Wave Math Evidence

Use wave data and equations to support scientific claims.

HS-PS4-1 "Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media..."

NAME ______________________ DATE ____________

1 READ AND MARK

Read it twice

YOUR JOB Underline every speed, frequency, and wavelength value, circle each medium, and number the equations or statements that show how the quantities are related. Use your marks to find the data you need for each claim.

Waves in Different Media

1 Waves carry energy from place to place. Their speed (v), frequency (f), and wavelength (λ) are connected by $v = f\lambda$. Frequency is the number of wave cycles that pass a point each second, measured in hertz (Hz). Wavelength is the distance from one matching point on a wave to the next, measured in meters. To solve for wavelength, use $\lambda = v/f$. In one medium, if speed stays constant, increasing frequency makes wavelength decrease. If frequency stays constant, a change in speed produces the same-direction change in wavelength.

2 Electromagnetic waves can travel through a vacuum, but their speed depends on the medium. In a vacuum, light travels at 3.00×10^8 m/s. In a certain glass, it travels at 2.00×10^8 m/s. A laboratory sends light with a frequency of 6.00×10^{14} Hz from vacuum into that glass. The frequency is set by the source and remains 6.00×10^{14} Hz when the light enters the glass. Use meters and seconds so each calculated wavelength is in meters. These data let you test a claim with equations rather than observations alone.

3 Sound waves need matter to travel. Near room temperature, sound speed is about 340 m/s in air and 1,500 m/s in water. A 500 Hz tuning fork is heard by a microphone first in air and then in water. The fork sets the frequency, so use 500 Hz for both calculations. The two media have different speeds, even though the source frequency is unchanged. A scientist can calculate a wavelength for each situation with $\lambda = v/f$, then use the results as mathematical evidence for a claim about the effect of medium on wavelength.

2 ANSWER WITH EVIDENCE

Use the passage

1. Calculate the wavelength of the light while it travels in the vacuum. Show the equation you use.

2. Calculate the wavelength of the same light in the glass. Then write a claim about how entering the glass changed its wavelength, using both calculated values as evidence.

3. Calculate the wavelength of the 500 Hz sound wave in air and in water. What claim do these calculations support about speed and wavelength when frequency stays the same?

4. For the light data, compare the speed ratio of glass to vacuum with the wavelength ratio of glass to vacuum. What do the matching ratios show?

3 YOUR TURN

Your own words

A wave with a frequency of 250 Hz travels at 1,000 m/s in medium A and 1,500 m/s in medium B. Make a two-row table showing speed, frequency, and calculated wavelength for each medium, then write a claim supported by your calculations.

ANSWER KEY **Wave Math Evidence** HIGH SCHOOL · HS-PS4-1

PART 1 · READ AND MARK

Underline every speed, frequency, and wavelength value, circle each medium, and number the equations or statements that show how the quantities are related. Use your marks to find the data you need for each claim. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Calculate the wavelength of the light while it travels in the vacuum. Show the equation you use.	**λ = v/f = (3.00 × 10^8 m/s)/(6.00 × 10^14 Hz) = 5.00 × 10^-7 m.**
2	Calculate the wavelength of the same light in the glass. Then write a claim about how entering the glass changed its wavelength, using both calculated values as evidence.	**λ = (2.00 × 10^8 m/s)/(6.00 × 10^14 Hz) = 3.33 × 10^-7 m. Claim: At the same frequency, the light has a shorter wavelength in the glass because its speed is lower there.**
3	Calculate the wavelength of the 500 Hz sound wave in air and in water. What claim do these calculations support about speed and wavelength when frequency stays the same?	**Air: λ = 340/500 = 0.68 m. Water: λ = 1,500/500 = 3.0 m. Claim: At the same frequency, the faster sound wave has the longer wavelength.**
4	For the light data, compare the speed ratio of glass to vacuum with the wavelength ratio of glass to vacuum. What do the matching ratios show?	**Speed ratio = (2.00 × 10^8)/(3.00 × 10^8) = 0.667. Wavelength ratio = (3.33 × 10^-7)/(5.00 × 10^-7) = about 0.667. The matching ratios show that wavelength is proportional to speed when frequency is constant.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Medium A | v = 1,000 m/s | f = 250 Hz | λ = 1,000/250 = 4.0 m Medium B | v = 1,500 m/s | f = 250 Hz | λ = 1,500/250 = 6.0 m Claim: At the same frequency, the wave in medium B has a longer wavelength because it travels faster. The calculations show a 6.0 m wavelength in B and a 4.0 m wavelength in A.

Accept equivalent equations, units, and reasonable rounding, including 3.3 × 10^-7 m and 0.67 for the ratios. Claims must connect the calculated values to the relationship that, at constant frequency, wavelength changes in the same direction as wave speed.