Elevator speed by barometer

FizziQ activity · Middle and high school · 15 min

Scan to open in FizziQ

By recording air pressure during a ride, students reconstruct the elevator's altitude profile in FizziQ and calculate its speed from smartphone barometer data.

Learning objectives

- Measure atmospheric pressure variations with the smartphone barometer
- Convert pressure variations into altitude changes
- Identify the phases of an elevator ride (acceleration, constant speed, deceleration)
- Calculate the maximum speed reached
- Compare with typical elevator specifications

Instruments and sensors

Altimeter (barometric) · Absolute acceleration · Barometer · Accelerometer

Materials

- Smartphone or tablet with FizziQ (built-in barometer sensor)
- Access to an elevator
- Optional: FizziQ Connect module with barometer, for phones without a built-in sensor
- Note: the protocol remains adaptable to any comparable pressure/altitude data acquisition tool.

Protocol

1. Open FizziQ and select the Barometer (atmospheric pressure) and Accelerometer instruments.
2. Before entering the elevator, start a short test recording then stop. This stabilizes the sensor.
3. Enter the elevator. Start the recording just before pressing the destination floor button.
4. Remain still during the entire ride. The phone can be in your pocket or hand — the position does not matter for pressure.
5. Stop the recording once the elevator has completely stopped and the doors are open.
6. Observe the pressure versus time graph. You should see a clear variation corresponding to the altitude change.
7. The application uses the barometric formula to convert pressure variations into altitude: $\Delta h \approx \Delta p \times (-8.5\ \text{m/hPa})$.
8. Observe the speed graph (derivative of height). Identify the acceleration, constant speed, and deceleration phases.
9. Note the maximum speed reached. Compare with typical elevator specifications (1 to 2.5 m/s for a residential elevator).
10. Repeat the experiment going up then down. Compare the graphs.

Expected results

Pressure decreases by about 0.12 hPa per meter of ascent and increases equally during descent. For a 5-floor trip (about 15 m), the pressure variation is about 1.8 hPa, clearly measurable. Typical elevator speeds are 1-2.5 m/s, with acceleration/deceleration phases lasting 2-3 seconds.

Questions

- Why does atmospheric pressure decrease with altitude?
- What precision can be achieved for height measurement with a smartphone barometer?
- How can you distinguish the acceleration phase from the constant-speed phase on the graph?
- Why is the speed graph not a simple rectangle (constant speed throughout)?
- Could you use this method to measure the height of a building?
- How does the deceleration profile compare between going up and going down?

Going further

- Measure the height of a building by riding all floors and noting pressure at each landing
- Compare the speeds of different elevators (residential, office, shopping mall)
- Use the accelerometer data to independently verify the acceleration phases
- Record a staircase climb and compare the altitude profile with the elevator
- Calculate the power of the elevator motor from the speed and cabin mass estimate