Buffers and pH titration curves

OCR A H432 · Full A-level

Answer on your own paper. Show your working where needed.

1. An ethanoic acid buffer

An aqueous mixture contains ethanoic acid and sodium ethanoate. Explain how it resists a small pH change if strong acid is added. Then explain what happens if strong base is added to a fresh sample. Include ionic equations.

2. Find a buffer pH

A buffer contains 0.300 mol dm^{-3} HA and 0.150 mol dm^{-3} A^-. The pKa of HA is 4.75. Calculate the pH.

3. Ethanoic acid mixed with sodium hydroxide

Mix 40.0 cm^3 of 0.200 mol dm^{-3} ethanoic acid with 15.0 cm^3 of 0.200 mol dm^{-3} NaOH. For ethanoic acid, pKa = 4.76.

Calculate the pH of the mixture and explain why it can act as an acidic buffer.

4. A small acid addition

A buffer initially contains 0.00800 mol HA and 0.0120 mol A^-. The pKa of HA is 3.75. Add 0.00100 mol H^+ from a strong acid.

Calculate the pH before and after the addition.

5. Find Ka from titration readings

A weak monoprotic acid is titrated with NaOH. The equivalence volume is 25.0 cm^3. The pH values are 4.30 at 6.25 cm^3, 4.78 at 12.5 cm^3 and 5.26 at 18.75 cm^3.

Select the reading that lets you obtain pKa directly and explain your choice. Calculate Ka.

6. A titration curve and an indicator

Volume of added alkali / cm^3: 0.0, 10.0, 20.0, 24.8, 25.0, 25.2, 30.0. Corresponding pH: 2.9, 4.6, 5.4, 6.9, 8.7, 10.6, 12.0.

Sketch the curve. Use it to choose an indicator from methyl orange (pH 3.1-4.4), methyl red (4.4-6.2) and phenolphthalein (8.3-10.0). Justify your choice.

7. Carbonic acid and hydrogencarbonate

Blood plasma contains a carbonic acid-hydrogencarbonate buffer. Write the equilibrium for the conjugate pair.

Explain how the buffer limits a pH decrease when an acid is added and a pH increase when a base is added. Give an ionic equation for each addition.

8. A buffer at a target pH

Prepare a buffer from 0.0240 mol ethanoic acid and anhydrous sodium ethanoate, M_r = 82.0. The acid has pKa = 4.76.

Calculate the mass of salt needed for pH 5.06. Calculate the new pH after adding 0.00150 mol OH^-.

9. Extra challenge · Two buffers with the same starting pH

Two buffers use HA with pKa = 4.76. Buffer X contains 0.00400 mol HA and 0.00800 mol A^-. Buffer Y contains 0.0200 mol HA and 0.0400 mol A^-.

Calculate their initial pH and their pH after adding 0.00250 mol H^+ to each. Use the results to explain which buffer better resists the pH change.

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