Investigate: Air Resistance

In Episode Five, *Selenia and the Historical Adventure,* Selenia makes a balloon so that they can travel to London. Daiki admits he is afraid of height. Perhaps he would feel safer in the balloon if he had a parachute. Could your students make and test parachutes to find out what the best size and shape is?

Learning outcomes

Students will

- Ask a question that can be investigated scientifically
- Decide how to find answers
- Explore the forces of gravity and air resistance

Curriculum links

Sc1 Scientific enquiry

Investigative skills—Planning

- Ask questions that can be investigated scientifically
- Decide how to find answers

Sc4 Physical Processes

Forces and Motion

- Types of forces—gravity and friction

Science background

This investigation focuses on **asking questions** that can be investigated scientifically. A question can be investigated scientifically if you can devise experimental conditions that will test the question. Scientific questions need to be objective (observable, the same for different people) rather than subjective (about personal opinion). In the case of parachutes, students could ask 'what shape makes the best parachute?' but not 'what colour makes the prettiest parachute?'

Once students have agreed a suitable question, they should consider what data they will need to answer the question. This will involve thinking about other factors that might affect their results and will help them devise a fair test.

Parachutes: what's going on?

In order to devise a fair test, students will need to understand a little about how parachutes work. When an object falls to the ground it is affected by two forces: the force of gravity pulling it down and the force of air resistance, a type of friction, which slows down its fall.

Gravity draws an object towards the centre of the Earth (or other large masses, such as the Moon). On Earth, gravity causes all objects to fall at the same rate of acceleration (9.8 ms^{-2}). This means that, ignoring air resistance, an object falling freely near the earth's surface increases its velocity by 9.8 ms^{-1} for each second of its descent.

When an object falls to Earth it also experiences air resistance. This is a type of frictional force (the air particles bump into the object causing it to slow down a tiny bit). An object with a bigger surface area experiences more air resistance because more air particles bump into it.

Parachutes work by using air resistance to oppose the force of gravity, slowing down the rate at which an object falls to Earth.

What do I do?

You might like to start this lesson with a general discussion of gravity including:

- What causes objects to fall to Earth?
- Why do two objects, a shoe and a feather, for example, take the same amount of time to fall to Earth if dropped from the same height? (Remember that as gravity is constant air resistance is causing the feather to fall more slowly).
- Explore what air resistance is (air particles hitting the surface of an object and slowing it down).

Explain Daiki's predicament: that he's scared of heights and would like something to make him feel safer. Your class could come up with a range of methods for slowing Daiki down if he were to fall e.g. paragliders, kites and parachutes. Take the parachute as the example to work on and ask your class to come up with a question (or questions) about the design of a parachute that they could test. For example, they could test the parachute's shape (rectangles, squares, circles), size (small vs. large), or the materials used for the parachute strings (string vs thread). As this is an activity about asking questions, spend some time getting a really good question. Your students could write this down, or you could put it up on the whiteboard.

Note: in the case of parachutes, the total surface area affects how much air resistance there is, so if students want to test shape, they should keep the surface area constant (e.g. use a rectangle and square with the same total area).

The parachute will need a small weight or object attached to the bottom to represent Daiki. Air resistance will have the biggest effect if this is a very light weight (such as a small badge or lightweight plastic figure).

To make a standard parachute:

- Cut a large circle out of a light weight plastic carrier bag
- Cut six strings of equal length
- Attach the six strings to the edge of the plastic circle (these should be placed at equal distances around the circle)
- Attach the small weight to the strings

Test two parachutes at a time and order them from slowest to fastest. To launch parachutes fairly they must be dropped from the same height each time, the higher the better! Much fun can be had by throwing them up in the air but this would not be a fair test of the parachute's effectiveness.

Equipment

- Plastic bags - enough for each group to make 2 or 3 parachutes
- String, thread or wool (to tie the weight onto)
- A small weight for each group
- Scissors

Investigate parachutes

My question about parachutes is:

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Eeurggh, I didn't feel well in that hot air balloon. I would have liked a parachute to make me feel safer.

Can you help me make and test some parachutes?

Scientists ask very careful questions before they start an experiment. What question do you want to answer to help Daiki?