



## Absolute Pressure/Temperature Sensor

PS-2146



<b>Sensor Specifications:</b>	
<b>Pressure:</b> Range: 0 to 700 kPa Accuracy: $\pm 2$ kPa Resolution: 0.1 kPa Repeatability: 1 kPa Units: kPa, N/m <sup>2</sup> , psi, atm, torr	<b>Temperature:</b> Range: 263.2 to 343.2 <sup>o</sup> K Accuracy: $\pm 0.5^{\circ}$ K Resolution: 0.0025 <sup>o</sup> K Repeatability: 0.01 <sup>o</sup> K Units: <sup>o</sup> C, <sup>o</sup> F, <sup>o</sup> K
<b>Probe Specifications:</b>	
<b>Fast Response Temperature* (PS-2135)</b> Range: -10 <sup>o</sup> C to +70 <sup>o</sup> C Accuracy: $\pm 0.5^{\circ}$ C Resolution: 0.0025 <sup>o</sup> C	Construction: A 10K thermistor is housed in a water proof PVC tip. The thermistor is connected to a 3.5 mm stereo connector with a 4-foot PVC insulated wire.

\*A Fast Response Temperature probe is included with the sensor.

## Absolute Pressure/Temp. Quick Start

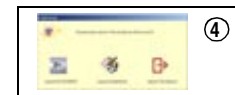
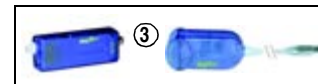
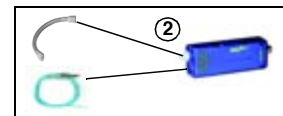
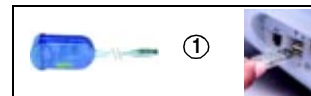
The PS-2146 Sensor simultaneously measures pressure and temperature. The pressure port has a fitting that mates with fittings and tubing provided with a sensor. The temperature port uses a 3.5 mm jack for PASCO's thermistor-based probes.

### Additional Equipment Needed

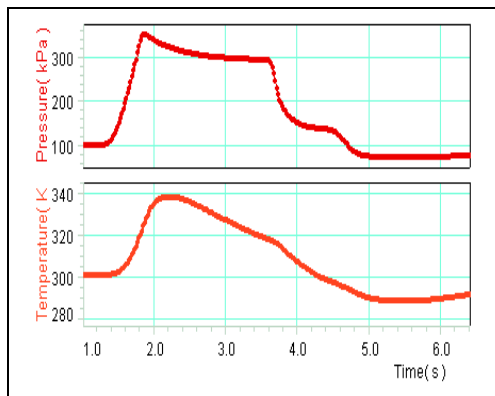
- PASPORT™ interface (USB Link, PowerLink, Xplorer, etc.) with USB-compatible computer or a PS-2000 Xplorer
- EZscreen or DataStudio® software (version 1.9.0 or later)

### Equipment Setup

- Connect the PASPORT interface to a USB port on your computer or to a USB hub.
- On the Absolute Pressure/Temperature Sensor, plug a piece of tubing into the pressure port and/or insert a temperature probe into the temperature port.
- Connect the Absolute Pressure/Temperature Sensor to the PASPORT interface.
- The software launches when it detects a PASPORT sensor. Launch DataStudio.



## Sample Data: Pressure and Temperature Fluctuations while Changing the Volume with the Ideal Gas Law Syringe (TD-8596)



## Activity: Understanding the Relationship between Volume, Pressure, and Temperature

**Equipment Required:** Ideal Gas Law Syringe (TD-8596), PASPORT Absolute Pressure/Temperature Sensor (PS-2146), DataStudio software (ver. 1.9.0 or later), PASPORT interface.

1. Connect the Ideal Gas Law Syringe to a PASPORT Absolute Pressure/Temperature Sensor. Set the syringe to 45 cc.
2. Connect the Absolute Pressure/Temperature Sensor to a PASPORT interface.
3. Open DataStudio and create a graph display of pressure and temperature vs. the time.
4. In DataStudio, click the **Start** button to begin data collection.
5. Push the syringe to the 25 cc position.
6. Pull the syringe from the 25 cc position back out to the 50 cc position. To end data collection, click the **Stop** button.
7. How does changing the volume affect the pressure and temperature? Use the ideal gas law equation ( $PV=nRT$ ) to explain your results.



**Figure 1: Measuring Pressure and Temperature Changes in the Ideal Gas Law Syringe**

DataStudio/DS Lite Tasks:	Procedures (optional):
<b>Open a display:</b>	In the Displays list, double click on any display.
<b>Change measurement units:</b>	In the Setup window, scroll to the Absolute Pressure/Temp. Sensor box. To change a unit, click on the down arrow next to the pressure or temperature.
<b>Change the sample rate:</b>	In the Setup window, go to the Absolute Pressure/Temp. Sensor box. Click on the down arrow and select a new unit and/or use the <b>Plus</b> and <b>Minus</b> buttons to increase or decrease the rate.
<b>Create a graph of pressure vs. temperature:</b>	From the Data list, drag the Pressure icon to a Graph display. Drag the Temperature icon over the x-axis and release the mouse.

## Calibrating the Temperature Probe

Calibration of the temperature probe is not usually required. The accuracy of the PASCO temperature probes is better than  $0.5^{\circ}\text{C}$  across the entire range of the probe. However, the probe may be calibrated using the following procedure.

1. Plug the PS-2146 Sensor into a PASPORT interface connected to a USB-compatible computer.
2. Insert a temperature probe into the sensor box using the 3.5 mm input on the right side of the sensor box.
3. Click the **Setup** button in the DataStudio toolbar. The Setup window will open.
4. Click on the Temperature **Calibrate** button in the Setup window. The Calibrate window will open.
5. Place the temperature probe in an ice water bath.
6. Ensure the value in the dialogue box for **Point 1** is 0. This value may be changed to the temperature of the controlled temperature bath if it is different than  $0^{\circ}\text{C}$ .
7. Click the **Set** button adjacent to the Point 1 dialogue box.
8. Place the temperature probe in boiling water.
9. Ensure the value in the dialogue box for **Point 2** is 100. This value may be changed to the temperature of a controlled temperature bath if it is different than  $100^{\circ}\text{C}$ .
10. Click the **Set** button adjacent to the Point 2 dialogue box.
11. To save the calibration values, click the **OK** button. The calibration is complete.

## Absolute Pressure Calibration

The absolute pressure for this sensor is factory calibrated. If your values appear off, check your pressure port connections and retake the measurement.

## Collecting Data with the Absolute Pressure/Temperature Sensor

1. Connect the Absolute Pressure/Temperature Sensor to a PASPORT interface (connected to a USB-compatible computer or an Xplorer.)
2. Plug any external tubing or apparatus to the pressure port on the sensor box.
3. Plug the temperature probe into the temperature port on the sensor box.
4. Set up your experimental apparatus.
5. Launch DataStudio (or Xplorer).
6. In DataStudio, open a graph display and click the **Start** button to begin data collection. Alter the pressure or temperature and watch these variables change in DataStudio.

**Note:** To change units of measurement, see the DataStudio table on card 1B.

## Sensor Usage Tips



**CAUTION:** To avoid damaging the sensor, do not place the Absolute Pressure/Temperature box in water or liquids, chemicals, ovens, or fire at any time.



**CAUTION:** Never allow liquids to get into the pressure port or condensation to enter the sensor. Do not use the sensor outside the pressure and temperature range on card 1A.

**Note:** If measuring temperature changes in a freezer, place the probe inside the freezer, but keep the sensor box outside of the freezer.

**Tip:** DataStudio 1.9.0 will automatically detect when a temperature probe is first connected. The temperature measurement can be manually added in the Setup window.

## Suggested Applications

- Studying chemistry gas laws, such as Charles' Law, Boyles' Law, and the Ideal Gas Law
- Extrapolating to Absolute Zero
- Exploring pressure and temperature relationships

## PASCO Equipment used with the Absolute Pressure/Temperature Sensor

<u>Temperature Probes*</u> <ul style="list-style-type: none"> <li>• PS-2135 Fast Response Temperature Probe (3-pack)</li> <li>• PS-2131 Skin/Surface Temperature Probe</li> <li>• PS-2153 Stainless Steel Temperature Probe</li> </ul>	<u>Heat Engines</u> <ul style="list-style-type: none"> <li>• TD-8572 Heat Engine/Gas Law Apparatus</li> <li>• TD-8592 Small Piston Heat Engine</li> </ul> <u>Other Apparatus</u> <ul style="list-style-type: none"> <li>• TD-8596 Ideal Gas Law Syringe</li> <li>• TD-8595 Absolute Zero Apparatus</li> </ul>
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\*Note: The Absolute Pressure/Temperature Sensor was designed for use with PASCO temperature probes that have a 3.5 mm stereo plug.