

Strong and weak acids, bases and pH

AP Chemistry · Test answers (mark scheme)

Each model answer is followed by the marking guide. Award method marks even where the final value is wrong, and allow an error carried forward if later steps are consistent.

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

Question 1 Brønsted-Lowry base (2 marks)

- a. A proton acceptor.
- b. NH_4^+ .

Marking: 1 mark each.

Question 2 Strong acid pH (2 marks)

HI is strong, so $[\text{H}_3\text{O}^+] = 0.0042 \text{ mol/dm}^3$. $\text{pH} = -\log_{10}(0.0042) = \mathbf{2.38}$.

Marking: 1 mark for recognising complete ionisation, 1 mark for the pH value.

Question 3 Weak acid calculation (3 marks)

$K_a = x^2/0.250$, so $x = \sqrt{(4.5 \times 10^{-6})} = 2.121 \times 10^{-3} \text{ mol/dm}^3$. $\text{pH} = -\log_{10}(2.121 \times 10^{-3}) = \mathbf{2.67}$.

Marking: 1 mark for the K_a expression, 1 for x , 1 for the pH.

Question 4 Equal neutralisation (2 marks)

HCl ionises completely, HF only partly, so HCl has more H_3O^+ and a lower pH. Both have the same amount of acid in moles, and the unionised HF keeps ionising as OH^- removes H_3O^+ , so **both need the same NaOH volume**.

Marking: 1 mark for the pH explanation, 1 for the equal moles argument.

Question 5 Weak base calculation (3 marks)

- a. $x = [\text{OH}^-] = \sqrt{(1.8 \times 10^{-5} \times 0.150)} = 1.643 \times 10^{-3} \text{ mol/dm}^3$; $\text{pOH} = 2.78$; $\text{pH} = \mathbf{11.22}$.
- b. $K_a = 1.0 \times 10^{-14} / 1.8 \times 10^{-5} = \mathbf{5.6 \times 10^{-10}}$.

Marking: (a) 1 mark for $[\text{OH}^-]$, 1 for pH; (b) 1 mark.

Question 6 Comparing pH values (2 marks)

$[\text{H}_3\text{O}^+]$ in A = 10^{-3} and in B = 10^{-5} mol/dm³, so the ratio is **100**. A is more acidic.

Marking: 1 mark for the ratio, 1 for the conclusion.

Question 7 Ranking three acids (3 marks)

a. Lowest pH means most H_3O^+ at equal concentration: **P, then Q, then R**.

b. $[\text{H}_3\text{O}^+] = 10^{-2.20} = 6.31 \times 10^{-3}$ mol/dm³; $K_a = (6.31 \times 10^{-3})^2 / (0.100 - 6.31 \times 10^{-3}) =$
 4.2×10^{-4} .

Marking: (a) 1 mark; (b) 1 mark for $[\text{H}_3\text{O}^+]$, 1 for K_a .

Question 8 Acidic and basic salts (3 marks)

NH_4^+ is the conjugate acid of a weak base: $\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$, so the solution is **acidic**. CH_3COO^- is the conjugate base of a weak acid: $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$, so the solution is **basic**. Cl^- and Na^+ do not react with water.

Marking: 1 mark per equation, 1 mark for stating that Na^+ and Cl^- are spectators.