

Key Equations:

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

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

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

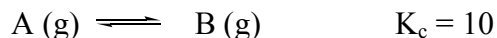
(the above weak acid/base equations assume <5% ionization and assume no alternative source of common ions)

$$K_a K_b = 10^{-14} \text{ for a conjugate acid/base pair} \quad \text{Quadratic Equation:} \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1. At equilibrium

- All chemical processes have ceased
- The rate of the forward reaction equals that of the reverse
- The rate constant for the forward reaction equals that of the reverse
- 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
- None of the above

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

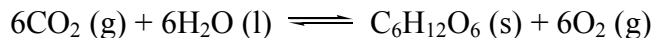


- At equilibrium, the reaction is product favored
- If $[\text{A}] = 1.0 \text{ M}$ and $[\text{B}] = 1.0 \text{ M}$, then the reaction is not at equilibrium; the concentration of $[\text{B}]$ will increase as the reaction moves toward equilibrium
- If $[\text{A}] = 0.1 \text{ M}$ and $[\text{B}] = 1.0 \text{ M}$, then the reaction is already at equilibrium, and the concentrations of products and reactants will not change
- If $[\text{A}] = 1.0 \text{ M}$ and $[\text{B}] = 1.0 \text{ M}$, then the reaction is not at equilibrium; the concentration of $[\text{A}]$ will increase as the reaction moves toward equilibrium

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

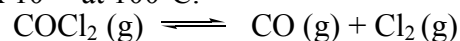
- changing temperature
- changing the volume of the reaction container
- varying the initial concentrations of reactants
- varying the initial concentrations of products

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

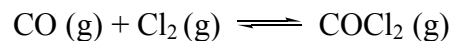


- a) $\frac{[\text{C}_6\text{H}_{12}\text{O}_6] [\text{O}_2]^6}{[\text{CO}_2]^6 [\text{H}_2\text{O}]^6}$
 b) $\frac{[\text{CO}_2]^6}{[\text{O}_2]^6}$
 c) $\frac{[\text{O}_2]^6}{[\text{CO}_2]^6}$
 d) $\frac{[\text{O}_2]^6}{[\text{CO}_2]^6 [\text{H}_2\text{O}]^6}$

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

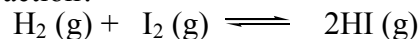


What is the value of K_c for the reaction shown below?



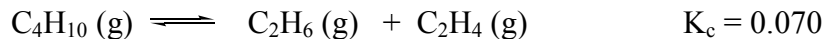
- a) -2×10^{-10}
 b) 5×10^9
 c) 2×10^{10}
 d) -5×10^9

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?



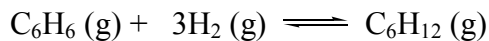
- a) 23
 b) 111
 c) 0.0090
 d) 6.1

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?

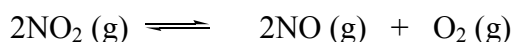


- a) 0.018 M
 b) 57 M
 c) 0.50 M
 d) 2.0 M

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?



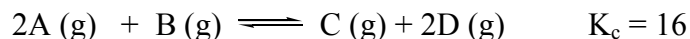
- a) 0.137
 b) 0.411
 c) 0.0457
 d) 2.59
 e) 2.86
9. When 0.70 mol NO_2 was placed in a 1.00 L flask and allowed to reach equilibrium, its concentration was found to be 0.28 M, once equilibrium was established. Calculate K_c for this reaction.



- 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.



- a) $2.9 \times 10^{-3} M$
 b) $5.8 \times 10^{-3} M$
 c) $3.2 \times 10^{-6} M$
 d) $6.4 \times 10^{-6} M$
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!)

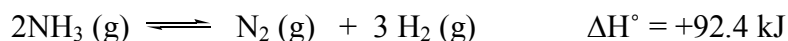


- a) $[A] = [B]$
 b) $[A] = [D]$
 c) $[A] > [B]$
 d) $[A] > [D]$
 e) $[A] < [B]$

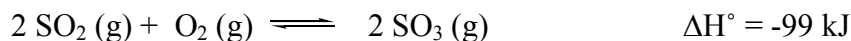
12. What effect will adding additional $O_2(g)$ to the following equilibrium system have, once equilibrium is reestablished?



- The concentration of $CO(g)$ will increase
 - The concentration of $CO_2(g)$ will decrease
 - The equilibrium constant for the reaction will increase
 - 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:



- High temperature and low volume
 - High temperature and high volume
 - Low temperature and high volume
 - Low temperature and low volume
14. What is the consequence of heating the following equilibrium system to a higher temperature?



- The concentration of SO_3 will decrease, and the equilibrium constant will decrease
- The concentration of SO_2 will decrease, and the equilibrium constant will decrease
- The concentration of SO_3 will increase, and the equilibrium constant will increase
- The equilibrium constant will neither increase nor decrease

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

- HNO_3 and HF .
- HF and C_6H_5COOH .
- H_2SO_4 and H_2S .
- HCl and CH_3COOH .
- H_3PO_4 and HBr

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

- $5.6 \times 10^{-4} \text{ M}$
- $7.5 \times 10^{-3} \text{ M}$
- $5.6 \times 10^{-11} \text{ M}$
- $1.8 \times 10^{-4} \text{ M}$
- none of the above

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

- 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 $[\text{H}_3\text{O}^+]$?

- a) A solution with a $\text{pH} = 3.0$
- b) A solution with a $\text{pOH} = 12.0$
- 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, $K_a = 3.0 \times 10^{-8}$.

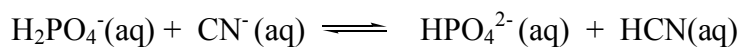
- a) 3.41
- b) 8.94
- c) 4.47
- d) 5.32

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 $\text{CH}_3\text{NH}_2 = 4.4 \times 10^{-4}$.
- 10.2
 - 3.8
 - 12.1
 - 1.9
 - none of the above
24. Calculate the pH of 0.15 M solution of KF (K_a for HF = 7.0×10^{-4}).
- 12.01
 - 5.83
 - 8.17
 - 9.33
 - none of the above
25. The K_a for HCN is 4.9×10^{-10} . What is the value of K_b for CN^- ?
- 2.0×10^{-5}
 - 4.0×10^{-6}
 - 4.9×10^4
 - 4.9×10^{-24}
26. Which of the following is not a weak base?
- $(\text{CH}_3)_2\text{NH}$
 - NaOCl
 - NaCN
 - NaClO₄
27. Which one of the following 0.1 M solutions would have the highest pH?
- FeCl₃
 - CoI₂
 - NH₄I
 - NaF
 - KBr
28. Which one of the following 0.1 M solutions would have a pH of 7.0?
- NaOCl
 - KCl
 - NH₄Cl
 - NiBr₂
 - None of these

29. Which are the Bronsted bases in the following reaction?



- 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 not a conjugate acid-base pair?

- a) $(\text{CH}_3)_2\text{NH}_2^+$, $(\text{CH}_3)_2\text{NH}$
- 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)

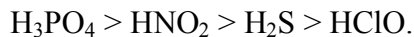
- a) strong, stronger, stronger
- b) weak, weaker, weaker
- c) weak, stronger, weaker
- d) weak, stronger, stronger
- e) strong, weaker, stronger

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



- 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 most basic, given that acid strength decreases in the series:



- 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