

Project 4... Estimating the Mass of Earth

From Kepler's Third Law (balancing the gravitational force and centripetal force in a circular orbit) we have the formula

$$\frac{V^2}{D} = \frac{GM}{D^2}$$

Where V is the orbit speed of the moon, D is its distance from Earth's center to the Moon's center, and M is the mass of Earth.

Step 1: Solve the equation for M .

Step 2: From Project 1 or Project 3, we have measured the lunar distance, D .

Step 3: From Project 2 we have an estimate for the ground speed of the moon's shadow. Because Earth is rotating in the same direction as the orbiting moon, we have to add Earth's rotation speed to the ground speed to get the orbit speed.

$$V(\text{orbit}) = V(\text{ground}) + V(\text{rotation})$$

The rotation speed of Earth at the latitude, q , of the observer of the shadow is

$$V(\text{rotation}) = 1674 \cos(q).$$

Given $V(\text{ground})$ and $V(\text{rotation})$ compute $V(\text{orbit})$

Step 4: Convert R and V to meters and meters/sec.

Step 5: Use the constant of gravity $G = 6.67 \times 10^{-11}$ and the mass M in kilograms from your equation in Step 1.