C77A Barometer/Temperature

User Guide

July 19 2010, Second Edition

WARNING:

For safety reasons and to avoid personal injury, read all operating guides and information in the product guide. Please check that this product is operating properly prior to when you intend to use it for educational purposes only. Use this device and sensors for teaching and learning. The information given in this electronic document shall not be regarded as a guarantee or warranty of physical characteristics and any conditions. We will not replace or cover the costs of a damaged sensor or probe due to negligent or destructive, improper use.

1. DO NOT attempt to modify Mentor device and sensors in any way. This may result in fire, injury, electric shock or severe damage to you or them.
2. DO NOT operate Mentor device and sensors with wet hands, this may cause an electric shock.
3. DO NOT use Mentor device and sensors in close proximity to flammable or explosive gases, or chemical vapors. Use this product in a well ventilated area.
4. DO NOT breathe the vapors in a chemical reaction. Be careful when you use a strong acid, strong base or other materials in an experiment.
5. For safety reasons keep this sensor out of reach of children or animals to prevent accidents, for example swallowing small size of the sensor. DO NOT allow children to play on or around the sensor.

CAUTION:

1. DO NOT use Mentor device and sensors in extreme conditions which are over the operating range and short-term exposure limit conditions. Stresses above input range may cause permanent damage.
2. Exposure to absolute maximum conditions for extended periods may degrade sensor reliability.
3. The sensors are permanently sealed during construction and cannot be opened to any purpose. DO NOT attempt to decompose, modify or repair the sensor in any other ways. This may cause permanent damage to the sensor.

Features and Specifications

Features

Item	Description
Feature	Measure the barometric pressure in hPa and the ambient air temperature in °C or °F. Sensing element is mounted inside case (air box).
Dimension	37x18x16 (WxDxH) in mm
Usage	Use only in a dry place at room temperature below +40°C.

Specifications

Item	Description
Input range	Barometric pressure: +300hPa to 1100hPa Temperature : -40°C to 85°C
Resolution	±0.01hPa/16bit (up to 19bit) ±0.1°C/16bit
Uncertainty (Accuracy)	Temperature: at 25°C, Typ. ±0.5°C, Max: ±1.0°C 0 to 65°C, Typ. ±1.0°C, Max: ±2.0°C Pressure: 0°C to 65°C, Typ. ±1.0hPa, Max. ±3.0hPa
Reading time	Static (ambient) temperature reading in the air box*: Pressure: Typ. 9ms in high resolution mode Temperature: Typ. 3ms in standard mode
Sampling rate	Power-up default sampling rate is 2Hz Max. 10samples/second

*This reading time is the conversion time inside case of air box, and if a temperature change surrounding outside the case is occurred, please wait (2 or 5 minutes) until the incoming air flow through from the outside will be filled in the case. The full reading time vary with the type of the air flow, or the outside environment of the sensor.

Additional equipment or application

Mentor device and **MentorStart** application software needed. If you are using Mentor application, consult your instructor for more information.

CAUTION:

1. DO NOT use this sensor in close proximity to flammable or explosive gases. Chemical vapors may interfere with the polymer layers used for capacitive this sensor and high levels of pollutants may cause permanent damage to this sensor.
2. DO NOT use or expose this sensor in maximum range under 5seconds residence time (exposure limit with max. input range) and compressed hot air flow.
3. Prolonged direct exposure to extreme conditions over temperature may cause damage and melting the plastic housing of the sensor.
4. DO NOT place sensor or cable in water, liquids, flame or on a hot plate.
5. DO NOT place the sensor in a freezer, oven or near fire. To protect against electrical shock, DO NOT connect the plug of the sensor cable to the electric outlet or conductive solutions.
6. Liquids shall not come into direct contact with the sensor.
7. The sensor shall not the placed close that the fast heating parts.

Setup and Usage

1. Launch the **MentorStart** software and connect the sensor to the sensor port in your Mentor device. **MentorStart** will automatically detect the sensor. Place this sensor in ambient air condition.
2. Wait minimum 10 seconds for the measurement digits display to stabilize. You may wait more seconds for stable readings when you want to record the accurate temperature of the static air.
3. To maintain the accuracy in environmental monitoring experiments for example, requiring the barometric pressure measurement, care should be taken to isolate the sensor from ambient air temperature and allow the outside air to easily flow onto the sensor element.
4. To determine your absolute altitude, calibrate the MSL(Mean Sea Level) pressure with MentorStart while you are reading the pressure at your location with the known altitude.

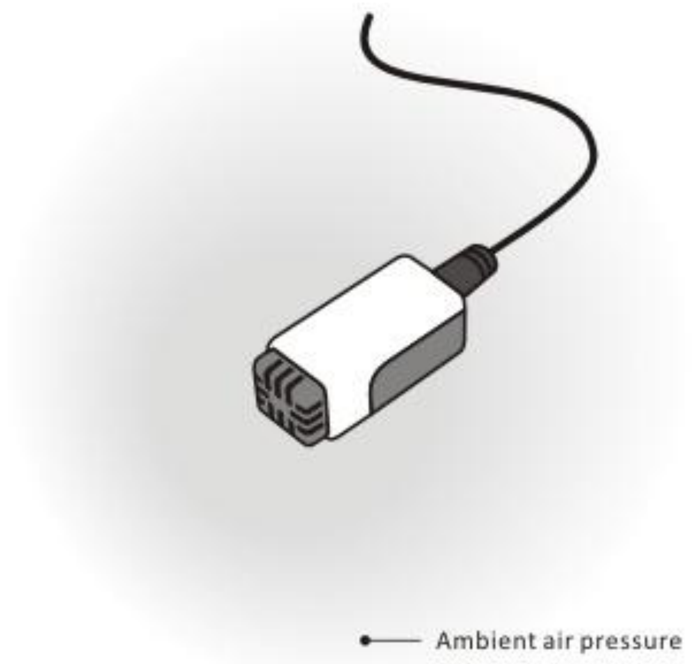

Fig.1 Measure the barometric pressure and temperature around you in an ambient air condition.

Fig.2 Reading the barometric pressure, temperature and altitude in one-shot mode constantly every 0.3s on the snapshot screen. MentorStart shows the calculated altitude with the measured pressure **p** and the constant value of the pressure at sea level **p0**=1013.25hPa. If you determine the real value of your altitude, you calibrate the pressure at sea level.

Determining your altitude with **MentorStart**[1] application

With the barometric pressure **p** and the pressure[2] at MSL **p0**, the altitude in meters is calculated with the following formula and a pressure change of 1hPa corresponds to 8.43m:

Altitude =44300*(1-(p/p0)^(1/5.255))

You can view the calculated altitude value from the default sea level pressure **1013.25hPa** in the snapshot or measurement mode. If you know the sea level pressure from your site as you are using GPS, you can read the absolute altitude by entering the **p0** value to the sensor settings pane. In the same sense, if you know the absolute altitude **A0** at your location, you can read the pressure **p0** at the location and then if you enter the reading value of the **A0** in the sensor settings, you can see the absolute altitude value at the any position in your open space of environment, but it is not accurate if you are in the closed space such as a room, office building, etc.

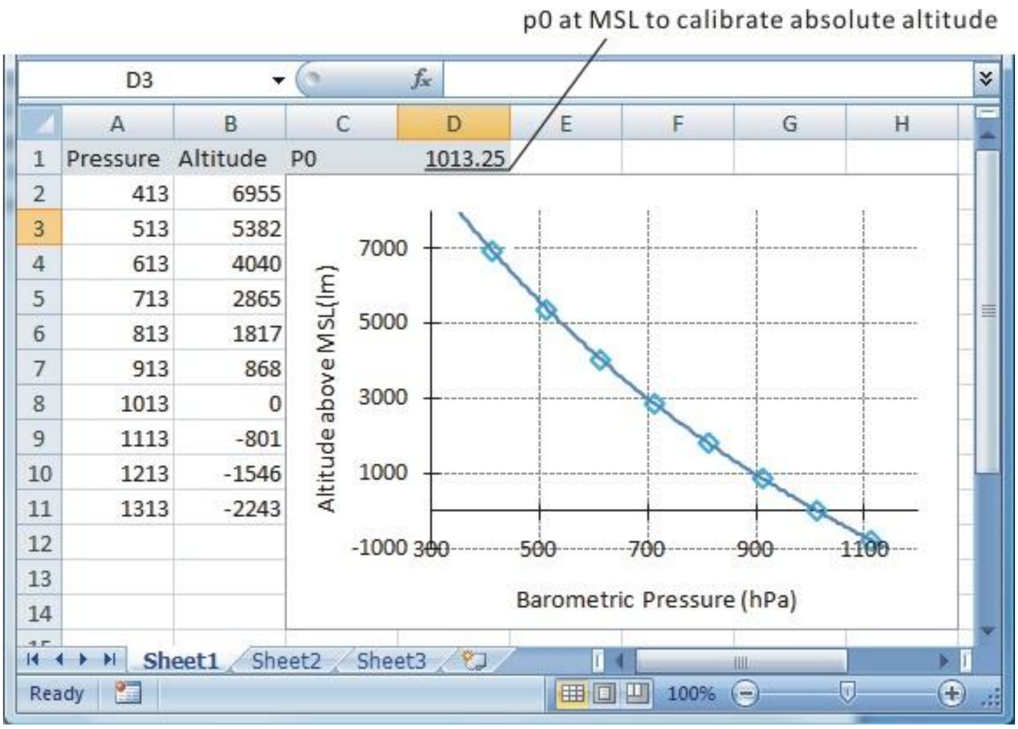

Fig.3 Calculating your absolute altitude with MSL pressure p0. When you use the sensor with MentorStart, you can input the p0 value in the settings of the calibration.

---

[1] See the user guide for **MentorStart** application

[2] With the measured pressure p and the absolute altitude h at your location, the pressure at mean sea level (MSL) can be calculated as the following: Pressure P0 at MSL =p/(1-h/44330)^5.255

Guide to Science Experiments

Table.1 Easy Science Experiments with everyday household materials using Barometric Pressure and Temperature.

	Students' activity (Science Experiments)
1	Monitor the outdoor temperature at different circumstance such as sunset, sunrise, shiny bright or overcast day.
2	Measure the barometric pressure in outdoor place.
3	Draw the temperature contour map in outdoor place like a temperature in the shadow of a tree.
4	Monitor the cool down temperature using the white frost from the freezer (refrigerator) or snow from the ground
5	Explore the barometric pressure with altitude, while you place the sensor at different outdoor location.
6	Measure the pressure change inside an air balloon using balloon pump while simultaneously taking measurements and pumping.

NOTE: If you are planning to use this sensor while experiment length is long (over 30minutes), check the battery level of Mentor device before beginning the experiment and use a low sampling rate like 1 to 2 samplings per minute.

Explore the pressure and temperature inside a plastic bottle

You can explore how the air pressure inside an empty soda bottle change and the temperature is held constant or not when you squeeze the sealed bottle. You can practically measure the pressure and temperature as you are trying to squeeze, hold and then release the bottle. As you squeeze the bottle to cause the volume of the bottle to decrease, you increase the air pressure everywhere inside the bottle. You know what happened to the temperature when you squeezed the bottle and after you stopped squeezing it and you describe how the air pressure and temperature relates to each other.

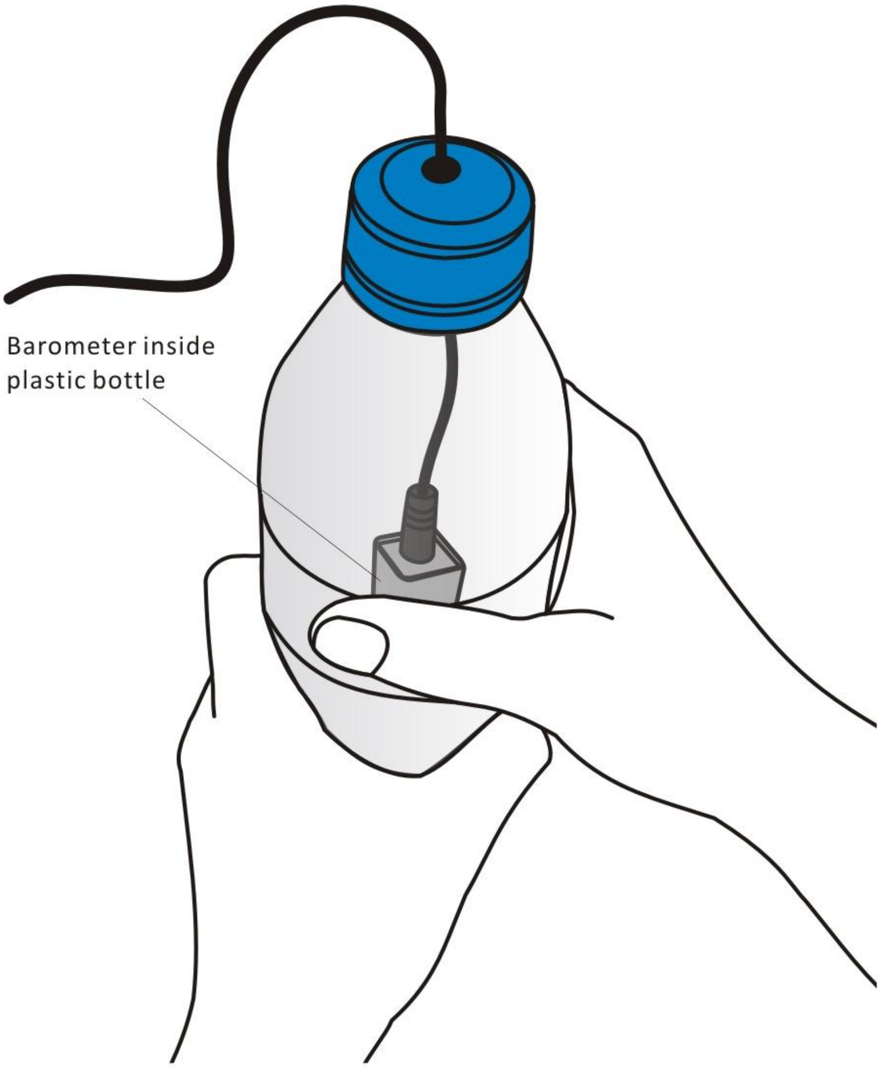

Fig.1 Squeezing and releasing 500ml plastic bottle which is fully empty and sealed. For example, punch or drill one hole into the top of the bottle cap to thread the sensor cable, and then seal air leaks in the cap surrounding using the sealing wax. You use your both hands to squeeze hard the bottle, after about 10seconds or 10 minutes[3], stop the squeezing it, and discuss with your peers, what cause or not the increasing temperature of the air, and what does the relationship between the pressure with volume changes and temperature.

CAUSTION: DO NOT allow water or any liquids into the sensor. DO empty the bottle before you put the sensor into the bottle.

In this activity, internal energy of air related to temperature can be expressed by the first law of thermodynamics:

$$\Delta U = Q + W,$$
$$\delta W = p dV \text{ and } U = (1/2) f k T$$

[3] Discuss the results when the experiment length is 10s or more than 60s, and why the results depend on the time.

where **ΔU** is the change in internal energy, **Q** is the heat added to the bottle and **W** is the mechanical work done on the bottle as you squeezing it, **U** is the thermal energy and **f** is the number of degrees of freedom, **k** is Boltzmann's constant and **T** is the temperature. When you squeeze the bottle, you can see the decreasing volume of the bottle, and simultaneously read the increasing pressure with the sensor inside the bottle.

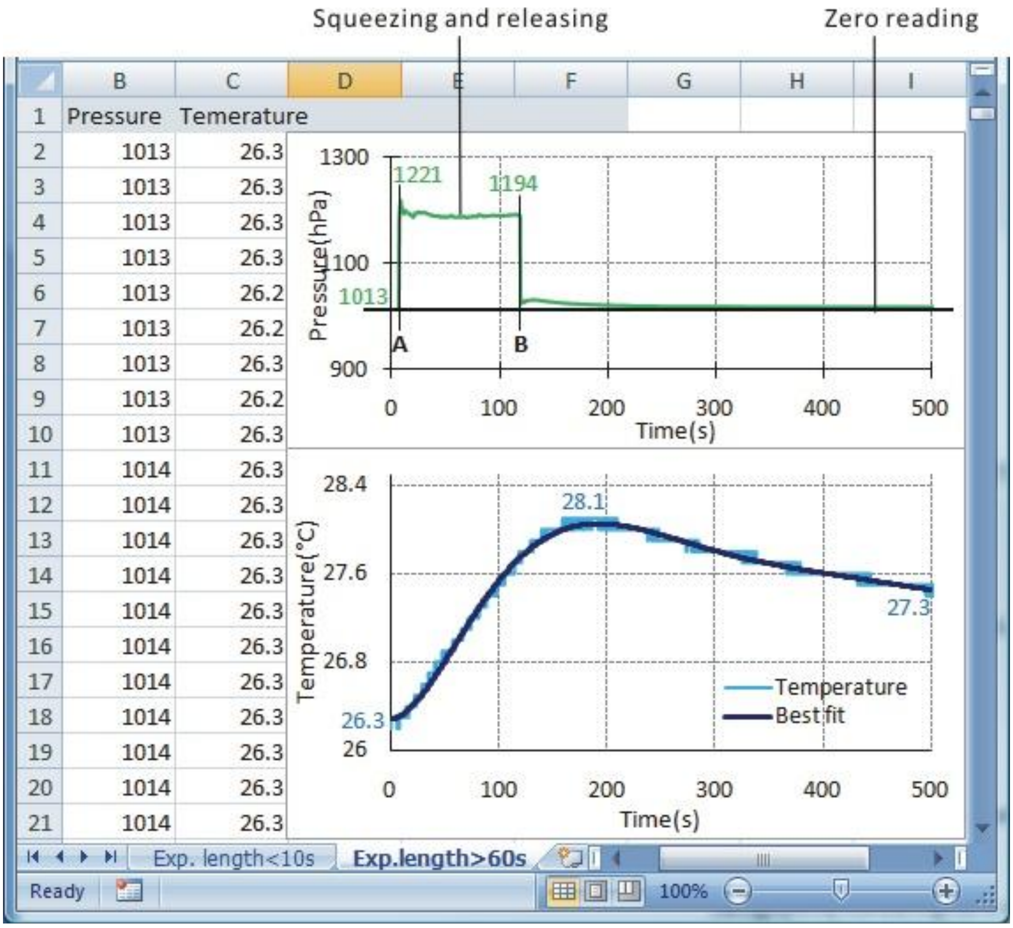

Fig.2 Demonstration for thermodynamic process of air using an empty plastic bottle. In this demonstration, you can describe the physical quantity related to the pressure, volume and temperature of the bottle. As an example, if you are trying to explain how clouds are formed in the bottle, you can report the experimental result and discuss when you squeeze the bottle, the pressure which raise the air temperature increase, and the warmer air cause the evaporation of water that it becomes clouds.

Korea Digital Co., Ltd.

707, Ace Twin Tower1
804, Ace Twin Tower2
Guro Digital Complex, Seoul, Korea

+82-2-2109-8877 (Tel)
+82-2-2109-8878 (Fax)
www.sciencecube.com

Designed by Korea Digital in Korea

For more information about installing Mentor, using other applications and getting the feedbacks, contact: ScienceCube international distributor.

If you have any questions about a guide to physics experiment using the sensor, please contact author at sooall@snu.kr