Spring 2009 CH302 Practice Exam 2

1. What would be the pH of a solution prepared by dissolving 120.1 g of CH_3COOH and 82 g of $NaCH_3COO$ in 1 L of water? Acetic acid has a K_a of 1.8×10^{-5}.
   1. 5.05
   2. 4.78
   3. 4.12
   4. 4.44

2. Which of the following pairs of solutions would **not** result in a buffer upon mixing?
   1. 100 mL of 10 mM NaOH & 80 mL of 20 mM NH_4Cl
   2. 20 mL of 0.3 M NaF & 12 mL of 0.4 M HCl
   3. 0.4 L of 10 mM $HClO_3$ & 0.5 L of 8 mM $C_6H_5NH_2$
   4. 2 L of 1.35 M $Ba(OH)_2$ & 3 L of 2 M CHOOH

Explanation: A buffer prepared by a neutralization reaction requires a weak acid mixed with less strong base or a weak base mixed with less strong acid. The only pair of solutions which fails to satisfy this constraint is 0.4 L of 10 mM HClO3 and 0.5 L of 8 mM $C_6H_5NH_2$.

3. Consider the following acids and their provided pK_as. Rank them in terms of increasing strength of their conjugate bases.

   CH_3COOH $pK_a = 4.75$

   $CH_3CHOHCOOH$ $pK_a = 3.85$

   CHOOH $pK_a = 3.74$

   CH_3CH_2COOH $pK_a = 4.88$

   1. CHOOH < $CH_3CHOHCOOH$ < CH_3COOH < CH_3CH_2COOH
   2. CH_3CH_2COOH < CHOOH < $CH_3CHOHCOOH$ < CH_3COOH
   3. CH_3COOH < CH_3CH_2COOH < CHOOH < $CH_3CHOHCOOH$
   4. $CH_3CHOHCOOH$ < CH_3COOH < CH_3CH_2COOH < CHOOH

4. Which of the following buffers could absorb the greatest amount of strong base before being exhausted?
   1. 45 mL of 2 mM N_2H_5Cl, 4 mM N_2H_4
   2. 3.2 L of 0.4 M HClO, 0.5 NaClO
   3. 2 L of 9 mM HF, 7 mM NaF
   4. 0.3 L of 0.4 M NH_4Cl, 0.6 M NH_3
   5. 20 mL of 5 M CHOOH, 4 M NaCHOO

5. If one added 200 mL of 6 M HCl to 1 L of a buffer composed 4.2 M CH_3COOH and 6.6 M $NaCH_3COO$, what would be the resulting pH? The K_a of CH_3COOH is 1.8×10^{-5}.
   1. 5.3
   2. 4.9
   3. 5.1
   4. 4.7

6. How many buffer regions and equivalence points would be visible on the titration curve of a weak tetraprotic acid?
   1. 3, 1
   2. 3, 4
   3. 1, 4
   4. 4, 1
   5. 4, 4

7. A 100 mL sample of 0.1 M H_3PO_4 is titrated with 0.2 M NaOH. What is the pH of the solution after 100 mL of NaOH has been added? Phosphoric acid has $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$ and K_{a3} =

2.1×10^{-13}.

1. 4.10
2. 8.51
3. 4.67
4. 7.40
5. 9.94

8. What will be the pH at the first equivalence point of a titration of 0.2 M H_2SO_4 with 0.2 M NaOH? The K_a for HSO_4^- is 2×10^{-2}.

1. 1.45
2. 1.35
3. 7.00
4. not enough information

9. All of the salts below have the same **approximate** molar solubility except for one. Which is it?

1. TlBr $K_{sp} = 4.00 \times 10^{-6}$
2. PbI_2 $K_{sp} = 7.47 \times 10^{-9}$
3. AgSCN $K_{sp} = 1.16 \times 10^{-12}$
4. $CsIO_4$ $K_{sp} = 5.16 \times 10^{-6}$

10. The K_{sp} of $MgNH_4PO_4$ at 25 °C is 2.5×10^{-13}. What is its molar solubility at this temperature? (Hint: do the RICE diagram for this one.)

1. 3.2×10^{-4}
2. 4.0×10^{-5}
3. 6.3×10^{-5}
4. 1.2×10^{-3}

11.2 What would be the molar solubility of $Sn(OH)_2$ ($K_{sp} = 10^{-26}$) in pH 13 NaOH solution?

1. 1×10^{-24}
2. 4×10^{-24}
3. 1×10^{-28}
4. 4×10^{-28}
5. not enough information

12. Consider the table below. Which anion would be the best for separating Pb^{2+} from Ca^{2+}? Which would be the worst?

K_{sp} values	$C_2O_4^-$	CO_3^{2-}	SO_4^{2-}	IO_3^-
Pb^{2+}	2.74×10^{-11}	3.3×10^{-14}	1.6×10^{-8}	1.2×10^{-13}
Ca^{2+}	2.57×10^{-9}	8.7×10^{-9}	4.93×10^{-5}	6.44×10^{-7}

1. $C_2O_4^-$ & SO_4^{2-}
2. IO_3^- & SO_4^{2-}
3. CO_3^{2-} & IO_3^-
4. IO_3^- & $C_2O_4^-$
5. CO_3^{2-} & $C_2O_4^-$

13. A student used the equation $[H^+] = (K_a \cdot C_a)^{1/2}$ to calculate $[H^+]$ and got a value of 0.4 M. The actual value was determined experimentally to be 0.35 M. Which of the following are possible

explanations for this discrepancy?

I. K_a was too small

II. K_a was too large

III. C_a was too small

1. I only
2. II only
3. III only
4. I & II
5. I & III
6. II & III
7. none

14. For a solution of H_3PO_4, addition of Na_2HPO_4 will increase the concentration of which of the following species?

I. H_3PO_4

II. $H_2PO_4^-$

III. PO_4^{3-}

1. I only
2. II only
3. III only
4. I & II
5. I & III
6. II & III
7. I, II and III

15. Determine the pH of a 5 M solution of Na_2HPO_4. Assume H_3PO_4 has a pK_{a1} of 2.1, a pK_{a2} of 7.2 and a pK_{a3} of 12.7.

1. 9.95
2. 4.65
3. 7.4
4. not enough information

16. Write a mass balance for carbon for a solution that initially contains H_2CO_3.

1. $C_{H2CO3} = [HCO_3^-] + [CO_3^{2-}]$
2. $C_{H2CO3} = [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
3. $C_{H2CO3} = [CO_2] + [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
4. $C_{H2CO3} = [CO_2] + [H_2CO_3]$

17. How many equation are necessary to define a system initially composed of $MgNH_4PO_4$?

1. 9
2. 8
3. 7
4. 5

18. Which of the following would be equal to K_{a1} times K_{a2} for orthocarbonic acid, H_4CO_4?

1. $[H_2CO_4^{2-}]\cdot[H^+]/[H_4CO_4]$
2. $[H_3CO_4^-]\cdot[H^+]/[H_4CO_4]$
3. $[H_2CO_4^{2-}]\cdot[H^+]/[H_3CO_4^-]$
4. $[H_2CO_4^{2-}]\cdot[H^+]\cdot[H_3CO_4^-]/[H_4CO_4]$
5. $[H_2CO_4^{2-}]\cdot[H^+]^2/[H_4CO_4]$

19. What would be the pH of a 2 x 10^{-8} M solution of $Ba(OH)_2$?

1. 7.009
2. 7.019
3. 7.013
4. 7.004

20. What would be the $[H^+]$, $[HSO_4^-]$ and $[SO_4^{2-}]$ in a 1 M solution of H_2SO_4?

1. 1.02, 0.98, 0.02 M, respectively
2. 0.00, 2.00, 1.00 M, respectively
3. 1.14. 0.86, 0.14 M, respectively
4. 0.14, 1.00, 0.14 M, respectively

21. What would be the pH of a 4 mM M $Na_3C_6H_5O_7$ solution (trisodium citrate)? Citric acid has K_{a1} = 7.1 x 10^{-4}, K_{a2} = 1.7 x 10^{-5} and K_{a3} = 4.0 x 10^{-7}.

1. 6.62
2. 5.00
3. 9.00
4. 7.38
5. 7.00

22. Fully balance the reaction below in acid. How many protons are needed? How many water molecules? (Hint: this one is tricky - the water molecules and protons go on the same side.)

$N_2(g) \rightharpoonup 2\ NH_4OH(aq)$

1. 3, 1
2. 6, 2
3. 2, 2
4. 8, 2
5. 8, 1

23. Fully Balance the reaction below in acid. What is the sum of the coefficients?

$Zn(s) + MnO_2(s) + NH_4Cl(aq) \rightharpoonup ZnCl_2(s) + Mn_2O_3(s) + NH_3(aq)$

1. 7
2. 12
3. 6
4. 10
5. 9

24. Which of the following statements is untrue concerning ranking the strength/weakness of oxidizing/reducing agents.

1. A reactant with a high reduction potential is a good reducing reagent.
2. A product with a low reduction potential is a good reducing reagent.
3. A reactant with a low reduction potential is a poor oxidzing reagent.
4. A product wit a high reduction potential is a poor reducing agent.

25. If the two half reactions below were used to make a battery, what species would be consumed at the anode?

$Pb^{2+}(aq) + 2\ e^- \rightharpoonup Pb(s)$ $\quad E° = -0.13$

$Zn^{2+}(aq) + 2\ e^- \rightharpoonup Zn(s)$ $\quad E° = -0.76$

1. Zn(s)
2. $Zn^{2+}(aq)$
3. Pb(s)
4. $Pb^{2+}(aq)$

26. For a discharging battery, which of the following must be negative?

I. $E°_{cell}$

II. anode

III. cathode

1. I only
2. II only
3. III only
4. I & II
5. I & III
6. II & III
7. none must be negative

27. What would be the $E°_{cell}$ of an electrolytic cell made from the following two half reactions?

$Pb^{2+}(aq) + 2\ e^- \rightharpoonup Pb(s)$ $E° = -0.13$

$Zn^{2+}(aq) + 2\ e^- \rightharpoonup Zn(s)$ $E° = -0.76$

1. -0.89
2. 0.89
3. 0.63
4. -0.63

28. What is K for the reaction below at room temperature?

$O_2(g) + 2H_2O(l) \rightharpoonup 4OH^-(aq)$ $E° = 0.40$ V

1. 1.72×10^{-7}
2. 5.82×10^{6}
3. 8.70×10^{-28}
4. 1.15×10^{27}

29. How many grams of solid silver (Ag) could be produce by electrolysing a solution of Ag+ for 10 hours at a current of 0.02 amperes?

1. 0.80 g
2. 2.24×10^{-5} g
3. 1.34×10^{-3} g
4. 0.016 g

30. What $[Pb^{2+}]$ and $[Sn^{2+}]$ would be present at equilibrium in in a battery built from the two half reactions below?

$Pb^{2+} \rightharpoonup Pb$ $E° = -0.13$

$Sn^{2+} \rightharpoonup Sn$ $E° = -0.14$

1. 0.629 M, 1.371 M
2. 1.371 M, 0.629 M
3. 0.808 M, 1.192 M
4. 1.192 M, 0.808 M