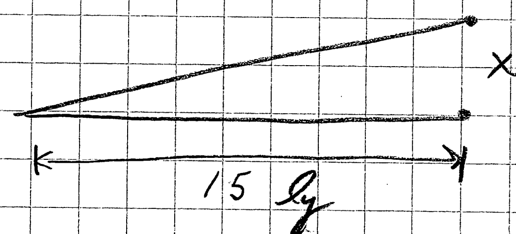
p724 48, 51, 52, 53, 67, 73

(48) $\theta = 1.22\dfrac{\lambda}{b}$

$\theta = \sin^{-1}\left(\dfrac{1.22(550\times10^{-9}\,m)}{254\times10^{-2}\,m}\right)$

$\theta = 1.5\times10^{-5\,\circ}$

(51) $\theta = 1.22\dfrac{\lambda}{b}$

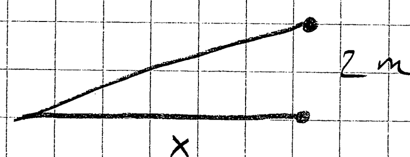


$\dfrac{x}{15\,ly} = 1.22\dfrac{\lambda}{b}$

$x = \dfrac{1.22(550\times10^{-9}\,m)\;15(9.46\times10^{15}\,m)}{55\times10^{-2}\,m}$

$= 1.73\times10^{11}\,m$

(52) (a) $\theta = 1.22\dfrac{\lambda}{b}$

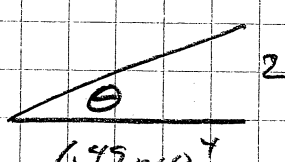


$\theta = \dfrac{2}{x}$

$x = \dfrac{2b}{1.22\lambda}$

$= \dfrac{2(5.0\times10^{-3}\,m)}{1.22(550\times10^{-9}\,m)} = \underline{1.49\times10^{4}\,m}$

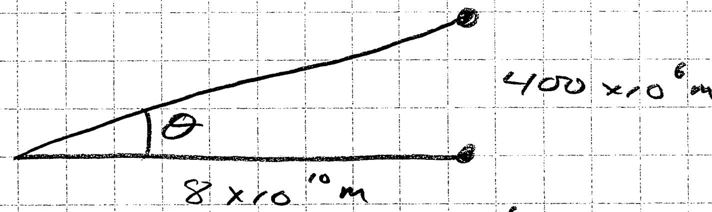
(b)



$\theta = \tan^{-1}\left(\dfrac{2}{1.49\times10^{4}}\right) = \underline{7.69\times10^{-3\,\circ}}$

(1' of arc is 0.017°)
The actual limit is larger due to effects other than diffraction.

(53) $\theta = 1.22 \dfrac{\lambda}{b}$



$$\theta = \frac{1.22\,(550\times10^{-9}\,m)}{5\times10^{-3}\,m}$$

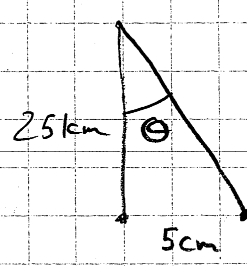
$$= 1.342\times10^{-4}\ rad$$

$$\theta = \frac{400\times10^{6}\,m}{8\times10^{10}\,m}$$

$$= 0.005\ rad$$
$$= 50\times10^{-4}\ rad$$

The actual angle is greater than the just resolved angle. Therefore, the Earth and Moon could be resolved without a telescope.

(67) $\theta = 1.22 \dfrac{\lambda}{b}$



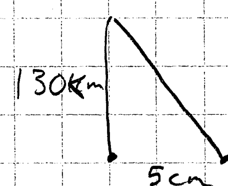
$$\theta = \frac{5\times10^{-2}\,m}{25\times10^{3}\,m}$$

$$b = \frac{1.22\,\lambda}{\theta}$$

$$= \frac{1.22\,(550\times10^{-9}\,m)}{\dfrac{5\times10^{-2}\,m}{25\times10^{3}\,m}}$$

$$= \underline{0.34\ m}$$

(73) $\theta = 1.22 \dfrac{\lambda}{b}$



$$\theta = \frac{5\times10^{-2}}{130\times10^{3}}$$

$$b = \frac{1.22\,\lambda}{\theta}$$

$$= \frac{1.22\,(550\times10^{-9}\,m)}{\dfrac{5\times10^{-2}}{130\times10^{3}}}$$

$$= 1.7\,m$$