

Answers to Coursebook questions – Chapter 4.8

- 1** The angular separation of the points is $\theta_A = \frac{1 \times 10^{-2}}{10 \times 10^3} = 10^{-6}$ rad.
 The diffraction angle is $\theta_D = \frac{1.22 \times 600 \times 10^{-9}}{20 \times 10^{-2}} = 4 \times 10^{-5}$ rad.
 The objects will not be resolved since $\theta_A < \theta_D$.
- 2** The angular separation is $\theta_A = \frac{1.4}{d}$ and the diffraction angle is
 $\theta_D = 1.22 \times \frac{500 \times 10^{-9}}{5.0 \times 10^{-2}} = 1.22 \times 10^{-5}$ rad.
 For resolution we need $\theta_A \geq \theta_D$, i.e. $\frac{1.4}{d} \geq 1.22 \times 10^{-5}$ and so $d \leq \frac{1.4}{1.22 \times 10^{-5}} = 115$ km.
- 3** **a** The diffraction angle is $\theta_D = 1.22 \times \frac{5.0 \times 10^{-7}}{4.0 \times 10^{-3}} = 1.52 \times 10^{-4}$ rad and this is the smallest angular separation that can be resolved.
b With $\theta_D = \theta_A = 1.52 \times 10^{-4}$ we get $1.52 \times 10^{-4} = \frac{s}{3.8 \times 10^8} \Rightarrow s \approx 58$ km.
- 4** **a** The diffraction angle is $\theta_D = 1.22 \times \frac{21 \times 10^{-2}}{76} = 3.4 \times 10^{-3}$ rad and this is the smallest angular separation that can be resolved.
b The angular separation of the two stars is $\frac{3.6 \times 10^{11}}{8.8 \times 10^{16}} = 4.1 \times 10^{-6} < \theta_D$ so the stars cannot be resolved.
- 5** The diffraction angle is $\theta_D = 1.22 \times \frac{8.0 \times 10^{-2}}{300} = 3.3 \times 10^{-4}$ rad. The angular separation of two points on a diameter of Andromeda is $\frac{2.2 \times 10^5}{2.5 \times 10^6} = 0.088 > \theta_D$, so the telescope sees Andromeda as an extended object.
- 6** The diffraction angle is $\theta_D = 1.22 \times \frac{5.5 \times 10^{-7}}{4.5 \times 10^{-3}} = 1.5 \times 10^{-4}$ rad. When this is about equal to the angular separation of the earth and the moon, i.e. $\theta_A = \frac{3.8 \times 10^8}{d}$, the objects will be resolved. This means $\frac{3.8 \times 10^8}{d} = 1.5 \times 10^{-4} \Rightarrow d = 2.5 \times 10^{12}$ m.



- 7 a** The diffraction angle is $\theta_D = 1.22 \times \frac{5.5 \times 10^{-7}}{2.4} = 2.8 \times 10^{-7}$ rad.
- b** It is free from atmospheric disturbances.