JASPERSE CHEM 210 PRACTICE TEST 2 VERSION 1
Ch. 14 Chemical Equilibria
Ch. 16 Acid-Base Equilibria

Key Equations:

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

for weak acids in water: $K_a = [H^+]^2/[HA]_{init}$ $[H^{\oplus}] = \sqrt{K_a \times [HA]_{init}}$

for weak based in water: $K_b = [OH^-]^2/[Base]_{init}$ $[HO^{\ominus}] = \sqrt{K_b \times [Base]_{init}}$

(the above weak acid/base equations assume <5% ionization and assume no alternative source of common ions)

$K_aK_b = 10^{-14}$ for a conjugate acid/base pair Quadratic Equation: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

1. At equilibrium

   a) All chemical processes have ceased
   b) The rate of the forward reaction equals that of the reverse
   c) The rate constant for the forward reaction equals that of the reverse
   d) Both the rate of the forward reaction equals that of the reverse and the rate constant for the forward reaction equals that of the reverse
   e) None of the above

2. Which of the following statements are false regarding the following reaction, given the equilibrium constant shown?

   $A\ (g) \rightleftharpoons B\ (g)$ $K_c = 10$

   a) At equilibrium, the reaction is product favored
   b) If [A] = 1.0 M and [B] = 1.0 M, then the reaction is not at equilibrium; the concentration of [B] will increase as the reaction moves toward equilibrium
   c) If [A] = 0.1 M and [B] = 1.0 M, then the reaction is already at equilibrium, and the concentrations of products and reactants will not change
   d) If [A] = 1.0 M and [B] = 1.0 M, then the reaction is not at equilibrium; the concentration of [A] will increase as the reaction moves toward equilibrium

3. Which one of the following will change the value of an equilibrium constant?

   a) changing temperature
   b) changing the volume of the reaction container
   c) varying the initial concentrations of reactants
   d) varying the initial concentrations of products

4. Identify the correct equilibrium expression for the following reaction.

$$6CO_2\,(g) + 6H_2O\,(l) \rightleftharpoons C_6H_{12}O_6\,(s) + 6O_2\,(g)$$

a) $[C_6H_{12}O_6]\,[O_2]^6 / [CO_2]^6\,[H_2O]^6$
b) $[CO_2]^6 / [O_2]^6$
c) $[O_2]^6 / [CO_2]^6$
d) $[O_2]^6 / [CO_2]^6\,[H_2O]^6$

5. The value of K_c for the following reaction is 2×10^{-10} at 100˚C.

$$COCl_2\,(g) \rightleftharpoons CO\,(g) + Cl_2\,(g)$$

What is the value of K_c for the reaction shown below?

$$CO\,(g) + Cl_2\,(g) \rightleftharpoons COCl_2\,(g)$$

a) -2×10^{-10}
b) 5×10^{9}
c) 2×10^{10}
d) -5×10^{9}

6. At equilibrium, the concentrations of H_2, I_2, and HI were found to be 0.15 M, 0.33 M, and 0.55 M respectively. What is the value of K_c for this reaction?

$$H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$$

a) 23
b) 111
c) 0.0090
d) 6.1

7. What is the equilibrium concentration of C_4H_{10} if the equilibrium concentrations of C_2H_6 and C_2H_4 are both 0.035 M?

$$C_4H_{10}\,(g) \rightleftharpoons C_2H_6\,(g) + C_2H_4\,(g) \qquad K_c = 0.070$$

a) 0.018 M
b) 57 M
c) 0.50 M
d) 2.0 M

8. When 1.00 mol C_6H_6 and 3.00 mol H_2 are put into a 1 L container and allowed to reach equilibrium, the resulting mixture contains 0.137 mol C_6H_{12}. What is the equilibrium amount of H_2 in moles?

$$C_6H_6\ (g) + 3H_2\ (g) \rightleftharpoons C_6H_{12}\ (g)$$

a) 0.137
b) 0.411
c) 0.0457
d) 2.59
e) 2.86

9. When 0.70 mol NO_2 was placed in a 1.00 L flask and allowed to reach equilibrium, it's concentration was found to be 0.28 M, once equilibrium was established. Calculate K_c for this reaction.

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

a) 1.9
b) 0.94
c) 0.47
d) 0.14

10. Calculate the equilibrium concentration of Cl_2 (g) if the initial concentration of ICl (g) is 1.33 M.

$$2\ ICl\ (g) \rightleftharpoons I_2\ (g) + Cl_2\ (g) \qquad K_c = 4.8 \times 10^{-6}$$

a) 2.9×10^{-3} M
b) 5.8×10^{-3} M
c) 3.2×10^{-6} M
d) 6.4×10^{-6} M

11. If the equilibrium is established by initially adding 0.40 mol each of A (g) and B (g) to a 1L container, then which of the following must be true once the mixture achieves equilibrium? (note: a calculator is not required to answer this question!)

$$2A\ (g) + B\ (g) \rightleftharpoons C\ (g) + 2D\ (g) \qquad K_c = 16$$

a) [A] = [B]
b) [A] = [D]
c) [A] > [B]
d) [A] > [D]
e) [A] < [B]

12. What effect will adding additional O_2 (g) to the following equilibrium system have, once equilibrium is reestablished?

$$2\ CO_2\ (g) \rightleftharpoons 2\ CO\ (g) + O_2\ (g) \qquad \Delta H^\circ = -514\ kJ$$

a) The concentration of CO(g) will increase
b) The concentration of CO_2 (g) will decrease
c) The equilibrium constant for the reaction will increase
d) The concentration of CO_2 (g) will increase

13. Consider the following reaction at equilibrium. Which of the following situations would cause the maximum number of moles of N_2 (g) at equilibrium:

$$2NH_3\ (g) \rightleftharpoons N_2\ (g) + 3\ H_2\ (g) \qquad \Delta H^\circ = +92.4\ kJ$$

a) High temperature and low volume
b) High temperature and high volume
c) Low temperature and high volume
d) Low temperature and low volume

14. What is the consequence of heating the following equilibrium system to a higher temperature?

$$2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g) \qquad \Delta H^\circ = -99\ kJ$$

a) The concentration of SO_3 will decrease, and the equilibrium constant will decrease
b) The concentration of SO_2 will decrease, and the equilibrium constant will decrease
c) The concentration of SO_3 will increase, and the equilibrium constant will increase
d) The equilibrium constant will neither increase nor decrease

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15. Which of the following pairs contains two weak acids?

a) HNO_3 and HF.
b) HF and C_6H_5COOH.
c) H_2SO_4 and H_2S.
d) HCl and CH_3COOH.
e) H_3PO_4 and HBr

16. What is the $[H^+]$ concentration of a solution with pH = 3.75?

a) 5.6×10^{-4} M
b) 7.5×10^{-3} M
c) 5.6×10^{-11} M
d) 1.8×10^{-4} M
e) none of the above

17. What is the $[OH^-]$ concentration of a solution with pH = 12.73?

a) 1.27 M
b) 1.9×10^{-13} M
c) 0.054 M
d) 2.3×10^{-12} M
e) none of the above

18. Which of the following possesses the lowest concentration of $[H_3O^+]$?

a) A solution with a pH = 3.0
b) A solution with a pOH = 12.0
c) A 1.0×10^{-4} M solution of HNO_3
d) Neutral water

19. Calculate the pH of a solution that is 0.030 M in HCl.

a) 3.00
b) 1.52
c) 3.51
d) 0.52

20. Which one of the following is the weakest acid?

a) HF ($K_a = 6.8 \times 10^{-4}$)
b) HClO ($K_a = 3.0 \times 10^{-8}$)
c) HNO_2 ($K_a = 4.5 \times 10^{-4}$)
d) HCN ($K_a = 4.9 \times 10^{-10}$)

21. Calculate the pH of 0.0385 M hypochlorous acid, $K_a = 3.0 \times 10^{-8}$.

a) 3.41
b) 8.94
c) 4.47
d) 5.32

22. A 0.25 M solution of the weak acid HX has a pH of 4.15. What is the value of K_a for HX?

a) 2.8×10^{-4} M
b) 1.7×10^{-10} M
c) 7.1×10^{-5} M
d) 2.0×10^{-8} M
e) none of the above

23. Calculate the pH of 0.35 M CH_3NH_2. The basicity constant K_b for $CH_3NH_2 = 4.4 \times 10^{-4}$.

a) 10.2
b) 3.8
c) 12.1
d) 1.9
e) none of the above

24. Calculate the pH of 0.15 M solution of KF (K_a for HF = 7.0×10^{-4}).

a) 12.01
b) 5.83
c) 8.17
d) 9.33
e) none of the above

25. The K_a for HCN is 4.9×10^{-10}. What is the value of K_b for CN^-?

a) 2.0×10^{-5}
b) 4.0×10^{-6}
c) 4.9×10^{4}
d) 4.9×10^{-24}

26. Which of the following is <u>not</u> a weak base?

a) $(CH_3)_2NH$
b) NaOCl
c) NaCN
d) $NaClO_4$

27. Which one of the following 0.1 M solutions would have the highest pH?

a) $FeCl_3$
b) CoI_2
c) NH_4I
d) NaF
e) KBr

28. Which one of the following 0.1 M solutions would have a pH of 7.0?

a) NaOCl
b) KCl
c) NH_4Cl
d) $NiBr_2$
e) None of these

29. Which are the Bronsted <u>bases</u> in the following reaction?

$$H_2PO_4^-(aq) + CN^-(aq) \rightleftharpoons HPO_4^{2-}(aq) + HCN(aq)$$

a) $H_2PO_4^-$ and HPO_4^{2-}
b) $H_2PO_4^-$ and HCN
c) CN^- and HPO_4^{2-}
d) CN^- and HCN

30. Which of the following is <u>not</u> a conjugate acid-base pair?

a) $(CH_3)_2NH_2^+$, $(CH_3)_2NH$
b) H_2CO_3, HCO_3^-
c) H_2Te, HTe^-
d) H_2SO_4, SO_4^{2-}

31. H_2CO_3 is a _____ acid; (weak or strong)
H_2CO_3 is a _____ acid than HCO_3^-, (weaker or stronger)
and HCO_3^- is a _____ base than CO_3^{2-}. (weaker or stronger)

a) strong, stronger, stronger
b) weak, weaker, weaker
c) weak, stronger, weaker
d) weak, stronger, stronger
e) strong, weaker, stronger

32. For the reaction shown, which of the following statements would be false?

$$HF(aq) + CN^-(aq) \rightleftharpoons HCN(aq) + F^-(aq) \quad K = 1.8 \times 10^6$$

a) HF is the strongest acid
b) Fluoride anion is the strongest base
c) Cyanide anion is the strongest base
d) The solution will contain more HCN than HF at equilibrium

33. Which of the following would be the <u>most basic</u>, given that acid strength decreases in the series:

$$H_3PO_4 > HNO_2 > H_2S > HClO.$$

a) $H_2PO_4^-$
b) NO_2^-
c) HS^-
d) ClO^-

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Chem 210
Answers, Test2
Version 1

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