Displacements in opposite directions produce destructive interference

What happens if the pulses are on opposite sides of the equilibrium position, as they are in **Figure 17(a)**? In this case, the displacements have different signs, one positive and one negative. When the positive and negative displacements are added, as shown in **Figure 17(b)** and **(c),** the resultant wave is the difference between the pulses. This is called **destructive interference.** After the pulses separate, their shapes are unchanged, as seen in **Figure 17(d).**

destructive interference

a superposition of two or more waves in which individual displacements on opposite sides of the equilibrium position are added together to form the resultant wave

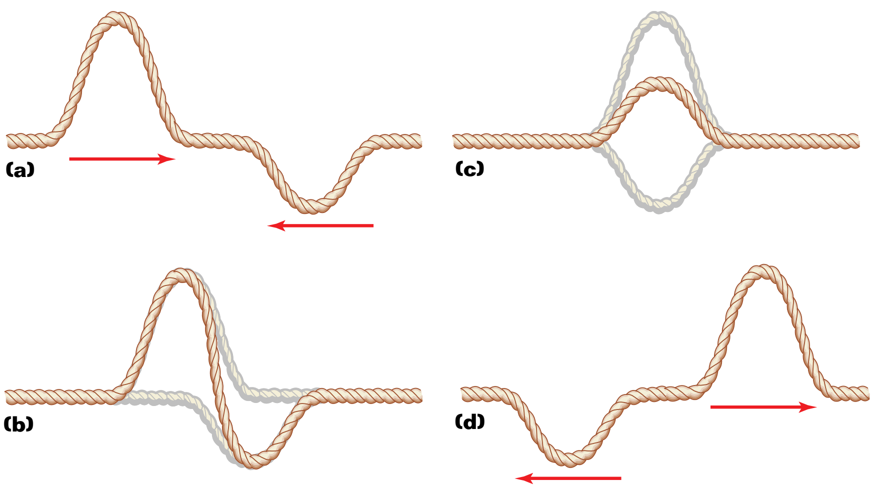

Figure 17
In this case, known as destructive interference, the displacement of one pulse is subtracted from the displacement of the other.

Figure 18 shows two pulses of equal amplitude but with displacements of opposite signs. When the two pulses coincide and the displacements are added, the resultant wave has a displacement of zero. In other words, at the instant the two pulses overlap, they completely cancel each other; it is as if there were no disturbance at all. This situation is known as *complete destructive interference.*

If these waves were water waves coming together, one of the waves would be acting to pull an individual drop of water upward at the same instant and with the same force that another wave would be acting to pull it downward. The result would be no net force on the drop, and there would be no net displacement of the water at that moment.

Thus far, we have considered the interference produced by two transverse pulse waves. The superposition principle is valid for longitudinal waves as well. In a *compression,* particles are moved closer together, while in a *rarefaction,* particles are spread farther apart. So, when a compression and a rarefaction interfere, there is destructive interference.

In our examples, we have considered constructive and destructive interference separately, and we have dealt only with pulse waves. With periodic waves, complicated patterns arise that involve regions of constructive and destructive interference. The locations of these regions may remain fixed or may vary with time as the individual waves travel.

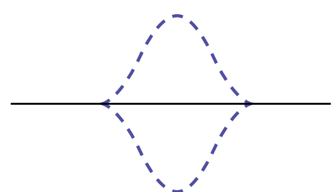

Figure 18
The resultant displacement at each point of the string is zero, so the two pulses cancel one another. This is complete destructive interference.