P6F Waves: Foundation Tier Practice

AQA 8463 · Calculator allowed · about 90 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A wave is a way of transferring energy from one place to another.

(a) State what a wave transfers from one place to another, without transferring matter. **(1)**

(b) Describe the difference between a transverse wave and a longitudinal wave. **(2)**

(c) Give one example of a transverse wave and one example of a longitudinal wave. **(2)**

(Total for Question 1 is 5 marks)

2 A wave has an amplitude, a wavelength and a frequency.

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

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

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

(Total for Question 2 is 3 marks)

3 The period of a wave is the time taken for one complete wave to pass a point. Use the equation: period = 1 / frequency (T = 1 / f).

(a) A wave has a frequency of 5 Hz. Calculate its period. **(2)**

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(b) A different wave has a period of 0.02 s. Calculate its frequency. **(2)**

.....

(Total for Question 3 is 4 marks)

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4 Use the wave speed equation: wave speed = frequency x wavelength (v = f x λ).

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

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

.....

(Total for Question 4 is 4 marks)

5 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)**

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(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)**

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(Total for Question 5 is 5 marks)

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6 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 6 is 3 marks)

7 A boat uses an echo sounder to find the depth of the sea below it. The echo sounder sends a pulse of sound straight down, and the pulse reflects off the seabed and returns to the boat. The speed of sound in seawater is 1500 m/s.

(a) The pulse takes 0.080 s to travel from the boat to the seabed and back again. Calculate the total distance travelled by the pulse. **(2)**

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(b) Use your answer to part (a) to calculate the depth of the sea below the boat. **(2)**

.....

(Total for Question 7 is 4 marks)

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8 The electromagnetic spectrum is a continuous range of waves, grouped into seven types.

(a) List the seven types of electromagnetic wave in order, starting with the type that has the longest wavelength. **(1)**

(b) State how the speed of electromagnetic waves in a vacuum compares across the seven types. **(1)**

(Total for Question 8 is 2 marks)

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9 Different types of electromagnetic wave have different everyday uses.

(a) Give one everyday use of microwaves. **(1)**

(b) Give one everyday use of infrared radiation. **(1)**

(c) Explain why people are advised to limit their exposure to ultraviolet radiation from the Sun. **(1)**

(Total for Question 9 is 3 marks)

10 When a wave hits a flat, smooth surface such as a mirror, it can be reflected.

(a) State the law of reflection. **(1)**

(b) Describe the difference between specular reflection and diffuse reflection. **(2)**

(Total for Question 10 is 3 marks)

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11 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 11 is 3 marks)

12 The table shows the wavelength and frequency of three water waves, A, B and C.

Wave	Wavelength (m)	Frequency (Hz)
A	0.050	4.0
B	0.020	4.0
C	0.050	8.0

(a) Calculate the speed of wave A. **(2)**

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(b) Calculate the speed of wave C. **(2)**

.....

(c) State which of the three waves, A, B or C, has the lowest speed, without calculating it. **(1)**

(Total for Question 12 is 5 marks)

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13 A doctor can use X-rays to produce an image of a patient's broken arm bone, or use ultrasound (high-frequency sound waves) to produce an image of an unborn baby inside its mother. Explain why X-rays are a suitable choice for imaging bone, and why ultrasound, rather than X-rays, is used for imaging an unborn baby.

(Total for Question 13 is 6 marks)

Mark scheme · P6F Waves: Foundation Tier Practice

Question 1

- (a) **B1** energy (accept information), oe
- **(a) Answer: Energy.**
- (b) **B1** in a transverse wave, the particles/oscillations are at right angles (perpendicular) to the direction of energy transfer, oe
- (b) **B1** in a longitudinal wave, the particles/oscillations are parallel to (in the same direction as) the direction of energy transfer, oe
- **(b) Answer: In a transverse wave, the vibrations are at right angles to the direction of energy transfer. In a longitudinal wave, the vibrations are parallel to (along) the direction of energy transfer.**
- (c) **B1** transverse example, e.g. light/electromagnetic waves, or a water ripple
- (c) **B1** longitudinal example, e.g. sound waves
- **(c) Answer: Transverse: light (or a water ripple). Longitudinal: sound.**

Question 2

- (a) **B1** the maximum displacement of a point on the wave from its undisturbed (rest) position, oe
- **(a) Answer: The maximum displacement of a point on the wave from its undisturbed (rest) position.**
- (b) **B1** the distance from a point on one wave to the equivalent point on the next wave (e.g. crest to crest), oe
- **(b) Answer: The distance from a point on one wave to the equivalent point on the adjacent wave, for example from one crest to the next crest.**
- (c) **B1** the number of waves passing a point (or produced by a source) each second, oe
- **(c) Answer: The number of waves passing a point, or produced by a source, each second.**

Question 3

- (a) **M1** T = 1 / 5
- (a) **A1** 0.2 s cao
- **(a) Answer: 0.2 s**
- (b) **M1** f = 1 / 0.02
- (b) **A1** 50 Hz cao
- **(b) Answer: 50 Hz**

Question 4

- (a) **M1** v = 2.0 x 0.30
- (a) **A1** 0.60 m/s cao
- **(a) Answer: 0.60 m/s**
- (b) **M1** wavelength = 340 / 170
- (b) **A1** 2.0 m cao
- **(b) Answer: 2.0 m**

Question 5

- (a) **B1** 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
- **(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) **M1** 12 / 6.0
- (b) **A1** 2.0 Hz cao
- **(b) Answer: 2.0 Hz**
- (c) **M1** v = 2.0 x 0.040, ft from (b)
- (c) **A1** 0.080 m/s cao
- **(c) Answer: 0.080 m/s**

Question 6

- (a) **B1** longitudinal
- **(a) Answer: Longitudinal.**
- (b) **B1** sound needs particles (a medium) to vibrate and pass the wave on, and a vacuum contains no particles, oe
- **(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) **B1** 20 Hz to 20 000 Hz, oe
- **(c) Answer: Approximately 20 Hz to 20 000 Hz.**

Question 7

- (a) **M1** distance = 1500 x 0.080
- (a) **A1** 120 m cao
- **(a) Answer: 120 m**
- (b) **M1** 120 / 2, ft from (a)
- (b) **A1** 60 m cao
- **(b) Answer: 60 m**

Question 8

- (a) **B1** radio, microwave, infrared, visible light, ultraviolet, X-ray, γ cao
- **(a) Answer: Radio, microwave, infrared, visible light, ultraviolet, X-ray, γ.**
- (b) **B1** all types of electromagnetic wave travel at the same speed in a vacuum, oe
- **(b) Answer: All seven types travel at the same speed as each other in a vacuum.**

Question 9

- (a) **B1** e.g. cooking food, or satellite communication, oe
- **(a) Answer: For example, cooking food (or satellite communication).**
- (b) **B1** e.g. cooking (grilling/toasting), thermal imaging cameras, or remote controls, oe
- **(b) Answer: For example, cooking (grilling), thermal imaging cameras, or television remote controls.**
- (c) **B1** UV radiation can damage skin cells/DNA, which increases the risk of skin cancer (and can cause premature skin ageing), oe
- **(c) Answer: UV radiation can damage skin cells and DNA, which increases the risk of skin cancer.**

Question 10

- (a) **B1** the angle of incidence is equal to the angle of reflection, oe
- **(a) Answer: The angle of incidence is equal to the angle of reflection.**
- (b) **B1** specular reflection happens at a smooth surface, and all the reflected rays travel in the same (one) direction, oe
- (b) **B1** diffuse reflection happens at a rough surface, and the reflected rays are scattered in many different directions, oe
- **(b) Answer: Specular reflection happens at a smooth surface, where all the reflected rays travel in the same direction. Diffuse reflection happens at a rough surface, where the reflected rays are scattered in many different directions.**

Question 11

- (a) **B1** refraction
- **(a) Answer: Refraction.**
- (b) **B1** light travels more slowly in glass than in air, oe
- (b) **B1** this change in speed at the boundary causes the wave to change direction (bend), unless it hits the boundary straight on, oe
- **(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 12

- (a) **M1** 0.050 x 4.0
- (a) **A1** 0.20 m/s cao
- **(a) Answer: 0.20 m/s**
- (b) **M1** 0.050 x 8.0
- (b) **A1** 0.40 m/s cao
- **(b) Answer: 0.40 m/s**
- (c) **B1** wave B, because it has the smallest wavelength while its frequency is the same as wave A, oe
- **(c) Answer: Wave B, because for the same frequency as wave A, it has the smallest wavelength.**

Question 13

- **Level 3** (5-6): A clear, well-linked explanation of why X-rays are suitable for bone, referring to their absorption by dense tissue such as bone, and why ultrasound is used for the unborn baby, referring to reflection of sound waves at tissue boundaries and the risk that X-rays (ionising radiation) pose to a developing fetus.
- **Level 2** (3-4): A partial explanation. Some correct reference to how X-rays or ultrasound form an image, or to the safety issue, but the answer may not clearly link both waves to both situations.
- **Level 1** (1-2): A simple statement, for example that X-rays show bones or that ultrasound is used for babies, with little or no explanation of why.
- **Indicative content:**
  - X-rays pass easily through soft tissue but are absorbed much more strongly by dense material such as bone, so a detector on the far side of the patient records a clear shadow-image showing the shape of the bone.
  - This makes X-rays a suitable choice for imaging a broken bone, because the contrast between bone and surrounding soft tissue is high.
  - X-rays are a form of ionising radiation, and repeated or unnecessary exposure carries a risk of damaging cells and DNA, which could harm a developing fetus.
  - Ultrasound waves are non-ionising and are not known to carry this risk, so they are considered safer to use on an unborn baby.
  - Ultrasound waves are partially reflected whenever they cross a boundary between two different types of soft tissue (for example, between fluid and the baby's body), and detecting these reflected waves and the time they take to return allows an image to be built up.
  - Overall, X-rays are chosen for bone because of the strong contrast in absorption between bone and soft tissue, while ultrasound is chosen for the unborn baby because it does not use ionising radiation and can still distinguish between different soft tissues by reflection.