Activity K

Examining a Scientific Argument

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Introduction

This activity is based on a version of a well known thought experiment originally developed by Galileo. Thought experiments have an important role in science as they lay out a series of ideas about how the world should behave. Examining the argument critically is an important task to see where fallacies might exist. If they cannot be found to exist, then this demonstrates a fundamental idea in science – that we believe in ideas until they are refuted. Sir Karl Popper first advanced this idea in the first half of the 20th Century.

The activity asks pupils to provide a written argument for their choices. Justifying reasoning and linking an idea to the evidence that supports it is central in science. Pupils' writing, however, needs to be supported and this activity uses a writing frame.

Objective

Pupils will learn

- to consider and evaluate scientific arguments;
- to develop arguments in writing;
- about a key scientific idea.

Outcomes

By the end of the lesson, pupils will be able to:

- explain using scientifically sound ideas, why, in the absence of air, all objects fall at the same rate;
- evaluate different scientific arguments;
- communicate their arguments in written form.

Notes for Teachers

Pupils will need to know that forces are measured in Newtons and that the pull of gravity is a force that acts on all objects.

Teaching Sequence

- Begin by posing the question, 'Do heavier things fall faster?' and asking each pupil to write down his or her answer. Ask them to give any reasons that they can think of for their answer.

- Ask the pupils to share their views with the person next to them.

- Now demonstrate with a 1kg mass and a 1p piece (make sure that they drop into a tray of sand to minimise the damage to the floor). This process is likely to expose that most people think that 'heavier things fall faster'. The demonstration will challenge that idea and the task offers an opportunity to provide some reasons for what they have just seen.

- Hand out the '*Do heavier things fall faster?*' sheet and explain that their task is to examine the argument that heavier things do not fall faster than lighter ones. Tell them that the argument is presented in steps. For each step, they must decide whether it is true or false. Then, they must use the space beneath to justify their choice.

- Whilst they are doing this task, circulate and find one or two examples of a better quality answer which can then be read out so that the class gets a better sense of what they are being asked to do.

- Let them work in pairs on all of the steps of the argument. Remind them that they must choose true or false and that they MUST provide reasons for their choice as scientists do.

- Then let the pairs join with another pair ('pairs' to 'fours') to share their answers and reasoning.

- Finish by holding a class plenary. Go through each step asking 'Who want to argue that this is TRUE?' and elicit one or two arguments. Then ask 'Who wants to argue that this statement is FALSE?' and, likewise, elicit one or two arguments. You will have to resolve the argument by pointing to what the scientific case is. Point out that it is irrefutable which is why we believe it.

- A suggested homework activity is provided (pupil activity sheet 2).

Do heavier things fall faster?

Lots of people think that heavier things fall faster than lighter ones. We see it around us every day – the feather reaches the floor after the brick and a piece of paper flutters slowly to the ground. But is this always true?

Consider each of the following steps of the argument. For each step, decide whether it is **TRUE** or **FALSE**. Give reasons to justify your choice.

Step 1:

The weight of an object is the force of the pull of gravity on an object.

This is **TRUE** **FALSE**

Reasons to justify choice

Step 2

The pull of gravity on a 2kg object is twice that on 1kg object.

This is **TRUE** **FALSE**

Reasons to justify choice

Step 3

The rate at which an object accelerates (speeds up) depends on the force on it and how big it is. So a 2kg object will speed up more slowly than a 1kg object if the same force is applied.

This is **TRUE** **FALSE**

Reasons to justify choice

Step 4

A 2kg object has twice as much force acting on it as a 1kg object. But, there is twice as much matter to speed up. So, if twice as much force acts on the 2kg object, it will speed up (accelerate) at the same rate as a 1kg object. The result is that it will hit the ground at the same time.

This is **TRUE** **FALSE**

Reasons to justify choice

Step 5

If you think that this argument is true – then why?

a) Does this argument also apply to feathers?

b) Why do you think that so many people believe that heavier things fall faster?

Examining a scientific Argument:

Imagine that a brick is dropped from an aeroplane, flying at a height of 1000 metres. It falls to the ground. The statements in the boxes below link together to explain how the brick falls.

Some boxes contain more than one statement. In each of these boxes, pick the statement that you think is correct, and fits into the whole explanation. Indicate your choice by putting a line through the other statement(s) in the box.

Continue until you have chosen one statement from every box, to produce a complete explanation for the way the brick falls.

1	There is a force of gravity on the brick.

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2	This force acts downwards.

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3a	It is roughly the same size throughout the fall.
3b	It gets a lot bigger as the brick gets closer to the Earth.
3c	It is biggest when the brick is high up and gets a lot smaller as it falls.

↓

4a	This force makes the brick begin to accelerate downwards.
4b	This force makes the brick begin to move downwards at a steady speed.

↓

5	Once the brick begins to move, there is also an air resistance force on it.

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6a The air resistance force acts downwards, in the direction the brick is going.

6b The air resistance force acts upwards, in the opposite direction to the brick's motion.

↓

7a The size of the air resistance force on the brick is constant throughout the fall.

7b The air resistance force gets bigger as the brick gets faster.

↓

8a The air resistance force on the brick is much smaller than the force of gravity, and so it can be ignored.

8b The air resistance force on the brick becomes quite large, and has to be taken into account.

↓

9a So the total force on the brick is equal to the force of gravity, and is constant

9b The total force on the brick is the sum of the gravity force and air resistance, and this gets gradually less as it falls, because the air resistance increases.

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10a Therefore the brick has a uniform acceleration throughout its fall.

10b Therefore acceleration of the brick is biggest to begin with, and gets gradually less. Once the air resistance force becomes equal to the gravity force, the acceleration is zero and the box then falls at a steady speed.

10c Therefore the brick falls at a steady speed throughout its fall.