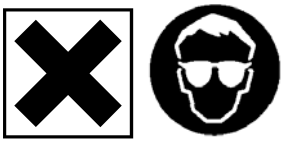
The action of a buffer solution

Aims



You will compare the effects of adding small amounts of acid and alkali to buffered and unbuffered solutions of the same pH. The unbuffered solution is simply de-ionised water. The buffer solution has been prepared by mixing solutions of sodium dihydrogenphosphate (NaH_2PO_4) and disodium hydrogenphosphate (Na_2HPO_4) in the correct proportions to obtain pH 7.

Apparatus

Safety goggles	2 x 100cm^3 beakers	pH indicator paper
Bench mats	1 x 25cm^3 transfer pipette	Buffer solution, pH 7
2 x burettes with stand	1 x pipette filler	0.1M sodium hydroxide ☒
2 x plastic funnels	pH probe	0.1M hydrochloric acid ☒
1 x 100cm^3 conical flask	Glass rod	
1 x 50cm^3 beaker	White tile	

Methods

1. Following the usual precautions, fill one burette with 0.1M NaOH solution and the other with 0.1M hydrochloric acid. Transfer 25cm^3 of the buffer solution to the 50cm^3 beaker.
2. Rinse the pH probe with de-ionised water from the wash bottle, then put it into the beaker. Make sure that the glass bulb is completely immersed, then set the meter to 7.00.
3. Using the correct burette, add **one drop** of 0.1M NaOH solution. Stir gently to ensure thorough mixing and record the pH in a suitable table.
4. Add more 0.1M NaOH to make the total volume added 1.00cm^3. Stir and record the pH.
5. Add more 0.1M NaOH to make the total volume added 5.00cm^3. Stir and record the pH. Rinse the electrode in distilled water and stand it in a flask of distilled water.
6. Take another 25cm^3 portion of buffer. Repeat steps 2 - 5, but using 0.1M hydrochloric acid.
7. Repeat steps 2 - 6, but using pure water instead of the buffer solution.

   Note: Rinse the electrode and beaker carefully to ensure that the starting value is between pH 6.00 and 7.00 (it is unlikely to be exactly pH 7.00 as it will aborb carbon dioxide from the air).

Analysis

1. Describe the differences between the behaviour of the buffer solution, and the pure water, upon the addition of alkali.
2. By how much does the pH of 25cm^3 of water change for the addition of 1.00cm^3 of 0.1M HCl?
3. Calculate: $$\frac{[H^+(aq)] \text{ after addition of } 1.00\text{cm}^3 \text{ of } 0.1\text{M HCl to pure water}}{[H^+(aq)] \text{ in pure water}}$$

   By contrast, the addition of 1.00cm^3 of 0.1M HCl to 25cm^3 of the buffer solution should decrease the pH by about 0.1 (corresponding to increasing $[H^+(aq)]$ by a factor of only about 1.25). The same number of H^+ ions were added to both solutions, so what must have happened to most of the H^+ ions added to the buffer?

