3.6 Waves: 1-hour Pack

AQA 8463 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A smooth bathroom mirror produces a clear, sharp reflection of a person's face, but a sheet of white paper reflects light without producing any clear image.

(a) State what is meant by specular reflection. **(1)**

(b) Explain why light reflecting off the rough surface of the paper does not produce a clear image. **(2)**

(Total for Question 1 is 3 marks)

2 A converging lens is used to form an image of an object.

(a) An object of height 2 cm produces an image of height 0.5 cm. Calculate the magnification produced by the lens. Use the Physics Equations Sheet: magnification = image height / object height **(2)**

(b) A second lens produces a magnification of 3 for an object of height 1.5 cm. Calculate the height of the image formed. **(2)**

(Total for Question 2 is 4 marks)

© Revision Library | revisionlibrary.co.uk

3 Required practical: A student investigates the speed of water waves in a ripple tank. She changes the frequency of the dipper and measures the resulting wavelength of the waves produced each time, in order to test whether her results agree with the equation wave speed = frequency x wavelength. Evaluate this method. Your answer should include how the student could improve the accuracy and reliability of her wavelength measurements, and how she could use her results to check whether they support the equation.

(Total for Question 3 is 6 marks)

---

4 Aisha wants to measure the speed of sound in air. She stands 170 m from a large flat wall, claps her hands once and starts a stopwatch at the same instant. She stops the stopwatch as soon as she hears the echo. The stopwatch reads 1.0 s.

(a) Calculate the speed of sound in air using Aisha's results. Use the Physics Equations Sheet: speed = distance / time **(2)**

.....

(b) The sound wave produced by the clap has a frequency of 340 Hz. Using your answer to part a) and the wave speed equation, calculate the wavelength of the sound wave. **(3)**

.....

(Total for Question 4 is 5 marks)

© Revision Library | revisionlibrary.co.uk

5 A student uses a ripple tank to test the equation wave speed = frequency x wavelength, by measuring the wavelength produced at several different dipper frequencies. Her results are: frequency = 2 Hz, wavelength = 40 cm; frequency = 4 Hz, wavelength = 20 cm; frequency = 6 Hz, wavelength = 20 cm; frequency = 8 Hz, wavelength = 10 cm; frequency = 10 Hz, wavelength = 8 cm.

Frequency (Hz)	Wavelength (cm)
2	40
4	20
6	20
8	10
10	8

(a) For the results at 2 Hz, 4 Hz, 8 Hz and 10 Hz, calculate the speed of the wave in each case (convert each wavelength to metres first), and show that the wave speed is approximately constant for these four results. **(3)**

(b) Identify which one of the five results is anomalous, and calculate the wavelength that would have been expected at that frequency for consistency with the rest of the data. **(3)**

.....

(Total for Question 5 is 6 marks)

© Revision Library | revisionlibrary.co.uk

6 A sound wave travels through air at a speed of 340 m/s and has a frequency of 850 Hz.

(a) Rearrange the wave speed equation, wave speed = frequency x wavelength, to make wavelength the subject. **(1)**

(b) Calculate the wavelength of the sound wave. Use the Physics Equations Sheet: wave speed = frequency x wavelength **(2)**

(Total for Question 6 is 3 marks)

---

7 For each of the following types of electromagnetic wave, state one everyday use and one associated hazard: (i) microwaves (ii) infrared (iii) ultraviolet (iv) X-rays (v) γ rays.

(Total for Question 7 is 5 marks)

---

8 A ray of light travels from air into a block of glass, hitting the flat surface of the glass at an angle.

(a) State the name given to the change in direction of a wave as it crosses a boundary between two different materials. **(1)**

(b) Explain, in terms of wave speed, why the ray of light changes direction as it enters the glass. **(2)**

(Total for Question 8 is 3 marks)

© Revision Library | revisionlibrary.co.uk

9 A group of students used a ripple tank to investigate water waves. They used a strobe light to 'freeze' the wave pattern and counted the number of complete waves passing a fixed point in a measured time.

(a) Describe how the students could measure the wavelength of the water waves, once the wave pattern was frozen by the strobe light. **(1)**

(b) The students counted 12 complete waves passing a fixed point in 6.0 s. Calculate the frequency of the waves. **(2)**

(c) The wavelength of the waves was measured as 0.040 m. Calculate the speed of the waves, using your answer to part (b). **(2)**

(Total for Question 9 is 5 marks)

10 A loudspeaker cone vibrates back and forth, producing sound waves of frequency 250 Hz that travel through air at a speed of 340 m/s.

(a) State whether the sound wave produced is transverse or longitudinal, and explain how the vibration of the particles relates to the direction the wave travels. **(2)**

(b) Calculate the wavelength of this sound wave. Give your answer to 3 significant figures. **(3)**

(Total for Question 10 is 5 marks)

© Revision Library | revisionlibrary.co.uk

Mark scheme · 3.6 Waves: 1-hour Pack

Question 1

(a) reflection from a smooth surface in which parallel incident rays are all reflected in a single direction (parallel rays remain parallel), oe **B1**

(a) Answer: Reflection from a smooth surface where parallel rays are all reflected in the same direction.

(b) the paper's surface is rough/uneven at a small scale, so the normal at each point on the surface faces a different direction **B1**

(b) parallel incident rays are therefore reflected in many different directions (diffuse reflection), so no consistent image can form **B1**

(b) Answer: The rough surface has normals pointing in many directions, so parallel light rays are scattered (diffuse reflection) rather than reflected in one direction, preventing a clear image forming.

Question 2

(a) substitution: magnification = 0.5 / 2 **M1**

(a) magnification = 0.25, cao (no unit, magnification has no units) **A1**

(a) Answer: magnification = 0.25

(b) rearrange and substitute: image height = 3 x 1.5 **M1**

(b) image height = 4.5 cm, cao, with unit **A1**

(b) Answer: image height = 4.5 cm

Question 3

Level 1 A simple, isolated statement (or statements) is made about the method or a possible improvement, with little or no reasoning or linkage to accuracy or reliability. **1-2**

Level 2 Relevant improvements to the method are described, with some linkage of ideas showing how the changes would improve the accuracy or reliability of the results. **3-4**

Level 3 A detailed and coherent evaluation is given, covering both how to improve the accuracy/reliability of the wavelength and frequency measurements and how to check whether the results support wave speed = frequency x wavelength, with clear scientific reasoning throughout. **5-6**

Indicative content:

- Use a stroboscope to make the moving wave pattern appear stationary, allowing the wavelength to be measured more accurately.
- Measure the distance across several complete waves (e.g. 5 or 10) and divide by the number of waves, to reduce the percentage error in the wavelength measurement.
- Take repeat readings at each frequency and calculate a mean wavelength, to improve reliability and help identify anomalous results.
- Keep the depth of water in the tank constant (control variable), since wave speed depends on water depth, so changing the depth would make it an unfair test.
- View the wave pattern from directly above and use a fixed marker or set square to avoid parallax error when measuring.
- Calculate the wave speed (wave speed = frequency x wavelength) for each frequency tested; if the equation holds, the calculated speed should stay approximately constant across all frequencies, since wave speed depends on water depth, not frequency.
- Plot a graph of wavelength against 1/frequency; a straight line through the origin would support wave speed = frequency x wavelength, with the gradient equal to the wave speed.
- Repeat the whole experiment and compare results, re-testing any anomalous points that do not fit the overall pattern.

Question 4

(a) total distance travelled by the sound = 2 x 170 = 340 (m), since the sound travels to the wall and back **M1**

(a) speed = 340 / 1.0 = 340 m/s, cao, with unit **A1**

(a) Answer: speed of sound = 340 m/s

(b) select and rearrange wave speed = frequency x wavelength to give wavelength = wave speed / frequency **M1**

(b) substitute the speed found in part a): wavelength = 340 / 340 **M1**

(b) wavelength = 1.0 m, cao, with unit **A1**

(b) Answer: wavelength = 1.0 m

© Revision Library | revisionlibrary.co.uk

Question 5

(a) correct unit conversion of wavelength to metres for at least two results (e.g. 40 cm = 0.40 m) **M1**

(a) correct use of wave speed = frequency x wavelength for at least three of the four results, e.g. 2 x 0.40 = 0.8 m/s; 4 x 0.20 = 0.8 m/s; 8 x 0.10 = 0.8 m/s; 10 x 0.08 = 0.8 m/s **M1**

(a) conclusion that the wave speed is approximately constant at about 0.8 m/s for these four results, cso **A1**

(a) Answer: The wave speed is approximately constant at 0.8 m/s for the 2 Hz, 4 Hz, 8 Hz and 10 Hz results.

(b) the 6 Hz result (wavelength = 20 cm) is anomalous **B1**

(b) use the constant wave speed of 0.8 m/s found in part a) with wavelength = wave speed / frequency = 0.8 / 6 **M1**

(b) expected wavelength = 0.13 m (13.3 cm, 2 s.f.), cao, awrt 0.13 m **A1**

(b) Answer: The 6 Hz result is anomalous; the expected wavelength would be about 0.13 m (13.3 cm), not the recorded 20 cm.

Question 6

(a) wavelength = wave speed / frequency **B1**

(a) Answer: wavelength = wave speed / frequency

(b) substitution: wavelength = 340 / 850 **M1**

(b) wavelength = 0.4 m, cao, with unit **A1**

(b) Answer: wavelength = 0.4 m

Question 7

microwaves: use e.g. satellite communications/cooking food; hazard = internal heating of body tissue/cells **B1**

infrared: use e.g. cooking, thermal imaging, remote controls; hazard = skin burns **B1**

ultraviolet: use e.g. sun tanning, fluorescent lamps, security marking; hazard = skin cancer/skin ageing/eye damage **B1**

X-rays: use e.g. medical imaging of bones, airport security scanning; hazard = mutation of cells/cancer risk **B1**

γ rays: use e.g. sterilising medical equipment, treating cancer (radiotherapy); hazard = cancer/cell mutation/cell death **B1**

Answer: See mark scheme for accepted use-hazard pairs for each wave type.

Question 8

(a) refraction **B1**

(a) Answer: Refraction.

(b) light travels more slowly in glass than in air, oe **B1**

(b) this change in speed at the boundary causes the wave to change direction (bend), unless it hits the boundary straight on, oe **B1**

(b) Answer: Light travels more slowly in glass than in air. This change in speed as the wave crosses the boundary causes it to change direction (bend), unless it hits the boundary straight on.

Question 9

(a) measure the distance across several complete waves using a ruler, then divide by the number of waves, to get an average/more accurate wavelength, oe **B1**

(a) Answer: Measure the distance across several complete waves using a ruler, then divide by the number of waves, to find an average wavelength.

(b) 12 / 6.0 **M1**

(b) 2.0 Hz cao **A1**

(b) Answer: 2.0 Hz

(c) v = 2.0 x 0.040, ft from (b) **M1**

(c) 0.080 m/s cao **A1**

(c) Answer: 0.080 m/s

Question 10

(a) longitudinal **B1**

(a) the air particles vibrate parallel to (in the same direction as) the direction the wave travels/energy is transferred, oe **B1**

(a) Answer: Longitudinal: the air particles vibrate parallel to (along) the direction the wave travels.

(b) rearranges v = f x wavelength to wavelength = v / f **M1**

(b) substitutes: wavelength = 340 / 250 **M1**

(b) 1.36 m cao (3 s.f.) **A1**

(b) Answer: 1.36 m

© Revision Library | revisionlibrary.co.uk