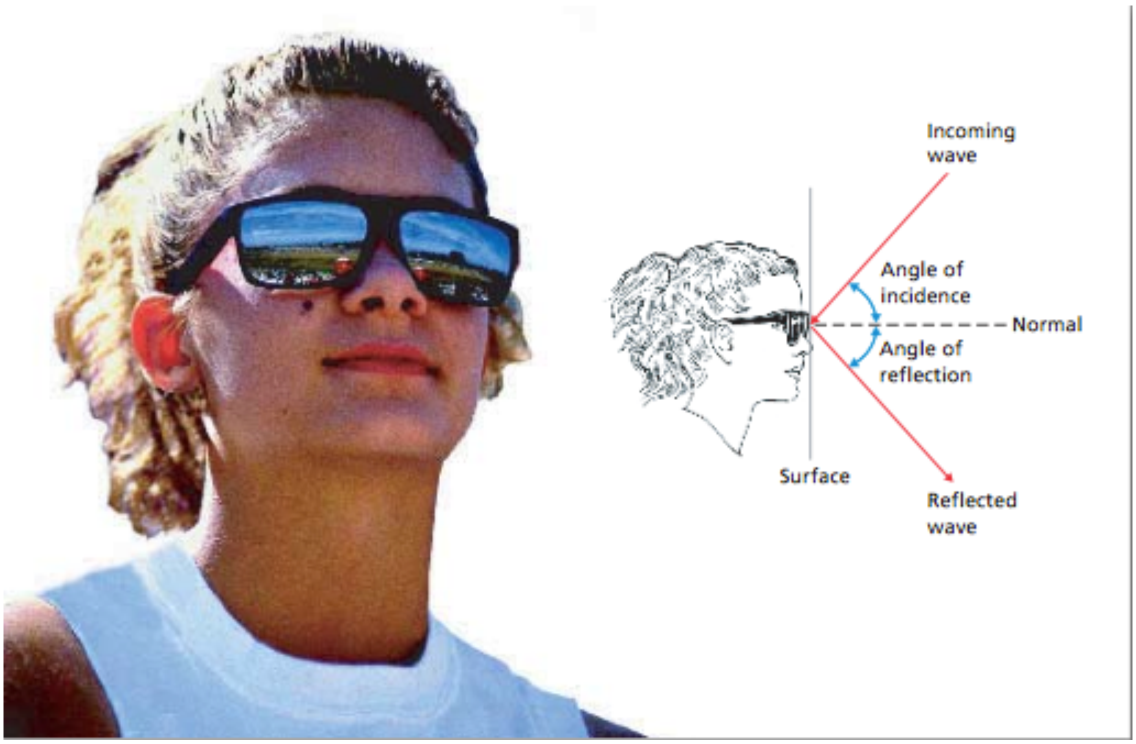
Interactions of Waves

It is a hot, sunny day. You are the first person to enter the calm water of the swimming pool. To test the temperature of the water, you dip one foot in first. Your foot causes a series of ripples to travel across the water to the far wall of the pool. As each ripple hits the wall, it bounces off the wall and travels back toward you.



Reflection

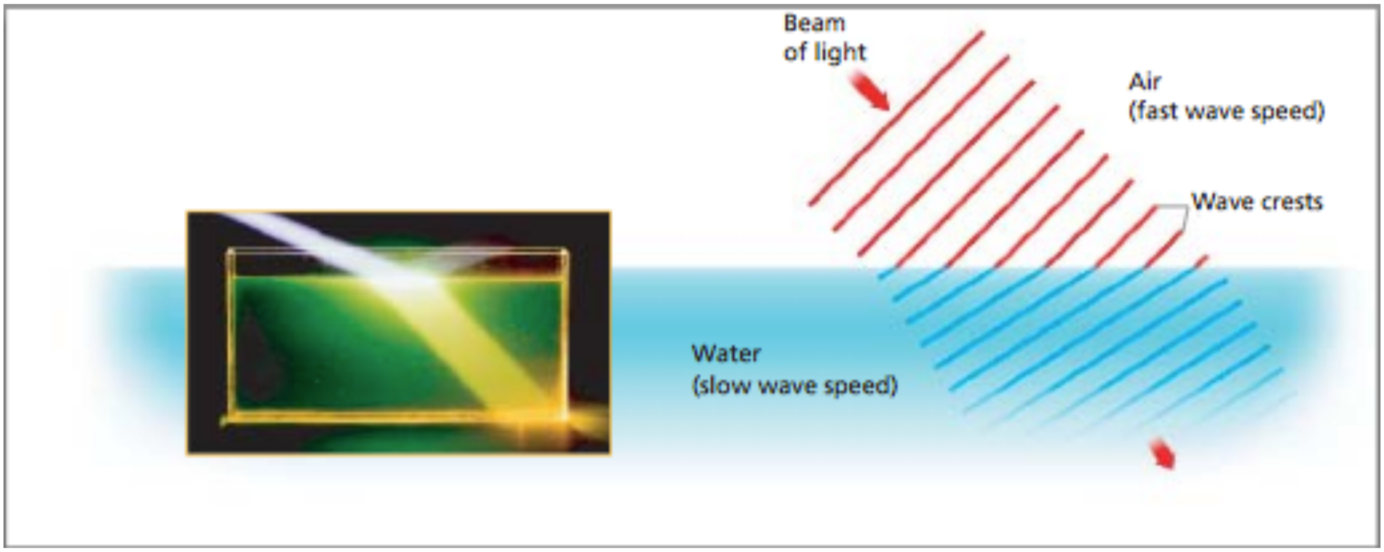
When water waves hit the side of a swimming pool, they bounce back. When an object or wave hits a surface though which it cannot pass, it bounces back. This is called reflection.

To show reflection of a wave, draw a line to represent a surface. Draw another line to show a wave moving toward the surface at an angle. No imagine a line perpendicular to the surface. The angel of incidence is the angle between the incoming wave and the imaginary perpendicular line. The angle of wave and the imaginary perpendicular line. The angle of reflection is the angle between the reflected wave and the imaginary line. The law of reflection states that the angle of reflection equals the angle of incidence. All wave obey the law of reflection.

There are many examples of reflection in your everyday life. A ball that hits a wall bounces back, or is reflected. When you look in a mirror, you use reflected light to see yourself. An echo is an example of reflected sound.

Refraction

Perhaps you have tried to grab a sinking object when you are in a swimming pool, only to come up empty-handed. Yet you were sure you grabbed right where you saw the object. You missed grabbing the object because the light rays from the object changed direction as they passed from the water into the air. The bending of waves due to a change in speed is called refraction.



Diffraction

Sometimes waves can bend around an obstacle in their path. For example, waves can pass through a narrow entrance to a harbor and then spread outside the harbor. Figure 10 shows water waves diffracting as they enter a harbor.

When a wave passes a barrier or moves through a hold in a barrier, it bends and spreads out. The bending of waves around the edge of a barrier is known as diffraction. Figure 11 shows a water wave passing through a hold in a barrier and another bending around a barrier. In each case, you see the wave diffracting on the other side of the barrier.

Interference

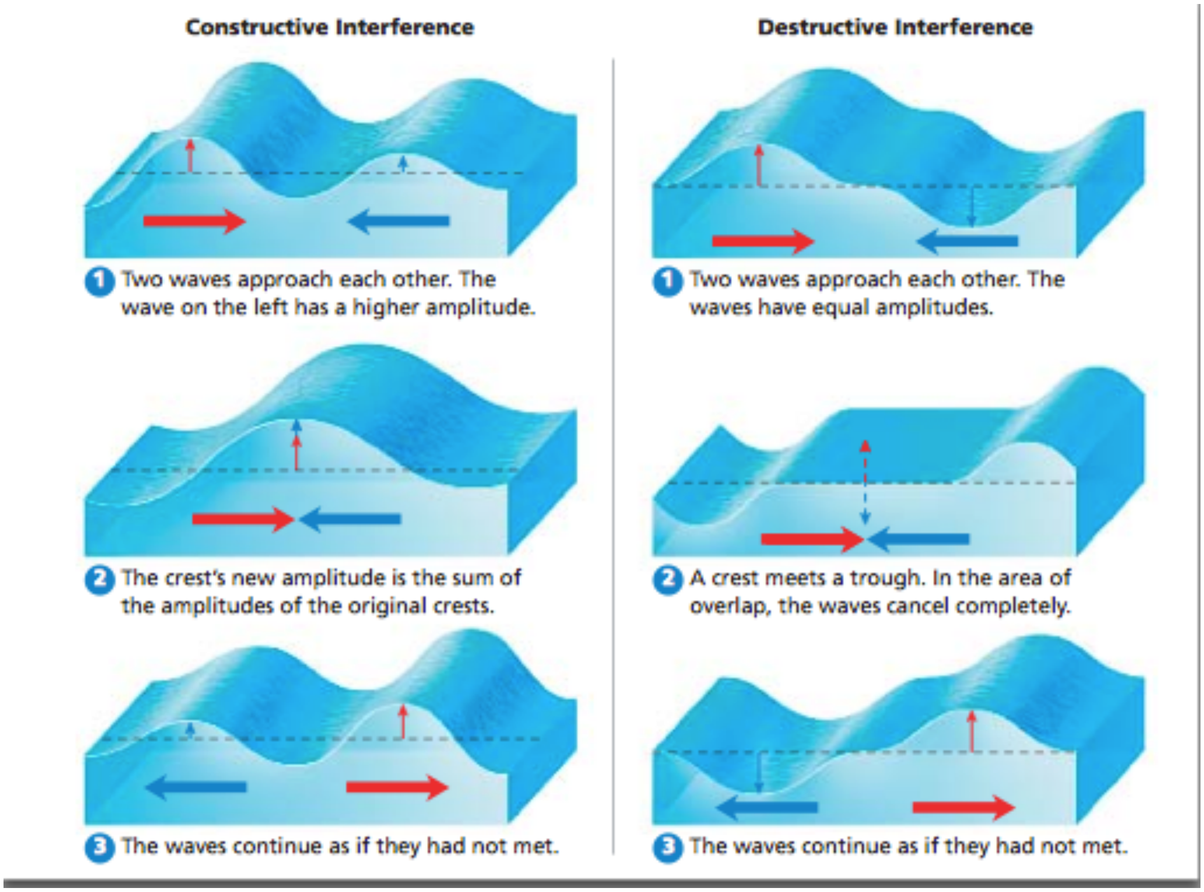
Suppose that you and a friend are each holding one end of a rope. If you both flick the ends at the same time, you send two waves towards each other. What will happen when those two waves meet?

When two or more waves meet, they have an effect on each other. This interaction is called interference. There are two types of interference: constructive and destructive.

Constructive Interference Constructive interference occurs whenever two waves combine to make a wave with a larger amplitude. You can think of constructive interference as waves "helping each other" to give a stronger result, or combining energy.

Figure 12A shows two identical waves (same amplitude, same wavelength) traveling in the same direction at the same time. If the two waves travel along the same path at the same time they will behave as one. What will the combined wave look like? The crests of the firs wave will occur at the same place as the crest of the second wave. The energy from the two waves will combine. Thus the amplitude of the new wave will be twice the amplitude of either of the original waves.

If the waves have the same wavelength but different amplitudes, the crest will still occur at the same place and add together. The resulting amplitude will be the sum of the two original amplitudes. Similarly, the troughs will occur together, making a deeper trough than either wave alone.



Destructive Interference

When the amplitudes of two waves combine with each other producing a smaller amplitude, the result is called destructive interference. What happens if the crest don't meet at the same place? In this case, one wave comes after the other. Figure 12B shows what happens when the crests of the first wave occur at the same place as the troughs of the second wave. The amplitude of the first wave cancels out the amplitude of the second wave. This type of interference produces a wave with amplitude of zero. The original waves seem to be destroyed. If the two waves have different amplitudes, they will not cancel each other out but will combine to produce a wave with a smaller amplitude.

Two identical waves can travel along the same path, one a little behind the other. When this happens, the waves combine constructively in some places and destructively in others.