

Black Hole Simulator

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

Name: _____ Date: _____

Learning objectives

- Describe how gravity bends the path of light.
- Explain what the event horizon is.
- Relate the Schwarzschild radius to mass.

Variables to change

- Black hole mass
- Light-ray impact parameter
- Viewing angle

Procedure

1. Send light rays past the black hole at a large distance and observe their paths.
2. Move the rays closer and watch the bending increase.
3. Increase the mass and observe the event horizon and lensing grow.

Observations

Note how the bending of light changes with distance from the black hole and with its mass.

Questions

1. What is the event horizon?
2. What happens to light that passes close to a black hole?
3. How does the Schwarzschild radius depend on mass?

4. Does a black hole's gravity differ from ordinary gravity far away?
5. Why do we see a dark shadow with a bright ring around a black hole?

Answer key (instructors)

- **1.** The boundary around a black hole within which nothing, not even light, can escape.
- **2.** Its path bends (gravitational lensing); very close in, it can be captured.
- **3.** It is proportional to mass: $r_s = 2GM/c^2$. More massive black holes have larger horizons.
- **4.** No — at a distance it pulls like any mass of the same amount; the extreme effects appear only close to the horizon.
- **5.** Light near the horizon is bent and captured, leaving a dark region rimmed by lensed light.

Massive bodies curve spacetime and bend light. A black hole is so dense that within its event horizon ($r_s = 2GM/c^2$) escape is impossible. Passing light is lensed into arcs and rings, while its distant gravity behaves like any equal mass.