Defying Gravity

Theme of the Lesson

This lesson is all about forces and how different forces govern the movement of different objects. We look at the force of gravity that pulls objects towards the Earth and other forces that help to counteract the force of gravity. We look at the different forces that are in operation when an aeroplane is taking off and flying. We also look at centripetal force, how it allows objects to follow a circular motion and how this force can be applied to the movement of a rollercoaster.

Curriculum Links

Strand: Energy and Forces; Environmental Awareness and Care

Strand Unit: Science and the Environment

Curriculum Objectives:

- Identify and explore how objects and materials may be moved
- Investigate falling objects; come to appreciate that gravity is a force
- Become aware that objects have weight because of the pull of gravity
- Explore how some moving objects may be slowed down
- Explore the effect of friction on movement and how it may be used to slow or stop moving objects
- Recognise the contribution of scientists to society
- Appreciate the application of science and technology in familiar contexts

Background Science

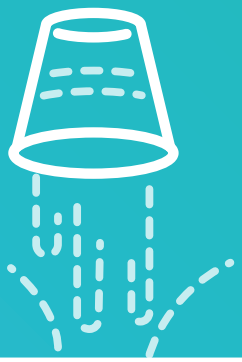
Aeroplanes

An object can only move if a force acts on it. In simple terms, a force can be described as a push or a pull. We can have visible forces where we can see a hand lifting up a cup or pushing a chair across the floor. We can also have invisible forces such as the wind pushing the leaves of a tree or a magnet pulling steel pins towards itself. In order for an aeroplane to fly, there are a number of different forces in operation. The pilots in this episode talk about four different forces: Lift, thrust, weight and drag.

Thrust refers to the forward force of the plane cause by the burning of fuel in the engine. As the plane accelerates and moves forward, another force acts against it. As the plane is pushing forwards against the air, the air is pushing back against the plane. This is the force known as drag. The curved shape of the plane helps to reduce the effect of drag by

reducing the surface area for the air to push against. We can say that the plane is aerodynamic.

The weight of the plane is a force pulling it downwards (towards the Earth) as a result of gravity. In order for the plane to take off, there needs to be an opposite force pushing it upwards. This upward force is known as lift and is caused by the shape of the wings. The wings are curved on top and flattened below. This allows air to move faster over the top of the wing and slower underneath. The slower moving air underneath exerts a greater air pressure which provides the lift. This is known as Bernoulli's principle.



Studio Experiment

The studio experiment demonstrates another force called centripetal force, which is the force of circular motion. If you held a cup of water upside down above your head, the force of gravity would pull on the water and you would get wet. However, as Mark demonstrates, if you can rotate that cup fast enough in a circle, the centripetal force is greater than the force of gravity and keeps the water in the cup.

The second part of the studio experiment also makes use of centripetal force. A mug tied to a string would be pulled down by the force of gravity as soon as you let the string go. If, however you put a weight such as a spoon on the other end of the string and place the string over your finger, the spoon acts as a pendulum and swings around in a circle. This centripetal force causes the string to wrap around your finger and counteracts the force of gravity so the mug stops falling.

This experiment also makes use of another force called friction. Friction is a force that can slow down the movement of one object over another. As the string wraps around your finger, the force of friction stops the string from sliding and locks it in place to stop the mug falling.

Supersize Experiment

The supersized experiment makes use of the exact same forces as the studio experiment with the mug and spoon. The centripetal force of the weight on the rope and the force of friction between the rope and the bar counteract the force of gravity on the bowling ball and stop it from falling.

Rollercoaster

Energy and Forces are important in the operation of a rollercoaster. The potential energy at the high point of the rollercoaster is converted to kinetic energy as the rollercoaster travels down the slope. Centripetal force helps to hold the rollercoaster on the tracks and the people in the rollercoaster if it goes over loops.

Equipment and Tips

for conducting the Studio Experiment in your school

Mark performs two simple studio experiments that can easily be carried out with your class. These should be done outdoors where there is plenty of space. If you want to be ready to carry them out after watching the video you will need to collect the following equipment.

For the first part, you will need:

- Plastic frisbee. You will need to make three holes equidistant from each other around the rim of the frisbee (you will be threading string through these holes).
- String or twine. This will be used to swing the frisbee around in a circle so use a cotton twine or similar rather than using wool which might break.
- Paper cup part filled with water. Don't fill it too much just in case it goes wrong.

Note: rather than putting holes in multiple frisbees, you might want to demonstrate this part yourself or ask one child to demonstrate. As it is a short activity, it could be repeated by a number of children.

For the second part, you will need:

- An unbreakable cup or mug with a handle. A stainless steel cup works well but a plastic camping mug is less noisy if it is dropped or hit with the spoon.
- A teaspoon
- String or twine (not wool – see above).

Note: For this part, you could have a few sets of the equipment if you wish but make sure that children are well spaced out for safety (maybe get them to do the activity one at a time so you can watch them). Practice yourself beforehand so you are aware of what safety issues there may be.

Tips for Further Investigations on Forces

Use the Lesson Plans to help your class with brainstorming ideas and coming up with a question. Remember that the children may start out with very broad ideas around questions but working through the steps in the lesson plans will help them to refine it down and come up with a testable question. The children will be more invested in their project if they are investigating a question that they developed as a class rather than one that was set by the teacher although you might want to narrow it down to ideas based on a particular theme. They may do some smaller investigations on the way towards refining their project idea and the finished project may be quite different from the original idea, but this is all part of the process.

There are lots of ways to carry out a project. It might involve a fair test investigation, some gathering of data or even a design and make project. Remember to encourage the children to make predictions and to think about the best way to record and communicate their results. Encourage them to make use of maths where appropriate. **Korey Kiepert** spoke about the importance of maths in designing rollercoasters.

The themes in this episode could provide lots of inspiration for project ideas:

- Children might do some investigations on forces such as gravity or air resistance. They might investigate flying or falling objects and carry out projects based on aeroplanes, helicopters or parachutes. The primaryscience.ie website has lots of inspiration for investigations on forces. They could also investigate forces in water.
- Children might investigate centripetal force by designing their own rollercoasters. Remember that that is how **Korey Kiepert** got started. He and his brother were inspired to design their own amusement parks after visiting their favourite park as children.
- Children might investigate the effects of friction by examining the movement of different objects on different surfaces. They might design their own wheeled vehicles or their own tracks or marble runs.
- Children might look at animals that fly. They might look at the conditions that affect flight and carry out some surveys on flying insects to see when they are most active.

Linkages

The children will obviously be spending some time on their ESB Science Blast project but remember that this is time well spent. They will not just be doing Science but depending on the project theme, it can cross over into lots of other subjects and become the focus for cross curricular work. There can also be linkages with other projects such as the SFI Discover Science and Maths Awards, Active Flag or Green Flag. Some possible linkages.

- **Language**: Written and oral language skills through recording and communicating about their project.
- **Maths**: Data collection, recording of results, tables, graphs, calculations
- **History**: The history of flight or other modes of transport.
- **Geography**: Mapping could be a feature of projects involving data collection on living things. Weather conditions could be a factor in projects on forces and movement in the outdoors.
- **PE**: Investigations on forces involving sport.

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