Displacements in the same direction produce constructive interference

In **Figure 16(a),** two wave pulses are traveling toward each other on a stretched rope. The larger pulse is moving to the right, while the smaller pulse moves toward the left. At the moment the two wave pulses meet, a resultant wave is formed, as shown in **Figure 16(b).**

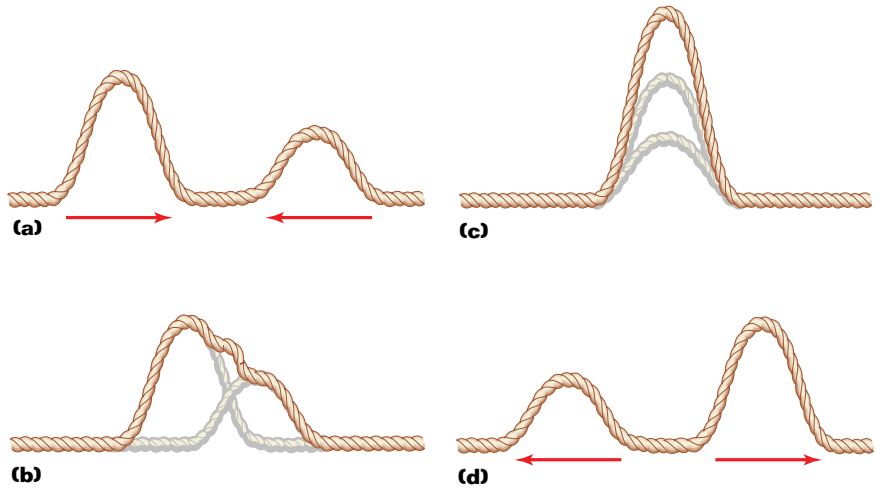

Figure 16
When these two wave pulses meet, the displacements at each point add up to form a resultant wave. This is an example of constructive interference.

At each point along the rope, the displacements due to the two pulses are added together, and the result is the displacement of the resultant wave. For example, when the two pulses exactly coincide, as they do in **Figure 16(c),** the amplitude of the resultant wave is equal to the sum of the amplitudes of each pulse. This method of summing the displacements of waves is known as the *superposition principle.* According to this principle, when two or more waves travel through a medium at the same time, the resultant wave is the sum of the displacements of the individual waves at each point. Ideally, the superposition principle holds true for all types of waves, both mechanical and electromagnetic. However, experiments show that in reality the superposition principle is valid only when the individual waves have small amplitudes—an assumption we make in all our examples.

Notice that after the two pulses pass through each other, each pulse has the same shape it had before the waves met and each is still traveling in the same direction, as shown in **Figure 16(d).** This is true for sound waves at a concert, water waves in a pond, light waves, and other types of waves. Each wave maintains its own characteristics after interference, just as the two pulses do in our example above.

constructive interference

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

You have seen that when more than one wave travels through the same space at the same time, the resultant wave is equal to the sum of the individual displacements. If the displacements are on the same side of equilibrium, as in **Figure 16,** they have the same sign. When added together, the resultant wave is larger than the individual displacements. This is called **constructive interference.**