16.3 – Activation Energy

16.3.1 - Describe qualitatively the relationship between the rate constant (k) and temperature (T)

The relationship between reaction rate and temperature is that a <u>10°C rise in temperature will almost double the reaction rate</u>. As the temperature rises, more of the molecules will be at or above their **activation energy**, having sufficient energy to bond if they collide with the correct orientation.

The activation energy is the minimum amount of energy required for the reaction to proceed. Once the bonds between the reactants are weakened or broken, they are called **activated complexes**, or in the **transition state**. A reaction with a small activation energy will proceed quickly, whilst one with a large activation energy will proceed more slowly.

The rate of reaction is affected by the rate constant, k. However, when the activation energy is small, increasing the temperature will not have as a significant impact on the rate as if the activation energy were high. The relationship between the k value and the temperature is expressed according to the equation:

$$\ln k = \ln A - \frac{E_a}{RT}$$

This indicates that as the temperature rises, the value of k also rises.

16.3.2 - Determine activation energy (Ea) values from the Arrhenius equation by a graphical method

The Arrhenius equation can be rearranged into the form of a linear equation *y = mx + c*:

$$\ln k = \frac{-E_a}{RT} + \ln A$$

$$k = Ae^{\frac{-E_a}{RT}}$$

k = rate constant
A = frequency factor
E_a = activation energy (J)
R = gas constant (8.314 J K^{-1} mol^{-1})
T = temperature (K)

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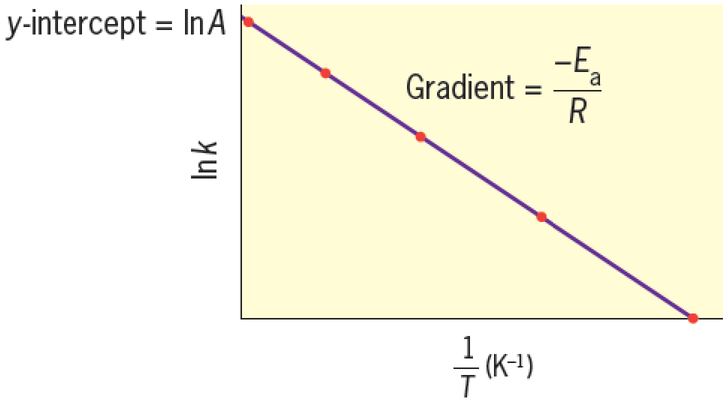
When graphed, it looks like this:



Using these graphs, if the other conditions are known, then the activation energy can be determined.