

Strong and weak acids, bases and pH

AP Chemistry · Worksheet

Name: _____ Date: _____ Class: _____

These problems train the full toolkit for Unit 8 of AP Chemistry: pH and pOH, strong and weak acids and bases, K_a and K_b , and the 5 % check. They also suit first-year university and A Level chemistry.

Start with the level 1 problems, which use logarithms and strong species. Level 2 problems need ICE tables, and the last five are level 3 problems with approximations that can fail, mixtures and explanations.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 8

Problem 1 pH of a strong acid (easy)

Aarav in Pune prepares 0.0100 mol/dm^3 HCl for a school titration.

1. Calculate $[\text{H}_3\text{O}^+]$.
2. Calculate the pH.

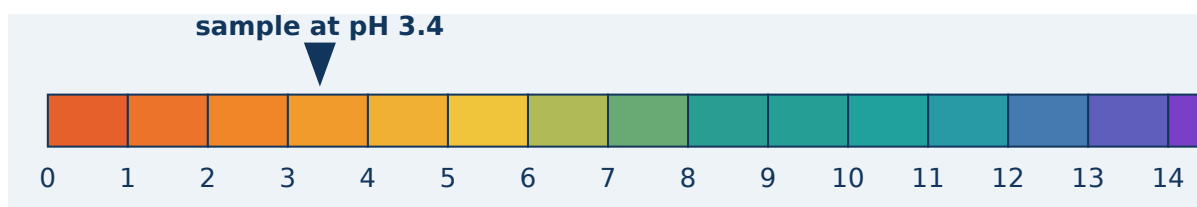
Problem 2 pH of a strong base (easy)

Chiamaka in Lagos dissolves NaOH to make 0.0030 mol/dm^3 .

1. Calculate pOH.
2. Calculate pH at 25°C .

Problem 3 Hydronium from pH (easy)

A rainwater sample in Leeds has pH 3.40.



Position of the rainwater sample on the pH scale.

1. Calculate $[\text{H}_3\text{O}^+]$.
2. State how many times larger it is than in neutral water at 25°C .

Problem 4 Classify the species (easy)

Classify each as strong acid, weak acid, strong base or weak base: HNO_3 , HF, NH_3 , KOH,

CH_3COOH , HBr .

Problem 5 Calcium hydroxide (easy)

Diego in Texas makes 0.050 mol/dm^3 $\text{Ca}(\text{OH})_2$ solution.

1. Calculate $[\text{OH}^-]$.
2. Calculate the pH.

Problem 6 Conjugate pairs (easy)

In the reaction $\text{HCO}_3^- + \text{NH}_3 \rightleftharpoons \text{CO}_3^{2-} + \text{NH}_4^+$, identify the two conjugate acid-base pairs.

Problem 7 Dilution of a strong acid (medium)

Emma in Leeds pipettes 10.0 cm^3 of 0.50 mol/dm^3 HCl into a 500 cm^3 volumetric flask and fills to the mark.

1. Calculate the new concentration.
2. Calculate the pH.

Problem 8 Neutral water at 50°C (medium)

At 50°C , $K_w = 5.5 \times 10^{-14}$.

1. Calculate $[\text{H}_3\text{O}^+]$ in pure water.
2. Calculate its pH.
3. Explain why the water is still neutral although pH is not 7.

Problem 9 Hydrocyanic acid (medium)

HCN is a weak acid with $K_a = 4.9 \times 10^{-10}$. Calculate the pH of a 0.10 mol/dm^3 solution.

Problem 10 Fluoride as a base (medium)

The K_a of HF is 6.8×10^{-4} .

1. Calculate $\text{p}K_a$ of HF .
2. Calculate K_b of F^- .
3. Calculate $\text{p}K_b$ of F^- .

Problem 11 HCl against ethanoic acid (medium)

Compare 0.10 mol/dm^3 HCl with 0.10 mol/dm^3 CH_3COOH ($K_a = 1.8 \times 10^{-5}$).

1. Calculate the pH of each.
2. Explain why 25.0 cm^3 of each needs the same volume of 0.10 mol/dm^3 NaOH to neutralise.

Problem 12 Ka from a pH reading (medium)

A student measures pH 3.00 for 0.100 mol/dm³ of a weak monoprotic acid HA.

1. Calculate [H₃O⁺].
2. Calculate Ka.

Problem 13 Percent ionisation of HF (medium)

Wanjiru in Nairobi prepares 0.500 mol/dm³ HF (Ka = 6.8 × 10⁻⁴).

1. Calculate [H₃O⁺] with the shortcut.
2. Calculate the pH.
3. Calculate the percent ionisation.

Problem 14 Methylamine (medium)

CH₃NH₂ is a weak base with Kb = 4.4 × 10⁻⁴. Calculate the pH of a 0.40 mol/dm³ solution.

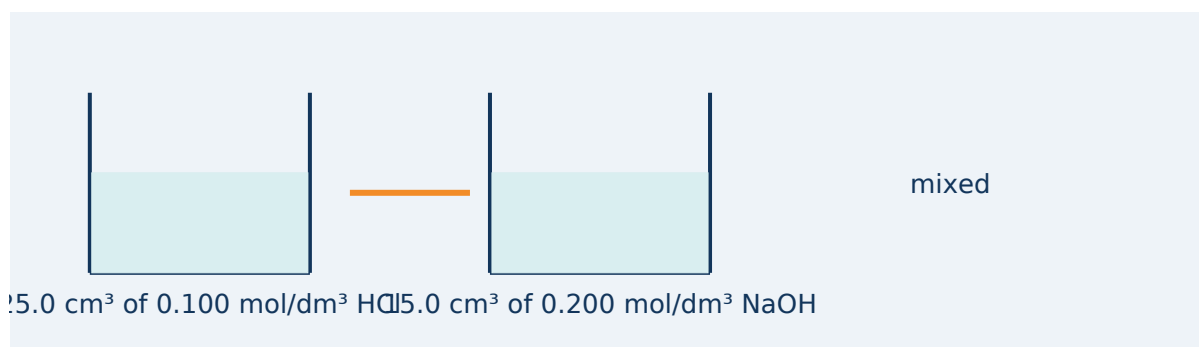
Problem 15 Ammonium chloride solution (medium)

Bilal in Lahore dissolves NH₄Cl to make 0.10 mol/dm³. Kb of NH₃ is 1.8 × 10⁻⁵.

1. Calculate Ka of NH₄⁺.
2. Calculate the pH.

Problem 16 Mixing acid and base (hard)

Mei in Singapore mixes 25.0 cm³ of 0.100 mol/dm³ HCl with 15.0 cm³ of 0.200 mol/dm³ NaOH.



The two solutions are poured together.

1. Calculate the amount of each reactant in mol.
2. Identify which is in excess and by how much.
3. Calculate the final pH.

Problem 17 When the shortcut fails (hard)

Calculate the pH of 0.0100 mol/dm³ HF (Ka = 6.8 × 10⁻⁴) in two ways.

1. Use $x = \sqrt{K_a \times C}$ and test the 5 % rule.
2. Solve the quadratic and compare the two pH values.

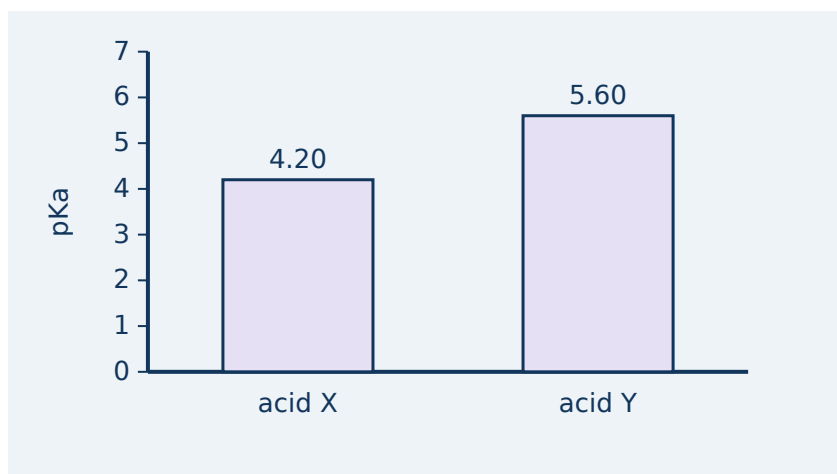
Problem 18 Very dilute acid (hard)

A student states that $1.0 \times 10^{-8} \text{ mol/dm}^3$ HCl has pH 8.00.

1. Explain why the claim cannot be right.
2. Calculate the actual pH, including the water ionisation.

Problem 19 Two weak acids (hard)

Acid X has pKa 4.20 and acid Y has pKa 5.60. Both solutions are 0.20 mol/dm^3 .



The two acids compared by pKa.

1. Calculate K_a of each.
2. Calculate the pH of each.
3. Calculate the ratio $[\text{H}_3\text{O}^+]_X / [\text{H}_3\text{O}^+]_Y$ and explain it.

Problem 20 Dilution and ionisation (hard)

Kofi in Accra dilutes 0.100 mol/dm^3 ethanoic acid ($K_a = 1.8 \times 10^{-5}$) tenfold to 0.0100 mol/dm^3 .

1. Calculate the pH before and after dilution.
2. Calculate the percent ionisation before and after.
3. Explain the trend using Le Chatelier's principle or Q.