Solubility Product Map

Cambridge International AS & A Level Chemistry · Topic 25 Equilibria · 25.1 Solubility product

1 Solubility equilibria

25.1.7

- **Sparingly soluble** salts
- Saturated: **solid ⇌ ions**
- $AgCl(s) \rightleftharpoons Ag^+ + Cl^-$
- A dynamic equilibrium
- Constant at one temperature



2 Writing K_{sp}

25.1.8

- $K_{sp} = [Ag^+][Cl^-]$
- Powers from the formula
- PbI_2: $[Pb^{2+}][I^-]^2$
- **No solid** term
- Units: $mol^2\ dm^{-6}$, $mol^3\ dm^{-9}$

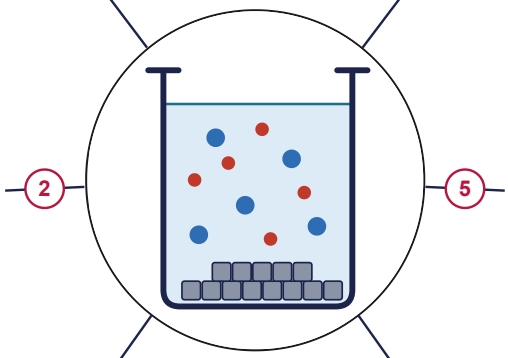


3 K_{sp} from solubility

25.1.9

- Each ion in terms of **s**
- 1 : 1: $K_{sp} = s^2$
- 1 : 2: $K_{sp} = 4s^3$
- g dm^{-3} ÷ M_r first
- CaF_2: $[F^-] = 2s$





4 Solubility from K_{sp}

25.1.9

- 1 : 1: $s = \sqrt{K_{sp}}$
- 1 : 2: $s = \sqrt[3]{(K_{sp} \div 4)}$
- Then each ion from s
- Compare K_{sp} only for
- the **same formula type**



5 Precipitation

25.1.9

- Concentrations **after mixing**
- Equal volumes: **halve**
- Ionic product with powers
- **> K_{sp}**: a precipitate
- ≤ K_{sp}: none



6 Common ion effect

25.1.10

- Shared ion: shifts **left**
- Less salt dissolves
- **K_{sp} unchanged**
- **$s = K_{sp} \div [ion]$**
- Squared ion: ÷ $[ion]^2$



Some solubility products at 298 K

solubility in water from s^2 (1 : 1) or $4s^3$ (1 : 2)

Salt	K_{sp} expression	K_{sp}	Solubility / mol dm^{-3}
AgCl	$[Ag^+][Cl^-]$	$1.77 \times 10^{-10}\ mol^2\ dm^{-6}$	1.33×10^{-5}
$BaSO_4$	$[Ba^{2+}][SO_4^{2-}]$	$1.08 \times 10^{-10}\ mol^2\ dm^{-6}$	1.04×10^{-5}
CaF_2	$[Ca^{2+}][F^-]^2$	$3.45 \times 10^{-11}\ mol^3\ dm^{-9}$	2.05×10^{-4}
PbI_2	$[Pb^{2+}][I^-]^2$	$8.79 \times 10^{-9}\ mol^3\ dm^{-9}$	1.30×10^{-3}
Ag_2CrO_4	$[Ag^+]^2[CrO_4^{2-}]$	$1.12 \times 10^{-12}\ mol^3\ dm^{-9}$	6.54×10^{-5}

Worked examples

K_{sp} from s

- CaF_2: $s = 2.14 \times 10^{-4}$
- $[F^-] = 4.28 \times 10^{-4}$
- **$K_{sp} = 3.92 \times 10^{-11}$**

Precipitate?

- equal volumes, 2.0×10^{-4} each
- Ag^+ and Cl^-: 1.0×10^{-8}
- **$> 1.77 \times 10^{-10}$: yes**

Common ion

- AgCl in 0.100 NaCl
- $s = 1.77 \times 10^{-10} \div 0.100$
- **1.77×10^{-9} mol dm^{-3}**

25.1 is complete: acids and pH, buffer solutions and the solubility product. Next: 25.2 Partition coefficients.

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