JASPERSE CHEM 160 PRACTICE TEST 3 VERSION 3

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 combinations would provide buffer solutions?

Combination 1:	0.6 moles of NaCN and 0.2 moles of HCl
Combination 2:	0.4 moles of NaCN and 0.2 moles of HCN
Combination 3:	0.6 moles of NaCN and 0.6 moles of HCl
Combination 4:	0.6 moles of NaCN and 0.2 moles of NaOH

a. Combination 1 only
b. Combination 2 only
c. Combinations 1 and 2 only
d. Combinations 2 and 4 ony
e. Combinations 1, 2, and 3 only

2. K_a for acetic acid CH_3COOH is 1.7×10^{-5}. The pH of a buffer prepared by combining 50.0 mL of 1.00 M CH_3COONa and 50.0 mL of 1.00 M CH_3COOH is:

a. 1.70
b. 0.85
c. 3.40
d. 4.77
e. 2.38

3. Consider a solution prepared by dissolving 0.35 mol of CH_3NH_3Cl (methylamine hydrochloride) in 1.00 L of 1.1 M CH_3NH_2 (methylamine). If 10 mL of 0.10 M NaOH is added to this buffer solution, the pH of the solution will _____ slightly but not dramatically because the NaOH reacts with the _____ present in the solution.

   a. Increase, $CH_3NH_3^+$
   b. Increase, CH_3NH_2
   c. Decrease, CH_3NH_2
   d. Decrease, $CH_3NH_3^+$

4. Consider a solution containing 0.80 M HOCl (K_a for HOCl is 3.5×10^{-8}) and 0.60 M NaOCl. Calculate the pH after 20 mL of 1.00 M HCl is added to 60 mL of this buffer solution.

   a. 6.83
   b. 8.24
   c. 4.67
   d. 8.90
   e. none of the above.

5. Determine the pH of a solution prepared by mixing 40.0 mL of 0.60 M HCl with 100.0 mL of 0.40 M NaF (HF $K_a = 7.2 \times 10^{-4}$)

   a. 2.3
   b. 5.6
   c. 3.0
   d. 9.3
   e. none of the above

6. HF is a weak acid. Which of the following statement is <u>false</u>?

   a. Addition of NaOH will increase dissociation of HF, and the pH of the final solution will be higher
   b. Addition of NaF will decrease dissociation of HF, and the pH of the final solution will be higher
   c. Addition of HCl will decrease dissociation of HF, and the pH of the final solution will be lower
   d. Addition of NaCl will decrease dissociation of HF, and the pH of the final solution will be lower

7. Determine the pH of a solution prepared by mixing 40.0 mL of 0.60 M HCl with 60.0 mL of 0.40 M NaOCl (HOCl $K_a = 3.5 \times 10^{-8}$)

   a. 2.3
   b. 5.6
   c. 4.0
   d. 9.3
   e. none of the above

8. Determine the pH of a solution prepared by mixing 45 mL of 0.183 M KOH with 65 mL of 0.145 M HCl

   a. 1.31
   b. 2.92
   c. 0.74
   d. 1.97
   e. none of the above

9. An initial pH of 4.0 and an equivalence point at pH = 9.1 corresponds to a titration curve for a

   a. Strong acid to which strong base is added
   b. Strong base to which strong acid is added
   c. Weak acid to which strong acid is added
   d. Weak base to which strong acid is added
   e. Weak acid to which strong base is added

10. How many mL of 0.48 M NaOH will it take to neutralize 36 mL of 0.40 M HCl?

    a. 43 mL
    b. 30 mL
    c. 69 mL
    d. 14 mL
    e. none of the above

11. In a titration experiment it was found that a 42.0 mL sample of HNO_3 required 48.0 mL of 0.70M NaOH to reach the equivalence point. What was the molarity of the HNO_3 sample?

    a. 0.61 M
    b. 0.80 M
    c. 1.06 M
    d. 1.24 M
    e. none of the above

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

a. HNO_3 + KF
b. NH_3 + HCl
c. HCN + NaOH
d. $HClO_4$ + NaOH
e. None of the above

13. Formic acid HCOOH has $K_a = 1.8 \times 10^{-4}$. What is the concentration of the formate anion $HCOO^-$ in a solution that is 0.40M in HCOOH and 0.26M in HBr?

a. 3.5×10^{-3}
b. 8.5×10^{-3}
c. 2.8×10^{-4}
d. 8.0×10^{-6}
e. none of the above

14. Which one of the following substances, when added to a saturated solution of $Pb(OH)_2$, will <u>decrease</u> the solubility of $Pb(OH)_2$ in the solution?

a. $NaNO_3$
b. NaOH
c. HNO_3
d. $Pb(NO_3)_3$

15. Calculate the molar solubility of Ag_2CO_3 ($K_{sp} = 6.2 \times 10^{-12}$)

a. 1.2×10^{-4} M
b. 2.5×10^{-6} M
c. 6.2×10^{-7} M
d. 1.2×10^{-6} M
e. none of the above

16. The solubility of $PbCl_2$ is 1.6×10^{-2} M. What is the K_{sp} for $PbCl_2$?

a. 5.0×10^{-4} M
b. 4.1×10^{-6} M
c. 3.1×10^{-7} M
d. 1.6×10^{-5} M
e. none of the above

17. The K_{sp} for $Zn(OH)_2$ is 5.0×10^{-17}. Determine the molar solubility of $Zn(OH)_2$ in a solution that has a pH of 11.50.

a. 5.0×10^{6} M
b. 1.2×10^{-12} M
c. 1.6×10^{-14} M
d. 5.0×10^{-12} M
e. none of the above

18. Which of the following compounds will <u>not</u> get more soluble as the pH gets lower?

a. AgCN
b. PbF_2
c. $PbCl_2$
d. $Ni(OH)_2$
e. None of the above

19. Which of the following is <u>false</u> regarding the solubility of MnF_3? ($K_{sp} = 3.2 \times 10^{-18}$)

a. Lowering the pH from 7.0 to 3.0 will <u>increase</u> it's solubility
b. It will be <u>less soluble</u> in a solution that already contains 0.20 M NaF, which is fully soluble, then when added to pure water
c. It will be <u>less soluble</u> in a solution that already contains 0.20 M $Mn(NO_3)_3$, which is fully soluble, then when added to pure water
d. It will be <u>less soluble</u> in a solution that already contains 0.20 M NaCl, which is fully soluble, then when added to pure water

20. Which of the following has the most entropy?

a. C_4H_6O (l)
b. $C_3H_6O_2$ (s)
c. C_3H_8 (g)
d. C_5H_{12} (g)

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

a. $NaCl\ (s) \rightarrow Na^+\ (aq) + Cl^-\ (aq)$
b. $CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$
c. $Pb^{+2}\ (aq) + 2Cl^-\ (aq) \rightarrow PbCl_2\ (s)$
d. $C_6H_{10}Br_2\ (l) \rightarrow C_6H_{10}\ (l) + Br_2\ (l)$
e. $C_6H_8\ (l) + 8O_2\ (g) \rightarrow 6CO_2\ (g) + 4H_2O\ (g)$

22. Which of the following statements is true:

a. Both ΔG_f° and S° are zero for N_2 (g)
b. Neither ΔG_f° and S° are zero for N_2 (g)
c. ΔG_f° is zero for N_2 (g) but S° is not equal to zero for N_2 (g)
d. The less positive the value of S° for a substance, the less entropy it contains

23. Calculate the ΔS° (in J/mol•K) for the following reaction, given the tabulated S° values:

$$C_2H_2\ (g) + 2H_2\ (g) \rightarrow C_2H_6\ (g)$$

Substance	S° (J/mol•K)
H_2 (g)	131
C_2H_2 (g)	201
C_2H_4 (g)	219
C_2H_6 (g)	230
H_2O (g)	189

a. -117
b. -102
c. 233
d. -233

24. Calculate the ΔG° (in kJ/mol) for the following reaction, given the tabulated ΔG_f° values:

$$2NO\ (g) + O_2\ (g) \rightarrow 2NO_2\ (g)$$

Substance	ΔG_f° (kJ/mol)
NO (g)	86.7
NO_2 (g)	51.8

a. -35
b. -70
c. 105
d. -105
e. none of the above

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

$$C\ (s) + H_2O\ (g) \rightarrow CO\ (g) + H_2\ (g) \qquad \Delta H^\circ = +131\ kJ/mol,\ \Delta S^\circ = +134\ J/mol•K$$

a. Above 273˚C
b. Above 325˚C
c. Above 552˚C
d. Above 705˚C
e. At all temperatures

26. What is the value of ΔG° (in kJ/mol) for this reaction at 25˚C?

$$A\ (g) \rightarrow B\ (g) \qquad \Delta H^\circ = -42.4\ kJ/mol \qquad \Delta S^\circ = -56\ J/mol•K$$

a. -136
b. +236
c. -26
d. -59
e. none of the above

27. For a reaction to be product favored at all temperatures, what must be true for the signs of ΔH° and ΔS°?

a. Both are positive
b. Both are negative
c. ΔH° is positive and ΔS° is negative
d. ΔH° is negative and ΔS° is positive

28. What is the value of ΔH° (in kJ/mol) for this reaction at 25°C?

$$A\ (g) \rightarrow B\ (g) + C\ (g)$$

Given: $\Delta G^\circ = -42.6$ kJ/mol
$\Delta S^\circ = +131.4$ J/mol•K

a. -136
b. 13.2
c. –3.4
d. -27
e. none of the above

29. Which of the following statements is true for the product-favored reaction shown at 25°C?

$$A\ (g) \rightarrow B\ (g) \qquad \Delta H^\circ = -20\ \text{kJ/mol} \qquad \Delta S^\circ = -26\ \text{J/mol•K}$$

a. The reaction is both enthalpy and entropy driven
b. The reaction is enthalpy driven
c. The reaction is entropy driven
d. In the reaction, the overall entropy change for the universe is negative
e. This reaction is at equilibrium at 25°C

30. The dissolving of $CaCl_2$ in water is product-favored, but the temperature of the water gets colder during the process. What would be the appropriate signs for ΔG, ΔH and ΔS during this process?

$$CaCl_2\ (s) \rightarrow CaCl_2\ (aq)$$

a. ΔG is positive, ΔH is positive, and ΔS is positive
b. ΔG is negative, ΔH is positive, and ΔS is positive
c. ΔG is positive, ΔH is positive, and ΔS is negative
d. ΔG is negative, ΔH is negative, and ΔS is positive
e. ΔG is negative, ΔH is positive, and ΔS is negative

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

a. $CH_3COOH\ (l) \rightarrow CH_3COOH\ (s)$
b. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
c. $C_5H_{10}\ (l) + Cl_2(l) \rightarrow C_5H_{10}Cl_2(l)$
d. $NaCl(aq) \rightarrow NaCl(s)$
e. $FeSO_4(s) \rightarrow FeO(s) + SO_3(g)$

32. Which of the following statements is false?

a. The overall entropy of the universe is increasing
b. The overall enthalpy of the universe does not change, and is conserved
c. For a reaction at equilibrium ΔG is negative
d. A reaction will be product-favored if the overall entropy of the universe increases in the process, even if the entropy change for the system itself is not necessarily positive
e. A reactant-favored process can be pushed in the product direction by the continuous input of free energy from outside, but as soon as the outside energy stops being supplied, the reaction will stop.

33. Which of the following statements is <u>true</u> when you consider the following reaction:

$$A + B \rightarrow C + D$$

a. If $\Delta H<0$ and $\Delta S<0$, then the reaction is product-favored at all temperatures
b. If $\Delta H<0$ and $\Delta S<0$, then the reaction is never product-favored at any temperature
c. If $\Delta H<0$ and $\Delta S<0$, then the reaction is product-favored at high temperatures but not at low temperature
d. If $\Delta H<0$ and $\Delta S<0$, then the reaction is product-favored at low temperatures but not at high temperatures

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Chem 160
Answers, Test3
Version 3

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