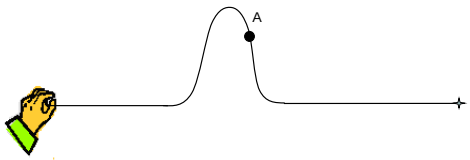
Wave unit

by Trish Loeblein

I gave these clicker questions after each sim activity was completed except for the Wave interference demonstration day. Activities:

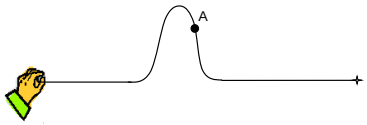
- Waves on a String
- Sound
- Wave interference
- Fourier: Making Waves
- Geometric Optics
- Resonance



Waves on a String Activity

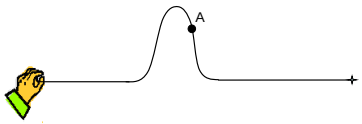
Trish Loeblein phet.colorado.edu

Learning Goals: Students will be able to discuss wave properties using common vocabulary and they will be able to predict the behavior of waves through varying medium and at reflective endpoints.



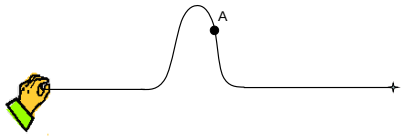
1. If you advance the movie one frame, the knot at point A would be

A. in the same place
B. higher
C. lower
D. to the right
E. to the left



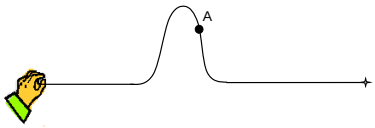
2. If the person generates a new pulse like the first but more quickly, the pulse would be

A. same size
B. wider
C. narrower



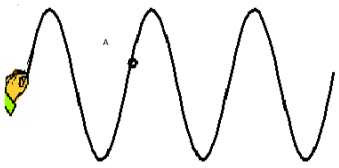
3. If the person generates another pulse like the first but he moves his hand further, the pulse would be

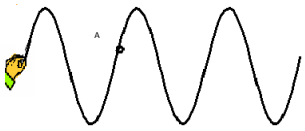
A. same size
B. taller
C. shorter



4. If the person generates another pulse like the first but the rope is tightened, the pulse will move

A. at the same rate
B. faster
C. slower





5. If you advance the movie one frame, the knot at point A would be

A. in the same place
B. higher
C. lower
D. to the right
E. to the left

6. If you advance the movie one frame, the pattern of the waves will be _____relative to the hand.

A. in the same place
B. shifted right
C. shifted left
D. shifted up
E. shifted down

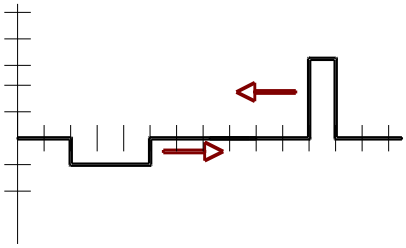
7. If the person starts over and moves his hand more quickly, the peaks of the waves will be

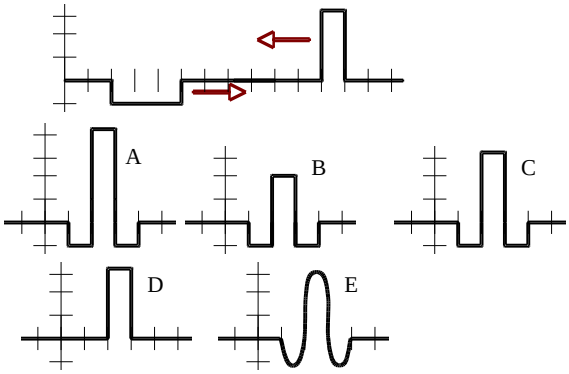
A. the same distance apart
B. further apart
C. closer together

If you lower the frequency of a wave in a string you will

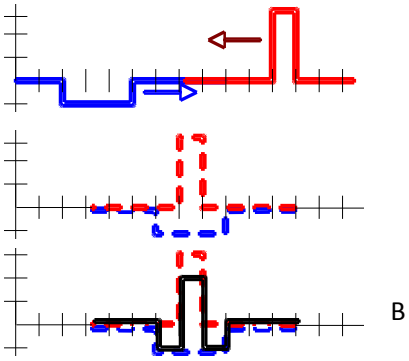
A. lower its speed.
B. increase its wavelength.
C. lower its amplitude.
D. shorten its period.

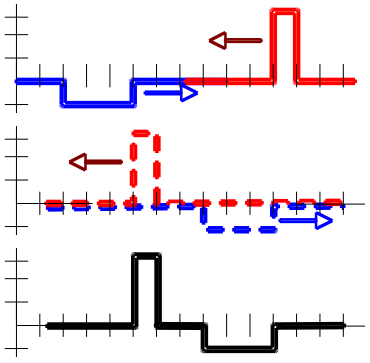
The pulse on the left is moving right, the pulse on the right is moving left. What do you see when the pulses overlap?





Rest of question





After interacting

Adapted from CQ from Pollock University of Colorado

A periodic wave is made to travel from a thick string into a thin string held at the same tension.

As the wave passes the join the wave's

A. frequency increases.

B. frequency decreases.

C. wavelength increases.

D. wavelength decreases.

Wave refraction

Sound Activity

I used questions 1-8 with the sound activity and the rest on the next day.

Learning Goals: Students will be able to

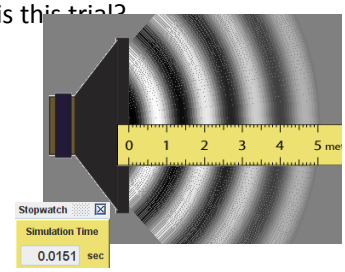
- **Explain how different sounds are modeled, described, and produced.**

Design ways to determine the speed, frequency, period and wavelength of a sound wave model.

Trish Loeblein phet.colorado.edu

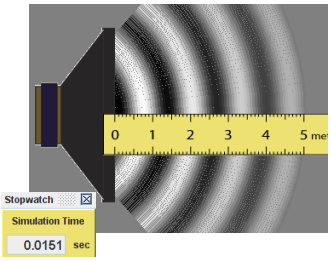
1. A student started the speaker by clicking on the stopwatch. How many sound waves are there is this trial?

A. 3
B. 5
C. 4
D. 8



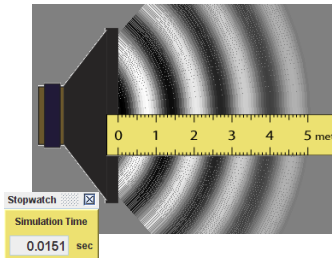
2. What is the speed of the sound waves shown here?

A. 300 m/s
B. 330 m/s
C. 0.0030 m/s
D. 66 m/s



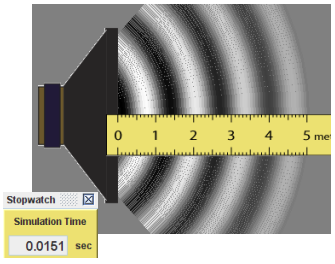
3. What is the frequency of the sound waves shown here?

A. 0.0037 hz
B. 66 hz
C. 260 hz
D. 300 hz
E. 330 hz



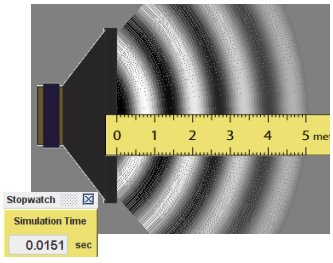
4. What is the period of the sound waves shown here?

A. 0.0151 s
B. 0.0037 s
C. 260 s
D. 300 s
E. 330 s

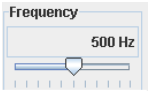


5. What is the wavelength of the sound waves shown here?

A. 5 m
B. 1.3 m
C. 1 m
D. 0.71 m
E. 300 m



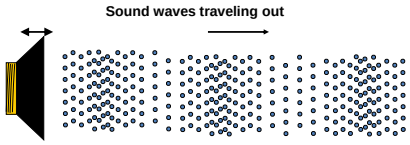
6. If your lab partner moved the frequency slider to the left so that it changed from 500 to 250 the period would be



A. twice as big
B. 1/2 as big
C. Stays the same
D. 1/4 times as big
E. Not enough information to decide

7. If you moved the slider to the far right, doubling the amplitude, the period would be…

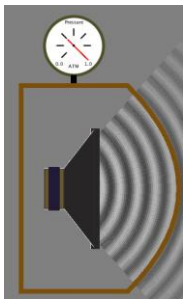
A. twice as big
B. 1/2 as big
C. Stays the same
D. 1/4 times as big
E. Not enough information to decide



8. If the speaker vibrates back and forth at 200 Hz how much time passes between each time it produces a maximum in pressure?

a. 0.2 seconds
b. 0.200 seconds
c. 0.005 seconds
d. 0.02 seconds
e. 0.05 seconds

9.A speaker is playing a constant note. What happens to the sound when you
1) put a solid, thick glass jar over it and
2) pump the air out from the jar.



A) 1 => hardly any difference
2 => hardly any difference

B) 1=> hardly any difference
2 => much quieter

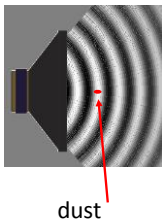
C) 1=> noticeably quieter
2 => hardly any MORE quiet

D) 1=> noticeably quieter
2=> much quieter still (near silence)

E) None of these/something else/??

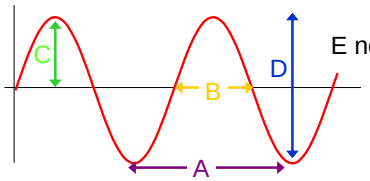
Adapted From Pollock at CU 1240 course at University of Colorado

10. If you could put a dust particle in front of the speaker. Which choice below shows the *motion* of the dust particle?



A) ↕ (up and down)
B) → (steadily to the right)
C) ↔ (left and right)
D) (no motion)
E) ↻ (circular path)

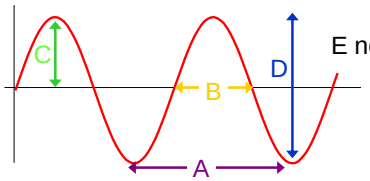
11.The picture shows "displacement as a function of location along a string"
What is the wavelength ("λ")?



E none of these

Remember X axis is **position** not time

12.The picture shows "displacement as a function of location along a string"
What is the amplitude?

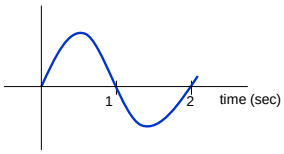


E none of these

Remember X axis is **position** not time

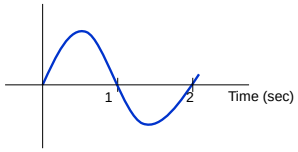
Fundamentals of waves

13.Looking at the following waveform, what is the period? assume it repeats itself over and over



A.1 sec
B. 2 sec
C. 1 m/s
D. 2 m/s
E.Not enough information

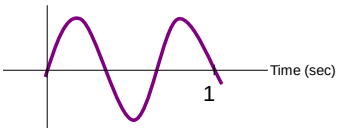
14 Looking at that same wave, what is its speed?



A.1/2 m/s
B.2 m/s
C.5 m/s
D.20 m/s
E.Not enough information

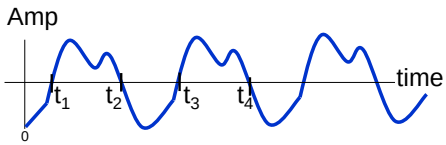
CT 2.1.10

15 The wavelength, λ, is 10 m. What is the speed of this wave?



A) 1 m/s
B) just under 7 m/s
C) 10 m/s
D) 15 m/s
E) None of the above/not enough info/not sure

16 What is the period of this wave?



a) t_1
b) t_2
c) t_2-t_1
d) t_3-t_1
e) None of the above

17 Which one of the following is most likely to be *impossible*?

A. Transverse waves in a gas
B. Longitudinal waves in a gas
C. Transverse waves in a solid
D. Longitudinal waves in a solid
E. They all seem perfectly possible

18. To increase the volume of a tone at 400 Hz heard by the listener, the speaker must oscillate back and forth more times each second than it does to produce the tone with lower volume.

A. True B. False

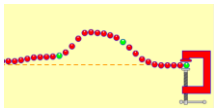
Wave Interference Activity is a demo that uses three simulations: *Waves on a String, Wave Interference, and Sound*.

Trish Loeblein phet.colorado.edu

Learning Goals: Students will be able to

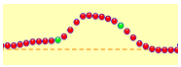
- Predict the pattern of a reflected wave
- Relate two dimensional representations of waves to three dimensional waves
- Explain wave patterns from interfering waves *(Apply the superposition principle to water, sound and light)*
- Recognize the Doppler effect and predict the change in frequency that occurs.

1. What will this wave look like after it reflects?

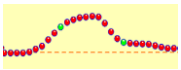


Fixed end

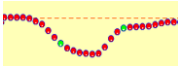
A.



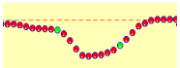
B.



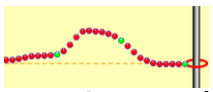
C.



D.

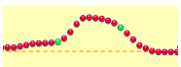


2. What will this wave look like after it reflects?

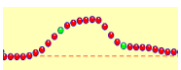


Loose end

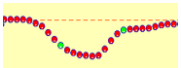
A.



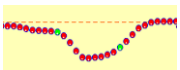
B.



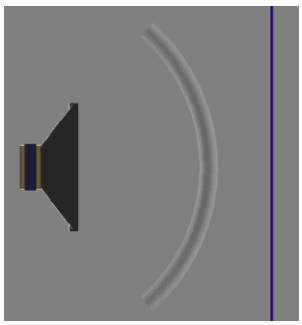
C.



D.

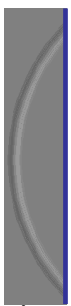


Draw what you think this wave will look like after reflecting off the barrier.



3. Which one is the reflection pattern?

Wave pulse from speaker



A

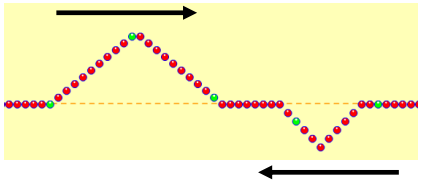
B

"Sound waves are three dimensional."

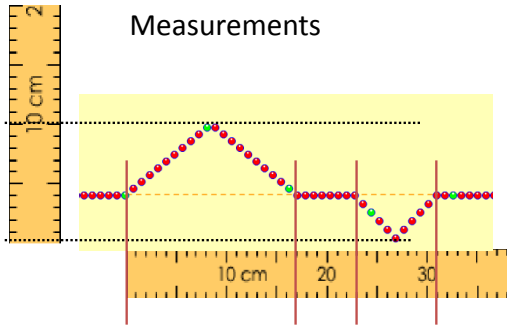
Talk to your partner:

- What evidence you have that supports this.
- How the wave could be represented
- How would reflection change?

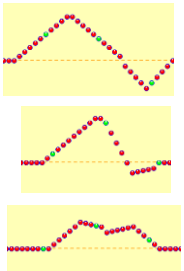
Sketch what you think the pattern will look like



Measurements



Paused clips



Fourier: Making Waves Activity

1 Wave Representation Learning Goals:
Students will be able to think about waves as a function of time, space or space-time and explain why waves might be represented in these different ways.

2 Superposition of Waves Learning Goals:
Students will be able to:
•Define harmonic, determine the relationship between the harmonics,
•Explain the relationship between harmonics and the corresponding wave function.
•Predict what happens when more than one wave is present.

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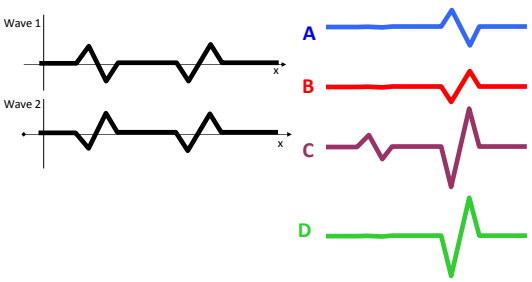
1. If these two waves were moving through water at the same time, what would the water look like?



Geometric Optics Activity

Plane mirrors only

Learning Goals: Students will be able to explain

- How a converging lens makes images.
- How changing the lens effects where the image appears and how it looks

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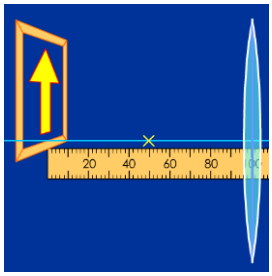
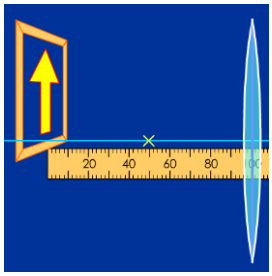
Where will the image appear?

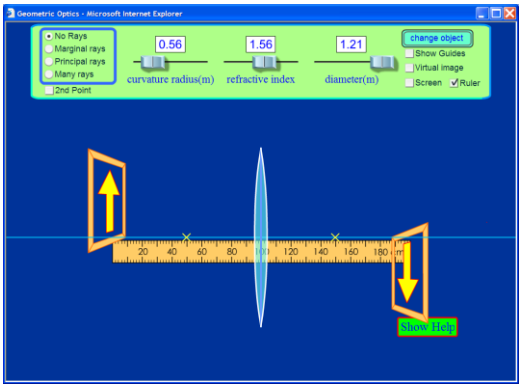


A. On the left, at the zero mark.
B. On the right, at the 150 mark.
C. On the right, at the 200 mark.
D. On the right, at the 300 mark.

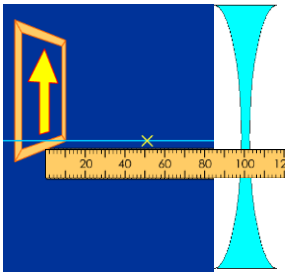
How will the image look?



A. Same size ⇧
B. Smaller ⇧
C. Larger ⇧
D. Same size ⇩
E. Smaller ⇩

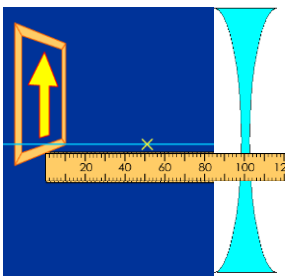


Where will the image appear if the lens were concave?



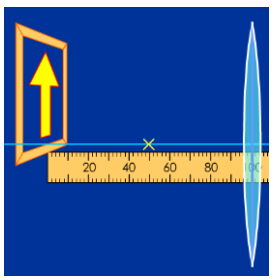
A. On the left, at the zero mark.
B. On the left, at the 67 mark.
C. On the left, at the 33 mark.
D. On the right, at the 200 mark.

How will the image look?

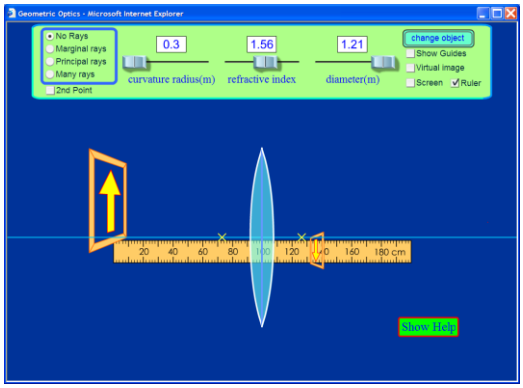


A. Same size ⇧
B. Smaller ⇧
C. Larger ⇧
D. Same size ⇩
E. Smaller ⇩

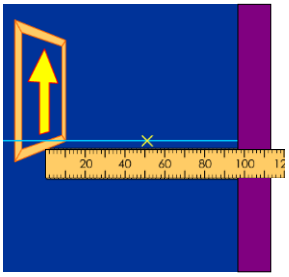
If the lens is made fatter in the middle, how will the image change?



A. Larger, further away
B. Smaller, further away
C. Larger, closer
D. Smaller, closer

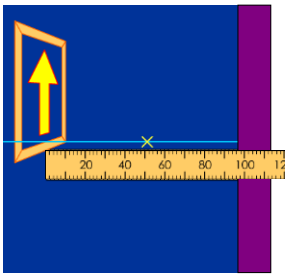


If you replace the lens with a mirror, the image will be



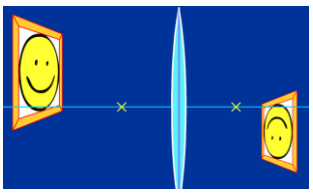
A. Same size
B. Smaller
C. Larger
D. Same size
E. Smaller

If you move the arrow towards the mirror, the image will be

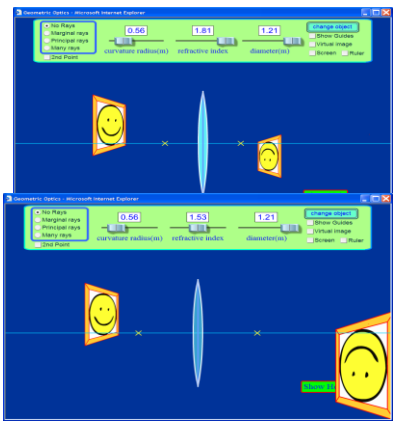


A. Same size
B. Smaller
C. Larger
D. Same size
E. Smaller

If the lens had a lower index of refraction, the image be



A. Same size
B. Smaller
C. Larger
D. Same size
E. Smaller



Resonance
Activity
by Trish Loeblein and Mike Dubson

Learning Goals: Students will be able to:

1. Describe what resonance means for a simple system of a mass on a spring.
2. Identify, through experimentation, cause and effect relationships that affect natural resonance of these systems.
3. Give examples of real-world systems to which the understanding of resonance should be applied and explain why. (not addressed in CQ's)

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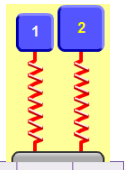
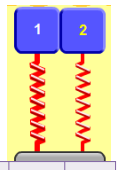
1. **Which system will have the lower resonant frequency?**



Mass (kg)	2.5	5.0
Spring constant (N/m)	100	100

A) 1 B) 2 C) Same frequency

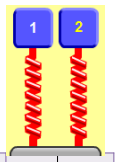
2. **Which system will have the lower resonany frequency?**



Mass (kg)	5.0	5.0
Spring constant (N/m)	200	100

A) 1 B) 2 C) Same frequency.

3. **Which system will have the lower resonance frequency?**

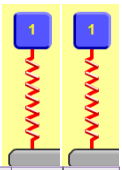


Mass (kg)	3.0	3.0
Spring constant (N/m)	400	400
Driver Amplitude (cm)	0.5	1.5

A) 1 B) 2 C) Same frequency.

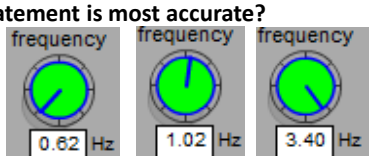
4. **Which best describes how the motion of the masses vary?**

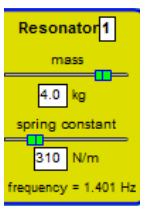
A. Less driver amplitude results in greater max height & faster oscillation
B. More driver amplitude results in greater max height & faster oscillation
C. Less driver amplitude results in greater max height
D. More driver amplitude results in greater max height



Mass (kg)	3.0	3.0
Spring constant (N/m)	400	400
Driver Amplitude (cm)	0.5	1.5

4. **If the frequency f of the driver is not the same as the resonant frequency, which statement is most accurate?**





The steady-state amplitude is ..
a) smallest at the highest driver f.
b) largest at the highest driver f.
c) is largest at driver f nearest the resonant frequency.
d) is independent of driver f.