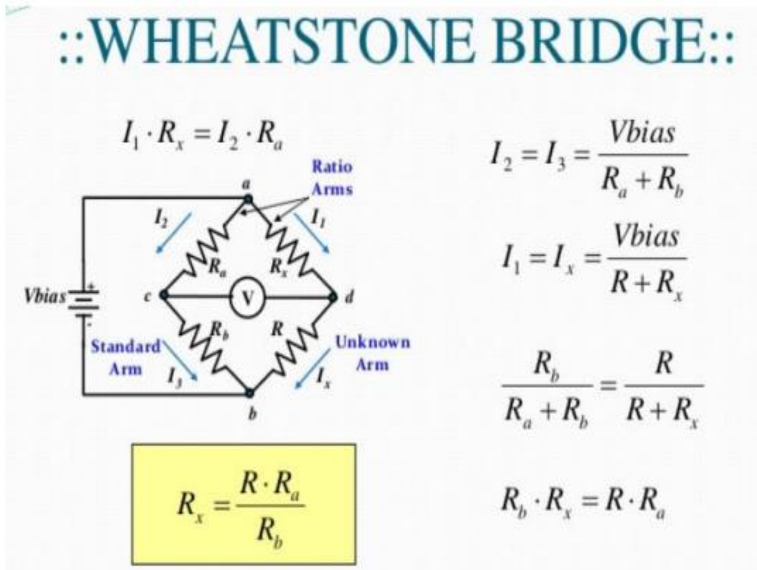
Meter Bridge Or Resistance of a wire

THEORY

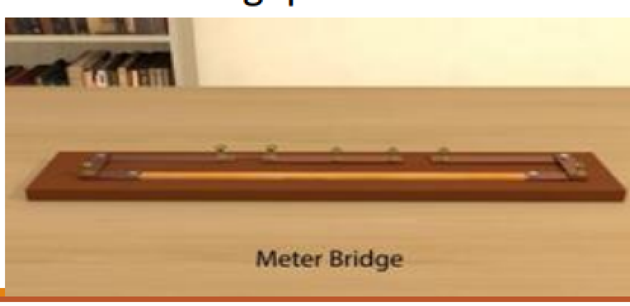
A meter bridge is the practical application of Wheatstone bridge arrangement as shown in figure below. The four resistances are connected to each other as shown and if the bridge is in balanced state, i.e., there is no deflection in the galvanometer (G),

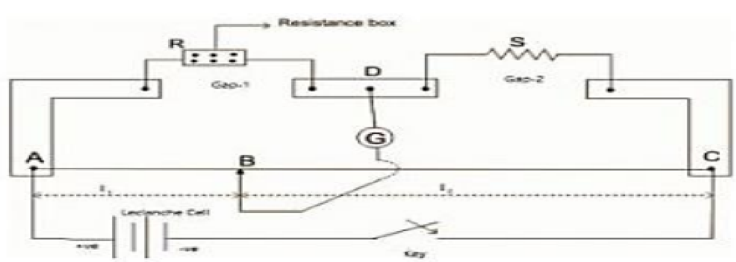


We can use this relation to find the unknown resistance of the given material of wire. The unknown resistance 'X' can be found by Meter bridge which uses the principle of Wheatstone bridge.

Metre Bridge apparatus

The metre bridge, also known as the slide wire bridge consists of a one-metre-long wire of uniform cross sectional area, fixed on a wooden block. A scale is attached to the block. Two gaps are formed on it by using thick metal strips in order to make the Wheat stone's bridge. The terminal B between the gaps is used to connect galvanometer and jockey.





A resistance wire is introduced in gap S and the resistance box is in gap R. One end of the galvanometer is connected to terminal D and its other end is connected to a jockey. As the jockey slides over the wire AC, it shows zero deflection at the balancing point (null point).
If the length AB is l , then the length BC is (100-l).
Then, according to Wheatstone's principle;

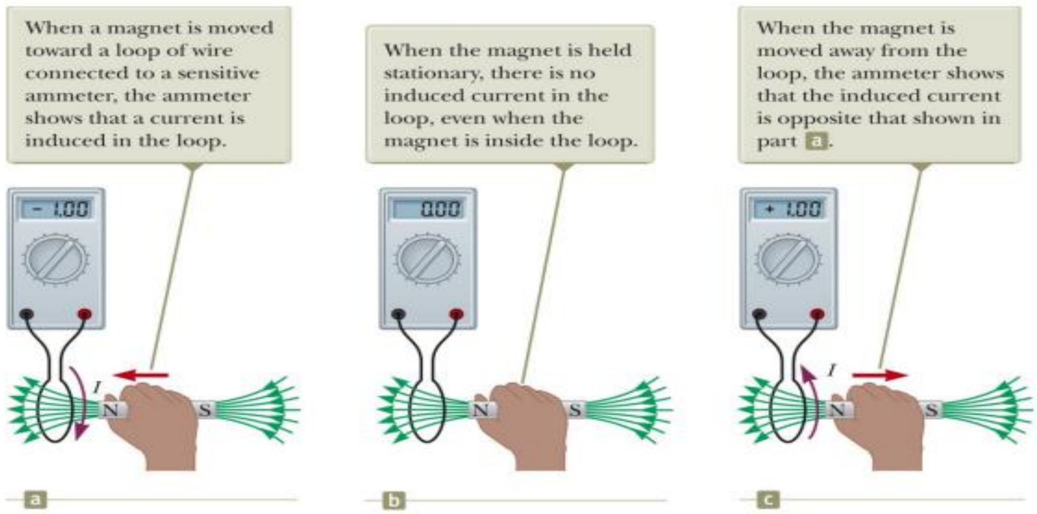
$$\frac{X}{R} = \frac{l}{(100 - l)}$$

Now, the unknown resistance can be calculated as

$$X = R\frac{l}{(100 - l)}$$

Faraday's Law

31.1 Faraday's Law of Induction



- The emf induced in a circuit is directly proportional to the time rate of change of the magnetic flux through the circuit.

Mathematically,

$$\varepsilon = -\frac{d\Phi_B}{dt}$$

Remember, Φ_B is the magnetic flux through the circuit and is found by:

$$\Phi_B = \int \vec{\mathbf{B}} \cdot d\vec{\mathbf{A}}$$

If the circuit consists of N loops, all of the same area, and if Φ is the flux through one loop, an emf is induced in every loop and Faraday's law becomes

$$\varepsilon = -N\frac{d\Phi_B}{dt}$$

- ✓ The magnitude of the magnetic field can change with time.
- ✓ The area enclosed by the loop can change with time.
- ✓ The angle between the magnetic field and the normal to the loop can change with time.
- ✓ Any combination of the above can occur.

Joule's Law

We are aware of the heating impact of electric current. The heat is produced due to the collision electrons in the wire. You might have wondered about the amount of heat generated during the flow of current through a wire and the parameters and conditions it is based upon. To answer all these questions, Joule gave a formula that describes this phenomenon precisely and called it Joule's Law.

Joule's Law of Heating

Joule's law is a mathematical description of the rate at which resistance in a circuit converts electric energy into heat energy.

The heat that is generated because of the current flow in an electric wire is described in Joules. The mathematical expression of Joule's law is as explained below.

Joule's first law

The joule's first law shows the relationship between heat produced by flowing electric current through a conductor.

$Q = I^2 R T$

Where,

- Q indicates the amount of heat
- I show electric current
- R is the amount of electric resistance in the conductor
- T denotes time

Solved Example

Q1) Calculate the heat energy produced in resistance of 5 Ω when 3 A current flows through it for 2 minutes.

The amount of heat produced by the conductor is given by the formula:

$Q = I^2 R T$

Substituting the values in the above equation we get

$Q = 3^2 \times 5 \times 2 \times 60 = 5400$ J

Q2) An heater of resistance 300 Ω is connected to the main supply for 30 mins. If 10 A current flows through the filament of the heater then what is the heat produced in the heater?

The amount of heat produced by the heater is calculated as follows:

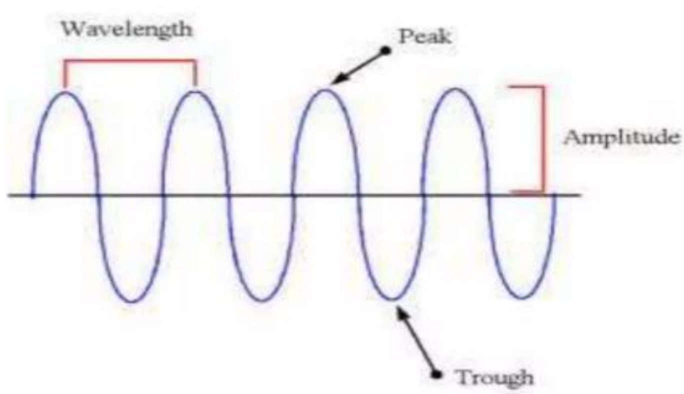
$Q=I^2RT$

substituting the values in the equation, we get

$Q = 10^2 \times 300 \times 30 \times 60 = 54000000$ J or 54 MJ.

What is Light? 

Light is an electromagnetic radiation refers to visible regions of electromagnetic spectrum corresponding to the wavelength range of 400nm to 760nm which has transverse vibrations.



Wave

2) The Ray Approximation in Geometric Optics

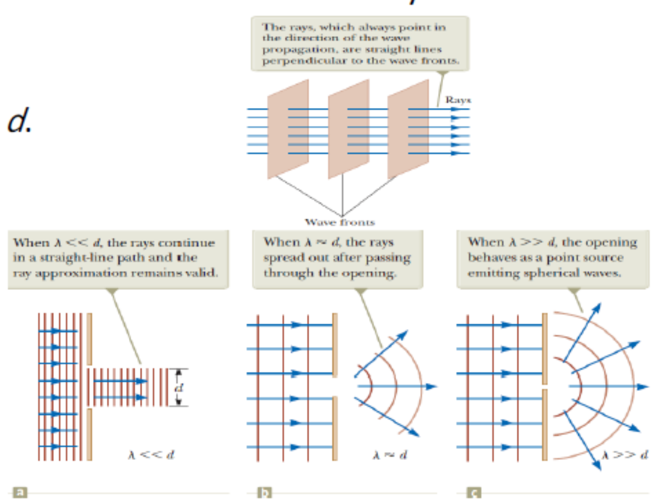
In the ray approximation, we assume that a wave moving through a medium travels in a straight line in the direction of its rays.

A plane wave of wavelength λ is incident on a barrier in which there is an opening of diameter *d*.

(a) When $\lambda \ll d$, the rays continue in a straight-line path, and the ray approximation remains valid.

(b) When $\lambda = d$, the rays spread out after passing through the opening.

(c) When $\lambda \gg d$, the opening behaves as a point source emitting spherical waves.

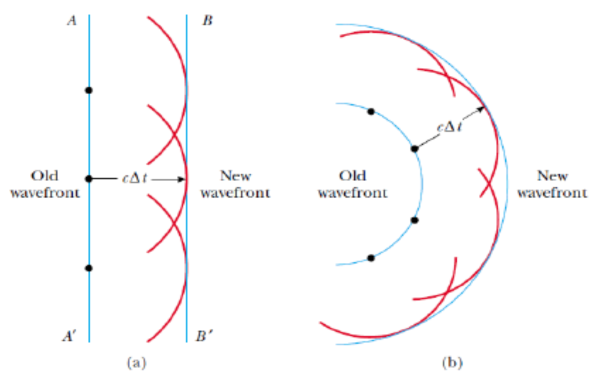


Some definitions :

- The light wave ray can be plane or spherical this is depend on the source and the direction of propagation of its rays.
- Wave front is the surface tangent to the light wave emerging from the opening continues to move from a point source.
- Two light wave rays are out of phase if one of them have maxmum amplitude and the other have minimum amplitude at the same time.
- Two light wave rays are in phase if they have the same amplitude at the same time.

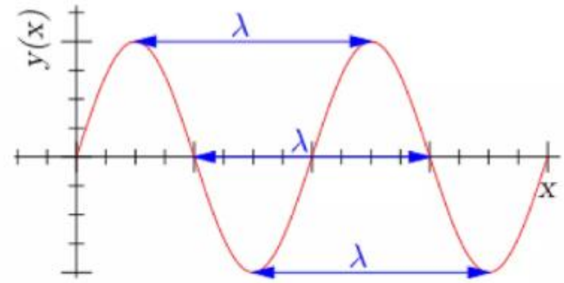
Huygen's Principle:

- In Huygens's construction all points on a given wave front are taken as point sources for the production of spherical secondary waves, called wavelets, which propagate outward through a medium with speeds characteristic of waves in that medium.
- After some time interval has passed, the new position of the wave front is the surface tangent to the wavelets.

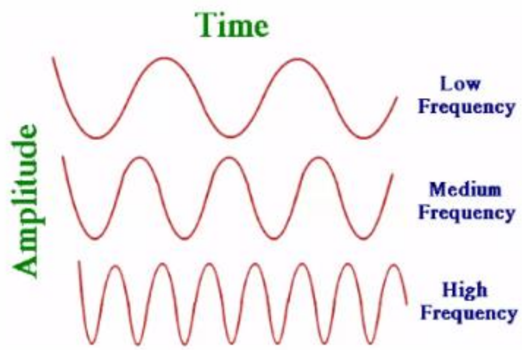


General Definitions

The Wavelength of a sin wave, λ, can be measured between any two points with the same phase, such as between crests, or troughs, as shown.

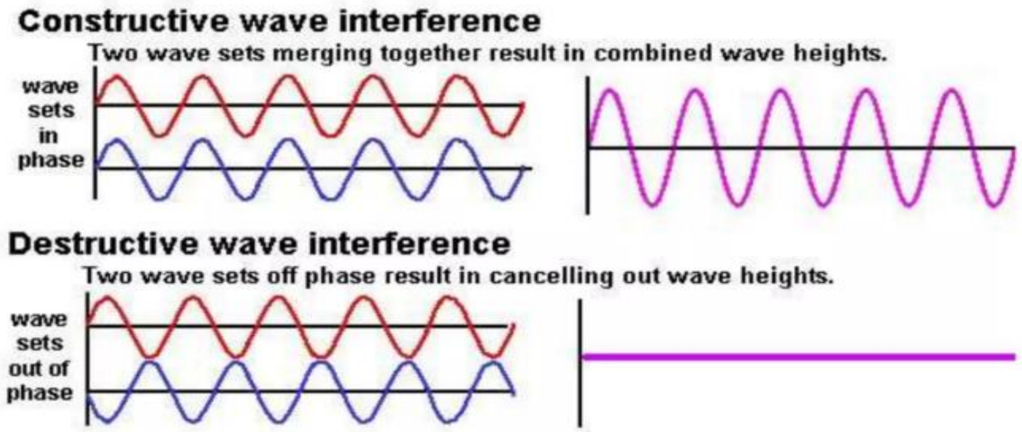


The frequency, f, of a wave is the number of waves passing a point in a certain time. We normally use a time of one second, so this gives frequency the unit hertz (Hz), since one hertz is equal to one wave per second.

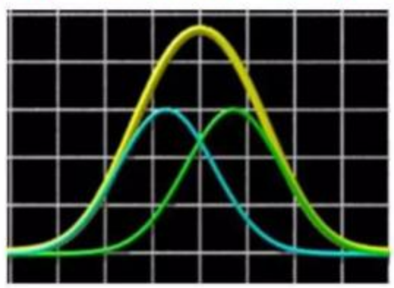


Principle of Superposition

"Whenever two or more waves superimpose in a medium, the total displacement at any point is equal to the vector sum of individual displacement of waves at that point"



$y = y_1 + y_2 = a \sin(\omega t) + a \sin(\omega t + \phi)$



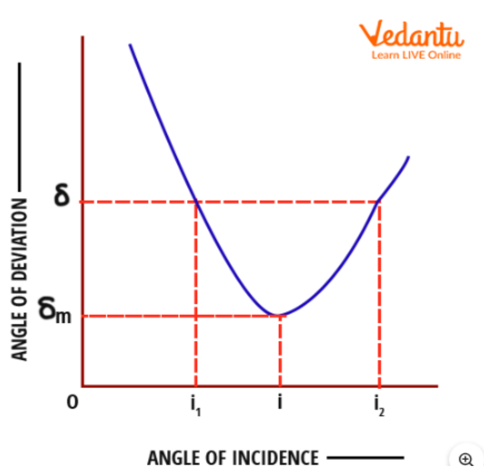
If Y_1, Y_2, Y_3…are different displacement vector due to the waves 1,2,3 …acting separately then according to the principle of superposition the resultant displacement is given by

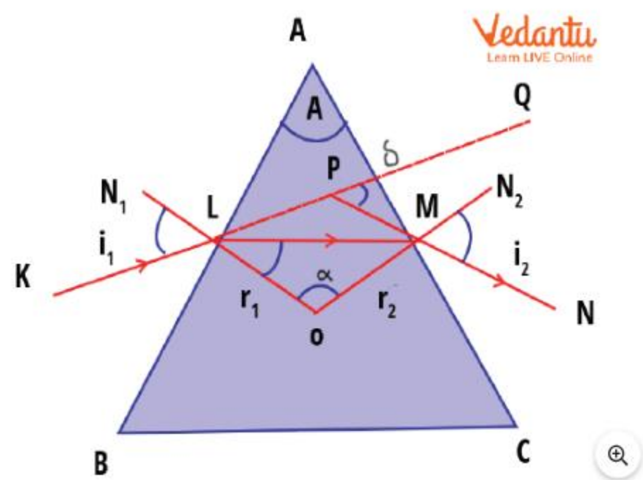
$Y = Y_1 + Y_2 + Y_3 + \ldots\ldots$

Triangular prism

A prism can be defined as a wedge-shaped body that is made from a refracting medium. It is bound by two plane faces which are placed at an incline with each other at some angle. The two plane faces of the prism are called the refracting faces. The angle between the two faces is known as the angle of the prism. It is also known as the refracting angle. The faces of a prism can be parallelograms or rectangles without their bases. There are a variety of prisms and depending on the shape, the base of a prism could be a triangle, square, rectangle, or any n-sided polygon in general.

What is The Angle of Deviation in Prism? Before deriving the expression of the angle of deviation in the prism, it is important to understand what happens to a beam of light that is incident on one of the faces of the prism. A light that is incident on a surface of the prism undergoes refraction at both the surfaces of the prism and is deviated from the original path that was supposed to follow. There is a deviation in the path of the beam of light due to refraction from the faces of the prism. The angle of deviation is the angle between the original path that the beam should have followed and the deviated beam. It can also be defined as the angle through which the incident ray gets deviated when passing through a prism.





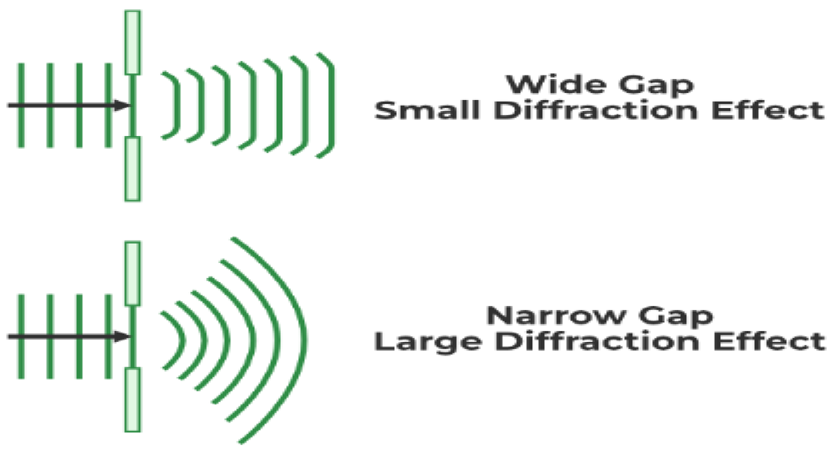
<u>**Diffraction of light**</u>

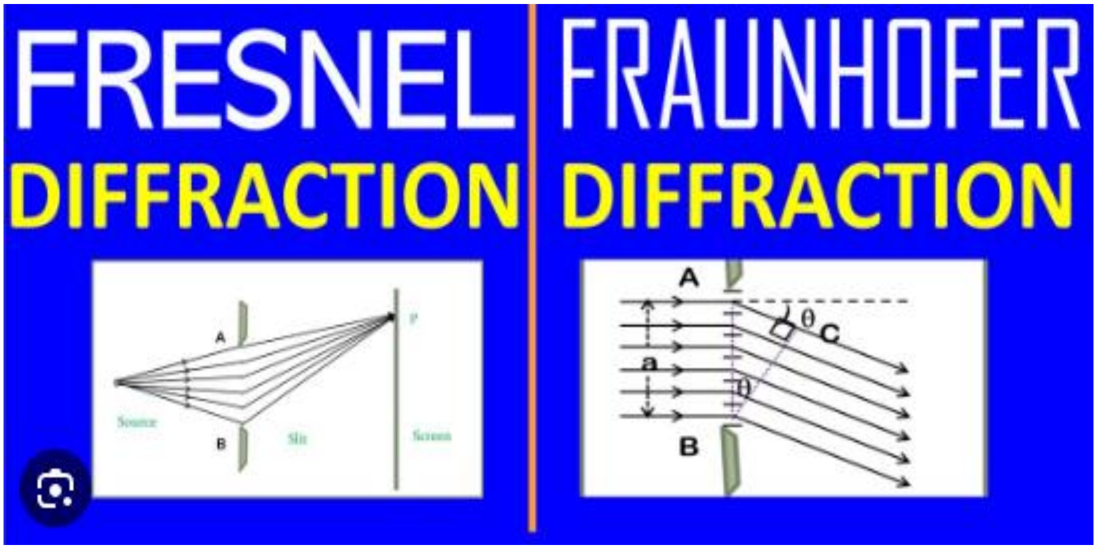
the Bending of light around corners such that it spreads out and illuminates regions is known as diffraction.

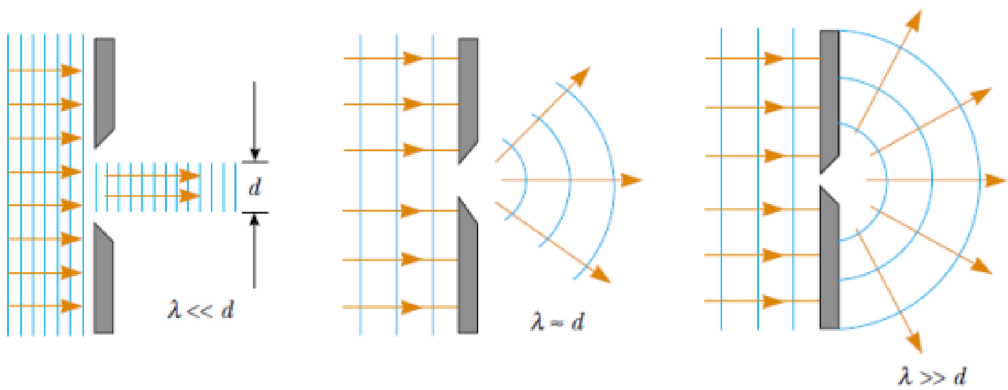
Types of Diffraction

We can categorise diffraction into two categories that are,

- Fraunhofer Diffraction: In this type of diffraction, the source of light and the screen are effectively at infinite distances from the obstacle
- Fresnel Diffraction: In this type of diffraction, the source of light and the screen are effectively at finite distances from the obstacle
- Wide small Diffraction
- Narrow gab Diffraction




FRESNEL DIFFRACTION
FRAUNHOFER DIFFRACTION
A
B
a
θ
C


d
λ << d
λ ≈ d
λ >> d