

Exercise walk-through

12.1

Waves, measurement and refraction

International Baccalaureate · IB Diploma · Physics · HL

12.1 Waves, measurement and refraction

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS frequency • wavelength

Objective

Waves, measurement and refraction. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

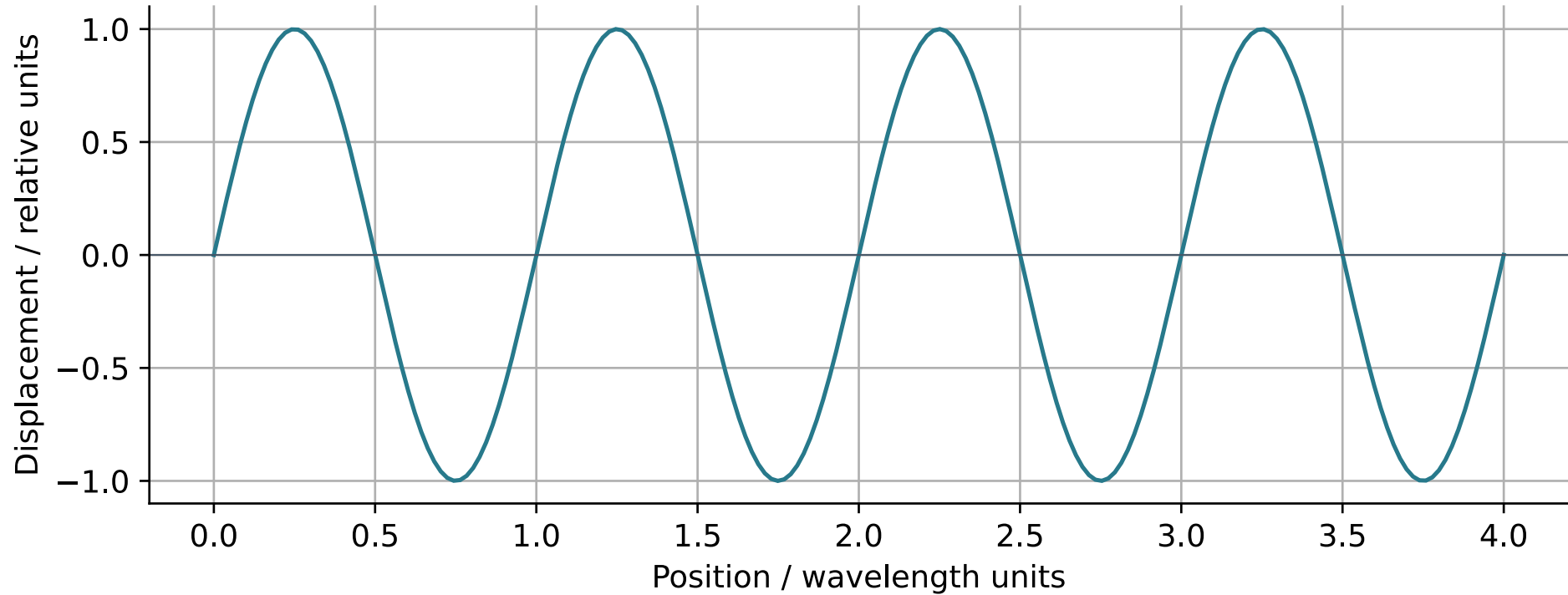
■ What would explain this observation?

- A wave can carry energy across water while a floating marker mainly oscillates. Energy transfer and bulk transfer of matter are different.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- **Frequency** is oscillations per time; **wavelength** is distance between successive points in phase. Wave speed equals frequency multiplied by wavelength. Transverse oscillations are perpendicular to propagation.

- wavelength: Distance between successive points in phase; frequency: Number of oscillations per unit time.



■ **Choose evidence that can test it**

- At a boundary, frequency stays fixed by the source. A change of speed changes wavelength. Refraction follows from speed differences; angles are measured from the normal.
- Measure several wavelengths and divide to reduce fractional reading uncertainty. Use a ray box with a normal drawn at the boundary. Keep the beam away from eyes and record incident and refracted angles clearly.

■ **Work from known quantities**

- State the known values and their units. Choose the relation because its assumptions

fit this case, then rearrange before substitution.

- Known: frequency 5 Hz and wavelength 0.40 m. Use $v = f\lambda$. $v = 5 \times 0.40 = 2.0$ metres per second. If speed falls to 1.5 metres per second at the same frequency, wavelength $= v/f = 1.5/5 = 0.30$ m.

Example:

Frequency is 8 Hz and wavelength is 0.25 m. Find wave speed. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- The wave frequency does not change simply because the medium changes. A longitudinal wave has oscillations parallel to propagation.

- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Wave frequency always changes when a wave enters a new medium. This claim is false: The wave frequency does not change simply because the medium changes. A longitudinal wave has oscillations parallel to propagation.

Key:

Waves, measurement and refraction: At a boundary, frequency stays fixed by the source. A change of speed changes wavelength. Refraction follows from speed differences; angles

are measured from the normal.

Exercises 2.1·2.3

2.1 When a wave enters a slower medium, what stays constant? Choose one answer.

- **A** Frequency
- **B** Wavelength
- **C** Speed

[1]

2.2 Frequency is 8 Hz and wavelength is 0.25 m. Find wave speed. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Wave frequency always changes when a wave enters a new medium.

[2]

Exercises 2.1·2.3

2.1 When a wave enters a slower medium, what stays constant? Choose one answer.

- **A** Frequency
- **B** Wavelength
- **C** Speed

[1]

2.1 A At a boundary, frequency stays fixed by the source. A change of speed changes wavelength. Refraction follows from speed differences; angles are measured from the normal.

2.2 Frequency is 8 Hz and wavelength is 0.25 m. Find wave speed. Show the relation, substitution and units.

[2]

2.2 $v=f\lambda=8\times 0.25=2.0\text{ m/s}$.

2.3 Decide whether this claim is true and justify: Wave frequency always changes when a wave enters a new medium.

[2]

2.3 False. The wave frequency does not change simply because the medium changes. A longitudinal wave has oscillations parallel to propagation.

Exercises 2.4·3.1

2.4 Distance between successive points in phase: write the technical term. [1]

3 Exam-style questions

3.1 A 5 Hz wave crosses a stationary boundary where speed falls from 2 to 1 m/s. Compare wavelengths and frequency. Explain the unchanged frequency. [4]

Exercises 2.4·3.1

2.4 Distance between successive points in phase: write the technical term. [1]

3 Exam-style questions

2.4 wavelength. wavelength means Distance between successive points in phase.

3.1 A 5 Hz wave crosses a stationary boundary where speed falls from 2 to 1 m/s. Compare wavelengths and frequency. Explain the unchanged frequency. [4]

3.1 Wavelengths are 0.40 and 0.20 m; frequency remains 5 Hz because the boundary is driven by the same source. Moving boundaries require a different analysis.