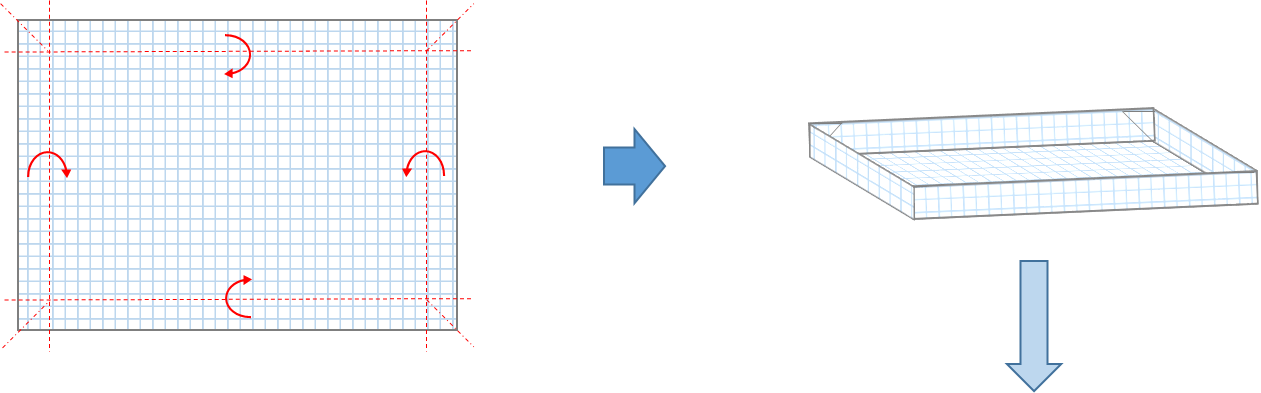
**Parachutes**

You can test parachutes by using paper trays.

Fold a piece of graph paper with sharp creases and pinch the corners in.



Place the tray on your hand and drop it from above your head.

It will fall straight, which makes it easy to observe.

**Safety**

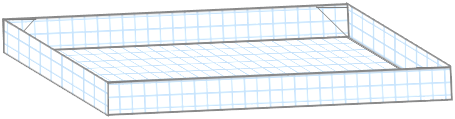
Stand on the floor at all times; do not climb onto stools or desks

**Apparatus and materials**

* x2 sheets of graph paper
* Timer

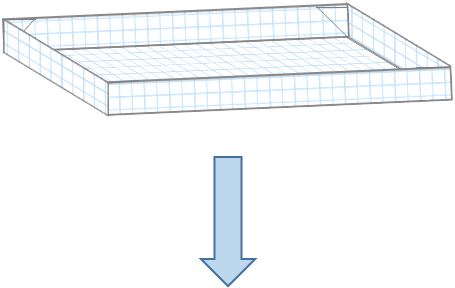
**Procedure**

1. Make a tray out of a sheet of graph paper.
2. Place it on your hand and hold it up in the air.
3. Move your hand away quickly so the tray falls.
4. Time how long it takes the tray to fall to the ground.



1. Fold another piece of graph paper in half.
2. Fold this into a second tray with half the area of the first one.

*Both trays weigh the same*

**Parachutes**

Make a tray out of a piece of graph paper.

**Time how long it takes to fall from a known height.**

Fold a piece of graph paper in half.

Make this into a tray with half the area of the one.

**Predict**

How long do you think the small tray will take to fall from the same place as the big tray?

**Explain**

Why do you think this will happen?

|  |
| --- |
| **Measure the time for the small tray to fall** |

**Observe**

Record the time the small tray takes to fall.

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain what happens more clearly.

*Physics > Big idea PFM: Forces and motion > Topic PFM2: Moving by force > Key concept PFM2.4: Drag*

|  |
| --- |
| **Response activity** |
| **Parachutes** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The drag force on an object moving through a fluid increases with its speed and can be reduced by making the object more streamlined |
| Observable learning outcome: | Describe the forces acting on an object when it is moving at a constant speed through a fluid  Explain how using a parachute can make it safe to jump out of an aeroplane |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Drag, weight, resultant force, speed |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Top speed
* Diagnostic question: Safe landing

**What does the research say?**

When the speed of an object is being increased, students tend to focus on the applied force that appears to be needed to get it going, and keep it going. They often think that a moving object *has* force that keeps it moving, and which runs out when it comes to rest (Gunstone, R and Watts, 1985; Driver et al., 1994a). Osborne (1985) found that as students get older they *increasingly* hold the view that a force, pushing in the direction of motion, is needed to keep an object moving. In a study of 200 students he found 46% of 13 year olds believed this, increasing to 53% of 14 year olds and 66% of 15 year olds.

Instead of concentrating on the applied force students need to think about all the forces acting and how they combine to produce the resultant force. They need to identify when the resultant force acts, when it changes and when it ceases. This involves understanding drag and the direction it acts in in order to recognise how it contributes to the resultant force (Driver et al., 1994b).

For most students the idea that a bigger resultant force produce a bigger effect is intuitive, but it is important to emphasise that resultant force does not produce speed, but a change in speed (Driver et al., 1994b). In other words: any moving object will continue to accelerate whilst a resultant force is acting on it.

The effect of drag on falling objects can be very confusing because although drag (air resistance in air) can significantly affect the motion of an object falling in the real world, students often do not take it into account. In a study, Lee and Kwok (2009) found that when 11- to 12-year-olds (n=204) were asked to label the forces on a falling ball, 90% were able to label the gravitational force, but none of them included any drag force.

This activity gives students opportunity to construct and rehearse their own explanations of how drag and weight affect the speed of a falling object.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* x2 sheets of graph paper
* Timer

**Technician notes**

Use graph paper with 5 squares per centimetre, or paper with 1cm sided squares.

**Health and safety**

Students will be moving around the room.

They should remain standing on the floor and not climb on chairs, stools or desks

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

* The tray with half the area will fall faster than the larger tray, but not exactly twice as fast.
* The downwards force on each tray is the same (weight)
* At the same speed, the drag on the smaller tray is about half the size as the drag on the larger tray.
* Drag on both trays increases with speed.
* The smaller tray will speed up at a faster rate than the large one and reach a higher top speed.

*NB The top speed of the small tray is less than twice the speed of the large tray.*

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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