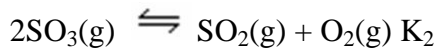
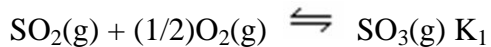


Study Guide 5

Student: _____

1. Consider the two gaseous equilibria



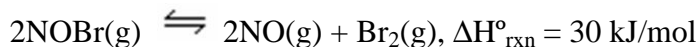
The values of the equilibrium constants K_1 and K_2 are related by

- A. $K_2 = K_1^2$
 - B. $K_2^2 = K_1$
 - C. $K_2 = 1/K_1^2$
 - D. $K_2 = 1/K_1$
 - E. none of these.
2. The equilibrium constant for the reaction $\text{Ni}(\text{s}) + 4\text{CO}(\text{g}) \rightleftharpoons \text{Ni}(\text{CO})_4(\text{g})$ is 5.0×10^4 at 25°C . What is the equilibrium constant for the reaction
- $$\text{Ni}(\text{CO})_4(\text{g}) \rightleftharpoons \text{Ni}(\text{s}) + 4\text{CO}(\text{g})?$$
- A. 2.0×10^{-5}
 - B. 2.5×10^9
 - C. 5.0×10^4
 - D. 5.0×10^{-4}
 - E. 2.0×10^{-3}
3. Calculate K_p for the reaction $2\text{NOCl}(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g})$ at 400°C if K_c at 400°C for this reaction is 2.1×10^{-2} .
- A. 2.1×10^{-2}
 - B. 1.7×10^{-3}
 - C. 0.70
 - D. 1.2
 - E. 3.8×10^{-4}

4. On analysis, an equilibrium mixture for the reaction $2\text{H}_2\text{S}(\text{g}) \rightleftharpoons 2\text{H}_2(\text{g}) + \text{S}_2(\text{g})$ was found to contain 1.0 mol H_2S , 4.0 mol H_2 , and 0.80 mol S_2 in a 4.0 L vessel. Calculate the equilibrium constant, K_c , for this reaction.
- A. 1.6
B. 3.2
C. 12.8
D. 0.64
E. 0.8
5. The reaction $\text{A}(\text{g}) + 2\text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g})$ was allowed to come to equilibrium. The initial amounts of reactants placed into a 5.00 L vessel were 1.0 mol A and 1.8 mol B. After the reaction reached equilibrium, 1.0 mol of B was found. Calculate K_c for this reaction.
- A. 0.060
B. 5.1
C. 17
D. 19
E. 25
6. Phosgene, COCl_2 , a poisonous gas, decomposes according to the equation $\text{COCl}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{Cl}_2(\text{g})$. Calculate K_p for this reaction if $K_c = 0.083$ at 900°C .
- A. 0.125
B. 8.0
C. 6.1
D. 0.16
E. 0.083
7. Equilibrium is established for the reaction $2\text{X}(\text{s}) + \text{Y}(\text{g}) \rightleftharpoons 2\text{Z}(\text{g})$ at 500K, $K_c = 100$. Determine the concentration of Z in equilibrium with 0.2 mol X and 0.50 M Y at 500K.
- A. 3.2 M
B. 3.5 M
C. 4.5 M
D. 7.1 M
E. None of these.

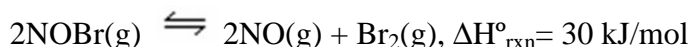
8. Consider the reaction $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$, for which $K_c = 0.10$ at $2,000^\circ\text{C}$. Starting with initial concentrations of 0.040 M of N_2 and 0.040 M of O_2 , determine the equilibrium concentration of NO .
- A. $5.4 \times 10^{-3}\text{ M}$
B. 0.0096 M
C. 0.011 M
D. 0.080 M
E. 0.10 M
9. Hydrogen iodide decomposes according to the equation $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$, for which $K_c = 0.0156$ at 400°C . 0.550 mol HI was injected into a 2.00 L reaction vessel at 400°C . Calculate the concentration of HI at equilibrium.
- A. 0.138 M
B. 0.220 M
C. 0.550 M
D. 0.275 M
E. 0.0275 M
10. At 700 K , the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ has the equilibrium constant $K_c = 4.3 \times 10^6$, and the following concentrations are present: $[\text{SO}_2] = 0.10\text{ M}$; $[\text{SO}_3] = 10.\text{ M}$; $[\text{O}_2] = 0.10\text{ M}$. Is the mixture at equilibrium? If not at equilibrium, in which direction (as the equation is written), *left to right* or *right to left*, will the reaction proceed to reach equilibrium?
- A. Yes, the mixture is at equilibrium.
B. No, *left to right*
C. No, *right to left*
D. There is not enough information to be able to predict the direction.
11. For the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, $K_c = 50.2$ at 445°C . If $[\text{H}_2] = [\text{I}_2] = [\text{HI}] = 1.75 \times 10^{-3}\text{ M}$ at 445°C , which one of the following statements is *true*?
- A. The system is at equilibrium, thus no concentration changes will occur.
B. The concentrations of HI and I_2 will increase as the system approaches equilibrium.
C. The concentration of HI will increase as the system approaches equilibrium.
D. The concentrations of H_2 and HI will fall as the system moves toward equilibrium.
E. The concentrations of H_2 and I_2 will increase as the system approaches equilibrium.

12. For the following reaction at equilibrium, which choice gives a change that will shift the position of equilibrium to favor formation of more products?



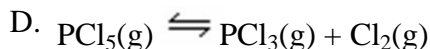
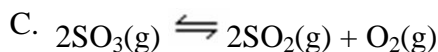
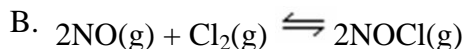
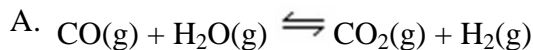
- A. Increase the total pressure by decreasing the volume.
- B. Add more NO.
- C. Remove Br₂.
- D. Lower the temperature.
- E. Remove NOBr selectively.

13. For the following reaction at equilibrium in a reaction vessel, which one of the changes below would cause the Br₂ concentration to *increase*?

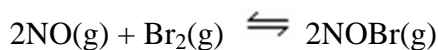


- A. Lower the temperature.
- B. Remove some NO.
- C. Remove some NOBr.
- D. Compress the gas mixture into a smaller volume.

14. In which of the following gas-phase equilibria is the yield of products increased by increasing the total pressure on the reaction mixture?



15. A. Fill in the table below, which refers to the following reaction:



Concentration (M)	[NO]	[Br ₂]	[NOBr]
Initial	2.5	5.0	1.0
Change			
Equilibrium	2.0		

B. Calculate K_c.

16. 75.0 g of $\text{PCl}_5(\text{g})$ is introduced into an evacuated 3.00 L vessel and allowed to reach equilibrium at 250°C .



If $K_p = 1.80$ for this reaction, what is the total pressure inside the vessel at equilibrium.

- A. 2.88 atm
- B. 2.27 atm
- C. 4.54 atm
- D. 7.42 atm
- E. 9.69 atm

17. Consider the chemical reaction $2\text{NH}_3(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$.

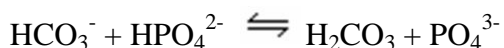
The equilibrium is to be established in a 1.0 L container at 1,000 K, where $K_c = 4.0 \times 10^{-2}$. Initially, 1,220 moles of $\text{NH}_3(\text{g})$ are present.

- A. Estimate the equilibrium concentration of $\text{H}_2(\text{g})$.
 - B. Estimate the equilibrium concentration of $\text{N}_2(\text{g})$.
 - C. Calculate K_p for the reaction.
-

18. In the reaction $\text{HSO}_4^-(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$, the conjugate acid-base pairs are

- | | pair 1 | pair 2 |
|----|-------------------------------------------|---------------------------------------------|
| A. | HSO_4^- and SO_4^{2-} | H_2O and OH^- |
| B. | HSO_4^- and H_2O | SO_4^{2-} and OH^- |
| C. | HSO_4^- and OH^- | SO_4^{2-} and H_2O |
| D. | HSO_4^- and H_2O | OH^- and SO_4^{2-} |
| E. | HSO_4^- and OH^- | SO_4^{2-} and H_2O |
-

19. Identify the conjugate acid of HCO_3^- in the following reaction:



- A. H_2O
- B. HCO_3^-
- C. H_2CO_3
- D. PO_4^{3-}
- E. HPO_4^{2-}

20. The OH^- concentration in a 1.0×10^{-3} M $\text{Ba}(\text{OH})_2$ solution is
- A. 0.50×10^{-3} M.
 - B. 1.0×10^{-3} M.
 - C. 2.0×10^{-3} M.
 - D. 1.0×10^{-2} M.
 - E. 0.020 M.
21. What is the H^+ ion concentration in a 4.8×10^{-2} M KOH solution?
- A. 4.8×10^{-2} M
 - B. 1.0×10^{-7} M
 - C. 4.8×10^{-11} M
 - D. 4.8×10^{-12} M
 - E. 2.1×10^{-13} M
22. Calculate the H^+ ion concentration in a 8.8×10^{-4} M $\text{Ca}(\text{OH})_2$ solution.
- A. 8.8×10^{-4} M
 - B. 1.8×10^{-3} M
 - C. 2.2×10^{-11} M
 - D. 1.1×10^{-11} M
 - E. 5.7×10^{-12} M
23. Calculate the pH of a 6.71×10^{-2} M NaOH solution.
- A. 12.83
 - B. 2.17
 - C. 11.82
 - D. 6.71
 - E. 1.17

24. Diet cola drinks have a pH of about 3.0, while milk has a pH of about 7.0. How many times greater is the H_3O^+ concentration in diet cola than in milk?
- A. 2.3 times higher in diet cola than in milk
 - B. 400 times higher in diet cola than in milk
 - C. 0.43 times higher in diet cola than in milk
 - D. 1,000 times higher in diet cola than in milk
 - E. 10,000 times higher in diet cola than in milk
25. The pOH of a solution is 9.60 Calculate the hydrogen ion concentration in this solution.
- A. $2.5 \times 10^{-10} \text{ M}$
 - B. $6.0 \times 10^{-9} \text{ M}$
 - C. $4.0 \times 10^{-5} \text{ M}$
 - D. $2.4 \times 10^{-4} \text{ M}$
 - E. $1.0 \times 10^{-14} \text{ M}$
26. Acid strength decreases in the series $\text{HI} > \text{HSO}_4^- > \text{HF} > \text{HCN}$. Which of the following anions is the *weakest* base?
- A. I^-
 - B. SO_4^{2-}
 - C. F^-
 - D. CN^-
27. Which of the following will act as a Lewis acid?
- A. NH_3
 - B. NH_4^+
 - C. H_2O
 - D. BF_3
 - E. F^-

28. Which one of the following salts will form a *basic* solution upon dissolving in water?

- A. NaI
- B. NaF
- C. NH_4NO_3
- D. LiBr
- E. $\text{Cr}(\text{NO}_3)_3$

29. Which one of the following salts will form an *acidic* solution upon dissolving in water?

- A. LiBr
- B. NaF
- C. NH_4Br
- D. KOH
- E. NaCN

30. Write the formula for the conjugate base of H_2PO_4^- .

31. A solution containing $\text{NH}_3(\text{aq})$ and $\text{NH}_4\text{Cl}(\text{aq})$ has a pH of 9.5. What is the $[\text{NH}_3]/[\text{NH}_4^+]$ ratio in this solution? (For ammonia, $K_b = 1.8 \times 10^{-5}$.)
