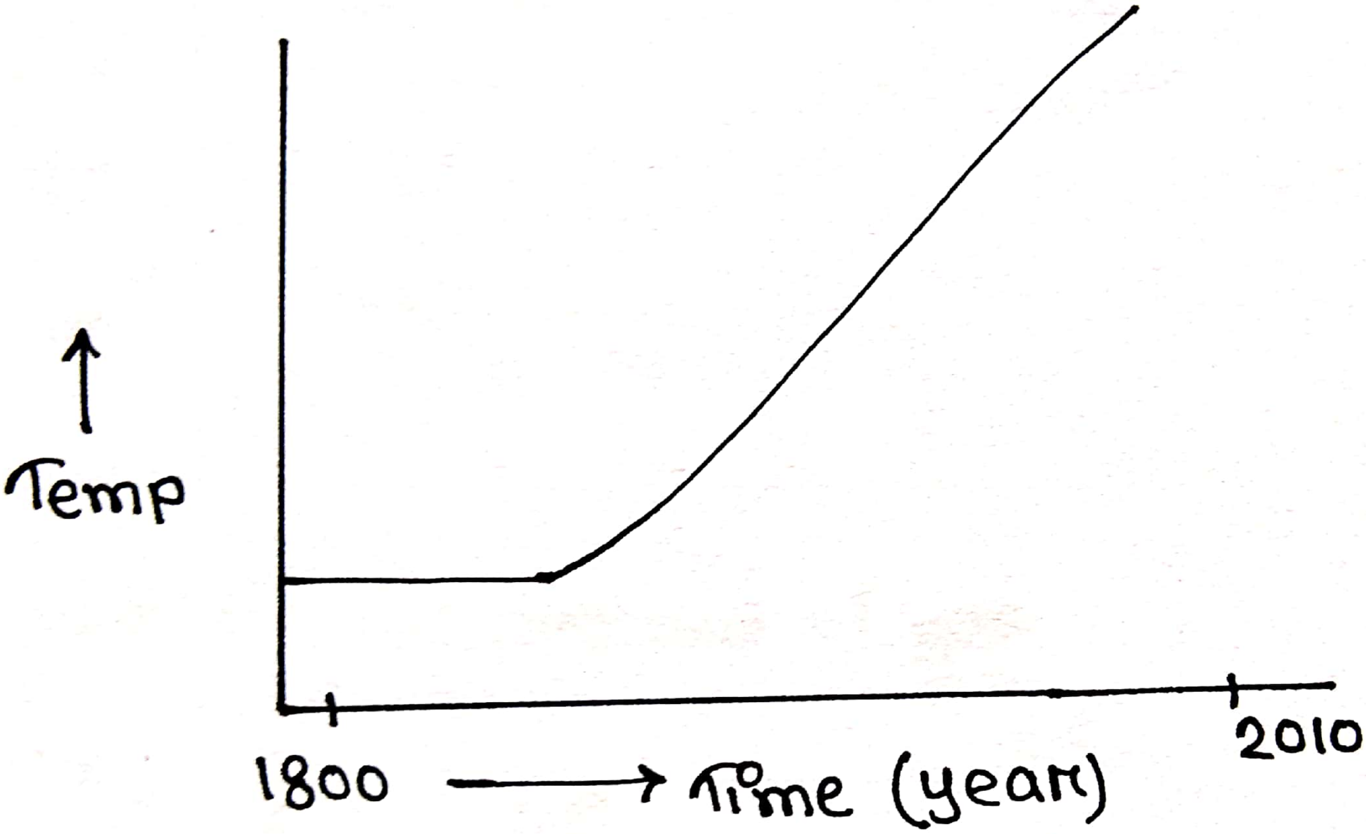
The lose in entropy in $\frac{\text{work}}{\text{hot}}$ body (A→B)

$$\frac{H}{T_1}$$

The gain in entropy (C→D)

$$\frac{H}{T_2}$$

$$ds = \frac{H}{T_2} - \frac{H}{T_1} = +ve$$



Third law of thermodynamics:

entropy $\rightarrow$ disorder of the system

$$\frac{H_1}{T_1} \neq \frac{H_2}{T_2}$$

is not zero but +ve quantity

$$ds = \int_{T_1}^{T_2} \frac{\delta H}{T}$$

(i) $-10 \rightarrow 0$ $\quad \delta H = ms.\Delta T$

(ii) $0 \rightarrow 0K$ $\quad \delta H = 80$

(iii) $0 \rightarrow 100°C$ $\quad ds = \int_{T_1}^{T_2} \frac{\delta H}{T}$

(iv) $100 \rightarrow 100°C$

$$ds_1 = \int_{T_1}^{T_2} \frac{ms\,\Delta T}{T}$$

change in entropy of the reservior.

$$ds_2 = \frac{-\delta H}{T} = \frac{-ms\,\Delta T}{373}$$

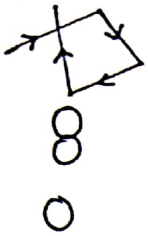
$ds_1 - ds_2 = 43{\cdot}9$ cal/K

Scanned by CamScanner

Kinetic theory of gas:

postalates:

① ② ③



Expressure for the pressure of gas.

$$P = \frac{1}{3}\rho c^2$$

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

$M \rightarrow$ Mass of gas of volume V.

$m \rightarrow$ mass of the each molecule.

$\rho \rightarrow$ density.

$$P = \frac{1}{3} \cdot \frac{M}{V} \cdot c^2$$

$$\Rightarrow PV = \frac{1}{3} Mc^2$$

$$PV = RT$$

$$\Rightarrow \frac{1}{3} Mc^2 = RT$$

$$\Rightarrow \frac{1}{2} Mc^2 = \frac{3}{2} RT$$

let,

$M = m \times N$ (For 1 mole gas)

$$\therefore \frac{1}{2} mNc^2 = \frac{3}{2} RT$$

$$\Rightarrow \frac{1}{2} mc^2 = \frac{3}{2} \left(\frac{R}{N}\right) T$$

$$\Rightarrow \frac{1}{2} mc^2 = \frac{3}{2} KT$$

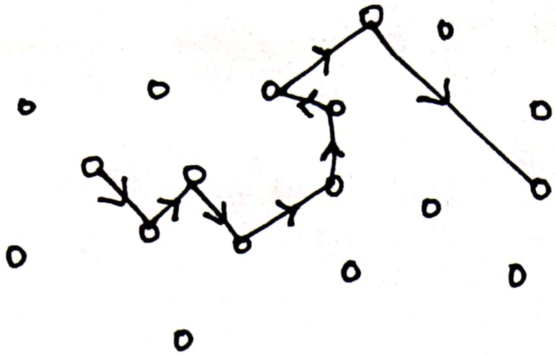
$$\therefore E_K = \frac{3}{2} KT$$

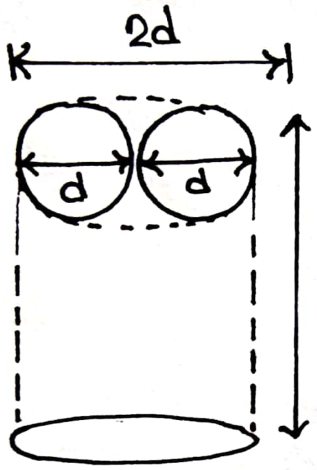
At $T = 0$, $E_K = 0$

↳ molecules or atoms are stable.

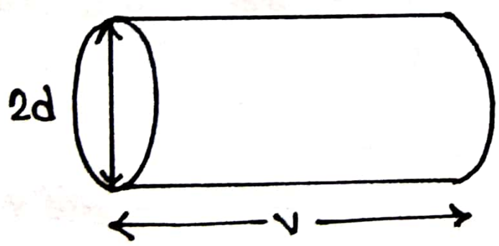
$E_K \propto T$.

Mean Free path:





The effective collision area, πd^2



$\lambda = \frac{S}{N}$ $\longrightarrow$ average distance; $N \longrightarrow$ number of collision.