Preparation for Tutorial 2B

Chapter 14.5

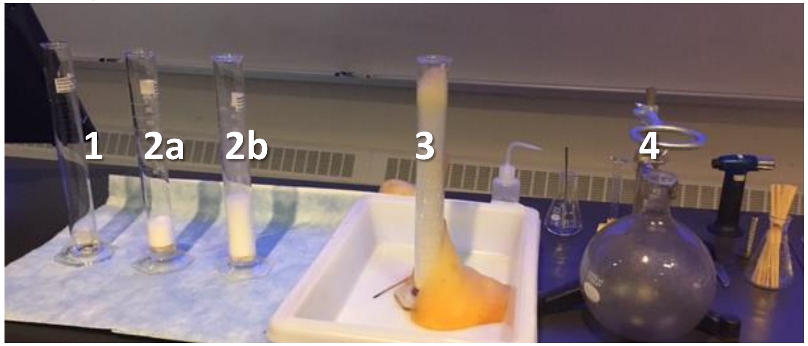
The speed of a reaction can be manipulated.

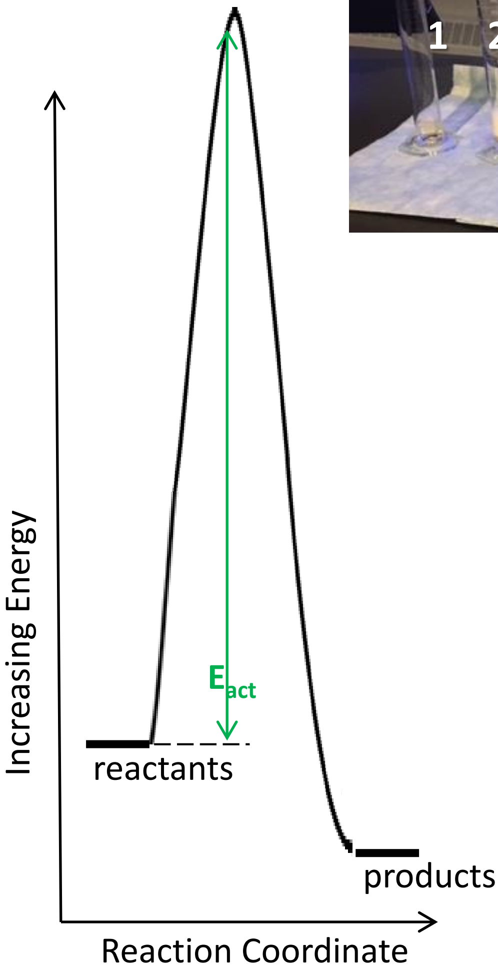
There is a slide which summarizes our demo and how a reaction coordinate changes with the various types of catalysts we used to accelerate the decomposition of peroxide.

The following two slides review how temperature affects speed of a reaction in a qualitative sense…..**but what we missed going over was how temperature affects speed in a quantative sense. Pay attention to this last slide. Try questions 14.5, 14.59 and 14.61..**

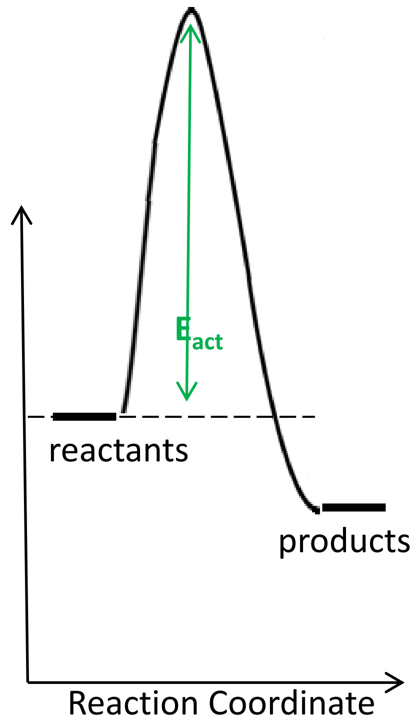
Explain how reaction speed can be modified using a catalyst

What does a catalyst do?

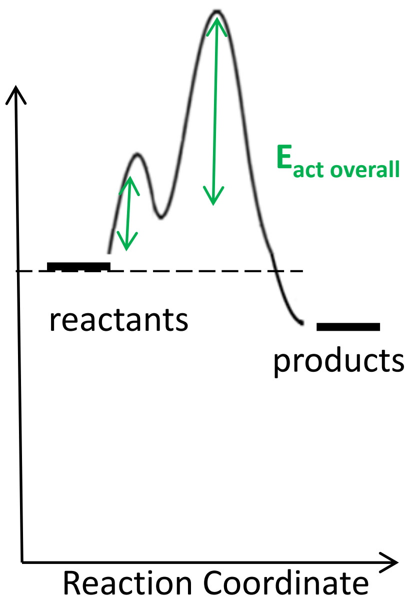




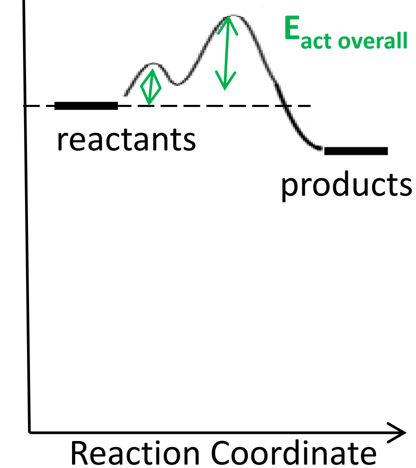
1. The decomposition of peroxide has a very high Ea. It decomposes over a long time.



2. A catalyst in potato raises the energy of reactants AND products but lowers Ea. Note how an increase in surface area simply increases collisions.



3. KI catalyst changes the mechanism which lowers the overall Ea some more.



3. MnO_2 catalyst changes the mechanism AND lowers the overall Ea the most

Determine the effect of changing temperature on rate and activation energy

What exactly is a change in temperature affecting?

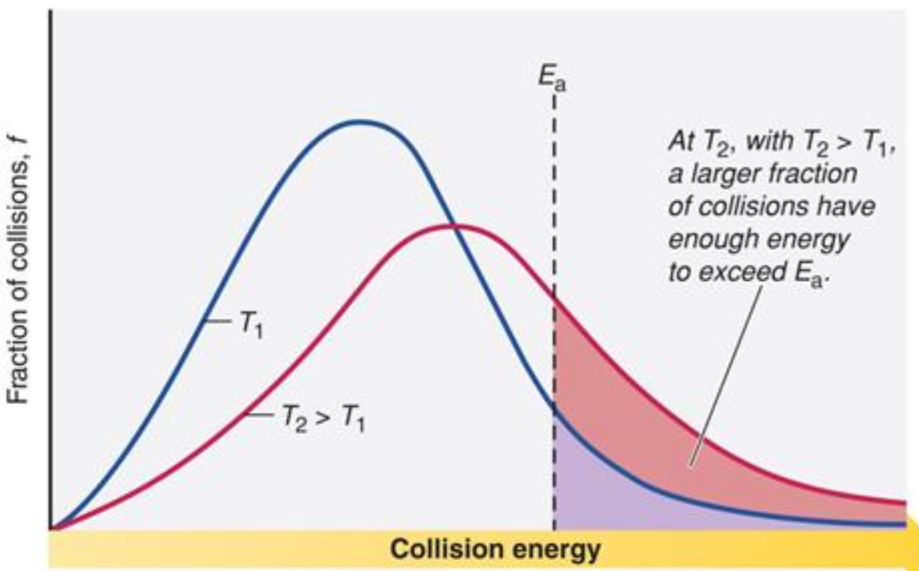
Recall that the elements of collision theory are encompassed in the expression for k.

$$k = Ae^{\frac{-E_{act}}{RT}}$$

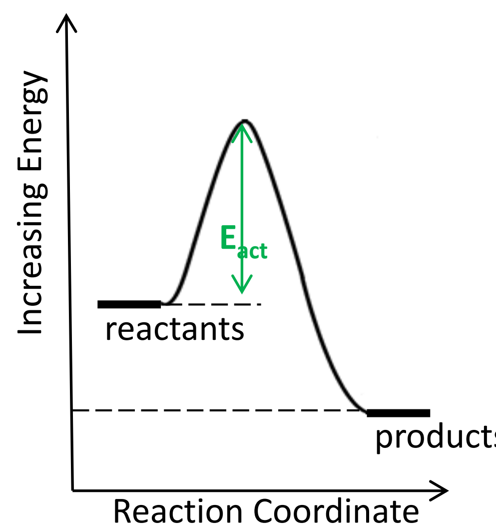
Where $e^{\frac{-E_{act}}{RT}}$ is the ***fraction of molecules with minimum energy for reaction.***

When a reaction is heated the number of effective collisions **changes significantly** with temperature.

The reaction coordinate will not change only the number of molecules that can achieve **E_{act}.**



Modification Figure 14.16



Determine the effect of changing temperature on rate and activation energy

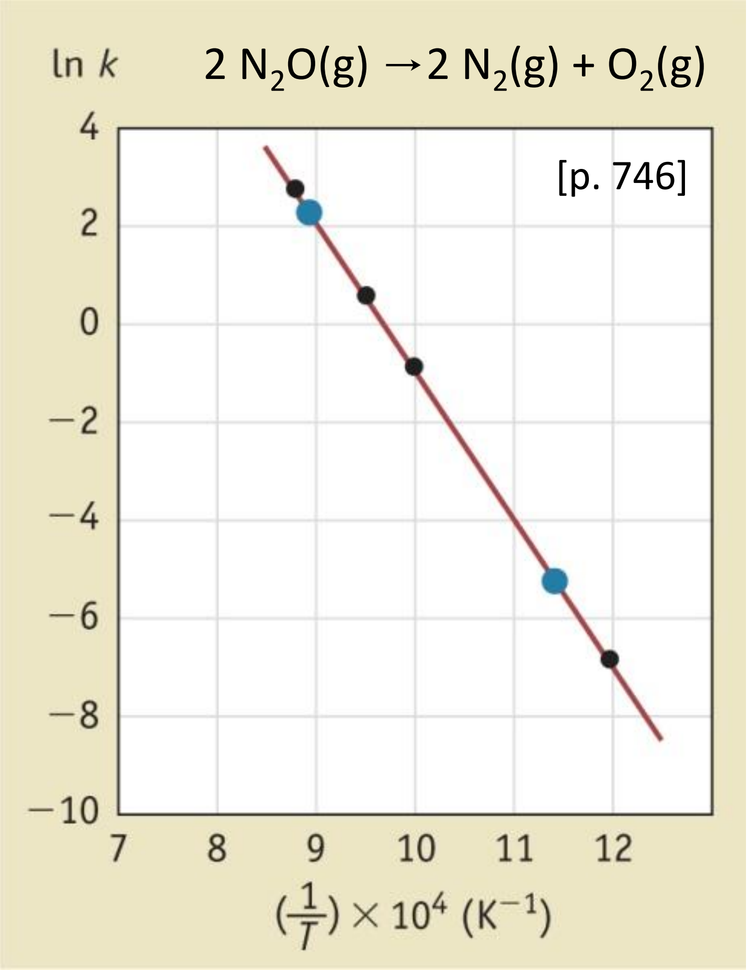
How is the affect of temperature on k quantitatively examined?

Taking the natural logarithm of both sides of the expression for k, given on the right, and rearranging it gives the linear equation below:

$$k = Ae^{\frac{-E_{act}}{RT}}$$

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

y = m (x) + b



Mahaffy et al, 2nd ed, p. 746

If the frequency factor, A, is unknown, **the rate constants determined at two temperatures** (using the method of initial rates) can be used to determine E_{act}:

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

- The equation above can also be used to calculate the rate constant of a reaction at one temperature if the energy of activation and the rate constant at another temperature is known.