3.6 Waves: Test Pack

AQA 8463 · Calculator allowed · about 50 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Waves can be described as either transverse or longitudinal.

(a) Define a transverse wave and give one example of a transverse wave. **(2)**

(b) Define a longitudinal wave and give one example of a longitudinal wave. **(2)**

(Total for Question 1 is 4 marks)

2 A loudspeaker cone vibrates 500 times each second, producing a sound wave.

(a) State what is meant by the frequency of a wave. **(1)**

(b) Calculate the period of the sound wave produced by the loudspeaker. Use the Physics Equations Sheet: T = 1 / f **(2)**

(Total for Question 2 is 3 marks)

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3 Sound is a type of wave.

(a) State whether sound is a transverse wave or a longitudinal wave. **(1)**

(b) Explain why sound cannot travel through a vacuum (empty space). **(1)**

(c) State the approximate range of frequencies that a healthy young human can hear. **(1)**

(Total for Question 3 is 3 marks)

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4 The human ear can only detect sound waves within a limited range of frequencies.

(a) State the approximate range of frequencies that a healthy human ear can hear. **(1)**

(b) Bats use ultrasound (sound waves above the range of human hearing) with a much shorter wavelength than typical audible sound to detect small insects in flight. Suggest why using a shorter-wavelength sound wave allows the bat to detect smaller objects. **(2)**

(Total for Question 4 is 3 marks)

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5 Required practical: Priya investigates the speed of water waves using a ripple tank. She uses a stroboscope to find that the dipper is producing waves at a frequency of 4 Hz. She then measures the distance across 5 complete waves on the water surface and finds it to be 60 cm.

(a) Explain why measuring the distance across 5 complete waves, rather than measuring a single wavelength, gives a more accurate value for the wavelength. **(2)**

(b) Calculate the wavelength of one wave. **(2)**

(c) Calculate the speed of the water waves. Use the Physics Equations Sheet: wave speed = frequency x wavelength **(2)**

(Total for Question 5 is 6 marks)

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6 Use the wave speed equation: wave speed = frequency x wavelength ($v = f \times \lambda$).

(a) A water wave has a frequency of 2.0 Hz and a wavelength of 0.30 m. Calculate the wave speed. **(2)**

(b) A sound wave travels at 340 m/s and has a frequency of 170 Hz. Calculate its wavelength. **(2)**

(Total for Question 6 is 4 marks)

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7 A group of students carried out the required practical to investigate the frequency, wavelength and speed of waves in a solid, using a length of string stretched between a vibration generator and a fixed point, with the frequency of the vibration generator varied to produce a clear stationary wave pattern. They repeated the wavelength measurement three times for one frequency setting. Results (wavelength, in cm): 24.2, 24.6, 31.0, 24.4.

(a) Identify the anomalous (outlier) result in the data, and suggest one likely cause of it. **(2)**

(b) Calculate the mean wavelength, excluding the anomalous result. **(2)**

(c) The vibration generator was set to a frequency of 35 Hz. Use your answer to part (b) to calculate the speed of the wave on the string, in m/s. **(2)**

(d) Suggest one improvement to this method that would increase the precision of the wavelength measurement. **(1)**

(Total for Question 7 is 7 marks)

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8 A student generates water waves of different amplitudes in a ripple tank and measures the energy transferred to a small floating cork placed in the path of the waves, using a simple sensor. Her results are shown below.

Amplitude (mm)	Energy transferred to cork per second (arbitrary units)
2	4
4	16
6	36
8	64

(a) Describe the relationship between the amplitude of the waves and the energy transferred per second, as shown by the data. **(2)**

(b) Predict the energy transferred per second for a wave amplitude of 10 mm, based on the pattern in the data. **(1)**

(Total for Question 8 is 3 marks)

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9 Seismologists around the world detect the seismic waves produced by a large earthquake. On the opposite side of the Earth from the earthquake, S-waves are not detected at all, and this 'S-wave shadow zone' provides evidence about the structure of the Earth's interior.

(a) Explain what the absence of S-waves in this shadow zone tells scientists about the outer core of the Earth. **(2)**

(b) P-waves are detected on the far side of the Earth, but their paths are refracted (bent), producing a P-wave shadow zone in a different location to the S-wave shadow zone. Suggest what this refraction of P-waves tells scientists about the core. **(1)**

(Total for Question 9 is 3 marks)

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Mark scheme · 3.6 Waves: Test Pack

Question 1

(a) a wave in which the oscillations (vibrations) are at right angles (perpendicular) to the direction of energy transfer, oe **B1**

(a) correct example, e.g. light/electromagnetic waves/ripples on water/waves on a rope **B1**

(a) Answer: A transverse wave has oscillations at right angles to the direction of energy transfer, e.g. light waves.

(b) a wave in which the oscillations are parallel to (along) the direction of energy transfer, oe **B1**

(b) correct example, e.g. sound waves/P-waves (seismic waves)/waves on a slinky spring **B1**

(b) Answer: A longitudinal wave has oscillations parallel to the direction of energy transfer, e.g. sound waves.

Question 2

(a) the number of complete waves (oscillations) passing a point per second, oe **B1**

(a) Answer: The number of complete waves passing a point each second.

(b) substitution: T = 1 / 500 **M1**

(b) T = 0.002 s (2 x 10^{-3} s), cao, with unit **A1**

(b) Answer: T = 0.002 s

Question 3

(a) longitudinal **B1**

(a) Answer: Longitudinal.

(b) sound needs particles (a medium) to vibrate and pass the wave on, and a vacuum contains no particles, oe **B1**

(b) Answer: Sound waves need particles to vibrate and pass the wave on, and a vacuum contains no particles for it to travel through.

(c) 20 Hz to 20 000 Hz, oe **B1**

(c) Answer: Approximately 20 Hz to 20 000 Hz.

Question 4

(a) approximately 20 Hz to 20 000 Hz (20 kHz) **B1**

(a) Answer: 20 Hz to 20 000 Hz

(b) waves diffract (spread out) around obstacles/gaps that are similar in size to their wavelength; a longer-wavelength wave would diffract around a small insect rather than reflecting off it **B1**

(b) the shorter-wavelength ultrasound is closer in size to (or smaller than) the insect, so it reflects off the insect and produces a detectable echo instead of diffracting around it **B1**

(b) Answer: Shorter-wavelength ultrasound diffracts less around a small insect than longer-wavelength sound would, so it reflects off the insect and produces an echo the bat can detect.

Question 5

(a) reduces the percentage (relative) error/uncertainty in the measurement **B1**

(a) because the same absolute reading error (e.g. from the ruler) is spread over a much longer measured distance, oe **B1**

(a) Answer: Measuring across several wavelengths reduces the percentage error, because any reading error is a smaller fraction of a longer distance.

(b) 60 / 5 = 12 (cm) **M1**

(b) wavelength = 0.12 m, cao, with unit converted to metres **A1**

(b) Answer: wavelength = 0.12 m

(c) substitution: v = 4 x 0.12 **M1**

(c) v = 0.48 m/s, cao, with unit **A1**

(c) Answer: v = 0.48 m/s

Question 6

(a) v = 2.0 x 0.30 **M1**

(a) 0.60 m/s cao **A1**

(a) Answer: 0.60 m/s

(b) wavelength = 340 / 170 **M1**

(b) 2.0 m cao **A1**

(b) Answer: 2.0 m

Question 7

(a) 31.0 cm is the anomalous result **B1**

(a) a likely cause, e.g. a measurement/reading error, the string was not vibrating in a clear stable pattern at that instant, or the ruler was misaligned, oe **B1**

(a) Answer: 31.0 cm is anomalous, likely caused by a misread measurement or the string pattern not being stable at that instant.

(b) (24.2 + 24.6 + 24.4) / 3 **M1**

(b) 24.4 cm cao **A1**

(b) Answer: 24.4 cm

(c) converts 24.4 cm to 0.244 m and substitutes: v = 35 x 0.244, ft from (b) **M1**

(c) 8.54 m/s cao (3 s.f.) **A1**

(c) Answer: 8.54 m/s

(d) e.g. measure the distance across several wavelengths and divide by the number of wavelengths, rather than measuring a single wavelength, oe **B1**

(d) Answer: Measure the distance across several wavelengths and divide by the number of wavelengths, rather than measuring just one.

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Question 8

(a) as amplitude increases, the energy transferred per second increases, oe **B1**

(a) the relationship is not linear/proportional; the energy increases much faster than the amplitude (e.g. doubling the amplitude from 2 to 4 mm roughly quadruples the energy, from 4 to 16), oe **B1**

(a) Answer: As amplitude increases, the energy transferred per second increases, but not in direct proportion; the energy increases much faster than the amplitude (for example, doubling the amplitude from 2 mm to 4 mm quadruples the energy transferred, from 4 to 16 units).

(b) 100 (units), following the pattern that energy = amplitude^2, oe; accept a reasonable extrapolated value with correct reasoning shown **B1**

(b) Answer: 100 units, since the pattern in the table shows that the energy transferred is equal to the amplitude squared (energy = amplitude^2).

Question 9

(a) S-waves cannot travel through liquids, oe **B1**

(a) so the absence of S-waves on the far side of the Earth shows that they have been blocked by a region that must be liquid; this shows that the outer core of the Earth is liquid, oe **B1**

(a) Answer: Because S-waves cannot travel through liquids, the fact that they are not detected on the far side of the Earth shows that they have been blocked by a liquid region; this is evidence that the Earth's outer core is liquid.

(b) the P-waves change speed suddenly as they cross the boundary into (and out of) the core, showing that the core has a different density/composition from the mantle around it, oe **B1**

(b) Answer: The sudden change in P-wave speed as they cross into and out of the core shows that the core has a different density (and composition) from the surrounding mantle.

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