

Newton's Cannon

Mission: Isaac Newton imagined a cannon on a mountain so tall it poked out of the air. Fire cannonballs at different speeds to discover how gravity keeps the Moon and satellites in orbit.

Big question: How does gravity keep objects in orbit?

★ Warm-up: Would you rather?

Choose and explain.

Throw a ball gently or as hard as you can: which lands farther away? Why? ✓ **Harder: more speed carries it farther before gravity brings it down.**

If gravity disappeared, what would the Moon do? ✓ **Fly off in a straight line.**

Key vocabulary

Gravity	The force that pulls objects with mass toward each other.
Orbit	The curved path of an object around another object.
Velocity	Speed in a direction.
Escape velocity	The speed needed to break free of a planet's gravity.

1 Box 1

Predict

PREDICTION If you fire faster (6 km/s), the ball will...

- ☐ land farther around Earth ☐ land in the same place ☐ go straight up

Speed trials

Fire at each speed and record the result (crashed, orbit, or escaped).

Speed	Result
4 km/s	from simulator
6 km/s	from simulator
8 km/s	from simulator
12 km/s	from simulator

2 Box 2

Falling around Earth

At 8 km/s the ball is still being pulled by gravity. Why doesn't it hit Earth?

- ☐ It moves sideways so fast that Earth curves away as it falls ☐ Gravity turned off
☐ It is above the atmosphere so it stops falling

✓ **It moves sideways so fast that Earth curves away as it falls**

3 Box 3

Turn off gravity

In the simulator: Turn **Gravity OFF** and fire at 8 km/s.

Without gravity, what path did the ball take?

- ☐ A straight line into space ☐ The same orbit ☐ It crashed

✓ **A straight line into space**

4 Box 4

Connect to the Moon

How is the Moon like the 8 km/s cannonball?

- ☐ It is always falling toward Earth but moving sideways fast enough to keep missing ☐ It is held up by nothing
☐ It is pushed by the Sun

✓ **It is always falling toward Earth but moving sideways fast enough to keep missing**

5 Box 5

Legend: the Sun's pull 🏆 Legend only

Earth orbits the Sun at about 30 km/s. What would happen if Earth suddenly stopped moving sideways?

- ☐ It would fall toward the Sun ☐ It would stay still ☐ It would fly away

✓ **It would fall toward the Sun**

6 Box 6

Explain orbits (CER)

How does gravity keep objects in orbit?

Claim

Look for: Gravity pulls toward the center; at least 6 words

Evidence

Look for: Uses a crash result; Uses the orbit result; a number from the simulator; at least 12 words

Reasoning

Look for: Explains sideways speed; Explains falling around the curve; at least 12 words

🔑 Exit ticket: answer the big question in your own words

How does gravity keep objects in orbit?

Look for: Gravity pulls every object toward Earth's center. A slow cannonball falls and hits the ground. Fast enough (about 8 km/s), it falls around the curve of Earth without hitting it: that is an orbit. Even faster (about 11 km/s) it escapes. The Moon orbits Earth, and Earth orbits the Sun, the same way.

Completion codes

Students see a code like **ABC-I3** when they finish. The first part must match below. The letter is the level (E = Explorer, I = Investigator, L = Legend), and the number at the end is how many stars they earned.

Level	Code starts with
 Explorer	1TS-E
 Investigator	1GY-I
 Legend	DYE-L

! Watch for these misconceptions

- "There is no gravity in space." Gravity reaches across space; astronauts float because they are falling around Earth.
- "Moon phases are caused by Earth's shadow." Only lunar eclipses involve Earth's shadow.
- "Summer happens when Earth is closest to the Sun." Earth is closest in January. Tilt causes seasons.