JASPERSE CHEM 160 PRACTICE TEST 3 VERSION 1

Ch. 17: Additional Aqueous Equilibria
Ch. 18: Thermodynamics: Directionality of Chemical Reactions

Key Equations:

for weak acids alone in water: $[H^+] = K_a \bullet [HA]$

for weak bases alone in water: $[OH^-] = K_b \bullet [B]_{init}$

pZ= -logZ (general definition for p of anything)

$[H^+][HO^-] = 1.00 \times 10^{-14}$ pH + pOH = 14

$K_aK_b = 1.00 \times 10^{-14}$ for a conjugate acid/base pair

for Buffers: $pH = pK_a + \log[base]/[acid]$ Henderson-Hasselbalch Equation

$\Delta S^\circ = S^\circ$ (products) – S° (reactants)

$\Delta G^\circ = G^\circ$ (products) – G° (reactants)

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ (T in Kelvin)

1. Which of the following substances, when added to a 1L solution of 0.4M HF, could be used to prepare a buffer solution?

   a. 0.4 moles of HCl only
   b. 0.4 moles NaF only
   c. 0.2 moles NaOH only
   d. both 0.4 moles of NaF and 0.2 moles NaOH
   e. 0.4 moles of NaCl

2. Consider a solution prepared by adding 0.50 moles of CH_3COONa (sodium acetate) to 1.00 L of 1.00M CH_3COOH (acetic acid, $K_a = 1.8 \times 10^{-5}$). If 0.050 moles of HCl is added to this buffer solution, the pH of the solution will drop slightly. The pH does not drastically decrease because the HCl reacts with the _____ present in the buffer solution.

   a. CH_3COONa
   b. H^+
   c. H_2O
   d. CH_3COOH

3. For the following, in which case would the buffer capacity <u>not</u> be exhausted either by the addition of 0.5 moles of HCl or by the addition of 0.5 moles of NaOH?

   a. 0.80 M HF and 0.20 M NaF
   b. 0.80 M HF and 0.90 M NaF
   c. 0.10 M HF and 0.20 M NaF
   d. 0.10 M HF and 0.60 M NaF

4. Calculate the pH of a solution prepared by dissolving 0.15 mol of benzoic acid (C_6H_5COOH) and 0.30 mol of sodium benzoate (C_6H_5COONa) in 1.00 L of solution. (K_a of $C_6H_5COOH = 6.5 \times 10^{-5}$)

    a. 2.51
    b. 3.89
    c. 4.49
    d. 10.11

5. Consider a solution containing 0.100 M NaF and 0.126 M HF. Calculate the concentration of fluoride ion after addition of 5.00 mL of 0.100 M HCl to 25.0 mL of this solution.

    a. 0.0850 M
    b. 0.00167 N
    c. 0.0980 M
    d. 0.0667 M
    e. 0.00253 M

6. Calculate the final pH after 20.0 mL of 0.250 M NaOH solution is added to 50.0 mL of 0.200 M HN_3 ($K_a = 2.6 \times 10^{-5}$).

    a. 2.61
    b. 8.79
    c. 12.21
    d. 4.59
    e. 7.00

7. To prepare a buffer solution with pH = 4.70, how many moles of NaN_3 should be added to a 1.0 L solution that is 0.40 M in HN_3? (K_a for $HN_3 = 2.6 \times 10^{-5}$).

    a. 0.12 moles
    b. 0.31 moles
    c. 0.40 moles
    d. 0.52 moles
    e. none of the above

8. What is the final pH when 0.56 moles of HCl is added to 1.0 L of 0.56M NaOCl solution. (K_a for HOCl = 3.0×10^{-8}) (Assume the final volume is still 1.0 L).

   a. 7.77
   b. 3.89
   c. 4.76
   d. 5.33
   e. none of the above

9. If you start with 40.0 mL of 0.80 M $HClO_4$, calculate the $[H^+]$ concentration after addition of 60.0 mL of 0.60 M KOH.

   a. 4.0×10^{-2} M
   b. 4.0×10^{-3} M
   c. 2.5×10^{-12} M
   d. 2.5×10^{-13} M
   e. none of the above

10. An initial pH of 1.00 and an equivalence point at pH 7.0 corresponds to a titration curve for

    a. A strong acid to which strong base is added
    b. A strong base to which strong acid is added
    c. A weak acid to which strong base is added
    d. A weak base to which strong acid is added
    e. A weak base to which weak acid is added

11. A weak acid HX has $K_a = 4.0 \times 10^{-6}$. What is the concentration of the anion X^- in a solution in which 0.40M HX and 0.20M HCl are combined?

    a. 3.5×10^{-3}
    b. 2.0×10^{-3}
    c. 2.0×10^{-6}
    d. 8.0×10^{-6}
    e. none of the above

12. Which of the following combinations of chemicals in 1.0 L of water will give a solution with a basic pH?

    a. 1 mole of HCl and 1 mole of KN_3
    b. 1 mole of HCl and 1 mole of NaOH
    c. 1 mole of HCl and 0.8 mole of NaOH
    d. 1 mole of HCN and 1 mole of NaOH

13. What is the molarity of an HCl solution if 25.5 mL of this solution required 37.5 mL of 0.175 M NaOH to reach the equivalence point?

    a. 0.119
    b. 1.83×10^{-4}
    c. 0.257
    d. 0.365

14. Which of the following combinations would give a pH of 7.00 at the "equivalence point" (when equal moles of each have been added)

    a. $HClO_4$ + NaF
    b. HNO_3 + KOH
    c. HCl + NH_3
    d. HOCl + NaOH
    e. None of the above

15. The solubility of which one of the following will <u>not be affected</u> by the pH of the solution?

    a. Na_3PO_4
    b. NaF
    c. KNO_3
    d. Al_2S_3
    e. $Mn(OH)_2$

16. Zinc carbonate ($ZnCO_3$, 125.4 g/mol) has a $K_{sp} = 1.4 \times 10^{-11}$. How many grams of $ZnCO_3$ can dissolve in 1.0 L of water?

    a. 4.69×10^{-4} g/L
    b. 3.74×10^{-6} g/L
    c. 6.39×10^{-2} g/L
    d. 5.43×10^{-4} g/L
    e. none of the above

17. The solubility of $Mn(OH)_2$ is 2.2×10^{-5} mol/L. What is the K_{sp} of $Mn(OH)_2$?

    a. 1.1×10^{-14}
    b. 4.3×10^{-14}
    c. 2.1×10^{-14}
    d. 4.8×10^{-10}
    e. none of the above

18. Consider the following table of K_{sp} values. Which one of the compounds shown in the table is the least soluble?

Compound	K_{sp}
CdS	8.0×10^{-27}
CuS	6.3×10^{-36}
PbS	8.0×10^{-28}
$MnCO_3$	1.8×10^{-11}

a. CdS
b. CuS
c. PbS
d. $MnCO_3$

19. What is the solubility (in moles/liter) of $PbCl_2$ in a solution that is 0.15 M solution in HCl? (K_{sp} $PbCl_2 = 1.6 \times 10^{-5}$)

a. 2.0×10^{-3}
b. 1.1×10^{-4}
c. 1.8×10^{-4}
d. 7.1×10^{-4}
e. none of the above

20. Which of the following statements is true regarding the impact of additional chemicals on the solubility of a saturated solution of $CaCO_3$?

a. $CaCl_2$ will decrease it's solubility, NaOH will increase it's solubility
b. HCl will decrease it's solubility, $CaCl_2$ will increase it's solubility
c. $CaCl_2$ will decrease it's solubility, HCl will increase it's solubility
d. NaCl will decrease it's solubility, HCl will increase it's solubility

21. Calculate ΔS° (at 25°C in J/mol•K) for the following reaction, given the standard entropies shown (in J/mol•K):

$$2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s)$$

Standard entropies: 27 223 142

a. -439
b. +108
c. -108
d. -380
e. +380

22. Which of the following reactions would have a <u>positive</u> value for ΔS°?

a. $Ba(OH)_2\ (s) + CO_2\ (g) \rightarrow BaCO_3\ (s) + H_2O\ (l)$
b. $N_2\ (g) + 3H_2\ (g) \rightarrow 2\ NH_3\ (g)$
c. $2SO_3\ (g) \rightarrow 2SO_2\ (g) + O_2\ (g)$
d. $AgNO_3\ (aq) + HCl\ (aq) \rightarrow AgCl\ (s) + HNO_3\ (aq)$

23. Determine the value of ΔG° (in kJ/mol) for the following reaction using data from the table below.

Substance	ΔG_f° (kJ/mol)
$H_2O\ (g)$	-228
$H_2O_2\ (g)$	-105

$$2H_2O\ (g) + O_2\ (g) \rightarrow\ 2H_2O_2\ (g)$$

a. -246
b. 666
c. 246
d. -666

24. What is the value for ΔH° for this reaction at 25°C?

$$C(s) + H_2O\ (g) \rightarrow CO\ (g) + H_2\ (g)$$

$\Delta G^\circ = +91.2$ kJ/mol
$\Delta S^\circ = 135$ J/K•mol

a. 40 kJ/mol
b. 226 kJ/mol
c. 91 kJ/mol
d. 131 kJ/mol

25. Based on your knowledge of chemical reactions, which of the following processes has a <u>negative</u> standard free energy change at 25°C?

a. $CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g)$ only
b. $2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$ only
c. $2H_2O\ (l) \rightarrow 2H_2\ (g) + O_2\ (g)$
d. <u>both</u> $CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g)$ and $2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$

26. Which one of the following has the greatest entropy?

a. HCl (l)
b. HCl (s)
c. HCl (g)
d. These are all the same

27. When a reaction is found by thermodynamics to be product-favored,

a. It will be always be very rapid as written
b. Once it starts, it is possible for it to proceed as written without outside intervention
c. It is also reactant-favored
d. The equilibrium position lies very far to the left

28. Under which temperature conditions will the following reaction be product-favored?

$$A(s) + B(g) \rightarrow C(g) + D(g) \qquad \Delta H^\circ = +44.2 \text{ kJ/mol} \quad \Delta S^\circ = +135 \text{ J/mol•K}$$

a. Above 54˚C
b. Above 327˚C
c. Below 54˚C
d. Below 159˚C
e. Always

29. The entropy of the universe is

a. constant
b. continually decreasing
c. continually increasing
d. zero

30. What are the signs for ΔH and ΔS for a reaction that is product-favored at low temperature but reactant -favored at high temperature?

a. ΔH is positive, ΔS is positive
b. ΔH is negative, ΔS is negative
c. ΔH is positive, ΔS is negative
d. ΔH is negative, ΔS is positive

31. Consider the following product-favored reaction occurring in an automobile engine (C_8H_{18} is gasoline). The signs for ΔH, ΔS, and ΔG would be:

$$2\ C_8H_{18}\ (l) + 25\ O_2\ (g) \rightarrow 16\ CO_2\ (g) + 18\ H_2O\ (g)$$

a. -, +, +
b. +, -, -
c. +, +, -
d. -, +, -

32. "Ice", frozen water, melts at 0˚C. What are the signs for ΔG, ΔH and ΔS when ice is melting at 0˚C?

    a. ΔG is negative, ΔH is negative, and ΔS is positive
    b. ΔG is positive, ΔH is positive, and ΔS is positive
    c. $\Delta G = 0$, ΔH is negative, and ΔS is negative
    d. $\Delta G = 0$, ΔH is positive, and ΔS is positive
    e. none of the above

33. Solid Ammonium nitrate is highly soluble in water. When it dissolves the solution gets very cold. Based on this experimental data alone, what must be the signs for ΔH, ΔS, and ΔG for the process, and is the process enthalpy driven, entropy driven, both, or neither?

    a. +, +, + Neither
    b. +, -, - Both
    c. +, +, - Entropy driven
    d. -, -, - Enthalpy driven

34. Which of the following statements is <u>false</u>?

    a. When a reaction is exothermic, this results in dispersal of energy and in an increase in the entropy of the surrounding
    b. Both the dispersal of energy and the dispersal of matter tend to be favorable things
    c. All exothermic reactions are product-favored
    d. Gaseous molecules tend to have higher entropy than solid molecules

Jasperse
Chem 160
Answers, Test3
Version 1

1. D
2. A
3. B
4. C
5. D
6. D
7. D
8. B
9. D
10. A
11. D
12. D
13. C
14. B
15. C
16. A
17. B
18. B
19. D
20. C
21. A
22. C
23. C
24. D
25. D
26. C
27. B
28. A
29. C
30. B
31. D
32. D
33. C
34. C