

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} .

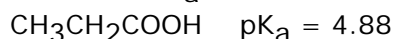
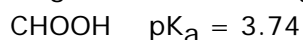
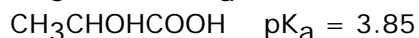
1. 5.05
2. 4.78
3. 4.12
4. 4.44

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 $\text{C}_6\text{H}_5\text{NH}_2$
4. 2 L of 1.35 M $\text{Ba}(\text{OH})_2$ & 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 HClO_3 and 0.5 L of 8 mM $\text{C}_6\text{H}_5\text{NH}_2$.

3. Consider the following acids and their provided $\text{p}K_a$ s. Rank them in terms of increasing strength of their conjugate bases.



1. $\text{CHOOH} < \text{CH}_3\text{CHOHCOOH} < \text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{COOH}$
2. $\text{CH}_3\text{CH}_2\text{COOH} < \text{CHOOH} < \text{CH}_3\text{CHOHCOOH} < \text{CH}_3\text{COOH}$
3. $\text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{COOH} < \text{CHOOH} < \text{CH}_3\text{CHOHCOOH}$
4. $\text{CH}_3\text{CHOHCOOH} < \text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{COOH} < \text{CHOOH}$

4. Which of the following buffers could absorb the greatest amount of strong base before being exhausted?

1. 45 mL of 2 mM $\text{N}_2\text{H}_5\text{Cl}$, 4 mM N_2H_4
2. 3.2 L of 0.4 M HClO , 0.5 M 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 $\text{Sn}(\text{OH})_2$ ($K_{sp} = 10^{-26}$) 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 $[\text{H}^+] = (K_a \cdot C_a)^{1/2}$ to calculate $[\text{H}^+]$ 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. $C_{H_2CO_3} = [HCO_3^-] + [CO_3^{2-}]$
- 2. $C_{H_2CO_3} = [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
- 3. $C_{H_2CO_3} = [CO_2] + [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
- 4. $C_{H_2CO_3} = [CO_2] + [H_2CO_3]$

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 ?

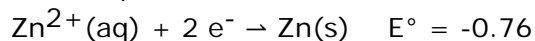
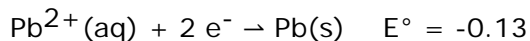
- 1. $[H_2CO_4^{2-}] \cdot [H^+] / [H_4CO_4]$
- 2. $[H_3CO_4^-] \cdot [H^+] / [H_4CO_4]$
- 3. $[H_2CO_4^{2-}] \cdot [H^+] / [H_3CO_4^-]$
- 4. $[H_2CO_4^{2-}] \cdot [H^+] \cdot [H_3CO_4^-] / [H_4CO_4]$
- 5. $[H_2CO_4^{2-}] \cdot [H^+]^2 / [H_4CO_4]$

19. What would be the pH of a 2×10^{-8} M solution of $\text{Ba}(\text{OH})_2$?
1. 7.009
 2. 7.019
 3. 7.013
 4. 7.004
20. What would be the $[\text{H}^+]$, $[\text{HSO}_4^-]$ and $[\text{SO}_4^{2-}]$ 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 $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$ solution (trisodium citrate)? Citric acid has $K_{a1} = 7.1 \times 10^{-4}$, $K_{a2} = 1.7 \times 10^{-5}$ and $K_{a3} = 4.0 \times 10^{-7}$.
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.)
 $\text{N}_2(g) \rightarrow 2 \text{NH}_4\text{OH}(aq)$
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?
 $\text{Zn}(s) + \text{MnO}_2(s) + \text{NH}_4\text{Cl}(aq) \rightarrow \text{ZnCl}_2(s) + \text{Mn}_2\text{O}_3(s) + \text{NH}_3(aq)$
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 oxidizing reagent.
 4. A product with 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?
- $$\text{Pb}^{2+}(aq) + 2 e^- \rightarrow \text{Pb}(s) \quad E^\circ = -0.13$$
- $$\text{Zn}^{2+}(aq) + 2 e^- \rightarrow \text{Zn}(s) \quad E^\circ = -0.76$$
1. $\text{Zn}(s)$
 2. $\text{Zn}^{2+}(aq)$
 3. $\text{Pb}(s)$
 4. $\text{Pb}^{2+}(aq)$
26. For a discharging battery, which of the following must be negative?
- I. E°_{cell}
 - II. anode

III. cathode

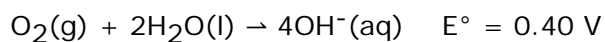
1. I only
2. II only
3. III only
4. I & II
5. I & III
6. II & III
7. none must be negative

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



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

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

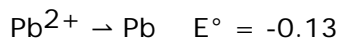


1. 1.72×10^{-7}
2. 5.82×10^6
3. 8.70×10^{-28}
4. 1.15×10^{27}

29. How many grams of solid silver (Ag) could be produced by electrolyzing 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 $[\text{Pb}^{2+}]$ and $[\text{Sn}^{2+}]$ would be present at equilibrium in a battery built from the two half reactions below?



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