1)  

a) For a reflecting telescope that has a mirror with an aperture of 300mm and a focal length of 1200mm what is the focal ratio of the focal ratio?

Solution: The focal ratio is

\[ F = \frac{f}{D} = \frac{1200\text{mm}}{300\text{mm}} = 4 \]

Where \( f \) is the focal length, and \( D \) the aperture of the telescope. The units cancel and we are left with a dimensionless number.

b) Is the focal ratio associated with fast or slow speeds?

Solution: The above ratio is considered to be small and therefore is associated with fast speeds.

2)  

a) If a reflecting telescope has a \((f/8)\) ratio and a focal length of 2000mm what size is the aperture of the main mirror?

Solution: We can determine the aperture size by rearranging the equation for focal ratio seen above.

\[ F = \frac{f}{D} \]

We start with the equation for focal ratio.

\[ D \times F = \frac{f}{D} \times D \]

We multiply each side by \( D \) the aperture.

\[ \frac{D \times F}{F} = \frac{f}{D} \times \frac{D}{F} \]

Then we divide both sides by \( F \) the focal ratio.

\[ D = \frac{f}{F} \]

Finally we are left with the equation for aperture.

\[ D = \frac{f}{F} = \frac{2000\text{mm}}{8} = 250\text{mm} \]

b) Is this telescope best for photographing deep space or observing lunar and planetary objects? Why?

Solution: Lunar and planetary objects because it has a medium to large focal ratio.
3)

a) How many times could a refracting telescope magnify an object if the eyepiece focal length is 30mm and the focal length of the telescope is 2250mm.

*Solution: The magnification is given as the ratio of the focal length over the focal length of the eyepiece of a telescope. We plug in our values and get;*

\[
M = \frac{f}{e} = \frac{2250\text{mm}}{30\text{mm}} = 70
\]

b) What about for an eyepiece focal length of 25mm?

*Solution: The same as previous but with a new e value;*

\[
M = \frac{f}{e} = \frac{2250\text{mm}}{25\text{mm}} = 90
\]

c) On a clear night which eyepiece is the best one to use?

*Solution: 25mm*

d) On an average night which eyepiece would be sufficient to use?

*Solution: 30mm*

4)

a) If the lens of a refracting telescope has an aperture of 250mm and can magnify an image 39.3 times what is the value of the exit pupil of the telescope?

*Solution: We use the formula for the exit pupil;*

\[
Ep = \frac{D}{M} = \frac{250\text{mm}}{39.3} = 6.36\text{mm}
\]

b) How does this compare to the aperture of the pupil of a human eye? Is the image blurred? Why?

*Solution: The human eye is anywhere between 5mm - 7mm in diameter. The value above falls within the middle of this range roughly and therefore we can assume that there is no blurring of an image.*
5) An observer’s pupil is fully dilated to 5mm. The reflecting telescope being used has an aperture of 200mm and a magnification of 33.3. What happens to the image viewed?

Solution: Our first step is to find the size of the exit pupil;

\[ Ep = \frac{D}{M} = \frac{200\text{mm}}{33.3} = 6.00\text{mm} \]

The exit pupil is greater than the observer’s pupil. This tells us that not all of the light from the exit pupil will enter the observer’s pupil and therefore the image will be darkened.

6)

a) What is the maximum magnification of a telescope that has a focal length of 2250mm and an eyepiece focal length of 2mm?

Solution: We use the maximum magnification equation;

\[ M = \frac{f}{e} = \frac{2250\text{mm}}{2\text{mm}} = 1125 \]

b) Suppose you are out buying a telescope, is this a good one to buy?

Solution: No! Huge magnifications will simply blur what you are looking at. Resolution is a much more important feature to look for.

7)

a) Given a magnification of 80, and an eyepiece FOV of 40° what is the telescope FOV?

Solution: This is again just a “plug in problem” using the FOV formula;

\[ FOV = \frac{e_{\text{FOV}}}{M} = \frac{40^\circ}{80} = 0.5^\circ \]

Where \( e_{\text{FOV}} \) is the eyepiece field of view and \( M \) is the magnification.

b) How does this compare to the angular size of the moon?

Solution: It is roughly the same.
8)

a) Find the resolution angle $\theta$ in seconds of arc for your eye. The eye has an aperture of 0.25 inches.

Solution: Using the resolution angle formula for inches we get;

$$\theta = \frac{\text{4.56''in}}{D} = \frac{4.56''\text{in}}{0.25\text{in}} = 18.24''$$

b) Find the resolution angle $\theta$ in seconds of arc of a telescope that has an aperture of 10 inches.

$$\theta = \frac{4.56''\text{in}}{D} = \frac{4.56''\text{in}}{10.0\text{in}} = 0.456''$$

9) Which of the following double star systems could or could not be resolved by your eye and by the telescope in question 8?

Solution: In order for you to be able to resolve something with your eye or with a telescope the resolution angle $\theta$ must be less than the separation angle of the object you are trying to resolve.

a) eye (no) telescope (yes)

b) eye (no) telescope (no)

c) eye (yes) telescope (yes)

d) eye (no) telescope (yes)