Puzzle Problem

P3-16B What five things are wrong with this solution?

The reaction

$$2A + B \rightarrow C$$

follows an elementary law. At 50°C the specific reaction rate constant is 10(m³/mol)²/s with an activation energy of 400J/mol. What is the rate of reaction at 100°C when the concentrations of A and B are 2 and 4 moles/m³ respectively?

Solution

In order to completely consume a 4-molar solution of B would require an 8-molar concentration of A. Because the initial concentration of A is only 2 molar, A is the limiting reactant. Thus, we choose A as our basis of calculation and divide by its stoichiometric coefficient of A to get

$$A + \frac{1}{2}B \rightarrow \frac{1}{2}C$$

because the reaction follows an elementary rate law

$$-r = kC_A^{1/2}$$

Converting the rate constant at 50°C to k at 100°C

$$k(100°C) = k(50°C)\exp\left(\frac{E}{RT_1} - \frac{1}{T_2}\right)$$

$$= 10\exp\left(\frac{400}{1.98} \left(\frac{1}{50} - \frac{1}{100}\right)\right)$$

$$= 75.4(m³/mol)/s$$

Substituting for k, $C_A$ and $C_B$

$$-r_A = (75.4)(2)(4)^{1/2} = \frac{301}{m³ \cdot h}$$