

# High Resolution pH/ORP/ISE Amplifier with Temperature Sensor

**PS-2147**


<b>Sensor Specifications:</b>	
<b>pH:</b> Range: 0 to 14 Accuracy: $\pm 0.1$ Resolution: 0.001	<b>ORP and ISE:</b> Range: -2000 mV to +2000 mV Accuracy: $\pm 2.0$ mV Resolution: 0.05 mV
<b>Temperature:</b> Range: -35°C to +135°C Accuracy: $\pm 0.5^\circ\text{C}$ Resolution: 0.0025°C	
<b>Probe Specifications:</b>	
<b>Fast Response Temperature (PS-2135):</b> Range: -10°C to +70°C Accuracy: $\pm 0.5^\circ\text{C}$ Resolution: 0.0025°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.	<b>pH electrode (699-085):</b> Range: 0 to 12 Accuracy: See pH electrode calibration on card 2A. Resolution: 0.001 Temperature range: 0°C to +80°C Construction: Double junction, electrode with three-foot cable and BNC connector. Reference is gel-filled.

## pH/ORP/ISE/Temp Quick Start

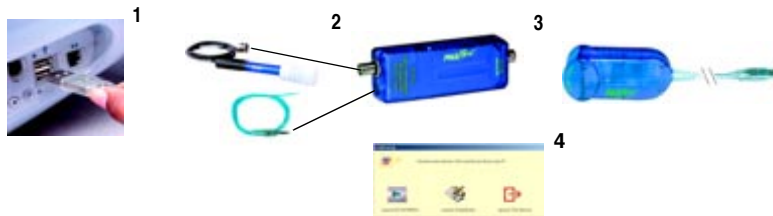
The PS-2147 Sensor is a multi-purpose millivolt (mV) meter that accepts standard BNC connectors and works with both PASCO and industry standard ion selective electrodes (ISE), including pH and ORP. The sensor is capable of measuring temperature using PASCO's thermistor-based temperature probes.

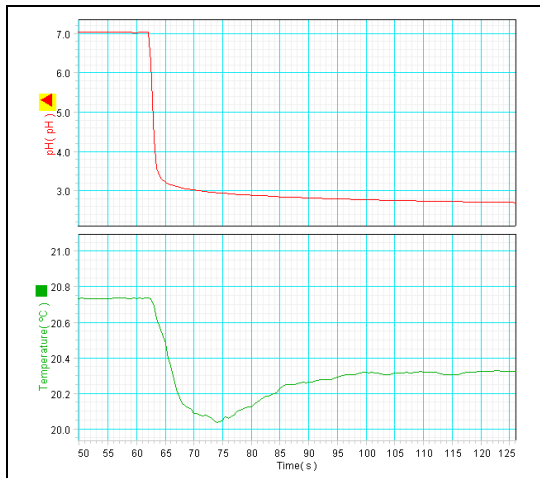
### Additional Equipment Needed

- PASPORT™ interface (USB Link, PowerLink, Xplorer, etc.) with USB-compatible computer or a PS-2000 Xplorer
- EZscreen or DataStudio® software (version 1.8.5 or later)

### Equipment Setup

1. Connect the PASPORT interface to a USB port on your computer or to a USB hub.
2. Connect an electrode to the BNC port and a temperature probe to the 3.5 mm plug input on the sensor box.
3. Connect the PS-2147 sensor to the PASPORT interface. (If using an Xplorer in the classroom, connect the Xplorer cable to your computer.)
4. The software launches when it detects a PASPORT sensor. Select a point of entry.





## Activity: Enthalpy of Neutralization with pH Measurement

**Equipment required:** PS-2147 High Resolution pH/ORP/ISE Sensor, pH electrode, Fast Response Temperature Probe, DataStudio software (ver. 1.8.5 or later), ring stand, clamp for pH probe, stirring machine, stir bar, calorimeter (part no. 650-02976 or two styrofoam cups stacked together), 1 mL pipette, citric acid powder, balance to measure +/- 0.01 g, 100 mL graduated cylinder, deionized water. (Optional): vinegar solution for stable pH, 0.1 M NaOH solution

### Procedure:

- Set out chemicals a few hours before the experiment to allow the chemicals time to equilibrate to room temperature.
  - Add 100 mL of deionized water to the calorimeter and stir until the temperature is stable. (Note: Without buffer, the pH is not stable or predictable. See the step 2b option.)
- OR
- Prepare 0.6 mM acetic acid by adding 0.5 mL vinegar to 1.00 L of deionized water and adjusting to pH 7.0 with drops of 0.1 M NaOH. Add 100 mL of this 0.6 mM acetic acid to the calorimeter and stir until the temperature is stable.
  - Place the temperature probe and pH probe into the solution. In DataStudio's Experiment menu, select "Monitor data." Stir until the solution comes to a steady temperature.
  - Weigh 10 millimoles (about 1.9 g) of citric acid powder.
  - When the temperature is steady, stop the monitoring run by pressing the **Stop** button.
  - Click the **Start** button and wait one minute to establish a baseline. Then add the citric acid powder to the stirring solution.
  - After about two minutes, the temperature and pH should become level, and you can stop the experiment.
  - (Optional): To find the amount of heat absorbed by the calorimeter, stir bar, and pH electrode, repeat steps 1-5. In place of step 6, add a fixed volume of water that is slightly cooled; follow the cooling curve after mixing the known amount of cool water. Combining this information with the above data can allow a description of the heat absorbed per mole citrate.
  - (Optional): Use the DataStudio calculator to convert pH to  $[H^+]$ . Use a graph display to show the temperature change per mole of acid dissolved.

DataStudio/DS Lite Tasks:	Procedure:
<b>Open the Setup window:</b>	On the main toolbar, click the <b>Setup</b> button.
<b>Change measurements:</b>	In the Setup window, go to the ISE Sensor box and click to place a check in the box(es) next to the desired measurement(s).
<b>Change the sample rate:</b>	In the ISE Sensor box, click on the down-arrow next to the sample rate and select a new unit. Use the <b>Plus</b> and <b>Minus</b> buttons to increase/decrease the rate.
<b>Measure the temp. change:</b>	Click on the <b>Smart Tool</b> and drag the cross hairs to a data point. When the delta appears, click and drag to measure the change.

## Calibrating the pH Electrode: A Practical Approach

Typically, pH electrodes are sensitive to the condition of the surface that is in contact with the solution. Electrode performance depends on the history of chemical treatment imposed on the critical measuring surfaces.

If the electrodes are kept in the appropriate solutions and not contaminated from the solution or from evaporative deposits, they function well without calibration.

Calibration is often not needed for qualitative observations, especially where concentrations of runs are being compared. If a quantitative result is desired for calculation, or to compare to later results, then calibration is required.

**Factory Calibration (no user intervention required):** The sensor is calibrated at the factory for a pH slope of  $-0.059$  mV per pH unit and zero at a pH of 7. Accuracies of 1.0 pH unit or better may be expected. This is the nominal slope for a new pH electrode at 25 degrees C.

**Full-Scale Calibration:** pH calibration buffers of 4.0 and 10.0 are required for this calibration. Accuracies of 0.1 pH units or better may be expected between 2.0 and 12.0 pH units after the full-scale calibration. (See the procedure on the right side of this card.)

### High Accuracy Calibration Procedure:

Very accurate pH measurements may be made with the PS-2147 if two basic guidelines are followed: a) Select two buffer calibration solutions that closely bracket the sample to be measured. b) Ensure the temperature of the calibration solution is the same as the sample to be tested. To calibrate the sensor, follow the calibration procedures outlined in the "Full-Scale Calibration Procedure" instructions on this card; Be sure to insert the pH values of the buffers used.

## pH Calibration (continued)

### Full-Scale Calibration Procedure:

With the sensor and electrode connected, do the following:

1. In DataStudio, click the **Setup** button on the main toolbar. The Setup window will open.
2. Click on the pH **Calibrate** button in the Setup window. The Calibrate window will open.
3. Rinse the pH electrode with deionized water and place it in the pH 4.0 buffer solution. Gently stir the electrode in the buffer solution.
4. Ensure the value in the dialogue box for **Point 1** is 4.0. If using a different solution, this value may be changed to the pH of the calibration buffer.
5. Watch the pH reading display in the dialogue box. When the pH reading stabilizes, click the **Set** button adjacent to the Point 1 dialogue box.
6. Rinse the pH electrode with deionized water and place it in the pH 10.0 buffer solution. Gently stir the electrode in the buffer solution.
7. Ensure the value in the dialogue box for **Point 2** is 10.0. This value may be changed to match the pH of the calibration buffer.
8. When the pH reading stabilizes, click the **Set** button adjacent to the Point 2 dialogue box.
9. To save the calibration values, click the **OK** button. The calibration is complete.

## Calibrating the ISE/ORP Electrodes

Specific calibration instructions for the ISE and ORP electrodes are included with the electrodes. You will need to prepare or purchase specific standard solutions for each ISE probe. Standard solutions can be purchased from any commercial supplier of probe chemicals.


## Calibrating the Temperature Probe

CARD 2B

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-2147 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.

## Sensor Usage Tips

 **CAUTION:** Do not place the PS-2147 pH/ORP/ISE Sensor case in liquids or expose to chemicals. The connectors and internal electronic circuit may be damaged.

## Suggested Activities

- Compare ORP of water from a faucet, fish tank, and a pond.
- Discover how long chlorinated tap water needs to stand before adding to a fish tank. Analyze the effect of temperature on this process.
- Study the effects of temperature on pH in a buffer
- Observe the heat of neutralization in a titration
- Measure the freezing and boiling point of a solution
- Study the effects of temperature and dilution on buffers

## PASCO Equipment used with the pH/ORP/ISE with Temperature Sensor

### Temperature Probes

- PS-2135 Fast Response Temperature Probe (3-pack)
- PS-2131 Skin/Surface Temperature Probe
- PS-2153 Stainless Steel Temperature Probe

### Related Sensors

- PS-2117 Drop Counter

### Ion Selective Electrodes

- CI-6717 Ammonium
- CI-6727 Calcium
- CI-6726 Carbon Dioxide (aqueous)
- CI-6732 Chloride
- CI-6728 Fluoride
- CI-6736 Lead
- CI-6735 Nitrate
- CI-6716 Oxidation-Reduction Potential (ORP)
- CI-6733 Potassium
- CI-6734 Sodium

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