



Early depiction of a 'Dutch telescope' from the "Emblemata of zinne-werck" (Middelburg, 1624) of the poet and statesman Johan de Brune (1588-1658). The print was engraved by Adriaen van de Venne, who, together with his brother Jan Pieters van de Venne, printed books not far from the original optical workshop of Hans Lipperhey.

Telescopes can magnify the sizes of distant objects so that the eye can see them more clearly. This is very handy for astronomers who want to study distant planets, stars and galaxies to figure out what they are!

A simple telescope, called a refractor, has two lenses. The large one collects the light from a distant object and amplifies it so that the image is much brighter than what the eye normally sees. This is called the Objective Lens, or for reflecting telescopes, the Objective Mirror. A second lens is placed at the focus of the Objective and provides the magnification you need to study the objects.

Both the Objective and the eye lens (called the Eyepiece) have their own focus points. The distance between the lens and this focus point is called the focal length. The magnification of the telescope is just the ratio of the Objective focal length to the eyepiece focal length!

$$M = \frac{\text{Objective focal length}}{\text{Eyepiece focal length}}$$

Note, the units for the focal lengths both have to be the same units...inches...millimeters....etc.

**Problem 1** – Galileo’s first telescope consisted of two lenses attached to the inside of a tube. The Objective had a focal length of 980 millimeters and the eye lens had a focal length of 50 millimeters. What was the magnification of this telescope?

**Problem 2** – In 1686, astronomer Christian Huygens built an 8-inch refractor with a 52 meter focal length. If he used the same magnifying eyepiece that Galileo had used, what would be the magnification of this ‘long tube refractor’?

**Problem 3** – An amateur builds a 20-inch reflector that has a focal length of 157 inches. He already owns three very expensive eyepieces with focal lengths of 4mm, 20mm and 35 mm. What magnification will he get from each of these eyepieces? (1 inch = 25.4 mm)

**Problem 1** – Galileo’s first telescope consisted of two lenses attached to the inside of a tube. The Objective had a focal length of 980 millimeters and the eye lens had a focal length of 50 millimeters. What was the magnification of this telescope?

Answer.  $M = 980/50 = \mathbf{19.6 \text{ times}}$ .

**Problem 2** – In 1686, astronomer Christian Huygens built an 8-inch refractor with a 52 meter focal length. If he used the same magnifying eyepiece that Galileo had used, what would be the magnification of this ‘long tube refractor’?

Answer: 52 meters = 52000 millimeters, then for a 50mm eyepiece, the magnification is  $M = 52000/50 = \mathbf{1040 \text{ times}}$ .

**Problem 3** – An amateur builds a 20-inch reflector that has a focal length of 157 inches. He already owns three very expensive eyepieces with focal lengths of 4mm, 20mm and 35 mm. What magnification will he get from each of these eyepieces?

Answer: 157 inches x 25.4 mm/inch = 3988 mm, then

$$M = 3988/4 = 997x,$$

$$M = 3988/20 = 199 x$$

$$M = 3988/35 = 114 x$$