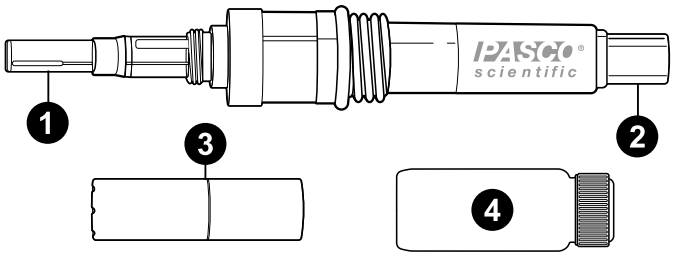
Carbon Dioxide ISE Probe (PS-3517)

Introduction

The Carbon Dioxide Ion Selective Electrode (ISE) Probe is a gas-sensing electrode that allows fast, simple, economical, and accurate measurement of dissolved CO_2 in aqueous solutions.

Components



1 Internal glass electrode
The sensing element of the ISE Probe.

2 BNC connector
Use this to connect the probe to a pH sensor, such as the Wireless pH Sensor (PS-3204), via the included BNC cable.

3 Membrane module
Holds the Internal Fill Solution which is used in the assembled electrode.

4 Storage bottle
Contains storage solution used to preserve the functionality of the electrode while not in use. See **Electrode storage** for more information on storing the electrode.

Included equipment and solutions:

- Carbon Dioxide Electrode
- Storage bottle
- Membrane module (2x)
- BNC male-to-BNC male cable
- Internal Fill Solution
- 1000 ppm Carbon Dioxide Standard Solution
- Ionic Strength Adjuster (ISA)
- Pipette

Required equipment and solutions:

- Wireless pH Sensor (PS-3204)

NOTE: You can also use the PASPORT High Precision pH/Temperature with ISE/ORP Amplifier (PS-2147) and a compatible PASPORT interface. However, unlike the Wireless pH Sensor, the PASPORT pH/Temperature sensor does not have direct concentration reading capabilities.

- PASCO Capstone or SPARKvue data collection software
- Wash bottle filled with distilled or de-ionized (DI) water
- pH 4.0 Buffer Solution
- pH 7.0 Buffer Solution
- Lab wipes
- Clean volumetric flasks (100 mL)
- Clean beakers

Get the software

You can use the Carbon Dioxide ISE Probe with SPARKvue or PASCO Capstone software. If you're not sure which to use, visit pasco.com/products/guides/software-comparison.

SPARKvue is available as a free app for Chromebook, iOS, and Android devices. We offer a free trial of SPARKvue and Capstone for Windows and Mac. To get the software, go to pasco.com/downloads or search for **SPARKvue** in your device's app store.

If you have installed the software previously, check that you have the latest update:

SPARKvue

Go to Main Menu > **Check for Updates**

PASCO Capstone

Go to **Help** > **Check for Updates**.

Using Ionic Strength Adjuster (ISA) solution to improve accuracy

At low concentrations of CO_2 ions, a standard method for removing the influence of charged particles on the detector is to add Ionic Strength Adjuster (ISA) solution to each of your standard solutions and samples. The addition assures that the overall ion activity in each solution being measured is nearly equal. The ISA contains no ions common to the Carbon Dioxide ISE itself.

Electrode assembly

IMPORTANT! Please read these instructions *before* assembling the Carbon Dioxide ISE Probe!

1. Carefully remove the internal glass electrode from the storage bottle. Set the storage bottle aside for later use.

NOTE: Soaking the internal glass electrode in Internal Fill Solution or pH 4.0 buffer for at least 1 hour before proceeding with the following steps will ensure fast response.

2. Fill one of the membrane modules with approximately 0.75 mL of the provided Internal Fill Solution.
3. Rinse the internal glass electrode with DI water and blot dry. Place the electrode into the membrane module filled with Internal Fill Solution and tighten the cap until snug. *Do not over-tighten.*

Set up the electrode

NOTE: These procedures use the Wireless pH Sensor (PS-3204). For information on connecting a different pH sensor to PASCO Capstone or SPARKvue, consult the manual for the sensor and the Capstone or SPARKvue online help. The PASPORT High Precision pH/Temperature with ISE/ORP Amplifier (PS-2147) cannot be directly configured as a Carbon Dioxide ISE.

1. Prepare the electrode as described in **Electrode assembly**.
2. Connect the electrode to the Wireless pH Sensor using the attached BNC cable, then turn on the sensor.
3. Start PASCO Capstone or SPARKvue.

To connect the Wireless pH Sensor to the computer and configure it as a Carbon Dioxide ISE, follow the steps below for your chosen program.

SPARKvue:

4. Click **Sensor Data**.
5. From the list of available wireless devices, select the pH sensor matching your device's printed ID number (XXX-XXX) to connect to the sensor.
6. Under the list of measurements for the pH sensor, click **Configure ISE** and select **Carbon Dioxide (aqueous) ISE** from the list of ISE options.

PASCO Capstone:

4. Select **Hardware Setup** from the **Tools** palette.
5. From the list of **Available Wireless Devices**, select the pH sensor matching your device's printed ID number (XXX-XXX) to connect to the sensor.
6. Click **Properties** next to the sensor's name.
7. From the **Properties** menu, click the dropdown box next to **ISE Configuration**, then select **Carbon Dioxide (aqueous) ISE**.

Checking electrode slope

The following procedure allows you to check the electrode slope of your sensor. This process is used to ensure your sensor is recording accurate measurements. It is recommended that you perform this test once every few years to check your sensor's functionality.

1. Connect the electrode to the Wireless pH Sensor (or equivalent), then connect the sensor to PASCO Capstone or SPARKvue.
2. In Capstone or SPARKvue, create a **Digits** display measuring the electric potential (**Voltage**) in millivolts (mV).

NOTE: See the PASCO Capstone or SPARKvue online help for more detailed instructions on setting up displays and other aspects of the data collection process.

3. Place 80 mL of DI water into a 100 mL volumetric flask. Add 1 mL of the provided ISA solution and invert the flask repeatedly to mix.
4. Check the pH of the water using lab pH paper. The pH value must be between 4.0 and 4.5. If it is not, add additional ISA in 1 mL increments until the pH value is between 4.0 and 4.5.
5. Add 10 mL of 1000 ppm Carbon Dioxide Standard Solution into the flask. Fill the flask to the 100 mL line with DI water and invert flask several times to mix.
6. Rinse the electrode tip with DI water and blot dry.
7. Pour the resulting solution into a 100 mL beaker. Immerse the electrode tip into the prepared solution to a depth of at least one inch.

TIP: To prevent air entrapment on the membrane surface, use an electrode holder to keep the electrode at a 20 degree angle away from vertical.

8. Begin recording data and wait for a stable reading to be displayed. (This may take several minutes.) Record this potential ($\mathbf{E_1}$) in mV.
9. In a separate 100 mL beaker, place 10 mL of the solution from the first beaker, then fill to the 100 mL mark with DI water. Stir thoroughly.
10. Remove the electrode from the first beaker. Rinse the electrode tip with DI water and blot dry.
11. Immerse the electrode tip into the second prepared solution to a depth of at least one inch.
12. Begin recording data and wait for a stable reading to be displayed. Record this potential ($\mathbf{E_2}$) in mV.
13. The difference between the first and second potential readings, ($\mathbf{E_1 - E_2}$), is defined as the *slope* of the electrode. At a standard room temperature of 25 °C, the normal range for this slope is 56±4 mV.

Troubleshooting the electrode slope

If the electrode slope is not within the normal range stated above, or the electrode mV reading drifts, the Internal Fill Solution may need to be refilled. Follow the procedures outlined in **Electrode assembly**. If this does not fix the problem, check the slope of the internal glass electrode through the following procedure:

1. Remove the membrane module from the electrode body.
2. Rinse the internal glass electrode with DI water and blot dry.
3. Connect the probe to the Wireless pH Sensor (or equivalent), then connect the sensor to SPARKvue or PASCO Capstone as described in **Set up the electrode**.
4. Create a **Digits** display measuring the potential in mV.
5. Immerse the internal glass electrode in a beaker of pH 7.0 buffer. Make sure the annular ceramic junction of the internal glass electrode is submerged.
6. Begin data recording. Once the reading has stabilized, record the potential in mV.

7. Remove the internal glass electrode from the pH 7.0 buffer. Rinse the electrode with DI water and blot dry.
8. Immerse the internal glass electrode in a beaker of pH 4.0 buffer.
9. Begin data recording again. Once the reading has stabilized, record the potential in mV.

The potential reading in pH 7.0 buffer should be 0±25 mV. The potential difference between the two readings should be greater than 168 mV. If the difference is less than 160 mV, consider replacing the sensor. Contact PASCO if the sensor is still within the warranty (1 year from purchase), or purchase a new sensor.

If the internal glass electrode functions properly but the completely assembled electrode does not, replace the membrane module with a new one filled with Internal Fill Solution. A spare membrane is included with the electrode. Follow the steps under **Check electrode operation (slope)** again after replacing the membrane.

NOTE: All solutions should be prepared fresh. For best performance, use ISA in all solutions.

Reading samples with the electrode

Various procedures may be used to determine the concentration of a sample. The most common is the Direct Calibration method, which is described in the following sections. Contact PASCO's Technical Support department for details of other methods.

In Direct Calibration, a series of standard solutions of differing concentration is used to calibrate the electrode. From there, each sample requires only a single reading, which is compared with the calibration readings to obtain the sample concentration. ISA is added to all solutions to ensure that the samples and standards have very similar ionic strength and pH.

Measurement set-up

1. Prepare the electrode as described in **Electrode assembly**.
2. Connect the electrode to PASCO Capstone or SPARKvue and configure it as a Carbon Dioxide ISE, as described in **Set up the electrode**.
3. Prepare two standards that differ in concentration by a factor of ten and bracket the expected sample concentration range. Both standard solutions can be obtained by diluting the 1000 ppm Standard Solution (provided with the electrode) in DI water. For example, if your expected sample concentration is 50 ppm carbon dioxide, dilute 10 mL of the 1000 ppm standard solution in a 100 mL volumetric flask to obtain a 100 ppm high standard, then dilute 10 mL of the high standard in an identical flask to obtain a 10 ppm low standard. All samples and standard solutions should be at the same temperature.

Calibrating with direct concentration reading

Follow the procedures below for your program of choice if using a pH sensor with direct concentration reading capabilities, such as the Wireless pH Sensor (PS-3204).

SPARKvue:

1. From the **Sensor Data** screen, check the box next to **Carbon Dioxide (aqueous) ISE** in the list of available measurements, then select a template to open the **Experiment Screen**.
2. From the **Live Data Bar** on the bottom left of the Experiment Screen, click on **Carbon Dioxide (aqueous) ISE** and select **Calibrate measurement** from the list.
3. Make sure that the following settings are selected in the **Calibrate Sensor** window:
   - **Sensor:** {Name of the sensor you are using}
   - **Measurement:** Carbon Dioxide (aqueous) ISE (mg/L)
   - **Calibration Type:** 2 point (Adjust Slope and Offset)
4. Click **Continue**.
5. Remove approximately 10 mL of your low standard solution from its volumetric flask and set it aside until Step 7. Add 1 mL of ISA to the flask and invert repeatedly to mix.
6. Use lab pH paper to check the pH of the standard. The value must be between 4.0 and 4.5; if it is not, add ISA in 1 mL increments and continue mixing until the value is within this range.
7. Fill your flask to the 100 mL mark with the low standard solution that you removed in Step 5. (If you do not have enough solution to reach the 100 mL mark, simply add all of the removed solution.) Invert repeatedly to mix, then pour the entire solution into a 150 mL beaker.
8. Rinse the electrode with DI water, blot dry, and place it into the beaker. Wait for a stable reading in the **Current Value** boxes. (This may take several minutes.)
9. Enter the known concentration of the low standard solution, in mg/L, into the **Standard Value** box under **Calibration Point 1**, then click **Set Calibration**.

TIP: For solutions dissolved in DI water, 1 ppm and 1 mg/L are approximately equivalent.

10. Remove the electrode from the low standard solution beaker. Rinse the electrode with DI water and blot dry.
11. Remove approximately 10 mL of your high concentration standard from its volumetric flask and set aside until the next step. Add 1 mL of ISA to the flask and invert to mix.
12. Repeat Step 6 for the high standard solution, then fill the flask to the 100 mL mark with the high standard solution removed in the previous step. Invert to mix, then pour the solution into a new 150 mL beaker.
13. Place the electrode into the high standard solution beaker and wait for a stable reading in the **Current Values** boxes.
14. Enter the known concentration of the high standard solution, in mg/L into the **Standard Value** box under **Calibration Point 2**, then click **Set Calibration**.
15. Review your new calibration, then click **OK**.

PASCO Capstone:

1. Select **Calibration** from the **Tools** palette.
2. Select **Concentration** from the list of measurements, then click **Next**.
3. Ensure that **Two Standards (2 point)** is selected from the list of calibration types, then click **Next**.
4. Remove approximately 10 mL of your low standard solution from its volumetric flask and set it aside until Step 6. Add 1 mL of ISA to the flask and invert repeatedly to mix.
5. Use lab pH paper to check the pH of the standard. The value must be between 4.0 and 4.5; if it is not, add ISA in 1 mL increments and continue mixing until the value is within this range.
6. Fill your flask to the 100 mL mark with the low standard solution that you removed in Step 4. (If you do not have enough solution to reach the 100 mL mark, simply add all of the removed solution.) Invert repeatedly to mix, then pour the entire solution into a 150 mL beaker.
7. Rinse the electrode with DI water, blot dry, and place it into the beaker. Wait for a stable reading in the **Current Value** box. (This may take several minutes.)
8. Enter the known value of the concentration, in mg/L, into the **Standard Value** box and click **Set Current Value to Standard Value**.

TIP: For solutions dissolved in DI water, 1 ppm and 1 mg/L are approximately equivalent.

9. Remove the electrode from the low standard solution beaker. Rinse the electrode with DI water and blot dry.
10. Remove approximately 10 mL of your high concentration standard from its volumetric flask and set aside until the next step. Add 1 mL of ISA to the flask and invert to mix.
11. Repeat Step 5 for the high standard solution, then fill the flask to the 100 mL mark with the high standard solution removed in the previous step. Invert to mix, then pour the solution into a new 150 mL beaker.
12. Place the electrode into the high standard solution beaker and wait for a stable reading in the **Current Values** boxes.
13. Enter the known concentration of the high standard solution, in mg/L into the **Standard Value** box and click **Set Current Value to Standard Value**.
14. Review your new calibration and click **Finish**.

Calibrating with millivolt reading

Follow this procedure **only if** you are using the PASPORT High Precision pH/Temperature with ISE/ORP Amplifier.

1. Connect the sensor to a compatible PASPORT interface, such as the 550 Universal Interface (UI-5001), and connect the interface to SPARKvue or PASCO Capstone.
2. Create a **Digits** display measuring the potential reading, in mV, from the sensor.
3. Remove approximately 10 mL of your low standard solution from its volumetric flask and set it aside until Step 6. Add 1 mL of ISA to the flask and invert repeatedly to mix.
4. Use lab pH paper to check the pH of the standard. The value must be between 4.0 and 4.5; if it is not, add ISA in 1 mL increments and continue mixing until the value is within this range.
5. Fill your flask to the 100 mL mark with the low standard solution that you removed in Step 3. (If you do not have enough solution to reach the 100 mL mark, simply add all of the removed solution.) Invert repeatedly to mix, then pour the entire solution into a 150 mL beaker.
6. Rinse the electrode with DI water, blot dry, and place it into the beaker. Start data collection and wait for a stable reading. (This may take several minutes.)
7. Once the reading stabilizes, record the potential reading in mV and the known concentration of the low standard solution.
8. Remove the electrode from the beaker. Rinse the electrode with DI water and blot dry.
9. Remove approximately 10 mL of your high concentration standard from its volumetric flask and set aside until the next step. Add 1 mL of ISA to the flask and invert to mix.
10. Repeat Step 4 for the high standard solution, then fill the flask to the 100 mL mark with the high standard solution removed in the previous step. Invert to mix, then pour the solution into a new 150 mL beaker.
11. Once the reading stabilizes, record the potential reading and the known concentration of the high standard solution.
12. Remove the electrode from the beaker, rinse with DI water, and blot dry.
13. Using semilogarithmic graph paper, prepare a calibration curve by plotting the recorded millivolt values on the linear axis and the known concentration values of the standard solutions.

Measuring with direct concentration reading

After completing **Calibrating with direct concentration reading**, measure the sample concentration with these steps:

1. Remove 10 mL of your sample solution from the 100 mL volumetric flask and set it aside for Step 3. Add 1 mL of ISA and invert to mix.
2. Use lab pH paper to check the pH of the sample. The value must be between 4.0 and 4.5; if it is not, add ISA in 1 mL increments and continue mixing until the value is within this range.
3. Fill the flask to the 100 mL line with the remaining solution removed in Step 1. Invert repeatedly to mix, then pour the solution into a 150 mL beaker for testing.
4. Rinse the electrode with DI water, blot dry, and place it into the beaker.
5. In the program the sensor is connected to, create a **Digits** display measuring the concentration of carbon dioxide from the ISE Probe.
6. Begin data collection. Once the reading stabilizes, record the concentration value.
7. Repeat Steps 1 through 6 for any additional samples.

Measuring with millivolt reading

Follow the below procedures **only if** you are using the PASPORT High Precision pH/Temperature with ISE/ORP Amplifier (PS-2147). After completing **Calibrating with millivolt reading**, follow these steps to calculate the concentration of a sample:

1. Remove 10 mL of your sample solution from the 100 mL volumetric flask and set it aside for Step 3. Add 1 mL of ISA and invert to mix.
2. Use lab pH paper to check the pH of the sample. The value must be between 4.0 and 4.5; if it is not, add ISA in 1 mL increments and continue mixing until the value is within this range.
3. Fill the flask to the 100 mL line with the remaining solution removed in Step 1. Invert repeatedly to mix, then pour the solution into a 150 mL beaker for testing.
4. Rinse the electrode with DI water, blot dry, and place it into the beaker.
5. In the **Digits** display used for calibration, resume data collection. Once the reading stabilizes, record the potential value in mV.
6. Determine the sample concentration using the calibration curve you created in **Calibrating with millivolt reading** and the mV value obtained in Step 5.
7. Repeat Steps 1 through 6 for any additional samples.

Electrode storage

Short-term

Between measurements, keep the electrode tip immersed in a 10 ppm standard *without* ISA. For overnight storage, immerse the electrode tip in a pH 7.0 buffer.

Long-term

For storage of one week or more, disassemble the electrode completely. Rinse the membrane module and the tip of the internal glass electrode with DI water and blot dry. Cover the tip of the internal glass electrode with the original storage bottle. Store all parts securely in the original box. When reassembling, follow the procedure in **Electrode assembly**, as well as **Checking electrode operation** if the sensor has been stored for several months or more.

Software help

The SPARKvue and PASCO Capstone Help provide additional information on how to use this product with the software. You can access the help within the software or online.

SPARKvue

Software: Main Menu > Help

Online: help.pasco.com/sparkvue

PASCO Capstone

Software: Help > PASCO Capstone Help

Online: help.pasco.com/capstone

Specifications and accessories

Visit the product page at pasco.com/product/PS-3517 to view the specifications and explore accessories. You can also download support documents from the product page.

Technical support

Need more help? Our knowledgeable and friendly Technical Support staff is ready to answer your questions or walk you through any issues.

Chat	pasco.com
Phone	1-800-772-8700 x1004 (USA) +1 916 462 8384 (outside USA)
Email	support@pasco.com

Regulatory information

Limited warranty

For a description of the product warranty, see the Warranty and Returns page at www.pasco.com/legal.

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Product end-of-life disposal

This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle or disposal service, or the place where you purchased the product. The European Union WEEE (Waste Electronic and Electrical Equipment) symbol on the product or its packaging indicates that this product must not be disposed of in a standard waste container.