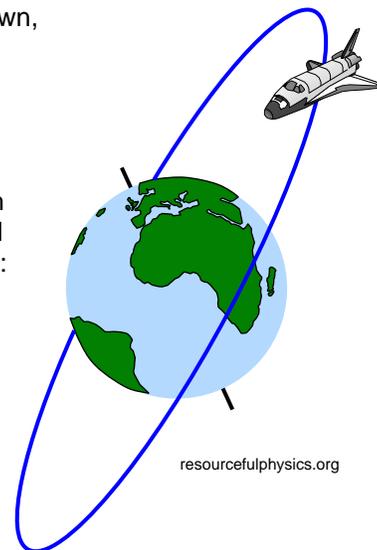


Episode 400: Preparation for gravitational fields topic

Students will have been aware of the effects of gravity since they first fell down, so it is probably the force they feel most familiar with. In this topic, they will extend their terrestrial experience to develop a much broader picture of the force of gravity, and its representation in the form of a gravitational field.

Students are often initially surprised by the fact that they pull up on the Earth with exactly the same force that the Earth pulls down on them. This topic will develop the idea that Newton's Law of Universal Gravitation is precisely that: universal. Every single object with a mass in the universe gravitationally attracts every other object with mass.



Episode 401: Newton's law of universal gravitation

Episode 402: Fields, field lines and field strength

Episode 403: Orbital motion

Episode 404: Gravitational potential energy and gravitational potential

Main aims

Students will:

1. Understand the concept of a field and its depiction with field lines.
2. Understand and use Newton's law of universal gravitation.
3. Understand what is meant by an *inverse square law*.
4. Understand and use the term *field strength*.
5. Understand and use the terms *potential energy* and *potential* and know that the zero of potential is defined to be at infinity.
6. Understand that the gradient of potential is related to field strength.
7. Understand the motion of objects in gravitational fields (circular orbits only, including geosynchronous orbits).

Prior knowledge

Students will have a vague notion of the concept of a field, and its representation by lines of force, from studies of magnetism. When developing the idea of a gravitational field, you can refer back to these earlier ideas.

In earlier studies, your students should have covered the following concepts:

Mass; weight $W = mg$; g defined as field strength in N kg^{-1} or as gravitational acceleration in m s^{-2} ; all bodies in free-fall (no resistive forces) accelerate at the same rate; work; kinetic energy; gravitational potential energy close to the Earth's surface = mgh ; conservation of energy; Newton's laws of motion.

In their advanced studies, they should also have covered circular motion and centripetal force.

Where this leads

The concept of a field is hugely important in physics (traditionally as a model to explain “action-at-a-distance” effects). In classical physics the known forces (gravitation and electromagnetism) were modelled incredibly successfully as fields, with a great many applications to industry and society as a whole.

More recently, QED (quantum electrodynamics), often quoted as the most accurately tested theory known to man, is in essence nothing more than a theory about electric fields. Although the modern view of a field is quite different to the classical one, fields are an essential cornerstone of physics.

Gravitation is a great starting point for the subject of fields, introducing and developing concepts that are found in all field physics (such as field strength and potential), and it also gives an opportunity for revising Circular Motion and Energy.