

LESSON PLAN – Liquid Energy

Academic Subject: Physics, physical science

Academic Topics: Waves, sound, sonic booms

Background: Dallas Friday is considered the number one female wake-boarder in the world. In order to do some serious stunts on her board, she needs some serious waves. Not just any boat can create the desired waves – a wake boarder never holds onto a rope pulled by a slow-moving barge. Why is the lightweight, powerful speedboat the only boat that will do?

Discussion: All waves are caused by a disturbance and transfer energy from one location to another. Throwing a rock into a pond disturbs the water and clapping one's hands disturbs the air molecules around them. All mechanical waves require a medium to travel through, and how the particles in the medium move when the wave passes through classifies what type of wave it is.

A transverse wave can be created using a slinky stretched out between two students. If one student flicks his/her wrist, energy will be transferred along the slinky to the other student. As this wave of energy travels horizontally, the slinky moves up or down – in a direction perpendicular to the direction of the wave. Points of maximum amplitude are called crests and points of minimum amplitude are labeled troughs. Water waves are an example of transverse waves.

A longitudinal wave can be created when one student gathers up several coils and then releases them towards the other student. Now the motion of the slinky is in the same direction as the wave. The gathered up coils represent an area of high pressure known as a compression. Right in front of the compression is an area of low pressure known as a rarefaction. Sound is an example of a longitudinal wave.

When a boat travels through water transverse waves build up in front of it creating a wave barrier. (How fast a wave can travel depends on the medium through which it moves.) A powerful speedboat is capable of going faster than the waves it creates and breaking through the wave barrier. When this occurs, the older waves created combine with the current waves being produced. When two or more waves meet they undergo interference. Constructive interference occurs when two crests meet and the result is an even bigger wave. The waves that pile up behind the boat are called shock waves. Shock waves are the key ingredient to wakeboarding.

Similarly, as a jet travels through the sky sound waves build up in front of it forming a sound barrier. The speed of sound in air is approximately 340 m/s, which is a difficult speed to overtake. Jets capable of traveling faster than this can break the sound barrier and build up shock waves behind them. When shock waves created by a speedboat reach an observer nearby, he/she experiences a high-pressure area of water in the form of a

splash. The shock waves created by the jet affect an observer the same way. The high-pressure sound that hits the observer is known as a sonic boom.

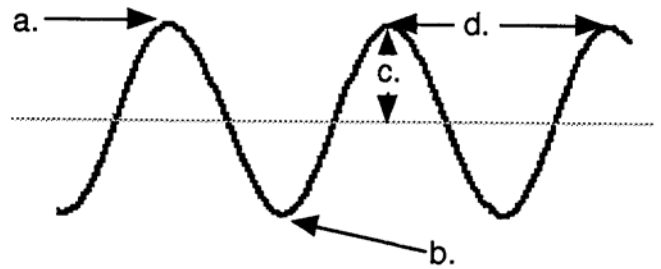
Extending the Lesson:

Use a slinky to demonstrate various properties of waves. Ask for a volunteer to make a transverse wave and a longitudinal wave. Create a series of pulses and show that as frequency increases wavelength decreases. Demonstrate interference by sending two pulses down the slinky from opposite ends.

ACTIVITY SHEET

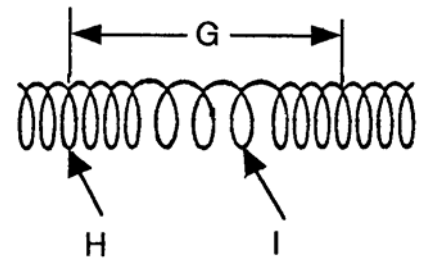
1. Tugboats tug many things. Why are they never used to tug along a wake-boarder?

2. The illustration to the right shows a wave. Label each part in the space below:



- a. _____
- b. _____
- c. _____
- d. _____

3. The following questions refer to the diagram to the right:



- a. Is this wave transverse or longitudinal?
- b. Letter H represents a _____
- c. Letter I represents a _____
- d. Letter G represents a _____

4. Cracking a whip is an example of a sonic boom. Since the speed of sound in air is 340 m/s, what does this tell you about the speed of the tip of the whip?

ANSWERS

1. A tugboat will not go fast enough to break the wave barrier of the waves it creates. No shock waves will pile up behind it.

2. a. crest b. trough c. amplitude d. wavelength
3. a. longitudinal b. compression d. rarefaction e. wavelength
4. The tip of the whip is traveling faster than 340 m/s.