Chemistry 2740 Spring 2022 Assignment 3 Solutions

The reaction is $H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$.
The rate constant at $37\,°C$ and zero ionic strength is

$$k_0 = A\exp\left(\frac{-E_a}{RT}\right)$$

$$= (3.94 \times 10^{13}\,\mathrm{L\,mol^{-1}s^{-1}})\exp\left(\frac{-14.6 \times 10^3\,\mathrm{J\,mol^{-1}}}{(8.314\,472\,\mathrm{J\,K^{-1}mol^{-1}})(310.15\,\mathrm{K})}\right)$$

$$= 1.37 \times 10^{11}\,\mathrm{L\,mol^{-1}s^{-1}}$$

The Brønsted-Bjerrum equation is

$$\ln k = \ln k_0 + 2.214 \times 10^{-10} Z_A Z_B (\varepsilon T)^{-3/2}\sqrt{I_c}$$

$$= \ln(1.37 \times 10^{11}\,\mathrm{L\,mol^{-1}s^{-1}})$$

$$+ (2.214 \times 10^{-10})(+1)(-1)\left[(74.22)(8.854\,188 \times 10^{-12})(310.15\,\mathrm{K})\right]^{-3/2}\sqrt{0.01}$$

$$= 25.40$$

$$\therefore k = e^{25.40} = 1.08 \times 10^{11}\,\mathrm{L\,mol^{-1}s^{-1}}$$