Solutions

Each answer shows the steps, then the **result**.

2.1

- two sources (or waves) are coherent when they have a **constant phase difference**

2.2

- path difference $= 26 - 20 = 6$ cm $= 1.5\lambda$
- the waves arrive in antiphase, so there is a **minimum**

2.3

- double-slit equation, $\lambda = \dfrac{ax}{D}$

$$\lambda = \frac{ax}{D} = \frac{0.40 \times 10^{-3} \times 2.7 \times 10^{-3}}{1.8} = \mathbf{6.0 \times 10^{-7}}\ \text{m}$$

2.4

- the sources are coherent
- the waves have similar amplitudes (or: for light, the slits are close together and the screen far away)

2.5

- $x \propto D$, so doubling D doubles x: **5.4** mm

3.1 D

- $x = \dfrac{\lambda D}{a}$: a larger D makes x larger
- **A**, **B** and **C** all make the fringes closer together

3.2 B

- 2.5 wavelengths is an odd number of half wavelengths, so the waves arrive in antiphase and cancel
- **D**: interference still happens; it is destructive

3.3

(a) both slits are lit by the same transmitter

- so the waves leaving them have the same frequency and a constant phase difference

(b) a series of maxima and minima (the signal rises and falls)

(c) $x = \dfrac{\lambda D}{a}$

$$x = \frac{\lambda D}{a} = \frac{0.028 \times 0.80}{0.060} = \mathbf{0.37}\ \text{m}$$

(d) 4.2 cm $= 1.5\lambda$: the waves arrive in antiphase

- so there is a **minimum**

3.4

(a) the superposition of waves from coherent sources, giving regions of maximum and minimum amplitude

(b) $x = \dfrac{\text{width measured}}{\text{number of spacings}} = \dfrac{34\ \text{mm}}{8} = 4.25 \times 10^{-3}$ m

- double-slit equation, $\lambda = \dfrac{ax}{D}$

$$\lambda = \frac{ax}{D} = \frac{0.30 \times 10^{-3} \times 4.25 \times 10^{-3}}{2.00} = \mathbf{6.4 \times 10^{-7}}\ \text{m}$$

(c) the percentage uncertainty in one small spacing is large; measuring several and dividing reduces it

(d) the fringes become **closer together**: the fringe separation halves

- because $x = \dfrac{\lambda D}{a}$, so $x \propto \dfrac{1}{a}$