Problem 62

(a) Estimate the density of the Moon. (b) Estimate the diameter of the Moon. (c) Given that the Moon subtends at an angle of about half a degree in the sky, estimate its distance from Earth.

Solution

Part (a)

According to Appendix D on page 894,

$$\text{Mass of Moon}: \quad 7.36 \times 10^{22} \text{ kg}.$$

Using the fact (on page 10) that Earth has a radius of about $\frac{1}{2} \times 10^7$ m, assume that the Moon has half this radius.

$$\text{Radius of Moon}: \quad \frac{1}{4} \times 10^7 \text{ m} = 2.5 \times 10^6 \text{ m}$$

Therefore, the density of the Moon is

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{7.36 \times 10^{22} \text{ kg}}{\frac{4}{3}\pi(2.5 \times 10^6 \text{ m})^3} \approx 1 \times 10^3 \ \frac{\text{kg}}{\text{m}^3}.$$

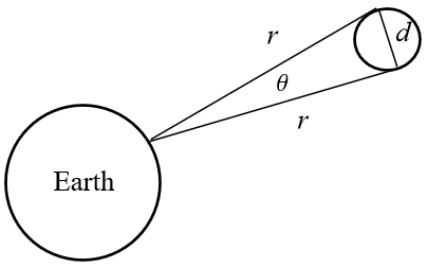
Part (b)

The diameter of the Moon is double the radius.

$$\text{Diameter of Moon}: \quad 5 \times 10^6 \text{ m}$$

Part (c)

Draw the Earth, the Moon, and the subtended angle θ. Let the distance from the Earth to the Moon be r, and let the diameter of the Moon be d.



The equation relating these variables is the formula for arclength.

$$d = r\theta$$

Solve for r, noting that θ has to be in radians.

$$r = \frac{d}{\theta} = \frac{5 \times 10^6 \text{ m}}{0.5 \times \frac{\pi}{180}} \approx 6 \times 10^8 \text{ m}$$