

Key Equations:

$$[\text{H}^+][\text{OH}^-] = 1.00 \times 10^{-14}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{for weak acids: } K_a = [\text{H}^+]^2/[\text{HA}]_{\text{init}}$$

$$[\text{H}^+] = K_a \cdot [\text{HA}]_{\text{init}}$$

$$\text{for weak bases: } K_b = [\text{OH}^-]^2/[\text{Base}]_{\text{init}}$$

$$[\text{OH}^-] = K_b \cdot [\text{Base}]_{\text{init}}$$

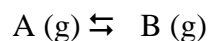
(the above weak acid/base equations assume <5% ionization and assume no alternative source of common ions)

$$K_a K_b = 10^{-14} \text{ for a conjugate acid/base pair}$$

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?



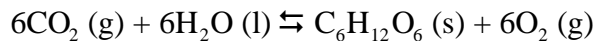
$$K_c = 10$$

- a) At equilibrium, the reaction is product favored
- b) 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
- c) 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
- d) 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?

- 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.

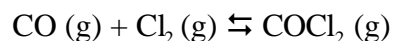


- a) $[\text{C}_6\text{H}_{12}\text{O}_6] [\text{O}_2]^6 / [\text{CO}_2]^6 [\text{H}_2\text{O}]^6$
- b) $[\text{CO}_2]^6 / [\text{O}_2]^6$
- c) $[\text{O}_2]^6 / [\text{CO}_2]^6$
- d) $[\text{O}_2]^6 / [\text{CO}_2]^6 [\text{H}_2\text{O}]^6$

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

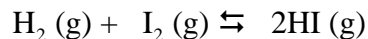


What is the value of K_c for the reaction shown below?



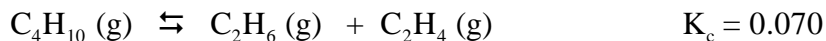
- a) -2×10^{-10}
- b) 5×10^9
- c) 2×10^{10}
- d) -5×10^9

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?



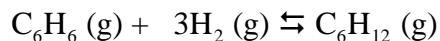
- a) 23
- b) 111
- c) 0.0090
- d) 6.1

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

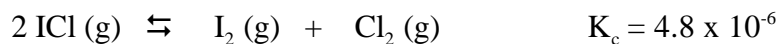
8. When 1.00 mol C_6H_6 and 3.00 mol H_2 are put into a 1 L container and allowed to reach equilibrium, the resulting mixture contains 0.137 mol C_6H_{12} . What is the equilibrium amount of H_2 in moles?



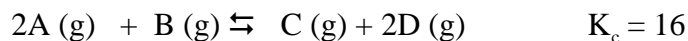
- a) 0.137
 - b) 0.411
 - c) 0.0457
 - d) 2.59
 - e) 2.86
9. When 0.70 mol NO_2 was placed in a 1.00 L flask and allowed to reach equilibrium, its concentration was found to be 0.28 M, once equilibrium was established. Calculate K_c for this reaction.



- a) 1.9
 - b) 0.94
 - c) 0.47
 - d) 0.14
10. Calculate the equilibrium concentration of $\text{Cl}_2 (\text{g})$ if the initial concentration of $\text{ICl} (\text{g})$ is 1.33 M.

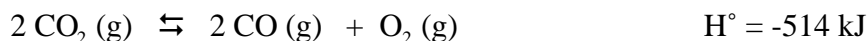


- a) $2.9 \times 10^{-3} \text{ M}$
 - b) $5.8 \times 10^{-3} \text{ M}$
 - c) $3.2 \times 10^{-6} \text{ M}$
 - d) $6.4 \times 10^{-6} \text{ M}$
11. If the equilibrium is established by initially adding 0.40 mol each of A (g) and B (g) to a 1L container, then which of the following must be true once the mixture achieves equilibrium? (note: a calculator is not required to answer this question!)



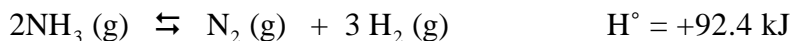
- a) $[\text{A}] = [\text{B}]$
- b) $[\text{A}] = [\text{D}]$
- c) $[\text{A}] > [\text{B}]$
- d) $[\text{A}] > [\text{D}]$
- e) $[\text{A}] < [\text{B}]$

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



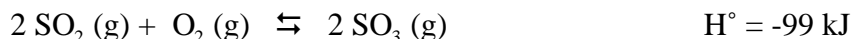
- a) The concentration of $\text{CO}(\text{g})$ will increase
- b) The concentration of CO_2 (g) will decrease
- c) The equilibrium constant for the reaction will increase
- d) The concentration of CO_2 (g) will increase

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:



- 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?



- 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

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

- a) HNO_3 and HF .
- b) HF and $\text{C}_6\text{H}_5\text{COOH}$.
- c) H_2SO_4 and H_2S .
- d) HCl and CH_3COOH .
- e) H_3PO_4 and HBr

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

- a) $5.6 \times 10^{-4} \text{ M}$
- b) $7.5 \times 10^{-3} \text{ M}$
- c) $5.6 \times 10^{-11} \text{ M}$
- d) $1.8 \times 10^{-4} \text{ M}$
- e) 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 $\text{CH}_3\text{NH}_2 = 4.4 \times 10^{-4}$.

- 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 not a weak base?

- a) $(\text{CH}_3)_2\text{NH}$
- b) NaOCl
- c) NaCN
- d) NaClO_4

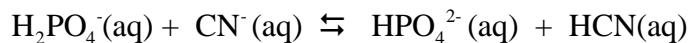
27. Which one of the following 0.1 M solutions would have the highest pH?

- 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 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

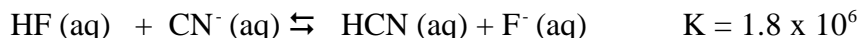
30. Which of the following is not a conjugate acid-base pair?

- 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)

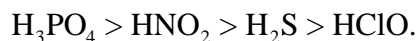
- a) strong, stronger, stronger
- b) weak, weaker, weaker
- c) weak, stronger, weaker
- d) weak, stronger, stronger
- e) strong, weaker, stronger

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 160
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