Marks 5

- The autoionisation of water conforms to the following balanced equation:

$$2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq) \qquad \Delta H = 56.3 \text{ kJ mol}^{-1}$$

Is this an exothermic or endothermic reaction?

Endothermic (as ΔH is positive).

What will happen to the equilibrium if the temperature is raised?

The reaction will shift to the right. From le Chatelier's principle, the equilibrium will shift to reduce the effect of the change. As the forward reaction is endothermic, it is able to mitigate the increase in temperature by shifting forwards.

The equilibrium constant, K, for this reaction is 1.8×10^{-16} at 25 °C. Calculate ΔG.

Using $\Delta G = -RT\ln K$,

$$\Delta G = -(8.314 \text{ J K}^{-1} \text{ mol}^{-1}) \times ((25 + 273) \text{ K}) \times 1.8 \times 10^{-16} = +89 \text{ kJ mol}^{-1}$$

Answer: **+89 kJ mol^{-1}**

Why is ΔG not equal to ΔH for this reaction?

By definition, $\Delta G = \Delta H - T\Delta S$. As the entropy change for the reaction and the temperature are not zero, so $\Delta G \neq \Delta H$.

The pH of pure water is 6.81 at 37 °C. Is water acidic, basic or neutral at this temperature? Explain.

Neutral. Pure water is neutral at all temperatures as the chemical equation always gives $[H_3O^+(aq)] = [OH^-(aq)]$. A pH value of 7.0 only corresponds to a neutral solution at 25 ^oC.