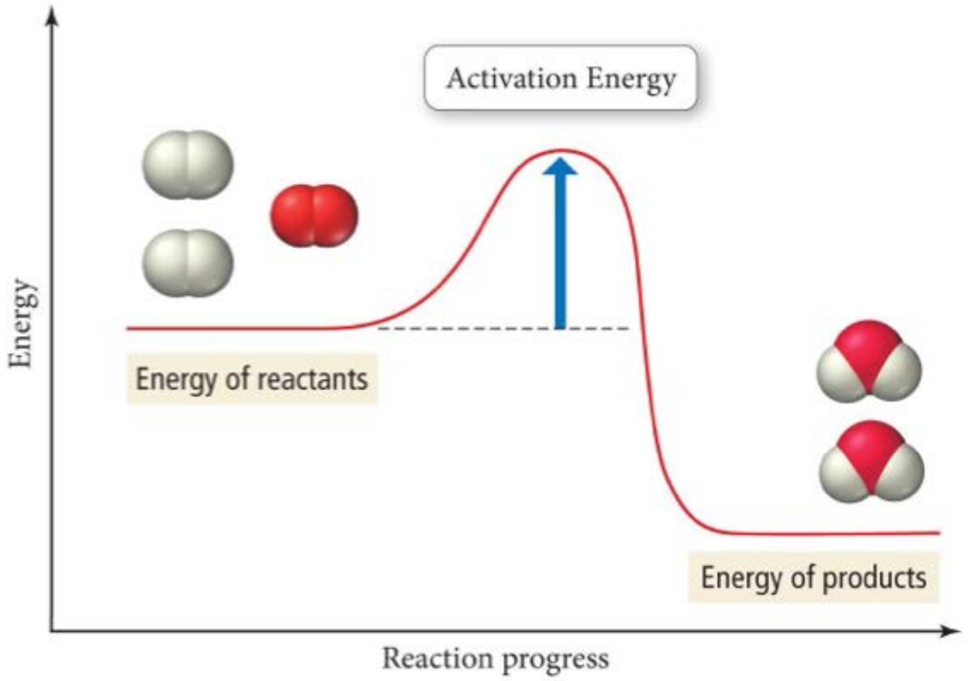
How can ↑ rate of a reaction?

<u>ideas</u>

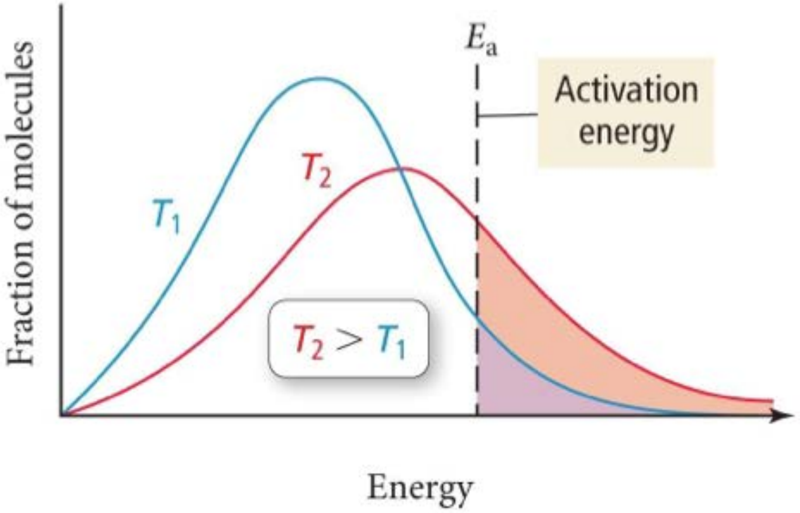
Activation Energy

$$2\,H_2(g) + O_2(g) \rightleftharpoons 2\,H_2O(g)$$



Thermal Energy Distribution

As temperature increases, the fraction of molecules with enough energy to surmount the activation energy barrier also increases.



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

k ↙ rate constant

A ↪ frequency factor

E_a is activation energy

Arrhenius Plots

- The Arrhenius equation can be algebraically solved to give the following form:

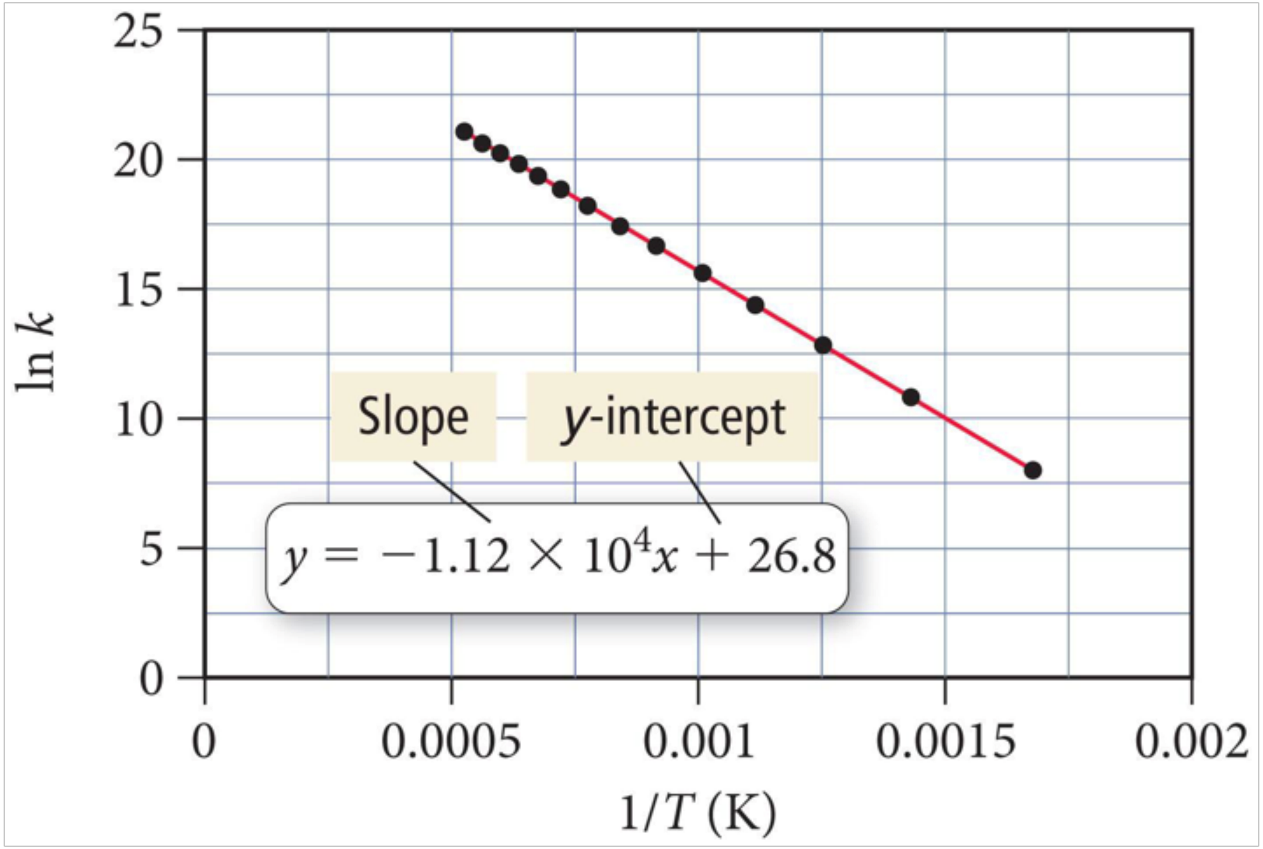
$$\ln(k) = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln(A)$$

This equation is in the form $y = mx + b$, where $y = \ln(k)$ and $x = (1/T)$.

A graph of $\ln(k)$ versus $(1/T)$ is a straight line.

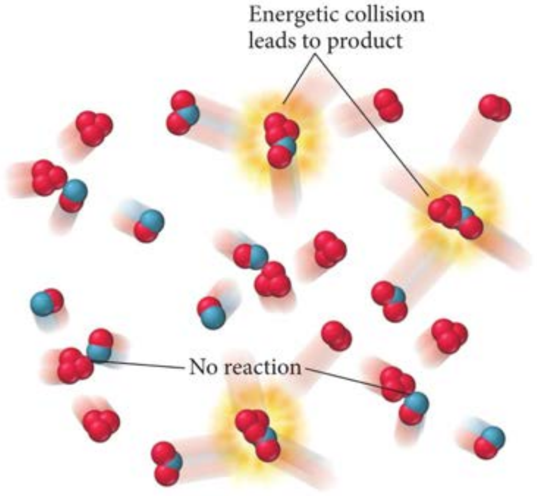
-Slope (R) = Ea

Determine the activation energy.



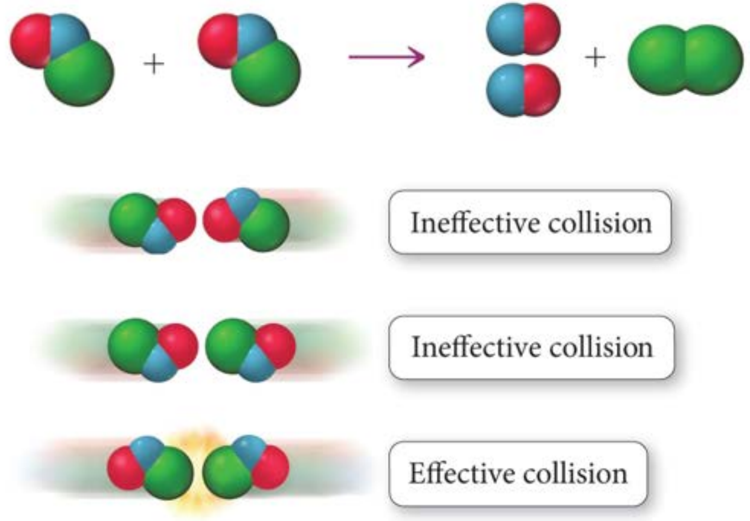
Arrhenius Plot Using Excel

Effective Collisions: Kinetic Energy Factor



Effective Collisions: Orientation Effect

$$NOCl(g) + NOCl(g) \longrightarrow 2\,NO(g) + Cl_2(g)$$



Time to think…

- Other factors affecting reaction rate

Reaction Mechanisms

Molecularity

Validating a Mechanism

To validate (not prove) a mechanism, two conditions must be met:

1. The elementary steps must sum to the overall reaction.
2. The rate law predicted by the mechanism must be consistent with the experimentally observed rate law.

Rate Determining Step is….

Rate Determining Step

$NO_{2(g)} + CO_{(g)} \rightarrow NO_{(g)} + CO_{2(g)}$

$Rate_{obs} = k[NO_2]^2$

Validate the following mechanism

1. $NO_{2(g)} + NO_{2(g)} \rightarrow NO_{3(g)} + NO_{(g)}$ Slow
2. $NO_{3(g)} + CO_{(g)} \rightarrow NO_{2(g)} + CO_{2(g)}$ Fast

What is the intermediate species in this mechanism ?

$$2\,O_3(g) \longrightarrow 3\,O_2(g) \qquad \text{Rate} = k[O_3]^2[O_2]^{-1}$$

$$O_3(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2(g) + O(g) \qquad \text{Fast}$$

$$O_3(g) + O(g) \xrightarrow[k_2]{} 2\,O_2(g) \qquad \text{Slow}$$