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

Key Equations:

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

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

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

(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. Which of the following is <u>false</u> about a system at equilibrium:

   a) The rate of the forward reaction becomes equal to the rate of the reverse reaction
   b) So long as the equilibrium is not disturbed, the relative amounts of products and reactants present will not change no matter how long you wait
   c) In an equilibrium situation, interconversion between reactants and products continues to occur.
   d) The rate constant for the forward reaction becomes equal to the rate constant for the reverse reaction

2. Which of the following statements are true, regarding the equilibrium constant K for a reaction and the reaction quotient Q:

   1) If Q > K, the reaction is not at equilibrium, and will reach equilibrium by shifting some products over to reactants
   2) If $K = 3.2 \times 10^{-6}$, the reaction is product favored
   3) If $K = 5.2 \times 10^{4}$, the reaction is product favored
   4) If Q = K, the reaction is already at equilibrium.

   a) 1 and 2 only
   b) 1, 2, and 4 only
   c) 1, 3, and 4 only
   d) 3 and 4 only
   e) 2 and 4 only

3. Which of the following statements are <u>true</u> regarding equilibrium constants for the following reaction:

$$2\,NH_3\,(g) \rightleftharpoons N_2\,(g) + 3H_2\,(g) \qquad \Delta H^\circ = +92\text{ kJ}$$

   a) Increasing the volume of the container will increase the equilibrium constant
   b) Increasing the temperature of the reaction will increase the equilibrium constant
   c) Increasing the volume of the container will increase the concentration of NH_3 (g)
   d) Increasing the concentration of H_2 (g) will increase the equilibrium constant
   e) Increasing the concentration of NH_3 (g) will increase the equilibrium constant

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

$$A\ (aq) + 2B\ (aq) \rightleftharpoons C\ (aq) + D\ (s)$$

a) $[A]\,[B]^2 / [C]\,[D]$
b) $[C]\,[D] / [A]\,[B]^2$
c) $[A]\,[B]^2 / [C]$
d) $[C] / [A]\,[B]^2$

5. For the following reaction, determine whether the system is at equilibrium when [CO] = 0.50 M and [CO_2] = 0.75 M. The system __________ at equilibrium, because __________________ ___.

$$C\ (s) + CO_2\ (g) \rightleftharpoons 2\ CO\ (g) \qquad K_c = 168$$

a) Is; the value of Q is 0.33
b) Is not; the value of Q is 0.33
c) Is; the value of Q is 0.67
d) Is not; the value of Q is 0.67
e) More information is needed to answer this question

6. What is the equilibrium constant K_c for the following reaction, if at equilibrium [C_4H_{10}] = 0.018 M, [C_2H_6] = 0.035 M, and [C_2H_4] = 0.035 M?

$$C_4H_{10}\ (g) \rightleftharpoons C_2H_6\ (g) + C_2H_4\ (g)$$

a) 0.068
b) 0.13
c) 14
d) 2.2×10^{-5}

7. What is the equilibrium concentration of N_2O (g) (in moles/liter), if at equilibrium [N_2]= 0.048 M and [O_2] = 0.093 M?

$$2N_2\ (g) + O_2\ (g) \rightleftharpoons 2\ N_2O\ (g) \qquad K_c = 1.5 \times 10^{-30}$$

a) 8.2×10^{-17}
b) 1.8×10^{-17}
c) 4.7×10^{-27}
d) 3.4×10^{-28}
e) 3.2×10^{-34}

8. When 1.00 mol NH_3 (g) was placed into a 1 L container and allowed to reach equilibrium, the resulting mixture contained 0.60 mol NH_3 (g). How many moles of N_2 (g) and H_2 (g) are present at equilibrium?

$$2\ NH_3\ (g) \rightleftharpoons N_2\ (g) + 3H_2\ (g)$$

a) 0.40 moles of N_2 ; 1.20 moles of H_2
b) 0.80 moles of N_2 ; 2.40 moles of H_2 (g)
c) 0.20 moles of N_2 ; 0.60 moles of H_2 (g)
d) 0.80 moles of N_2 ; 0.27 moles of H_2 (g)
e) 0.20 moles of N_2 ; 0.40 moles of H_2 (g)

9. 0.50 mol of I_2 (g) and 0.50 mol of Br_2 (g) are placed in a 1.00 L flask and allowed to reach equilibrium. At equilibrium, the flask contains 0.84 mol of IBr. What is the value of K_c for this reaction?

$$I_2\ (g) + Br_2\ (g) \rightleftharpoons 2IBr\ (g)$$

a) 11
b) 4.0
c) 110
d) 6.1

10. 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

11. Calculate the equilibrium concentration of CO (g) and Cl_2 (g) if the initial concentration of $COCl_2$ (g) was 0.0627 M.

$$COCl_2\ (g) \rightleftharpoons CO\ (g) + Cl_2\ (g) \qquad K_c = 2.73 \times 10^{-10}$$

a) 2.30×10^{8} M
b) 1.52×10^{-4} M
c) 2.03×10^{-3} M
d) 4.14×10^{-6} M
e) 1.71×10^{-11} M

12. Consider the following reaction at equilibrium. Adding N_2 (g) to this reaction will:

$$2\ NH_3\ (g) \rightleftharpoons N_2\ (g) + 3H_2\ (g) \qquad \Delta H^\circ = +92\ kJ$$

a) Decrease the concentration of NH_3 (g) at equilibrium
b) Decrease the concentration of H_2 (g) at equilibrium
c) Increase the value of the equilibrium constant
d) Cause the reaction to shift to the right

13. Given the following equilibrium, which of the following statements is <u>true</u>?

$$C\ (s) + CO_2\ (g) \rightleftharpoons 2\ CO\ (g) \qquad \Delta H^\circ = +143\ kJ$$

a) An increase in temperature will cause a shift in the equilibrium position to the left
b) An increase in the concentration of CO_2 (g) will cause the concentration of CO (g) to decrease
c) An increase in the amount of carbon will cause the amount of CO (g) to increase
d) An increase in temperature will make the equilibrium constant get larger
e) A reduction in volume will cause a shift in the equilibrium position to the right

14. What would be the effect of reducing the volume for the following system, once equilibrium was reestablished:

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2\ NH_3\ (g) \qquad \Delta H^\circ = +92\ kJ$$

a) Decrease the number of moles of NH_3 (g) at equilibrium
b) Decrease the number of moles of H_2 (g) at equilibrium
c) Decrease the value of the equilibrium constant
d) Cause the reaction to shift to the left

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15. The $[H^+]$ and pH of 0.021 M HNO_3 are:

a) 4.8×10^{-13} M and 12.32
b) 0.021 M and 12.32
c) 0.021 M and 1.68
d) 0.021 M and –1.68
e) 4.8×10^{-6} M and 5.32

16. Calculate the hydronium ion concentration in a 0.012 M aqueous solution of NaOH.

a) 7.8×10^{-4} M
b) 5.5×10^{-13} M
c) 5.6×10^{-11} M
d) 8.3×10^{-13} M
e) none of the above

17. What is the $[OH^-]$ concentration of a solution with pH = 4.50?

a) 3.2×10^{-5} M
b) 8.2×10^{-9} M
c) 8.3×10^{-10} M
d) 3.2×10^{-10} M
e) none of the above

18. A 0.55 M solution of the weak acid HBrO has a pH of 4.48. What is the value of K_a for HBrO?

a) 2.0×10^{-9} M
b) 1.1×10^{-9} M
c) 6.0×10^{-5} M
d) 3.3×10^{-5} M
e) none of the above

19. Calculate the pH of 0.020 M hypochlorous acid, $K_a = 3.0 \times 10^{-8}$.

a) 2.45
b) –2.45
c) 3.60
d) 9.22
e) 4.61

20. The basicity constant K_b for $C_6H_5NH_2 = 4.3 \times 10^{-10}$. Calculate the pH of a 0.15 M solution of $C_6H_5NH_3^+$ in water.

a) 11.3
b) 8.6
c) 5.2
d) 2.7
e) none of the above

21. Calculate the pH of a 0.20 M solution of $C_4H_5NH_2$ in water. The basicity constant K_b for $C_4H_5NH_2 = 3.5 \times 10^{-6}$.

a) 3.1
b) 4.9
c) 10.9
d) 9.6
e) none of the above

22. The K_a for HF is 7.0×10^{-4}. What is the value of K_b for NaF?

a) 2.0×10^{-8}
b) 1.4×10^{-11}
c) 7.0×10^{-18}
d) 1.4×10^{-10}
e)

23. Calculate the pH of 0.374 M solution of $NaNO_2$ (K_a for $HNO_2 = 4.5 \times 10^{-4}$).

a) 8.5
b) 1.9
c) 0.013
d) 12.1
e) none of the above

24. Which one of the following is the strongest acid?

a) CH_3COOH ($K_a = 1.8 \times 10^{-5}$)
b) HCOOH ($K_a = 1.0 \times 10^{-4}$)
c) HClO ($K_a = 3.0 \times 10^{-8}$)
d) HF ($K_a = 6.8 \times 10^{-4}$)

25. What is the conjugate acid of $C_4H_7NH_2$?

a) $C_4H_7NH^+$
b) $C_4H_7NH^-$
c) $C_4H_7NH_3^-$
d) $C_4H_7NH_3^+$

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

a) Na_2S
b) $CoCl_3$
c) $NaNO_3$
d) NH_4Cl
e) None of these

27. Given the K_a values shown, which one of the anions shown is the strongest base?

CH_3COOH ($K_a = 1.8 \times 10^{-5}$) HCOOH ($K_a = 1.0 \times 10^{-4}$)
HClO ($K_a = 3.0 \times 10^{-8}$) HF ($K_a = 6.8 \times 10^{-4}$)

a) CH_3COO^-
b) $HCOO^-$
c) ClO^-
d) F^-

28. For the reaction shown, which of the following statements would be <u>false</u>?

$$H_2CO_3\ (aq) + CH_3COO^-\ (aq) \rightleftharpoons CH_3COOH\ (aq) + HCO_3^-\ (aq) \quad K = 2.3 \times 10^{-2}$$

a) CH_3COOH is the strongest acid
b) HCO_3^- anion is the strongest base
c) H_2CO_3 is the strongest acid
d) The solution will contain more H_2CO_3 than CH_3COOH at equilibrium

29. Which of the following would give an acidic solution in water?

a) NaCN
b) KF
c) NH_3
d) CH_3COOH

30. Rank the relative basicity of NH_3, OH^-, F^-, HSO_4^-, given the following acidity data:

NH_4^+ ($K_a = 1.8 \times 10^{-5}$) HF ($K_a = 7.2 \times 10^{-4}$)

a) $OH^- > NH_3 > HSO_4^- > F^-$
b) $OH^- > F^- > NH_3 > HSO_4^-$
c) $HSO_4^- > F^- > NH_3 > OH^-$
d) $OH^- > NH_3 > F^- > HSO_4^-$
e) None of the above

31. Which of the following would <u>not</u> give an acidic solution?

a) H_2S
b) NH_4Cl
c) $NaNO_2$
d) $FeCl_3$
e) None of these

32. Which of the following acidity relationships is <u>true</u>?

a) $H_2SO_3 > H_2SO_4$
b) $H_2PO_4^- > HPO_4^{2-}$
c) $HF > HClO_4$
d) $H_2CO_3 > HNO_3$
e) None of these

33. For the reaction shown, which of the following statements would be <u>false</u>?

$$H_2SO_3\ (aq) + HS^-\ (aq) \rightleftharpoons HSO_3^-\ (aq) + H_2S\ (aq)$$

a) H_2SO_3 and H_2S are acids
b) HS^- and HSO_3^- are bases
c) The equilibrium will favor the side with the weaker acid and the weaker base
d) H_2SO_3 and HS^- are a conjugate acid/base pair

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Chem 210
Answers, Test2
Version 2

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