Exercise 8.4
More Variation of Equilibrium Constant with Temperature

1. Phosphorus trichloride reacts with chlorine gas to give phosphorus pentachloride:

$$PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)} \qquad \Delta H° = -87.9 \frac{kJ}{mol}$$
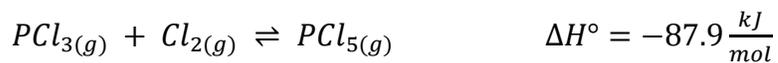
(a) A particular mixture reaches equilibrium when the following state is obtained at 25 °C:
   - $p_{Cl_2} = 9.1 \times 10^{-5} \ bar$
   - $p_{PCl_3} = 2.5 \times 10^{-3} \ bar$
   - $p_{PCl_5} = 0.75 \ bar$

Calculate the equilibrium constant for this reaction at 25 °C.

(b) Calculate the equilibrium constant for this reaction at 250 °C.

2.   Chlorine monoxide can be oxidized to chlorine dioxide:

$$2 \, ClO_{(g)} + O_{2(g)} \rightleftharpoons 2 \, ClO_{2(g)}$$
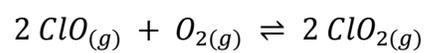
(a)   Calculate the equilibrium constant for this reaction at 25 °C.

(b)   Calculate the equilibrium constant for this reaction at 750 °C.

3.   Calculate the freezing point of a solution prepared by dissolving 125 g NaCl in 500 g water. The enthalpy of fusion of water is $+6007 \frac{J}{mol}$.

4.   The equilibrium vapour pressure for water at $25\ °C$ is 0.0317 bar.

The enthalpy of vaporization of water is $+40.66\ \frac{kJ}{mol}$.

(a)   Calculate the vapour pressure over a solution prepared by dissolving $125\ g$ NaCl in $500\ g$ water at $25\ °C$.

(b)   Calculate the normal boiling point of a solution prepared by dissolving $125\ g$ NaCl in $500\ g$ water.