Exercise walk-through

6.1

Transverse and longitudinal waves; properties of waves (4.6.1.1–4.6.1.2, RP8)

AQA · GCSE · Physics

Waves: sound, light and the electromagnetic spectrum

- describe **transverse** and **longitudinal** waves, and use the wave equation;
- measure the speed of waves in water and in a solid;
- describe the electromagnetic spectrum, its uses and its dangers, and investigate infrared radiation;
- (physics only) explain reflection, sound, ultrasound and seismic waves, lenses, colour and black body radiation.

Transverse and longitudinal waves

- In a **transverse** wave, the oscillations are at right angles to the direction the wave travels. Examples: ripples on water, waves on a string, and all electromagnetic waves.
- In a **longitudinal** wave, the oscillations are in the same direction as the wave travels. Sound waves in air are **longitudinal**. They have **compressions**, where the particles are close together, and **rarefactions**, where they are spread out.

Electromagnetic waves

- Electromagnetic (EM) waves are **transverse** waves that transfer energy from a source to an absorber.
- They form a continuous spectrum, and they all travel at the same speed in a vacuum or in air: 3×10^8 m/s.
- In order of decreasing wavelength and increasing **frequency**:
- Our eyes detect only visible light, a very small part of the spectrum.

radio $\rightarrow$ microwaves $\rightarrow$ infrared $\rightarrow$ visible light $\rightarrow$ ultraviolet $\rightarrow$ X-rays $\rightarrow$ gamma rays

Exercises 2.1·2.3

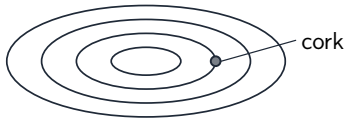
2.1 A wave has frequency 250 Hz. Calculate the period. [2]



2.2 Water waves of wavelength 0.25 m travel at 1.5 m/s. Calculate the frequency. [2]



2.3 State one piece of evidence that in a water ripple it is the wave, not the water, that travels. [1]



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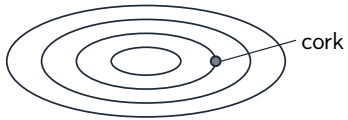
2.1 $T = 1/f = 1/250 = \mathbf{4.0 \times 10^{-3}}$ s (C1, A1)

2.2 Water waves of wavelength 0.25 m travel at 1.5 m/s. Calculate the frequency. [2]



2.2 $f = v/\lambda = 1.5/0.25 = \mathbf{6.0}$ Hz (C1, A1)

2.3 State one piece of evidence that in a water ripple it is the wave, not the water, that travels. [1]



2.3 A floating ball bobs up and down but does not travel with the ripple.

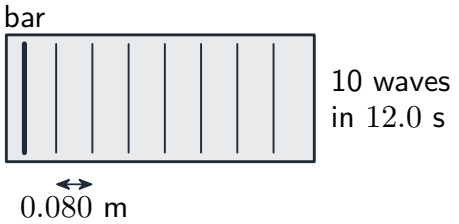
Exercise 3.1

3.1 A teacher times 10 complete cycles passing a point in a ripple tank: 12.0 s in total. The wavelength at the water surface, measured with a calibrated scale, is 0.080 m.

(a) Calculate the frequency. [2]

(b) Calculate the speed of the water waves. [2]

(c) The bar motor speeds up. State and explain the effect on wavelength at constant wave speed. [2]



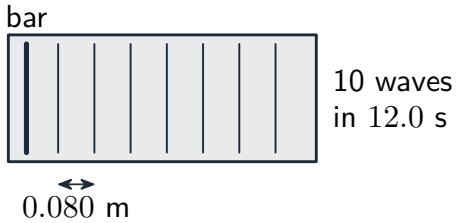
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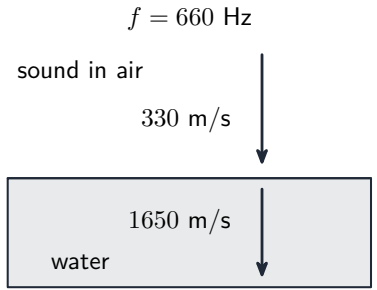
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3.1 (a) $f = N/t = 10/12.0 = \mathbf{0.83}$ Hz (2 s.f.) (C1, A1) (b) $v = f\lambda = 0.833 \times 0.080 = \mathbf{0.067}$ m/s (C1, A1) (c) Wavelength decreases: $\lambda = v/f$ – the question specifies constant speed, so a higher frequency forces a shorter wavelength.

Exercise 3.2

3.2 Sound from a stationary source crosses a stationary boundary from air into water, where it moves faster.



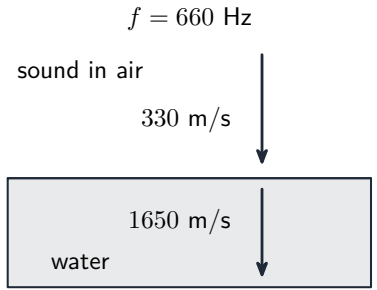
(a) State which of frequency and wavelength changes, and why frequency cannot. [2]

(b) The speed rises from 330 m/s to 1650 m/s at an unchanged frequency of 660 Hz. Calculate both wavelengths. [3]

(c) Describe how the wavefront spacing looks in a diagram after entering the water. [1]

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3.2 (a) Wavelength changes; frequency does not – the number of wavefronts arriving per second cannot change at the boundary. (b) Air: $\lambda = v/f = 330/660 = \mathbf{0.50}$ m (C1); water: $\lambda = v/f = 1650/660 = \mathbf{2.5}$ m; five times longer, matching the speed ratio. (c) The wavefronts are drawn further apart.