I. Multiple Choice Questions (96 pts)

There is only **one** correct answer for each of the following multiple-choice questions. **Circle the correct answer**. Each question is worth 8 points, and no partial credit will be given.

1. Ammonium chloride is used as an electrolyte in dry cells. Which of the following statements about a 0.10 M solution of NH₄Cl, is correct?

- A) The solution is weakly basic.
- B) The solution is strongly basic.
- C) The solution is neutral.
- D) The solution is acidic.

The values for K_a and K_b for the species in solution must be known before a prediction can be E) made.

2. A solution is prepared by adding 0.10 mol of lithium nitrate, LiNO₃, to 1.00 L of water. Which statement about the solution is correct?

- A) The solution is basic.
- B) The solution is neutral.
- C) The solution is weakly acidic.
- D) The solution is strongly acidic.

The values for K_a and K_b for the species in solution must be known before a prediction can be E) made.

3. An aqueous solution is prepared by dissolving the salt formed by the neutralization of a weak acid by a weak base. Which statement about the solution is correct?

- The solution is strongly basic. A)
- B) The solution is weakly basic.
- C) The solution is neutral.
- D) The solution is acidic.

The values for K_a and K_b for the species in solution must be known before a prediction can be E) made.

4. Which one of the following aqueous solutions, when mixed with an equal volume of 0.10 mol L^{-1} aqueous NH₃. will produce a buffer solution?

- A)
- B)
- $\begin{array}{l} 0.10 \mbox{ mol } L^{-1} \mbox{ HCl} \\ 0.20 \mbox{ mol } L^{-1} \mbox{ HCl} \\ 0.10 \mbox{ mol } L^{-1} \mbox{ CH}_3 \mbox{ COOH} \end{array}$ C)

- 0.050 mol L⁻¹ NaOH D)
- 0.20 mol L⁻¹ NH₄Cl E)
- 5. Which of the following acids should be used to prepare a buffer with a pH of 4.5?
 - HOC₆H₄OCOOH, $K_a = 1.0 \times 10^{-3}$ A)
 - B) $C_6H_4(COOH)_2, K_a = 2.9 \times 10^{-4}$
 - CH₃COOH, $K_a = 1.8 \times 10^{-5}$ C)
- D) $C_5H_5O_5COOH, K_a = 4.0 \times 10^{-6}$
- HBrO, $K_a = 2.3 \times 10^{-9}$ E)

Chemistry 1C Name:
Circle One: Section 01 or 02
6. What mass of NaF must be added to 50.0 mL of a 0.500 *M* HF solution to achieve a pH of 3.25? For HF,
$$K_a = 7.2 \times 10^{-4}$$
.

B) 0.69 g C) 6.9 g A) 1.3 g D) 23 g E) 1.5 g

7. Which one of the following is the best representation of the titration curve which will be obtained in the titration of a weak acid $(0.10 \text{ mol } \text{L}^{-1})$ with a strong base of the same concentration?



8. A 50.0-mL sample of 0.50 M HCl is titrated with 0.50 M NaOH. What is the pH of the solution after 28.0 mL of NaOH have been added to the acid?

A) 0.85 B) 0.75 C) 0.66 D) 0.49 E) 3.8

9. Which of the following substances has the greatest solubility in water?

A)	MgCO ₃ , $K_{\rm sp} = 3.5 \times 10^{-8}$	D)	CuBr, $K_{\rm sp} = 5.0 \times 10^{-9}$
B)	NiCO ₃ , $K_{sp} = 1.3 \times 10^{-7}$	E)	AgCN, $K_{\rm sp} = 2.2 \times 10^{-16}$

AgIO₃, $K_{\rm sp} = 3.1 \times 10^{-8}$ C)

Name:

10. A lab technician adds 0.20 mol of NaF to 1.00 L of 0.35 M cadmium nitrate, Cd(NO₃)₂. Which of the following statements is correct? $K_{sp} = 6.44 \times 10^{-3}$ for CdF₂. A) Cadmium fluoride precipitates until the solution is saturated.

- B) The solution is unsaturated and no precipitate forms.
- C) The solubility of cadmium fluoride is increased by the presence of additional fluoride ions.
- D) One must know K_{sp} for cadmium nitrate to make meaningful predictions on this system.
- The presence of NaF will raise the solubility of $Cd(NO_3)_2$. E)

11. Consider the following balanced redox reaction

 $Mn^{2+}(aq) + S_2O_8^{2-}(aq) + 2H_2O(l) \rightarrow MnO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq)$ Which of the following statements is true?

- $Mn^{2+}(aq)$ is the oxidizing agent and is reduced. A)
- B) $Mn^{2+}(aq)$ is the oxidizing agent and is oxidized.
- C) $Mn^{2+}(aq)$ is the reducing agent and is oxidized.
- D) $Mn^{2+}(aq)$ is the reducing agent and is reduced.
- Manganese does not change its oxidation number in this reaction. E)

12. A voltaic cell is prepared using copper and silver. Its cell notation is shown below. $\operatorname{Cu}(s) \mid \operatorname{Cu}^{2+}(aq) \parallel \operatorname{Ag}^{+}(aq) \mid \operatorname{Ag}(s)$

Which of the following processes occurs at the cathode?

- $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$ A)
- $\operatorname{Cu}^{2+}(aq) + 2e^{-} \rightarrow \operatorname{Cu}(s)$ B)
- $Ag(s) \rightarrow Ag^+(aq) + e^-$ C)
- $Ag^+(aq) + e^- \rightarrow Ag(s)$ D)
- $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$ E)

II. Problem Solving (54 pts)

To receive full credit you must **show all of your work**. Answers that do not have **correct** supporting calculations will receive **zero** credit. Make sure that your answers contain the proper number of significant figures as well as the correct units. **Place your final answer for each question in the box provided.**

1. The solubility of magnesium phosphate is 2.27×10^{-3} g/1.0 L of solution. What is the K_{sp} for Mg₃(PO₄)₂? (14 points)

See posted picture.

Answer



2. Balance the following reaction in basic solution. (16 points) $MnO_4^-(aq) + \Gamma(aq) \rightarrow MnO_2(s) + I_2(aq)$ (basic solution)

See posted picture.

Answer

- 3. Propanoic acid (CH₃CH₂COOH) has a K_a of 1.34×10^{-5} . A 25.00 mL sample of 0.1000 mol L⁻¹ propanoic acid (in flask) is titrated with 0.1000 mol L⁻¹ NaOH solution, added from a buret. Carry out the calculations of the quantities indicated below. (24 points)
- a. The pH after 15.00 mL of NaOH are added.

See posted picture.

b. The pH after 25.00 mL of NaOH are added.

See posted picture.

Answer

Answer

c. The pH after 26.00 mL of NaOH are added.

See posted picture.

Name:

$$K_{w} = [H_{3}O^{+}][OH^{-}] = 1.0 \times 10^{-14} \quad pH = -\log [H_{3}O^{+}] \qquad pOH = -\log [OH^{-}] \qquad K_{a} \times K_{b} = K_{w}$$

$$pH + pOH = 14.00 \qquad pK_{a} = -\log K_{a} \qquad pK_{b} = -\log K_{b} \qquad pK_{w} = pK_{a} + pK_{b} = 14.00$$

pH= pK_a + log ([conjugate base]/[weak acid])

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