Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Transverse: particle oscillations perpendicular to the direction of energy transfer, e.g. waves on a rope; longitudinal: oscillations parallel to it, as compressions and rarefactions, e.g. sound.

2.2 $v = f\lambda = 8.0 \times 0.25 = 2.0$ m/s.

2.3 Any two: sound is longitudinal, electromagnetic waves are transverse; sound is mechanical and needs a medium, electromagnetic waves cross a vacuum; sound travels far slower – about 340 m/s in air against 3.0×10^8 m/s for light; sound is a disturbance of matter, electromagnetic waves are oscillating fields.

2.4 Speed decreases and wavelength decreases; frequency is unchanged.

3.1 $\lambda = v/f = 340/440 = 0.77$ m; $T = 1/f = 2.3 \times 10^{-3}$ s; amplitude sets loudness, not speed – speed is fixed by the medium.

3.2 $\lambda = c/f = (3.0 \times 10^8)/(2.45 \times 10^9) = 0.12$ m; microwaves sit between radio and infrared; electromagnetic waves are oscillating electric and magnetic fields that need no medium, while sound is a mechanical vibration of matter.

3.3 A sinusoid of period 0.50 s repeating each cycle – the particle oscillates up and down about equilibrium in simple harmonic fashion; in a longitudinal wave the particles oscillate parallel to the propagation direction, so displacements appear as compressions and rarefactions rather than crests and troughs.

3.4 Deep: $\lambda = 0.60/2.0 = 0.30$ m; shallow: $\lambda = 0.40/2.0 = 0.20$ m; frequency stays fixed because it is set by the source – the medium controls speed, and wavelength follows.