Nature and propagation of light.

CH-10

Wave Theory of Light

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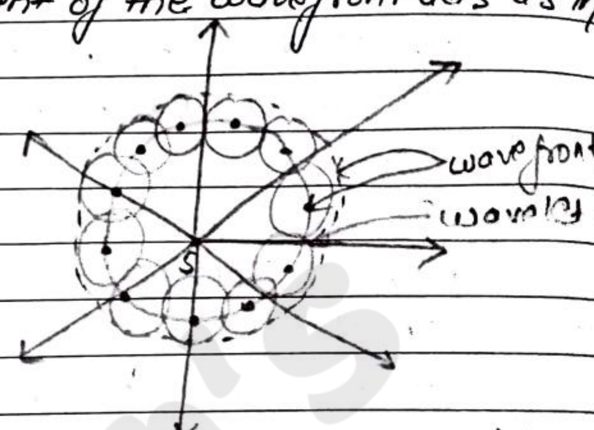
S.Q(1) Distinguish between wavefront and wavelet. [2072]

Ans, The plane on which the waves are in the same phase is called wave front. Wavelets are the secondary waves which are produce when each point of the wavefront acts as the new source of the wave.




parameters of light

S.Q(2) If light moves from one medium to the others medium (i.e refraction) which parameters of light do not change? [2063, 2071 supp]

Ans When light moves from one medium to the another medium (i.e during refraction) the energy $E=hf$ remains constant, hence frequency $f$ also remains constant. But due to change of refractive ~~index~~ index of medium velocity of light changes. Therefore

$$f = \frac{c}{\lambda} = \frac{v_1}{\lambda_1}$$

Hence, velocity and wavelength changes.

S.Q(3) A normally incident wavefront does not deviate, when it travels from one medium to another medium. Explain [2070 supp]

Ans For a normally incident wavefront angle of incidence $i = 0$ therefore from snell's law angle of refraction $r=0$ therefore, it does not deviate on going from one medium to the other medium.

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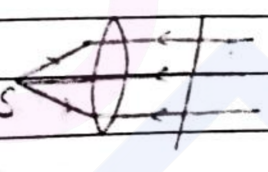
SQ.(4) When monochromatic light is incident on a surface, the reflected and refracted light has same frequency why? [2076 old]

Ans From the law of conservation of energy, the energy of light $E = hf$ remains constant, hence frequency remains constant during reflection and refraction of light.

SQ(5) Differentiate between plane wavefront and spherical wavefront [2062]

Ans following are the differences between plane wavefront and spherical wavefront :-

| | plane wavefront | spherical wavefront. |
|---|---|---|
| 1) | It is plane in shape. | 1. It is spherical in shape |
| 2) | plane wave front is formed when source of light is at infinity. ~~For~~ Practically it is formed with a convex lens. | 2. Spherical wavefront is formed near a point sources. |





SQ(6) State Huygen's principle. [2067]

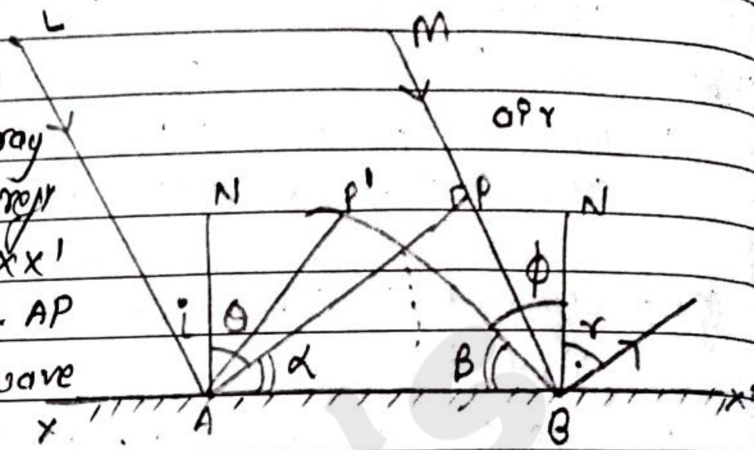
Ans To explain the mode of propagation of light Huygene enunciated the following two statements called Huygen's principle

i) Every point on the primary wavefront is origin of secondary wavefront.

ii) The wavefront travels with speed of light. The backward wavefronts are ~~are~~ neglected and the forward wavefronts are accepted.

Important (4 marks)

* Laws of reflection of light on the basis of wave theory (ie by Huygen's principle):




In fig (1) LA AND MB are two parallel rays of light incident on a reflecting plane surface XX' at angle of incidence i. AP is the incident plane wave front.

If in time t, light moves from fig (1) P to B then in the same time point A acting as secondary source of light constructs a wavelet of radius $AP' = AP = ct$ where $c$ = velocity of light in air. Tangent BP' is the reflected wavefront.

Between $\Delta APB$ and $\Delta AP'B$, we have,

$$\begin{cases} \angle APB = \angle AP'B = 90^\circ \\ \text{side } AB \text{ is common} \\ \text{side } BP = \text{side } AP' = ct \end{cases}$$

$\therefore \Delta APB \cong \Delta AP'B$

$\therefore \angle\alpha = \angle\beta$ ---- (1)

Now from fig. $i + \theta = \alpha + \theta = 90^\circ$.

$\therefore i = r$ --- (2)

also $\beta + \phi = r + \phi = 90^\circ$

$\therefore \beta = r$ -- (3)

From eqns (1), (2) and (3) we get

$\angle i = \angle r$.

Thus, the angle of incident is equal to angle of reflection of light.

Also the incident wavefront AP, reflected wavefront BP' and the normal at the point of incidence lie in the same plane.

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Thus, both laws of reflection of light hold good on the basis of wave theory of light.

Important (4 marks)

* Laws of refraction of light on the basis of wave theory (i.e by Huygen's principle):-

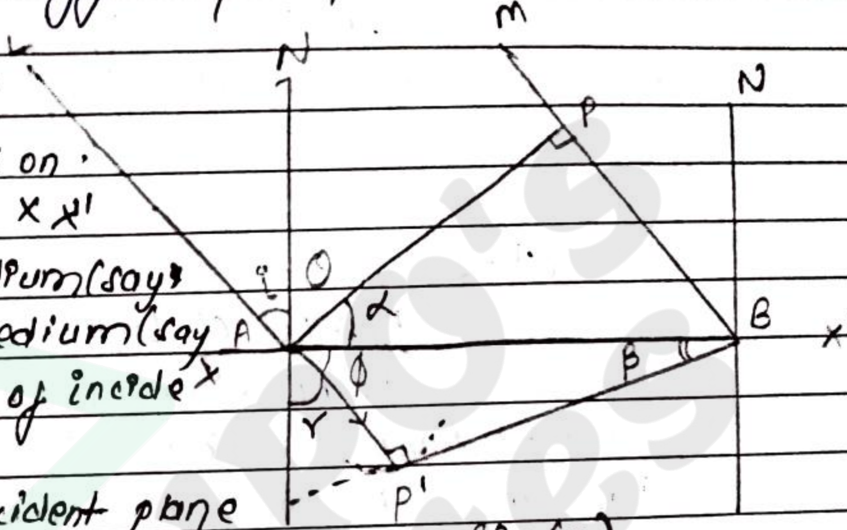


fig (2)

Let LA and MB be two parallel rays on a plane surface $XX'$ from rarer medium (say air) to denser medium (say glass) at angle of incidence $i$.

Thus AP is the incident plane wave front. Let c and v be the velocities of light in air and glass respectively. If in time t light moves from P to B in air then,

$$PB = c.t$$

In the same time t, point A acts as secondary source of light and ~~makes~~ makes a wavelet of radius $AP' = vt$ in glass. Tangent $BP'$ of this wavelet gives new plane wavefront $BP'$ which is refracted wavefront.

Now from fig (2)

$$i + \theta = \alpha + \theta = 90^\circ \quad \therefore \alpha = i$$

$$\text{Also, } r + \phi = \beta + \phi = 90^\circ \quad \therefore \beta = r$$

Now,

$$\frac{\sin \alpha}{\sin \beta} = \frac{\left(\frac{BP}{AB}\right)}{\left(\frac{AP'}{AB}\right)} = \frac{BP}{AP'} = \frac{c.t}{v.t} = \frac{c}{v}$$

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$$\therefore \frac{\sin i}{\sin r} = \mu \text{ ---- (1)}$$

(where $\mu = \frac{c}{v}$ = refractive index of glass)

Eqn (1) is Snell's law of refraction of light. Also the incident wavefront BR, refracted wavefront AP' and the normal at the point of incidence lie in the same plane.

Thus, both law's of refraction of light hold good on the basis of wave theory of light.

# Bipin Khatri

## (Bipo)

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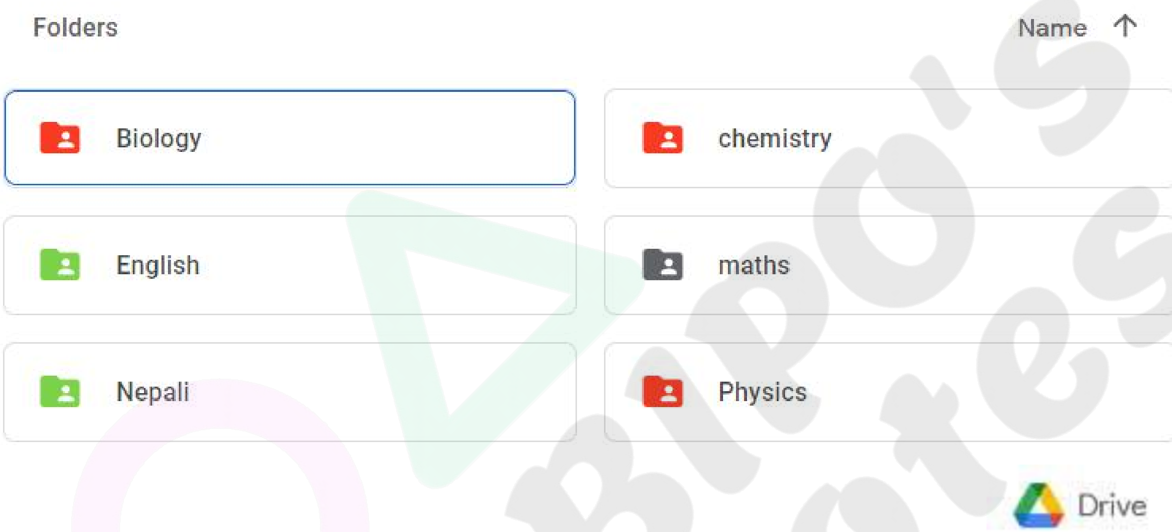
## Class 12 complete notes and paper collection.

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