Activity worksheet: waves

Name	Group	Date

What you will learn

With the waves simulation you will make a string and a spring vibrate. You will discover that a wave carries energy but not matter, you will tell transverse waves from longitudinal ones and you will measure the quantities that describe a wave: amplitude, wavelength, period, frequency and speed.

How to work. Each activity has three steps:

1. **Predict.** Before looking at the simulation, write down what you think will happen and why.
2. **Observe.** Set up the simulation, watch what happens and note down the data.
3. **Explain.** Compare what happened with your prediction and explain why.

If your prediction turns out to be wrong, don't rub it out: getting it wrong and understanding why is the best way to learn.

Each activity has a link that opens the simulation already set up. If you have the worksheet on paper, go to **simulaciencia.es/en/simulations/ondas** and set it up as described under “Set up the simulation”.

How to read the data. On the left is the source, which produces the wave. If you click on a particle of the medium, it is marked in red as P. The “Wave quantities” box gives the amplitude (A, in m), the wavelength (λ, in m), the period (T, in s), the frequency (f, in Hz) and the speed (v, in m/s). With “×0.25” everything runs four times slower and is easier to watch.

Before you start

What do you think now? Write T (true) or F (false). You will come back to this table at the end.

Statement	T or F
a) When a wave travels along a string, the pieces of string travel with it.	
b) If you move the source faster, the wave travels faster.	
c) A wave with a larger amplitude (taller) travels faster.	
d) A longitudinal wave has no wavelength and no amplitude.	
e) Sea waves carry the water to the beach.	

Activity 1. What travels with the wave?

Set up the simulation: Transverse mode, type **One pulse at a time**. Open the simulation ready to use

Predict. Click on a particle in the middle of the string to mark it. When the pulse arrives, do you think the particle will travel with it to the end of the string?

My prediction

Observe. Press "〰 Send a pulse" several times and follow particle P. Look at the row "Particle P has moved" in the "Energy, yes; matter, no" box.

Question	What I observe
How does P move when the pulse arrives?	
Where is P once the pulse has passed?	
How far has the pulse travelled?	

Explain. If the particle does not travel with the pulse, what is it that travels along the string? Write a definition of a wave.

My explanation

Activity 2. The parts of a wave

Set up the simulation: Transverse, **Continuous wave**, amplitude 0.20 m, frequency 1.00 Hz and speed 1.5 m/s. Open the simulation ready to use

Predict. Draw a wave and mark on your drawing a crest, a trough, the amplitude and the wavelength.

My drawing

Observe. Press "↺ Restart" and watch the wavefront advance. Then read the measurements marked on the drawing. To measure the period, choose "×0.25", mark a particle and time one complete oscillation (remember that time runs four times slower).

Quantity	Value	How did you measure it?
Amplitude A		

Quantity	Value	How did you measure it?
Wavelength λ		
Period T		
Frequency f		
Speed v		

Explain. Use your data to check that T = 1 / f and v = λ · f. What does a frequency of 1 Hz mean?

My explanation

Activity 3. Moving the source faster

Set up the simulation: Transverse, continuous wave with frequency **0.50 Hz** and speed 1.5 m/s. Open the simulation ready to use

Predict. If the source vibrates faster (higher frequency), will the wave travel faster? What will happen to the distance between crests?

My prediction

Observe. Change the "Frequency (f)" and wait for the new wave to fill the string.

Frequency f (Hz)	Period T (s)	Wavelength λ (m)	Speed v (m/s)	λ · f (m/s)
0.50				
1.00				
2.00				

Explain.

1. When the frequency goes up, does the speed of the wave change? What does change?
2. When you change the frequency, does the whole wave change at once? Why?

My answers

My answers

Activity 4. Changing the medium

Set up the simulation: Transverse, continuous wave with frequency 1.00 Hz and speed **1.0 m/s**. Open the simulation ready to use

Predict. The speed of a wave depends on the medium; for example, on how tight the string is. If the wave travels faster and the source vibrates in the same way, what will happen to the wavelength?

My prediction

Observe. Change the "Wave speed (v)".

Speed v (m/s)	Frequency f (Hz)	Wavelength λ (m)
1.0	1.00	
1.5	1.00	
3.0	1.00	

Explain. What depends on the source and what depends on the medium? Give a real-life example of a wave changing medium.

My explanation

Activity 5. How much energy does the wave carry?

Set up the simulation: Transverse, continuous wave with amplitude **0.10 m** and frequency 1.00 Hz. Open the simulation ready to use

Predict. If you double the amplitude, will the wave travel faster? Will it carry twice as much energy?

My prediction

Observe. Change the amplitude and the frequency and read the energy bar, which compares with the starting wave (A = 0.20 m and f = 1.00 Hz).

Amplitude A (m)	Frequency f (Hz)	Speed v (m/s)	λ (m)	Energy (× the starting value)
0.10	1.00			
0.20	1.00			
0.30	1.00			
0.20	2.00			

Explain.

1. Do the speed or the wavelength change when you change the amplitude? What does change?
2. When you double the amplitude, how many times greater is the energy? Link this to the volume of a loudspeaker or to an earthquake.

My answers

Activity 6. Transverse and longitudinal

Set up the simulation: Compare mode, continuous wave. Open the simulation ready to use

Predict. On the string, the particles vibrate up and down. How do you think the particles of the spring will vibrate?

My prediction

Observe. Mark one particle on the string and another on the spring and compare them.

	String (transverse)	Spring (longitudinal)
Direction in which the particles vibrate		
Direction in which the wave travels		
What do you see instead of crests?		
What do you see instead of troughs?		
Wavelength λ (m)		

Explain. Classify these waves as transverse or longitudinal: sound, light, a wave on a skipping rope, a spring that is stretched and compressed. Open “Key formulas” if you need help.

My explanation

Apply what you have learnt

Solve these without the simulation. Write the formula, the calculation with its units and the result.

1. A wave has a frequency of 5 Hz and a wavelength of 0.40 m. Calculate its period and its speed.
2. Sound travels through air at 340 m/s. Calculate the wavelength of the note A (440 Hz).
3. A buoy rises and falls 10 times in 20 s and the distance between two crests of the waves is 3 m. Calculate the frequency, the period and the speed of the waves.
4. Why does an anchored boat rise and fall with the waves but not move towards the beach?

Problem	Working and result
1	
2	
3	
4	

Review your ideas

Go back to the “Before you start” table. Would you change any of your answers? Write which one and explain why, using something you saw in the simulation.

What has changed in my ideas

Going further (Year 13)

Tick the box “Show the equation, the graphs and the phase”. Open the simulation ready to use

1. With A = 0.20 m, f = 1.00 Hz and v = 1.50 m/s, calculate ω, k and λ and write the equation y(x, t). Compare it with the one under “Equation and phase”.
2. Calculate the maximum vibration speed, A · ω. Is it the same as the wave speed? Raise the amplitude to 0.30 m: which of the two changes?

3. Press “Δx = λ/2” and “Δx = λ”. What is the phase difference Δφ between P and Q in each case? What do their curves look like on the “Displacement – time” graph?

My answers

Self-assessment

Put an X to show how confident you feel at the end.

I can...	Yes	Nearly	Not yet
Explain that a wave carries energy but not matter			
Tell transverse and longitudinal waves apart and give examples			
Identify the amplitude, the wavelength, the crests and the troughs			
Use T = 1 / f and v = λ · f			
Explain what depends on the source and what depends on the medium			
Use a prediction and an observation to change an idea I had			

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