

Key Equations:

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

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

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

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

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

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)

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

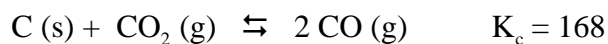
- Which of the following is false about a system at equilibrium:
 - It's a "dynamic equilibrium": reactants and products are constantly going back and forth
 - It's a "steady state"; the concentrations stay steady once equilibrium is established
 - The rate of the forward reaction exactly equals the rate of the reverse reaction
 - The equilibrium state will be the same, no matter what the direction of approach to the equilibrium. It doesn't matter whether you start from the right side or from the left side.
 - If a catalyst is present, a different equilibrium state will be achieved then if no catalyst is used
- Which of the following is true about the following system at equilibrium, given the listed K value:
$$\text{A (g)} + 2\text{B (g)} \rightleftharpoons \text{C (g)} + \text{D (g)} \quad K = 139$$
 - Products predominate
 - Reactants predominate
 - Roughly equal molar amounts of products and reactants are present
 - Only products exist
 - Only reactants exist
- 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 reactants over to products
 - If $Q > K$, the reaction is not at equilibrium, and will reach equilibrium by shifting some reactants over to products
 - If $Q = K$, the reaction is already at equilibrium.
 - If some extra reactants are added to a reaction previously at equilibrium, immediately following the addition $Q > K$
 - If some extra reactants are added to a reaction previously at equilibrium, immediately following the addition $Q < K$

- 1 and 4 only
- 2, 3, and 4 only
- 1, 3, and 5 only
- 1, 3, and 4 only
- 2, 3, and 5 only

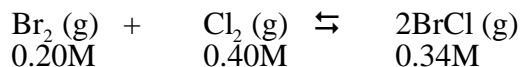
4. Identify the equation that would give the equilibrium expression shown:

$$K_c = [\text{H}_2]^2 [\text{O}_2] / [\text{H}_2\text{O}]^2$$

- a) $2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightleftharpoons \text{H}_2\text{O} (\text{g}) + \text{D} (\text{g})$
 - b) $\text{H}_2\text{O} (\text{g}) \rightleftharpoons \text{H}_2 (\text{g}) + 1/2\text{O}_2 (\text{g})$
 - c) $\text{H}_2\text{O} (\text{g}) \rightleftharpoons 2\text{H} (\text{g}) + \text{O} (\text{g})$
 - d) $2\text{H}_2\text{O} (\text{g}) \rightleftharpoons 2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g})$
5. For the following reaction, determine whether the system is at equilibrium when $[\text{CO}] = 0.60 \text{ M}$ and $[\text{CO}_2] = 0.40 \text{ M}$. The system _____ at equilibrium, because _____.



- a) Is; the value of Q is 1.50
 - b) Is not; the value of Q is 0.90
 - c) Is; the value of Q is 0.90
 - d) Is not; the value of Q is 01.11
 - e) More information is needed to answer this question
6. What is the equilibrium constant K_c for the following reaction, given the equilibrium concentrations shown?

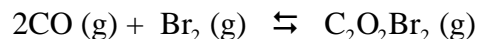


- a) 1.4
 - b) 4.2
 - c) 0.71
 - d) 2.2×10^{-3}
7. What is the equilibrium concentration of $\text{Cl}_2 (\text{g})$ (in moles/liter), given the K value and the equilibrium concentrations shown for the other chemicals?



- a) 4.5×10^{-3}
- b) 2.2×10^3
- c) 1.1×10^{-2}
- d) 4.5×10^{-6}
- e) none of the above

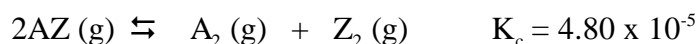
8. When 1.0 mole each of CO (g) and Br₂ (g) were placed into a 1 L container and allowed to reach equilibrium, the resulting mixture contained 0.60 moles of CO (g). How many moles of Br₂ (g) and C₂O₂Br₂ (g) are present at equilibrium?



- a) 0.60 moles of Br₂ ; 0.40 moles of C₂O₂Br₂
 - b) 0.80 moles of Br₂ ; 0.20 moles of C₂O₂Br₂
 - c) 0.20 moles of Br₂ ; 0.80 moles of C₂O₂Br₂
 - d) 0.40 moles of Br₂ ; 1.20 moles of C₂O₂Br₂
 - e) none of the above
9. 0.400 mol of HI (g) was placed in a 1.00 L flask that had no NO₂ (g) initially. After equilibration occurred, the concentration of HI (g) was found to be 0.328 M. What is the value of K_c for this reaction?



- a) 3.95×10^{-3}
 - b) 1.20×10^{-2}
 - c) 4.80×10^{-4}
 - d) 63.5
10. 0.30 mol of AZ (g) was placed in a 1.00 L flask. What is the equilibrium concentration of Z₂ (g) for this reaction?

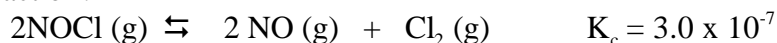


- a) $2.30 \times 10^8 \text{ M}$
 - b) $1.52 \times 10^{-4} \text{ M}$
 - c) $2.08 \times 10^{-3} \text{ M}$
 - d) $4.14 \times 10^{-6} \text{ M}$
 - e) $1.71 \times 10^{-11} \text{ M}$
11. What is the effect of increasing the temperature for the following equilibrium?



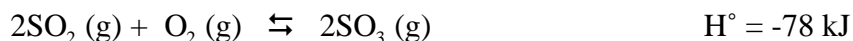
- a) There will be a shift in the position of equilibrium to the right; K will increase
- b) There will be a shift in the position of equilibrium to the left; K will decrease
- c) There will be no effect on the equilibrium position; K will not change
- d) The concentration of N₂ (g) will decrease
- e) None of the above

12. 131 g of 2NOCl (g) (65.5 g/mol) was placed in a 4.00 L flask. What is the equilibrium concentration of $\text{Cl}_2 \text{ (g)}$ for this reaction?



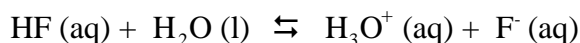
- a) $2.30 \times 10^8 \text{ M}$
- b) $1.52 \times 10^{-4} \text{ M}$
- c) $3.79 \times 10^{-3} \text{ M}$
- d) $2.66 \times 10^{-3} \text{ M}$
- e) $1.71 \times 10^{-11} \text{ M}$

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 right
- b) A reduction in volume will cause a shift in the equilibrium position to the left
- c) An increase in the concentration of $\text{O}_2 \text{ (g)}$ will cause the concentration of $\text{SO}_3 \text{ (g)}$ to increase
- d) An increase in the amount of $\text{SO}_2 \text{ (g)}$ will cause the amount of $\text{SO}_3 \text{ (g)}$ to decrease
- e) None of the above

14. Given the following equilibrium, which of the following statements is true if additional F^- is added to the solution?



- a) $[\text{H}_3\text{O}^+]$ will increase and the pH value will increase.
- b) $[\text{H}_3\text{O}^+]$ will increase and the pH value will decrease
- c) $[\text{H}_3\text{O}^+]$ will decrease and the pH value will increase
- d) $[\text{H}_3\text{O}^+]$ will decrease and the pH value will decrease
- e) none of the above

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15. The $[\text{H}^+]$ and pH of 0.0037 M HBr are:

- a) 0.0074 M and 2.43
- b) 0.0037 M and 2.43
- c) 0.0074 M and 2.13
- d) 0.0037 M and 2.13
- e) 0.0037 M and -2.13

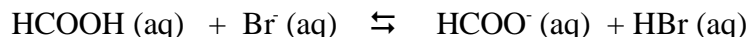
16. What is the $[H^+]$ concentration of a solution with $pH = 3.48$?
- a) $3.31 \times 10^{-4} \text{ M}$
 - b) $2.87 \times 10^{-4} \text{ M}$
 - c) $3.31 \times 10^{-3} \text{ M}$
 - d) $3.01 \times 10^{-11} \text{ M}$
 - e) none of the above
17. Calculate the hydronium ion concentration in a $1.8 \times 10^{-3} \text{ M}$ aqueous solution of NaOH .
- a) $7.8 \times 10^{-4} \text{ M}$
 - b) $5.5 \times 10^{-13} \text{ M}$
 - c) $5.6 \times 10^{-12} \text{ M}$
 - d) $8.3 \times 10^{-13} \text{ M}$
 - e) none of the above
18. The K_a for $\text{H}_2\text{S} = 9.1 \times 10^{-8}$. Calculate the pH of a 0.15 M solution of H_2S in water.
- a) 5.1
 - b) 3.9
 - c) 4.5
 - d) 7.9
 - e) none of the above
19. A 0.45 M solution of a newly discovered weak acid HZ has a pH of 2.60. What is the value of K_a for HZ ?
- a) $1.1 \times 10^{-5} \text{ M}$
 - b) $1.1 \times 10^{-4} \text{ M}$
 - c) $2.8 \times 10^{-6} \text{ M}$
 - d) $1.4 \times 10^{-5} \text{ M}$
 - e) none of the above
20. The K_b for ethylamine is 4.7×10^{-4} . What is the hydroxide ion concentration in an aqueous solution that is 0.15 M in ethylamine?
- a) $6.9 \times 10^{-5} \text{ M}$
 - b) $8.4 \times 10^{-3} \text{ M}$
 - c) $2.8 \times 10^{-5} \text{ M}$
 - d) $7.6 \times 10^{-5} \text{ M}$
 - e) none of the above

21. The basicity constant K_b for aniline, $C_6H_5NH_2 = 4.3 \times 10^{-10}$. Calculate the pH of a 0.15 M solution of aniline in water.
- 5.1
 - 8.9
 - 6.8
 - 12.0
 - none of the above
22. The K_a for a newly discovered acid is HZ is 7.0×10^{-4} . What is the value of K_b for the anion Z^- ?
- 1.4×10^{-11}
 - 4.7×10^{-11}
 - 3.5×10^{10}
 - 3.5×10^{-10}
 - 2.8×10^{-11}
23. The K_a for HF is 6.8×10^{-4} . What is the pH of an 0.19 M solution of KF in water?
- 8.2
 - 5.8
 - 9.6
 - 4.3
 - none of the above
24. What is the conjugate base of CH_3OH ?
- CH_3O^+
 - CH_3O^-
 - $CH_3OH_2^+$
 - CH_3OH^+
25. Given the K_a values shown, which one of the anions shown is the weakest 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 ($K_a = 6.8 \times 10^{-4}$) |
- CH_3COO^-
 - $HCOO^-$
 - ClO^-
 - F^-

26. Are any of the following acidity relationships false?

- a) $\text{H}_2\text{SO}_4 > \text{H}_2\text{SO}_3$
- b) $\text{H}_3\text{PO}_4 > \text{H}_2\text{PO}_4^-$
- c) $\text{HPO}_4^{2-} > \text{H}_2\text{PO}_4^-$
- d) $\text{HBr} > \text{HBrO}$
- e) $\text{HNO}_3 > \text{H}_2\text{CO}_3$

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

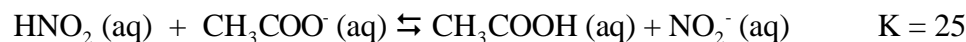


- a) HCOOH and HBr function as the acids
- b) HBr is the stronger acid, so the equilibrium will favor the left side
- c) HCOO^- would function as a base in the reaction
- d) HBr is the stronger acid, so $K > 1$
- e) HCOOH and HCOO^- are a conjugate acid/base pair

28. The acid strength decreases in the series $\text{CH}_3\text{COOH} > \text{HCN} > \text{HCO}_3^-$. Which of the following statements is true

- a) CN^- has a greater love for protons than does CH_3COO^-
- b) CN^- has a greater love for protons than does CO_3^{2-}
- c) CH_3COO^- has a greater love for protons than does CO_3^{2-}
- d) CH_3COO^- would be a stronger base than CO_3^{2-}
- e) CH_3COO^- would be a stronger base than CN^-

29. For the reaction shown, which of the following statements would be true, given the listed value for K ?



- a) CH_3COO^- is the weakest acid
- b) HNO_2 is the weakest acid
- c) CH_3COOH is the weakest acid
- d) NO_2^- is the strongest base
- e) The solution will contain more HNO_2 than CH_3COOH at equilibrium

30. Three of the following will give an acidic solution in water. Which one would not give an acidic solution in water?

- a) TiCl_4
- b) $\text{C}_3\text{H}_7\text{COOH}$
- c) NH_4Cl
- d) NaNO_3

31. Which of the following causes it's aqueous solution to be basic?

- a) NaHSO_4
- b) LiClO_4
- c) KClO
- d) FeBr_3

32. Which one of the following solutions would have a pH of 7.0?

- a) Na_2S
- b) FeCl_3
- c) NaClO_4
- d) $\text{CH}_3\text{NH}_3\text{Cl}$
- e) None of these

33. Rank the relative pH's for solutions of the following salts, from lowest pH to highest pH, given the following acidity data:



Salts: NaOH KCl NH_4Br KCN KF

- a) $\text{NH}_4\text{Br} < \text{KCl} < \text{KF} < \text{KCN} < \text{NaOH}$
- b) $\text{NH}_4\text{Br} < \text{KCl} < \text{KCN} < \text{KF} < \text{NaOH}$
- c) $\text{NaOH} < \text{KCN} < \text{KF} < \text{KCl} < \text{NH}_4\text{Br}$
- d) $\text{NH}_4\text{Br} < \text{KCN} < \text{KCl} < \text{KF} < \text{NaOH}$
- e) None of the above

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Jasperse

Chem 160

Answers, Test2

Version 3

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