➡ The rate constant, the activation energy and the arrhenius parameter of a chemical reaction at 25^oC are $3.0 \times 10^{-4} s^{-1}$, $104.4\, kJ\, mol^{-1}$ and $6.0 \times 10^{14} s^{-1}$ respectively. The value of the rate constant as $T \to \infty$ is [IIT 1996]

A) $2.0 \times 10^{18} s^{-1}$

B) $6.0 \times 10^{14} s^{-1}$

C) Infinity

D) $3.6 \times 10^{30} s^{-1}$

Correct Answer: B

Solution :

$$T_2 = T(say),\ T = 25^oC = 298K, \qquad E_a = 104.4\ \text{kJ}\ mol^{-1} = 104.4 \times 10^3\ \text{J}\, mol^{-1}$$

$$K_1 = 3 \times 10^{-4},\ K_2 = ?, \qquad \log \frac{K_2}{K_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log \frac{K_2}{3 \times 10^{-4}} = \frac{104.4 \times 10^3 \text{J}\ mol^{-1}}{2.303 \times (8.314\ \text{J}\ k^{-1}\ mol^{-1})} \qquad \left[\frac{1}{298K} - \frac{1}{T}\right]\ \text{As T} \to \infty, \frac{1}{\text{T}} \to 0$$

$$\therefore\ \log \frac{K_2}{3 \times 10^{-4}} = \frac{104.4 \times 10^3\ \text{J}\ mol^{-1}}{2.303 \times 8.314 \times 298} \qquad \log \frac{K_2}{3 \times 10^{-4}} = 18.297,\ \frac{K_2}{3 \times 10^{-4}} = 1.98 \times 10^{18} \text{ or}$$

$$K_2 = (1.98 \times 10^{18}) \times (3 \times 10^{-4}) = 6 \times 10^{14} s^{-1}$$