Wave Interference

When two waves meet, we find that they pass through each other and keep moving. While passing through each other, the amplitudes of the waves are affected. This behavior is known as wave **interference**, and is the second wave behavior that we will discuss.

When two waves occupy the same space at the same time, we call it **superposition**, and we say that the waves are superimposed. When waves are superimposed, the medium will take on a sort of combined shape. The **principle of superposition** allows us to determine what this shape would look like.

The **principle of superposition** says that when two waves are superimposed, the amplitude of the resulting wave is the algebraic sum of the amplitudes of the two waves. Crests are considered to be positive amplitudes, while troughs are negative amplitudes.

Constructive interference occurs when two waves are superimposed in such a way as to result in a wave with a larger amplitude than the original waves. In general, this will occur when two crests interfere, or when two troughs interfere.

Destructive interference occurs when two waves are superimposed in such a way as to result in a wave with a smaller amplitude than the original waves. In general, this will occur when a crest and a trough interfere.

One of the most interesting things about wave interference is that, after two waves have crossed paths, they will separate and continue on their way, completely unchanged by the event.
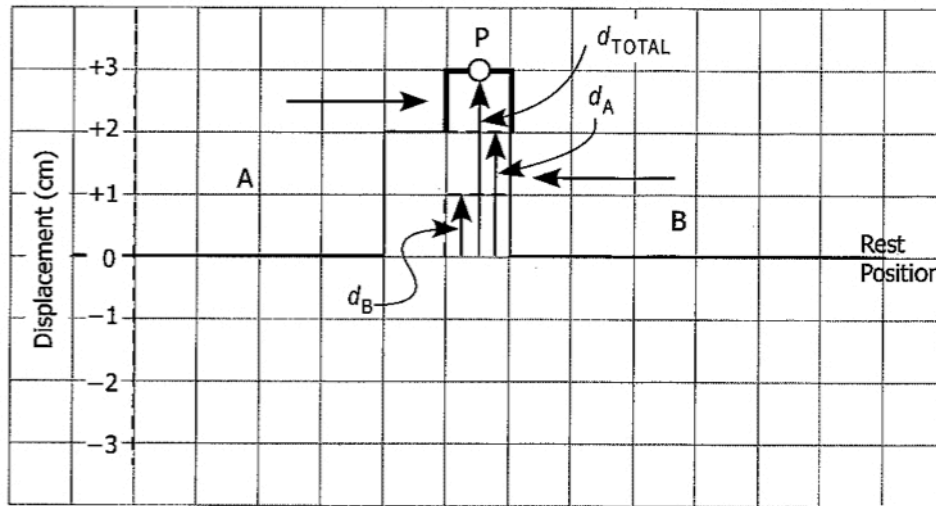
Superposition and Constructive Interference

The diagram below shows two square pulses approaching each other on a spring.
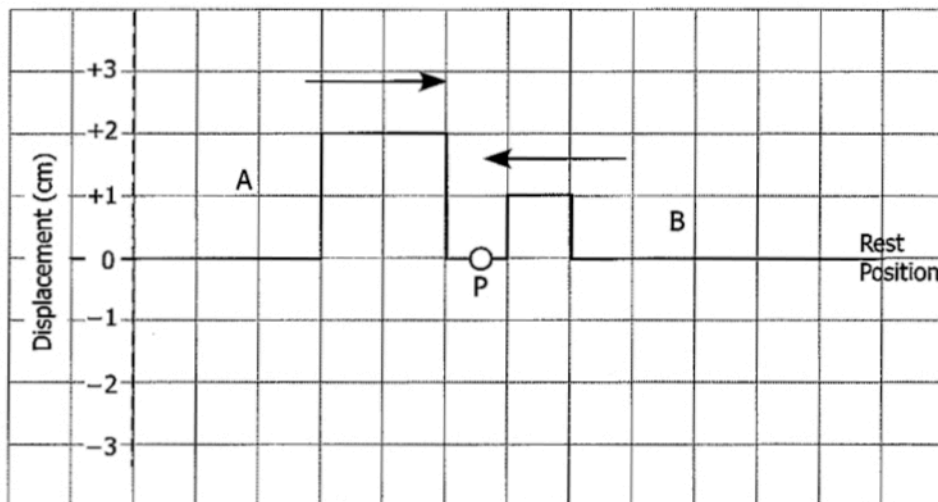

The amplitude of pulse A is +2 and the amplitude of pulse B is +1.

At a later moment in time, the pulses cross paths, as shown below.

Using the principle of superposition, we add the displacements for pulse A and pulse B to give the total displacement for point P. Other points around point P where the waves overlap can also be considered. Once enough points have been considered, you should have a clear picture of what the resulting wave would look like.

The wave that results from pulse A and pulse B interfering has the following shape.
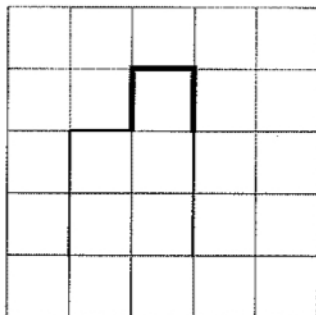

The **resultant wave** represents the total wave that results when two waves overlap and interfere with each other.
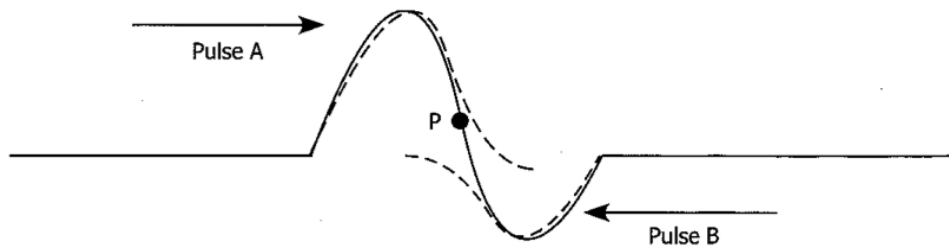
Two waves that interfere to produce a larger amplitude than would be produced by either wave is called **constructive interference**.

Superposition and Destructive Interference

The diagram below shows pulses A and B approaching each other on a spring.
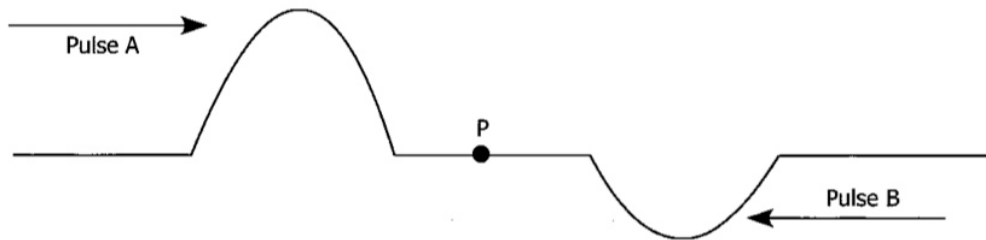
The series of diagrams below shows what happens to the point P as pulses A and B interfere with each other.


At the moment shown above, pulse A displaces the point P up 8 mm and pulse B displaces the point down 3 mm. The resultant displacement of the point P is up 5 mm.

In the next diagram, the pulses are directly on top of each other.
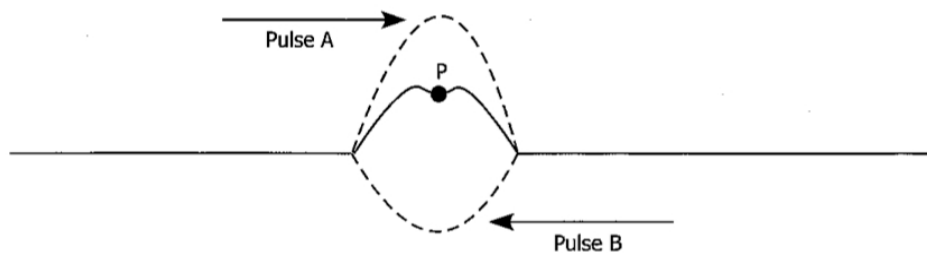
In this diagram, point P is displaced up 20 mm by pulse A and down 12 mm by pulse B, for a net displacement of 8 mm down.

The final diagram shows the pulses after they have nearly passed through each other.
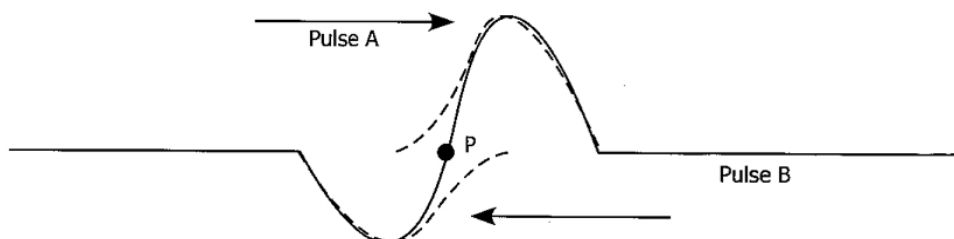
In this diagram, the upward displacement by pulse A (+9 mm) is cancelled by the downward displacement of B (–9 mm).

After the waves have passed through each other, they continue on exactly as they had been before interference occurred.