ROBOSTEM Project

Agreement no: 2019-1-RO01-KA202-063965

Chemistry Lesson Plan

Topic/Subject: Titration Experiments with Arduino-Based pH Sensor

Target Group: 10th Grade

Objectives:

Obj1. Describe the key steps in performing an acid–base titration
Obj2. Describe and understand the principle of operation of an Arduino-Based pH Sensor
Obj3. Identify suitable indicators by determining the equivalence points in plotted or tabulated pH data

Approach/Methodology used: Combining the Arduino with pH and temperature sensors and actuators. Potentiometric titration is operated by hand, providing a titration curve directly to the Microsoft Excel Spreadsheet. The titrant is added, under agitation, at a constant rate of 100 µL (1,0 mL) every 6 seconds.

Means/Tools/Educational technology

Desktop computers running Excel or similar software
Chemistry textbook
Arduino-Based pH Sensor
Arduino UNO
Breadboard
Cables
50 ml buret
250 ml beaker
Solutions of HCl and NaOH

Plan for work

Time	Activities	Methods/ means
10 min.	Demonstrate the operation of a buret by discharging small amounts of water into a flask. Explain to the students how to read the buret using the marks on the sides. Issue each group a buret and a flask. Have the students set up their burets and fill them with water. Have each student dispense a small amount of water (2-5 ml) into the flask.	Buret, flask

5 min.	Demonstrate the operation of the Arduino-Based pH Sensor. Show them how to use the meter without the risk of breaking the electrode.	Arduino-Based pH Sensor
10 min.	Have a group of students rinse their buret with the NaOH solution and dispose of the waste base properly. Then have them fill their burets to 50 ml with the NaOH solution. Add 1 drop of phenolphthalein indicator to the 30.0 ml of hydrochloric acid solution.	NaOH solution, HCl solution, phenolphthalein indicator
10 min.	Have students add the solution 5 ml at a time. Have them record the pH after each addition. If the pH changes dramatically, have them change the procedure and add NaOH 1-2 ml at a time. One student can control the stopcock, one can read the volume, and one can record the pH in a spreadsheet or on paper.	Computer, NaOH solution
10 min.	Have students dispose of their remaining chemicals appropriately.	

Assessment/Feedback: Students will turn in a group lab that includes of their titration graph, their calculations, and a short lab report from each team member. Reports will be assessed based on how well the students explain any difference between the estimated, calculated, and observed, values for their titration. Reports will also be assessed based on how well the student is able to describe the progress of the reaction in his or her own words.

This work has the potential to improve the integration of the visually impaired into mainstream settings in an area not previously covered. The use and interpretation of pH paper in measuring pH, which could not be attempted previously by the visually impaired, is now possible using the Arduino-based pH sensor.

Bibliography:

Kenkel, J., 2013. Analytical Chemistry for Technicians. 3rd ed. Hoboken: CRC Press, pp.99-101.

https://www.xylemanalytics.com/File%20Library/Downloads/SIA_Titration-handbook_English.pdf