

16 • Chemical Equilibria

PROBLEM SET # 2

1. Consider the equilibrium: $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g})$ $K_c = 4.36 \text{ M}^{-1}$
 Calculate the value of “Q” for a situation in which the concentrations are $[\text{SO}_2] = 2.00 \text{ M}$, $[\text{O}_2] = 1.50 \text{ M}$, and $[\text{SO}_3] = 1.25 \text{ M}$.

Does this mixture shift toward the reactants or products to reach equilibrium? _____

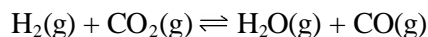
2. Study the discussion in your textbook about converting K_c and K_p . Write the K_p expression for the reaction in question 1 and calculate its value at 0°C . Remember, $R = 0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$.

3. Consider the equilibrium $\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g})$.
 How would the following changes affect the partial pressures of each gas at equilibrium?
 $\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g})$

- | | | | |
|--|-------|-------|-------|
| a) addition of PCl_3 | _____ | _____ | _____ |
| b) removal of Cl_2 | _____ | _____ | _____ |
| c) removal of PCl_5 | _____ | _____ | _____ |
| d) decrease in the volume of the container | _____ | _____ | _____ |
| e) addition of He without change in volume | _____ | _____ | _____ |

4. How will each of the changes in question 3 affect the K_{eq} ? (\uparrow =increase; \downarrow =decrease; $—$ = unchanged)
- a _____ b _____ c _____ d _____ e _____

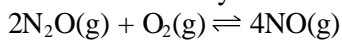
5. Indicate how each of the following changes affects the amount of each gas in the system below, for which $\Delta H_{\text{reaction}} = +9.9 \text{ kcal}$.



- | | | | | |
|--|-------|-------|-------|-------|
| a) addition of CO_2 | _____ | _____ | _____ | _____ |
| b) addition of H_2O | _____ | _____ | _____ | _____ |
| c) addition of a catalyst | _____ | _____ | _____ | _____ |
| d) increase in temperature | _____ | _____ | _____ | _____ |
| e) decrease in the volume of the container | _____ | _____ | _____ | _____ |

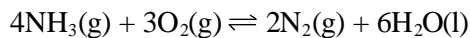
6. How will each of the changes in question 5 affect the equilibrium constant?
- a _____ b _____ c _____ d _____ e _____

7. Consider the equilibrium: $2\text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g})$
 How will the amount of chemicals at equilibrium be affected by



- | | | | |
|---|-----|-----|-----|
| a) adding N_2O | ___ | ___ | ___ |
| b) removing O_2 | ___ | ___ | ___ |
| c) increasing the volume of the container | ___ | ___ | ___ |
| d) adding a catalyst | ___ | ___ | ___ |

8. For the reaction, $4\text{NH}_3(\text{g}) + 3\text{O}_2(\text{g}) \rightleftharpoons 2\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
 How will the concentration of each chemical be affected by



- | | | | | |
|--|-----|-----|-----|-----|
| a) adding O_2 to the system | ___ | ___ | ___ | ___ |
| b) adding N_2 to the system | ___ | ___ | ___ | ___ |
| c) removing H_2O from the system | ___ | ___ | ___ | ___ |
| d) decreasing the volume of the container | ___ | ___ | ___ | ___ |

9. Consider the equilibrium: $2\text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g})$
 3.00 moles of $\text{NO}(\text{g})$ are introduced into a 1.00-Liter evacuated flask. When the system comes to equilibrium, 1.00 mole of $\text{N}_2\text{O}(\text{g})$ has formed. Determine the equilibrium concentrations of each substance. Calculate the K_c for the reaction based on these data.

	2 N_2O	O_2	4 NO
initial			
change			
equilibrium			

Remember: The "ice" box may be used with moles, molarity, or Liters (for gaseous equilibria)... never grams.