3.18 Wave Properties and Behaviour: 30-minute Pack

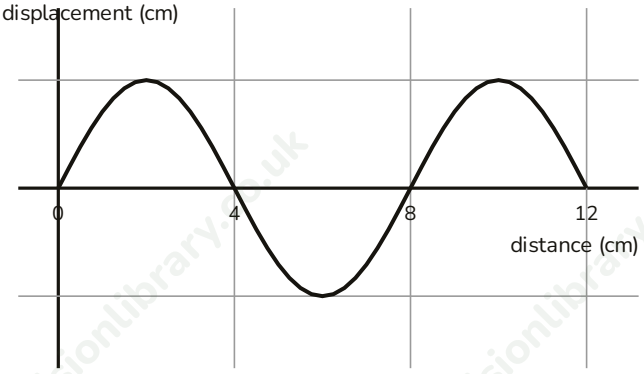
AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The diagram shows a transverse wave drawn on a displacement-distance grid. The wave trace crosses the centre line (its undisturbed position) at distances of 0 cm, 4 cm, 8 cm and 12 cm along the horizontal axis. Between 0 cm and 4 cm the trace rises to a maximum height of 3 cm above the centre line (at 2 cm), and between 4 cm and 8 cm it falls to a maximum of 3 cm below the centre line (at 6 cm), before repeating this pattern.



(a) Use the description to state the wavelength of the wave. **(1)**

(b) Use the description to state the amplitude of the wave. **(1)**

(Total for Question 1 is 2 marks)

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2 A water wave has a frequency of 2.5 Hz and a wavelength of 0.60 m. Use the Physics Equations Sheet: wave speed = frequency * wavelength ($v = f * \lambda$), to calculate the speed of the wave.

(Total for Question 2 is 2 marks)

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3 A ray of light travels from air into a glass block, crossing the boundary at an angle to the normal. The speed of light is lower in glass than in air. State and explain the direction in which the ray bends as it enters the glass.

(Total for Question 3 is 2 marks)

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4 A student wants to find out how the depth of water in a ripple tank affects the speed of the water waves produced. Describe a method the student could use to investigate this, making sure the method gives valid, repeatable and reliable results. In your answer you should refer to: how the depth of water is varied and measured; how the frequency and wavelength of the waves are measured; how the wave speed is calculated; and how repeatable results are obtained.

(Total for Question 4 is 6 marks)

5 Required practical: Meera uses a ripple tank to investigate water waves. She sets a motor-driven dipper vibrating at a constant rate to produce continuous straight waves across the water.

(a) Describe how Meera could measure the wavelength of the water waves produced in the ripple tank. **(2)**

(b) Meera uses a stopwatch to count the number of waves passing a fixed point in 10 s. She counts 24 waves. Calculate the frequency of the waves. **(2)**

(c) The wavelength Meera measures is 3.5 cm. Use the Physics Equations Sheet: wave speed = frequency * wavelength ($v = f * \lambda$), to calculate the speed of the waves. Give your answer in m/s. **(3)**

(d) Give one reason why repeating the wavelength measurement several times and calculating a mean improves the quality of Meera's result. **(1)**

(Total for Question 5 is 8 marks)

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6 Required practical: Kwame investigates waves on a stretched string. He attaches one end of the string to a vibration transducer connected to a signal generator, and fixes the tension in the string.

(a) State the piece of equipment, in addition to the string and vibration transducer, that lets Kwame read off the frequency of the waves he produces. **(1)**

(b) The signal generator is set to 40 Hz. Kwame adjusts the length of the string until exactly 2 complete waves fit onto a 1.6 m length of string. Calculate the wavelength of the waves on the string. **(2)**

.....

(c) Use the Physics Equations Sheet: wave speed = frequency * wavelength ($v = f * \lambda$), to calculate the speed of the waves on the string. **(2)**

.....

(d) Kwame then increases the tension in the string but keeps the frequency at 40 Hz. He observes that the wavelength on the string increases. Suggest what this shows about the effect of increasing the tension in a string on the speed of waves travelling along it. **(2)**

(Total for Question 6 is 7 marks)

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Mark scheme · 3.18 Wave Properties and Behaviour: 30-minute Pack

Question 1

(a) 8 cm (0.08 m), oe **B1**

(a) Answer: 8 cm (0.08 m)

(b) 3 cm (0.03 m), oe - not 6 cm (the peak-to-peak distance) **B1**

(b) Answer: 3 cm (0.03 m)

Question 2

substitutes correctly: v = 2.5 * 0.60 **M1**

v = 1.5 m/s, cao **A1**

Answer: 1.5 m/s

Question 3

the ray bends towards the normal **B1**

because the wave slows down as it enters the optically denser medium (glass), which changes its direction, oe **B1**

Answer: The ray bends towards the normal, because it slows down entering the denser medium (glass).

Question 4

Level 1 Simple, isolated statements are made about the method, for example mentioning changing the water depth and/or measuring wave speed, but with little detail, poor organisation, and key steps such as controlling other variables or taking repeats are missing. **1-2**

Level 2 Relevant steps of the method are given in a broadly logical order, showing how the depth is varied and how wave speed is found from measured frequency and wavelength, but some detail is missing, for example on repeats, control of other variables, or how measurements are made accurately. **3-4**

Level 3 A logical, detailed and coherent method is described. It clearly explains how the depth is varied and measured, how frequency and wavelength are measured accurately, how wave speed is calculated using v = f * lambda, and how repeatable and reliable results are obtained, for example repeats, mean values, controlling other variables. The steps are clearly linked and in a sensible sequence. **5-6**

Indicative content:

- Vary the depth of water in the ripple tank, e.g. by placing rigid sheets/blocks of known thickness under part of the tank, or adding measured volumes of water, and record each depth with a ruler.
- Keep the frequency (and amplitude) of the dipper the same for every depth tested, so depth is the only variable being changed (control variable).
- Keep the liquid used (water) and its temperature the same for every test (control variables).
- Measure the frequency of the waves, e.g. by counting the number of waves passing a fixed point in a measured time using a stopwatch, or by reading the value set on the signal generator/motor.
- Measure the wavelength by viewing the wave pattern, e.g. on a screen, or using a lamp or stroboscope, and using a ruler to measure the distance across several complete waves, then dividing by the number of waves to find a mean wavelength.
- Calculate the wave speed at each depth using the equation v = f * lambda.
- Repeat the frequency and wavelength measurements at each depth at least three times and calculate mean values, to improve the reliability of the results.
- Test a range of at least five different depths, spread evenly, to reveal a clear pattern.
- Record results in a table and/or plot a graph of wave speed against depth to identify the relationship between them.

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Question 5

(a) view the wave pattern on a screen below the tank (or use a lamp/stroboscope to freeze the pattern) and use a ruler/metre rule to measure across several complete waves **B1**

(a) divide the measured distance by the number of waves measured across, to find a mean (average) wavelength **B1**

(a) Answer: Measure the distance across several waves with a ruler and divide by the number of waves to get a mean wavelength.

(b) substitutes correctly: f = 24/10 **M1**

(b) f = 2.4 Hz, cao **A1**

(b) Answer: 2.4 Hz

(c) converts 3.5 cm to 0.035 m **M1**

(c) substitutes correctly: v = 2.4 * 0.035 **M1**

(c) v = 0.084 m/s, cao (ft from their answer to part b) **A1**

(c) Answer: 0.084 m/s

(d) reduces the effect of random error in an individual reading, giving a more accurate/reliable mean value, oe **B1**

(d) Answer: It reduces the effect of random error, giving a more accurate mean value.

Question 6

(a) the signal generator (with a frequency display/dial) **B1**

(a) Answer: The signal generator.

(b) substitutes correctly: $\lambda = 1.6/2$ **M1**

(b) $\lambda = 0.8$ m, cao **A1**

(b) Answer: 0.8 m

(c) substitutes correctly: v = 40 * 0.8 **M1**

(c) v = 32 m/s, cao (ft from their answer to part b) **A1**

(c) Answer: 32 m/s

(d) applies v = f * λ: since f is constant and λ has increased, v must have increased **M1**

(d) concludes that increasing the tension in the string increases the speed of waves on it, oe **A1**

(d) Answer: Increasing the tension increases the wave speed on the string.

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