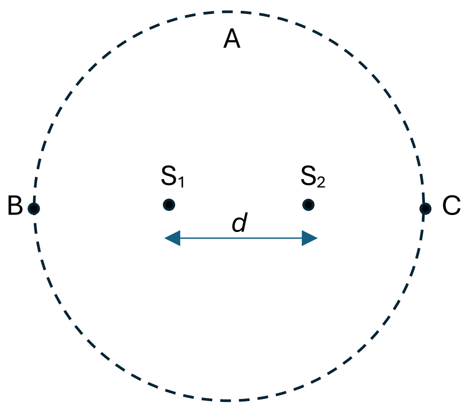
Teacher notes
Topic C

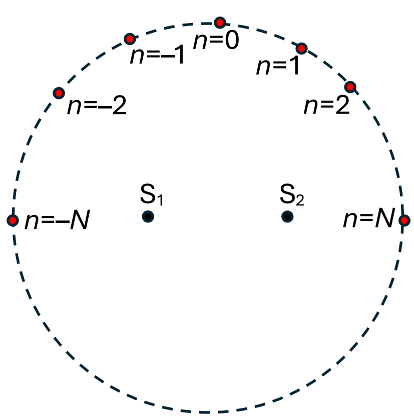
An extension of problem 14.32 in the textbook.

Two sources S_1 and S_2 emit identical waves in phase. The distance *d* between the sources is $d = N\lambda$ where λ is the wavelength. How many maxima are observed along a circle centered at the midpoint of the line joining the sources?

The path difference at a point P on the circle is $\Delta r = S_1P - S_2P$. A maximum is observed when this path difference is equal to an integral multiple of the wavelength: $\Delta r = n\lambda$. The maximum magnitude of the path difference is observed when P is at B or C. It equals $|S_1B - S_2B| = |S_1C - S_2C| \left(R + \dfrac{d}{2}\right) - \left(R - \dfrac{d}{2}\right) = d$ where *R* is the irrelevant circle radius.

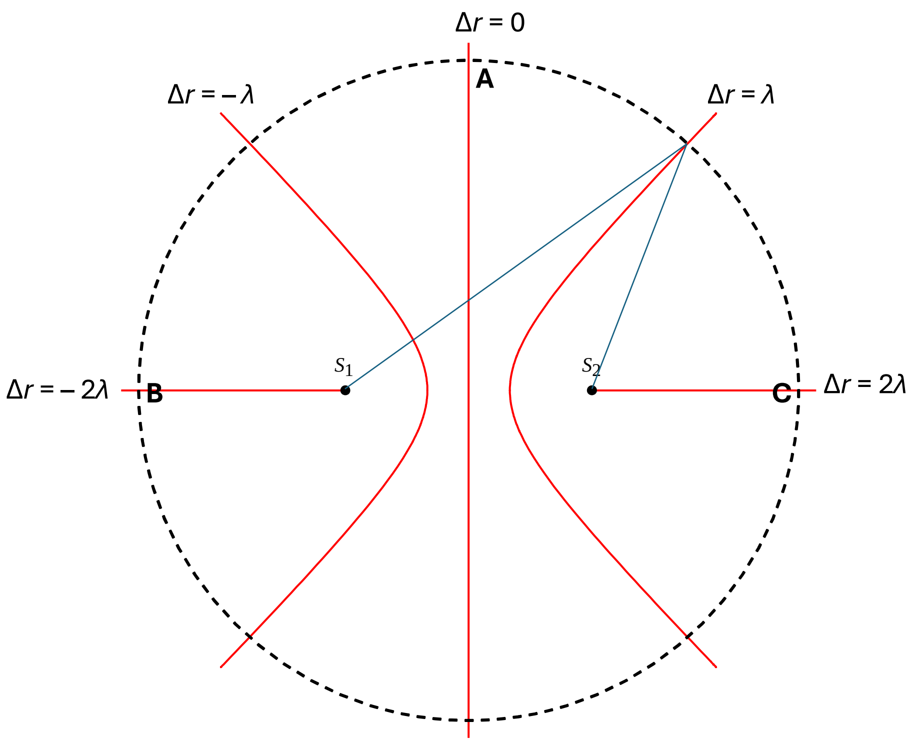


Since this is the maximum possible path difference we have that $|\Delta r| = |n|\lambda \le d$. Since $d = N\lambda$ we then have $|n|\lambda \le N\lambda$ and so $|n| \le N$. Hence $n = -N,\ -(N-1), \cdots,\ -1,\ 0,\ 1, \cdots, (N-1),\ N$, i.e. $2N+1$ values.



Including the symmetrical points in the lower half of the circle, this means that we have a total of $(2N+1)+(2N+1)-2=4N$ points on the circle where maxima are observed. (The -2 corrects for the double counting of the maxima at $n=\pm N$.)

This is illustrated below for the case N = 2, i.e. $d=2\lambda$. The red lines and curves (hyperbolas) are lines of constant path difference.



We see that there are 8 points where maxima are observed, consistent with the general result: 4N = 4×2 = 8.

In the textbook problem we had $d=5\lambda$ and so 20 maxima.