General Chemistry II

RR # 13
Summer 2022

1. A solution is 1 x 10^{-4} M in NaI, Na_2SO_4, and Na_3PO_4. What would the order of precipitation be as a source of Pb^{2+} is added gradually to the solution? The relevant K_{sp} values are: K_{sp} PbI_2 = 8.5 x 10^{-9}; K_{sp} $PbSO_4$ = 1.8 x 10^{-8}; K_{sp} $Pb_3(PO_4)_2$ = 7.9 x 10^{-43}. (Hint: there is no need to use ICE charts here – try to determine where the K_{sp} is exceeded)

2. **Fill in the blanks in the following table. Both ΔH and ΔS refer to the system.**

ΔH	ΔS	ΔG	Low Temp	High temp
-	+	-	Spontaneous	
-	-	Temp. dependent		
+	+			
+	-		Non-spontaneous	Non-spontaneous

3. Calculate ∆H°, ∆S°, and ∆G° for the following reaction to determine if it is spontaneous at 25°C.

$$NH_4NO_3\ s \rightarrow NH_4^+\ aq + NO_3^-(aq)$$

Compound	ΔH_f° (kJ/mol)	ΔS° (J/K*mol)

NH_4NO_3 (s)	-365.56	151.08
NH_4^+ (aq)	-132.51	113.4
NO_3^-(aq)	-205.0	146.4

4. An unknown metal M forms an ionic hydroxide with the formula $M(OH)_2$ that exhibits the equilibrium…

$$M(OH)_2\,(s) \leftrightarrow M^{2+}\,(aq) + 2OH^-(aq)$$

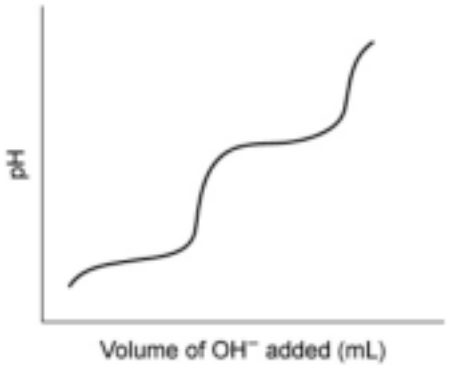
…in a saturated aqueous solution. If the solution pH is 10, what is the solubility product constant K_{sp} of the compound?

5. If the solubility product constant K_{sp} for $NaC_9H_7O_4$ is estimated to be 34.9, what is the approximate acetylsalicylate ion concentration in a saturated $NaC_9H_7O_4$ solution used for the reaction?

MCAT Style Questions

6. The figure below shows the titration curve for an acid titrated with aqueous sodium hydroxide. When titrated in solution, which of the following salts

would be most likely to produce a similar titration curve?



a. $(NH_4)_3PO_4$
b. KH_2PO_4
c. Na_2HPO_4
d. K_3PO_4

7. Suppose that citric acid ($H_3C_6H_5O_7$) is titrated with 0.1 M NaOH to form a citrate buffer solution with a pH of 4.5. What is the pH at the first equivalence point? (Note: $pK_a1 = 3.13$, $pK_a2 = 4.76$, $pK_a3 = 6.40$)

a) Less than 3.13
b) Between 3.13 and 4.76
c) Equal to 3.13
d) Greater than 4.76

8. Which of the following compound pairs, dissolved into solution at equal concentrations, will function as a buffer?

a) CH_3COOH (aq) and CH_3COONa (aq)
b) HNO_3 (aq) and $NaNO_3$ (aq)
c) NaBr (aq) and NaCN (aq)
d) NaOH (aq) and NaCl (aq)

9. Consider a solution of magnesium hydroxide, $K_{sp} = 8.9 \times 10^{-12}$. solid magnesium hydroxide begins to precipitate when which of the following expressions is true? a) $[OH^-] < 1 \times 10^{-7}$
b) $[Mg^{2+}] = 8.9 \times 10^{-12}$
c) $[OH^-] = [Mg^{2+}]$
d) $[Mg^{2+}][OH^-]^2 > 8.9 \times 10^{-12}$

10.Suppose that a research technician wants to separate an aqueous mixture of CuF_2 and BaF_2 ($K_{sp} = 3.0 \times 10^{-6}$) by precipitating CuF_2 from the solution. What should be added to the solution to perform the separation?

a. $Cu(NO_3)_2$
b. NaF
c. $Ba(NO_3)_2$
d. H_2O