



Datalogging with Handheld Technology.

KS3 Science

Unit 7E

Acids and Alkalis

What happens when an acid is added to an alkali?

This year 7 unit offers a number of opportunities to datalog, mainly with pH sensors but also with temperature sensors. The following extract from the QCA specification is particularly appropriate:-

<i>Learning Objectives</i>	<i>Possible Teaching Activities</i>	<i>Learning Outcomes Pupils</i>	<i>Points To Note</i>
<ul style="list-style-type: none"> ◆ that when an acid is added to an alkali, it lowers the pH ◆ that a neutral solution can be obtained by adding an acid to an alkali 	<ul style="list-style-type: none"> ◆ Ask pupils to explore what happens to the pH when a solution of an acid is added drop by drop to a solution of an alkali. Challenge pupils to predict what will happen if more acid is added, or if alkali is added to an acid, and test their predictions using a pH monitor and datalogger. 	<ul style="list-style-type: none"> ◆ describe that when an acid is added to an alkali, the pH of the mixture falls and vice versa ◆ explain how to obtain a neutral solution ◆ find information in reference books, on CD-ROMs, or from databases 	<ul style="list-style-type: none"> ◆ ICT: pH logging using ICT could be used to record changes and generate a graph. ◆ Teachers may wish to emphasise that acidity and alkalinity are measured on a continuous scale. ◆ Extension: pupils could be asked to describe what computer-generated graphs show about the way pH changes as more alkali is added. ◆ Extension: pupils could be asked to investigate changes in temperature during neutralisation and be introduced to the idea that a chemical reaction is taking place.

Safety

- ◆ 0.4 mol dm⁻³ solutions of acid and alkali can be used. These may be irritant, so eye protection is needed.

Datalogging kit

- ◆ TI-73, TI-82, TI-83 or TI-83plus graphing calculator.
- ◆ CBL or CBL2.
- ◆ pH sensor.
- ◆ temperature sensor.
- ◆ TI-GRAPH LINK™ software and cable to link to computer.
- ◆ chembio application (TI-83 plus) or program group (TI-73, TI-82 and TI-83).
- ◆ optional but very useful! A ViewScreen™ with VS calculator to project calculator screen via an OHP.

Apparatus required

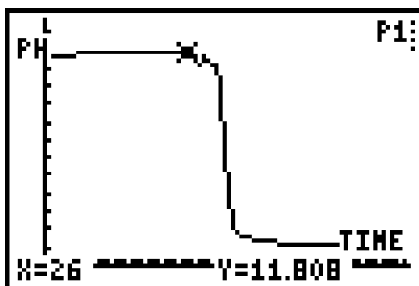
- ◆ distilled water, to keep the sensor in.
- ◆ 0.4 mol dm⁻³ hydrochloric acid.
- ◆ 0.4 mol dm⁻³ sodium hydroxide solution.
- ◆ buffer solutions (pH 4 and 10) for calibration.
- ◆ a suitable indicator to add to the sodium hydroxide solution, eg universal indicator solution.
- ◆ a plastic tap fitted into a plastic funnel to deliver the acid drop wise; a simple and effective method for demonstration or for young students to use! The tap needs to be eased with oil before use.
- ◆ alternatively, the acid can be added drop by drop with a pipette.
- ◆ optional: a magnetic stirrer.
- ◆ standard glassware.

Useful web sites

www.ti.com/calc/docs/graph.htm
www.vernier.com
www.oxford-educational.co.uk
www.qca.org.uk

Activity:
Adding Acid to an Alkali.

This suggested activity will generate a graph showing the change in pH as hydrochloric acid is added to sodium hydroxide solution, and can be compared to the colours obtained with the indicator.



Example of graph obtained.

1. Attach the calculator to the CBL/CBL2.
2. Take the pH sensor out of the storage fluid and place in a conical flask of distilled water for several minutes. Attach the sensor to channel 1 of the CBL/CBL2.
3. Open the chembio application/program and press enter to get to the following screen:-

```

***MAIN MENU***
1:SET UP PROBES
2:COLLECT DATA
3:VIEW GRAPH
4:VIEW DATA
5:FIT CURVE
6:RETRIEVE DATA
7:QUIT
  
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4. Select SET UP PROBES and follow the on screen prompts to place the pH sensor in channel 1.
5. On the CALIBRATION screen, select 2: PERFORM NEW. Take the sensor out of the distilled water and place in the pH4 buffer solution. Shake until a stable voltage is obtained.

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MONITOR VOLTAGE
                2.424
WHEN STABLE PUSH
[+]
ENTER REFERENCE:
4
  
```

*This is the calculator screen shot when using the CBL2.
 With the CBL, the voltage appears on the CBL screen.*

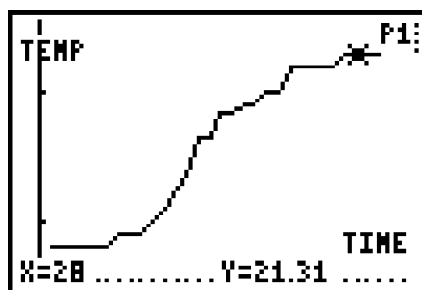
6. Press [+] when stable, and enter the pH reference 4.
7. Place the sensor in distilled water and then into pH10 buffer for the second calibration point.

8. Select 2: COLLECT DATA from the MAIN MENU.
9. Select 2: TIME GRAPH.
10. For the sampling, 60 samples @ one second intervals works well..
11. Then selecting 1: USE TIME SETUP, set Ymin=1;Ymax=14; Yscl =1.
12. Wash the sensor in distilled water and then in a little of the alkali, and place in a small conical flask containing 20 cm³ of sodium hydroxide solution. Shake for 30 seconds. Add 30 cm³ of hydrochloric acid to the funnel.
13. PRESS [ENTER] TO BEGIN COLLECTING DATA.
14. The tap needs to be adjusted to a fairly fast drip rate and the flask needs to be shaken constantly.

A real-time graph appears on the calculator screen, and at the end of the sampling period press enter and the final graph appears. Using the TI-GRAPH LINK™ program, the screen can be ‘grabbed’ and either printed or copied to the clipboard. The lists of data can also be transferred, saved as .txt files and then opened in spreadsheet applications.

Recording Temperature.

A temperature sensor can be included in this activity but, as the acid is added drop wise to a relatively large volume of alkali, the rise in temperature is small. What is more effective is a second activity where 20 cm³ of the hydrochloric acid is poured quickly into a small beaker containing a temperature sensor and 20 cm³ of the alkali.



Graph showing a rise of 1.50 °C.

Possible Extension Work.

- ◆ A weak acid-strong base ‘titration’ using a “household” acid such as ethanoic acid in vinegar.
- ◆ Investigating the effect of dilution on pH using 0.4 mol dm⁻³ hydrochloric acid.
- ◆ Adding pH values to a range of colours shown by universal indicator solution or paper.

These activities fit well into the unit specification.

Links

- ◆ Further opportunities to use pH sensors include *Unit 9E Reactions of metals and metal compounds* (reactions between acids and metal oxides) and *Unit 9G Environmental Chemistry* (testing a range of solutions for pH).