Lesson Plan - Falling Bodies with Appreciable Air Resistance

Total duration: 75 minutes (15 min introduction + 60 min development)
Year: 11th grade – Physics and Chemistry A
Theme: Falling bodies with appreciable air resistance
Methodology: Storytelling + active student-centered learning + use of digital tools and AI
Final product: Group digital science storytelling

🔴 Learning Objectives

Students should be able to:

1. Explain the effect of air resistance on the fall of a body and analyze the forces involved in the various stages of this movement.
2. Interpret the concept of terminal velocity.

   Common Alternative Design to anticipate: confuse terminal velocity with absence of motion — clarify that terminal velocity is motion at constant velocity, not stopping.
3. Interpret position-time, velocity-time and acceleration-time graphs in falling motion with air resistance.
4. Communicate scientific results and ideas through digital storytelling
5. Use digital tools and AI creatively and responsibly.
6. Collaborate effectively in a group, taking on different roles in a creative project.

🔴 Class Structure (75 minutes)

1. Introduction (15 min) — Kick-off storytelling

Objective: To arouse curiosity and contextualize the theme.

Challenge Questions:

- What would happen if air didn't exist?

- Why do some objects fall faster than others?

- What really stops a skydiver from accelerating indefinitely and smashing into the ground?

Activity:

- The teacher tells an **early story** (with images or short animation) entitled

"The Silent Leap: Felix Baumgartner and the Edge of Air"

On October 14, 2012, Austrian Felix Baumgartner did not jump out of a plane; he climbed aboard a pressurized capsule, suspended by a gigantic helium balloon, into the **stratosphere**, almost **39 km** above the Earth.

Up there, he opened the door and saw the world. A place where the sky is black and the Earth is a distant, blue and vulnerable curve. Air, this **invisible shield** that we studied, was almost nonexistent.

The Moment of Fall

When Felix jumped, there was not the roar of wind that one would expect from a normal free fall. There was silence. At this altitude, the density of the air is so low that the Air Resistance was practically zero. For Physics, his body was in conditions close to **free fall,** accelerating violently only under the action of the **Gravitational Force**. That's why, in less than a minute, Felix achieved what no human had achieved before: **he broke the sound barrier**, reaching a speed of **1357 km/h** (Mach 1.25) – all this, without an engine, just by the force of gravity!

The Return of the Air

However, as the free fall brought it back into the **troposphere** (the densest layer of air), something remarkable happened. With each meter that went down, the Air Resistance increased exponentially. The air has returned with full force! This invisible force, dependent on the speed and density of the air, **stopped** his body. Its acceleration slowed down, and eventually its speed stabilized at a new value, much lower than the speed of sound.

Felix demonstrated, in a single epic jump, the fundamental difference between:

1. The **free/ideal fall** (no air resistance, constant acceleration, reached in the stratosphere).
2. The **actual fall** (with air resistance, acceleration that decreases until it reaches terminal **velocity**, reached in the lower atmosphere).

His courage was not just in jumping, but in trusting that the physics of the atmosphere and his parachute would work exactly as calculated. It didn't fly, it fell with precision – a supreme test of our understanding of air resistance.

"I Jumped from Space": https://www.youtube.com/watch?v=Hz2F_S3Tl0Y

The day Felix Baumgartner jumped from the stratosphere:
https://www.youtube.com/watch?v=IcNe9mCq96Y

Short activity: Debate in class (2 min)

Guiding questions:

- In the stratosphere, Air Resistance is almost nil, allowing Felix to reach supersonic speed (Mach 1). In the Earth's atmosphere, why is it impossible to reach Mach 1, but only at 'Terminal Velocity'?

- What difference in Air Resistance Strength allowed him to break the sound barrier up there, and what stopped him down here?"

- Students discuss in pairs for 2 minutes the differences between falling into a vacuum and with air resistance.
- Teacher collects ideas on the digital board.

Suggested tools: Jamboard, Padlet or Mentimeter.

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2. Development (60 min)

Phase 1 - Guided exploration (15 min)

- Students, in groups of 3–4, are given a **narrative mini-challenge**.
- Each group uses a **digital simulation** (e.g., *PhET — "Forces and Motion: Air Resistance"* or *Algodoo*).
- Tasks:
    - Observe how the speed varies with and without air resistance.
    - Identify the instant at which **terminal velocity is** reached.
    - Analyze position, velocity, and acceleration graphs as a function of time
    - Record data/screenshots.

Phase 2 — Construction of the digital narrative (30 min)

Objective: Apply knowledge through storytelling.

Each group creates a **scientific narrative** (digital story) that explains the situation of the falling body and the laws of physics involved.

The story should:

1. Have a coherent plot (introduction, conflict, resolution).
2. Explain the phenomenon of air resistance.

3. Include graphical representations, formulas, or simulations.
4. Use **AI or digital tools** to enrich the product.

Suggested tools:

- **Generative AI:** ChatGPT, Bing Copilot, Gemini or Canva Magic Write for the script.
- **Production:** Canva, Genially, Adobe Express, or Powtoon (video/infographic).

Phase 3 (15 min): Sharing and discussion

- Each group presents its story in **3 minutes**.
- Colleagues give **quick feedback** (a strength + a suggestion).
- The teacher synthesizes the correct physical concepts and clarifies doubts.

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3. Final Synthesis Moment (5 min – in the next class)

- Joint reflection: "How does air alter our destiny?"

Debate: The teacher asks students to reflect on the importance of air resistance and terminal velocity.

Resources & Tools

• Computers or tablets with internet
• PhET Simulation – Air Resistance
• Canva, Genially, Powtoon ou Adobe Express
• ChatGPT / Bing Copilot (apoio IA)
• Padlet or Jamboard for collecting ideas
• Multimedia projector

Evaluation Rubric (summary)

Criteria: scientific understanding, integration of storytelling, use of AI/digital, collaboration and communication.

Adapted using AI (MagicSchool, Gemini; ChatGPT)