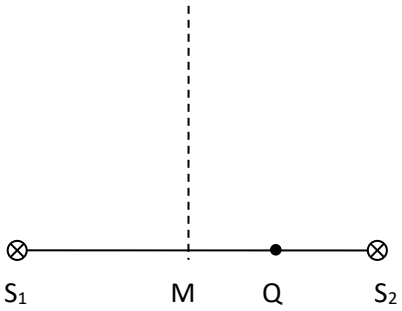
Teacher notes
Topic C

An instructive problem on interference

S_1 and S_2 are two sources of sound emitting identical waves in phase. The distance between the sources is 4.0 m.



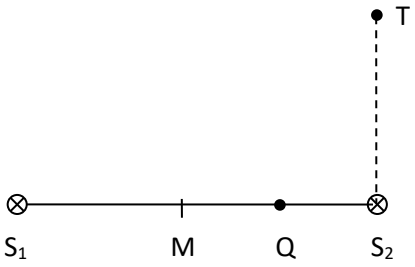
(i) The dotted line is the perpendicular bisector of the line joining the two sources. Explain what a sound sensor will record as it is moved along this dotted line.

(ii) Point Q is on the line joining the two sources. The path difference at Q is 2.0 m. Determine the distance S_1Q.

(iii) Point Q is a point of destructive interference. There is one point P of destructive interference between M and Q and one point R between Q and S_2. Determine the wavelength of sound.

(iv) State the distance between P and R.

(b) Point T is on a line perpendicular to the line S_1S_2 3.0 m from S_2.



(i) Determine what is observed at T.

(ii) Show that there is one point of destructive interference between T and S_2.

(iii) Calculate the path difference at this point.

Answers

(a)

(i) Waves from the sources arrive with zero path difference leading to constructive interference so a maximum in intensity will be observed.

(ii) $S_1Q - S_2Q = 2$ and $S_1Q + S_2Q = 4$, giving $S_1Q = 3.0\text{ m}$.

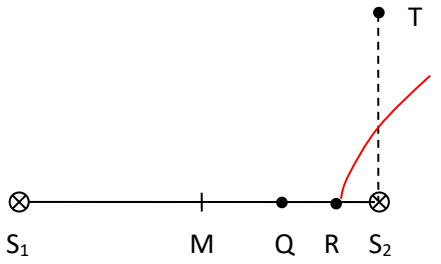
(iii) The path difference at Q is $(n+\frac{1}{2})\lambda$. Point P corresponds to n = 0 so Q corresponds to n = 1. Hence $(1+\frac{1}{2})\lambda = 2.0 \Rightarrow \lambda = \frac{4}{3} \approx 1.3\text{ m}$.

(iv) It is one wavelength, 1.3 m.

(b)

(i) The path difference at T is 5.0 – 3.0 = 2.0 m, the same as at Q, so we have destructive interference.

(ii) The red curve (hyperbola) is the collection of points with the same path difference as that at R. It marks one point on the line TS_2.



(iii) The path difference is the same as that at R i.e. $(2+\frac{1}{2})\lambda = \frac{5}{2} \times \frac{4}{3} \approx 3.3\text{ m}$.