Problem 1-06 Second-order reactions

An unidirectional reaction **A → B** takes place in aqueous solution with the rate constant k_c = 0.0125 $dm^3\ mol^{-1}\ s^{-1}$. How many minutes will it take to reach the concentration of the product B the value of 0.09 mol dm^{-3}, if the initial concentration of A is c_{A0} = 0.35 mol dm^{-3}?

[τ = 660.3 s = 11 min]

Solution:

Reaction order from the dimension of the rate constant:

(concentration)$^{(1-n)}$ time $^{-1}$ = (concentration)$^{-1}$ time^{-1}

$(1-n) = -1 \quad \Rightarrow \quad n = 2$ second-order reaction

k_c = 0.0125 $dm^3\ mol^{-1}\ s^{-1}$

c_A = 0.09 mol dm^{-3}

c_{A0} = 0.35 mol dm^{-3}

$$\frac{1}{c_A} - \frac{1}{c_{A0}} = k_c \cdot \tau$$

$$\tau = \frac{1}{k_c} \cdot \left(\frac{1}{c_A} - \frac{1}{c_{A0}} \right) = \frac{1}{0.0125} \cdot \left(\frac{1}{0.09} - \frac{1}{0.35} \right) \quad \left[\frac{1}{dm^3\ mol^{-1}\ s^{-1}} \cdot (mol\ dm^{-3}) = s \right]$$

τ = 660.3 s = 11 min