

Gravity Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/orbit-simulator/>

Name: _____ Date: _____

Learning objectives

- Apply Newton's law of gravitation to orbital motion.
- Relate orbital speed and radius.
- Recognize Kepler's laws in the simulated orbits.

Variables to change

- Mass of central body
- Initial speed
- Initial position
- Number of bodies

Procedure

1. Place one planet and give it a speed that produces a near-circular orbit.
2. Reduce the speed and observe the orbit shape; then increase it.
3. Increase the central mass and observe the effect on the orbit.

Observations

Note how orbit shape (circle, ellipse, escape) changes with initial speed and central mass.

Questions

1. What shape is a bound orbit in general?
2. How does gravitational force depend on distance?

3. What happens if the initial speed is too high?
4. State Kepler's second law and what it implies about speed.
5. How does increasing the central mass change a stable orbit at fixed radius?

Answer key (instructors)

- **1.** An ellipse, with the central body at one focus (a circle is the special case).
- **2.** It follows an inverse-square law: $F = G \cdot m_1 \cdot m_2 / r^2$.
- **3.** The object escapes on an unbound (parabolic or hyperbolic) path once it exceeds escape velocity.
- **4.** A line from the planet to the star sweeps equal areas in equal times, so the planet moves fastest at closest approach (perihelion).
- **5.** It increases the required orbital speed; stronger gravity demands faster motion to stay in orbit.

Gravity provides the centripetal force that holds bodies in orbit. The inverse-square law yields elliptical bound orbits (Kepler's first law) and equal-area sweeping (second law). Too much speed and a body escapes; more central mass demands faster orbits.