Marks 6

- Briefly describe two factors that determine whether a collision between two molecules will lead to a chemical reaction.

Molecules must collide with sufficient energy to overcome the activation energy of reaction.

Molecules must be oriented correctly for reaction to occur.

Briefly describe the relationship between the rate of a reaction and the activation energy for the reaction.

Experimentally, the rate constant for a reaction is related to the temperature through the Arrhenius equation:

$$k = Ae^{-Ea/RT}$$

where E_a is the activation energy and A is the pre-exponential or just "A" factor.

Higher activation energy results in slower reaction rates.

The rate constant for the decomposition of N_2O_5 increases from 1.50×10^{-5} s^{-1} at 27 °C to 3.80×10^{-3} s^{-1} at 57 °C. Calculate the activation energy for the reaction.

The rate constants at two different temperatures are related through the Arrhenius equation:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Thus,

$$\ln\left(\frac{3.80\times10^{-3}\ s^{-1}}{1.52\times10^{-5}\ s^{-1}}\right) = \frac{E_a}{(8.314\ J\ K^{-1}\ mol^{-1})}\left(\frac{1}{(27+273)\ K} - \frac{1}{(57+273)\ K}\right)$$

E_a = 151000 J mol^{-1} = 151 kJ mol^{-1}.

Answer: **151 kJ mol^{-1}**