# Gravity

Critical teaching ideas - Science Continuum F to 10
**Level:** Moving toward Level 10

## Student everyday experiences

Things falling towards the earth are such familiar occurrences that students may consider these events as 'natural' with no need for further explanation. (See AAAS maps).

Even students who use the word 'gravity' in an appropriate context may not be able to be able to explain what it is, or be inconsistent in their explanations. (See Skamp, 2004)

Students' views about gravity, the shape of the earth, and the direction of 'down' are often intertwined (See Forces without contact).

Students may have a range of views about gravity:

- Gravity is a push from above (in some instances due to air pressure)
- Gravity is related to the presence of air, or is something in the air, so if there is no air, there is no gravity. (Hence there is no gravity on the moon, in earth satellites or in space; as one rises above the surface of the earth gravity lessens because the atmosphere thins)
- Gravity increases with height
- Gravity is significantly less on high mountains or tall buildings and increases as we lose height (which is why falling object speed up).
- Gravity is caused by the earth spinning.
- Gravity affects things while they are falling but stops when they reach the ground. It does not operate on things that are moving upwards.
- Gravity acts upwards on things that are moving upwards.
- Gravity is a large force.
- There is no gravity in a spacecraft orbiting the earth.

(See Watts, 1982; Gunstone & Watts, 1985; Skamp, 2004; Palmer, 2001; Gunstone & Mitchell, 1998).

## The scientific view

- Gravitational forces are considered to be inherently linked to what we call 'mass'.
- There is a gravitational force of attraction between every object in the universe. The size of the gravitational force is proportional to the masses of the objects and weakens quickly as the distance between them increases.
- We only notice gravitational forces if one of the objects involved has a huge mass (such as the earth). Gravitational forces are relatively much weaker than magnetic and electric forces.

## Critical teaching ideas

- Gravitational force is an attraction between masses. (AAAS Atlas of science literacy)

- The greater the size of the masses, the greater the size of the gravitational force (also called the gravity force).
- The gravitational force weakens rapidly with increasing distance between masses (AAAS Atlas of science literacy)
- The gravitational force is extremely hard to detect unless at least one of the objects has a lot of mass
- Because the earth is so big, you have to travel to a very great height above the earth's surface before there are any detectable changes in the gravitational pull of the earth (there is only about 0.25% reduction at the top of Mt Everest)
- The weight force on an object tells us the size of the gravity force from earth acting on the object.

Two levels of discussion can be explored.

1. Near the earth's surface:
   Students need opportunities for discussion that draws out the idea that gravity forces on objects are exerted by the whole earth towards its centre. A gravity force acts on an object regardless of whether it is moving or not moving. In everyday situations, the size of the gravity force on something does not change significantly as it rises above the earth. (It needs to go much higher than a jumbo jet for major differences to occur. The size of the gravity force in the space shuttle, at an altitude of 200km, is still about 94% of what it was at sea level.)

   The gravity force on an object from the earth is the same regardless of whether the object is surrounded by air (or water or anything else) (See Mitchell, 2007).
2. The universe: It is helpful if students understand that the earth and other planets orbit the sun, and that when things change direction (as the planets are constantly doing) they have a force on them (See Pushes and Pulls; Pushes and Pulls – What is a force?; Day and Night). The idea that there must be a force on the planets that changes their direction can be linked to the gravity force of the earth on objects near its surface, thus helping students to understand the generalisation that gravity forces exist everywhere in the universe.

Film or videotapes demonstrating the gravitational forces between objects, and that astronauts were able to walk on the moon and drop objects on it because of the moon's gravity, can help make these ideas plausible for students.

## Teaching activities

**Challenging some existing ideas.**
POE (Predict-Observe-Explain). A spring balance with a weight attached hangs inside a sealed bell jar connected to a vacuum pump. Ask students to predict whether, and how, the spring balance reading will change when the air is pumped out. Then ask them to explain their observations. (It is helpful to show beforehand that the reading registers a reduction in a net downward force if the weight it placed in water due to the upward push of water).

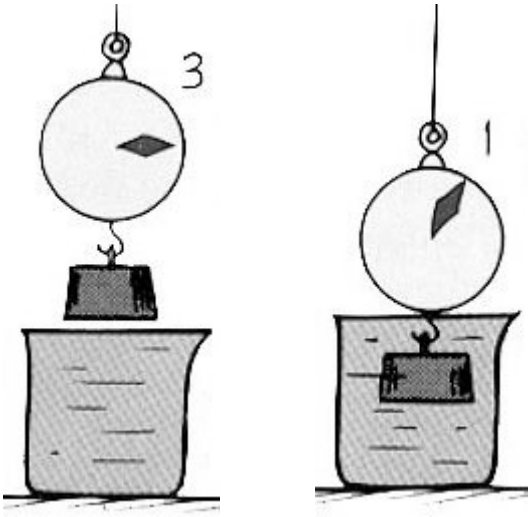


Image adapted from:
http://sol.sci.uop.edu/~jfalward/physics17/chapter5/chapter5.html

**Bring out students' existing ideas.**
Get students to think about whether the gravity force on them now is a lot more/ a bit more/ the same/ a lot less/ a tiny bit less/ zero when they are (1) in the same classroom with all the air pumped out; (2) on top of Mt Everest; (3) on top of the tallest building in Melbourne; (4) on the moon (1/6 the size of earth); in the classroom but the earth has stopped spinning; (5) next to another astronaut in deep space; (6) the only astronaut in deep space; (7) in free fall after jumping from a plane. Collate responses and conduct a whole class interpretive discussion to clarify students' thinking, and inform further teaching. (Gunstone & Mitchell 1998)

**Promote reflection on and clarification of existing ideas**

- POE (Predict-Observe-Explain). To help students discriminate between mass and volume, ask them to predict whether the gravity force from the earth on a shot put differs from that on a wooden ball of the same size. Then measure their respective weight forces and ask students to explain their observations.
- Interpretive discussions to explore the interaction of gravity forces, air resistance and friction.
    1. Ask students to identify the forces on a ball tossed into the air (a) as it is moving up, (b) when it reaches the top of its path, (c) as it is coming down.
    2. Ask students to identify the forces acting on a child sitting halfway down a slide.
- POE (Predict-Observe-Explain). To help students think about their relative sizes, ask students to predict which of these forces is smallest: magnetic, electric and gravity forces. Then ask them to observe a hair sticking to a charged comb and a hair clip sticking to a magnet. In the ensuing discussion, it may be helpful to point out that the whole of the earth is pulling on the hair/ hair clip.

(See Friction is a force; Forces without contact and AAAS Maps)

**Help students to work out some of the 'scientific' explanation for themselves.**

Using the Internet, students can look for examples of ‘weightlessness’ and develop explanations using the ideas about universal gravitation.