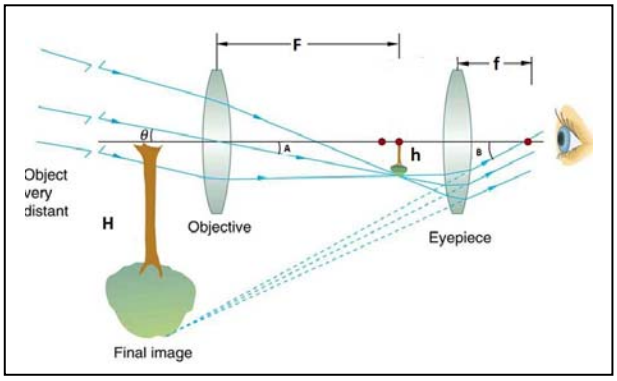

A telescope consists of an objective mirror or lens and an eyepiece. The role of the eyepiece is to change the angle, A, of the rays from the objective as they enter the eye. As the figure shows, when B > A, it appears as though the image of the tree is bigger than its actual image at the focus of the telescope objective. A simple proportion relates the image sizes to the focal lengths of the lenses:

$$\frac{H}{h} = \frac{F}{f}$$

For example, if the telescope objective has a focal length of 2000 millimeters and the eyepiece has a focal length of 4 millimeters, H/h = 2000/4 = 500, so the image h has been magnified by 500 times. The quantity F/f is the magnification.

Problem 1 – The table below gives the optical data for some large telescopes. Use this data to calculate the magnification for each indicated lens. Also fill in all other missing information. Focal lengths and aperture dimensions are given in millimeters.

Telescope	Type	Aperture	F/	Focal Length	Eyepiece F.L.	Magnification
8-inch Orion	Reflector	203		1198	10	
Obsession-20	Reflector	508	5.0		8	
1-meter	Reflector	1000	17.0			850
David Dunlop	Reflector	1880	17.3		100	
Hubble	Reflector	2400		57600		2880
Mt Palomar	Reflector		3.3	16830	28	
Yale	Refractor	1020	19.0		4	
Subaru	Reflector	8200		15000		7500
Keck	Reflector		1.75	17500	1	

Problem 2 – Suppose that the eyepiece was eliminated and the human eye was used as the eyepiece instead. If the focal length of the human eye is 25 cm, what is the magnification for the Obsession-20 telescope operating in this way? (Note: this is called Prime Focus observing).

Problem 1 – The table below gives the optical data for some large telescopes. Use this data to calculate the magnification for each indicated lens. Also fill in all other missing information.

Telescope	Type	Aperture	F/	Focal Length	Eyepiece F.L.	Magnification
8-inch Orion	Reflector	203	**5.9**	1198	10	**120**
Obsession-20	Reflector	508	5.0	**2540**	8	**317**
1-meter	Reflector	1000	17.0	**17000**	**20**	850
David Dunlop	Reflector	1880	17.3	32,524	**100**	**325**
Hubble	Reflector	2400	**24**	57600	**20**	2880
Mt Palomar	Reflector	**5100**	3.3	16830	28	**601**
Yale	Refractor	1020	19.0	**19400**	4	**4850**
Subaru	Reflector	8200	**1.83**	15000	**2**	7500
Keck	Reflector	**10000**	1.75	17500	1	**17500**

Problem 2 – Suppose that the eyepiece was eliminated and the human eye was used as the eyepiece instead. If the focal length of the human eye is 25 cm, what is the magnification for the Obsession-20 telescope operating in this way? (Note: this is called Prime Focus observing).

Answer: The focal length of the Obsession-20 mirror is 2540 mm, and the eye's focal length is 250 mm, so the magnification is only about **10 times**. This means that if you look at the moon in this way, it will appear 10 times bigger 'in the sky' than without the telescope.

Note: A rule-of-thumb is that you do not use a higher magnification than 2 times the aperture size in millimeters. At higher magnifications the image remains blurry and you do not see additional details. In the table in Problem 1, the only eyepiece that violates this rule is the one selected for the Yale Telescope, and so an eyepiece with a longer focal length and lower magnification is the best to use.