The Sound of Romance

Bzzzzzzzzz! Bzzzzzzzzz! What's that noise? It's the sound of a mosquito buzzing in your ear. This distinct buzzing sound comes from sound waves formed as a mosquito beats its wings. Researchers recently discovered that the buzzing sound of female mosquitoes attracts male mosquitoes. When a male mosquito meets a female, he quickly adjusts his own buzz to match the frequency of the sound waves created by the female. Researchers think that this matched buzzing frequency aids in mosquito mating.

Communicate Discuss this question with a partner. Write your answer below.

What are two other animals you know of that make buzzing sounds?

bees and flies

PLANET DIARY Go to Planet Diary to learn more about wave properties.

Lab zone® Do the Inquiry Warm-Up *What Do Waves Look Like?*

What Are the Amplitude, Wavelength, Frequency, and Speed of a Wave?

Waves may vary greatly. For example, waves can be long or short. They can carry a little energy or a lot of energy. They can be transverse or longitudinal. However, all waves have common properties—amplitude, wavelength, frequency, and speed.

Amplitude describes how far the medium in a wave moves. Wavelength describes a wave's length, and frequency describes how often it occurs. Speed describes how quickly a wave moves.

Amplitude The height of a wave's crest depends on its amplitude. Amplitude is the maximum distance the medium vibrates from the rest position. For a water wave, this distance is how far the water particles move above or below the surface level of calm water. High waves have more energy than low waves. The more energy a wave has, the greater its amplitude.

A transverse wave is shown in **Figure 1.** Its amplitude is the maximum distance the medium moves up or down from its rest position. The amplitude of a longitudinal wave is a measure of how compressed or rarefied the medium becomes. When the compressions are dense, it means the wave's amplitude is large.

FIGURE 1

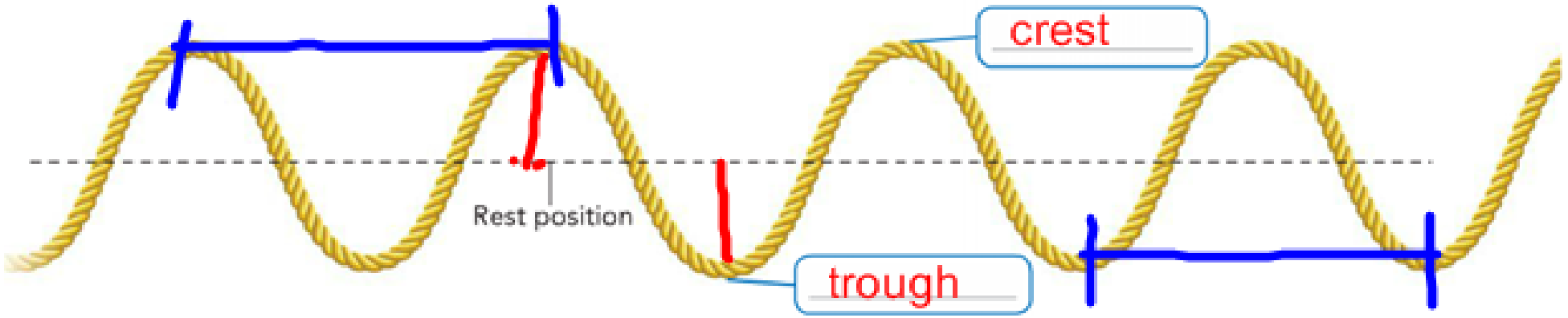
Amplitude

The amplitude of a transverse wave is the maximum distance the medium vibrates from the rest position.

Label the parts of the wave. Then answer the question.

Measure What is the amplitude of the wave in centimeters?

1.5 cm



Wavelength

Wavelength A wave travels a certain distance before it starts to repeat. The distance between two corresponding parts of a wave is its wavelength. You can find the wavelength of a transverse wave by measuring the distance from crest to crest as shown in **Figure 2.** For a longitudinal wave, the wavelength is the distance between compressions.

Frequency The frequency of a wave is the number of waves that pass a given point in a certain amount of time. For example, if you make waves on a rope so that one wave passes by a point every second, the frequency is 1 wave per second. Move your hand up and down more quickly and you increase the frequency.

Frequency is measured in units called hertz (Hz), and is defined as the number of waves per second. A wave that occurs every second has a frequency of 1 wave per second (1/s) or 1 Hz. If two waves pass every second the frequency is 2 waves per second (2/s) or 2 Hz.

Speed Different waves travel at different speeds. Think about watching a distant thunderstorm on a hot summer day. The thunder occurs the instant the lightning flashes, but the light and sound reach you seconds apart. This happens because light waves travel much faster than sound waves. In fact, light waves travel about a million times faster than sound waves!

The speed of a wave is how far the wave travels in a given amount of time. You can determine a wave's speed by dividing the distance it travels by the time it takes to travel that distance. Sound, for example, travels about 990 meters in 3 seconds in air when the temperature is 0°C. Therefore, its speed is 330 m/s in these conditions. As long as the temperature of the medium (air) doesn't change, the speed of sound will stay the same.

$S = \frac{D}{T}$ $\frac{990\,m}{3\,Sec}$ $3\overline{)990}$ $330\,m/s$

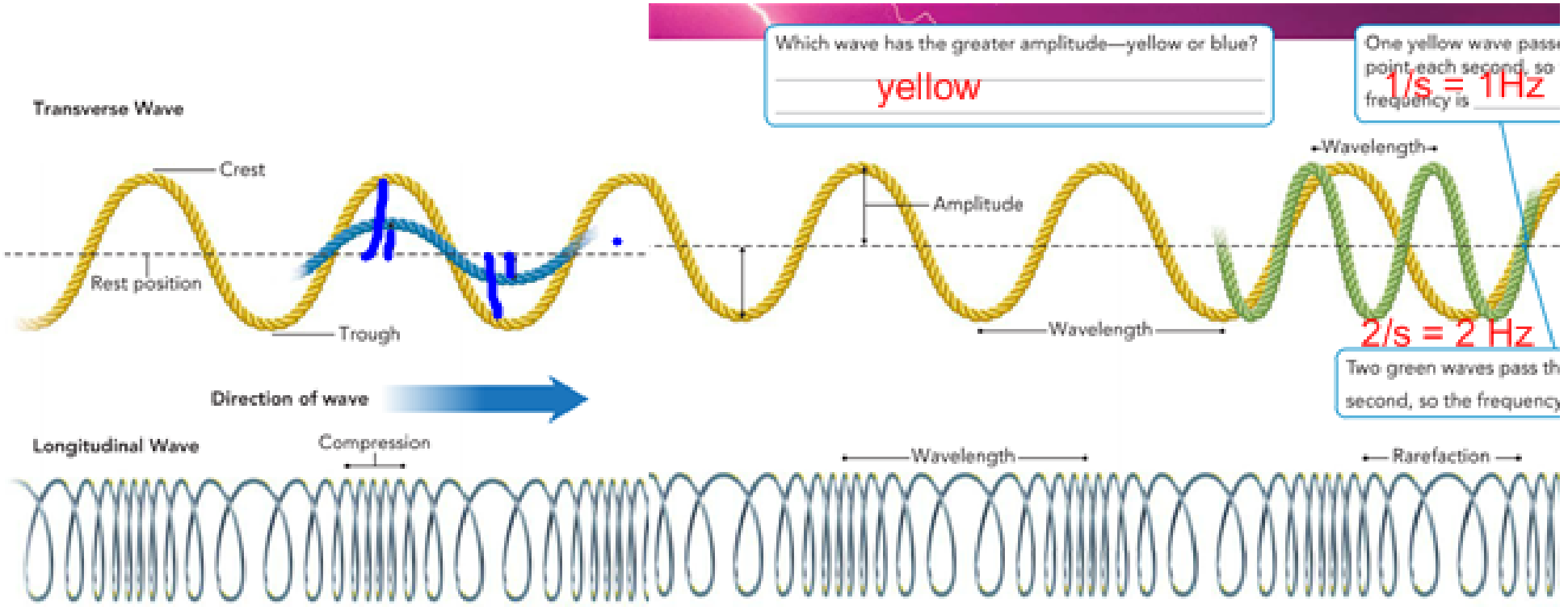
Lab zone® Do the Quick Lab *Properties of Waves.*

Assess Your Understanding

got it?

- I get it! Now I know that for any wave,
  amplitude describes how far the medium moves,
  wavelength describes it's length,
  frequency describes how often it occurs,
  and speed describes how fast it moves
- I need extra help with _____

Go to MY SCIENCE COACH *online for help with this subject.*



Which wave has the greater amplitude—yellow or blue?

yellow

One yellow wave passe
point each second, so
frequency is

1/s = 1Hz

2/s = 2 Hz

Two green waves pass th
second, so the frequency

1. **Name** Which transverse wave has the shortest wavelength?

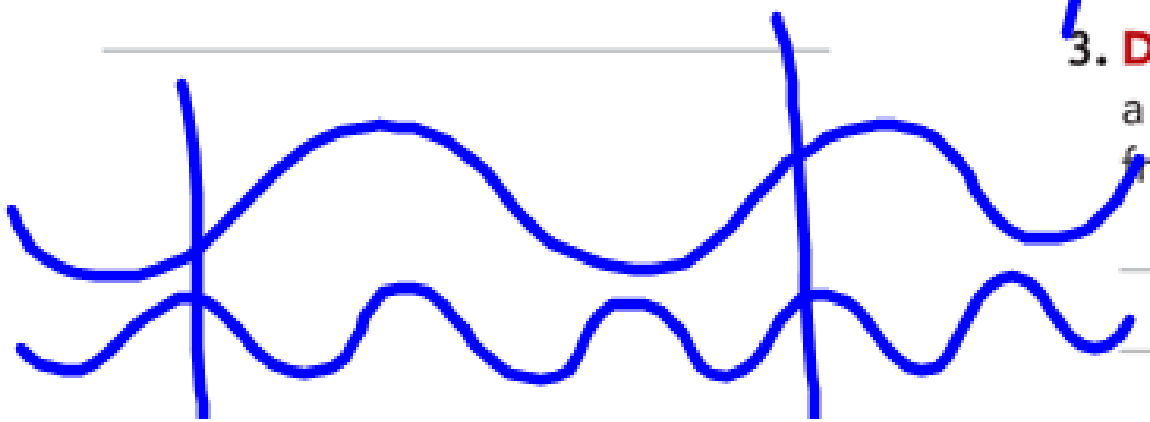
green

2. **Apply Concepts** If a transverse wave travels 10 meters in 5 seconds, what is its speed?

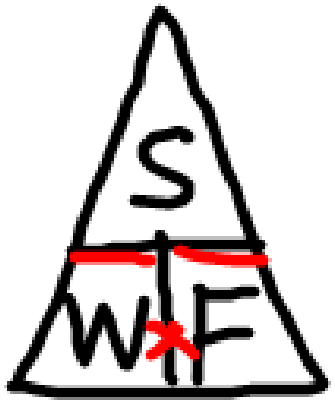
$S = \frac{D}{T}$ $S = \frac{10m}{5s}$ 2m/s

3. **Draw Conclusions** How does a shorter wavelength affect the frequency of a wave?

A shorter wavelength increase the frequency



How Are Frequency, Wavelength, and Speed Related?



You just learned that you can calculate the speed of a wave by dividing the distance it travels by the time it takes to travel that distance. But you can also calculate the speed of a wave if you know its wavelength and frequency. **The speed, wavelength, and frequency of a wave are related by a mathematical formula.**

$$\text{Speed} = \text{Wavelength} \times \text{Frequency}$$

$S = W \times F$

If you know two quantities in the formula, you can calculate the third quantity. For example, if you know a wave's speed and wavelength, you can calculate its frequency. If you know the speed and frequency, you can calculate the wavelength.

$$\text{Frequency} = \frac{\text{Speed}}{\text{Wavelength}}$$

$W = \frac{S}{F}$

$$\text{Wavelength} = \frac{\text{Speed}}{\text{Frequency}}$$

$F = \frac{S}{W}$

The speed of a wave remains constant if the medium, temperature, and pressure do not change. For example, all sound waves travel at the same speed in air at a given temperature and pressure. Even if a sound wave's frequency changes, its speed stays the same. So, if the frequency of a sound wave increases, its wavelength must decrease to maintain a constant speed.

Math!

The table shows measurements of some properties of a sound wave in water and in air.

Medium	Wavelength	Frequency	Speed
Water	7.5 m	200 Hz	1500 m/s
Water	3.75 m	400 Hz	1,500 m/s
Air (20°C)	10 m	34.3 Hz	343 m/s
Air (20°C)	20 m	17.15 Hz	343 m/s

1 **Calculate** Using what you know about the relationship between wavelength, frequency, and speed, fill in the table.

2 **CHALLENGE** What can this table tell you about the speed of a wave?

$W = \frac{S}{F}$

$W = \frac{1{,}500\ m/s}{200\ Hz}$

$$\begin{array}{r} 7.5 \\ 200\overline{)1500.0} \\ 14000 \\ \hline 1000 \\ -1000 \\ \hline 0 \end{array}$$

$S = W \times F$

$S = 3.75\ m \times 400\ Hz$

$$\begin{array}{r} 3.75 \\ \times\ 400 \\ \hline 000 \\ 000 \\ 15000 \\ \hline 150000 \end{array}$$

$S = 1{,}500\ m/s$

$F = \frac{S}{W}$

$F = \frac{343\ m/s}{10m}$

$$\begin{array}{r} 34.30 \\ 10\overline{)343.0} \\ -30 \\ \hline 43 \\ 40 \\ \hline 30 \\ 30 \\ \hline 0 \end{array}$$

$F = 34.3\ Hz$

$W = \frac{S}{F}$

$W = \frac{343\ m/s}{17.15\ Hz}$

$$\begin{array}{r} 20 \\ 17.15\overline{)34300.0} \\ -3430 \\ \hline 0 \end{array}$$

$W = 20m$

What are the properties of waves?

FIGURE 3

INTERACTIVE ART The waves in some amusement park wave pools are controlled by regularly spaced bursts of air. Changing the timing and strength of these air bursts also changes the characteristics of the waves that result.

Predict List and describe four wave characteristics. Which characteristic(s) do you think would change if the air bursts were stronger? Which would change if more air bursts came in a shorter amount of time? Explain.

Amplitude - how high the wave moves from the rest position

Wavelength - the length of the wave

Frequency - how often a wave passes a certain point in a given amount of time

Speed - how fast a wave travels.

Stronger bursts of air = larger amplitude

shorter bursts of air = higher frequency

zone the Speed of a Wave?

Assess Your Understanding

1a. What are the properties of waves?

amplitude, wavelenght, frequency and speed.

b. Calculate A wave's frequency is 2 Hz and its wavelength is 4 m. What is the wave's speed?

S = WxF

S = 4m x 2Hz

S = 8m/s

got it?

- I get it! Now I know that wavelength, frequency, and speed are related by the formula S = WxF F = S/W W= S/F
- I need extra help with _____

Go to MY SCIENCE COACH online for help with this subject.