

Key Equations:

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

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

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

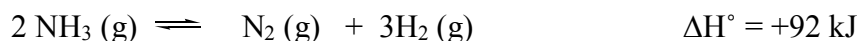
(the above weak acid/base equations assume <5% ionization and assume no alternative source of common ions)

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

- Which of the following is false about a system at equilibrium:
 - The rate of the forward reaction becomes equal to the rate of the reverse reaction
 - 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
 - In an equilibrium situation, interconversion between reactants and products continues to occur.
 - The rate constant for the forward reaction becomes equal to the rate constant for the reverse reaction

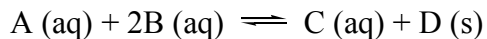
- Which of the following statements are true, regarding the equilibrium constant K for a reaction and the reaction quotient Q:
 - If $Q > K$, the reaction is not at equilibrium, and will reach equilibrium by shifting some products over to reactants
 - If $K = 3.2 \times 10^{-6}$, the reaction is product favored
 - If $K = 5.2 \times 10^4$, the reaction is product favored
 - If $Q = K$, the reaction is already at equilibrium.
 - 1 and 2 only
 - 1, 2, and 4 only
 - 1, 3, and 4 only
 - 3 and 4 only
 - 2 and 4 only

- Which of the following statements are true regarding equilibrium constants for the following reaction:



- Increasing the volume of the container will increase the equilibrium constant
- Increasing the temperature of the reaction will increase the equilibrium constant
- Increasing the volume of the container will increase the concentration of $\text{NH}_3 (\text{g})$
- Increasing the concentration of $\text{H}_2 (\text{g})$ will increase the equilibrium constant
- Increasing the concentration of $\text{NH}_3 (\text{g})$ will increase the equilibrium constant

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

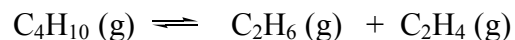


- a) $[A][B]^2 / [C][D]$
- b) $[C][D] / [A][B]^2$
- c) $[A][B]^2 / [C]$
- d) $[C] / [A][B]^2$

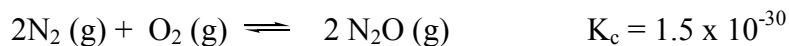
5. For the following reaction, determine whether the system is at equilibrium when $[CO] = 0.50$ M and $[CO_2] = 0.75$ M. The system _____ at equilibrium, because _____.



- 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?



- 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?

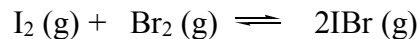


- a) 8.2×10^{-17}
- b) 1.8×10^{-17}
- c) 4.7×10^{-27}
- d) 3.4×10^{-28}
- e) 3.2×10^{-34}

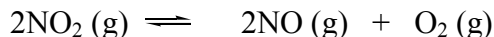
8. When 1.00 mol NH_3 (g) was placed into a 1 L container and allowed to reach equilibrium, the resulting mixture contained 0.60 mol NH_3 (g). How many moles of N_2 (g) and H_2 (g) are present at equilibrium?



- 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?



- 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, its concentration was found to be 0.28 M, once equilibrium was established. Calculate K_c for this reaction.

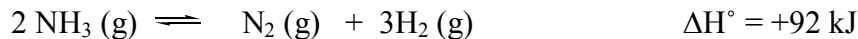


- a) 1.9
 b) 0.94
 c) 0.47
 d) 0.14
11. Calculate the equilibrium concentration of CO (g) and Cl_2 (g) if the initial concentration of COCl_2 (g) was 0.0627 M.



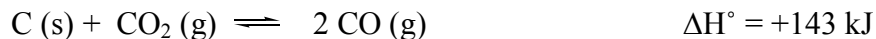
- a) 2.30×10^8 M
 b) 1.52×10^{-4} M
 c) 2.03×10^{-3} M
 d) 4.14×10^{-6} M
 e) 1.71×10^{-11} M

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



- 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 true?



- 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:



- 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

15. The $[\text{H}^+]$ 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 $[\text{OH}^-]$ concentration of a solution with $\text{pH} = 4.50$?

- a) $3.2 \times 10^{-5} \text{ M}$
- b) $8.2 \times 10^{-9} \text{ M}$
- c) $8.3 \times 10^{-10} \text{ M}$
- d) $3.2 \times 10^{-10} \text{ M}$
- 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) $2.0 \times 10^{-9} \text{ M}$
- b) $1.1 \times 10^{-9} \text{ M}$
- c) $6.0 \times 10^{-5} \text{ M}$
- d) $3.3 \times 10^{-5} \text{ M}$
- 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 $\text{C}_6\text{H}_5\text{NH}_2 = 4.3 \times 10^{-10}$. Calculate the pH of a 0.15 M solution of $\text{C}_6\text{H}_5\text{NH}_3^+$ 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 $\text{C}_4\text{H}_5\text{NH}_2$ in water. The basicity constant K_b for $\text{C}_4\text{H}_5\text{NH}_2 = 3.5 \times 10^{-6}$.

- 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 $\text{HNO}_2 = 4.5 \times 10^{-4}$).

- 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 ($K_a = 6.8 \times 10^{-4}$)

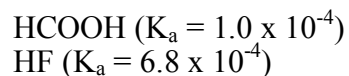
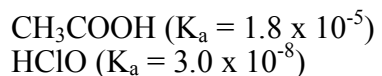
25. What is the conjugate acid of $\text{C}_4\text{H}_7\text{NH}_2$?

- a) $\text{C}_4\text{H}_7\text{NH}^+$
- b) $\text{C}_4\text{H}_7\text{NH}^-$
- c) $\text{C}_4\text{H}_7\text{NH}_3^-$
- d) $\text{C}_4\text{H}_7\text{NH}_3^+$

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?



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

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



- 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:



- a) $\text{OH}^- > \text{NH}_3 > \text{HSO}_4^- > \text{F}^-$
- b) $\text{OH}^- > \text{F}^- > \text{NH}_3 > \text{HSO}_4^-$
- c) $\text{HSO}_4^- > \text{F}^- > \text{NH}_3 > \text{OH}^-$
- d) $\text{OH}^- > \text{NH}_3 > \text{F}^- > \text{HSO}_4^-$
- e) None of the above

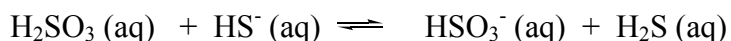
31. Which of the following would not give an acidic solution?

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

32. Which of the following acidity relationships is true?

- a) $\text{H}_2\text{SO}_3 > \text{H}_2\text{SO}_4$
- b) $\text{H}_2\text{PO}_4^- > \text{HPO}_4^{2-}$
- c) $\text{HF} > \text{HClO}_4$
- d) $\text{H}_2\text{CO}_3 > \text{HNO}_3$
- e) None of these

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



- 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