

Transverse and longitudinal wave properties

Name: _____ Class: _____ Date: _____

Start here

0-5 minutes

Today: Compare wave and particle directions, read wave quantities and explain energy transfer.

You need: Pen, a different-coloured pen, ruler and calculator. Figures and drawing boxes are supplied.

Work from memory. Write directly in the booklet; show working where needed.

1. A wave travels to the right while a rope point moves up and down. Are the two directions parallel or perpendicular?

2. A wave's full peak-to-trough displacement is 8 mm, symmetrical about its undisturbed position. State its amplitude.

3. A time trace records one point. Its adjacent crests are 2.0 s apart. Name that interval and give its unit.

Stop for check 1. Wait for your teacher before moving on.

Try again A

Only if directed. Use the first 2 reading minutes, then continue on page 2.

Help: Use page 2: compare particle and wave directions; amplitude is measured from equilibrium; a time-axis interval is a period.

(a) Energy travels upward while particles oscillate left and right. Name the relative directions. (b) A symmetric wave has full peak-to-trough height 10 mm. State amplitude. (c) A time trace has adjacent crests 3 s apart. Name the interval.

When your teacher says, turn to page 2.

Read the directions and quantities

5-15 minutes

A wave transfers energy through a travelling disturbance. In the models here, material particles oscillate about their undisturbed positions; they do not travel along with each crest. Compare particle motion with wave travel to classify the wave.

Wave model	Particle motion relative to wave travel
Transverse	Perpendicular (at right angles), e.g. vertical motion while the pattern travels horizontally.
Longitudinal	Parallel (along the same line), back and forth. Compressions are closer-spaced particles; rarefactions are further apart.

Quantity	How to read it
Amplitude	Maximum displacement from equilibrium. Full peak-to-trough height is twice amplitude for the symmetric waves here.
Wavelength, λ	Distance between adjacent matching points, e.g. crests; metres (m). Count gaps, not crests.
Period, T	Time for one complete cycle; seconds (s). Read adjacent matching phases on a TIME trace.
Frequency, f	Complete cycles per second; hertz (Hz). $f = \text{number} / \text{time} = 1 / T$.

Worked model - directions and cycles

A rope disturbance travels right while a marked rope point oscillates vertically. The point makes four complete oscillations in 2.0 s. Identify the wave type, calculate frequency and find period.

Transverse: the oscillation is perpendicular to wave travel. Frequency = $4 / 2.0 = 2.0$ Hz. Period = $1 / 2.0 = 0.50$ s per complete oscillation. The marked point is not carried right with the disturbance.

Read the horizontal axis before the shape

A distance snapshot shows the wave at one instant; matching-point spacing is wavelength. A time trace shows one point over time; matching-phase spacing is period. Graph height gives displacement, not wave speed.

Adapted from PhysicsUK Wave Properties, Speed, Frequency and Wavelength, sections 1-2 and 5. Online reading is optional. Optional online reading.

Turn to page 3 for question 4.

Check amplitude and wavelength

15-20 minutes; begin practice at 20 minutes

4. A DISTANCE snapshot has equilibrium at 0 cm, crests at +3 cm and troughs at -3 cm. Adjacent crests lie at horizontal positions 0.10 m and 0.50 m. Which pair is correct? Choose a letter and explain both quantities.

- A. Amplitude 6 cm; wavelength 0.40 m
- B. Amplitude 3 cm; wavelength 0.40 m
- C. Amplitude 3 cm; wavelength 0.50 m
- D. Amplitude 3 cm; wavelength 0.40 s

Amplitude and reason:

Wavelength - working and chosen letter:

Stop for check 2. Wait for your teacher before moving on.

Try again B

Only if directed. Complete this instead of questions 5-6; then answer questions 7-8.

Help: Use the quantity definitions on page 2. Measure amplitude from equilibrium and subtract adjacent matching distance coordinates for wavelength.

A different distance snapshot reaches +2.5 cm above equilibrium and -2.5 cm below it. Adjacent crests lie at 0.20 m and 0.80 m. State amplitude and calculate wavelength.

Apply the direction rule

5. In a school model, a water-surface marker moves up and down while ripples travel horizontally. Identify the wave type and explain your choice.

Continue with Figure 1 and questions 6-8 on page 4.

Read the distance snapshot

20-30 minutes

The harbour team records an idealised regular wave at ONE instant. The horizontal axis is distance. The marker is part of the water model.

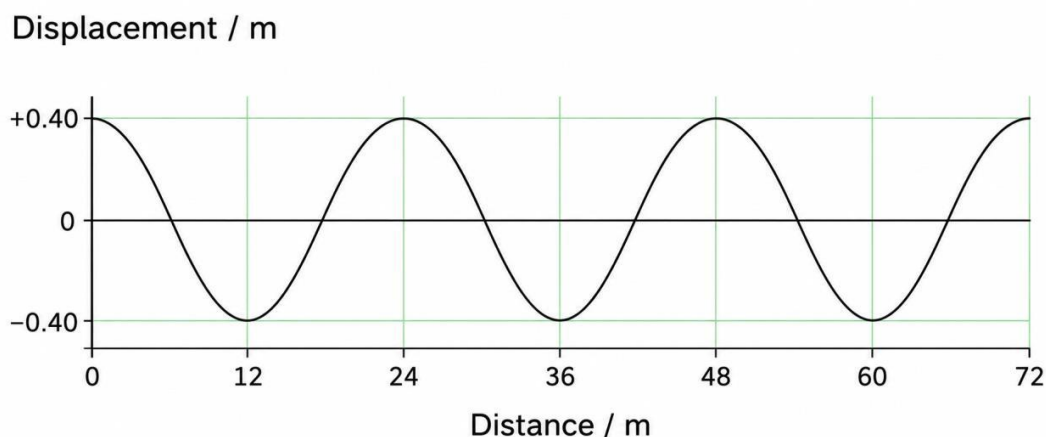


Figure 1: displacement against distance at one instant.

6. Read the wave's amplitude from the distance snapshot in Figure 1.

7. Use the first-to-last crest span in Figure 1 to calculate wavelength. Show the number of wavelength intervals.

Number of wavelength intervals:

Working and wavelength in metres:

8. A floating marker bobs as crests pass but stays near the same horizontal position. Explain what this shows about wave transfer.

At about 30 minutes turn to page 5 for the independent check.

Pause, then use a time trace

30-33 minutes; then continue practice

9. In a new TIME trace of one point, consecutive crests occur at 0.20 s and 0.70 s. Calculate period and frequency. Is that horizontal interval a wavelength? Explain using the axis unit.

Period - working and unit:

Frequency - working and unit:

Meaning of the time-axis interval:

Stop for check 3. Wait for your teacher before moving on.

Try again C

Only if directed. Complete this instead of questions 10-11; then continue with questions 12-15.

Help: Use the axis rule and $f = 1/T$ on page 2. Subtract the two times before taking the reciprocal.

A separate time trace has consecutive crests at 1.0 s and 3.0 s. Find period and frequency, and explain why the horizontal interval is not wavelength.

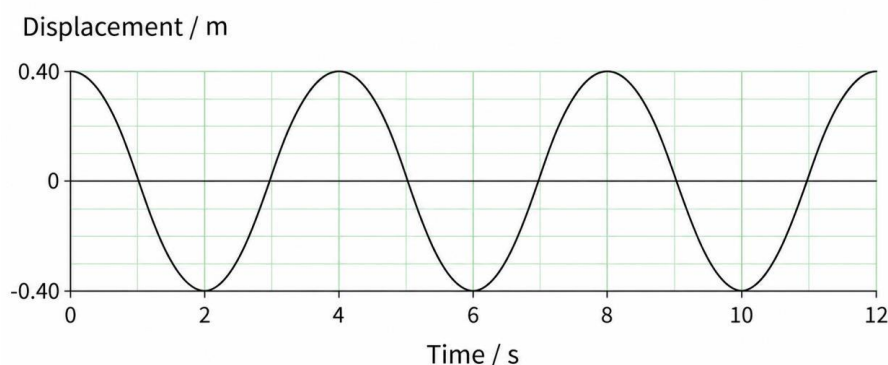


Figure 2: ONE moored buoy over time as the same harbour waves pass. No net horizontal buoy motion.

10. Use Figure 2 to read the period. Name two equivalent points on successive oscillations.

Equivalent points and period:

11. Calculate frequency from the time trace in Figure 2.

Working and frequency:

Continue the explanations on page 6.

Compare the wave with its particles

33-45 minutes - continue practice

For question 12, the harbour wave pattern moves horizontally at 6.0 m/s; this value is supplied. The buoy oscillates vertically about a fixed horizontal position.

12. The harbour wave pattern travels horizontally at 6.0 m/s (supplied). A pupil says the moored buoy also moves horizontally at 6.0 m/s. Explain the error.

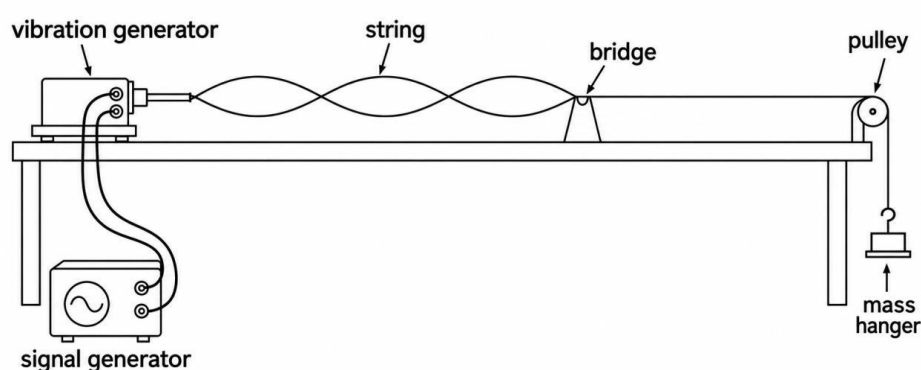


Figure 4: string apparatus shown as context. Moving string points vibrate up/down; the waves forming the pattern travel along the string. Do not explain how the stationary pattern forms.

13. Moving points on the string vibrate up and down while the waves forming the pattern travel along the string. Identify the wave type and explain your choice.

14. Sound in air is longitudinal. Describe air-particle motion relative to wave travel and describe particle spacing in compressions and rarefactions.

Finish practice with your labelled sketches on page 7.

Draw two clear wave models

Finish practice by 45 minutes

15. Use the two supplied boxes. In each, energy travels right. (a) Draw a transverse wave model: mark equilibrium, one amplitude and one wavelength; add a double-headed arrow for particle motion. (b) Draw a longitudinal particle model with one compression and one rarefaction labelled, and add a double-headed particle-motion arrow. For each, state whether particle motion is parallel or perpendicular to wave travel.

Transverse model

Energy travels right 

Longitudinal model

Energy travels right 

Boxes for question 15. Use the given wave-travel arrows, then add your particle-motion arrows and labels.

Write the direction comparison beside each model in its box.

At 45 minutes turn to page 8 for review and the final check.

Review, then show what you can do

45-55 minutes review; 55-60 minutes independent exit

16. Correct practice in a different colour and explain one correction using a direction, axis label or quantity definition. If all answers were correct, explain why the same-looking graph shape can show wavelength on one plot and period on another.

Independent exit - only when your teacher says

Cover earlier pages and previous answers. Complete question 17 on your own.

17. A fresh wave test records 14 complete oscillations in 7.0 s. Its maximum displacement from equilibrium is 4 mm. The wave travels right while particles oscillate horizontally back and forth. (a) Find frequency and period. (b) State amplitude. (c) Identify wave type using the two directions, and explain whether the particles travel steadily right with the wave.

(a) Frequency - working and unit:

Period - working and unit:

(b) Amplitude:

(c) Wave type and direction comparison:

Particle motion versus wave travel:

Stop for check 4. Wait for your teacher before moving on.

Write your name on page 1. Hand in the complete booklet, including sketches and corrections.

Try again D - next lesson

Leave this today. Your usual teacher may direct it next lesson.

Help: Next lesson revisit the directions, quantities and axis rules on page 2. Cover the reading before this independent attempt.

Next lesson: a wave makes 9 complete oscillations in 3.0 s and reaches 6 mm from equilibrium. Energy travels upward; particles oscillate left and right. Find frequency, period and amplitude. Identify the wave type and explain whether particles travel upward with the pattern.

Hand your complete booklet to your teacher.