

## Chapter 4.8

Q1 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  $\theta_A < \theta_D$ .

Q2 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.

Q3 (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.

Q4 (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.

Q5 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.

Q6 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.

Q7 (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.