

2.7 Relate wave properties to energy transfer and motion

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS frequency 频率 • wavelength 波长 • transverse wave 横波

Objective

Relate wave properties to energy transfer and motion. This is original GAC023-aligned practice, not an official assessment. All supplied case data and review records are fictional; explicitly cited background is factual. The case data are invented for learning; they are not findings about a real school, country or population. Use the supplied evidence and do not invent missing observations.

1 Key knowledge and worked examples

■ **Key knowledge: wavelength, frequency and amplitude describe different properties**

Frequency 频率 is the number of complete oscillations per second. **Wavelength** 波长 is the distance between successive points in the same phase, such as neighbouring crests. Wave speed follows $v = f\lambda$ for the stated wave. A **transverse wave** 横波 has oscillation perpendicular to propagation; a longitudinal wave has oscillation parallel to propagation. Amplitude is the maximum displacement from equilibrium, not crest-to-trough height. A travelling disturbance transfers energy without carrying each medium particle along with it.

■ **Source A: text or task brief**

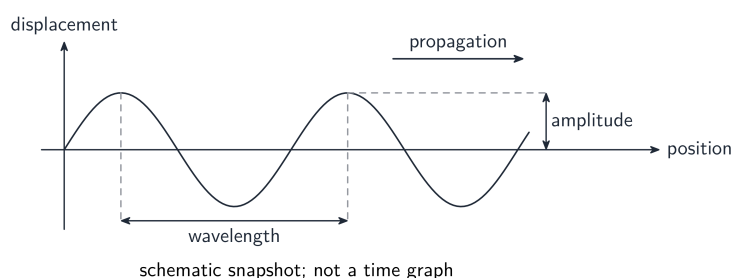
Supplied fictional string-wave record: frequency 5.0 Hz, wavelength 0.40 m and amplitude 0.030 m. A marked point on the string oscillates vertically while the disturbance travels horizontally. Use $v = f\lambda$ and $T = 1/f$. No change of medium, frequency or amplitude has been measured.

A separate spring description has coils oscillating along the direction in which compressions travel; it is a longitudinal mechanical-wave example. Electromagnetic waves do not require a material medium. Different electromagnetic frequencies share the same vacuum speed, but this does not give every mechanical wave that speed.

■ Source B: response or review record

Student note: “The string is longitudinal because the disturbance goes horizontally. Wavelength is the height from crest to trough, so it is 0.060 m. The marked point moves permanently to the right with the wave. Increasing amplitude must increase the frequency, and every wave travels at the speed of light because all electromagnetic waves do.”

■ Worked example: choose the relation from the quantity requested



Known: frequency 5.0 Hz and wavelength 0.40 m. Why multiply them? Each second there are five complete cycles, each associated with a spatial wavelength.

$$v = f\lambda$$

$$v = 5.0 \text{ Hz} \times 0.40 \text{ m} = 2.0 \frac{\text{m}}{\text{s}}$$

This is the supplied string-wave speed, not an electromagnetic vacuum speed. The marked point oscillates about equilibrium rather than travelling with each crest.

2 Practice

2.1 Classify the string wave and explain the direction relationship.

[2]

2.2 Calculate the string-wave speed.

[2]

2.3 Calculate the period and the crest-to-trough displacement difference. [3]

2.4 Explain the motion of the marked point and distinguish it from disturbance propagation. [3]

3 Exam-style questions

3.1 Evaluate the spring, amplitude and universal-speed claims using six points. [6]

Solutions

2.1

: transverse.: vertical oscillation is perpendicular to horizontal propagation.

2.2

: $v = f\lambda$.: $v = 5.0 \text{ Hz} \times 0.40 \text{ m} = 2.0 \text{ m/s}$.

2.3

: $T = 1/f$ and crest-to-trough difference = $2A$.: $T = 1/5.0 = 0.20 \text{ s}$.: difference = $2 \times 0.030 = 0.060 \text{ m}$; it is not wavelength.

2.4

: point moves up and down about equilibrium.: disturbance/energy moves along the string.: this does not imply a permanent rightward transport of that point with the wave.

3.1

each: spring example is longitudinal from parallel coil motion/propagation; direction on a page alone does not determine wave type; amplitude differs from frequency; no supplied observation establishes that changing amplitude changes frequency; electromagnetic waves share a vacuum speed under stated conditions; mechanical waves depend on their medium and are not all light-speed waves.

3.2

Local analytic rubric, 8 $\times$: classify string as transverse; distinguish directions; state 2.0 m/s; state 0.20 s; distinguish 0.060 m height from wavelength; explain point oscillation; keep amplitude distinct from frequency; avoid universal-light-speed claim; coherent truthful 80–110 word response. Example: “The string wave is transverse because its marked point oscillates vertically while the disturbance propagates horizontally. Its supplied frequency and wavelength give a speed of 2.0 metres per second and a period of 0.20 seconds. The amplitude is 0.030 metres, so crest-to-trough height is 0.060 metres; neither height is the wavelength. The marked point oscillates about equilibrium rather than moving permanently along with the disturbance. Amplitude and frequency describe different properties, and no change linking them was measured here. The spring example is longitudinal. Electromagnetic vacuum speed does not establish the speed of every mechanical wave.”