Rope Wave Lab

Use motion data to model a traveling wave

PHY.4.2 "Describe and model through digital or physical means the characteristics and properties of mechanical waves by simulating and investigating properties of simple harmonic motion."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two details that show how the tape moves, circle the measurements needed to model its motion, and number the steps you would use to find the wavelength.

A Wave Across the Gym

1. At a gym demonstration, a motor moves one end of a stretched rope up and down in a smooth, repeating cycle. A strip of tape marks one point near the middle. The tape crosses the rope's resting line, but it does not travel down the rope. The disturbance carries energy toward the far end.

2. The motor's sinusoidal motion makes the tape move in simple harmonic motion while the rope stays taut. A sensor records the tape's vertical displacement at regular times. Positive values mean above the resting line; negative values mean below it. The wave travels to the right at 2 meters per second.

DISPLACEMENT OF THE MARKED POINT

Time (s)	Vertical displacement (cm)
0.00	+4
0.25	0
0.50	-4
0.75	0
1.00	+4

3. Each point on the rope repeats the motor's motion, starting slightly later than its neighbor. Amplitude is the greatest distance from rest. Period is the time for one cycle, and frequency is cycles per second. Wave speed equals frequency times wavelength. With rope tension unchanged, changing motor frequency leaves wave speed nearly constant.

2 ANSWER WITH EVIDENCE

Use the passage

1. What amplitude should a model of the tape's motion use? Which table values support your choice?

2. What period and frequency should the model use? Explain how the table shows one full cycle.

3. What wavelength should the model show? Use the wave speed and the frequency you found.

4. If the motor's frequency doubles while rope tension stays unchanged, what wavelength should the model show? Explain your reasoning.

3 YOUR TURN

Your own words

Design a digital or physical rope-wave model with amplitude 3 cm, period 0.40 s, and wave speed 3 m/s, starting a marked point at its highest position. Give its displacement at five equally spaced times from 0 to 0.40 s, calculate frequency and wavelength, and explain what moves along the rope.

ANSWER KEY

Rope Wave Lab

PART 1 · READ AND MARK

Underline two details that show how the tape moves, circle the measurements needed to model its motion, and number the steps you would use to find the wavelength. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What amplitude should a model of the tape's motion use? Which table values support your choice?	**Use an amplitude of 4 cm. The largest distances from rest are +4 cm and -4 cm.**
2	What period and frequency should the model use? Explain how the table shows one full cycle.	**The period is 1.00 s, and the frequency is 1 Hz. The tape goes from +4 cm through 0 and -4 cm, then returns to +4 cm at 1.00 s.**
3	What wavelength should the model show? Use the wave speed and the frequency you found.	**The wavelength is 2 m: 2 m/s divided by 1 Hz equals 2 m.**
4	If the motor's frequency doubles while rope tension stays unchanged, what wavelength should the model show? Explain your reasoning.	**It should show a wavelength of about 1 m. Frequency doubles to 2 Hz while speed stays near 2 m/s, so wavelength is about 2 m/s divided by 2 Hz.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would move one end of a taut rope in a smooth repeating cycle and mark one point on it. At 0, 0.10, 0.20, 0.30, and 0.40 s, that point's displacements would be +3, 0, -3, 0, and +3 cm. Its frequency is 1 ÷ 0.40 s = 2.5 Hz. The wavelength is 3 m/s ÷ 2.5 Hz = 1.2 m. The disturbance moves along the rope, while the marked point moves up and down.

Accept equivalent descriptions of a digital simulation or physical setup. For the open task, check that the marked point completes one cycle without traveling along the rope.