

OCR A AS Wave Motion 1 Progressive Waves and Wave Quantities worksheet

35–40 minutes independent practice + 15–20 minutes review | 37 marks

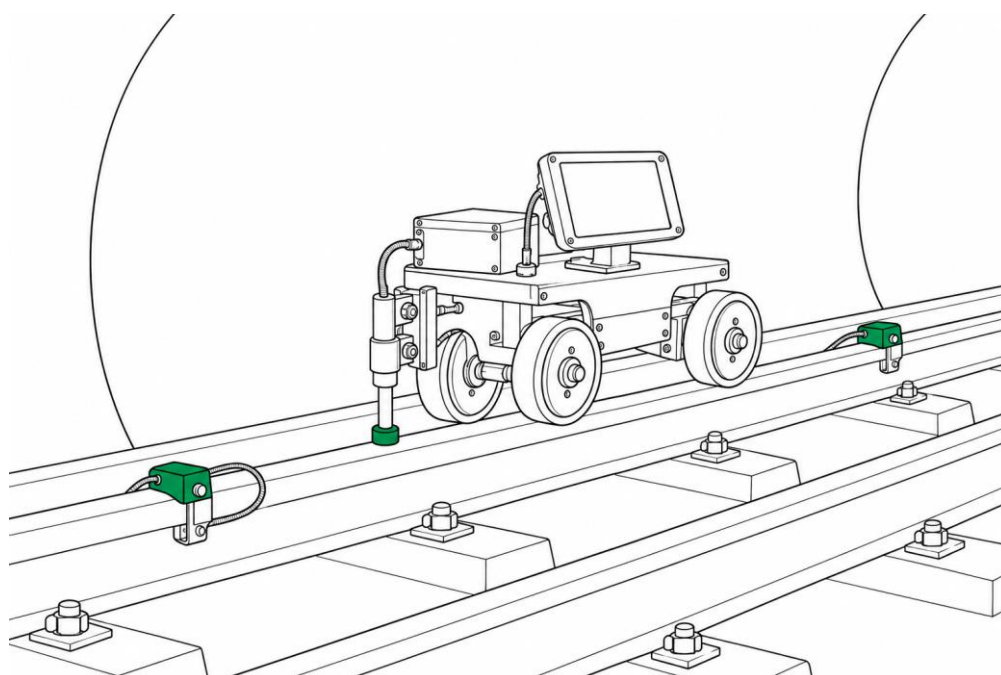
Specification points covered

- 4.4.1(a) Define and describe progressive, longitudinal and transverse waves.
- 4.4.1(b)(i) Define displacement, amplitude, wavelength, period, phase difference, frequency and wave speed.
- 4.4.1(b)(ii) Use an oscilloscope to determine frequency and wave characteristics.
- 4.4.1(c) Use $f = 1/T$ to relate frequency and period.
- 4.4.1(d) Use the wave equation $v = f\lambda$.
- 4.4.1(e) Interpret graphs of transverse and longitudinal waves.

Rail-tunnel inspection system

An autonomous trolley sends ultrasonic waves through rails and records vibration traces from sensors positioned along a tunnel.

Use wave types, graphs, oscilloscope scales, phase and wave equations to interpret the inspection data.



Context diagram: an ultrasonic rail-tunnel inspection trolley and its vibration sensors.

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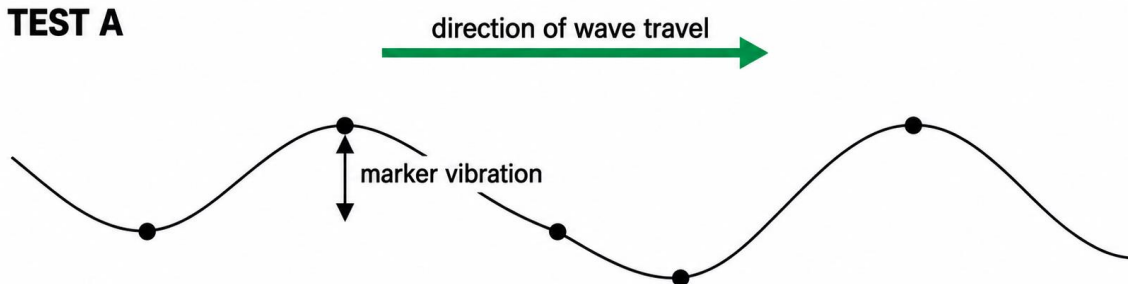
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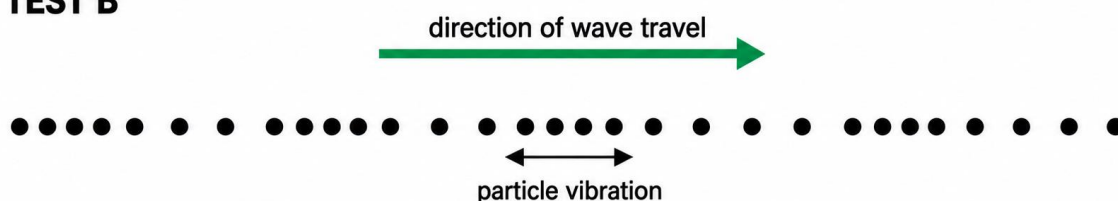
1 Recognising progressive waves

1. The diagram shows two wave tests used by the tunnel engineers. For each test, identify whether the wave is transverse or longitudinal and describe the direction of the local vibration relative to the direction of wave travel. [4 marks]

TEST A



TEST B



Two inspection tests. The arrows show wave travel and local vibration directions.

2. A marker on the inspection cable oscillates as a pulse passes, but remains near its original position afterwards. Explain why the pulse is a progressive wave and distinguish the transfer of energy from the motion of the cable material. [2 marks]

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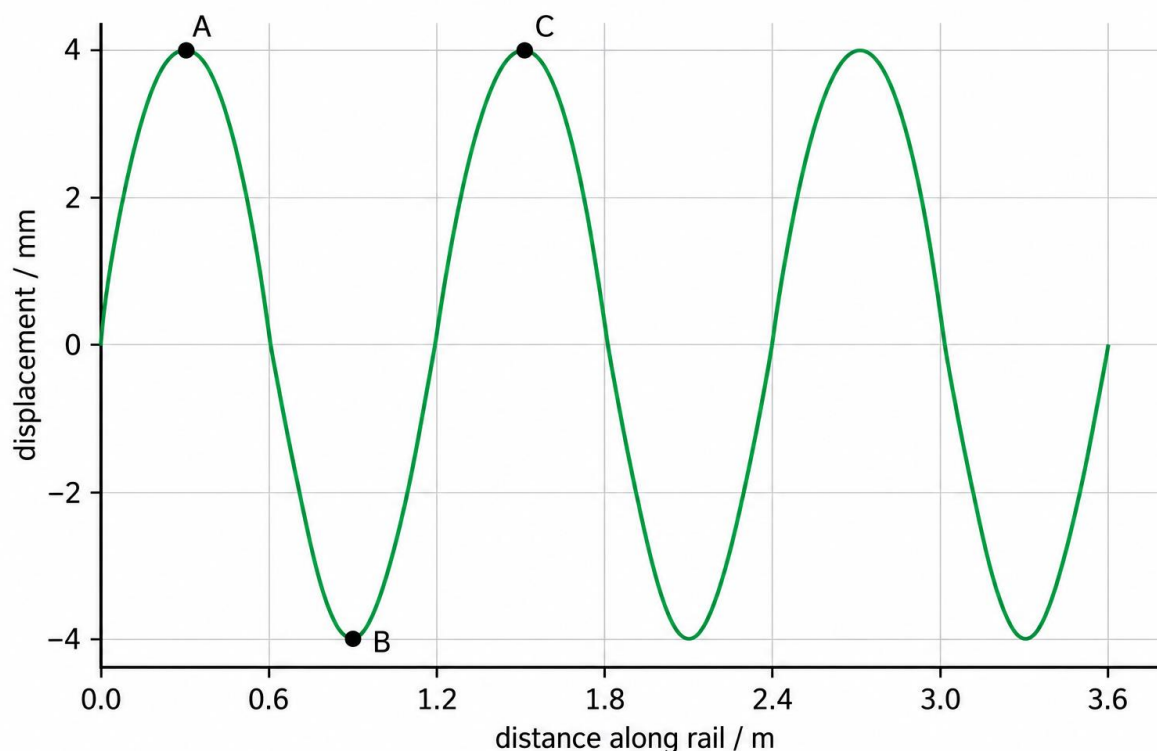
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2 Reading a displacement-distance graph

3. For the rail wave shown, define displacement and amplitude. [2 marks]



Displacement-distance graph for one rail vibration at a single instant.

4. Use the graph to state the amplitude and wavelength of the rail wave. [2 marks]

5. Determine the phase difference between A and B and between A and C. State whether A and C are in phase. [2 marks]

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3 Calculating wave quantities

6. The wave travels through the rail at $5.10 \times 10^3 \text{ m s}^{-1}$. Calculate its frequency. [1 mark]

7. Use your answer to Question 6 to calculate the period of the wave and the time taken for a point on the rail to move from a crest to the next trough. [2 marks]

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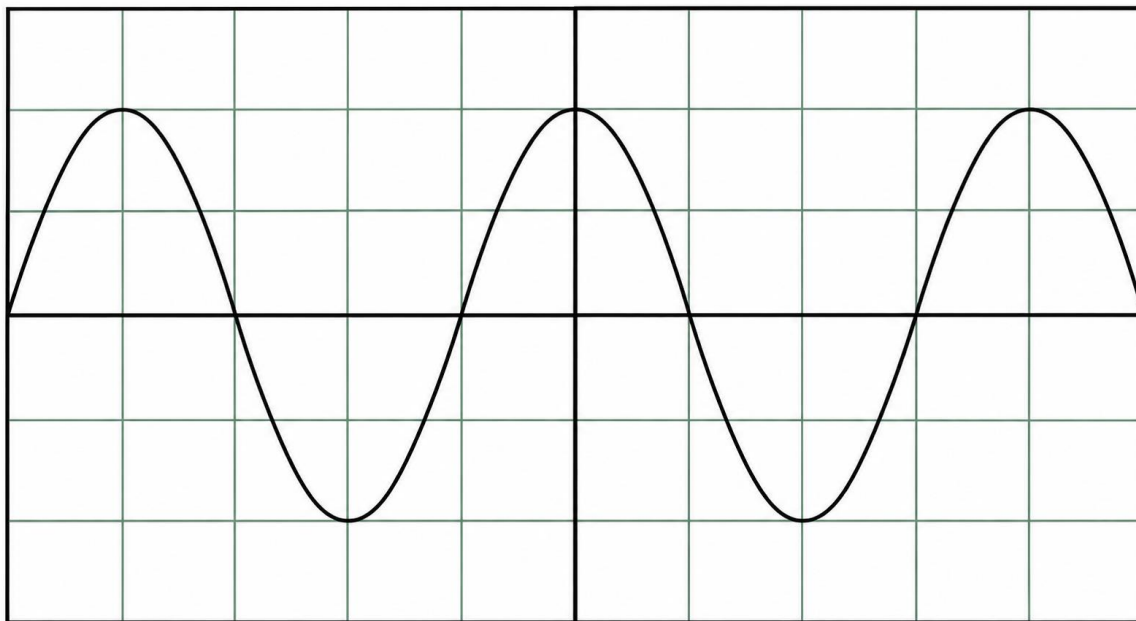
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4 Reading an oscilloscope

8. The oscilloscope y-sensitivity is 0.50 V div^{-1} . Determine the peak voltage of the signal. [1 mark]



Oscilloscope trace from the trolley's vibration sensor.

9. The oscilloscope time-base is 0.20 ms div^{-1} . Determine the period and frequency of the signal. [2 marks]

10. The time-base is changed to 0.10 ms div^{-1} without changing the signal. Calculate how many cycles would be displayed across the ten-division screen width. [2 marks]

11. Describe how an engineer should use several cycles on an oscilloscope trace to obtain a reliable value for the signal frequency. [2 marks]

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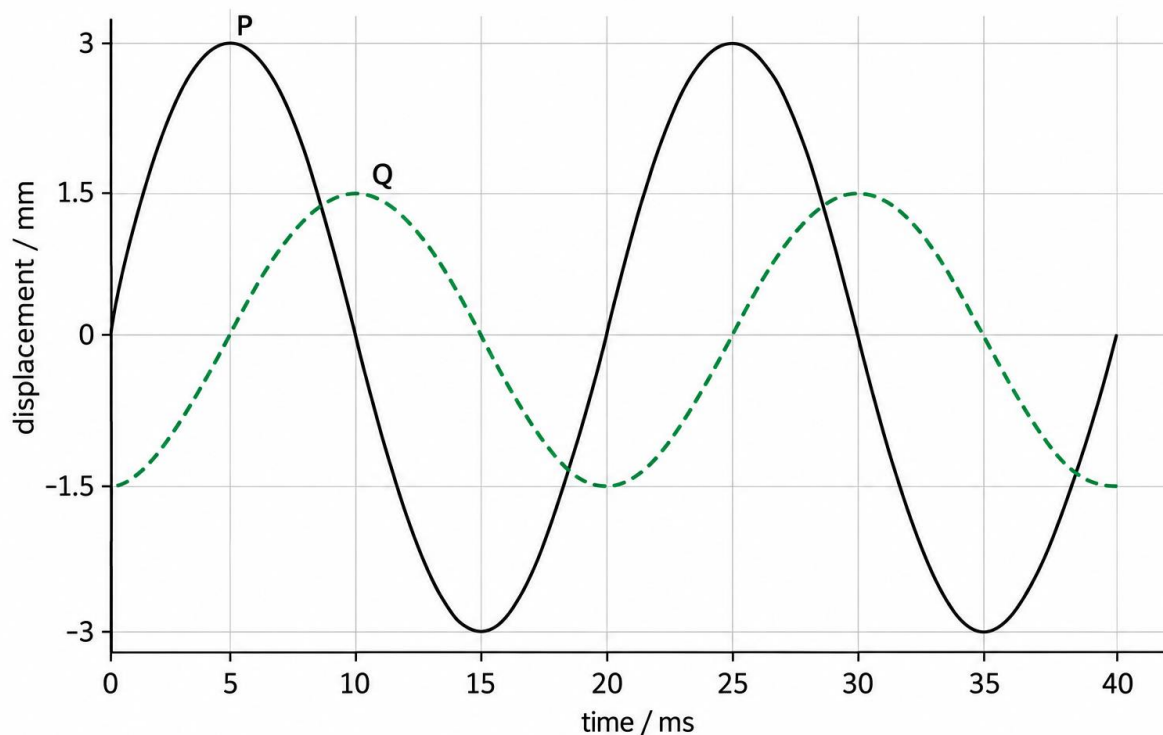
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5 Comparing sensor traces

12. Use the displacement-time graph to state the amplitude of trace P and the amplitude of trace Q. [2 marks]



Displacement-time traces from sensors P and Q.

13. Determine the period and frequency of the oscillations shown. [2 marks]

14. Determine the phase difference between P and Q. State which trace lags the other. [2 marks]

15. Explain why this is a displacement-time graph and why wavelength cannot be determined from this graph alone. [2 marks]

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6 Applying wave measurements

16. Two sensors on the same rail are 3.00 m apart. A pulse reaches sensor A at 1.20 ms and sensor B at 1.79 ms. Calculate the speed of the pulse between the sensors. [2 marks]

17. The ultrasonic transmitter operates at 75.0 kHz. Use the speed from Question 16 to calculate the wavelength in the undamaged rail. [2 marks]

18. In a damaged section of rail the wave speed is $4.50 \times 10^3 \text{ m s}^{-1}$ while the transmitter frequency remains 75.0 kHz. Explain why the frequency remains unchanged and calculate the wavelength in the damaged section. [3 marks]

Review and improve

- ☐ I distinguish displacement-time and displacement-distance graphs before reading a value.
- ☐ I measure amplitude from equilibrium and wavelength or period between adjacent points in phase.
- ☐ I convert milliseconds and kilohertz before using $f = 1/T$ or $v = f\lambda$.

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