Orbital period of the Moon

FizziQ activity · Middle school · 30-40 min

Scan to open in FizziQ

With the FizziQ Web Orbits and Gravitation simulation in the browser, middle school students measure the Moon's orbital period and compare it to the real 27.3 days.

Learning objectives

- Configure the Earth-Moon system in the FizziQ Web Orbits and Gravitation simulation
- Measure the Moon's orbital period in days
- Compare the experimental value to the real period of 27.3 days
- Identify the parameters that influence a satellite's trajectory (central mass, radius, speed)
- Qualitatively describe the role of gravitation in orbital motion

Instruments and sensors

FizziQ Web Orbits and Gravitation simulation

Materials

- Computer, tablet or smartphone with FizziQ Web
- FizziQ experiment notebook
- Note: the protocol remains adaptable to any comparable numerical simulation tool for orbital motion.

Protocol

1. Open the Orbits and Gravitation simulation in FizziQ Web (Experiment → Simulations → Orbits and gravitation).
2. Verify the default Earth-Moon configuration: body 1 (Earth, mass 1 M⊕, speed 0 km/s) and body 2 (Moon, mass 0.012 M⊕, speed 1.022 km/s, angle -90°).
3. Verify the scales: distance 2,000 km/pixel and time 30 minutes per frame (settings suited to the Earth-Moon system).
4. Click the body 1 centering button in the Centering area to lock the view on Earth during the simulation.
5. Click the red REC button to start position recording. The simulation launches automatically and traces the Moon's trajectory.
6. Observe the Moon's coloured trajectory around Earth. Read the chronometer in the upper-left corner, which displays elapsed time in days.
7. Identify the moment when the Moon returns to its initial position: note this time T in days. This is the orbital period.
8. Let the simulation run a second revolution to verify the measured duration is consistent.
9. Click REC again to stop recording. The data t, x_2, y_2 are automatically exported to the experiment notebook.
10. In the experiment notebook, plot the graph of x_2 versus time. The curve is sinusoidal: the duration between two maxima gives the period T.
11. Compare the measured value to the real period of 27.3 days. Compute the percentage deviation: deviation (%) = 100 × (T_measured − 27.3) / 27.3.
12. Repeat the simulation by doubling Earth's mass (2 M⊕) without changing the distance. Observe that the Moon orbits faster: the period decreases.

Expected results

The Moon's trajectory appears as a near-perfect circle centred on Earth, with a radius close to 384,400 km. The measured period is around 27.3 days, in agreement with the real value. A small deviation (of order 1 to 5%) may appear depending on simulation duration and time step, due to the numerical integration scheme. The x_2(t) curve is sinusoidal: the time between two successive maxima corresponds to the period. When Earth's mass is doubled, the Moon orbits about 1.4 times faster and the period decreases. If the initial speed is greatly increased, the Moon escapes because gravity can no longer hold it.

Questions

- Why doesn't the Moon fall to Earth even though it is gravitationally attracted?
- What would happen if Earth were twice as massive? How would the period change?
- What would happen if the Moon's initial speed were decreased? And greatly increased?
- Why does the Moon's sidereal period (27.3 days) differ from the cycle of phases (29.5 days)?
- What role does the orbit's radius play in a revolution's duration around the same central body?

Going further

- Modify the Moon's initial speed (0.5, 1.022, 1.5, 5 km/s) to observe fall, stable orbit and escape trajectories
- Reproduce the Sun-Earth system (mass 333,000 M⊕, distance 150 million km, speed 29.8 km/s) and verify T ≈ 365 days
- Double Earth's mass while keeping the Earth-Moon distance and observe the period decrease
- Add the Sun to the Earth-Moon system (3 bodies) and observe perturbations on the lunar orbit
- Test several orbital radii at fixed central mass and compare T^2/r^3 ratios to discover Kepler's 3rd law