Section 7.4: Qualitative Changes in Equilibrium Systems

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1. (a) If the volume of the container is decreased, the pressure will increase, so the equilibrium is likely to shift toward the right because there are fewer product entities.
(b) If the temperature of the container is increased, the additional energy is likely to be absorbed by a shift of the equilibrium toward the left and increase the concentration of the reactants.
(c) As ethane is removed, the equilibrium will shift toward the right because there are fewer product entities.
(d) As hydrogen is added, the equilibrium will shift toward the right, reducing the amount of reactants in the mixture.
2. (a) Prediction: As the concentration of chloride ions is increased, the equilibrium will shift toward the product, $CuCl_4^{2-}(aq)$.
(b) Increasing the concentration of chloride ions caused the colour to change from blue toward green, which indicates that the concentration of $CuCl_4^{2-}(aq)$ increased due to an equilibrium shift toward the reaction product.
(c) Independent variable: $[Cl^-(aq)]$; dependent variable: $[CuCl_4^{2-}(aq)]$; controls: total volume, mixing procedure.
3. If the temperature is increased, the smell of ammonia will increase. Because the reaction is endothermic, addition of thermal energy will shift the equilibrium to the right and increase the concentration of the product, ammonia.
4. (a) For an exothermic reaction, the equilibrium will shift toward the reactants, so the value of K will decrease.
(b) For an endothermic reaction, the equilibrium will shift toward the products, so the value of K will increase.
(c) If the value of K increases, the reaction is exothermic. An increase in K indicates that the equilibrium has shifted toward the products. An exothermic reaction shifts toward the products when thermal energy is removed.