Kinetics (8) – Activation Energy (2)

Q A reaction has 1st order rate const. of $4.82 \times 10^{-5}/s$ at 25°C and $1.41 \times 10^{-2}/s$ at 70°C. Calculate the rate constant at 90°C.

Ans

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left\{ \frac{1}{T_1} - \frac{1}{T_2} \right\}$$

$25 + 273 = 298\,K \qquad 70 + 273 = 343\,K$

$$\ln \frac{1.41 \times 10^{-2}/s}{4.82 \times 10^{-5}/s} = \frac{E_a}{8.3145\,J/mol\,K} \left[\frac{1}{298} - \frac{1}{343} \right]$$

$$5.68 = E_a \times 5.295 \times 10^{-5}\,mol/J$$

$$E_a = \frac{5.68}{5.295 \times 10^{-5}\,mol/J} = \boxed{1.07 \times 10^{5}\,J/mol}$$

$90 + 273 = 363\,K$

$$\ln \frac{k_3}{4.82 \times 10^{-5}} = \frac{1.07 \times 10^{5}\,J/mol}{8.3145\,J/mol\,K} \left[\frac{1}{298} - \frac{1}{363} \right]$$

$$\ln \frac{k}{4.82 \times 10^{-5}} = 7.73$$

inv. ln

$$\frac{k_3}{4.82 \times 10^{-5}/s} = 2.28 \times 10^{3}$$

$$k_3 = (2.28 \times 10^{3})(4.82 \times 10^{-5})$$

$$= \boxed{0.110/s}$$