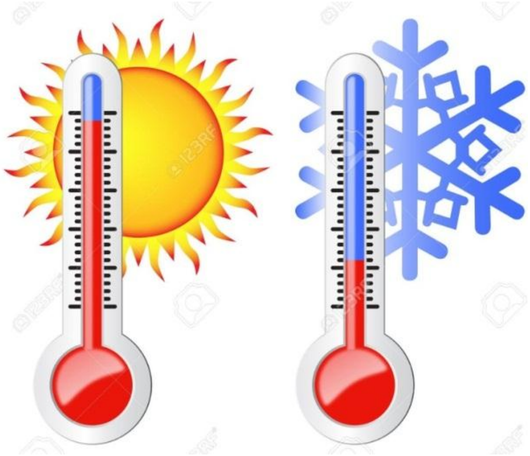
Kinetic Chemistry

(222 C)

Effect of Tempreture on The Reaction Rate

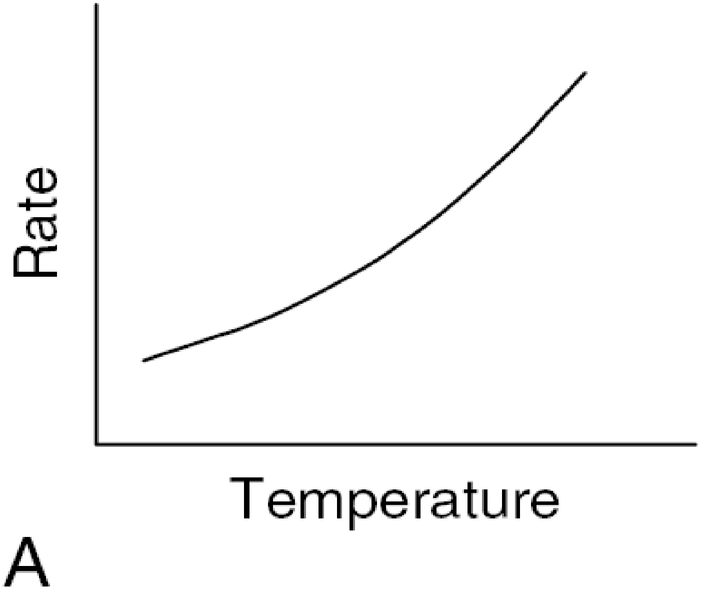


There are **several types** of behavior exhibited when the **rates** of reactions are studied as a function of **temperature**.

There are 3 common types.

1) The first type:

The variation followed by **most reactions**, that of an **exponentially increasing in the rate as temperature increases**.

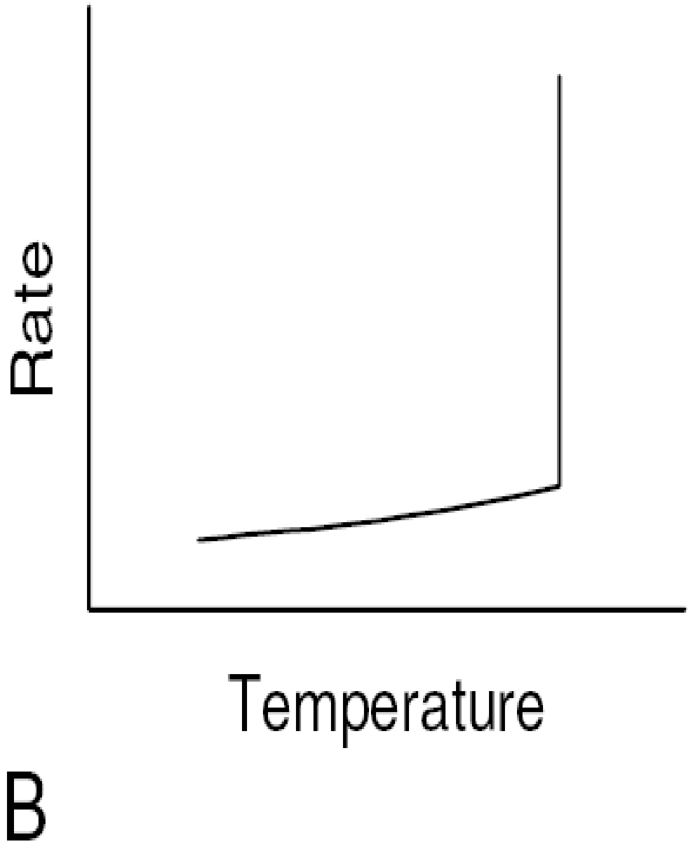


2) **The second type:**

It is for **materials which explosive** at a certain temp.

At temperature **below the explosive limit,** the rate is essentially unaffected by the temp.

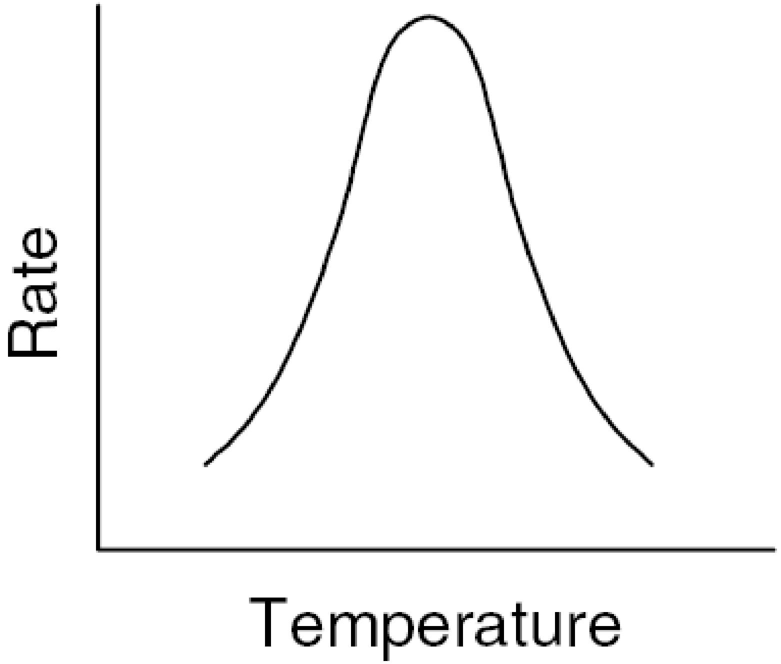
Then, as **the temp is reached at which the material becomes explosive,** **the rate increases extremely** as the temperature. is increased only very slightly.



3) The third type:

For **biological processes (enzymatic catalyzed reactions)**:

Normally increase in rate up to a certain temperature and **then decrease in rate at higher temp.**



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At the optimum temperature the rate is maximum.

***The rate decreases when the temperature is above or below that temperature*.**

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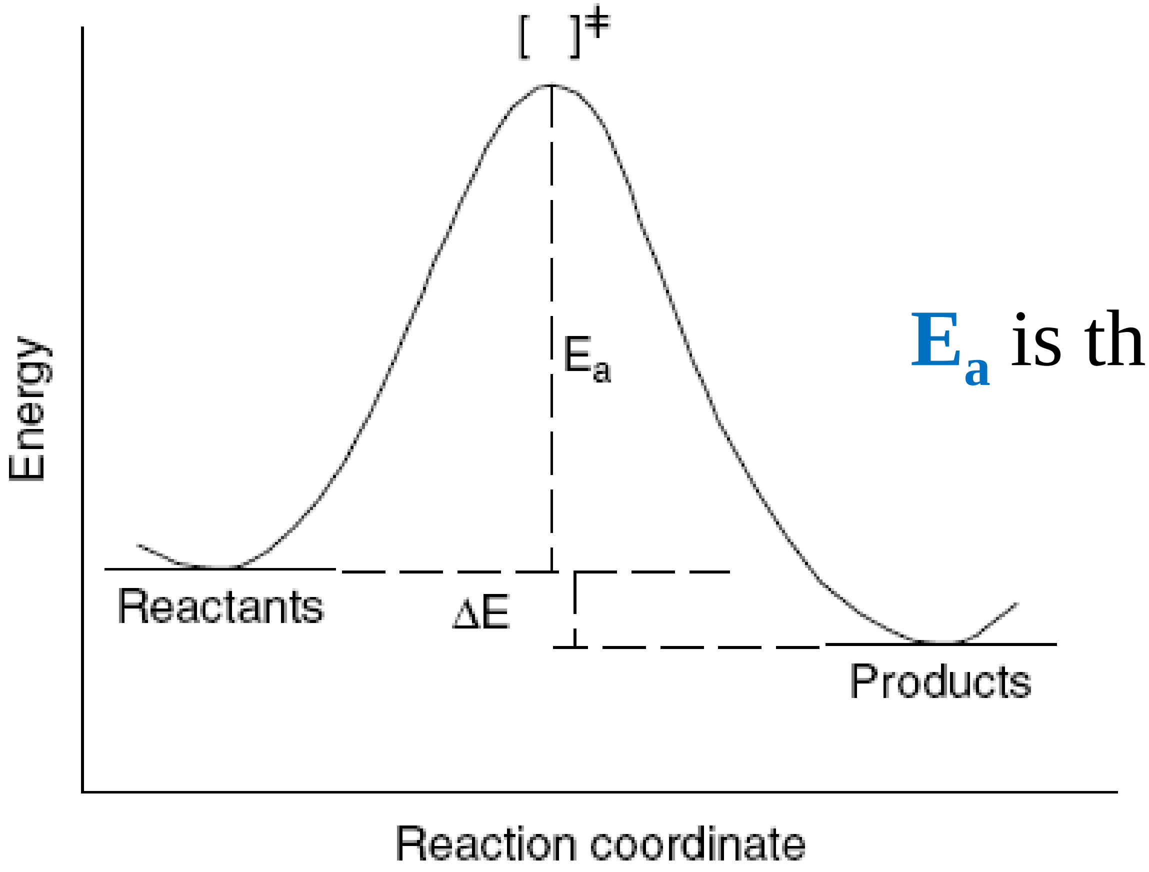


E_a is the activation energy.

Define E_a.

……………………………………………………………

What is the unit of E_a?

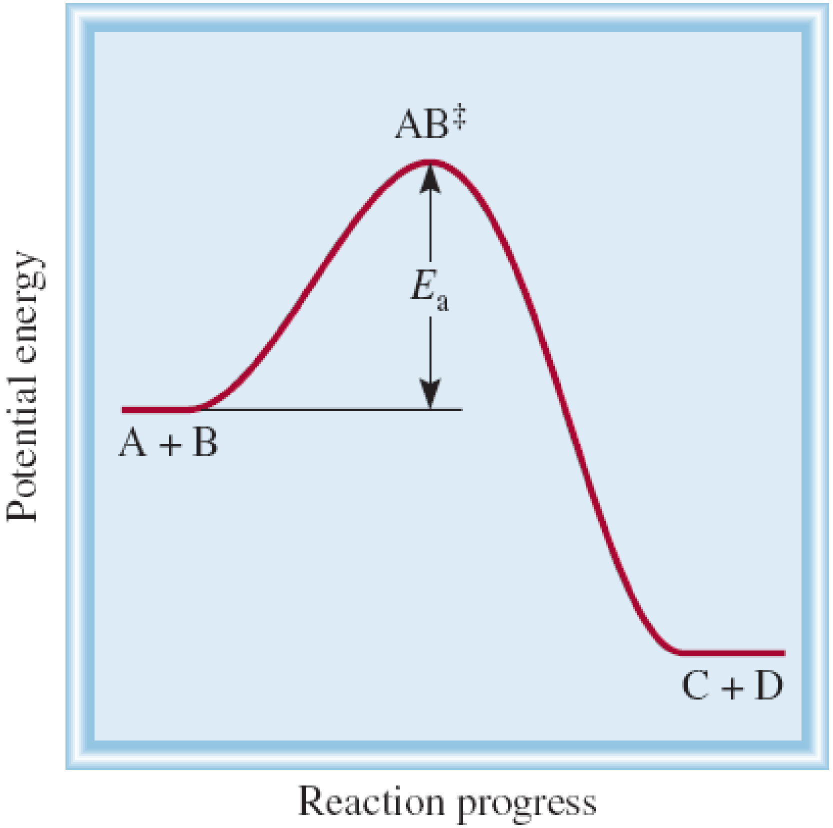
……………………………………………………………

For the following reaction:

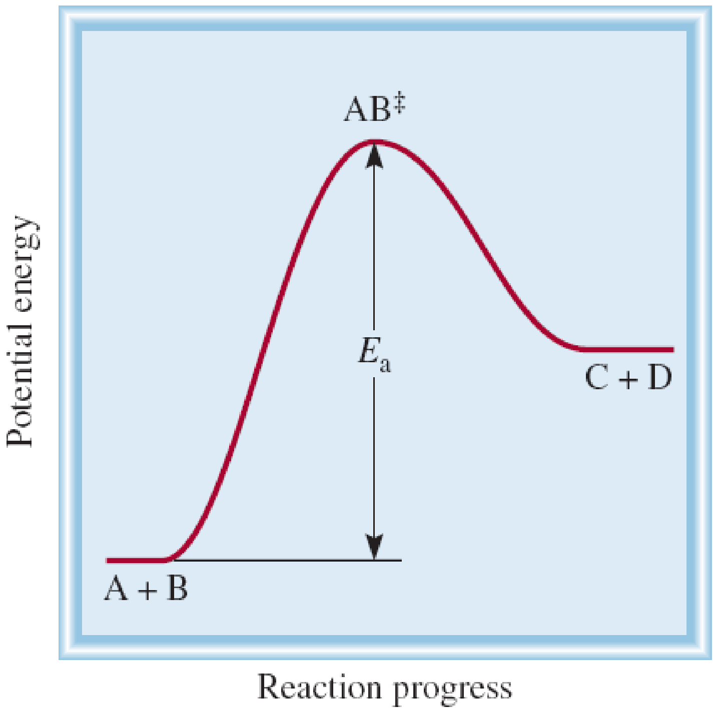
$$\boxed{A + B \longrightarrow AB^{\ddagger} \longrightarrow C + D}$$

$AB^{\ddagger}$ is called the ***activated complex*** (or ***transition state***), which is temporary species formed the collision of the reactant molecules before the formation of the products.

If the **products** are **more stable** than the **reactants**, then the reaction will be accompanied by a release of heat; that is, the reaction is **exothermic**.



If the **products** are **less stable** than the **reactants**, then heat will be absorbed by the reacting mixture from the surroundings and the reaction is **endothermic**.



Arrhenius Equation

$$k = A\mathrm{e}^{-E_a/\mathrm{RT}}$$

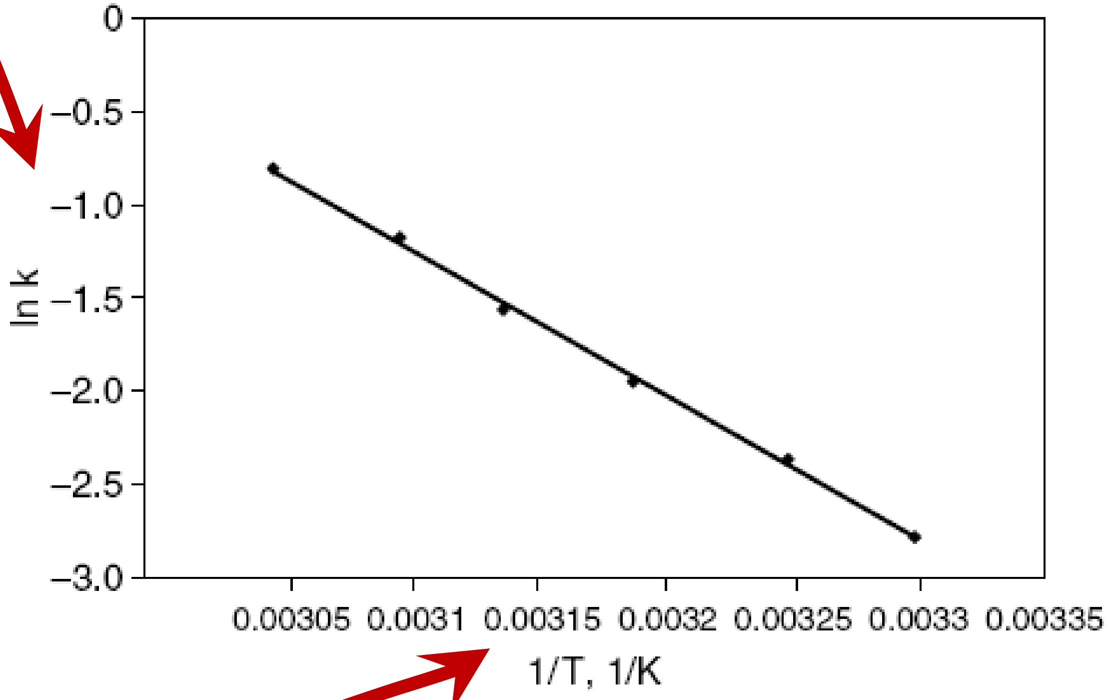
$$\ln k = -\frac{E_a}{\mathrm{RT}} + \ln A$$

where **k** is the rate constant, **A** is the frequency factor (or pre-exponential factor), **R** is the molar gas constant, **Ea** is the activation energy, and **T** is the temperature (K).

$$\boxed{\ln k = \left(-\frac{E_a}{R}\right)\left(\frac{1}{T}\right) + \ln A}$$

The plot of **ln *k*** versus **1/*T*** gives a **straight line** with **slope = -*E*$_a$/*R*** and **intercept = ln *A***

T	k	1/T	lnk
T_1	k_1	$1/T_1$	$\ln k_1$
T_2	k_2	$1/T_2$	$\ln k_2$
T_3	k_3	$1/T_3$	$\ln k_3$
T_4	k_4	$1/T_4$	$\ln k_4$
T_5	k_5	$1/T_5$	$\ln k_5$
T_6	k_6	$1/T_6$	$\ln k_6$



The value of $\mathbf{E_a}$ can be determined by 2 values of temperatures and their corresponding rate constant values.

If $\mathbf{k_1}$ is the rate constant at $\mathbf{T_1}$ and $\mathbf{k_2}$ is the rate constant at $\mathbf{T_2}$

$$\ln k_1 = \ln A - \frac{E_a}{\mathrm{RT}_1}$$

$$\ln k_2 = \ln A - \frac{E_a}{\mathrm{RT}_2}$$

$$\ln k_1 - \ln k_2 = \left(\ln A - \frac{E_a}{\mathrm{RT}_1}\right) - \left(\ln A - \frac{E_a}{\mathrm{RT}_2}\right)$$

$$\boxed{\ln \frac{k_2}{k_1} = \frac{E_a(\mathrm{T}_2 - \mathrm{T}_1)}{\mathrm{RT}_1\mathrm{T}_2}}$$