Practice Problems for Chem. 1B Exam 1 F2011
These represent the concepts covered for exam 1. There may be some additional net ionic equations from chem. 1A.
This is not the exact exam!

Sections 16.1-16.3

1. Which of the following statements is/are CORRECT?
    1. For a chemical system, if the reaction quotient (*Q*) is greater than *K*, products must be converted to reactants to reach equilibrium.
    2. For a chemical system at equilibrium, the forward and reverse rates of reaction are equal.
    3. For a chemical system at equilibrium, the concentrations of products divided by the concentrations of reactants equals one.

    a) 1 only b) 2 only c) 3 only d) 1 and 2 e) 1, 2, and 3

2. Write a balanced chemical equation which corresponds to the following equilibrium constant expression.

$$K_p = \frac{P_{N_2}^{1/2} P_{H_2}^{3/2}}{P_{NH_3}}$$

    a) 1/2 $N_2(g)$ + 3/2 $H_2(g)$ ↔ $NH_3(g)$
    b) $N_2(g)$ + 3 $H_2(g)$ ↔ 2 $NH_3(g)$
    c) 2 $NH_3(g)$ ↔ $N_2(g)$ + 3 $H_2(g)$
    d) $NH_3(g)$ ↔ 1/2 $N_2(g)$ + 3/2 $H_2(g)$
    e) 2 $N_2(g)$ + 6 $H_2(g)$ ↔ 4 $NH_3(g)$

3. A 5.0 L flask is filled with 0.25 mol SO_3, 0.50 mol SO_2, and 1.0 mol O_2, and allowed to reach equilibrium. Assume the temperature of the mixture is chosen so that K = 0.12. Predict the effect on the concentration of SO_3 as equilibrium is achieved by using Q, the reaction quotient.

    2 $SO_3(g)$ ↔ 2 $SO_2(g)$ + $O_2(g)$

    a) [SO_3] will decrease because $Q > K$.
    b) [SO_3] will decrease because $Q < K$.
    c) [SO_3] will increase because $Q < K$.
    d) [SO_3] will increase because $Q > K$.
    e) [SO_3] will remain the same because $Q = K$.

4. Excess $PbBr_2(s)$ is placed in water at 25°C. At equilibrium, the solution contains 0.012 M $Pb^{2+}(aq)$. What is the equilibrium constant for the reaction below?

    $PbBr_2(s)$ ↔ $Pb^{2+}(aq)$ + 2 $Br^-(aq)$

    a) 4.3×10^{-7} b) 1.7×10^{-6} c) 6.9×10^{-6} d) 1.4×10^{-4} e) 2.9×10^{-4}

5. When 0.50 mole CH_3CO_2H is dissolved in water to a volume of 1.00 L, 0.60% of the CH_3CO_2H dissociates to form $CH_3CO_2^-(aq)$. What is the equilibrium constant for the reaction?

    $CH_3CO_2H(aq)$ + $H_2O(l)$ ↔ $CH_3CO_2^-(aq)$ + $H_3O^+(aq)$

    a) 1.8×10^{-5} b) 3.6×10^{-5} c) 3.0×10^{-3} d) 6.0×10^{-3} e) 0.45

Sections 16.4-16.6

6. If a stress is applied to an equilibrium system, the system will respond is such a way as to relieve that stress. This is a statement :

    a) Le Chatelier's principle
    b) Law of conservation of Mass
    c) 2nd Law of Thermodynamics
    d) None of the above

7. Consider the reaction below

    $2NOCl(g) \leftrightarrow 2NO(g) + Cl_2(g)$ $\Delta_r H^o$ = + 77.1 kJ/mol-rxn

    How does [NOCl] change by a decrease in the temperature?

a) No change
b) NOCl decreases
c) NOCl increases
d) None of the above

8. A gaseous mixture of NO_2 and N_2O_4 is in equilibrium. If the concentration of N_2O_4 is 5.3×10^{-5} M, what is the concentration of NO_2?

$$2\ NO_2(g) \leftrightarrow N_2O_4(g) \qquad K_c = 170$$

a) 9.7×10^{-14} M b) 3.1×10^{-7} M c) 5.6×10^{-4} M d) 9.0×10^{-3} M e) 9.5×10^{-2} M

9. The equilibrium constant at 25 °C for the dissolution of silver iodide is 8.5×10^{-17}.

$$AgI(s) \leftrightarrow Ag^+(aq) + I^-(aq)$$

If an excess quantity of AgI(s) is added to water and allowed to equilibrate, what is the equilibrium concentration of I^-?

a) 7.2×10^{-33} M b) 4.3×10^{-17} M c) 8.5×10^{-17} M d) 6.5×10^{-9} M e) 9.2×10^{-9} M

10. Carbonyl bromide decomposes to carbon monoxide and bromine.

$$COBr_2(g) \leftrightarrow CO(g) + Br_2(g)$$

K_c is 0.19 at 73 °C. If an initial concentration of 0.63 M $COBr_2$ is allowed to equilibrate, what is the equilibrium concentration of $COBr_2$?

a) 0.26 M b) 0.28 M c) 0.35 M d) 0.37 M e) 0.40 M

11. For the following reaction,

$$SO_2(g) + 1/2\ O_2(g) \leftrightarrow SO_3(g)$$

the equilibrium constant, K_p, is 0.870 at 627 °C. What is the equilibrium constant, at 627 °C, for the reaction below?

$$2\ SO_3(g) \leftrightarrow 2\ SO_2(g) + O_2(g)$$

a) -1.74 b) -.757 c) 1.32 d) 2.30 e) 5.28

12. Assume that the following chemical reaction is at equilibrium.

$$2\ ICl(g) \leftrightarrow I_2(g) + Cl_2(g) \qquad \Delta H° = +26.9\ kJ$$

At 25 °C, $K_p = 2.0 \times 10^5$. If the temperature is decreased to 5 °C, which statement applies?

a) K_p will decrease and the reaction will proceed in the backward direction.
b) K_p will decrease and the reaction will proceed in the forward direction.
c) K_p will remain unchanged and the reaction will proceed in the forward direction.
d) K_p will remain unchanged and the reaction will proceed in the backward direction.
e) K_p will increase and the reaction will proceed in the forward direction.

13. In which of the following equilibrium systems will an increase in the pressure have no effect on the concentrations of products and reactants?

a) $H_2(g) + F_2(g) \leftrightarrow 2\ HF(g)$
b) $N_2(g) + 3\ H_2(g) \leftrightarrow NH_3(g)$
c) $CaCO_3(s) \leftrightarrow CaO(s) + CO_2(g)$
d) $2\ NOBr(g) \leftrightarrow 2\ NO(g) + Br_2(g)$
e) $2\ H_2O(g) + O_2(g) \leftrightarrow 2\ H_2O_2(g)$

Sections 17.1-17.8

14. Which of the following substances is never a Brønsted-Lowry acid in an aqueous solution?

a) hydrogen fluoride, HF(g)
b) sodium phosphate, $Na_3PO_4(s)$
c) ammonium chloride, $NH_4Cl(s)$
d) hydrogen bromide, HBr(g)
e) sodium bicarbonate, $NaHCO_3(s)$

15. Which equation depicts dihydrogen phosphate ion behaving as a Brønsted-Lowry base in water?

a) $H_2PO_4^-(aq) + H_2O(l) \leftrightarrow H_3PO_4(aq) + OH^-(aq)$
b) $H_2PO_4^-(aq) + OH^-(aq) \leftrightarrow HPO_4^{2-}(aq) + H_2O(l)$
c) $H_2PO_4^-(aq) + H_2O(l) \leftrightarrow HPO_4^{2-}(aq) + H_3O^+(aq)$
d) $H_2PO_4^-(aq) + O^{2-}(aq) \leftrightarrow PO_4^{3-}(aq) + H_2O(l)$

e) $H_2PO_4^-(aq) + H_2O(l) \leftrightarrow 2\ H_2O(l) + PO_3(s)$

16. What is the conjugate base of $[Fe(H_2O)_6]^{3+}(aq)$?
    a) H_3O^+
    b) $[Fe(H_2O)_6]^{2+}$
    c) $[Fe(H_2O)_5H_3O]^{4+}$
    d) $[Fe(H_2O)_5OH]^{2+}$
    e) $[Fe(H_2O)_5]^{3+}$

17. At 20 °C, the water ionization constant, K_w, is 6.8×10^{-15}. What is the H_3O^+ concentration in neutral water at this temperature?
    a) 4.6×10^{-29} M b) 3.4×10^{-15} M c) 6.8×10^{-15} M d) 8.2×10^{-8} M e) 1.0×10^{-7} M

18. What is the OH^- concentration of an aqueous solution with a pH of 4.45? ($K_w = 1.0 \times 10^{-14}$)
    a) 2.8×10^{-10} M b) 3.5×10^{-5} M c) 7.1×10^{-5} M d) 9.55 M e) 2.8×10^{4} M

19. Which of the following chemical equations corresponds to the acid ionization constant, K_a, for ammonium ion (NH_4^+)?
    a) $NH_3(aq) + H_3O^+(aq) \leftrightarrow NH_4^+(aq) + H_2O(l)$
    b) $NH_4^+(aq) + H_2O(l) \leftrightarrow NH_3(aq) + H_3O^+(aq)$
    c) $NH_4^+(aq) + OH^-(aq) \leftrightarrow NH_3(aq) + H_2O(l)$
    d) $NH_4^+(aq) + H_3O^+(aq) \leftrightarrow NH_5^+(aq) + H_2O(l)$
    e) $NH_3(aq) + H_2O(l) \leftrightarrow NH_4^+(aq) + OH^-(aq)$

20. Which of the following weak acids has the strongest conjugate base in an aqueous solution?
    a) acetic acid, $K_a = 1.8 \times 10^{-5}$
    b) hydrocyanic acid, $K_a = 4.0 \times 10^{-10}$
    c) hydrogen sulfite ion, $K_a = 6.2 \times 10^{-8}$
    d) nitrous acid, $K_a = 4.5 \times 10^{-4}$
    e) phosphoric acid, $K_a = 7.5 \times 10^{-3}$

21. At 25 °C, all of the following ionic compounds produce a basic aqueous solution, except _____.
    a) $KClO_4$ b) Na_2CO_3 c) $NaNO_2$ d) KCN e) $NaCH_3CO_2$

22. What is the net ionic equation for the reaction of aqueous calcium acetate and aqueous sodium carbonate?
    a) $Ca^{2+}(aq) + 2\ CH_3CO_2^-(aq) \rightarrow Ca(CH_3CO_2)_2(s)$
    b) $Na^+(aq) + CH_3CO_2^-(aq) \rightarrow NaCH_3CO_2(aq)$
    c) $Na^+(aq) + CH_3CO_2^-(aq) \rightarrow NaCH_3CO_2(s)$
    d) $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$
    e) $Ca^{2+}(aq) + 2\ Na^+(aq) \rightarrow CaNa_2(s)$

23. What is the net ionic equation for the reaction of aqueous sodium hydroxide and aqueous iron(II) chloride?
    a) $Na^+(aq) + OH^-(aq) \rightarrow NaOH(s)$
    b) $Na^+(aq) + Cl^-(aq) \rightarrow NaCl(s)$
    c) $Fe^{2+}(aq) + 2\ OH^-(aq) \rightarrow Fe(OH)_2(s)$
    d) $Fe^{2+}(aq) + OH^-(aq) \rightarrow FeOH^+(s)$
    e) $Fe^{2+}(aq) + 2\ Cl^-(aq) \rightarrow FeCl_2(s)$

24. What is the OH^- concentration in 0.48 M $F^-(aq)$? (K_b of $F^- = 1.4 \times 10^{-11}$)
    a) 6.7×10^{-12} M b) 1.4×10^{-11} M c) 3.9×10^{-9} M d) 1.7×10^{-6} M e) 2.6×10^{-6} M

25. What is the pH of the solution which results from mixing 150 mL of 0.50 M $CH_3CO_2H(aq)$ and 150 mL of 0.50 M NaOH(aq) at 25 ºC? (K_a of $CH_3CO_2H = 1.8 \times 10^{-5}$)
    a) 2.67 b) 4.74 c) 4.93 d) 8.26 e) 9.07

26. What is the pH of 1.0 M $Na_2SO_3(aq)$ at 25 ºC? ($K_{a1} = 1.2 \times 10^{-2}$, $K_{a2} = 6.2 \times 10^{-8}$)
    a) 3.40 b) 6.03 c) 7.96 d) 10.40 e) 10.60

Sections 18.1-18.3

27. An acid-base equilibrium system is created by dissolving 0.10 mol HF in water to a volume of 1.0 L. What is the effect of adding 0.050 mol F^-(aq) to this solution?
    a) The pH of the solution will decrease.
    b) Some F^-(aq) will react with H_3O^+, increasing the concentration of HF(aq) and reestablishing the solution equilibrium.
    c) The addition of F^-(aq) will have no effect on the pH or the concentration of HF(aq).
    d) Some HF(aq) will ionize, increasing the concentration of F^-(aq) and decreasing the pH.
    e) Some HF(aq) will ionize, increasing the concentration of F^-(aq) and increasing the pH.

28. What is the pH of a solution that results from diluting 0.50 mol formic acid (HCO_2H) and 0.10 mol sodium formate ($NaHCO_2$) with water to a volume of 1.0 L? (K_a of $HCO_2H = 1.8 \times 10^{-4}$)
    a) 2.22 b) 3.05 c) 3.74 d) 3.98 e) 4.44

29. What is the pH of a solution that results from adding 25 mL of 0.50 M NaOH to 75 mL of 0.50 M CH_3CO_2H? (K_a of $CH_3CO_2H = 1.8 \times 10^{-5}$)
    a) 4.44 b) 4.74 c) 5.05 d) 9.26 e) 13.10

30. Which of the following combinations would be best to buffer an aqueous solution at a pH of 4.5?
    a) H_3PO_4 and $H_2PO_4^-$, $K_{a1} = 7.5 \times 10^{-3}$
    b) HNO_2 and NO_2^-, $K_a = 4.5 \times 10^{-4}$
    c) CH_3CO_2H and CH_3COO^-, $K_a = 1.8 \times 10^{-5}$
    d) $H_2PO_4^-$ and HPO_4^{2-}, $K_{a2} = 6.2 \times 10^{-8}$
    e) NH_4^+ and NH_3, $K_a = 5.7 \times 10^{-10}$

31. What is the pH of the buffer that results when 15.0 g of NaH_2PO_4 and 15.0 g of Na_2HPO_4 are diluted with water to a volume of 0.50 L? (K_a of $H_2PO_4^- = 6.2 \times 10^{-8}$)
    a) 7.13 b) 7.21 c) 7.28 d) 8.05 e) 8.39

32. What mass of solid $NaCH_3CO_2$ (molar mass = 82.0 g/mol) should be added to 1.0 L of 0.50 M CH_3CO_2H to make a buffer with a pH of 7.21? (pK_a of $CH_3CO_2H = 7.21$)
    a) 0.0 g b) 1.9 g c) 41 g d) 71 g e) 1.6×10^2 g

33. A volume of 25.0 mL of 0.100 M CH_3CO_2H(aq) is titrated with 0.100 M NaOH(aq). What is the pH after the addition of 12.5 mL of NaOH? (K_a for $CH_3CO_2H = 1.8 \times 10^{-5}$)
    a) 3.74 b) 4.74 c) 5.74 d) 7.00 e) 9.26

34. A 50.00 mL sample of vinegar is titrated with 0.584 M NaOH(aq). If the titration requires 32.80 mL of NaOH(aq), what is the concentration of acetic acid in the vinegar?
    a) 0.0100 M b) 0.0192 M c) 0.0292 M d) 0.383 M e) 0.890 M

35. An impure sample of sodium carbonate, Na_2CO_3, is titrated with 0.123 M HCl according to the reaction below.
    $$2\ HCl(aq) + Na_2CO_3(aq) \leftrightarrow CO_2(g) + H_2O(l) + 2\ NaCl(aq)$$
    What is the percent of Na_2CO_3 in a 0.557 g sample if the titration requires 25.30 mL of HCl? The molar mass of Na_2CO_3 is 106.0 g/m ol.
    a) 0.559% b) 29.6% c) 55.9% d) 59.2% e) 118%

Answers:

1	d	21	a
2	d	22	d
3	d	23	c
4	c	24	e
5	a	25	e
6	a	26	e
7	c	27	b
8	c	28	b
9	e	29	a
10	d	30	c
11	c	31	a
12	a	32	c
13	a	33	b
14	b	34	d
15	a	35	b
16	d		
17	d		
18	a		
19	b		
20	b		