STEM Sims™

Ship Tracking

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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Start learning right now about how port security managers analyze acoustic waves from ships to determine the type and movement of the ships. Take the following brief quiz to see how much you already know about acoustic wave analysis. See the bottom of page 4 to check your answers.

1. Some submarines emit animal sounds to evade passive sonar.
   a. true
   b. false

2. Hydrophones can record sounds above water, and microphones can record sounds below water.
   a. true
   b. false

3. Marine shipping traffic in the Indian Ocean can be tracked as far away as South Africa.
   a. true
   b. false

4. Passive sonar in ports can detect the sounds made by scuba divers.
   a. true
   b. false

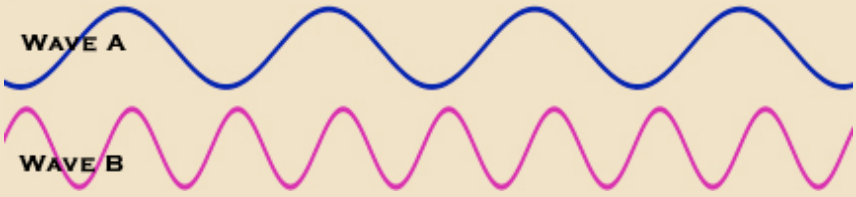
5. Whales in the northern Pacific Ocean off the coast of Washington can be tracked using sonar hydrophones located in the Hawaiian Islands.
   a. true
   b. false

Doing the Wave

Two important characteristics of waves are their frequency and amplitude. You can tell the difference between sound waves of different frequencies by their pitch. The greater the value of the wave's frequency, the higher the sound's pitch. A larger wave amplitude translates into a louder sound.

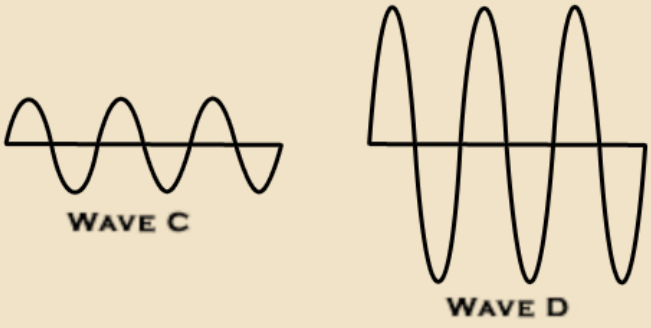
The frequency of a wave is measured by the distance between two adjoining wave peaks (or troughs). The smaller the distance between the two peaks, the greater the wave's frequency and the higher the sound's pitch. Figure 1 shows two waves that have two different frequencies. Which wave, A or B, would have the higher pitch?

Figure 1. Waves with different frequencies



Amplitude is related to the height of the wave. The taller the wave, the greater the wave's amplitude and the louder the sound. Figure 2 shows two waves that have two different amplitudes. Which wave, C or D, would be louder?

Figure 2. Waves with different amplitudes



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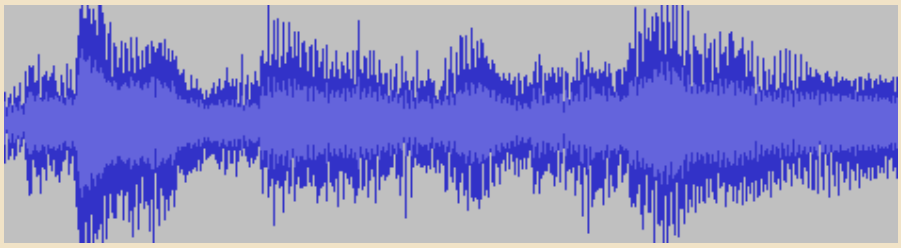
Real Ship Waves

Sound waves made by the propellers and the movement of real ships through water are much more complex than the waves shown on the previous page. The wave's complexity requires analysis that is much more difficult in order to identify ships as they move through harbor waters. Figure 3 below shows the wave made by a large cargo ship.

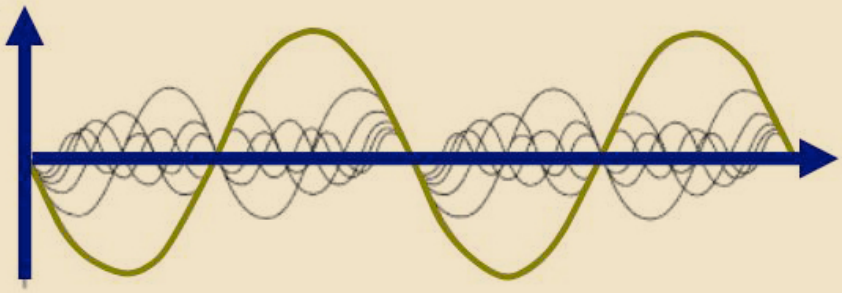
Figure 3. Cargo ship sound wave



The Superposition Principle provides the physics for combining waves. Figure 4 shows the results of combining waves with different frequencies and amplitudes. Sophisticated technology is required to isolate the identifying characteristics of the particular ship's sound wave by "undoing" the Superposition Principle. The technology breaks up the wave into multiple wavelets and isolates each part of the wave.

The gold line in Figure 4 is the combination of the blue waves at each point.

Figure 4. Superposition Principle



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Answers: Page 2 Answers: 1) a. Submarines can be so quiet that they cast an acoustic 'shadow' in the water that can be detected. To counter this effect, they emit animal sounds on purpose. 2) a. They do not work very well, however. 3) a. Hydrophones and computers are becoming more and more advanced, and shipping traffic is very loud. 4) a. Though divers are much quieter than ships, they can be detected at close ranges because sound travels farther in shallow water. 5) b. The distance would be too great to track individual whales. **Page 3 Answers**: Figure 1 - Wave B, Figure 2 - Wave D.

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