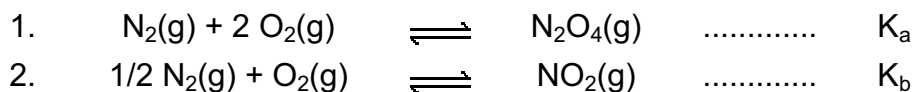
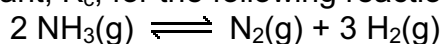


1. Consider the reaction: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
 Write the equilibrium constant for this reaction in terms of the equilibrium constants, K_a and K_b , for reactions 1 and 2 below:

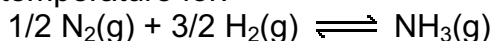


- a. K_a/K_b
- b. K_a^2/K_b
- c. K_b/K_a
- d. K_b/K_a^2
- e. K_b^2/K_a

2. The equilibrium constant, K_c , for the following reaction is 16.4 at 768 K:

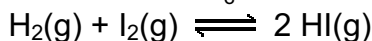


Calculate K_c at this temperature for:



- a. 268.96
- b. 4.05
- c. 0.25
- d. 0.06
- e. 0.03

3. Consider the following reaction where $K_c = 55.6$ at 698 K:



A reaction mixture was found to contain $4.05 \cdot 10^{-2}$ moles of $\text{H}_2(\text{g})$, $4.21 \cdot 10^{-2}$ moles of $\text{I}_2(\text{g})$ and 0.269 moles of $\text{HI}(\text{g})$, in a 1.00 Liter container. Which of the following statements is true?

- a. In order to reach equilibrium $\text{HI}(\text{g})$ must be consumed.
- b. In order to reach equilibrium K_c must decrease.
- c. In order to reach equilibrium H_2 must be produced.
- d. Q is less than K .
- e. The reaction is at equilibrium. No further reaction will occur.

4. The pH of an aqueous solution of 0.159 M sodium cyanide, $\text{NaCN}(\text{aq})$, is ($K_b(\text{CN}^-) = 2.5 \cdot 10^{-5}$)

- a. 0.80
- b. 2.70
- c. 4.60
- d. 9.40
- e. 11.30

5. We examine the following reaction at 250 °C: $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$. At equilibrium we find $[\text{PCl}_5] = 3.4 \times 10^{-5} \text{ M}$, $[\text{PCl}_3] = 1.3 \times 10^{-2} \text{ M}$, and $[\text{Cl}_2] = 1.0 \times 10^{-4} \text{ M}$. Calculate the equilibrium constant, K_C , for the reaction.

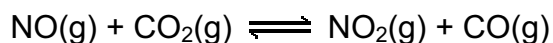
- a. 26
- b. 5.1
- c. 0.15
- d. 0.038
- e. 2.8×10^{-4}

6. A chemist prepared a sealed tube with 0.85 atm of PCl_5 at 500 K. The pressure increased as the following reaction occurred. When equilibrium was achieved, the pressure in the tube had increased to 1.25 atm. Calculate K_p .



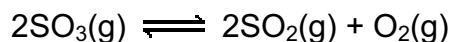
- a. 0.36
- b. 0.19
- c. 0.10
- d. 0.047
- e. 0.089

7. A mixture of 0.30 mol NO and 0.30 mole CO_2 is placed in a 2.00 L flask and allowed to reach equilibrium at a given temperature. Analysis of the equilibrium mixture indicated that 0.10 mol of CO was present. Calculate K_C for the reaction.



- a. 0.033
- b. 0.05
- c. 0.25
- d. 1.1
- e. 0.33

8. A 2.00 liter flask is filled with 1.5 mole SO_3 , 2.5 mole SO_2 , and 0.5 mole O_2 , and allowed to reach equilibrium. At this temperature, $K_C = 1.0$. Predict the effect on the concentration of O_2 as equilibrium is being achieved by using Q, the reaction quotient.



- a. $[\text{O}_2]$ will increase because $Q < K$
- b. $[\text{O}_2]$ will increase because $Q > K$
- c. $[\text{O}_2]$ will decrease because $Q < K$
- d. $[\text{O}_2]$ will decrease because $Q > K$
- e. $[\text{O}_2]$ will remain the same because $Q = K$

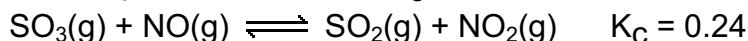
9. Consider the reaction $2A(g) \rightleftharpoons B(g)$ where $K_C = 0.5$ at the temperature of the reaction. If 2.0 moles of A and 2.0 moles of B are introduced into a 1.00 liter flask, what change in concentrations (if any) would occur in time?

- [A] increases and [B] increases
- [A] increases and [B] decreases
- [A] decreases and [B] increases
- [A] decreases and [B] decreases
- [A] and [B] remain the same

10. Consider the reaction $A(g) \rightleftharpoons 2B(g)$ where $K_C = 1.5$ at the temperature of the reaction. If 3.0 moles of A and 3.0 moles of B are introduced into a 1.00 liter flask, what change in concentrations (if any) would occur in time?

- [A] increases and [B] increases
- [A] increases and [B] decreases
- [A] decreases and [B] increases
- [A] decreases and [B] decreases
- [A] and [B] remain the same

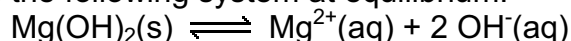
11. Exactly 0.50 mole of sulfur trioxide, 0.10 mole of sulfur dioxide, 0.20 mole of nitrogen monoxide and 0.30 mole nitrogen dioxide are sealed in a 1.0-L flask at 1500 °C. The equilibrium constant K_C is 0.24 for the following reaction.



When equilibrium is achieved, what changes in concentrations of SO_3 and NO will be observed?

- $[SO_3]$ increases; [NO] increases
- $[SO_3]$ increases; [NO] decreases
- $[SO_3]$ decreases; [NO] decreases
- $[SO_3]$ decreases; [NO] increases
- all concentrations remain the same

12. A flask contains the following system at equilibrium:



Which of the following reagents could be added to increase the solubility of $Mg(OH)_2$?

- NH_3
- NaOH
- HCl
- H_2O
- $MgCl_2$

13. All of the following can function both as an acid and base **EXCEPT**

- a. HPO_4^{2-}
- b. H_2PO_4^-
- c. HCO_2^-
- d. OH^-
- e. CH_3COO^-

14. The $K_a(\text{HCO}_3^-)$ is the equilibrium constant for the reaction

- a. $\text{H}_2\text{CO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HCO}_3^-$
- b. $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CO}_3^{2-}$
- c. $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}^- + \text{OH}^-$
- d. $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_2\text{CO}^- + \text{H}_2\text{O}$
- e. $\text{HCO}_3^- + \text{OH}^- \rightleftharpoons \text{CO}_3^{2-} + \text{H}_2\text{O}$

15. What is the pH of a 0.054 M NaOH solution at 25 °C?

- a. 1.14
- b. 1.27
- c. 8.64
- d. 12.73
- e. 13.95

16. We have a 4.63×10^{-4} M solution of HCl. What is the pH of this solution at 25 °C?

- a. 3.33
- b. 4.00
- c. 4.63
- d. 8.37
- e. 9.25

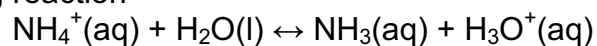
17. A 0.20 M solution of an acid, HA, has a pH of 3.82 at 25 °C. What is K_a for this acid?

- a. 7.6×10^{-4}
- b. 4.5×10^{-5}
- c. 1.1×10^{-7}
- d. 2.3×10^{-8}
- e. 4.5×10^{-9}

18. What is the pH of a 1.86 M $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ solution at 25 °C? $K_a = 1.3 \cdot 10^{-5}$

- a. 4.92
- b. 4.88
- c. 2.42
- d. 2.31
- e. 2.08

19. In the following reaction



- a. NH_4^+ is an acid and NH_3 is its conjugate base.
- b. H_2O is an acid and H_3O^+ is its conjugate base.
- c. NH_4^+ is an acid and H_3O^+ is its conjugate base.
- d. H_2O is an acid and NH_4^+ is its conjugate base.
- e. NH_3 is an acid and NH_4^+ is its conjugate base.

20. At 25 °C, what is the pH of a 3.25 M solution of ammonium chloride, NH_4Cl ?
 $K_a(\text{NH}_4^+) = 5.6 \cdot 10^{-10}$

- a. 2.37
- b. 4.37
- c. 4.62
- d. 9.37
- e. 9.63