Name _____ Date _____

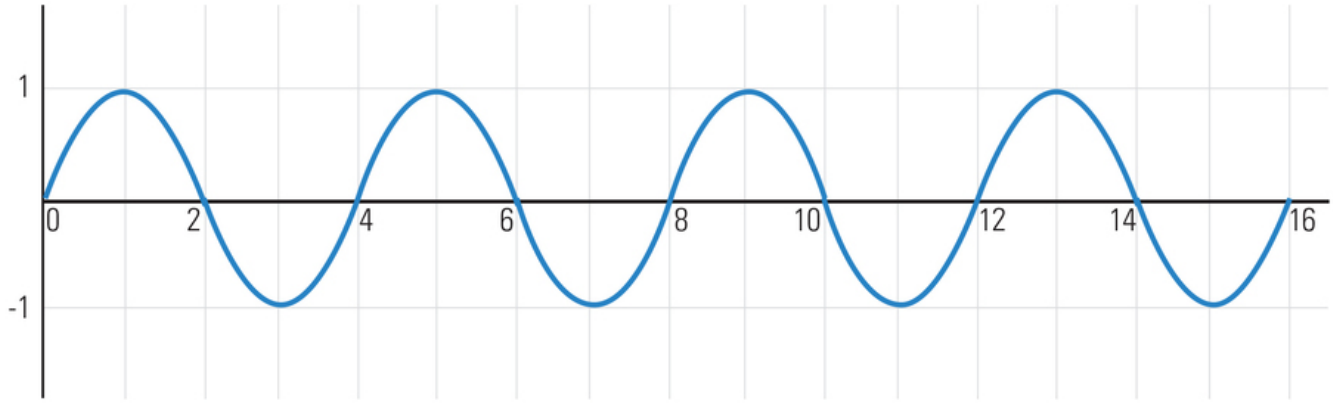
NGSS-Designed Lesson Assessment: Properties of Waves

Main Ideas

Read each item. Then select the letter next to the best answer.

1. Scientists and engineers use graphs and mathematical values to model wave patterns. A group of students adjusted a wave tank to create waves as shown in this graph.

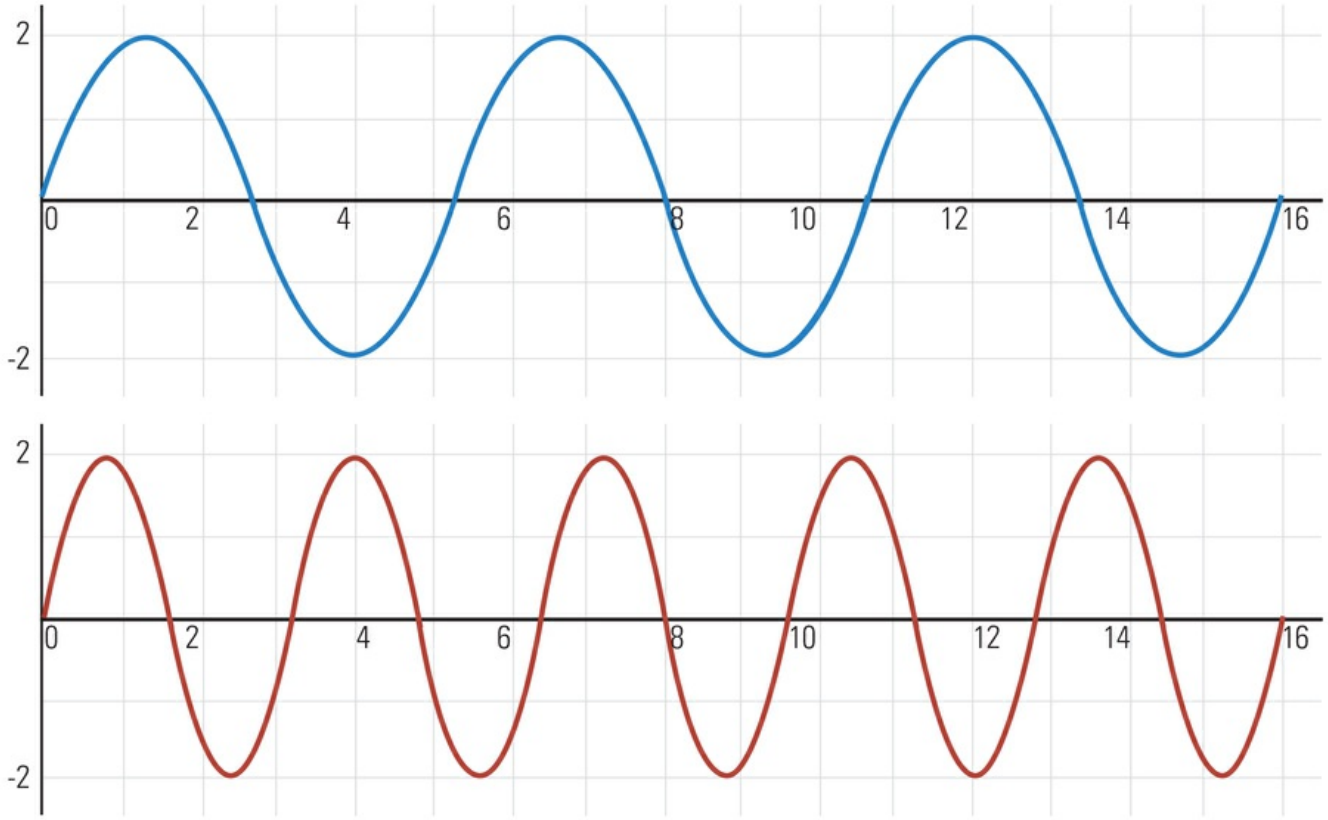
   Using data from the graph, which of the following statements best describes the amplitude of the waves they made?



A. The amplitude is 2, because it goes up to 1 and down to -1.
B. The amplitude is 1, because it goes up to 1 and down to -1.
C. The amplitude is 4, because it repeats starting at 0, 4, 8, 12, etc.
D. The amplitude is 2, because it crosses the x-axis at 0, 2, 4, 6, etc.

2. For a class assignment, a group of students were directed to create two different waves. There was a requirement: the two waves needed to share at least one property which was exactly the same, and at least one property which was different. After graphing their results, as shown below, they believed they had successfully completed the assignment.

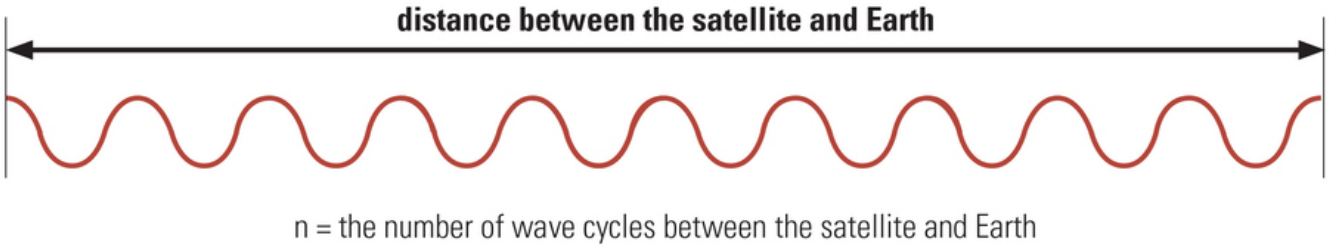
Based on the information provided in the graph the students were:



A. not successful, because the two waves do not have any properties that are the same.
B. not successful, because the two waves do not have any properties that are different.
C. successful, because the amplitudes are the same and the wavelengths are different.
D. successful, because the wavelengths are the same and the amplitudes are different.

3. The GPS, or Global Positioning System, uses waves from several different satellites to pinpoint a location on Earth. To do this, a GPS receiver must find the distance to at least four different satellites. Although not mechanical, the waves from satellites are modeled using the same properties. The receiver uses the mathematical properties of these waves to determine each distance.

   If the number of wave cycles is known, what other wave property is sufficient (*is enough*) to calculate the distance that the signal of the wave travelled from a given satellite to the receiver?

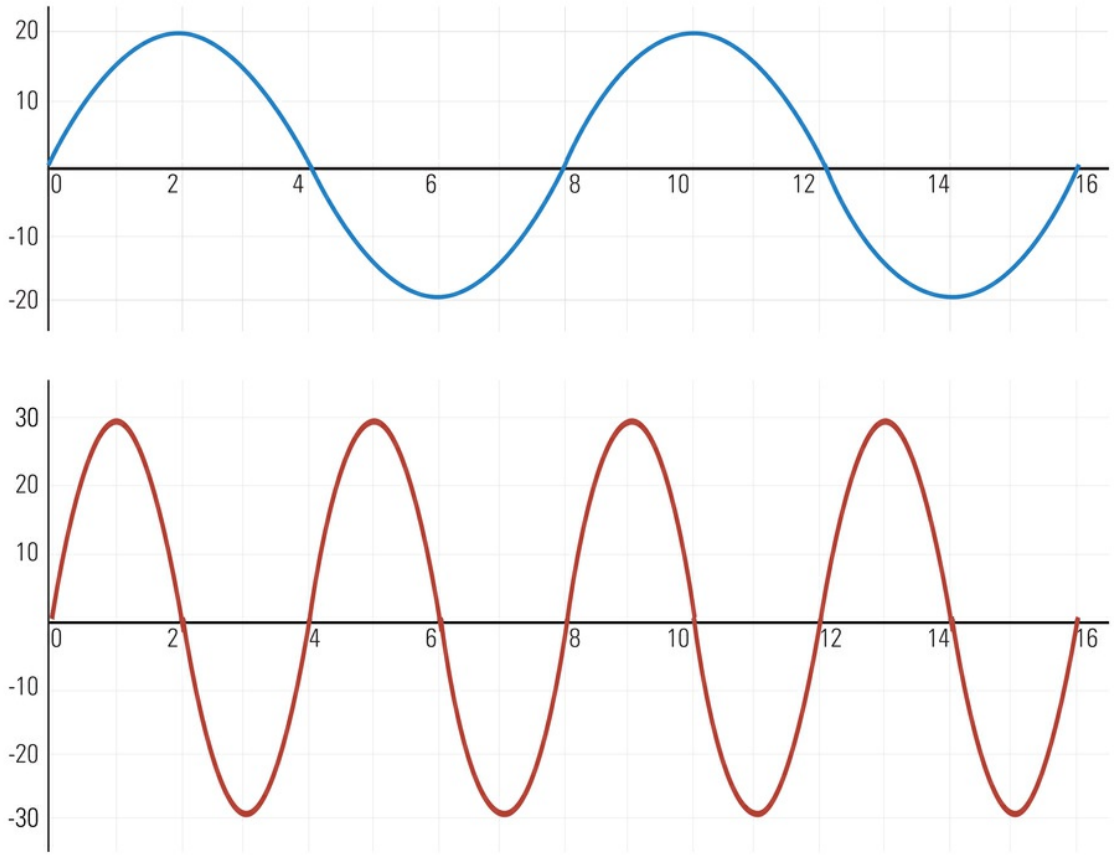


n = the number of wave cycles between the satellite and Earth

A. the amplitude, by multiplying the amplitude by the number of wave cycles
B. the frequency, by multiplying the frequency by the number of wave cycles
C. the wave length, by multiplying the wave length by the number of wave cycles
D. the wave speed, by multiplying the wave speed by the number of wave cycles

4. Rebecca and Ari used a spring toy to produce the first wave shown in blue below. Then they shook the spring toy faster to create a second wave pattern with increased frequency, as shown in red. After looking at the data they realized the data showed changes that could not be explained by ONLY shaking the spring faster.

Based on the information provided, which of the following statements best describes the cause of these results?



A. They shook the spring both faster and harder, as shown by the increase in wavelength.
B. They shook the spring both faster and harder, as shown by the increase in amplitude.
C. They shook the spring both faster and harder, as shown by the decrease in wavelength and the increase in amplitude.
D. They were mistaken about their claim, and the data can be explained by only shaking the spring faster.

5. A tuning fork, which produces a sound with 261.6 Hz, is struck and placed on a long slender gold rod. The sound waves travel through both the air and through the gold. The speed of sound in gold is about 10 times faster than the speed of sound in air.

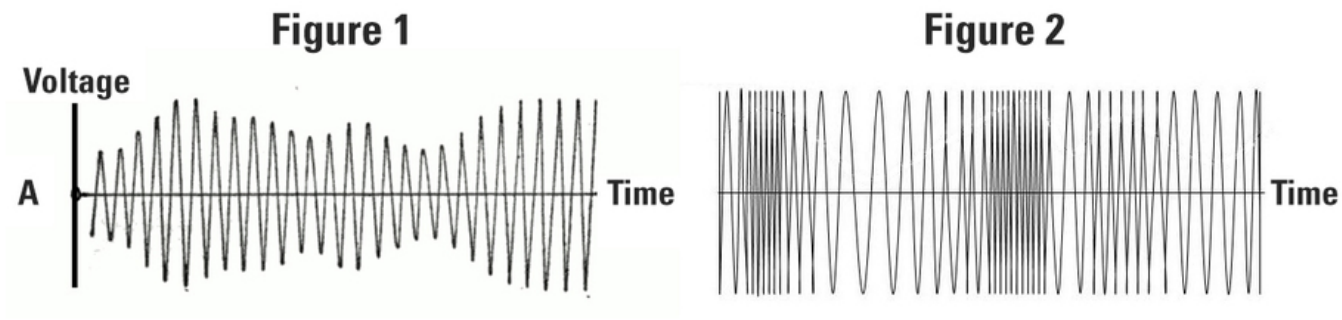
   Based on the wave relationship “wave speed = frequency × wavelength”, which of the following statements best describes the sound waves in each material?

   A. The wavelength of the sound in the gold will be about 10 times longer than the wavelength in the air.
   B. The wavelength of the sound in the air will be about 10 times longer than the wavelength in the gold.
   C. The frequency of the sound in the gold will be about 10 times greater than the wavelength in the air.
   D. The frequency of the sound in the air will be about 10 times greater than the wavelength in the gold.

6. AM and FM radio stations use different technologies, but both transmit signals using radio waves. Radio waves are not mechanical waves, but are modeled using the same mathematical features. AM stands for amplitude modulation, and operates by changing the amplitude of the signal wave for different sounds. FM stands for frequency modulation and makes variations in the signal waves frequency for different sounds.

   Below are two diagrams showing wave patterns.

   Based on the diagrams and the properties of wave patterns, which statement best states the difference between AM and FM signals?



   A. Figure 1 shows FM and Figure 2 shows AM.
   B. Figure 1 shows AM and Figure 2 shows FM.
   C. Figure 1 shows a combination of AM and FM.
   D. Figure 2 shows a combination of AM and FM.

Think Like a Scientist

Read about each scientific investigation. Then answer the questions that follow the investigation by selecting the letter next to the best answer.

Investigation A

You have been hired by TCI, the publisher of this text book, to be in charge of a team to build a machine to make wave patterns for classrooms. This machine will help teachers demonstrate the wave relationship between a wave's speed, frequency and wavelength.

The materials you have are a long-coiled spring and a motorized device which sends a pulse pattern down the spring. You are able to control this motorized device by setting the frequency and by changing the distance it moves back and forth when making the pulse.

7. Your first task is to provide directions about changing the wave speed. Which of the following statements correctly states the requirements to increase the wave speed?

   A. Increasing the frequency will increase the wave speed.
   B. Increasing the tension in the spring will increase the wave speed.
   C. Increasing the distance of the back and forth motion will increase the wave speed.
   D. Increasing both the frequency and the back and forth distance will be needed to increase the wave speed.

8. Based on the wave relationship "wave speed = frequency × wavelength", what settings could you use to make waves with a 2 m wavelength?

   A. Wave speed at 2 m/s with a frequency of 2 waves per second.
   B. Wave speed at 2 m/s with a frequency of 4 waves per second.
   C. Wave speed at 4 m/s with a frequency of 2 waves per second.
   D. Wave speed at 4 m/s with a frequency of 4 waves per second.

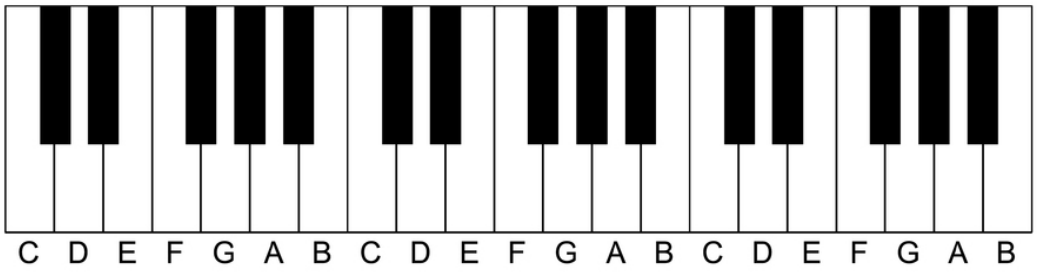
9. You have asked your team members to suggest improvements to make the wave machine cheaper to build and easier to use. Which of the following statements about design changes is true?

   A. The frequency adjustment is not necessary.
   B. The spring tension adjustment is not necessary.
   C. The back and forth distance adjustment is not necessary.
   D. All the current adjustments are necessary to demonstrate the wave relationship.

Investigation B

When sound waves are produced with different frequencies they are heard as different pitches, or notes. When a wave's frequency is halved or doubled it produces a similar sounding note, and we use the same letter to identify both notes. The two notes are said to be an octave apart. Notice that the wavelength is shorter for higher frequency waves and longer for lower frequency waves. The wavelength of a note changed by exactly one octave is half as long or twice as long as the other note.

Note: Many instruments are tuned using the A 440 note just above middle C on the piano.



Note	Frequency (Hz)	Wavelength (m) Wavelengths based on speed of sound = 340.29 m/s	
A	220	1.55m	
A# / Bb	233.1	1.46m	
B	246.9	1.38m	
C	261.6	1.30m	Middle C
C# / Db	277.2	1.23m	
D	293.7	1.16m	
D# / Eb	311.1	1.09m	
E	329.6	1.03m	
F	349.2	0.97m	
F# / Gb	370.0	0.92m	
G	392.0	0.87m	
G# / Ab	415.3	0.82m	
A	440	0.77m	Tuning reference note

10. Based on the data provided, what would be the frequency of the A note in the next higher octave above the tuning reference note?

    A. 110 Hz
    B. 220 Hz
    C. 440 Hz
    D. 880 Hz

11. Based on the wave relationship, for a given speed of sound the wavelength is determined by each frequency. Using the data in the table what would the wavelength be of the A note in the next higher octave above the tuning reference note?

    A. 0.220 m, because that is half of 0.440
    B. 0.385 m, because that is half of 0.77
    C. 0.440 m, because that matches 0.440
    D. 0.880 m, because that is twice 0.440

12. Based on the data provided, what note would have a wavelength of 2.06 m?

    A. the A in the octave below middle C
    B. the E in the octave below middle C
    C. the A in the octave above middle C
    D. the E in the octave above middle C

Expressing Science Practices, Concepts, and Ideas

Read the directions for each item carefully before constructing your response.

13. Your best friend has missed a lot of school recently. Your teacher has allowed you to create a study guide and will let your friend use it on the test.

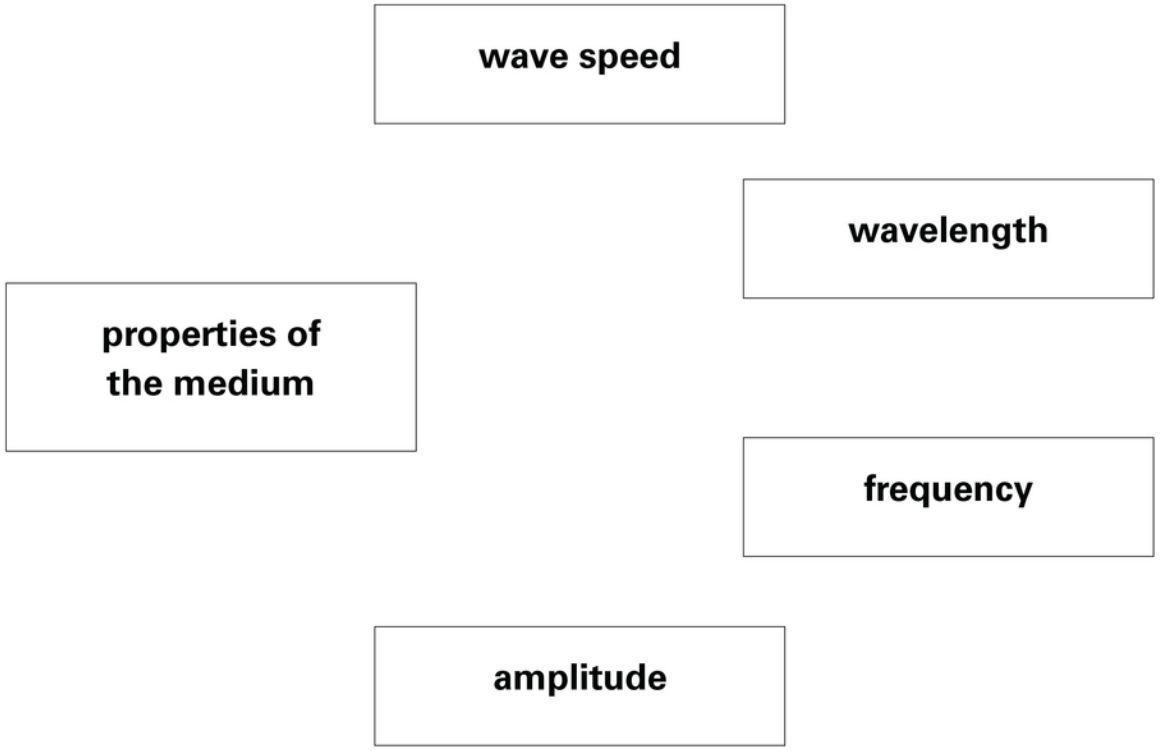
    The guide should include:
    • a sketch with a wave pattern that shows two periods with amplitude and wave length clearly labeled.
    • descriptions of frequency and wave speed.
    • the wave relationship equation, and explain which wave properties are dependent and independent.
    • the wave relationship for a given wave speed to show what happens to wavelength as frequency doubles.

14. Maria is preparing a presentation that describes the relationship between different properties of waves.

To help her, draw a model that illustrates the relationship between the different properties of mechanical waves: wave speed, wavelength, frequency, amplitude, and the properties of the medium.

Use arrows to show which properties are dependent on which other properties. Arrows should start on the independent variable and the arrow point should end on the dependent variable. More than one arrow can be drawn to or from any property and not all properties may need arrows.

Then, use your diagram to describe what happens to frequency, wavelength, and amplitude when wave speed is doubled. The properties will either be *doubled*, *halved* or *unchanged*.



Wave speed	Frequency	Wavelength	Amplitude
doubled			

15. Sound waves are invisible, but models can be used to help us make sense of what is happening. Some programmers want to build an application that will display how a longitudinal wave, like a sound wave, can be represented graphically by a transverse wave. The top half will have a sound wave moving across the screen, while a transverse wave will move along the bottom. They want you to sketch and label what a screen shot of the display would look like at a given moment in time. The parts of each wave with the least and greatest amplitude should be aligned vertically.

    Showing one full wavelength for each wave:
    • Use dots to represent the sound wave showing dots closer together and farther apart to represent differences in pressure.
    • Use a line to show the transverse wave, matching the sound wave pattern to show where particles in both waves are in neutral positions and where the wave has the greatest displacement from the neutral position, in any direction.
    • Label each wave as transverse or longitudinal.
    • Label the transverse wave with wavelength and amplitude.

16. Surfing is possible because the surfer controls their position to stay on top of the moving wave. An education foundation is providing a grant to any surf shop that will offer a science lesson combined with surf lessons to keep kids interested in science. The owner of Surf's UP has asked you to design a science lesson based on ocean waves. Your lesson should be two-to-three paragraphs long and include:

    • a definition of waves involving energy and matter and provide definitions of the four basic properties of waves: amplitude, wave speed, wave length and frequency.
    • a comparison each of the four properties of waves to ocean waves in particular, explaining what each property would look like in an ocean wave.
    • a description of ocean waves as patterns.