Solubility, Complex Ions, and Separation Models

g11_u04_w16

Purpose and boundary

Use original fictional equilibrium cards to compare saturation, precipitation predictions, and bounded separation claims. No chemicals, mixing, filtration, or procedure is requested.

Targets: I can write K_{sp}, compare Q_{sp} with K_{sp}, and state what a supplied complex-ion model can and cannot support. **Vocabulary:** solubility product, saturation, precipitate, common ion, complex ion. **Prerequisites:** equilibrium quotient, exponents, scientific notation.

1. For $MX(s) \rightleftharpoons M^+ + X^-$, write K_{sp}.

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2. Why is solid MX omitted from the expression?

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3. If $K_{sp} = 2.0 \times 10^{-6}$, $M^+ = .0010\,\text{M}$, $X^- = .0010\,\text{M}$, calculate Q_{sp}.

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4. In item 3, compare Q_{sp} and K_{sp}; predict saturation direction in the stated model.

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5. If $M^+ = .0040\,\text{M}$, $X^- = .0010\,\text{M}$, calculate Q_{sp} and prediction.

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6. Explain why $Q_{sp} > K_{sp}$ is a model prediction rather than a procedure instruction.

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7. For $M_2Y(s) \rightleftharpoons 2M^+ + Y^{2-}$, write K_{sp}.

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8. If $K_{sp} = 4.0 \times 10^{-12}$ and $Y^{2-} = .010\,\text{M}$, find the maximum M^+ concentration at saturation.

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9. A card gives $M^+ = 3.0 \times 10^{-5}\,\text{M}$, $Y^{2-} = .010\,\text{M}$. Calculate Q_{sp} and direction.

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10. Why does a coefficient of 2 become an exponent of 2 in item 7?

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11. A common-ion card raises X^- while holding a model K_{sp} fixed. Predict the direction of allowable M^+ change.

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12. State one limitation of treating concentrations as activities.

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13. A fictional complex model is $M^+ + L \rightleftharpoons ML^+$, $K_f = [ML^+]/([M^+][L])$. Write the expression in words.

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14. If a stated model binds free M^+ into ML^+, how can that change a Q_{sp} comparison? Keep the claim bounded.

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15. Name one additional measurement needed before claiming a real separation is selective.

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16. Two model ions have different K_{sp} values. Why is that alone insufficient to claim complete separation?

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17. A card reports $Q_{sp} = K_{sp}$. What equilibrium condition is represented?

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18. A card reports $Q_{sp} < K_{sp}$. Does it prove that no solid exists anywhere? Explain.

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19. Explain why a complex-ion equation does not automatically prove a coordination structure or mechanism.

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20. Write a bounded separation-model conclusion using Q_{sp}, K_{sp}, and one missing-evidence statement.
