

## Textbook Page 446 #1 to 4

1. (a) The equilibrium will shift **right** (toward products) if the volume of the container is decreased.  
(b) The equilibrium will shift **left** (toward reactants) if the temperature of the system is increased.  
(c) The equilibrium will shift **right** (toward products) if  $\text{C}_2\text{H}_6(\text{g})$  is removed.  
(d) The equilibrium will shift **right** (toward products) if more hydrogen gas is added to the system.
2. (a) Hypothesis: As the concentration of chloride ions is increased, the equilibrium will shift more to the right (products).  
Prediction: The system will appear more green at higher concentrations of hydrochloric acid.  
(b) The system appears more green when more concentrated hydrochloric acid is added. The results match the prediction, and therefore the hypothesis is supported. A higher concentration of chloride ions shifts the equilibrium to the right.  
(c) The independent variable is the concentration of chloride ions (concentration of HCl added).  
The dependent variable is the colour of the system at equilibrium.  
The controlled variables are the concentration of the copper(II) chloride used, the total volume, and the temperature of the system.
3. Increasing the temperature will shift an endothermic reaction toward the products. In this case, more ammonia gas is produced by the increase in temperature, and the smell of ammonia would increase.
4. (a) Increasing the temperature will shift an exothermic reaction toward the reactants (left). The value of  $K$  decreases (lower concentrations of products and higher concentrations of the reactants;  $K$  is a ratio of products to reactants).  
(b) Increasing the temperature will shift an endothermic reaction toward the products (right). The value of  $K$  increases (higher concentrations of products and lower concentrations of the reactants;  $K$  is a ratio of products to reactants).  
(c) A higher  $K$  at lower temperature indicates an exothermic reaction. The increase in  $K$  means the equilibrium shifted right (toward products) when the temperature was decreased — therefore the energy term must be on the right side of the equation.