Barometric altimetry

FizziQ activity · Middle and high school · 30 min

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By recording pressure floor by floor with a smartphone barometer in FizziQ, students see how it falls with altitude and derive their own altimetry formula.

Learning objectives

- Measure atmospheric pressure at different altitudes using the smartphone barometer
- Establish the relationship between pressure change and altitude difference
- Develop a simplified barometric formula from experimental data
- Calculate altitude from pressure measurements and evaluate accuracy
- Understand the physical reasons for the decrease of atmospheric pressure with altitude

Instruments and sensors

Atmospheric pressure meter · Barometer

Materials

- Smartphone with the FizziQ app (iOS or Android built-in barometer; an external sensor can be paired if the device has none)
- Access to a multi-storey building with at least 4 accessible floors, or a hill
- Tape measure or known floor-height reference
- FizziQ experiment notebook for recording pressure and altitude data
- Note: the protocol remains adaptable to any comparable pressure-measurement tool.

Protocol

1. Open the FizziQ application and select the Atmospheric Pressure sensor. Verify that it displays a value close to 1013 hPa (may vary with weather conditions and local altitude).
2. Choose a building with at least 4 accessible floors (ideally more). If possible, determine the height of each floor (typically 3 to 3.5 meters between floors).
3. Stand on the ground floor and record the pressure reading. Note it as your reference measurement (P_0). Wait at least 10 seconds for the sensor to stabilize.
4. Walk up to the first floor and wait 15 seconds for the pressure to stabilize. Record the new pressure value.
5. Repeat this measurement on each successive floor, always waiting for stabilization before recording.
6. For each floor, calculate the pressure difference $\Delta P = P_0 - P$ relative to the ground floor.
7. If you know the height of each floor, plot a graph of pressure difference versus altitude in your FizziQ notebook.
8. From your graph, determine the approximate rate of pressure change per meter of altitude (should be around 0.12 hPa/m or equivalently about 1 hPa per 8.5 m).
9. Use your data to derive a simplified formula: $\Delta h \approx (P_0 - P) \times 8.5$ where Δh is in meters and pressures are in hPa.
10. Test your formula by predicting the pressure at a known altitude (e.g., the top of a nearby hill) and comparing with the measured value.
11. Investigate the effect of opening and closing doors or turning on heating/ventilation on the pressure reading.

Expected results

Students should observe a consistent decrease in atmospheric pressure of approximately 0.10-0.12 hPa per meter of altitude gain. For a typical building with 3-meter floors, the pressure drop between consecutive floors should be about 0.3-0.4 hPa. The graph of pressure difference versus altitude should be approximately linear over the range of a few floors (up to about 30-50 meters). The derived conversion factor should be close to 8.5 m/hPa. Measurement precision with a smartphone barometer is typically ±0.1 hPa, corresponding to approximately ±1 meter of altitude uncertainty. Students may notice small pressure fluctuations due to wind, opening doors, or HVAC systems, which can introduce errors of 0.1-0.3 hPa.

Questions

- Why does atmospheric pressure decrease with altitude?
- Is the relationship between pressure and altitude perfectly linear? Why or why not?
- What factors other than altitude could cause the barometer reading to change?
- How do weather changes affect the accuracy of a barometric altimeter?
- Why do aircraft altimeters need to be regularly recalibrated during flight?
- Could you use this technique to measure the height of a mountain? What limitations would you encounter?

Going further

- Compare measurements from the smartphone barometer with an independent altitude measurement (GPS altitude or known building height)
- Investigate how weather changes over a full day affect the baseline pressure reading
- Take measurements on a hillside or mountain path and compare the pressure-altitude relationship over a larger altitude range
- Study the effect of rapid elevator rides on the barometer reading
- Compare the barometric sensitivity of different smartphone models to evaluate sensor precision