Chemistry with Chloe

AQA A Level Chemistry — 3.1 Physical Chemistry

3.1.12 Acids and Bases

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★ A-LEVEL ONLY — not examined at AS level

3.1.12.1 *Brønsted–Lowry acids (proton donors) and bases (proton acceptors). Conjugate pairs.*

Acid: proton (H■) donor. Base: proton (H■) acceptor.

Acid–base reactions = proton transfer.

Conjugate pair: differs by one H■. E.g. HA/A■ and H■O/H■O■.

3.1.12.2 *pH = –log■■[H■]. Calculate pH of strong acids from concentration.*

pH = –log■■[H■] and [H■] = 10■■■

For strong monobasic acid (e.g. HCl): [H■] = concentration of acid (fully dissociated). pH = –log(conc).

3.1.12.3 *Ionic product of water Kw = [H■][OH■]. Calculate pH of strong bases.*

Kw = [H■][OH■] = 1.00 × 10■¹■ mol² dm■■ at 25°C.

For strong base: [OH■] = conc of base → [H■] = Kw / [OH■] → pH = –log[H■].

Kw increases with temperature (dissociation is endothermic).

3.1.12.4 *Weak acids and Ka. pKa = –log Ka. Calculate pH of weak acids.*

Ka = [H■][A■] / [HA]

Assumptions: [H■] = [A■]; [HA] ≈ initial concentration (negligible dissociation).

[H■] = √(Ka × [HA]), then pH = –log[H■].

pKa = –log Ka; Ka = 10■■■■. Lower pKa = stronger weak acid.

3.1.12.5 *pH curves for all combinations of strong/weak acids and bases. Select indicators from pH curves.*

Strong acid + strong base: sharp vertical section at pH 7. Use phenolphthalein OR methyl orange.

Weak acid + strong base: equivalence pH > 7. Buffer region before equivalence. Use phenolphthalein ONLY.

Strong acid + weak base: equivalence pH < 7. Use methyl orange ONLY.

Weak acid + weak base: no sharp change. No suitable indicator.

Indicator choice: pKa of indicator must fall within the steep vertical section.

Phenolphthalein: colourless → pink (~8–10). Methyl orange: red → yellow (~3–5).

3.1.12.6 *Buffer solutions: definition, action, pH calculation.*

Buffer: resists pH change on addition of small amounts of acid or base.

Acidic buffer: weak acid + conjugate base (e.g. CH■COOH + CH■COONa).

Action: added H■ reacts with A■; added OH■ reacts with HA.

[H■] = Ka × [HA] / [A■], then pH = –log[H■].

Or: pH = pKa + log([A■] / [HA]) — Henderson–Hasselbalch.

At half-equivalence point: [HA] = [A■], so pH = pKa.

★ REQUIRED PRACTICAL RP9

Investigate pH Changes During Acid–Base Titrations

Method: Calibrate pH meter with buffer solutions (e.g. pH 4.00 and 7.00). Pipette 25.0 cm³ acid into beaker. Record initial pH. Add base from burette in 1 cm³ increments, record pH after each. Near equivalence point: 0.1–0.2 cm³ increments. Continue to 50 cm³ total. Plot pH vs volume. Identify equivalence point and buffer region.

Uncertainties: pH meter ±0.01; burette ±0.05 cm³; pipette ±0.06 cm³; temperature affects Kw.

Common errors: pH meter not calibrated; insufficient mixing; too-large increments near equivalence; CO■ from air dissolving in base.

Improvements: calibrate immediately before use; swirl and wait for stable reading; 0.1 cm³ increments near equivalence; magnetic stirrer; record temperature.