



Scope Phenomenon

Name: _____ Date: _____

Springy Waves

1. Describe what you notice is happening in the video.
2. What changes as the hand slows the push and pull of the spring?
3. Frequency is a measure of how many waves pass a point in a second. When was there a greater frequency?
4. Sound waves are a type of longitudinal wave, like the spring. What do you think happens to sound when there is a greater frequency? Give an example of when you could hear it.



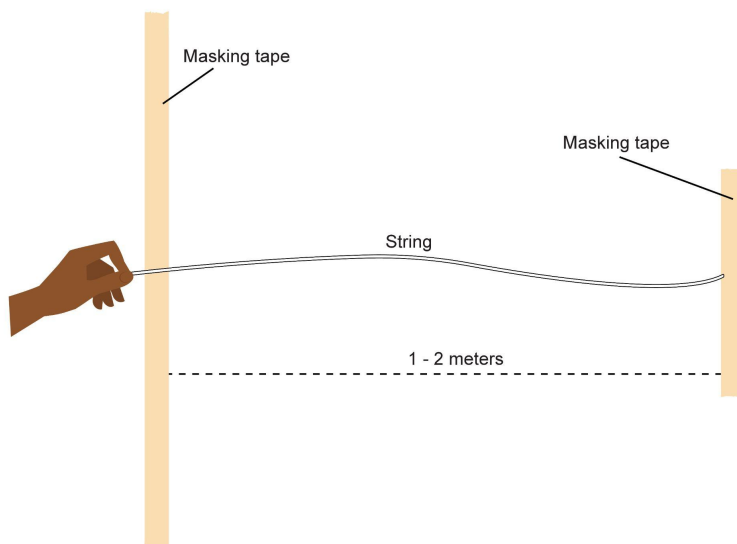
Explore

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Observing Waves, Their Properties, and Relationships

Part I: Setting Up the Activity

1. Refer to the material list for materials needed.
2. To successfully conduct this activity, you will need an area at least one meter wide and two meters long on a smooth (not carpet) floor or lab table.
3. Stretch out and attach the 50-centimeter piece of masking tape to the floor or table.
4. Using the marker, mark the center of the masking tape and place marks every 5 centimeters away from the center in both directions.
5. Label the mark in the center of the tape 0. Then label each mark by 5 centimeters moving outward from the center until you reach 20 centimeters on each side of the center.
6. Place one end of the string on the masking tape at the 0 and stretch the string away from the tape, perpendicular to the tape forming a T-shape.
7. Use some extra tape to tape the end of the string that is farthest away from the tape to the floor or table. The end of the string near the 50-cm piece of tape should be free to move. See the diagram. of the string and reach the secured end.



8. Take a moment to play with your setup. By rapidly moving the free end of the string back and forth, you should be able to create a wave in the string that reaches all the way to the secured end. When you stop moving your hand, the string will stop roughly in the shape of the wave you produced.
9. As you conduct the rest of this activity, always move the string fast enough for the wave to travel the entire length.



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Part I: Conducting the Activity

1. Move the string rapidly back and forth between the 5-centimeter marks on the tape. Once a wave has been established in the string, stop moving your hand and allow the string to settle. Draw the formation of the string in the box that follows labeled Trial 1.
2. Move the string rapidly back and forth between the 10-centimeter marks on the tape. Once a wave has been established in the string, stop moving your hand and allow the string to settle. Draw the formation of the string in the box that follows labeled Trial 2.
3. Move the string rapidly back and forth between the 15-centimeter marks on the tape. Once a wave has been established in the string, stop moving your hand and allow the string to settle. Draw the formation of the string in the box that follows labeled Trial 3.
4. Move the string rapidly back and forth between the 20-centimeter marks on the tape. Once a wave has been established in the string, stop moving your hand and allow the string to settle. Draw the formation of the string in the box that follows labeled Trial 4.

Trial 1

Trial 2



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Trial 3

Trial 4

Questions

1. Describe ways in which your four waves were similar.
2. Describe ways in which your four waves were different.
3. What do you think explains the difference in your waves? Why do you think so?

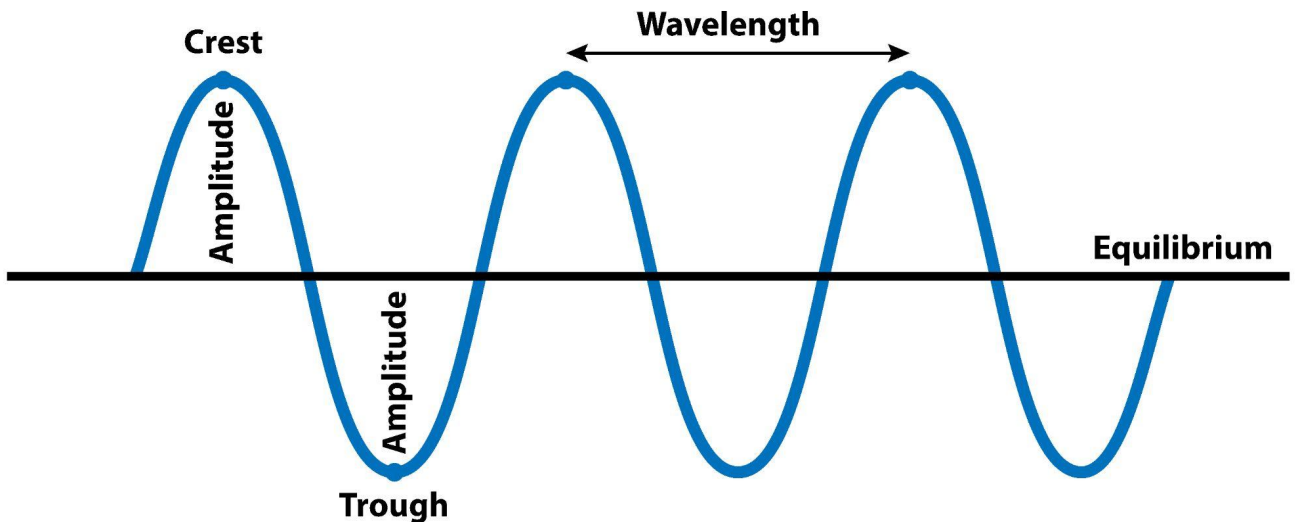


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Parts of a Wave

Waves have several parts. Look at the Diagram and compare it to the drawings you made in your Student Handout. Can you find the parts of a wave in your drawings?

Transverse Wave



Crest: Crest is the highest point of the wave.

Trough: Trough is the lowest point of the wave.

Wavelength: Wavelength is the distance between any two corresponding points on the wave such, as crest to crest or trough to trough.

Equilibrium: Equilibrium is the “middle point” around which the wave moves.

Amplitude: Amplitude is the distance between equilibrium and the crest or the trough of the wave.

- Go back to the drawings you made in boxes labeled Trial 1, 2, 3, and 4 and label the crests, troughs, wavelengths, and amplitudes.
- Were the wavelengths different between the waves in the various trials? Describe any differences in wavelengths and what you think may have been the cause.



Explore

6. Were the amplitudes different among the waves in the various trials? Describe any differences in amplitudes and what you think may have been the cause.

7. Do you think there is a relationship between wavelength, amplitude, and the energy involved in a wave? If so, what do you think the relationship is?

Part II: Setting Up the Activity

1. Refer to the material list for materials needed.
2. Use your favorite search engine to search “Wave on a String PhET Simulation.” Once you have located the simulation, launch it.
3. Take a few moments to play with the simulation and figure out the controls.
4. Some important things to note:
 - a. If you turn on the rulers, you can move the rulers around the screen.
 - b. If you turn on the reference line, you can move it around the screen.
5. When you are ready to begin the activity, click the reset button in the bottom right. It is an orange circle with a white arrow in it.
6. Select “Oscillate” in the top left box and leave it selected for the entire activity.
7. Select “No End” in the top right box and leave it selected for the entire activity.
8. Turn on the rulers by clicking the check box in the bottom right.
9. Turn on the timer by clicking the check box in the bottom right.
10. Set the “Tension” slider to “High” and leave it set to “High” for the entire activity.
11. Set the “Damping” slider to “None” and leave it set to “None” for the entire activity.
12. Notice that you can freeze the wave by clicking on the pause button.



Explore

1. Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between amplitude and wavelength.

Is there a connection between amplitude and wavelength? If you increase or decrease the amplitude of a wave, does it affect the wavelength? If it does, how? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

2. Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between frequency and wavelength. We have not discussed frequency yet, but the goal is for you to discover if a relationship between frequency and wavelength exists.

Is there a connection between frequency and wavelength? If you increase or decrease the frequency of a wave, does it affect the wavelength? If it does, how? Is there a mathematical way to describe the relationship between frequency and wavelength? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

Frequency

Picture yourself standing on the beach right where the waves come ashore. You begin counting how often the waves hit your feet, and you notice that one wave hits your feet each second. Over time, the rate at which the waves hit your feet increases, and you notice that the waves are now hitting your feet twice each second. The frequency of the waves has doubled. Frequency is the number of waves passing a point (in this case, your feet) in a certain amount of time.

If you return to the simulation and set the frequency to 1.00 Hz, you will notice that one wave crest passes through the window every second. If you increase the frequency to 2.00 Hz, you will notice that two wave crests pass through the window every second. Just like the example of the waves hitting your feet, the frequency of the waves doubled.

Although it may seem like it, a wave's frequency and its speed are **not** the same. Picture yourself standing on the side of a road. A line of semi trucks is driving by you at 60 kilometers per hour. You time the semi trucks as they go by and notice that one truck passes you each second. Suddenly, the line of semi trucks ends and a line of small cars drives by you also going 60 kilometers per hour. You time the cars and notice that two cars pass you every second. Even though the speed of the trucks and cars is the same (60 kilometers per hour), more cars are passing you per second than trucks. Why? The answer is because the cars are shorter than the trucks, therefore more of them can pass you by in the same amount of time. The number of vehicles (cars or trucks) passing you each second is their frequency, while the length of the vehicles is like the wavelength of a wave. Two waves can be travelling at the same speed, but if one has a shorter wavelength, it will have a higher frequency.

It is possible to make a mathematical statement about the relationship between a wave's wavelength and its frequency.

As long as the speed of the wave remains constant, wavelength and frequency are inversely related.

If the speed of a wave is constant...

Wavelength	Frequency
Increases	Decreases
Decreases	Increases



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Waves, Energy, and Sound

Part I: Setting Up the Activity

In this activity, you are going to be using a model to illustrate a concept. What you will be seeing is **not** a perfect representation of reality.

1. Refer to the material list for materials needed.
2. With a partner, each take one end of the spring toy, stretch it to about 1 meter in length, and rest the stretched spring toy on a smooth table or floor. It does not have to be exactly 1 meter, just approximately.
3. While one partner holds their end still, the other partner can “send” waves by repeatedly compressing their end of the spring toy back and forth.

Part I: Conducting the Activity

- Set the stopwatch for 10 seconds. Using a moderately slow tempo, send waves from one end of the spring toy to the other. Do not start out too fast. You will be completing five trials, increasing your tempo each time. Count the number of waves you send during the 10 seconds and record it in the first row of Table 1.
- Repeat four more times, increasing your tempo each time and recording the number of waves sent in each trial in Table 1. Shortening the length of the spring toy with each trial is perfectly acceptable and will help you to be able to send more waves with each trial.

Table 1

Trial 1	We sent _____ waves in 10 seconds.
Trial 2	We sent _____ waves in 10 seconds.
Trial 3	We sent _____ waves in 10 seconds.
Trial 4	We sent _____ waves in 10 seconds.
Trial 5	We sent _____ waves in 10 seconds.



Explore

1. By shortening the length of the spring toy, you were decreasing the _____ of the wave. (Hint: Think back to the example of the trucks and cars driving by.)
2. By **increasing** the number of waves that were sent during the 10 second time period, you were **increasing** the _____ of the wave. (Hint: Think back to the example of standing on the shore as the waves hit your feet.)

Frequency and Energy

As you were sending waves through the spring toy, you were transferring energy from one end to the other. Each wave that you sent carried with it a certain amount of energy. You can think of it as if each wave “delivered” some energy to the other end of the spring toy. To make things simple, let’s assume that each wave carried 5 units of energy with it. If you sent 9 waves during the 10 seconds, you would have sent a total of 45 units of energy (9 waves X 5 units each = 45 units). If, during trial 2, you sent 12 waves during the 10 seconds, you would have sent 60 units of energy (12 waves X 5 units each = 60 units).

- Complete Table 2 and then answer questions 3 and 4. You will copy the number of waves sent with each trial from Table 1 into the second column of Table 2 and then complete the third column.

Table 2

Trial	Number of Waves Sent (this is frequency)	Total Amount of Energy Sent (assuming 5 units sent with each wave)
1		
2		
3		
4		
5		

3. What do you notice about the relationship between the number of waves sent during a period of time and the total amount of energy sent during that time?
4. Write a one sentence description of the relationship between the frequency of a wave and the amount of energy transferred by the wave.



Explore

After completing Table 2, you should have noticed a relationship between the frequency of a wave and the amount of energy transferred by the wave. As the frequency increased, so did the total amount of energy transferred by the wave. There is a very significant mathematical relationship between a wave's frequency and the amount of energy transferred by the wave:

The amount of energy transferred by waves in a given time is proportional to frequency.

This simply means that if a wave's frequency doubles, the amount of energy being transferred by the wave doubles. If the wave's frequency triples, the amount of energy being transferred by the wave triples.

Part II: Setting Up the Activity

1. Refer to the materials list for materials needed.
2. Visit the following URL:
http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/oscilloscope_description_tutorial_sounds_frequency.htm
3. Take a few moments to play with the simulation and figure out the controls.
4. When you are ready to begin the activity, refresh your browser to reset all the settings.
5. Set the "V/div" knob to "1" and leave it selected for the entire activity.
6. Set the "ms/div" knob to "2" and leave it selected for the entire activity.
7. Select the yellow "sine" button and leave it selected for the entire activity.

Part II: Conducting the Activity

- There are two variables available for you to manipulate in the simulation: volume and pitch (the notes on the keyboard).
- Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between pitch and frequency.
- Record your data and complete #1 on the next page.



Explore

1. Is there a connection between pitch and frequency? If you increase or decrease the pitch, is the frequency different? If so, how? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

- Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between pitch and wavelength.
 - Record your data and complete #2 below.
2. Is there a connection between pitch and wavelength? If you increase or decrease the pitch, is the wavelength different? If so, how? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

- Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between pitch and amplitude.
 - Record your data and complete #3 below.
3. Is there a connection between pitch and amplitude? If you increase or decrease the pitch, is the amplitude different? If so, how? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

- Using the simulation and your knowledge of how to correctly control variables, conduct a simple experiment to determine if there is any connection between volume and amplitude.
 - Record your data and complete #4 below.
4. Is there a connection between volume and amplitude? If you increase or decrease the volume, is the amplitude different? If so, how? Record your data below (you might consider making a chart), and respond to the questions. Your conclusion should be supported by your data.

Conclusion:



Explore

Wave Properties and Sound

As you conducted the activities on the simulator, you should have discovered some relationships and non-relationships regarding the properties of waves and how those properties “show up” when dealing with sound. Most important to understand is:

- Amplitude and pitch **are not** connected. Low notes and high notes can have the same amplitude.
- Amplitude and volume **are** connected. Louder notes have greater amplitude than softer notes.
- Frequency and pitch **are** connected. Lower notes have lower frequencies than higher notes.

A Bit More About Amplitude

The amplitude of a wave is the result of the amount of energy in the wave. If there are two waves and they are the same except for the amplitude, the wave with the larger amplitude is the wave carrying the most energy. There is a very significant mathematical relationship between a wave's amplitude and the amount of energy in the wave:

The energy of the wave is proportional to the square of the amplitude.

This means that if the amplitude of a wave is doubled, each wave will have four times the energy of the original amplitude. If the amplitude of a wave is tripled, each wave will have nine times the energy of the original amplitude.

Do not get this confused with our earlier discussion of frequency and energy transfer. Think back to the example of the trucks and the cars. In this metaphor, the mass of the vehicles will represent the energy in the wave. The line of trucks certainly has more mass (energy) than the line of cars. However, if the frequency of the cars passing by is fast enough, the cars can deliver more total mass (energy) in the same amount of time. The amplitude of a wave is a result of the overall amount of energy in a wave, while the amount of energy transferred during a certain period of time is a result of the wave's frequency.

5. Complete table 3. The first two rows have been completed for you.

Example

Amplitude	Energy
1 unit	2 units
2 units	8 units
3 units	18 units
4 units	32 units
5 units	50 units

Table 3

Amplitude	Energy
1 unit	3 units
2 units	12 units
3 units	
4 units	
5 units	



Linking Literacy

Name: _____ Date: _____

Good Vibrations

Materials: Clear box with water ($\frac{3}{4}$ full), block, small rock or ball that will sink, your hands.

Instructions:

1. Drop the object into the water and observe what occurs on the top of the water.
2. Write down a brief description in the space below.
3. Let the water settle back to a still state.
4. Use your hands to drum on the table next to the box with water. Do not touch the box.
5. Record what you observe in the space below.
6. What word would you use to describe what happened in both activities?



Observations of object dropped in water:

Observations of drumming effect on water:



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Definition Continuum

Briefly preview the bolded subheadings and words and give either a definition or example. Begin reading the text and write down the definitions as they are covered in the text and list any new information or extra facts in the last paragraph.

Word	Preview of Subheadings	During Reading	Extra Facts
Wave			
Frequency			
Amplitude			
Wavelength			
Crest			
Trough			



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Spring Toy Applications

Spring toys are one of the coolest toys ever created, and they have been around for decades. The science applications for spring toys are perfect for an introduction to the properties of waves.

Materials

1 Spring toy

Mission

Create a wave using the spring toy and your partner. Try to keep the wave going for as long as possible (at least 20 to 30 seconds). Change the distance between you and your partner, and repeat the wave.

Observations of original wave:

Observations of second wave:

Sketch and label your first wave here:

Sketch and label your second wave here:

What did you have to do to create the wave motion with the spring toy?

What did you have to do to keep the wave moving?

What happened to the amplitude of the waves as you changed the distance? The frequency? The wavelength?