

Using Arduino – Measuring pH value (Student instructions)

Required materials

- Laptop with Arduino IDE
- Arduino board
- pH sensor (PH-4502C)
- pH electrode with BNC connector
- Eight connection cables (female – male)
- Two connection cables (male – male)
- LCD display
- Breadboard
- Power bank, if applicable
- Screwdriver

Required chemicals

- Buffer solution with pH = 7.0
- Beverages, household chemicals, or similar liquids to be tested

Safety information

The materials may be used only as instructed by your teacher or as described in the experimentation instructions. The beverages are not suitable for consumption.

Conducting the experiment

If the Arduino is not yet connected to the pH sensor, ask your teacher about the setup.

If you have connected the Arduino to the pH sensor yourself, you must first calibrate the sensor:

- First, connect the Arduino to the laptop using a USB cable.
- Open Arduino IDE on the laptop.
- In IDE, search for the calibration sketch (= program code) under *File* → *Open*.
- Click the arrow  at the upper left to load the sketch onto the Arduino board.
- Place the pH electrode in a buffer solution with pH = 7.0.
- Open the serial monitor in Arduino IDE (*Tools* → *Serial monitor*).
- There you can read the voltage output by the Arduino.

- Using a small screwdriver, rotate the screw on the small blue box closer to the pH electrode until the display shows a voltage of 2.50 V. Reason: The Arduino can read voltages from 0 to 5 V. To prevent negative values from occurring for the voltage, you must set pH = 7 to exactly the middle of the voltage range, thus to 2.5 V.



Figure 1: pH electrode in the buffer solution.

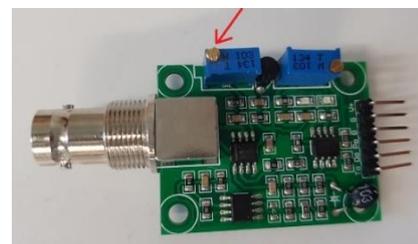


Figure 2: Screw that must be rotated on the pH sensor.

Measuring pH value

If the sensor is calibrated, you may begin measuring the pH value:

- First, connect the Arduino to the laptop using a USB cable.
 - Open Arduino IDE on the laptop.
 - In IDE, search for the right sketch (= program code). Your teacher can tell you which sketch you need.
 - Click the arrow  at the upper left to load the sketch onto the Arduino board.
 - Now you can test various beverages or other household chemicals.
 - Number each cup with a marker in the order in which you will test the beverages.
 - Note which beverage belongs to which number.
 - Immerse the pH electrode in the beverage. Wait **at least 30 seconds** until the measured value barely changes anymore.
 - Write down the pH value.
- After the experiment, empty the cups as instructed by the teacher, rinse them out with water, and wipe off the numbers.

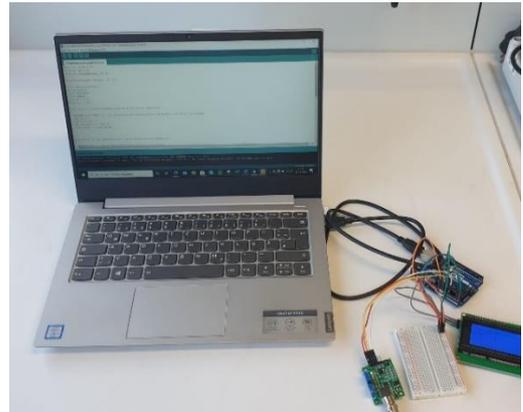


Figure 3: Experiment setup.



Figure 4: Label the cups.

Observation

Note the pH values of the various beverages.

Analysis

- a) Compare your measured values with those of your classmates.
- b) Look at the program code that you used to measure the pH values. Try to understand what the program code “does” and how the measured pH values are obtained.
- c) Add automatic “beverage recognition” to the program code. This program should recognize what the beverage is based on the measured pH value. In this way, you can quickly distinguish various beverages that look similar.
 - a. What do you have to keep in mind with regard to the measured values?
 - b. Which data do you need? Which data can you leave out?
 - c. How can you break down the overall problem into smaller subproblems?
 - d. Implement your considerations in program code. What do you notice?
 - e. Test your solution based on one of the beverages unknown to you.