

In this case the reflection Coefficient will be given by

$$R = \left| \frac{E_R}{E_i} \right| = \frac{(n-n_1)^2 + k^2}{(n+n_1)^2 + k^2}$$

$$\text{ie } R = \frac{n^2 + k^2 - 2nn_1 + n_1^2}{n^2 + k^2 + 2nn_1 + n_1^2} \quad \dots \dots \dots (13)$$

$$\text{or } R = \frac{n^2 + k^2 - 2nn_1}{n^2 + k^2 + 2nn_1} \quad (\text{as } n \approx k \gg n_1)$$

$$\text{or } R = \frac{2n^2 - 2nn_1}{2n^2 + 2nn_1} \quad (\text{as } n = k.)$$

$$\text{or } R = \frac{\left(1 - \frac{n_1}{n}\right)}{\left(1 + \frac{n_1}{n}\right)}$$

$$= \left(1 - \frac{n_1}{n}\right) \left(1 + \frac{n_1}{n}\right)^{-1}$$

$$= \left(1 - \frac{n_1}{n}\right) \left(1 - \frac{n_1}{n}\right)$$

$$= 1 - 2 \frac{n_1}{n} + \frac{n_1^2}{n^2}$$

$$\text{or } R = 1 - 2 \frac{n_1}{n} \approx 1 - 2 \frac{n_1}{k} \quad \dots \dots \dots (14)$$

From eqn (14) it is clear that greater the value of  $k_1$ , more nearly  $R$  is equal to unity.

In other words waves which are most strongly absorbed are very strongly reflected ie all good conductors

are good absorbers and good reflectors. Hence the colours of such substances is transmitted and reflected light are complementary. A good example is afforded by the optical properties of thin sheets of gold. They appear yellowish by reflection. This means that white is incident on thin gold foils, then the transmitted light appear greenish or bluish.

Further eqn (14) can be written as

$$R = 1 - 2n_s \sqrt{\left(\frac{2\omega\epsilon_0}{\sigma}\right)} \quad [\text{as } n_s \approx k = \sqrt{\left(\frac{\sigma}{2\omega\epsilon_0}\right)}] \quad (15)$$

From eqn (15) it is clear that at low frequency for substances of high conductivity the reflection coefficient will be close to unity and so essentially all the energy will be reflected, and this is why metal ie the good conductor of electricity opaque to light. The little energy that follows into the conductor is rapidly dissipated as the heat loss associated with the induced current.

However at high frequency the observed reflectivity becomes substantially smaller than that calculated from (15). This is because at high frequencies due to inertia the electrons are no longer able

to follow exactly the rapid changing field. This inertia effect is more pronounced in electrolytes eg. NaCl or  $\text{CaSO}_4$  solution which display superior conductivity statically but which at the same time are completely transparent. Since here the carriers of the current consists of ions whose mass is more than a thousand times of an electron, it is understandable that with respect to the electric field of light waves electrolytes behave like insulators.

Since the reflection coefficient is almost unity for a metallic surface, the magnitude of the vectors  $E_i$  and  $E_r$  are almost equal. Therefore we may write

$$E_i = n_x E_0 e^{-i(\omega t - k_i z)}$$

$$\text{and } E_r = n_x E_0 e^{-i(\omega t + k_i z)}$$

The total electric field in medium (1) will be given by

$$E = E_i + E_r$$

$$\text{i.e. } E = 2n_x E_0 e^{-i\omega t} [e^{ik_i z} - e^{-ik_i z}]$$

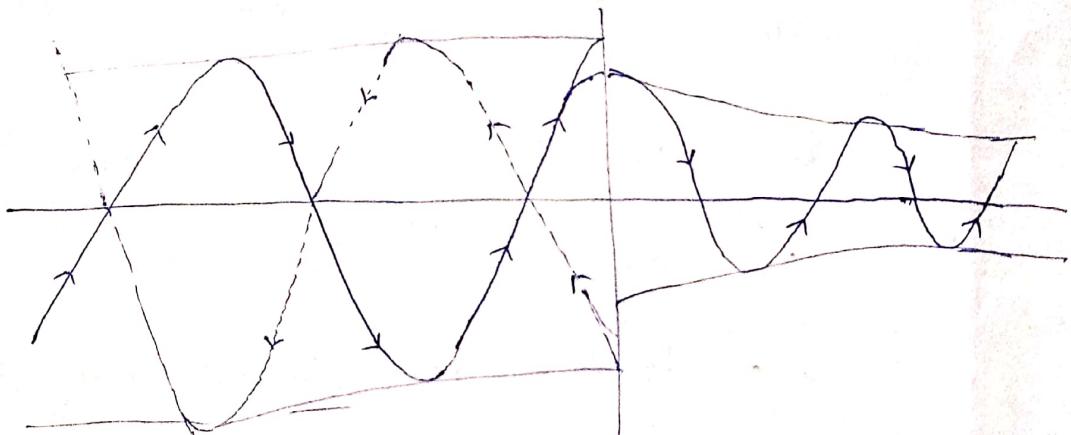
or upon taking the real part of this expression we have

$$E = 2n_x E_0 \sin k_i z \sin \omega t$$

The total electric field is therefore represented by standing wave, rather than propagating wave. The argument of the sine term depends on the space variable is

$$k_1 z = n_1 \frac{\omega}{c} z = \frac{2\pi n_1}{\lambda} z$$

So standing wave shows nodes separated by distance  $\lambda/2n_1$ . These standing waves have been detected by several methods, including the use of



photographic plates and by means of photo-electric effect.

our result therefore shows that electric fields behave as shown in fig.

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