ASTROPHYSICS

1-4 Angular resolution

1. (a) Diffraction

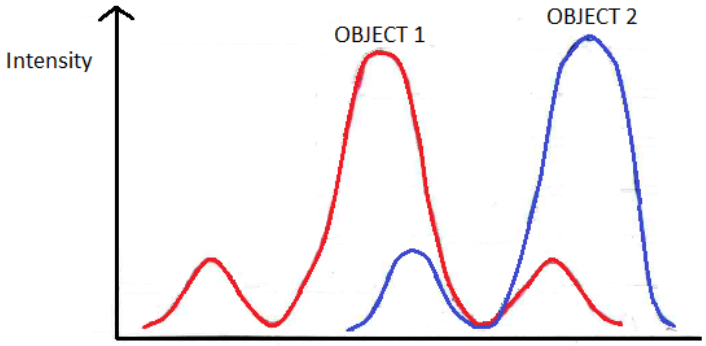
   (b) (i) image of point object from distant star:

   (ii) If a wider lens of the same focal length were used then the diffraction would be less and the image less spread out.

2. The Rayleigh criterion states that:

   "The resolution of the images of two point objects is not possible if any part of the central spot of either image lies inside the first dark ring of the other's image."

   This means that to see two images as separate the angular separation of the two stars must be at least equal to the angle of diffraction of the first dark ring (and the central spot must lie on the first bright ring of the other as a result).



3. (a) angular separation = 8.0×10^{-6} rad, $\lambda_{average}$ = 500 nm = 500×10^{-9} m

$$\theta \simeq \frac{\lambda}{D} \qquad \text{so} \quad D \simeq \frac{\lambda}{\theta} = \frac{500 \times 10^{-9}}{8.0 \times 10^{-6}} = 0.0625 \text{ m}$$

$$= 0.063 \text{ m to 2 sf}$$

   (b) If the new diameter was 2D and the angular magnification was the same, then the image would be completely resolved as the minimum angular resolution would have halved.

4. (a) objective diameter = 2.4 m, assuming $\lambda_{average}$ = 500 nm = 500 x 10^{-9} m again

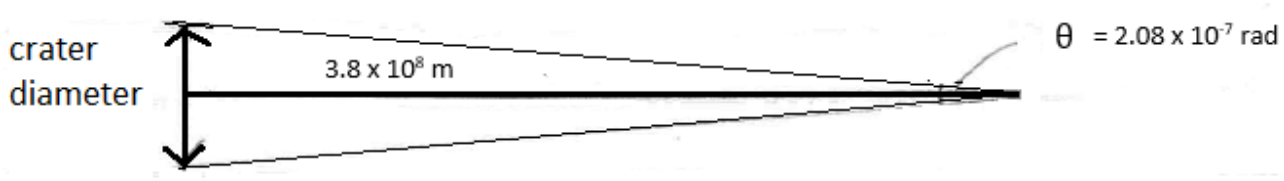
$$\theta \simeq \frac{\lambda}{D} = \frac{500 \times 10^{-9}}{2.4}$$ = 2.08 x 10^{-7} rad

= $\frac{2.08 \times 10^{-7} \times 180}{\Pi}$ degrees

= 1.19…. x 10^{-5} degrees

= 1.2 x 10^{-5} degrees to 2 sf

(b) Earth-Moon distance = 3.8 x 10^8 m



$\theta = \frac{\text{crater diameter}}{\text{Earth-Moon distance}}$ so crater diameter = θ x Earth-Moon distance

= 2.08 x 10^{-7} x 3.8 x 10^8

= 79.04 m

= 80 m to 1 sf

OR

$\tan\theta = \frac{\text{crater diameter}}{\text{Earth-Moon distance}}$ so crater diameter = tanθ x Earth-Moon distance

= tan(1.2 x 10^{-5}) x 3.8 x 10^8

= 79.5 m

= 80 m to 2 sf