Marks 3

- Consider the following reaction.

$H_2O(g) + Cl_2O(g) \rightleftharpoons 2HOCl(g)$ $\quad K_p = 0.090$ at 298 K

Calculate $\Delta G°$ (in J mol^{-1}) for this reaction.

Using $\Delta G° = -RT\ln K_p$:

$$\Delta G° = -(8.314\ \text{J K}^{-1}\ \text{mol}^{-1}) \times (298\ \text{K}) \times \ln(0.090) = 5.97 \times 10^3\ \text{J mol}^{-1}$$

$\Delta G°$ = **5.97 kJ mol^{-1}**

Calculate ΔG (in J mol^{-1}) at 25 °C when $p(H_2O)$ = 18 mmHg, $p(Cl_2O)$ = 2.0 mmHg and $p(HOCl)$ = 0.10 mmHg.

The reaction quotient, Q, for this reaction is given by:

$$Q = \frac{(p_{HOCl})^2}{(p_{H_2O})(p_{Cl_2O})} = \frac{(0.10)^2}{(18) \times (2.0)} = 0.00028$$

Hence:

$$\Delta G = \Delta G° + RT\ln Q$$
$$= (5.97 \times 10^3\ \text{J mol}^{-1}) + (8.314\ \text{J K}^{-1}\ \text{mol}^{-1}) \times (298\ \text{K}) \times \ln(0.00028)$$
$$= -14.3 \times 10^3\ \text{J mol}^{-1}$$

Answer: **-14.3 kJ mol^{-1}**