4.6. Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes. If the decomposition is a first order reaction, calculate the rate constant of the reaction.
Ans: For 1st order reaction,

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{60}$$
$$= 1.155 \times 10^{-2}\ \text{min}^{-1}$$
$$= 1.925 \times 10^{-4}\ \text{s}^{-1}$$

4.7. What will be the effect of temperature on rate constant?
Ans: With the rise in temperature by 10°, the rate constant of a reaction is nearly doubled. The dependence of rate constant on temperature is given the Arrhenius equation, $k = A\ e^{-Ea/RT}$ where A is the Arrhenius constant and Ea is activation energy of the reaction.

4.8.The rate of the chemical reaction doubles for and increase of 10 K in absolute temperature from 298 K. Calculate E_a.
Ans:

Here, $T_1 = 298$ K, $T_2 = 308$ K, $k_1 = k$, $k_2 = 2k$
We know,

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303k}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

$$\log\frac{2k}{k} = \frac{E_a}{2.303 \times 8.314}\left(\frac{308 - 298}{308 \times 298}\right)$$

$$\log 2 = \frac{E_a}{2.303 \times 8.314} \times \frac{10}{308 \times 298}$$

$$\Rightarrow \quad E_a = \frac{(\log 2)(2.303 \times 8.314)(308 \times 298)}{10}$$
$$= 52897.7\ \text{J mol}^{-1} = 52.8\ \text{kJ mol}^{-1}$$

4.9. The activation energy for the reaction , $2\ HI(g) \rightarrow H_2 + I_2\ (g)$ is

209.5 k J mol^{-1} at 581 K.Calculate the fraction of molecules of reactants having energy equal to or greater than activation energy?

Ans.Fraction of molecules having energy equal to or greater than activation energy is given by :

$$x = \frac{n}{N} = e^{-E_a/RT}$$

$$\therefore \quad \ln x = \frac{-E_a}{RT} \Rightarrow \log x = \frac{-E_a}{2.303RT}$$

$$\therefore \quad \log x = -\frac{209.5 \times 10^3}{2.303 \times 8.314 \times 581} = -18.8323$$

$$\therefore \quad x = \text{antilog}(-18.8323)$$

$$= 1.471 \times 10^{-19}$$

********** END **********