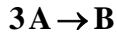


Problem 1-10 Second-order reactions [V], temperature dependence

The rate constant of the second-order reaction in solution, described by stoichiometry $3\text{A} \rightarrow \text{B}$, has the value $k_c = 0.0967 \text{ dm}^3 \text{ mol}^{-1} \text{ min}^{-1}$ at 380 K and its activation energy is $E^* = 74 \text{ kJ mol}^{-1}$. What time is needed to decompose 28 % of the reactant A at the temperature of 420 K, if its initial concentration is $c_{\text{A}0} = 0.023 \text{ mol dm}^{-3}$.

$$[\tau = 6.262 \text{ min}]$$

Solution:



$$c_{\text{A}0} = 0.023 \text{ mol dm}^{-3}$$

$$\frac{dc_{\text{A}}}{(-3)d\tau} = k_c \cdot c_{\text{A}}^2 \quad (\nu_{\text{A}} = -3)$$

$$\frac{1}{c_{\text{A}}} - \frac{1}{c_{\text{A}0}} = 3k_c \cdot \tau$$

$$c_{\text{A}} = c_{\text{A}0} - x$$

$$x = c_{\text{A}0} - c_{\text{A}} = 0.28 c_{\text{A}0}$$

$$c_{\text{A}} = 0.72 c_{\text{A}0}$$

$$\ln \frac{k_{c2}}{k_{c1}} = \frac{E^*}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right) = \frac{74000}{8.314} \cdot \left(\frac{1}{380} - \frac{1}{420} \right) = 2.23074$$

$$k_{c2} = 9.3067 \cdot 0.0967 = 0.9 \text{ dm}^3 \text{ mol}^{-1} \text{ min}^{-1}$$

$$\tau = \frac{1}{3k_2} \cdot \left(\frac{1}{c_{\text{A}}} - \frac{1}{c_{\text{A}0}} \right) = \frac{1}{3 \cdot 0.9} \cdot \left(\frac{1}{0.72 \cdot 0.023} - \frac{1}{0.023} \right) = 6.2623 \text{ min}$$