

Solutions

2.1 35° – the angle of reflection equals the angle of incidence.

2.2 20 Hz to 20 kHz.

2.3 Ultrasound is non-ionising; X-rays ionise and can mutate genes, so ultrasound avoids that risk – it is why it is used for prenatal scans.

3.1 (a) Draw the normal at 90° to the mirror at the point of incidence; measure the angle between the incident ray and the normal with a protractor. (b) Error: ray line too thick / mirror frame offset; improvement: use a thinner beam, mark ray points with crosses and join after, or repeat and average. (c) The light scatters in many directions; diffuse reflection.

3.2 (a) The pulse travels down and back – the time covers both legs. (b)

$$d = \frac{vt}{2} = \frac{1500 \times 0.40}{2} = \mathbf{300 \text{ m}}$$

(C1, C1, A1) (c) Water absorbs and scatters light quickly, while ultrasound (sound) travels far in water.

3.3 (a) P-waves are longitudinal; S-waves are transverse. (b) S-waves cannot travel through liquid; the region they crossed must contain a liquid layer – the outer core. (c) P-waves travel faster and arrive first; the time gap grows with distance from the quake, so comparing gaps at several stations triangulates the source.