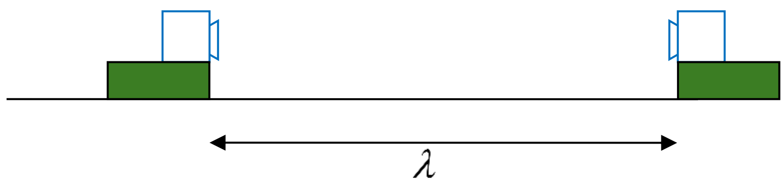
Teacher notes
Topic C

A problem inspired by the M2026 exam

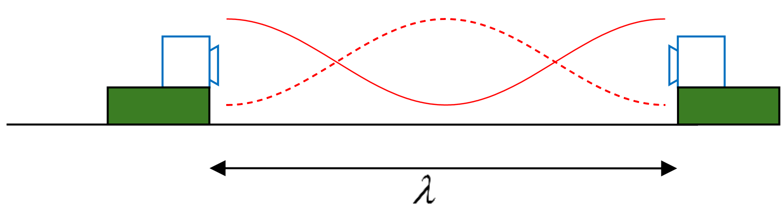
Two sources emitting waves in phase of wavelength λ are placed a distance λ apart, facing each other.



How many points of destructive interference are there along the line joining the two sources?

A similar problem was discussed in Teacher Notes 319 on this website. The problem can be viewed using interference or standing waves. This was the point of Note 319.

The easy way is to look at this from the point of view of standing waves. We have antinodes at the sources so this resembles standing waves in an open-open pipe. Since the distance between the sources is a wavelength, the pattern must be (the second harmonic):



There are two nodes so there are two points of destructive interference. They occur at points a distance $\frac{\lambda}{4}$ and $\frac{3\lambda}{4}$ from the left source.

Looking at this from the point of view of interference also gives the right answer but it is much trickier.
Consider a point on the line joining the sources a distance *x* from the left source. A wave arrives at this point from the left source having travelled a distance *x* and a second wave arrives from the right source having travelled a distance $\lambda - x$. The two waves will interfere. The path difference is $x-(\lambda - x) = 2x-\lambda$. We will have destructive interference if

$$2x-\lambda = (n+\frac{1}{2})\lambda$$

This gives

$$x = (n-\frac{1}{2})\frac{\lambda}{2}$$

The tricky part is to note that $0 < x < \lambda$ (otherwise we might be led into thinking that an infinite number of points exists where destructive interference takes place).

This constraint implies:

$$(n-\frac{1}{2})\frac{\lambda}{2} > 0 \qquad (n-\frac{1}{2})\frac{\lambda}{2} < \lambda$$

$$n-\frac{1}{2} > 0 \qquad \text{and} \qquad n-\frac{1}{2} < 2$$

$$n > \frac{1}{2} \qquad n < \frac{5}{2}$$

But *n* is an integer, so $n=1$ or $n=2$.

These values give the positions of destructive interference:

$$x = \begin{cases} \dfrac{\lambda}{4} & \text{for } n=1 \\ \dfrac{3\lambda}{4} & \text{for } n=2 \end{cases}$$

Looking at the last diagram, these are exactly the points we found with substantially less effort using standing waves.