JASPERSE CHEM 160 PRACTICE TEST 3 VERSION 2

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

Key Equations:

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

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

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. A solution containing which one of the following pairs of substances could be a buffer?

   a. NaI, HI
   b. KBr, HBr
   c. NH_4Cl, HCl
   d. KOCl, HOCl
   e. None of the above

2. 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

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 HCl is added to this buffer solution, the pH of the solution will _____ slightly because the HCl 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 NaF and 0.80 M HF. Calculate the moles of HF and the concentration of HF after addition of 20.0 mL of 0.40 M HCl to 60.0 mL of this buffer solution.

   a. 0.056 moles, 0.70 M
   b. 0.056 moles, 0.93 M
   c. 0.048 moles, 0.60 M
   d. 0.040 moles, 0.67 M
   e. none of the above.

5. What change will be caused by addition of 0.10 moles of HNO_3 to a 1 liter solution containing 0.50 moles of KF and 0.50 moles of HF?

   a. The concentration of hydronium ion will significantly increase, and the pH will drop by several pH units
   b. The concentration of fluoride will increase as will the concentration of hydronium ion
   c. The concentration of HF will be decreased and the concentration of fluoride will be increased
   d. The concentration of fluoride will be decreased and the concentration of HF will be increased
   e. The fluoride ion will precipitate out of solution

6. What will be the pH if 0.20 moles of NaOH is added to a 1.0 L solution originally containing 0.60 moles of HNO_2 and 0.40 moles of $NaNO_2$? (HNO_2 $K_a = 4.5 \times 10^{-4}$)

   a. 2.31
   b. 3.17
   c. 3.52
   d. 8.97
   e. none of the above

7. Determine the pH of a solution prepared by mixing 40.0 mL of 0.60 M HCl with 80.0 mL of 0.30 M NaOCl ($HOCl$ $K_a = 3.5 \times 10^{-8}$)

   a. 2.3
   b. 5.6
   c. 4.1
   d. 9.3
   e. none of the above

8. Which of the following statements is false, regarding a solution containing 0.20 moles of the weak acid HOCl.

    a. Adding NaOH will both increase the dissociation of HOCl, and decrease $[H^+]$
    b. Adding HCl will both decreased the dissociation of HOCl and decrease $[OCl^-]$
    c. Adding NaOCl will both increase the dissociation of the original HOCl, and will increase $[H^+]$
    d. Adding NaCl will not affect either the dissociation of the original HOCl or the solution pH

9. If the solid CuF_2 has a solubility of 0.0020 mol/L, what is the value of K_{sp}?

    a. 1.8×10^{-7}
    b. 4.0×10^{-6}
    c. 3.2×10^{-8}
    d. 8.0×10^{-9}
    e. none of the above

10. Calculate the pH of a solution containing 0.818 M acetic acid ($K_a = 1.76 \times 10^{-5}$) and 0.172 M sodium acetate.

    a. 4.08
    b. 5.43
    c. 8.57
    d. 8.37

11. Determine the pH of a solution prepared by mixing 40 mL of 0.30 M KOH with 30 mL of 0.40 M HCl.

    a. 6.3
    b. 7.0
    c. 8.1
    d. 5.8
    e. none of the above

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

    a. $HClO_4$ + NaF
    b. HNO_3 + KOH
    c. NH_4Cl + NaOH
    d. HF + NaOH
    e. None of the above

13. An initial pH of 10.7 and an equivalence point at pH = 4.5 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 base to which strong base is added

14. In a titration experiment it was found that a 50.0 mL sample of HNO_3 required 66.0 mL of 0.80M NaOH to reach the equivalence point. What was the molarity of the HNO_3 sample?

    a. 0.61 M
    b. 0.86 M
    c. 1.06 M
    d. 1.24 M
    e. none of the above

15. 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

16. Hydrazoic acid HN_3 has $K_a = 2.0 \times 10^{-5}$. What is the concentration of the azide anion N_3^- in a solution that is 0.50M in HN_3 and 0.40M in HNO_3?

    a. 3.5×10^{-3}
    b. 2.5×10^{-5}
    c. 2.0×10^{-6}
    d. 8.0×10^{-6}
    e. none of the above

17. Which of the following salts would have it's solubility influenced by pH, such that solubility increases at low pH?

    a. $Ca(NO_3)_2$
    b. CaF_2
    c. $CaCl_2$
    d. $CaBr_2$
    e. CaI_2

18. Calculate the concentration of iodide ions in a saturated solution of PbI_2 ($K_{sp} = 1.4 \times 10^{-8}$)

a. 1.5×10^{-3} M
b. 3.0×10^{-3} M
c. 4.2×10^{-2} M
d. 3.5×10^{-9} M
e. none of the above

19. KCN is completely soluble. What would be the molar solubility of AgCN when added to a solution that was 0.010 M in KCN, if $K_{sp} = 1.2 \times 10^{-16}$ for AgCN?

a. 5.2×10^{-11} M
b. 1.1×10^{-8} M
c. 1.2×10^{-14} M
d. 4.6×10^{-13} M
e. none of the above

20. 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. H_2O_2
c. HNO_3
d. $Pb(NO_3)_3$

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

a. $2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (g)$
b. $2NO_2\ (g) \rightarrow N_2O_4\ (g)$
c. $BaF_2\ (s) \rightarrow Ba^{+2}\ (aq) + 2F^-\ (aq)$
d. $H^+\ (aq) + F^-\ (aq) \rightarrow HF\ (aq)$

22. Calculate the entropy for Cl_2 (g) (in J/mol•K), given the overall ΔS° for the following reaction, and the available S° values tabulated:

$$2NO\ (g) + Cl_2\ (g) \rightarrow 2NOCl\ (g) \qquad \Delta S^\circ = -117\ J/mol•K$$

Substance	S°
NO (g)	211
NO_2 (g)	240
NOCl (g)	264
N_2O (g)	220

a. 106
b. 11
c. 223
d. -223

23. Which of the following would have the greatest entropy?

a. C_3H_8O (l) at 20˚C
b. C_5H_{12} (g) at 20˚C
c. C_3H_8 (l) at 80˚C
d. C_4H_{10} (g) at 80˚C
e. C_5H_{12} (g) at 80˚C

24. What is the value of ΔS° (in J/mol•K) for this reaction at 25˚C?

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

Given: $\Delta G^\circ = +91$ kJ/mol
$\Delta H^\circ = +131.4$ kJ/mol

a. -136
b. 1.6
c. -1.6
d. 136
e. none of the above

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

a. The driving force behind the expansion of a gas is the dispersal of matter
b. Exothermic reactions are often product-favored because energy is dispersed to the surrounding
c. The entropy of the universe is increasing, but the enthalpy of the universe is constant
d. Both the entropy and the enthalpy of the universe are constant

26. Consider a pure, crystalline solid being heated from absolute zero to some very high temperature. Which one of the following processes produces the greatest increase in the entropy of the substance?

a. Melting the solid
b. Heating the liquid
c. Heating the gas
d. Heating the solid
e. Boiling the liquid

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

Reaction 1: $2Na + Cl_2 \rightarrow 2NaCl$
Reaction 2: $2H_2 + O_2 \rightarrow 2H_2O$
Reaction 3: $H_2O(l) \rightarrow H_2O(s)$ at 25˚C

a. Reaction 1 only
b. Reaction 2 only
c. Reaction 3 only
d. Reactions 1 and 2 only
e. Reactions 1 and 3 only

28. For a reaction to be product favored at high temperature but not at low temperature, 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

29. What is the value for ΔG°, at 25°C?

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

$\Delta H^\circ = -54.0$ kJ/mol
$\Delta S^\circ = +87.0$ J/mol•K

a. –65 kJ/mol
b. –80 kJ/mol
c. $+2.6 \times 10^4$ kJ/mol
d. –56 kJ/mol
e. none of the above

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

$$C_4H_6\ (g) + 2H_2O\ (g) \rightarrow C_4H_8(OH)_2\ (l)$$

Substance	ΔG_f° (kJ/mol)
C_4H_6 (g)	-23
H_2O (g)	-229
$C_4H_8(OH)_2$ (l)	-522

a. -41
b. -270
c. +48
d. +322
e. none of the above

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

$$A\ (aq) + B\ (aq) \rightarrow C\ (s) + D\ (aq)$$

$\Delta H^\circ = -34.0$ kJ/mol
$\Delta S^\circ = -57.0$ J/mol•K

a. Above 273°C
b. Below 323°C
c. Above 552°C
d. Below 705°C
e. At all temperatures

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

a. For a reaction at equilibrium, $\Delta G = 0$ in every case
b. All reactions in which the entropy of the universe increases are product-favored
c. All reactions in which the entropy of the system increases are product-favored
d. Some reactions that are product-favored at room temperature may not be product-favored at higher temperatures.
e. It is possible for a reactant-favored process to proceed to the product side, but only if it is continuously fueled by some other source of free energy, such that the combined ΔG is negative and the overall entropy of the universe still increases

33. The conversion of solid CO_2 ("dry ice") to CO_2 gas is product-favored at room temperature. What would be the signs for ΔG, ΔH, and ΔS at room temperature?

$$CO_2\ (s) \rightarrow CO_2\ (g)$$

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

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Chem 160
Answers, Test3
Version 2

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