AP Ksp practice

1994 A $MgF_2(s) \leftrightarrow Mg^{2+}(aq) + 2\ F^-(aq)$

In a saturated solution of MgF_2 at 18ºC, the concentration of Mg^{2+} is 1.21×10^{-3} molar. The equilibrium is represented by the equation above.

(a) Write the expression for the solubility-product constant, K_{sp}, and calculate its value at 18ºC.

(b) Calculate the equilibrium concentration of Mg^{2+} in 1.000 liter of saturated MgF_2 solution at 18ºC to which 0.100 mole of solid KF has been added. The KF dissolves completely. Assume the volume change is negligible.

(c) Predict whether a precipitate of MgF_2 will form when 100.0 milliliters of a 3.00×10^{-3}-molar $Mg(NO_3)_2$ solution is mixed with 200.0 milliliters of a 2.00×10^{-3}-molar NaF solution at 18ºC. Calculations to support your prediction must be shown.

(d) At 27ºC the concentration of Mg^{2+} in a saturated solution of MgF_2 is 1.17×10^{-3} molar. Is the dissolving of MgF_2 in water an endothermic or an exothermic process? Give an explanation to support your conclusion.

1987 A $NH_3 + H_2O <=> NH_4^+ + OH^-$

Ammonia is a weak base that dissociates in water as shown above. At 25ºC, the base dissociation constant, K_b, for NH_3 is 1.8×10^{-5}.

(a) Determine the hydroxide ion concentration and the percentage dissociation of a 0.150 molar solution of ammonia at 25ºC.

(b) Determine the pH of a solution prepared by adding 0.0500 mole of solid ammonium chloride to 100. mL of a 0.150 molar solution of ammonia.

(c) If 0.0800 mole of solid magnesium chloride, $MgCl_2$, is dissolved in the solution prepared in part (b) and the resulting solution is well-stirred, will a precipitate of $Mg(OH)_2$ form? Show calculations to support your answer. (Assume the volume of the solution is unchanged. The solubility product constant for $Mg(OH)_2$ is 1.5×10^{-11}).

1985 A

At 25ºC the solubility product constant, K_{sp}, for strontium sulfate, $SrSO_4$, is 7.6×10^{-7}. The solubility product constant for strontium fluoride, SrF_2, is 7.9×10^{-10}.

(a) What is the molar solubility of $SrSO_4$ in pure water at 25ºC?

(b) What is the molar solubility of SrF_2 in pure water at 25ºC?

(c) An aqueous solution of $Sr(NO_3)_2$ is added slowly to 1.0 litre of a well-stirred solution containing 0.020 mole F^- and 0.10 mole SO_4^{2-} at 25ºC. (You may assume that the added $Sr(NO_3)_2$ solution does not materially affect the total volume of the system.)

1. Which salt precipitates first?
2. What is the concentration of strontium ion, Sr^{2+}, in the solution when the first precipitate begins to form?

(d) As more $Sr(NO_3)_2$ is added to the mixture in (c) a second precipitate begins to form. At that stage, what percent of the anion of the first precipitate remains in solution?

Bonus question (from an actual freshman chem test)…

When blood is donated, a sodium oxalate solution is used to precipitate the Ca^{2+}, which triggers clotting. A 104mL sample of blood contains 9.7×10^{-5} g/mL of Ca^{2}+. A technologist treats he sample with 110.0mL of 0.1350M $Na_2C_2O_4$. Calculate the $[Ca^{2+}]$ after the treatment. $K_{sp}\ CaC_2O_4 = 2.3 \times 10^{-9}$

Qualitative analysis scheme for identification of metal ions in solution

Utilizes the

"solubility rules"

-selectively precipitate out groups of ions

TABLE 4.2 Solubility Rules for Common Ionic Compounds in Water at 25°C

Soluble Compounds	Exceptions
Compounds containing alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+)	
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Hg^{2+}, and Pb^{2+}
Insoluble Compounds	**Exceptions**
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^{2-}), sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion