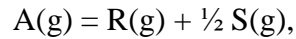


Problem 1-08 Second-order reactions[V]

An unidirectional reaction between ideal gases,



takes place in the reactor of constant volume at the temperature of 337 K. The rate constant is $k_c = 0.035 \text{ dm}^3 \text{ mol}^{-1} \text{ min}^{-1}$. What will be the concentration of A (mol dm^{-3}) in the reaction mixture if the reactor, initially filled by pure A to a pressure of 109 kPa, was tempered for one hour to a temperature of 337 K?

$$[c_A = 0.03596 \text{ mol dm}^{-3}]$$

Solution :

$$k_c = 0.035 \text{ dm}^3 \text{ mol}^{-1} \text{ min}^{-1}$$

$$\tau = 1 \text{ h} = 60 \text{ min}$$

$$T = 337 \text{ K} , \quad p = 109 \text{ kPa}$$

$$pV = n_{A0} RT$$

$$c_{A0} = \frac{n_{A0}}{V} = \frac{p}{RT} = \frac{109 \cdot 10^3}{8.314 \cdot 337} = 38.9 \text{ mol m}^{-3} = 0.0389 \text{ mol dm}^{-3}$$

Reaction order from the dimension of the rate constant:

$$\text{dm}^3 \text{ mol}^{-1} \text{ min}^{-1} = (\text{mol dm}^{-3})^{-1} \text{ min}^{-1}$$

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

$$(1-n) = -1 \Rightarrow n = 2 \Rightarrow \text{second-order reaction}$$

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

The concentration of remaining A:

$$\frac{1}{c_A} = k_c \cdot \tau + \frac{1}{c_{A0}} = 0.035 \cdot 60 + \frac{1}{0.0389} = 27.8069$$

$$c_A = 0.03596 \text{ mol dm}^{-3}$$