

## **Title: Air resistance in free fall**

Lesson Structure (70 Minutes)

### **Objectives:**

By the end of this unit, students are expected to:

- ✓ Understand the concept of air resistance and how it affects falling objects.
- ✓ Explain how Batman's cape functions similarly to a parachute by increasing air resistance and slowing down his fall.
- ✓ Compare the effects of different materials on air resistance by conducting hands-on experiments with model capes.
- ✓ Measure and record data on fall time for objects with and without capes, analyzing the impact of air resistance.
- ✓ Present findings through discussion and charts, demonstrating an understanding of how air resistance works in real life.
- ✓ Demonstrate their understanding of air resistance concepts through an interactive Kahoot quiz.

### **Materials:**

- old plastic bags, paper bags, fabric, thread, markers, scissors, glue, duct tape
- a stand, chair or some high surface (from which to release Batman)
- a stopwatch (can also be a mobile phone)
- spreadsheet for recording the results

### **Activity 1: Story and discussion (Science)**

Objective: To learn about body resistance during free fall.

Duration: 15 minutes

Instructions:

- Watch the video (Batman Moves): <https://www.youtube.com/watch?v=k-T-stiSYgw> from 00:00 to 02:00
- Answering the questions asked by the teacher:
  - Which hero did you see in the video?
  - What is its mode of movement?
  - How does Batman manage to slow down when jumping off buildings?
  - What does his cloak look like?
  - How does air resistance affect Batman's fall?
- Imagining the situation:

*"Imagine you're Batman and you're standing on top of a building in Gotham. Below you are the streets, and you have to jump to catch the villain. But what happens if you jump? Will you fall as fast as a rock or will something slow you down?"*

- Why is Batman's cape not just part of the costume, but helping him while jumping?
- Watch the video (How the parachute works):  
[https://www.youtube.com/watch?v=vZYwsAvHgVw&ab\\_channel=MocomiKids](https://www.youtube.com/watch?v=vZYwsAvHgVw&ab_channel=MocomiKids)
- How does a parachute help skydivers not hit the ground too fast?
- Read the text "How does a parachute work"? (students were given the text in paper form)

## Why does a parachute slow the fall? - The secret of air resistance

Imagine that you are standing on a tall tower and holding a pebble in one hand and a feather in the other. What do you think - which will fall to the ground faster if you drop them at the same time?

You've probably already noticed that a pebble falls fast and straight towards the ground, while a feather floats and sways in the wind before it hits the ground. But why is that so?

The culprit for this interesting phenomenon is air resistance!

What is air resistance?


When something falls through the air, it has to "break through" invisible air particles that slow it down. Imagine running through water - it's a lot harder than running on dry land, right? This is because water provides resistance to your body. Likewise, air resists objects falling through it.

Objects that are smooth and small, such as pebbles, pass through the air more easily and fall faster. But objects that are large and light, like feathers, have more surface area that "catch" air and slow them down.

How do paratroopers use it?

Skydivers use air resistance to land safely on the ground! When they jump out of a plane, they first move down quickly, but as soon as they open the big parachute, their fall becomes slower and safer. This is because the parachute expands and increases the surface area that collides with the air, thereby increasing drag and slowing the fall.

You can try this effect yourself! Take two sheets of paper - leave one flat and crumple the other into a ball. Release them at the same time from the same height and see which one will fall to the floor first. You will see that the crumpled paper falls faster, because it has a smaller surface on which air resistance acts!

The next time you see a leaf fall from a tree or blow up a balloon, remember this secret of air resistance - it's all around us, even if we can't see it! 

- ✓ <https://www.youtube.com/shorts/RQYkNQwjyc8>
- ✓ Discuss as a group: What material would be best for Batman's cape to slow his fall?
- ✓ Test different materials for air resistance.
- ✓ Decorate the parachute as desired.

### Activity 3: Batman Leap (Math, Technology)

Objective: Test parachutes and measure flight time.

Duration: 20 minutes

Instructions:

- Students release Batman from the same height (eg a chair or table).
- The time from the moment it is released to the moment it hits the floor is measured.
- For measurement, they use a stopwatch on a mobile phone.

- The procedure is repeated three times for each mantle and the average fall time is calculated.
- The time is recorded in the table.

Material	Fall time 1 (s)	Fall time 2 (s)	Fall time 3 (s)	Average time (Time1+Time2+Time3):3 (s)
Paper				
Plastic bag				
Fabric				

- Analysis of results
  - ✓ Students compare the time of the fall.
  - ✓ They discuss which material slowed Batman down the most and why.
  - ✓ They explain how their experiment relates to the real world (parachutes, flying).

#### Activity 4: Kahoot quiz (Technology)

Objective: Checking what has been learned through a Kahoot quiz

Duration: 10 minutes

Instructions:

- Students log into kahoot using the quiz PIN code.
- There is a projection of the quiz on the board  
(<https://create.kahoot.it/details/04542787-9b05-4e90-a1da-5a41063c2c62> )
- The teacher plays the questions, and the students have 20 seconds for each of them to think and click on the answer
- After each question, the teacher asks the students to explain their answer
- After completing the quiz, the teacher displays the final results
- Students discuss the final results of the quiz

#### STEPAM Components

Science:

- Students investigate air resistance and its effect on free fall.
- They understand how different materials affect the movement of objects through the air.

Technology:

- Using a stopwatch or mobile app to time your fall.

Engineering:

- Students make and test different versions of the cloak, thinking about its functionality.

Art:

- Design your ideal Batman cape.

Mathematics:

- Students measure the time of the fall and record the data in the table.
- They calculate the average fall time to get accurate results.