

8.11 pH and Solubility

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS pH 值 • acid 酸 • conjugate base 共轭碱 • weak acid 弱酸 • base 碱

Objective

Build the skills to answer exam questions on **pH and solubility** — how acid affects solubility.

You must be able to:

- explain why salts of **weak-acid anions** dissolve more in acid
- use Le Chatelier on the solubility equilibrium
- predict the effect of lowering pH

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Acid dissolves basic-anion salts

If a salt's anion is the conjugate base of a **weak acid** (e.g. CO_3^{2-} , F^- , OH^-), adding acid removes that anion (it reacts with H^+), so **more** salt dissolves.

■ The Le Chatelier view

$\text{CaCO}_3(s) \rightleftharpoons \text{Ca}^{2+} + \text{CO}_3^{2-}$. Add H^+ : it consumes CO_3^{2-} (forming $\text{HCO}_3^-/\text{H}_2\text{CO}_3$), so the equilibrium shifts **right** — more solid dissolves.

■ No effect for strong-acid anions

Salts whose anion is from a **strong** acid (e.g. Cl^- , NO_3^-) are **not** affected by pH — those anions do not react with H^+ .

■ A worked prediction

$\text{Mg}(\text{OH})_2$ dissolves more in acid: H^+ removes OH^- , shifting the dissolution right. AgCl is unaffected by pH (Cl^- is a spectator).

2 Practice

Now apply the methods above.

2.1 Does adding acid increase the solubility of CaCO_3 ? [1]

2.2 Why is AgCl solubility unaffected by pH? [1]

2.3 Adding H^+ to a hydroxide salt removes which ion? [1]

3 Exam-style questions

3.1 Lowering the pH increases the solubility of a salt whose anion is [1]

- **A** the conjugate base of a weak acid
 - **B** from a strong acid
 - **C** a metal
 - **D** always insoluble
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3.2 Consider $\text{CaF}_2(s) \rightleftharpoons \text{Ca}^{2+} + 2\text{F}^-$. Acid is added.

(a) State the effect on solubility. [1]

(b) Explain using Le Chatelier's principle (note F^- is a weak-acid anion). [2]

3.3 Explain why NaCl solubility does not change with pH but $\text{Mg}(\text{OH})_2$ does. [2]

Solutions

2.1 Yes.

2.2 Cl^- is the anion of a strong acid, so it does not react with H^+ .

2.3 OH^- .

3.1 A — the conjugate base of a weak acid.

3.2 (a) It increases. (b) H^+ reacts with F^- to form HF, removing F^- ; the equilibrium shifts right to replace it, dissolving more CaF_2 .

3.3 Cl^- is a strong-acid anion that does not react with H^+ , so pH has no effect; OH^- reacts with H^+ , so lowering pH dissolves more $\text{Mg}(\text{OH})_2$.