Wave-speed, frequency and wavelength calculations

Name: _____ Class: _____ Date: _____

Start here

0-5 minutes

Today: Use wave equations with correct units and distinguish distance snapshots from time traces.

You need: Pen, a different-coloured pen, ruler and calculator. All figures and reading are supplied.

Work from memory. Write in this booklet and show working. If unsure, make your best attempt.

1. Convert 45 cm to metres.

2. A marker makes 12 complete oscillations in 3.0 s. Calculate its frequency and give the unit.

Working:

Frequency = Hz

3. A wave has crests at distances 2 m, 7 m and 12 m in a snapshot. State the wavelength. Is that horizontal spacing a distance or a time?

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

Try again A

Only if your teacher asks. Use the first 2 reading minutes, then continue on page 2.

Help: Use the quantity/units table on page 2. Divide centimetres by 100. Frequency is complete cycles per second; wavelength is the distance from one crest to the next.

(a) Convert 35 cm to metres. (b) A marker makes 18 complete oscillations in 6.0 s. Find frequency. (c) A distance snapshot has consecutive crests at 1 m, 5 m and 9 m. State wavelength and its unit.

When your teacher says, turn to page 2.

Read the quantities, then choose an equation

5-15 minutes

Wave speed describes the travelling disturbance. A buoy or particle oscillates about its undisturbed position; it does not travel horizontally at the wave speed in this model. Read the quantity and unit on each axis before using a graph.

Quantity	Meaning and unit
Amplitude	Maximum displacement from the undisturbed position; m. Peak-to-trough height is twice amplitude.
Wavelength, λ (lambda)	Distance between adjacent matching points, e.g. crest to crest; m. Count gaps, not crests.
Frequency, f	Number of complete oscillations per second; Hz. f = number / time.
Period, T	Time for one complete oscillation; s. T = 1 / f; f = 1 / T.
Wave speed, v	Speed of the travelling disturbance; m/s. v = f × λ.

Convert first; rearrange for the unknown

Centimetres ÷ 100 gives metres. Milliseconds ÷ 1000 gives seconds. To find wavelength, λ = v / f. To find frequency, f = v / λ. Check by multiplying f × λ to recover v.

Worked model - speed, then wavelength

A wave has frequency 25 Hz and wavelength 0.080 m. Find its speed. Then find the wavelength of a different wave travelling at 2.0 m/s with frequency 5.0 Hz.

First, v = f × wavelength = 25 × 0.080 = 2.0 m/s. For the second test, wavelength = v / f = 2.0 / 5.0 = 0.40 m. Check: 5.0 × 0.40 = 2.0 m/s.

Check the horizontal axis

Distance snapshot: adjacent matching points give wavelength in metres. Time trace of one point: adjacent matching points give period in seconds. Take f = 1 / T before using v = f × λ.

At fixed speed, doubling frequency halves wavelength. Amplitude alone does not set speed; compare f and λ in the supplied data.

Adapted from PhysicsUK Wave Properties, Speed, Frequency and Wavelength: sections 2, 3 and 5, with the section 1 speed model. Online reading is optional. Optional online reading.

Turn to page 3 for question 4.

Choose the method, then begin practice

15-20 minutes; start practice at 20 minutes

4. A wave travels at 3.0 m/s with wavelength 60 cm. What is its frequency? Choose a letter, show the conversion and write the division.

A. 0.050 Hz

B. 5.0 Hz

C. 1.8 Hz

D. 0.20 Hz

Wavelength = m

Division and chosen letter:

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

Try again B

Only if your teacher asks. Complete this instead of questions 5-6, then continue with questions 7-11.

Help: Use page 2: convert first, then f = speed / wavelength. Check by multiplying the result by wavelength to recover speed.

A wave travels at 4.0 m/s with wavelength 50 cm. Convert wavelength to metres, then find frequency.

Separate harbour and cable tests

Each of questions 5-9 uses a separate test. Show your working and units.

5. A buoy completes 30 oscillations in 75 s. Calculate the frequency.

Working:

Frequency = Hz

6. A separate test wave has frequency 0.40 Hz and wavelength 15 m. Calculate its speed.

Working:

Speed = m/s

7. Another test wave travels at 5.0 m/s with frequency 0.25 Hz. Calculate its wavelength.

Working:

Wavelength = m

Continue with questions 8-11 on page 4.

Calculate, then read the distance snapshot

20-30 minutes

8. A travelling wave on a sensor cable has speed 18 m/s and wavelength 0.60 m. Calculate its frequency.

Working:

Frequency = Hz

9. A second cable test uses frequency 24 Hz and wavelength 75 cm. Calculate the wave speed in m/s.

Wavelength = m

Working and speed in m/s:

A harbour team models a wave-warning system. The warning is triggered when peak-to-trough height exceeds 0.70 m. This is an exercise rule, not a real safety standard.

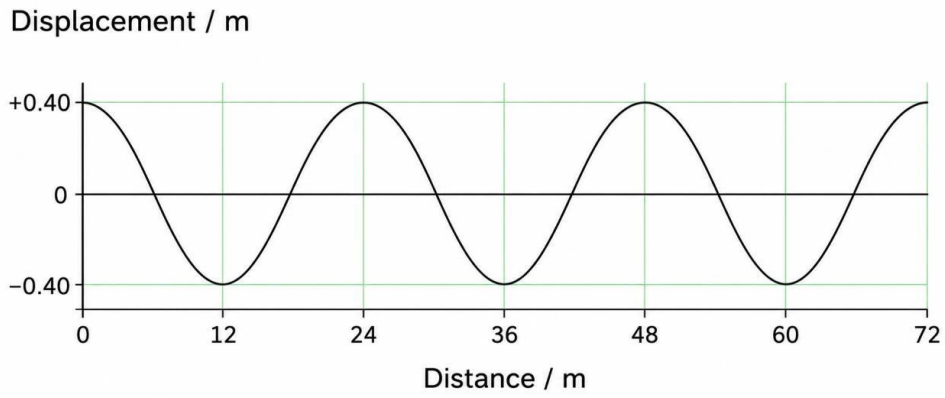

Figure 1: harbour snapshot at ONE instant; horizontal axis is distance / m.

10. Read the wave's amplitude from Figure 1.

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

Number of wavelength intervals:

Working and wavelength in m:

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

Pause, then explain the snapshot

30-33 minutes; then continue practice

12. In a new test, a DISTANCE snapshot has adjacent crests 0.80 m apart. A TIME trace at one point has adjacent crests 0.20 s apart. State wavelength and period, then calculate frequency and wave speed.

Wavelength = m; period = s

Frequency - working and unit:

Wave speed - working and unit:

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

Try again C

Only if your teacher asks. Complete this instead of questions 13-14, then continue with questions 15-20.

Help: Use the axis rule on page 2. Metres give wavelength; seconds per cycle give period. Take the reciprocal of period before using v = f × wavelength.

A different distance snapshot has adjacent crests 0.60 m apart. A time trace has adjacent crests 0.30 s apart. State wavelength and period, then calculate frequency and speed.

Model warning: triggered when peak-to-trough height exceeds 0.70 m.

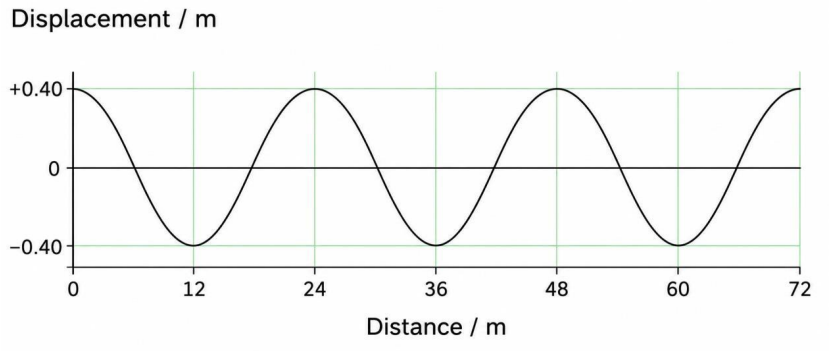

Figure 1: harbour snapshot at ONE instant; horizontal axis is distance / m.

13. Calculate the peak-to-trough height in Figure 1 and decide whether the model warning is triggered.

Height - working and unit:

Warning decision and reason:

14. A pupil counts four crests and calculates 72 / 4 = 18 m. Explain why this wavelength is incorrect.

Continue with the same harbour waves on page 6.

Combine distance and time readings

33-45 minutes - continue practice

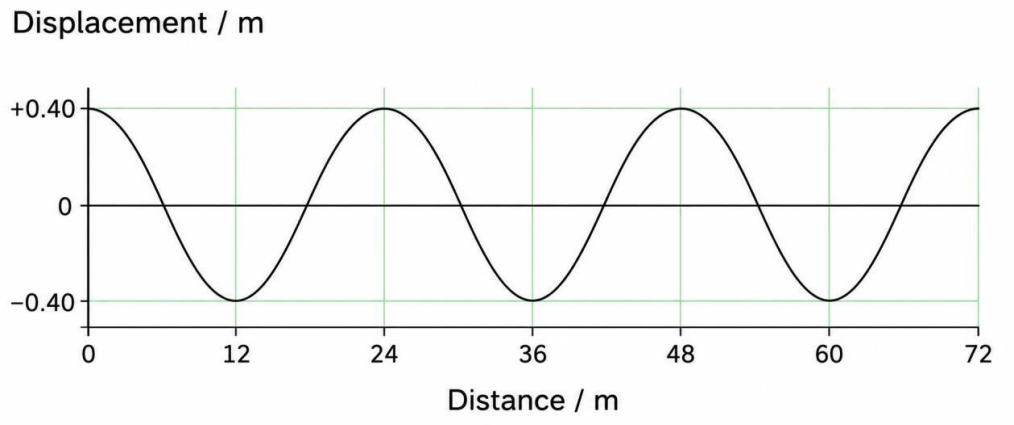

Figure 1: harbour snapshot at ONE instant; horizontal axis is distance / m.

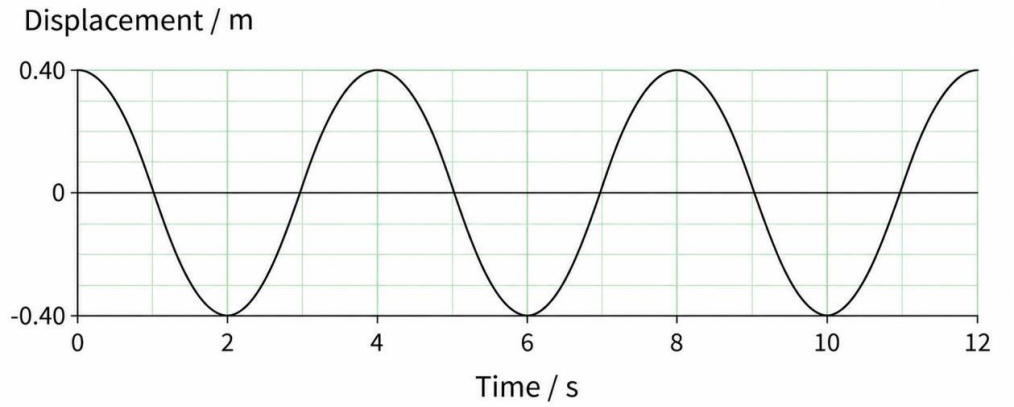

Figure 2: ONE moored buoy over time; horizontal axis is time / s. Same regular harbour waves as Figure 1.

15. Read the period from Figure 2. Identify two equivalent points on successive oscillations.

Two equivalent points:

Period = s

16. Calculate the frequency of the harbour waves using Figure 2.

Working:

Frequency = Hz

17. Use Figures 1 and 2 to calculate the harbour wave speed.

Working using both graphs:

Wave speed = m/s

Continue with the explanations on page 7.

Explain what changes and what stays the same

Finish practice by 45 minutes

Use your harbour wave speed from question 17. Figure 2 records a moored buoy, with no net horizontal motion.

18. A pupil says the buoy moves at the wave speed calculated in question 17. Explain why this is wrong.

19. Later, the buoy record has amplitude 0.20 m but still shows three complete oscillations in 12 s. Wavelength remains 24 m. A pupil says the wave speed has halved. Explain why the data do not support this.

Frequency - working and value:

Speed - working and value:

Explanation of the claim:

A new fixed-speed prediction

Use the fixed-speed rule on page 2 for this new test.

20. In a new test the wave speed stays at 6.0 m/s. Frequency rises from 0.25 Hz to 0.50 Hz. Calculate the new wavelength and explain how it compares with the old 24 m wavelength.

Equation and substitution:

New wavelength = m

Comparison with the old wavelength, with reason:

At 45 minutes, turn to page 8 to review, then complete the final check.

Review, then show what you can do

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

21. Correct your practice using a different colour. Explain one correction using an equation, unit conversion or graph-axis label. If all answers were correct, explain why counting four crests gives only three wavelength intervals.

Independent exit - only when your teacher says

Cover earlier pages and your previous answers. Complete question 22 independently.

22. In a fresh test, a wave has wavelength 40 cm and completes 15 oscillations in 3.0 s. (a) Calculate frequency and wave speed in m/s. (b) A trace of ONE point plots displacement against time in seconds. What quantity is the horizontal spacing between consecutive crests? (c) Amplitude then doubles while frequency and wavelength stay fixed. State whether speed changes and explain.

(a) Frequency - working and unit:

Wavelength = m; speed - working and unit:

(b) Horizontal crest spacing represents:

(c) Speed decision and reason:

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

Write your name on page 1. Hand in your whole booklet, including working and corrections.

Try again D - next lesson

Leave this today. Your usual teacher may ask you to do it next lesson.

Help: Next lesson, revisit the equations and axis rules on page 2. Treat the time trace as a separate example. Then cover the reading before this fresh attempt.

Next lesson: a wave has wavelength 30 cm and completes 24 oscillations in 4.0 s. Find frequency and wave speed. In a separate example, a time trace has consecutive crests 0.50 s apart: name that interval. Explain whether doubling amplitude at fixed frequency and wavelength changes speed.

Hand your complete booklet to your teacher.