CHM2046 **Practice Exam 2**

Look at the end for useful information.

VERSION A

1. The solubility product expression (K_{sp}) for $Ca_3(PO_4)_2$ (s) in water is:
   a. $[Ca^{2+}(aq)]^3 + [PO_4^{3-}(aq)]^2$
   b. none of these
   c. $[Ca^{2+}(aq)]^2[PO_4^{3-}(aq)]^3$
   d. $[Ca^{2+}(aq)]^3[PO_4^{3-}(aq)]^2$
   e. $3[Ca^{2+}(aq)] + 2[PO_4^{3-}(aq)]$

2. Addition of which of the following will increase the solubility of barium sulfate $BaSO_4$ (s) in water?
   a. Na_2SO_4
   b. $CaCl_2$
   c. MeCOOH
   d. none of these
   e. $BaNO_3$

3. Predict the sign of ΔS^o for the following reaction: $C_6H_{12}O_6$ (s) + 6 O_2 (g) → 6 CO_2 (g) + 6 H_2O (g)
   a. negative
   b. zero
   c. cannot be predicted
   d. depends on ΔH^o
   e. positive

4. What is the K_{sp} of the salt MX_2 (s) if its molar solubility is 1.4×10^{-2} M?
   a. 1.1×10^{-5}
   b. none of these
   c. 2.7×10^{-6}
   d. 2.0×10^{-4}
   e. 5.5×10^{-6}

5. What is the solubility of $Fe(OH)_2$ (s) ($K_{sp} = 1.6 \times 10^{-14}$) in a buffer solution whose pH = 9.00? Assume the pH doesn't change as $Fe(OH)_2$ dissolves.
   a. cannot be determined
   b. 1.6×10^{-4} M
   c. 1.6×10^{-9} M
   d. 1.6×10^{-6} M
   e. 1.6×10^{-5} M

6. What is the molar solubility of BaF_2 (s) in water? (K_{sp} of $BaF_2 = 1.5 \times 10^{-6}$).
   a. 9.1×10^{-3} M
   b. 1.1×10^{-2} M
   c. 8.7×10^{-4} M
   d. 7.2×10^{-3} M
   e. none of these

7. Calculate ΔS^o for the reaction between Cu (s) and O_2 (g) to give one mole of Cu_2O (s).
   S^o values (J/mol.K): Cu (s) = 33.1; O_2 (g) = 205.0; Cu_2O (s) = 93.1
   a. -178 J/K
   b. -75.6 J/K
   c. -151 J/K
   d. -145 J/K
   e. none of these

8. A particular reaction is spontaneous, and has $\Delta S^o_{rxn} < 0$. Which statement must be true?
   a. $\Delta H^o_{rxn} < 0$
   b. $\Delta H^o_{rxn} > 0$
   c. $\Delta S^o_{surr} < 0$
   d. $\Delta S^o_{univ} < 0$
   e. none of these

9. At the equivalence point of the titration of a 0.15 M NH_3 solution with 0.15 M HNO_3 solution, the pH will be:
   a. greater than 7.00
   b. 7.00
   c. less than 7.00
   d. 14.00
   e. none of these

10. Which of the following acids is best suited for preparing a buffer solution with pH = 3.7 and a high buffer capacity ? HNO_2, HClO, HCOOH, or $HClO_2$
    a. HNO_2
    b. HClO
    c. HCOOH
    d. $HClO_2$
    e. cannot be determined

11. A buffer solution of volume 110.0 mL contains 0.109 M $NaNO_2$ and 0.120 M HNO_2. What is the pH after addition of 10.0 mL of 0.250 M NaOH solution? The K_a for HNO_2 is 7.1×10^{-4}.
    a. 3.15
    b. 3.37
    c. 3.02
    d. 3.28
    e. 2.93

12. Which of the following salts will dissolve in water to give a basic solution (pH > 7.00)?

Na_2SO_4 KI $Ca(ClO_4)_2$ $NaNO_3$

a. KI
b. Na_2SO_4
c. $Ca(ClO_4)_2$
d. $NaNO_3$
e. none of these salts

13. In the reaction $CaO(s) + SO_3(g) \rightarrow CaSO_4(s)$

a. O^{2-} acts as a Lewis base, and SO_3 acts as a Lewis acid
b. Ca^{2+} acts as a Lewis base, and SO_3 acts as a Lewis acid
c. Ca^{2+} acts as a Lewis acid, and SO_3 acts as a Lewis acid
d. O^{2-} acts as a Lewis acid, and SO_3 acts as a Lewis base
e. Ca^{2+} acts as a Lewis acid, and SO_3 acts as a Lewis base

14. Which of the following salts is least soluble in water at 20 ^oC? CuCl ($K_{sp} = 2 \times 10^{-7}$); CuBr ($K_{sp} = 5 \times 10^{-9}$); CuI ($K_{sp} = 1 \times 10^{-12}$)

a. CuBr
b. CuI
c. cannot be determined
d. all are equally soluble
e. CuCl

15. For which of the following changes is ΔS_{sys} negative?

a. sugar dissolving in water
b. water warming from 10 ^oC to 20 ^oC
c. bubbles of CO_2 forming and escaping from a carbonated drink
d. liquid water freezing to ice
e. none of these

16. What is the pH of a solution that is 0.060 M in NH_3 (aq) and 0.050 M in NH_4^+ (aq)?

a. 4.74
b. 9.33
c. 9.26
d. 4.82
e. none of these

17. A solution of HCl of volume 100.0 mL has a pH of 1.00 at 300 K. What is the new pH if the volume of the solution is doubled by addition of 100.0 mL of pure water?

a. 2.00
b. 1.30
c. none of these
d. 1.00
e. 0.70

18. Predict the sign of $\Delta S°_{rxn}$ for the following reaction: $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

a. positive
b. depends on $\Delta H°_{rxn}$
c. cannot be predicted
d. negative
e. zero

19. Which of the following substances will have the greatest molar entropy S°?

a. CH_3COOH (l)
b. CO (g)
c. cannot be predicted
d. HCHO (g)
e. CH_3OH (l)

20. The following reaction has $\Delta S°_{rxn} = 197.9$ J/K and $\Delta H°_{rxn} = -49.7$ kJ. Is the reaction spontaneous as written? $A(g) + B(g) \rightarrow$ products

a. no
b. yes
c. cannot be determined without the temperature
d. only if $\Delta S_{univ} < 0$
e. only if $\Delta S_{surr} = 0$

21. Calculate $\Delta S°_{surr}$ for the reaction below at 27ºC : $\Delta S°_{rxn} = -34.3$ J/K and $\Delta G°_{rxn} = -55.6$ kJ

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

a. -151 J/K
b. 151 J/K
c. 220 J/K
d. cannot be determined without $\Delta S°_{univ}$
e. -220 J/K

22. A solution is prepared that contains [Ba^{2+} (aq)] = 1.4 x 10^{-2} M and [F^- (aq)] = 2.0 x 10^{-3} M. Will a precipitate of BaF_2 (s) form? (K_{sp} for BaF_2 is 1.5 x 10^{-6}).

a. yes
b. only if Na^+ (aq) is added
c. only if NH_4^+ (aq) is added
d. no
e. cannot be determined

23. Consider two buffer solutions **A** and **B**. **A** contains 0.33 M NH_3 (aq) and 0.33 M NH_4^+ (aq). **B** contains 0.50 M NH_3 (aq) and 0.50 M NH_4^+ (aq). Which of the following statements is true?

a. The pH of both solutions is the same, but buffer **A** has a lower buffer capacity than **B**.
b. Buffer **A** has a lower pH and lower buffer capacity than **B**.
c. The pH of both solutions is the same, but buffer **A** has a higher buffer capacity than **B**.
d. Buffer **A** has a lower pH and higher buffer capacity than **B**.
e. Buffer **A** has a higher pH and a higher buffer capacity than **B**.

24. Calculate ΔS^o for the reaction: $4\ NO_2\ (g) + O_2\ (g) \rightarrow 2\ N_2O_5\ (g)$

S^o values (J/mol.K): N_2O_5 (g) = 346, NO_2 (g) = 239.9, O_2 (g) = 205.0

a. -99 J/K
b. 246 J/K
c. 494 J/K
d. -246 J/K
e. -473 J/K

25. Calculate the pH of a 0.40 M solution of NH_2Me (aq).

a. 6.49
b. 1.88
c. 12.12
d. 10.28
e. none of these

26. What is the molar solubility of Ag_2SO_4 (s) in a solution that also contains 0.22 M Na_2SO_4 (aq) (which is very soluble)? K_{sp} for Ag_2SO_4 is 1.5 x 10^{-5}.

a. 8.2 x 10^{-3} M
b. 4.1 x 10^{-3} M
c. impossible to determine
d. 6.2 x 10^{-2} M
e. 8.4 x 10^{-2} M

27. At the equivalence point of the titration of a 0.20 M NaOH solution with a 0.10 M HBr solution, the pH will be:

a. cannot be determined without the temperature
b. greater than 7.00
c. cannot be determined without the total volume
d. 7.00
e. less than 7.00

28. What is the pH of a 0.20 M solution of $Ca(OH)_2$ (aq)?

a. 0.40
b. 13.60
c. 13.30
d. 0.70
e. none of these

29. What is the pOH of a 4.4 x 10^{-10} M solution of HBr (aq)?

a. 9.36
b. 4.64
c. 7.00
d. 2.96
e. none of these

30. Consider the following reaction at equilibrium at 300 K: $HNO_2 + ClO^- \rightleftharpoons NO_2^- + HClO$
What can you predict about this reaction?

a. Since it is at equilibrium, $K_c = 1$ and [HNO_2] = [HClO]
b. The equilibrium lies to the left-hand-side ($K_c < 1$)
c. The equilibrium lies to the right-hand-side ($K_c > 1$)
d. Since it is at equilibrium, [HNO_2] = [HClO]
e. No prediction can be made without knowing K_c

31. This question will not be graded. Bubble in your answer as question 31 so that we can check your exam version if we think something is wrong,

a. Version A
b. Version B
c. Version C

Acid K_a values (300 K)		**Equations**
HIO_3	1.6×10^{-1}	$pH = -\log[H_3O^+]$
$HClO_2$	1.1×10^{-2}	$K_W = 1.0 \times 10^{-14}$ (at 25^oC)
HNO_2	7.1×10^{-4}	$pH + pOH = 14.00$
HF	6.8×10^{-4}	
HCOOH	1.8×10^{-4}	
C_6H_5COOH	6.3×10^{-5}	
CH_3COOH	1.8×10^{-5}	
CH_3CH_2COOH	1.3×10^{-5}	
HClO	2.9×10^{-8}	
HBrO	2.3×10^{-9}	
HCN	6.2×10^{-10}	
HIO	2.3×10^{-11}	

Base K_b values (300 K)	
NH_3	1.8×10^{-5}
NH_2Me	4.4×10^{-4}