

Problem 1-03 First-order reactions

Consider a first-order unidirectional reaction



If you know that 30 per cent of this reaction is accomplished in 45 minutes, calculate how long it will take to change 80 per cent of initial amount of A to products.

$$[k_c = 1.321 \cdot 10^{-4} \text{ s}^{-1} ; \tau_2 = 3.384 \text{ h}]$$

Solution:

$$\tau_1 = 45 \text{ min} , c_{A1} = c_{A0} - 0.3 c_{A0} = 0.7 c_{A0}$$

$$\ln \frac{c_{A0}}{c_A} = k_c \cdot \tau$$

$$k_c = \frac{1}{\tau_1} \cdot \ln \frac{c_{A0}}{c_{A1}} = \frac{1}{45} \cdot \ln \frac{c_{A0}}{0.7 c_{A0}} = 0.0079261 \text{ min}^{-1} = \frac{0.0079261}{60} \text{ s}^{-1} = 1.321 \cdot 10^{-4} \text{ s}^{-1}$$

$$\tau_2 = ? , c_{A2} = c_{A0} - 0.8 c_{A0} = 0.2 c_{A0}$$

$$\tau_2 = \frac{1}{k_c} \cdot \ln \frac{c_{A0}}{c_{A2}} = \frac{1}{1.321 \cdot 10^{-4}} \cdot \ln \frac{c_{A0}}{0.2 c_{A0}} = 12183.313 \text{ s} = 3.384 \text{ h}$$