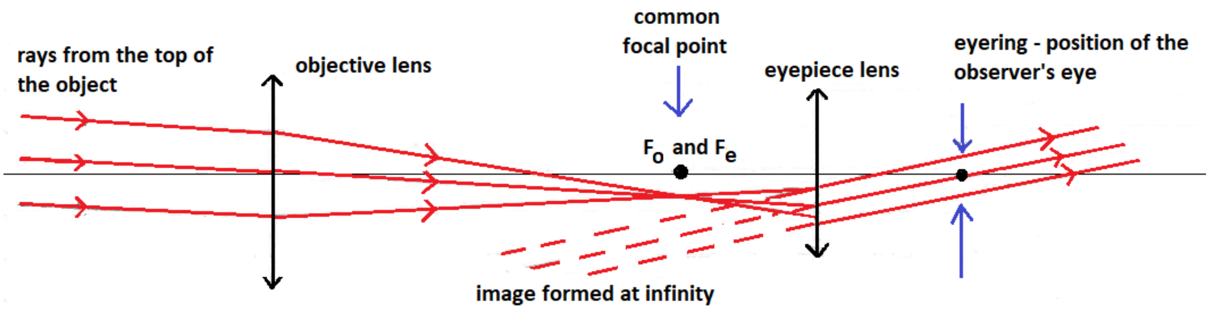
ASTROPHYSICS

1-2 The refracting telescope

1. Ray diagram:



2. (a) 'normal adjustment' is when the telescope has been adjusted so that the virtual image seen by the observer is at infinity

(b) (i) $f_0 = 450$ mm, $f_e = 60$ mm

angular magnification $= \frac{f_0}{f_e} = \frac{450}{60} = 7.5$

(ii) $\alpha = 0.15°$, $f_0/f_e = 7.5$

$$\frac{\text{angle subtended by image}}{\text{angle subtended by object}} = \frac{\beta}{\alpha} = \frac{f_0}{f_e}$$

$$\text{therefore } \beta = \frac{f_0}{f_e} \times \alpha$$

$$= 7.5 \times 0.15$$
$$= 1.125$$
$$= 1.13° \text{ to 3 sf}$$

3. (a) A telescope objective is wider than the pupil of the eye so more light from the starts enters it and hence the eye of the observer compared to observation with the naked eye. A star that is not visible to the unaided eye can thus be seen with a telescope.

(b) The Galilean moons of Jupiter would be too faint to be seen with the unaided eye but a telescope enables sufficient light from them to be collected and hence observed (as well as magnifying them).

4. f_e = 40 mm, angular magnification = 16

(a) (i)

$$\text{angular magnification} = \frac{f_0}{f_e}$$

so $f_0 = f_e \times$ angular magnification

$= 40 \text{ mm} \times 16$

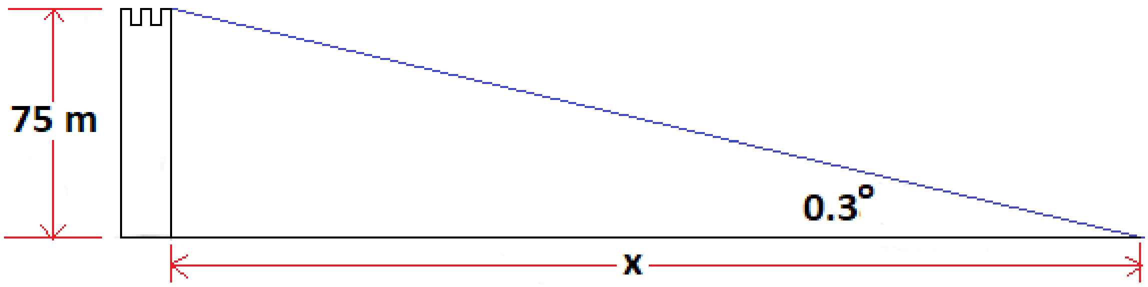
$= 640 \text{ mm}$

(ii) Separation of the two lenses $= f_0 + f_e$

$= 640 + 40$

$= 680 \text{ mm}$

(b) (ii)



$$\tan(0.3) = \frac{75}{x}$$

$$x = \frac{75}{\tan(0.3)}$$

$= 1.4323 \times 10^4$ m

$= 1.43 \times 10^4$ m to 3 sf

or $= 1.4 \times 10^4$ m to 2 sf

or = 14 km to 2 sf