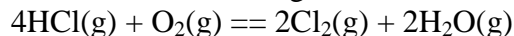




Topic 5 Exercise 3 – Changing the Position of Equilibrium

1. Consider the following exothermic reaction:



State, with a reason, what would happen to the amounts of chlorine and hydrogen chloride in the system if the following changes were made after equilibrium had been established in a sealed container:

- water is removed from the system;
 - extra oxygen is added to the system;
 - the volume of the container was reduced;
 - the temperature of the container was increased;
 - a catalyst was added.
2. For each of the following reactions, state and explain whether a high or low temperature and a high or low pressure should be used to maximize the yield of product:

- $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}), \quad H = -\text{ve}$
- $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}), \quad H = +\text{ve}$
- $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}), \quad H = -\text{ve}$
- $\text{HCOOH}(\text{l}) + \text{CH}_3\text{OH}(\text{l}) \rightleftharpoons \text{HCOOCH}_3(\text{l}) + \text{H}_2\text{O}(\text{l}), \quad H = 0$

3. The manufacture of ammonia by the Haber process is an important example of an industrial process which involves an equilibrium reaction:



The reaction is carried out at 450 °C and 250 atm with an iron catalyst.

- Give one reason why a higher temperature is not used.
- Give one reason why a lower temperature is not used.
- Give one reason why a higher pressure is not used.
- Give two reasons why a lower pressure is not used.
- Explain why a catalyst is used.