CH 302 Spring 2007 Practice Exam 2

1. Which of the following is **not** a strong acid?
   a. HCl
   b. H_2SO_4
   c. $HClO_4$
   d. H_2CO_3
   e. $HClO_3$

2. What is the pH of a buffer made up of 0.5 M pyridine (C_5H_5N) and 0.75 M $C_5H_5NH^+$? The pK_b of pyridine is 8.70.
   a. 8.9
   b. 6.4
   c. 5.1
   d. 7.6

3. Which of the following systems produces a buffer?
   I. 0.5 M CH_3COOH and 0.5 M $NaCH_3COO$
   II. 0.5 M CH_3COOH, 1.0 M $NaCH_3COO$, and 0.25 M $Ba(OH)_2$
   III. 0.75 M CH_3COOH and 0.5 M NaOH
   IV. 1.0 M Na^+ and 1.0 M NaOH
   V. 0.5 M CH_3COOH, 1.0 M $NaCH_3COO$, and 0.5 M HCl
   a. I, II, III, IV, and IV
   b. None of them
   c. I, III, and V only
   d. I only
   e. I, II, and IV only
   f. I and II only

4. Rank the following compounds in terms of increasing basicity.

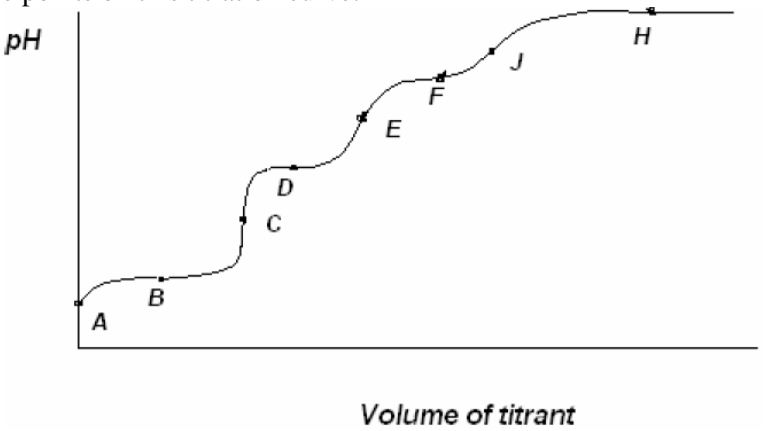
Compound	pK_b
$C_6H_5NH_2$	9.38
NH_3	4.74
$HONH_2$	8.18
$(CH_3)N$	4.13
CH_3NH_2	3.30

   a. $C_6H_5NH_2 < HONH_2 < NH_3 < (CH_3)N < CH_3NH_2$
   b. $CH_3NH_2 < (CH_3)N < NH_3 < HONH_2 < C_6H_5NH_2$
   c. $C_6H_5NH_2 < HONH_2 < (CH_3)N < NH_3 < CH_3NH_2$
   d. $CH_3NH_2 < NH_3 < (CH_3)N < HONH_2 < C_6H_5NH_2$

5. What is the buffer capacity of a buffer made up of 1.2 M CH_3NH_2 and 1.4 M $CH_3NH_3^+$? For CH_3NH_2, pK_b = 3.3.
   a. 1.4 M for H^+, 1.2 M for OH^-
   b. 1.2 M for H^+, 1.4 M for OH^-
   c. 0.2 M for H^+, 0.2 M for OH^-
   d. 2.6 M for H^+, 2.6 M for OH^-

6. 100 mL of 1.5 M HCN (pK_a = 9.40) and 75 mL of 2.5 M CN^- are mixed together, and 2 g of NaOH are added. What is the final pH?
   a. 4.60
   b. 9.13
   c. 9.40
   d. 9.77
   e. 13.25

7. Identify the equivalence points on this titration curve.



a. B, D, F, and H
b. B, D, and F
c. C, E, and J
d. C and E only
e. H only

8. On the same titration curve referred to in question 7, at which points might you use the equation for an amphiprotic acid? Assume the pH does not "jump" again as more titrant is added.
a. B, D, F, and H
b. B, D, and F
c. C, E, and J
d. C and E only
e. H only

9. You start out with 1 L of 0.1 M HCl. What is the pH after you've added 3 g $Mg(OH)_2$?
a. 7
b. 0
c. 14
d. 2.54
e. 11.46

10. You start out with 75 mL of 1.5 M HNO_3. How much NaOH must you add to reach the equivalence point?
a. 1.0 g
b. 60.0 g
c. 4.5 g
d. 3.7 g
e. 6.2 g

11. 100 mL 0.05 M $(CH_3)N$ ($K_b = 5.0 \times 10^{-5}$) is titrated with 3 mL 1.0 M HCl. What is the final pH?
a. 2
b. 9.52
c. 9.70
d. 9.87
e. 12

12. 75 mL 0.2 M HNO_2 ($K_a = 4.5 \times 10^{-4}$) is titrated with 15 mL 1.0 M NaOH. What is the final pH?
a. 9.72
b. 5.72
c. 3.35
d. 10.23
e. 8.28

13. Which of the following is the most soluble?
    a. $AgOH$ $K_{sp} = 2.0 \times 10^{-8}$
    b. PbI_2 $K_{sp} = 8.7 \times 10^{-9}$
    c. Ag_3PO_4 $K_{sp} = 1.3 \times 10^{-20}$
    d. $Ca_3(PO_4)_2$ $K_{sp} = 1.0 \times 10^{-25}$

14. What is the molar solubility of Fe_2S_3, given $K_{sp} = 1.4 \times 10^{-88}$?
    a. 1.05×10^{-18}
    b. 1.14×10^{-30}
    c. 1.4×10^{-88}
    d. 3.16×10^{-45}
    e. 8.20×10^{-19}

15. 0.05 M NaBr is added to a saturated solution of AgBr ($K_{sp} = 3.3 \times 10^{-13}$). What is the concentration of Ag^+ at equilibrium?
    a. 3.3×10^{-13} M
    b. 5.7×10^{-7} M
    c. 6.6×10^{-12} M
    d. 0.05 M

16. Which of these would be an appropriate C_a and K_a for a weak acid in water in order for our approximations to hold?
    I. $C_a = 10^{-7}$ M, $K_a = 10^{-7}$
    II. $C_a = 10^{-3}$ M, $K_a = 10^{-2}$
    III. $C_a = 10^{-3}$ M, $K_a = 10^{-7}$
    IV. $C_a = 10^{-3}$ M, $K_a = 10^{-12}$
    V. $C_a = 10^{-1}$ M, $K_a = 10^{-9}$
    a. I, II, III, IV, and V
    b. None of them
    c. I, III, and V only
    d. II, III, IV, and V only
    e. II, III, and V only
    f. III and V only
    g. I and IV only

17. You have HA^- at a concentration of C_{HA} in water. Which of the following statements is true for this solution?
    a. $[H^+] = (K_a C_{HA})^{1/2}$ if C is large and K's are far apart
    b. $[OH^-] = (K_b C_{HA})^{1/2}$ if C is large and K's are far apart
    c. $[H^+] = (K_{a1} K_{a2})^{1/2}$ if the K's are far enough apart
    d. $[H^+] = (K_{a1} K_{a2})^{1/2}$ if the K's are close enough together

18. You put H_2CO_3 and $NaHCO_3$ in water. How many equations do you need to completely solve this system exactly?
    a. 2
    b. 4
    c. 5
    d. 6
    e. 10

19. Which of the following is a correct mass balance for the system described in problem 18?
    a. $[H^+] + [Na^+] = [OH^-] + [HCO_3^-] + 2[CO_3^{2-}]$
    b. $C_{H2CO3} + C_{NaHCO3} = [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
    c. $C_{H2CO3} + C_{NaHCO3} = [HCO_3^-] + 2[CO_3^{2-}]$
    d. $C_{H2CO3} = [H_2CO_3]$
    e. $C_{NaHCO3} = [HCO_3^-]$

20. What is the equilibrium expression K_{a2} for H_3PO_4?
    a. $K_{a2} = [H^+]^3[PO_4^{3-}]/[H_3PO_4]$
    b. $K_{a2} = [H^+][H_2PO4^-]/[H_3PO_4]$
    c. $K_{a2} = [H^+][HPO_4^{2-}]/[H_2PO_4^-]$
    d. $K_{a2} = [H^+][PO_4^{3-}]/[HPO_4^{2-}]$

21. What is the pH of 3.7×10^{-8} M $Sr(OH)_2$?
    a. 7.47
    b. 6.53
    c. 6.76
    d. 7.24

22. Find the pH of 4×10^{-3} M H_2SO_4, if $K_a = 1.1 \times 10^{-2}$.
    a. 2.10
    b. 2.19
    c. 2.40
    d. 4.36

23. What is the pH of 0.25 M $NaHCO_3$? $K_{a1} = 10^{-4}$ and $K_{a2} = 10^{-10}$.
    a. 5.30
    b. 2.30
    c. 7.00
    d. 0.602
    e. 8.70
    f. 11.7

24. What are the proper coefficients for this reaction?

$$\_\_\_F_2(g) + \_\_\_Au(s) \rightarrow \_\_\_F^-(aq) + \_\_\_Au^{3+}(aq)$$

    a. 1, 1, 2, 1
    b. 3, 1, 6, 1
    c. 3, 2, 6, 2
    d. 1, 1, 1, 1

25. When the equation below is properly balanced in base, how many hydroxide ions and water molecules are on each side of the equation?

$$Ag_2O_3(s) + Ti(s) \rightarrow Ag^{2+} + Ti^{3+}$$

    a. 9 H_2O on the left, 18 OH^- on the right
    b. 18 OH^- on the left, 9 H_2O on the right
    c. 3 H_2O on the left, 6 OH^- on the right
    d. 6 OH^- on the left, 3 H_2O on the right
    e. 3 OH^- on the right
    f. 9 OH^- on the right

Half-reaction	ΔE_r^0 (V)
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.68
$Ti^{3+}(aq) + 3e^- \rightarrow Ti(s)$	-1.21
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$	+1.52

26. Refer to the table above. What is the strongest oxidizing agent in the table?
    a. Al(s)
    b. $Al^{3+}(aq)$
    c. Ti(s)
    d. $Fe^{3+}(aq)$
    e. Au(s)
    f. $Au^{3+}(aq)$

27. Refer to the table above. What is the strongest reducing agent in the table?
    a. Al(s)
    b. $Al^{3+}(aq)$
    c. Ti(s)
    d. $Fe^{3+}(aq)$
    e. Au(s)
    f. $Au^{3+}(aq)$

28. For an electrolytic cell made of the following two half-reactions, which species is the anode? What is the sign of this electrode?

$$Au^{3+}(aq) + 3e^- \rightarrow Au(s) \qquad \Delta E_r^0 = +1.52 \text{ V}$$
$$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s) \qquad \Delta E_r^0 = -0.25 \text{ V}$$

    a. $Au^{3+}(aq)$, positive
    b. Au(s), positive
    c. Au(s), negative
    d. $Ni^{2+}(aq)$, positive
    e. $Ni^{2+}(aq)$, negative
    f. Ni(s), positive

29. Given the ΔE_r^0 values below, what type of cell is this? To which species does electrons flow?

$$Fe^{3+}(aq) + Ti(s) \rightarrow Fe^{2+}(aq) + Ti^{3+}(aq)$$

$$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq) \qquad \Delta E_r^0 = +0.77 \text{ V}$$
$$Ti^{3+}(aq) + 3e^- \rightarrow Ti(s) \qquad \Delta E_r^0 = -1.21 \text{ V}$$

    a. Electrolytic; $Fe^{3+}(aq)$
    b. Electrolytic; Ti(s)
    c. Voltaic; $Fe^{3+}(aq)$
    d. Voltaic; Ti(s)

30. Calculate E_{cell} for the oxidation-reduction reaction composed of the following half reactions.

$$NO_3^-(aq) + 2H^+(aq) + e^- \rightarrow NO_2(g) + H_2O(l) \qquad \Delta E_r^0 = +0.80$$
$$CO_2(g) + 2H^+ + 2e^- \rightarrow HCOOH(aq) \qquad \Delta E_r^0 = -0.11$$

    a. -0.69
    b. +0.69
    c. -0.91
    d. +0.91