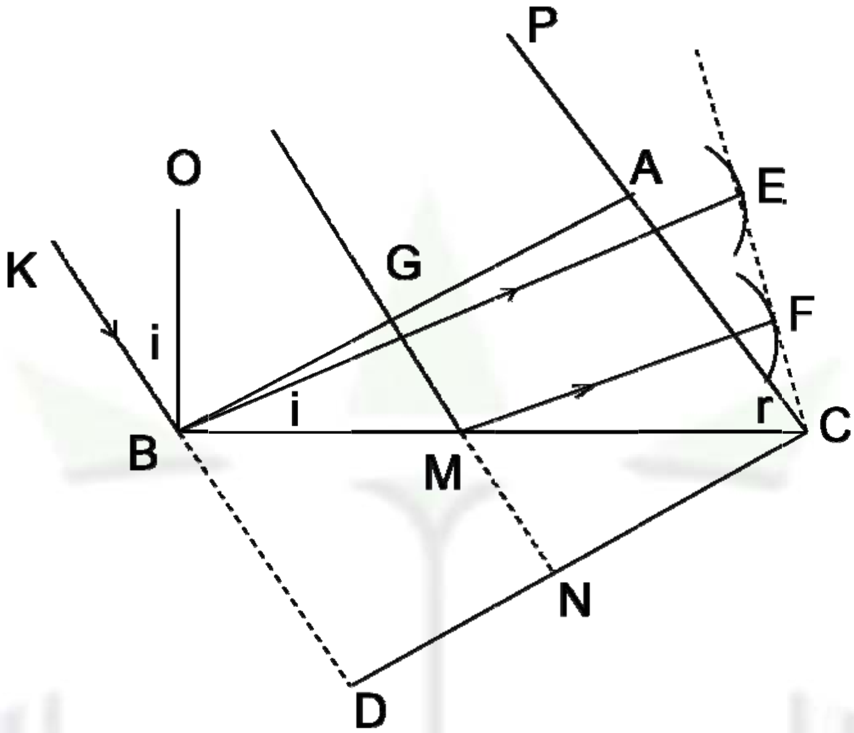
Explanation of the laws of reflection by wave theory:



BC = the section of the plane reflecting surface by the plane of the paper.

AB = the section of the incident plane wave front at an instant of time t=0, by the plane of the paper.

Both the plane incident wave front and the reflecting surface are perpendicular to the plane of the paper.

PA & KB are perpendicular drawn on the incident wave front AB hence they are the incident rays.

BO is normal drawn at B on the reflecting surface.

$$\angle KBO = i = \text{angle of incidence}$$

$$\angle OBA = 90^0 - i, \ \angle OBC = 90^0$$

$$\angle ABC = \angle OBC - \angle OBA = 90^0 - (90^0 - \mathrm{i}) = \mathrm{i}$$

Hence the angle of incidence can also be defined as the angle between the incident wave front and the reflecting surface. Similarly the angle of reflection can also be defined as the angle between the reflected wave front and the reflecting surface. Had there been no reflecting surface BC, the ray from G and B would have gone up to N and D respectively, during the time t in which ray from A goes up to C.

So that AC=GN=BD=v_0t ⟶ (1)

Hence CND would have been the wave front after time t. But due to the presence of the reflecting surface BC. Let the ray from B go up to E in time t

$$BE = v_0 t \longrightarrow (2)$$

With B as center and BE as radius we draw a sphere the section of which by the plane of the paper gives an arc of a circle. From C a tangent CE is drawn to this arc. Then a plane drawn through CE and perpendicular to the plane of the paper would represent the reflected wave front after time t provided the reflected wave front after time t provided we can show that ray from any other point G on the incident wave front also touches this plane through CE after time t.

From M, MF is perpendicular dropped on CE

ΔBEC and ΔMFC are similar

$$\therefore \frac{BE}{MF} = \frac{BC}{MC} \rightarrow (3)$$

ΔBDC and ΔMNC are similar

$$\therefore \frac{BD}{MN} = \frac{BC}{MC} \rightarrow (4)$$

From equation (3) and (4) : $\frac{BD}{MN} = \frac{BE}{MF} \rightarrow (5)$

Putting equation (1) and (2) in (5) we get

$$\frac{v_0 t}{MN} = \frac{v_0 t}{MF}$$

$$\therefore MN = MF$$

Hence time taken for the ray to go from M to F is same as that to go from M to N. Hence the ray goes from G to F (GM+MF) is same as to go from G to M (GM+MN) i.e. t sec.

Hence CFE is the reflected wave front after time t, using the definition of angle of reflection

$\angle ECB = r =$ The angle between the reflected wave front and reflecting surface.

We now prove the laws of reflection

In ΔBAC and ΔBEC

$\angle BAC = \pi/2 = \angle BEC$

$AC = v_0 t = BE$

BC is common to both. The $\Delta BAC \cong \Delta BEC$

$\therefore \angle ABC = \angle BCE$

i.e. i = r first law of reflection proved

From the mode of construction we find that the incident ray, reflected ray and normal all lie on the same plane i.e. plane of the paper.