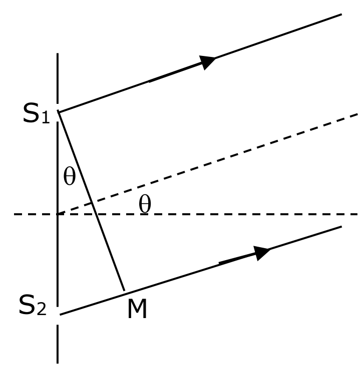
Q- In a location where the speed of sound is 354 m/s, a 2000 Hz sound wave impinges on two slits 30.0 cm apart.
(a) At what angle with the perpendicular bisector of the slits is the first maximum located?
(b) If the sound wave is replaced by a 3.00 cm microwave, what slit separation gives the same angle for the first maximum?
(c) If the slit separation is 1.00 micro-meter, what frequency of light gives the same angle for first maximum?

When a wave is passed through two slits, the two slits are behaving as coherent sources and the waves from the two slits will interfere.

The points at which the waves are reaching in same phase the resulting intensity is maximum. Same phase means a phase difference of $2n\pi$ or a path difference of $n\lambda$, where n is an integer.

The first maximum is corresponding to n = 1 and is located in the direction for which the path difference is λ.
Let the waves are received at an angle θ with the axis of the apparatus, then the path difference between the waves is given by S_2M and from the triangle this is given by

$$\delta = S_2M = S_2S_2 \sin\theta = d * \sin\theta$$



Here d is the distance between the slits

(a) For the first maximum to be located at this angle the path difference must be λ hence

$$d*\sin\theta = \lambda$$

Gives $\sin\theta = \lambda/d = (c/n*d) = (354 \text{ m/s})/(2000 \text{ Hz}*0.3 \text{ m}) = 0.59$ ……………….[$c = n\lambda$]

or **$\theta = 36.16^0$**

(b) Using the same relation

$$\sin\theta = \lambda/d = 0.59$$

Gives $d = \lambda/0.59 = 0.03 \text{ m}/0.59 = 0.0508 \text{ m}$

(c) using the same relation as in a) we have

$$\sin\theta = (c/n*d) = 0.59$$

Or $$\frac{3.0*10^8}{n*1.00*10^{-6}} = 0.59$$

Gives $$n = \frac{3.0*10^8}{0.59*1.00*10^{-6}} = 5.08*10^{14} \text{ Hz}$$