Lesson 52: Interference from Two Point Sources

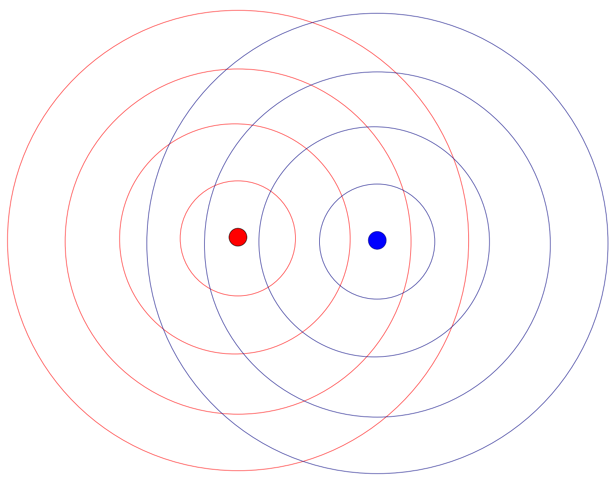
We can actually learn a lot about individual waves by looking at how they interact with other waves.

- You have already seen this, in examples of superpositioning.
- Another way is to look at how two sources of waves can create complex patterns of waves, and how those patterns form and repeat.

We will start off with two separate point sources making waves in-phase.

- In-phase just means that, even though they are separate, they are doing the same thing at the same time.
    - For example, as one of the sources is making a crest, the other source is also making a crest.
    - The two sources will also be creating waves that are identical in wavelength, frequency, velocity, and amplitude.

Look at how the crests and troughs of the waves produced by the two point sources interact in the following diagram.



Drawing 1: Top view of the wave trains created by two point sources.

- You'll notice that the two point sources are exactly the same in every way, and that their waves cross over each other in a very regular pattern.
- What we must examine is the way that the crests and troughs pass each other to cause either constructive or destructive interference.

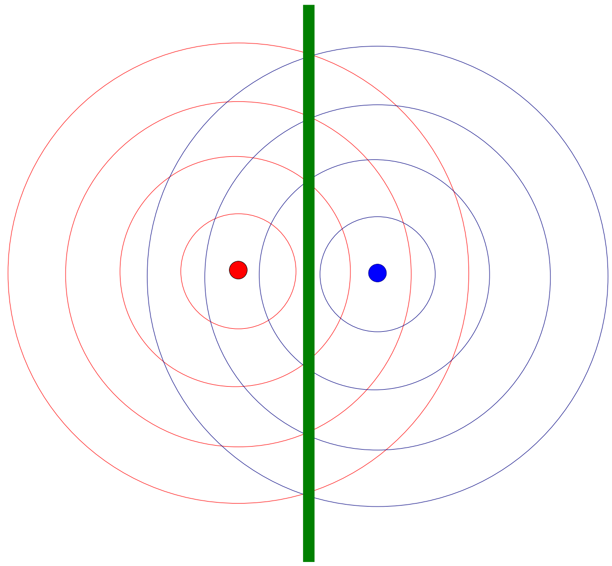
Central Maximum

The easiest section to spot happens straight down the middle between the two point sources.

- If we draw a line down the middle between them, we find that all along the line **crests from one point** exactly overlap **crests from the other point**.
- The same can be said for the troughs.
- What we get here is a perfect case of **constructive interference**.
    - The crests will be really tall.
    - The troughs will be very deep.
- The crests and troughs created by each point source have to travel exactly the same distance to

get to any location along this line, which is why they always arrive in-phase (crest-to-crest or trough-to-trough) with each other.

- Because of this perfect alignment of maximum crests and troughs, this line is called the **central maximum**.

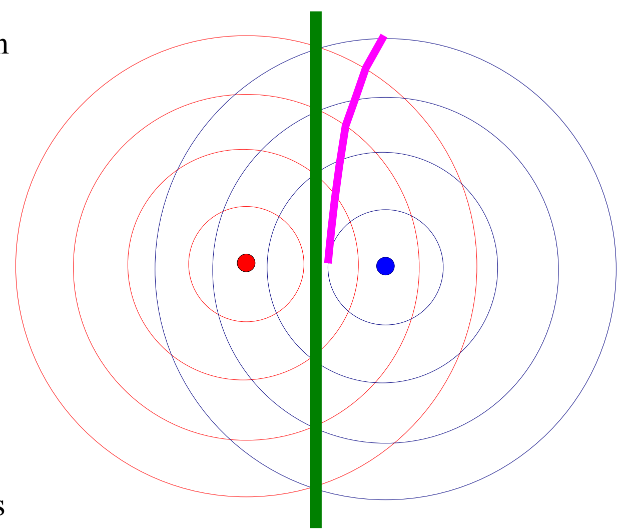


Drawing 2: Central maximum.

Minimal Lines

If we go just a little bit (to either side) of the **central maximum**, we see a very different interaction between the waves from the two point sources.

- If we were to look, for example, just a little to the right of the **central maximum**, we can see the **crests from one point** meet the **troughs from the other**.
  - The **troughs from one** meet the **crests from the other** also.
- All along this line the crests meeting troughs will cause **destructive interference**. Since the amplitudes were the same, we can expect that the interference will be perfect and result in ***no*** wave visible along this line.
- Since there is no wave seen along this line, it is called a **minimum line** (or **nodal line**).



Drawing 3: A minimum, or nodal, line.

Other Maxima and Minima Lines

If we kept on going outwards from the central maximum, we would find another line we could draw that again has **crests** meeting **crests** and **troughs** meeting **troughs**.

- This would create more waves that had really big crests and troughs.
- The difference is that they are no longer along the **central maximum**, so we would call them by names that are “orders.”

        - As the order number increases, you are further away from the **central maximum**.
- So, just off to the side of the **minimum line** described above, we would find the **first order maximum** (first out from the **central maximum**).
- As we go further outwards, we would find another line along which **crests** meeting **crests** and **troughs** meeting **troughs** again, and this would be the **second order maximum**.
- And so on, and so on...

In between the **maxima** we would also find a repeat of the crests meeting troughs.

- This would result in more **destructive interference** creating **minima** lines.
- This pattern would continue as we move out from the **central maximum**, alternating between **maxima** and **minima**.

The plural form of **maximum** is **maxima**, and the plural of **minimum** is **minima**.

If the waves being produced by the two point sources are not exactly the same, then these **maxima** and **minima** can start to have very complicated patterns.

- By analyzing these complex patterns, often using a computer, scientists can make predictions about the original waves that were involved.
- Seismologists use these sort of methods when analyzing the waves created in the earth during earthquakes.
    - The waves reflect, refract, and diffract because of the different layers of the Earth and then interact with each other.
    - The analysis can tell us things about the earthquake and the structure of the Earth itself.