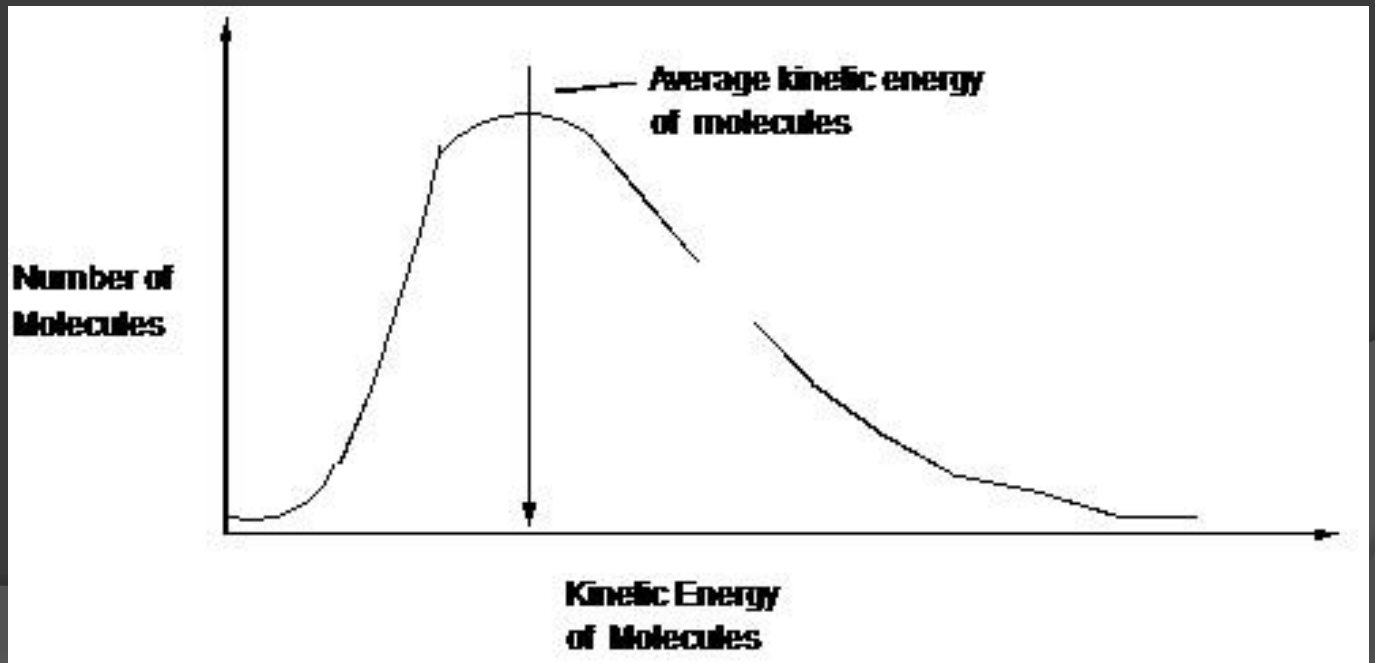
1.7 Kinetic Energy Distribution

i) ***Kinetic Energy of Reactants***

- i) Think of kinetic energy as speed at which reactants are traveling.
- ii) In a room full of reactants, they all have different kinetic energies (i.e.: they are all traveling at different speeds!)
- iii) This *continuous distribution* of kinetic energies can be shown graphically:



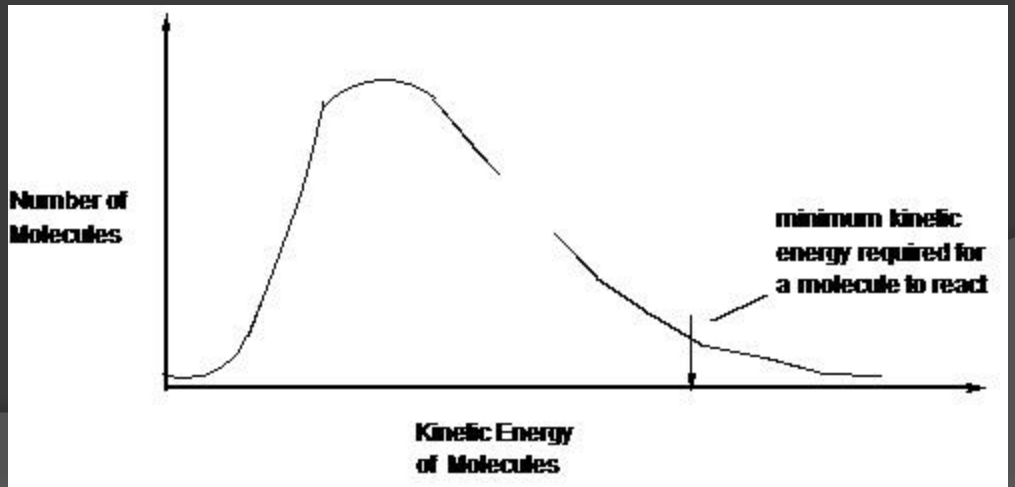
1.7 Kinetic Energy

- iv) If the average kinetic energy is higher, there will be more reactants with enough energy to effectively react to form products.

(Higher average KE = Faster Rate)

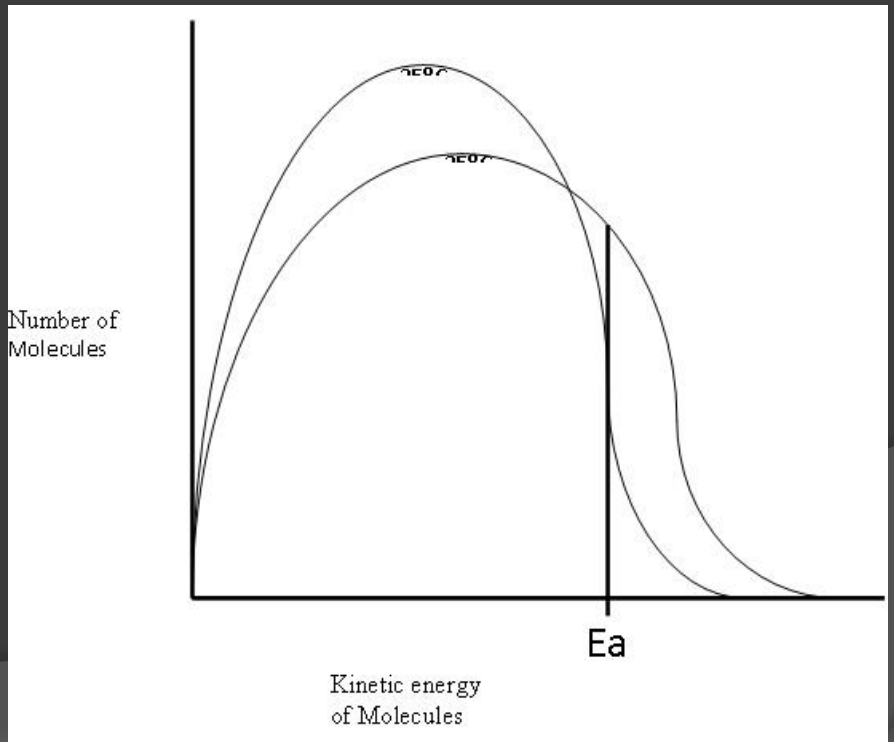
Kinetic Energy and Activation Energy

- i) With a minimum energy requirement (activation energy), only a small percentage of all the reactant molecules have enough kinetic energy to effectively react!

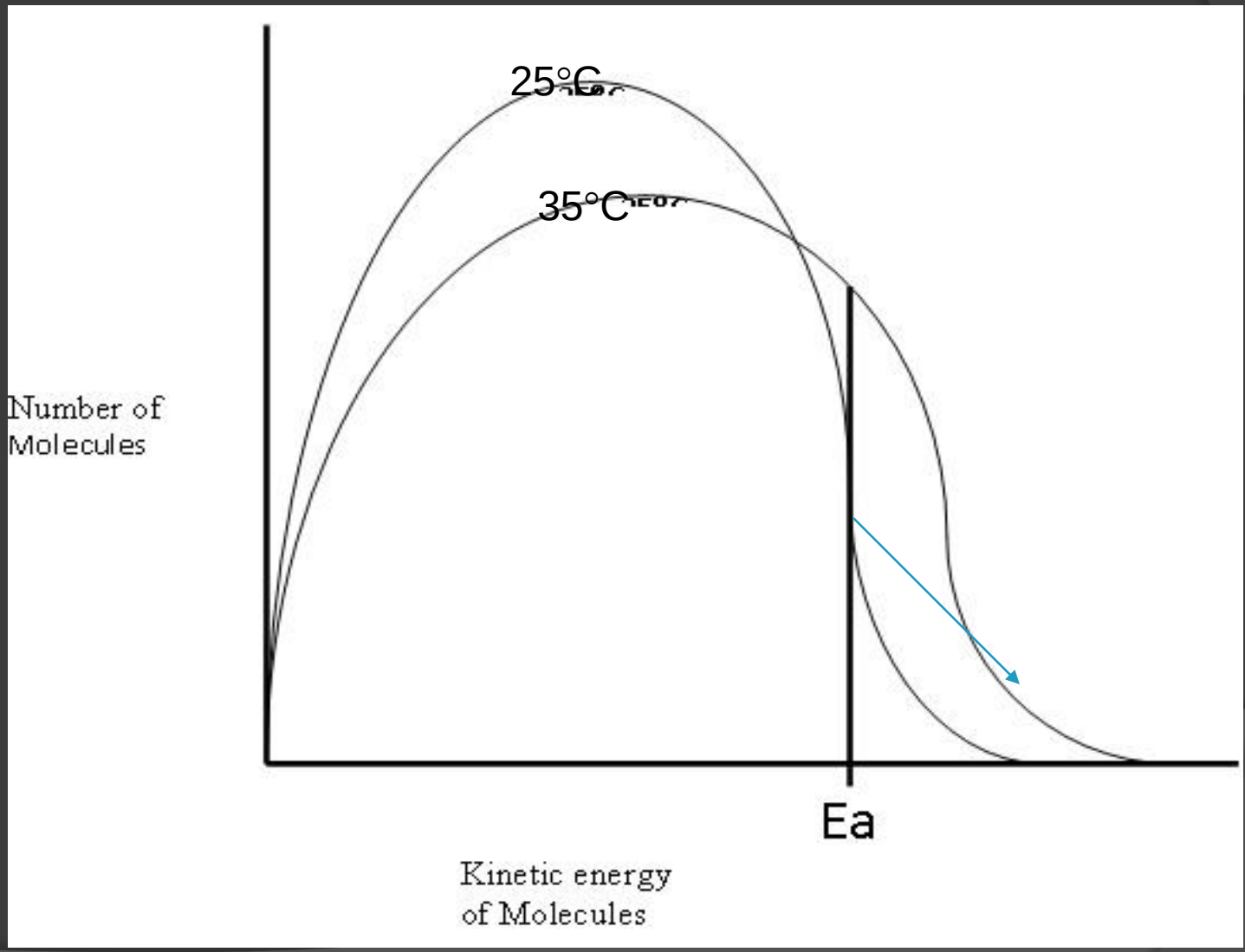


1.7Activation Energy

- i) The minimum kinetic energy is a major part of the activation energy (Ea) for a reaction!
- ii) **If we increase the temperature:**
- **• we increase the average kinetic energy and**
- **• also increase the number of molecules with the minimum kinetic energy required to react.**

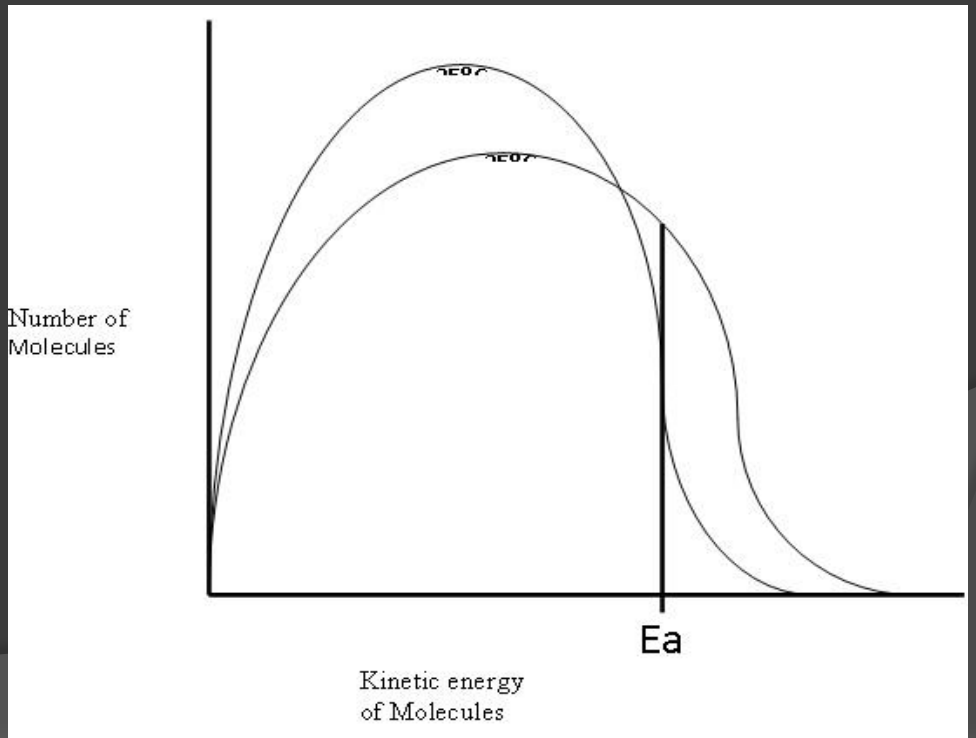


1.7 Kinetic Energy



1.7 Kinetic Energy

- The reaction rate is faster at higher temperature because more molecules have enough kinetic energy (activation energy) to react. General rule: Every 10°C increase = double the rate of reaction (for slow reactions!)



1.7 & 8 Activation Energy

a) Ineffective Collisions

- **Not all collisions between reactants will result in products. If they do not collide with enough "*activation energy*" (i.e.: not head on collision or not fast enough), then the reactants will not react!**

- **They will not react because there is not enough energy to rearrange the bonds!**

b) Effective Collisions

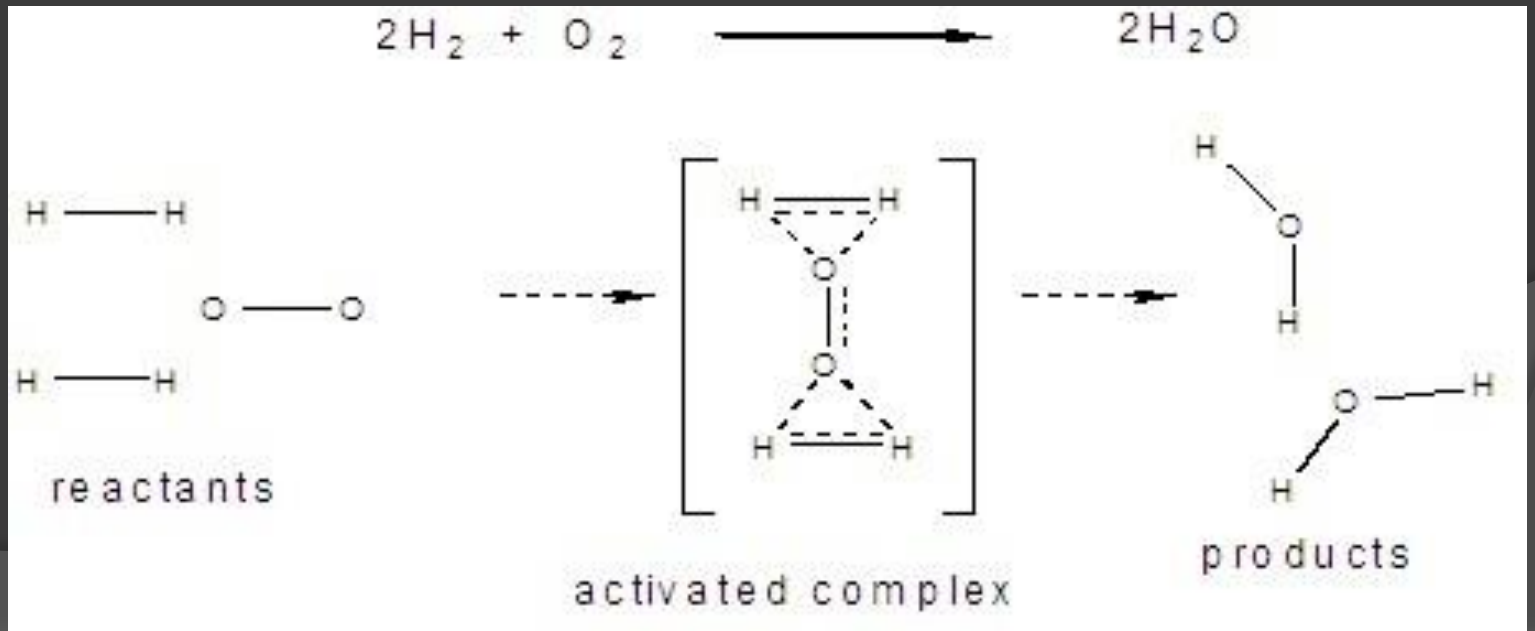
- **If two reactants do collide with enough "*activation energy*", then the reactants react to form products!**
- **There is enough energy to rearrange the bonds!**

1.8 Activation Energy

c) What is Activation Energy (E_a)?

-

d) What is an Activated Complex?

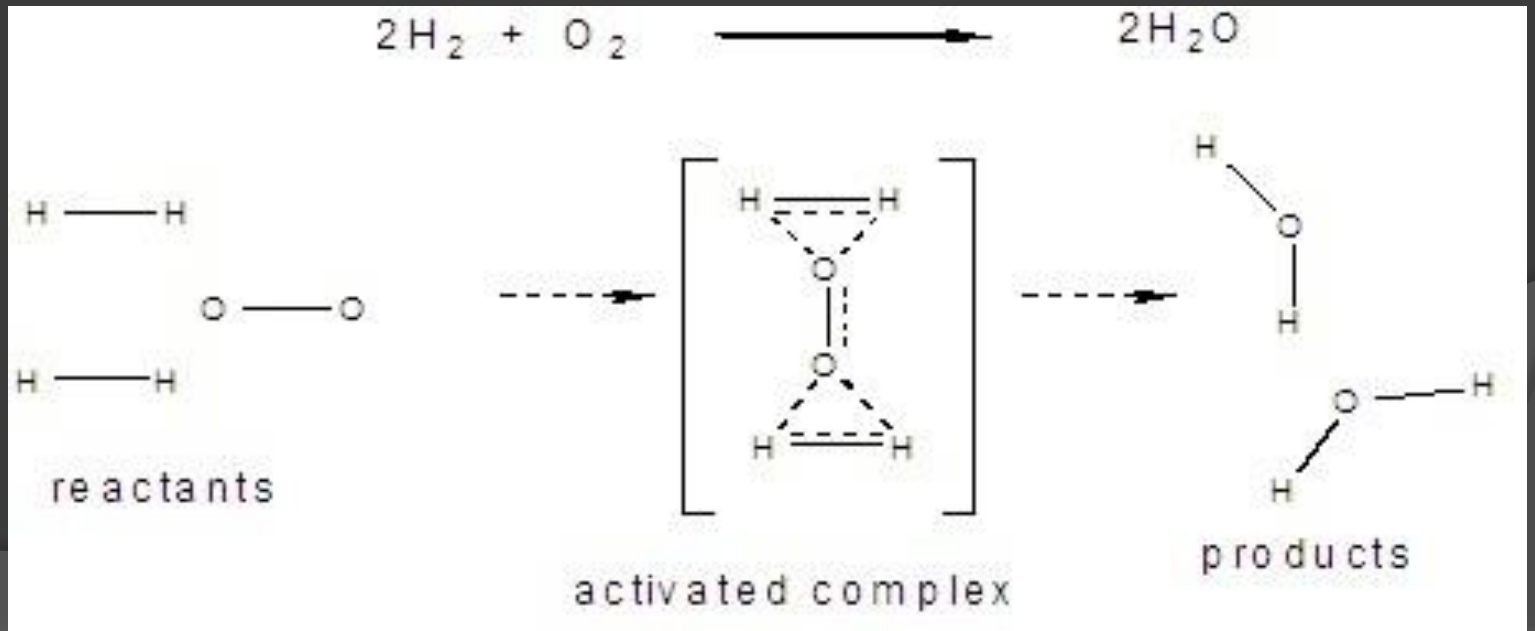


1.8 Activation Energy

c) What is Activation Energy (E_a)?

- The minimum energy required to change the reactants into an "activated complex".
-

d) What is an Activated Complex?



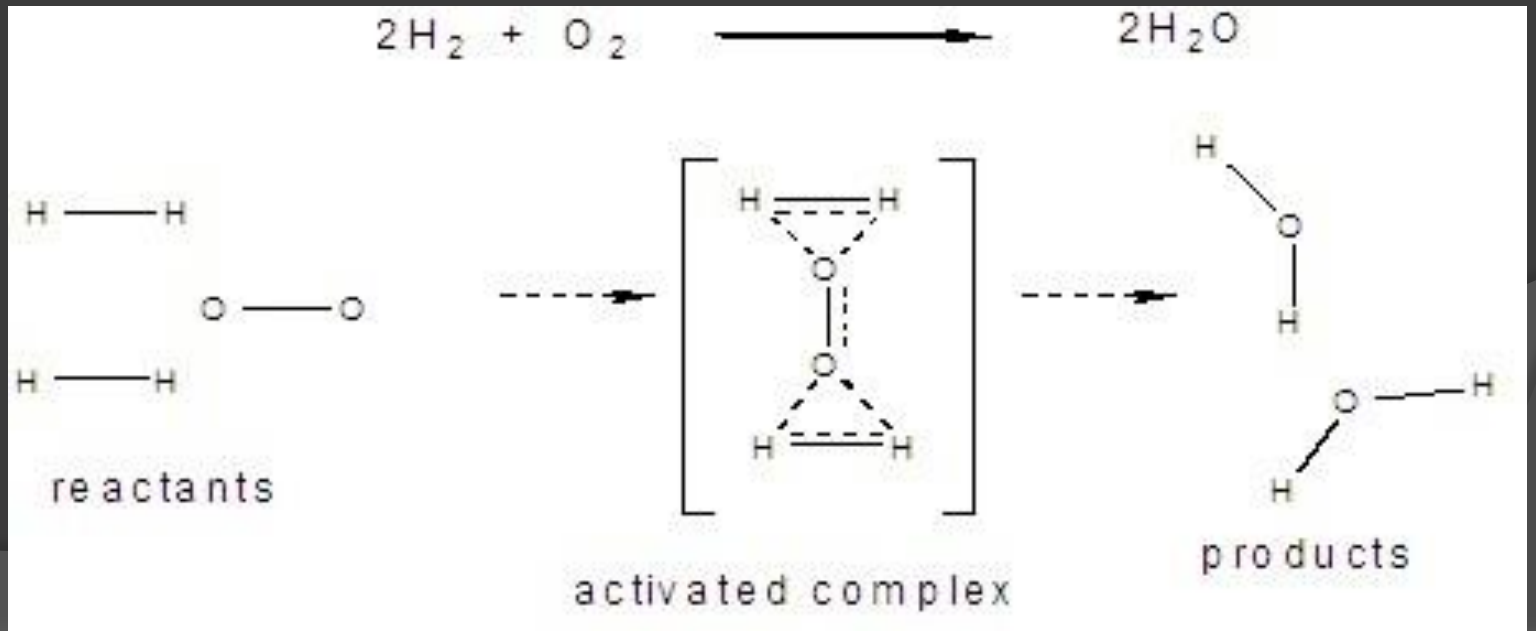
1.8 Activation Energy

c) What is Activation Energy (E_a)?

- The minimum energy required to change the reactants into an "activated complex".

d) What is an Activated Complex?

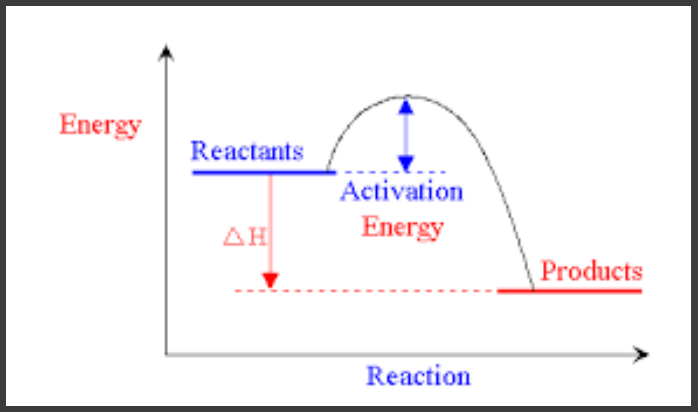
- A high energy "in between or intermediate" stage in a reaction, where the reactants are in the process of rearranging to form products.



1.8 Activation Energy

- ***e) Three possibilities for KE of reactant molecules:***

i. KE less than amount of PE equal to Ea
reactant molecules can't get to top of hill – ineffective collision



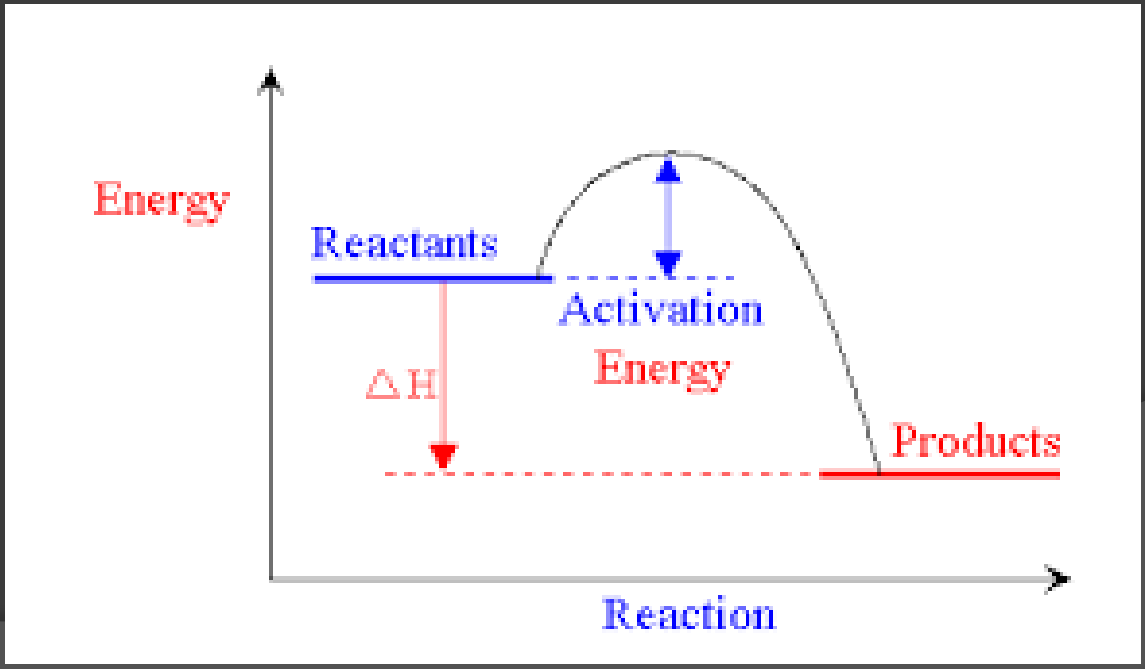
ii. KE is equal to minimum energy required (Ea)

reactant molecules come to standstill- reaction possible but not guaranteed

1.8 Activation Energy

iii. KE more than Ea needed for reaction

reactant molecules have enough energy for Ea and some left over – collision is effective



1.8 Activation Energy

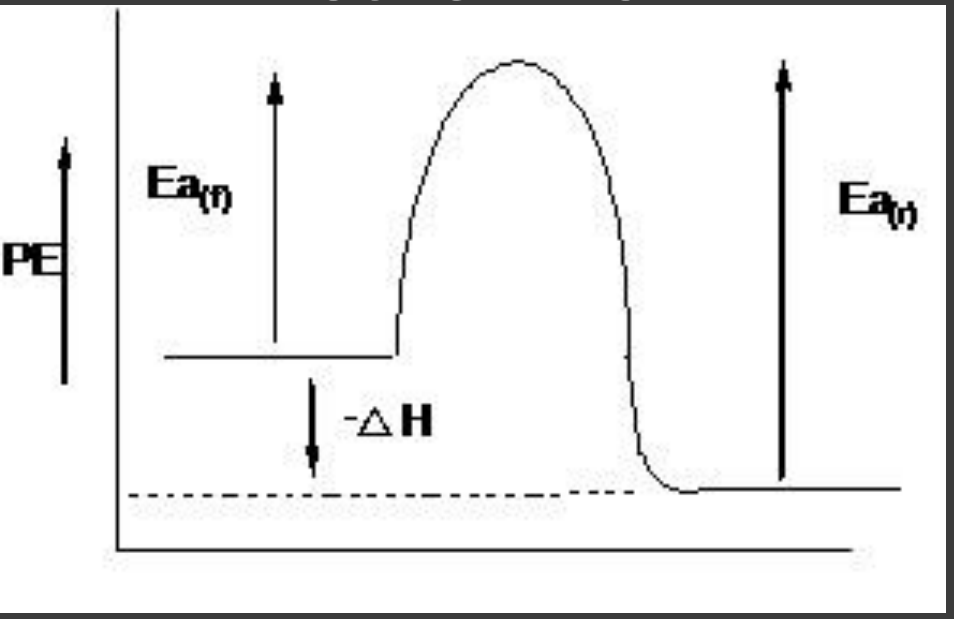
f) Two requirements for successful collision:

i. Sufficient KE (needed to convert to PE)
ii. Correct alignment (if reactants not aligned properly, more energy will be needed)

1.8 Activation Energy

- ***g) Reaction Profiles***

Exothermic

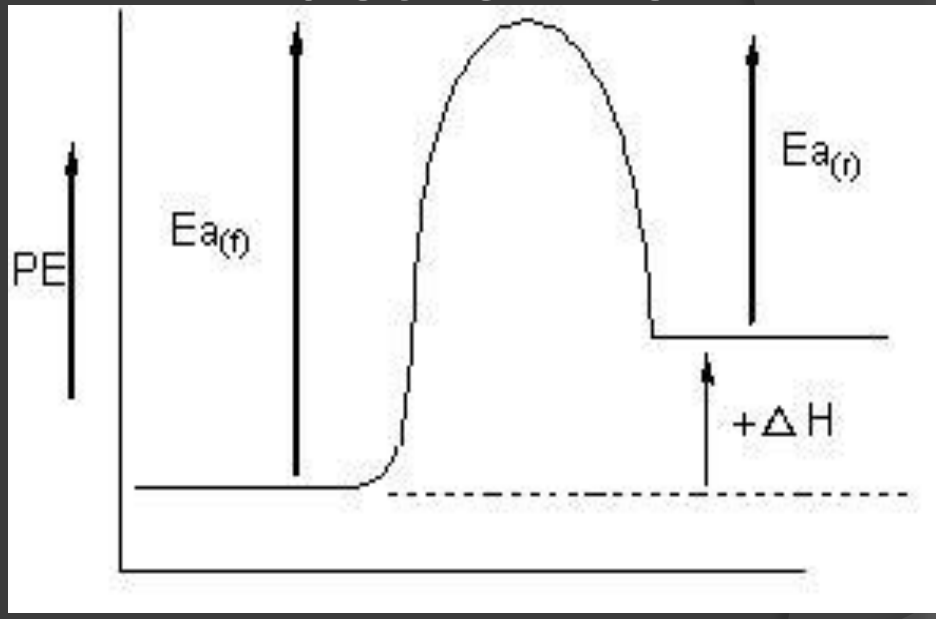


$Ea_{(f)} - \Delta H = Ea_{(r)}$

(Ea (f) = Ea(r) + ΔH !!)

Note: Λ H < 0

Endothermic

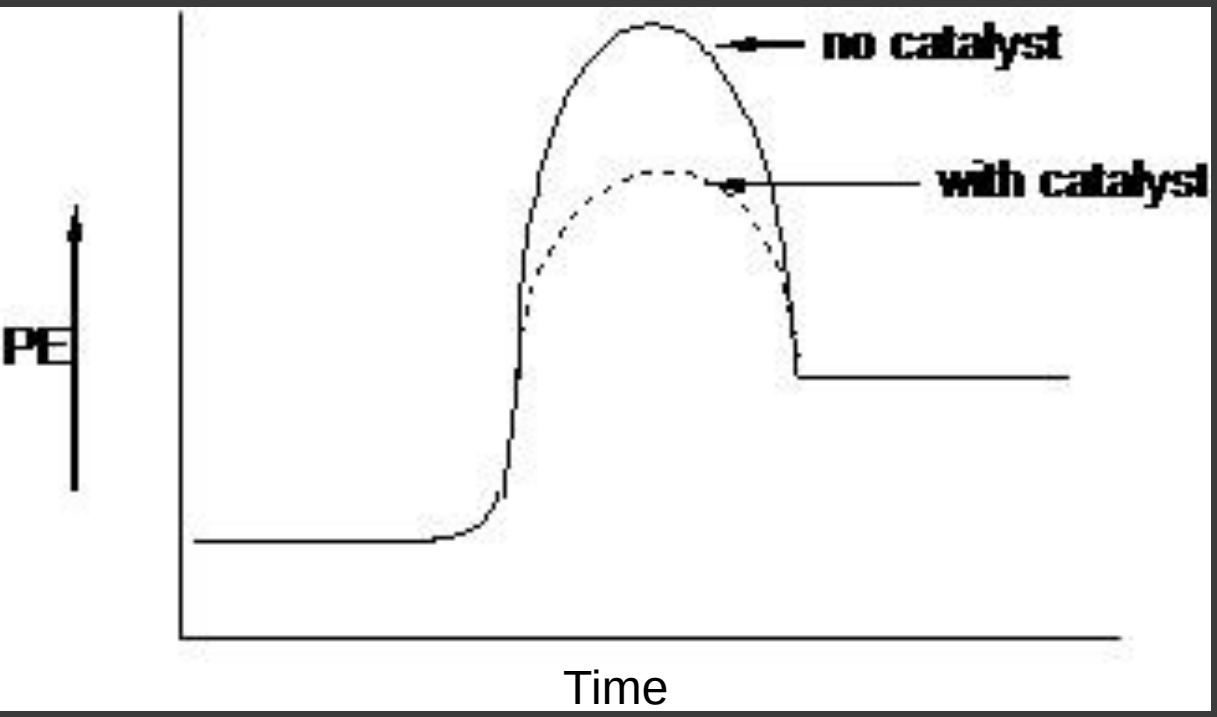


$Ea_{(f)} = Ea_{(r)} + \Delta H$

Note: Λ H >0

1.8 Activation Energy

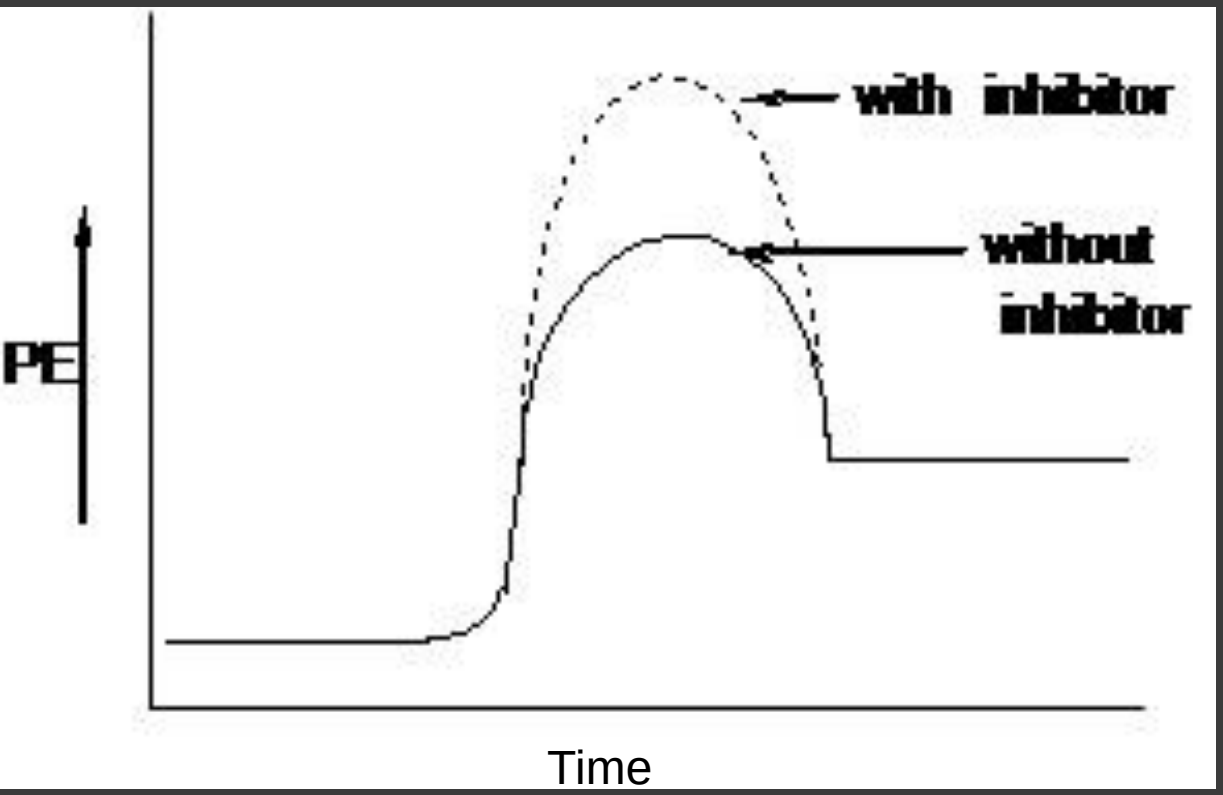
h) Catalysts



catalyst = chemicals that increase rate of reaction by lowering the Ea.

1.8 Activation Energy

i) Inhibitors



inhibitor = chemical that <u>decreases</u> rate of reaction by raising the Ea.

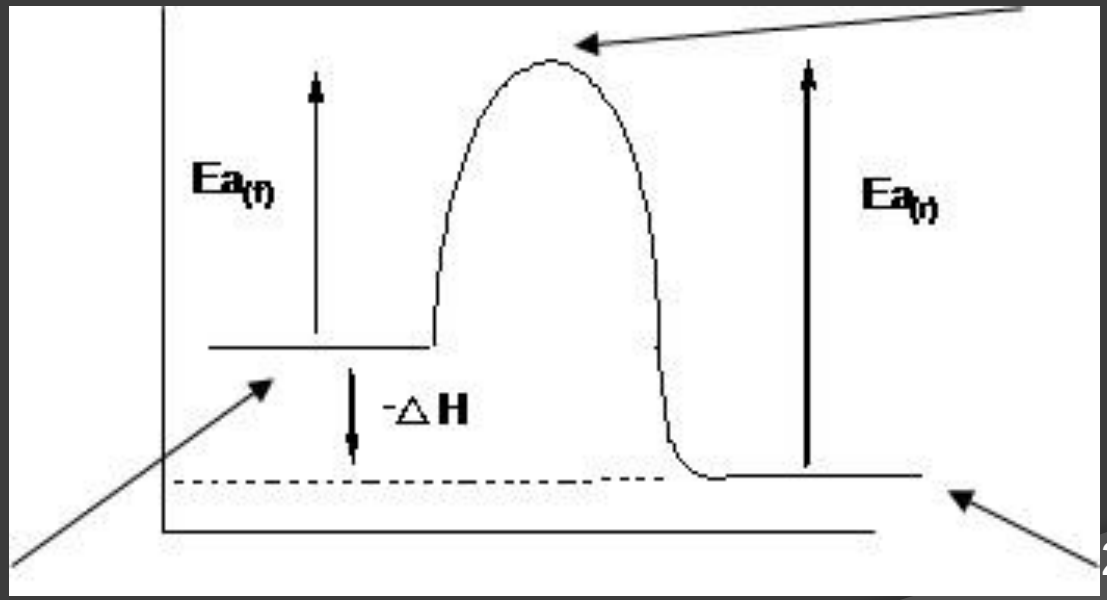
1.8 Activation Energy

j) Practice Question

H_2 + I_2 2HI + 100 KJ

For the above reaction, sketch the reaction profile. Label ΔH, $Ea_{(f)}$, $Ea_{(r)}$ and the where the activated complex will be found.

Activated complex



H_2 and I_2

2HI

1.8 Activation Energy

ii) If the $Ea_{(r)}$ is 400 KJ, what is the value of $Ea_{(f)}$?

- $Ea_{(f)} = Ea_{(r)} + \Delta H$
- $Ea_{(f)} = 400\ kJ + -100kJ = 300\ kJ$

iii) Draw a possible activated complex!

- Do questions: # 29-32 pg19-20, 34 - 36 37 a, b,c, d, e, 38, 39 page 23 and # 41-45 page 25