

## Core Worksheet – Chapter 7

- 1** By reference to both chemical and physical systems explain what is meant by **dynamic equilibrium**. [2]
- 2** Predict the effect of increasing pressure on each of the following equilibria:
- a**  $X_2(g) + AB_3(g) \rightarrow 2BX(g) + AB(g)$  [2]
- b**  $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$  [2]
- c**  $CH_3OH(g) \rightarrow CO(g) + 2H_2(g)$  [2]
- 3** Predict the effect of decreasing the temperature on each of the following equilibria:
- a**  $X_2(g) + AB_3(g) \rightarrow 2BX(g) + AB(g)$   $\Delta H = -50 \text{ kJ mol}^{-1}$  [2]
- b**  $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$   $\Delta H = -200 \text{ kJ mol}^{-1}$  [2]
- c**  $N_2O_5(g) + NO(g) \rightarrow 3NO_2(g)$   $\Delta H = +51 \text{ kJ mol}^{-1}$  [2]
- 4** Consider the equilibrium below:
- $$2[\text{CrO}_4]^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow [\text{Cr}_2\text{O}_7]^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- chromate(VI) ion
dichromate(VI) ion
- yellow
orange
- Predict and explain whether the following changes make the reaction mixture become more yellow or more orange:
- a** adding dilute sulfuric acid [2]
- b** adding sodium hydroxide solution [3]
- 5** Nickel hydroxide is essentially insoluble in water but when it is added to water a very small amount does dissolve and the following equilibrium is set up:
- $$\text{Ni}(\text{OH})_2(\text{s}) \rightarrow \text{Ni}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$$
- Predict and explain whether nickel hydroxide will be more soluble in water or in  $1 \text{ mol dm}^{-3} \text{ NaOH}(\text{aq})$ . [2]
- 6** When a weak acid, HA, is dissolved in water it dissociates according to the following equation:
- $$\text{HA}(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{A}^-(\text{aq})$$
- When the acid is dissolved in water at  $25^\circ\text{C}$ , 5% of the HA molecules dissociate. Explain whether the percentage dissociation will be higher or lower when the HA is dissolved in  $0.10 \text{ mol dm}^{-3}$  sulfuric acid. [3]
- 7** Write expressions for the equilibrium constant for the following reactions: [5]
- a**  $X_2(g) + AB_3(g) \rightarrow 2BX(g) + AB(g)$
- b**  $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$
- c**  $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$
- d**  $CH_3OH(g) \rightarrow CO(g) + 2H_2(g)$
- e**  $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

- 8** Predict the effect of the following changes on the value of the equilibrium constant:
- a** decreasing the temperature  
 $\text{CO(g)} + 2\text{H}_2\text{(g)} \rightarrow \text{CH}_3\text{OH(g)}$   $\Delta H^\circ = -90 \text{ kJ mol}^{-1}$  [3]
- b** decreasing the pressure  
 $\text{CO(g)} + 3\text{H}_2\text{(g)} \rightarrow \text{CH}_4\text{(g)} + \text{H}_2\text{O(g)}$  [2]
- c** introducing a  $\text{V}_2\text{O}_5\text{(s)}$  catalyst in the reaction  
 $2\text{SO}_3\text{(g)} \rightarrow 2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)}$  [2]
- 9**
- a** Write an equation for the reaction in which ammonia is produced in the Haber process. [1]
- b** Write the expression for  $K_c$  for the reaction in part a. [1]
- c** State and explain the reaction conditions used in the Haber process. [12]
- 10** The following reaction is part of the contact process for the production of sulfuric acid:
- $2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$   $\Delta H = -197 \text{ kJ mol}^{-1}$
- a** Explain why a temperature of  $420^\circ\text{C}$  is preferred to a temperature of  $20^\circ\text{C}$  in this process. [2]
- b** Explain why the pressure employed in this process is usually around atmospheric pressure. [2]