ScienceCube

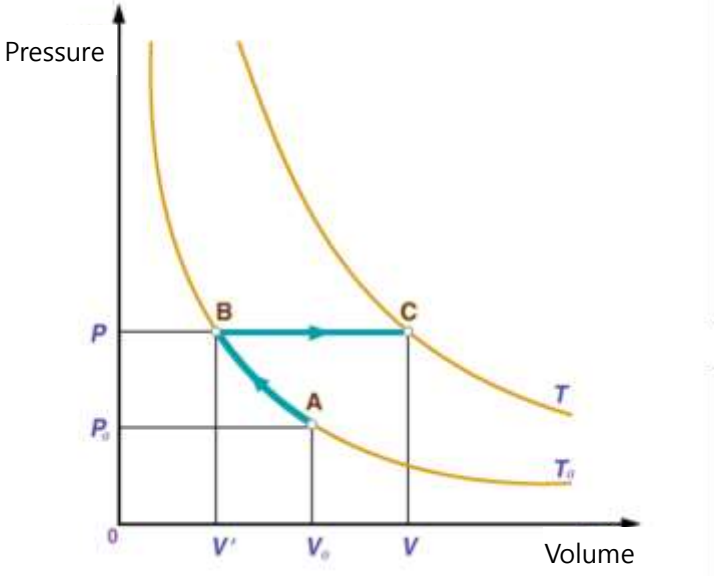
# Expansion of Choco Pie

1. **Measure the temperature inside the vacuum chamber according to pressure and explain the relationship between pressure and temperature.**
2. **Explain the changes in the Choco Pie inside the vacuum chamber in relation to pressure.**

# Fundamental Concept

## 1. Boyle's and Charles' Law

Boyle's Law states that at a constant temperature, the pressure of a gas is inversely proportional to its volume. Charles' Law states that at constant pressure, the volume of a gas is directly proportional to its temperature. Boyle's and Charles' Law combine these principles to describe the relationship between pressure, volume, and temperature when all three change simultaneously.



(1) Boyle's Law: $P_0V_0=PV'$

(2) Charles' Law: $\frac{V'}{T_0} = \frac{V}{T}$

(3) Combined Law: $\frac{P_0V_0}{T_0} = \frac{PV}{T} = \text{constant}$

Tip) These laws hold true for ideal gases and approximate real gases.

2. **Scientific Principles in the Vacuum Experiment**

When the air is removed from the vacuum chamber with a pump, the pressure exerted on the Choco Pie decreases, making the relative internal pressure of the Choco Pie stronger. As a result, the volume of the Choco Pie increases.

# Experiment

## Materials Needed

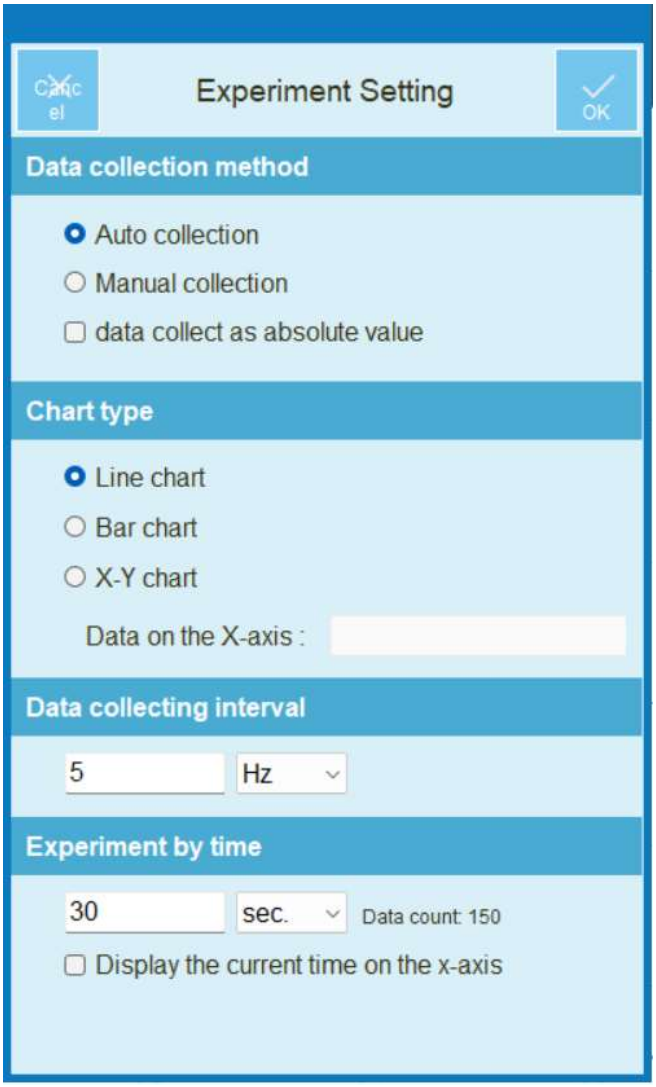
Interface, Science# Program, Gas Pressure Sensor (A), Temperature Sensor, Vacuum Chamber, Choco Pie (different colors , )

## Preparation of Experimental Setup

1. Place the Choco Pie inside the vacuum chamber.
2. Connect the gas pressure sensor and temperature sensor to the vacuum chamber.
3. Attach an orange Post-it note ( ) to the gas pressure sensor and a pink Post-it note ( ) to the temperature sensor.


## Interface Setup

1. Launch the Science# program.
2. Connect the temperature sensor to channel A and the gas pressure sensor to channel B.
3. Press 0 to calibrate the gas pressure sensor to 0.0 hPa.
4. Set up the experimental environment as shown below, or use the automatic setting option.




Automatic setup

## Data Collection

1. Use the augmented reality camera to capture the initial pressure and temperature readings inside the vacuum chamber and the state of the Choco Pie before pumping.
2. Press to start data collection.
3. Repeatedly pump the vacuum chamber to remove the air.
4. When the state of the Choco Pie changes, press to stop the experiment.

5. Use the augmented reality camera to capture the pressure and temperature readings and the state of the Choco Pie inside the vacuum chamber after pumping..

# Data Analysis

## Recording Data

1. Use the augmented reality camera to capture and record the initial pressure, temperature, and state of the Choco Pie inside the vacuum chamber before pumping.

2. Graph the changes in pressure and temperature inside the vacuum chamber as you repeatedly pump.

3. Use the augmented reality camera to capture and record the final pressure, temperature, and state of the Choco Pie inside the vacuum chamber after maximum pumping.

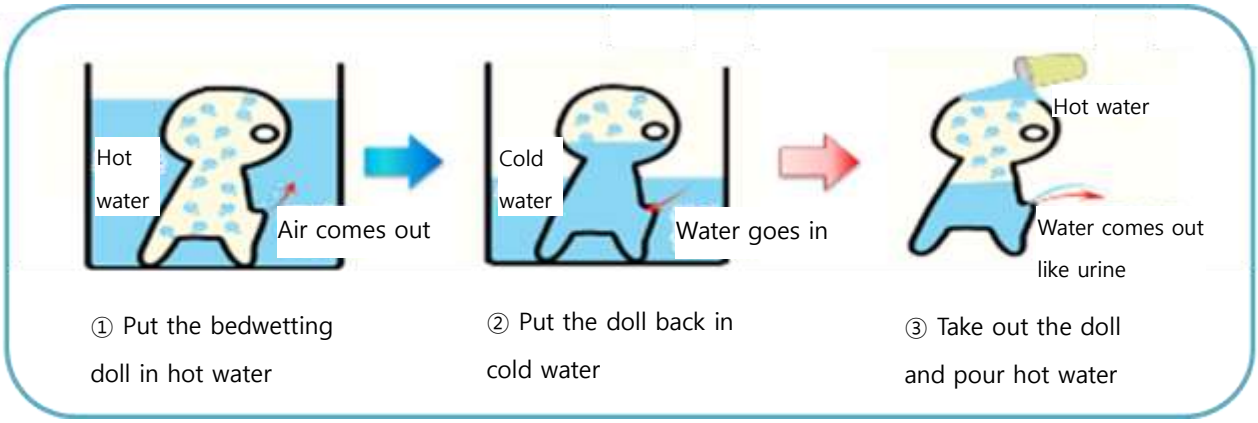
## Data Application and Extension Activities

1. Describe how the gas pressure inside the vacuum chamber changed during pumping.

2. Explain the relationship between temperature and pressure inside the vacuum chamber.

3. Describe how the Choco Pie changed with the gas pressure and explain why.

4. The following describes an experiment using a porcelain doll with a hole to simulate urination when placed in hot and cold water. Explain the principle based on the illustration.




**Report (For Teachers)**

**Report (For Students)**