Gravity and our place in the universe

Student activity • observation and reasoning

YEAR 11 / LESSON 105 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How can gravity change motion while mass stays the same?

Use scale-hierarchy cards and weight calculations instead of swinging objects on strings.

Equipment

- Booklet, hierarchy cards, ruler and calculator

Paper models only. No bungs, swinging masses, released strings or solar observation. Never look at the Sun through optical equipment.

Course coverage: Shared Physics / Double Award: 8.1–8.4. Cosmic structure, gravitational field strength and orbital motion.

Plan, model or apparatus sketch

Draw a labelled nuclear or astronomical model and state its limits.

Method and reasoning

Read the whole sequence before starting

YEAR 11 / LESSON 105 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Arrange planet, solar system, galaxy and universe cards in a containment hierarchy. Place our solar system in the Milky Way and distinguish a star from a planet.

2. Explain that the universe contains vast numbers of galaxies and galaxies contain large populations of stars. Do not depict every galaxy as identical in size or star count.

3. For a practice mass of 2.0 kg, calculate weight using $W = mg$ with Earth $g = 9.8\ N\ kg^{-1}$, Moon $g = 1.6\ N\ kg^{-1}$ and a hypothetical planet $g = 4.0\ N\ kg^{-1}$.

4. Explain why the mass remains 2.0 kg in all three examples while weight changes. State that gravitational field strength depends on the attracting body and distance from it.

5. Draw a moon, planet, artificial satellite and comet orbiting appropriate bodies. At one point draw gravitational force toward the attracting body and velocity tangential to the path.

6. Explain why an orbiting object can be continually falling without reaching the surface in the ideal model. Keep the diagram separate from a physical string-swinging demonstration.

Cleanup

- Collect cards and retain calculations.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 105 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

The gravitational field values are supplied approximate practice values. Weights are 19.6 N, 3.2 N and 8.0 N. Diagrams are not to scale; gravity supplies the inward force needed to curve an orbit.

Location / model	Known quantity	Result / explanation
Earth	$g = 9.8\ \text{N kg}^{-1}$	
Moon	$g = 1.6\ \text{N kg}^{-1}$	
Practice planet	$g = 4.0\ \text{N kg}^{-1}$	
Orbit arrows		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 105 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Which galaxy contains the solar system?

2. Find Earth weight for 2.0 kg.

3. Find Moon weight.

4. Does mass change in these examples?

5. Which way does orbital gravity act?

6. Which way is instantaneous velocity drawn?