V) Energy Changes in Reactions

Monday, September 11, 2017 2:21 PM

What two things are necessary for a collision to be effective (for a reaction to occur)?

- sufficient KE ... to attain the threshold energy
- correct collision geometry.

But how does the KE actually contribute to breaking reactant bonds?

As reactant particles approach, their KE (speed) begins to decrease due to electron repulsion between the two reacting particles. Since energy cannot be destroyed, the KE is converted to stored energy (potential energy - PE), which is stored mainly in the bonds.

At particle impact, the KE is at its lowest and the PE at its highest. If enough PE built up in the reactant bonds, they will break and the product bonds form, resulting in an effective collision and creation of products.

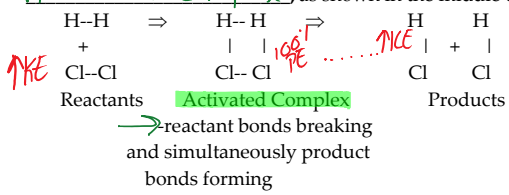
What happens if not enough PE is built up to break reactant bonds?

collision will be unsuccessful and the reactants will move away from each other after the collision ... awkwardly

Whether products form or not, when particles move away from one another after impact, the KE increase therefore the PE decrease.

As KE ⇑, PE & as KE ⇓, PE (KE and PE are *inversely* related)

If the collision is effective, there is a moment in time when reactant bonds are breaking, and simultaneously product bonds are forming. This structure is called the Activated Complex, as shown in the middle diagram below:



Activated complexes are very short lived, and very unstable. It is the point in the collision when PE is max!!.

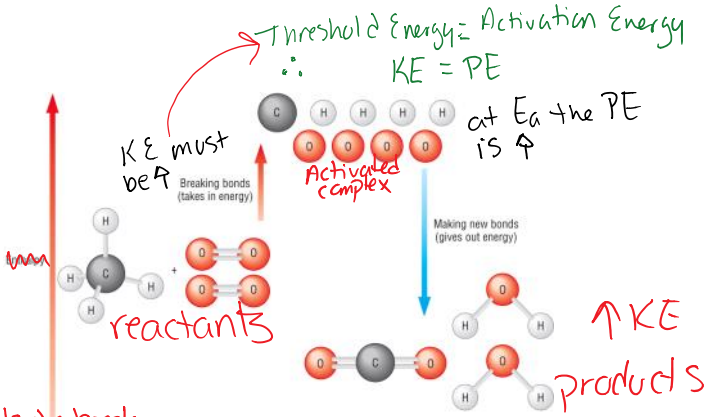
When discussing reaction energy from a KE standpoint, the **threshold energy** is the minimum amount of KE needed to cause the reactant bonds to break. But since the KE must transfer to PE first, the activation energy (Ea) is the minimum amount of PE needed to cause reactant bonds to break.

So, Threshold Energy (KE) = Activation Energy (PE)

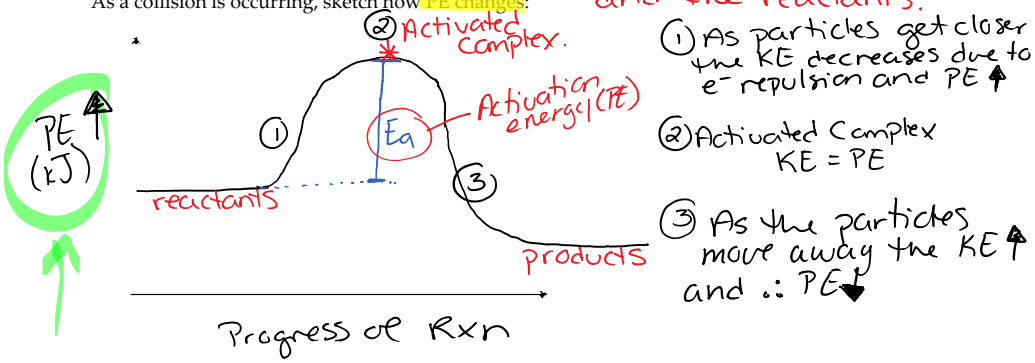
Define **activation energy**: (Ea)

the min. PE required for reactant bonds to break

or the PE difference between the activated complex and the reactants.



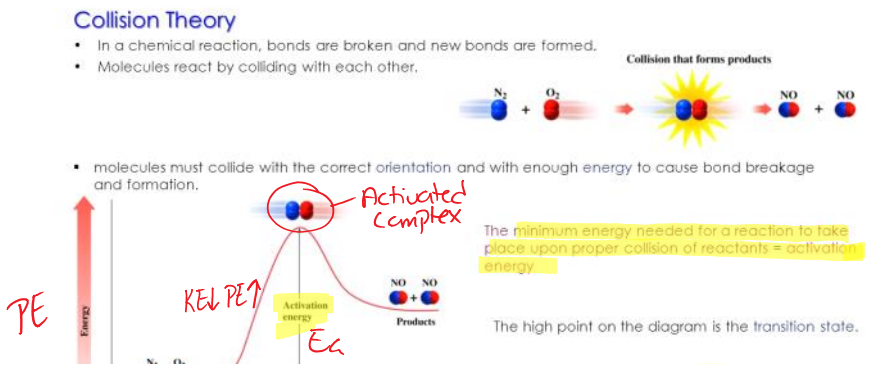
As a collision is occurring, sketch how PE changes:



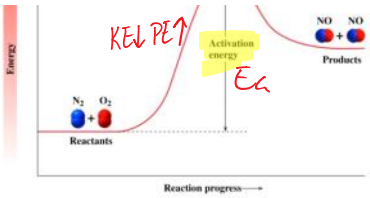
① As particles get closer the KE decreases due to e⁻ repulsion and PE ↑

② Activated Complex KE = PE

③ As the particles move away the KE ↑ and ∴ PE ↓



PE



The high point on the diagram is the transition state.

The species present at the transition state is called the activated complex.