String Wave Energy

Use simulation data to investigate how wave settings affect energy transfer.

PHY.4.4 "Investigate and communicate the relationship between the energy of a wave in terms of amplitude and frequency using probe systems, online simulations, and/or laboratory experiences."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that describes the power pattern, then circle pairs of table values that let you test amplitude separately from frequency.

Power Along a String

1. A motor shakes one end of a stretched string while a sensor records the wave. The string tension and string type stay fixed, so wave speed stays nearly constant. Amplitude is the greatest distance the string moves from its resting position. Frequency counts how many complete cycles pass a point each second.

2. An online model estimates average power carried along this string, meaning wave energy transferred each second. Its readings are shown below as relative values, not watts. Changing amplitude or frequency changes power, even when wave speed stays constant. Compare trials that change just one setting to see which setting caused a difference.

ONLINE STRING-WAVE MODEL READINGS

Trial	Amplitude (cm)	Frequency (Hz)	Relative average power
A	1	2	1
B	2	2	4
C	1	4	4
D	2	4	16

3. For a steady sinusoidal wave on this string, average power scales with the square of amplitude and the square of frequency. That model applies when the string's tension and mass per length stay fixed. A real setup can test the model with repeated trials, since sensor readings may vary because of friction or imperfect measurements.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare trials A and B. Which setting changes, and what happens to average power?

2. Compare trials A and C. Which setting changes, and what happens to average power?

3. Trials B and C have different settings but the same relative average power. How does each trial reach a value of 4 compared with trial A?

4. Compare trials A and D. How does changing both settings affect average power compared with changing only one setting?

3 YOUR TURN

Your own words

Design two new trials for the same string, each starting from trial A. Change only amplitude in one trial and only frequency in the other. Give both settings and predicted relative average power for each trial, then explain how an online simulation could check your predictions.

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PART 1 · READ AND MARK

Underline the sentence that describes the power pattern, then circle pairs of table values that let you test amplitude separately from frequency. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare trials A and B. Which setting changes, and what happens to average power?	**Amplitude doubles from 1 cm to 2 cm while frequency stays at 2 Hz. Relative average power rises from 1 to 4.**
2	Compare trials A and C. Which setting changes, and what happens to average power?	**Frequency doubles from 2 Hz to 4 Hz while amplitude stays at 1 cm. Relative average power rises from 1 to 4.**
3	Trials B and C have different settings but the same relative average power. How does each trial reach a value of 4 compared with trial A?	**B doubles amplitude while keeping frequency fixed. C doubles frequency while keeping amplitude fixed. Each change makes relative average power four times trial A's value.**
4	Compare trials A and D. How does changing both settings affect average power compared with changing only one setting?	**Doubling both amplitude and frequency raises relative average power from 1 to 16. Doubling only one setting raises it from 1 to 4.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

In my first new trial, I would use an amplitude of 3 cm and a frequency of 2 Hz. Tripling amplitude makes the predicted relative average power 9. In my second trial, I would use an amplitude of 1 cm and a frequency of 6 Hz. Tripling frequency also makes the predicted relative average power 9. I would enter each pair of settings in the simulation and compare its average-power reading with my prediction.

Accept predictions consistent with relative average power proportional to amplitude squared times frequency squared. Each new trial must change only one setting from trial A.