ScienceCube

Pressure Changes with Altitude

1. **You can calculate the altitude of a location using an atmospheric pressure sensor.**
2. **You can explain the relationship between altitude and atmospheric pressure.**

Fundamental Concept

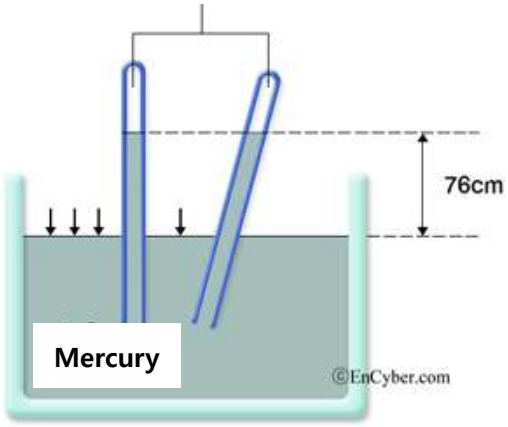
1. Magnitude of Atmospheric Pressure

Atmospheric pressure is the pressure exerted by a 76 cm column of mercury, equivalent to the pressure exerted by an air column about 1000 km high. If water were used instead of mercury, the atmospheric pressure would raise the water column to 1033.6 cm (10.33 m), as water is 13.6 times lighter than mercury. This implies that using a vacuum pump, water cannot be raised more than 10 m above the water surface.

2. Torricelli's Experiment

Physicist Torricelli conducted an experiment in 1643 using a glass tube and mercury. A glass tube, with a cross-sectional area of 1 cm^2 and a length of 1 m, was filled with mercury and inverted in a mercury-filled container. The mercury column inside the tube always maintained a height of 76 cm from the surface of the mercury in the container. The height of 76 cm is due to the weight of the mercury column balancing the atmospheric pressure acting on the mercury surface in the container. This experiment demonstrated that atmospheric pressure (1 atmosphere) is equal to the weight of a 76 cm high mercury column.

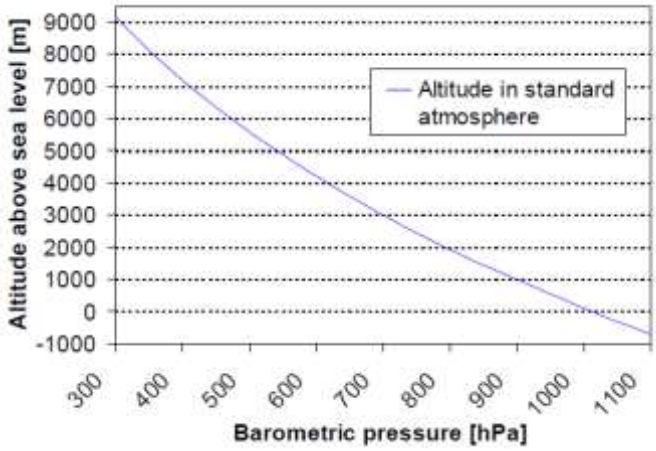
Torricelli vacuum



Atmospheric pressure changes over time due to meteorological factors. Even at the same location, factors like temperature and sunlight can change over time, resulting in different atmospheric conditions. For example, at the interface between land and sea, the land heats up faster during the day, causing rising air currents, while at night, the sea retains heat longer, leading to rising air currents over the sea. These temporal changes can affect atmospheric pressure.

3. Atmospheric Pressure with Altitude

The atmosphere extends several tens of kilometers above the Earth's surface, with over 50% of the atmosphere's mass within 5.6 km of the surface and 99% within 30 km. This means that most air molecules are concentrated near the surface due to Earth's gravity, and as altitude increases, the gravitational pull weakens, making the air density thinner. Consequently, atmospheric pressure decreases with altitude.



$$\text{Altitude} = 44{,}330 \times \left\{1 - \left(\frac{p}{p_0}\right)^{0.190295}\right\}$$

(p_0: atmospheric pressure at sea level, p: atmospheric pressure at the measured altitude)

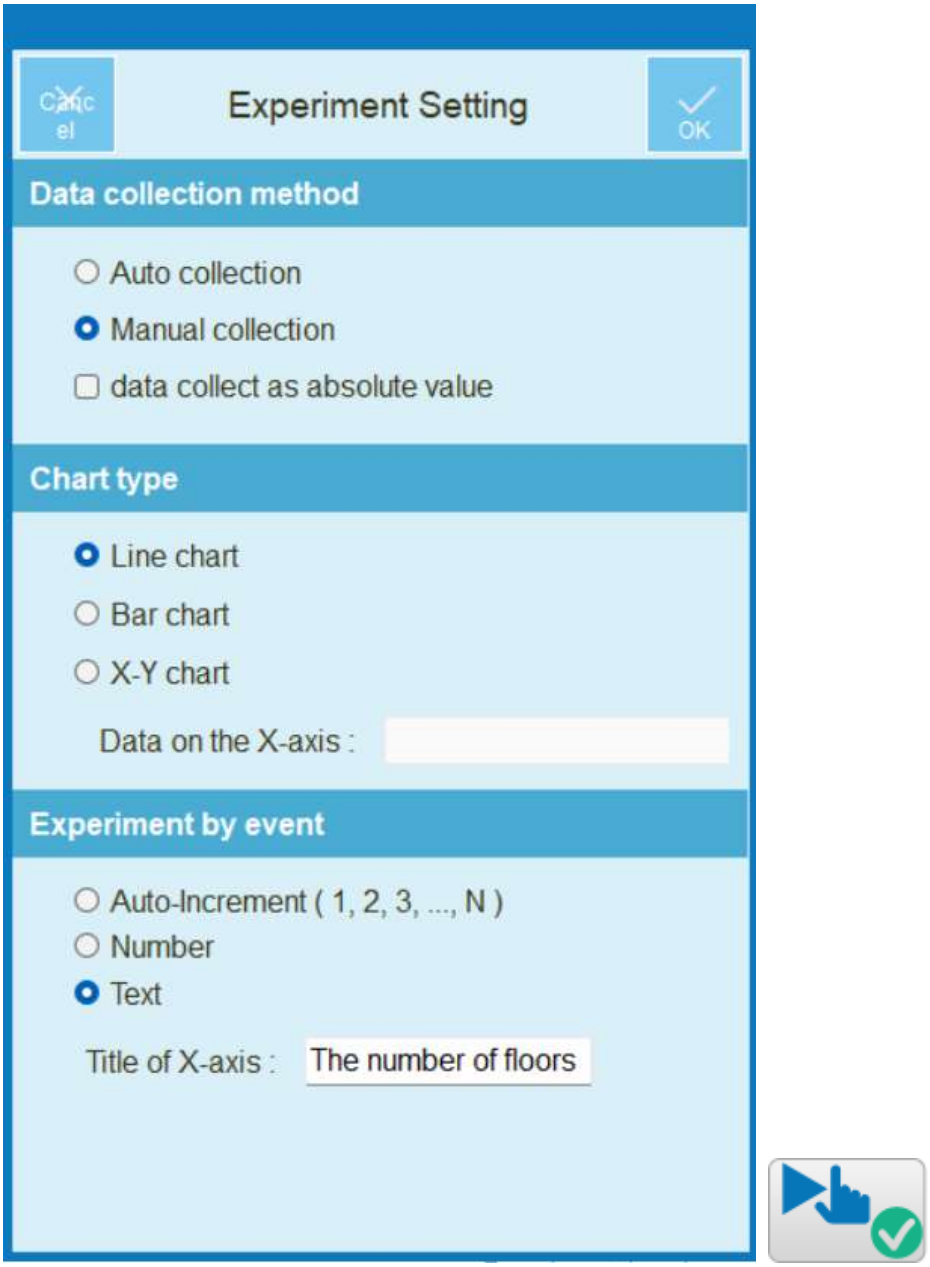
Experiment

Materials Needed

Interface, Science# Program, Atmospheric pressure sensor

Interface Setup

1. Run the Science# program  and connect the interface via Bluetooth.
2. Connect the atmospheric pressure sensor to the interface or, for smart sensor boxes, press the button  and select 'Atmospheric Pressure'.
3. Press the button  to set up the experiment environment or use the auto-setup  option.



Data Collection

1. Move to the lowest floor of the building.
2. Press the button  to start data collection.
3. Once the values stabilize, press the button  and enter the floor number of the measured location when prompted.
4. Measure the atmospheric pressure on each floor by moving up the stairs and repeating

the process.

5. Press the button  to stop data collection once all measurements are done..

Data Analysis

Recording

1. Use the Korea Meteorological Administration website to find and record today's sea-level pressure (hPa).

   [Website Link: http://www.kma.go.kr/weather/observation/currentweather.jsp]

   - Experiment Date:
   - Experiment Location:
   - Sea-level Pressure:

2. Draw a graph of the atmospheric pressure measured on each floor.

3. Record the atmospheric pressure for each floor in numerical form.

Floor										
Atmospheric Pressure (hPa)										

Applying Data

1. Sea-level pressure varies by location and time. Investigate and explain the standards used by the Korea Meteorological Administration to measure sea-level pressure.

2. Using the formula, calculate and record the altitude of each floor based on the measured atmospheric pressure.

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(p_0: atmospheric pressure at sea level, p: tmospheric pressure at the measured altitude))

Floor										
Altitude (m)										
Floor Height (m)										

3. Compare the calculated floor heights with the actual building floor heights. If they do not match, consider factors affecting the measurement accuracy and design a more precise experiment.

4. Based on the experimental data, explain the relationship between altitude and atmospheric pressure.

Extended Activities

1. Atmospheric pressure sensors are useful in real-life applications, such as measuring altitude for hikers with built-in sensors in watches. Research and describe other devices that use atmospheric pressure sensors and their applications.