



The Shape of Speed

As a duck moves slowly across a pond, a wave expands out into the water. If the duck moves fast enough, it will catch up to the wave and build up a wall of water called a bow wave. Such cone-shaped waves are familiar sights in front of boats as well, but they can also be formed when objects move rapidly through air or even interstellar space. If the objects move faster than the speed of the waves that they produce in their liquid or gas environments, a cone-shaped compression called a bow shock is formed.

Core concept: A bow wave is a v-shaped wall of water formed in front of a boat moving faster than the surrounding waves.

Exhibit connections: Bow Waves - Panel 1

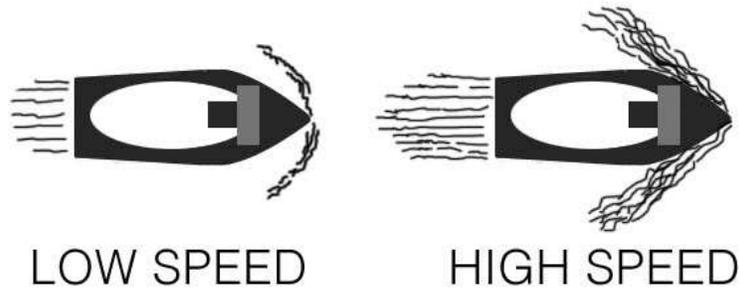
Materials: wave tank (window box), water, small boats, image of swimmer creating a bow wave, image of bulbous bow of ship, image of Zeta Ophiuchi

Suggestions for introducing the activity:

Ask visitors if they have seen a water bug skirting across a pond, kayaks or canoes moving swiftly across a calm lake or dolphins riding the waves of large boats. If so, they've probably witnessed a bow wave. These walls of water can be created when an object - or living thing moves quickly through the water. Ask visitors to observe the image of a bow wave created by a swimmer. How might this wave help their movement through the water? Swimmers can generate bow waves as they move through the water. The shape of the wave actually creates a trough on either side of the swimmer's head which is beneath the surface level of the pool. Using these pockets of air to breathe allows a swimmer to keep their head lower in the water, ultimately increasing their speed.

Procedure:

To demonstrate the shape of a bow wave, ask a visitor to slowly pull the small boat the length of the tank using the handle attached to the string, What do they observe? What does the pattern of waves created by this movement look like? Visitors should notice small circular waves. Now ask the visitor to pull the boat through more quickly? What happens to the shape of the wave in front of the boat? When the boat moves quickly through the water the circular waves transition to a V shaped wave in front of the boat. Visitors can continue to experiment with the size of bow waves using different size boats, different shaped bows and even varying the depth of the water in the tank.



Discussion/Questions for visitors to consider:

Ask visitors to view the image of a bulbous bow on a ship. Why have shipbuilders created this shaped bow? Because bow waves decrease the speed of a ship, bulbous bows were invented to change the flow of water around the hull, which reduces drag and increases the speed of the ship.

This phenomenon can also occur in media other than water. Shock waves (and their accompanying sonic booms) can be observed when a plane travels through air faster than the speed of sound, sometimes referred to as going through the sound barrier. Instead of the V-shaped wave seen with the boat, shock waves are cone shaped (think of an ice cream cone).

Show visitors an image of Zeta Ophiuchi taken by the WISE space telescope in infrared light. Zeta Ophiuchi is actually a very massive, hot, bright blue star plowing its way through a large cloud of interstellar dust and gas. In this image, the runaway star is flying from the lower right towards the upper left. As it does so, its very powerful stellar wind is pushing the gas and dust out of its way. And directly in front of the star's path the wind is compressing the gas together so much that it is glowing extremely brightly (in the infrared), creating a bow shock.