Physical Chemistry IV

Modul

CATALYST

NANIK DWI NURHAYATI, S.Si, M.Si
Chemical Education Study Program
Teacher Training and Educational Studies
Sebelas Maret University (UNS)

Website: http://nanikdn.staff.uns.ac.id,
email: nanikdn@uns.ac.id

What is a Catalyst ?

Catalyst is a substance that increases the rate of the reaction at which a chemical system approaches equilibrium , *without being* substantially *consumed in the process.*

Catalyst affects only the rate of the reaction,i.e.Kinetics.

It changes neither the thermodynamics of the reaction nor the equilibrium composition.

Reaction A + B -> D
Mechanism is

A + C -> AC	(1)
B + AC -> ABC	(2)
ABC -> CD	(3)
CD -> C + D	(4)
A + B -> D	(total)

Background

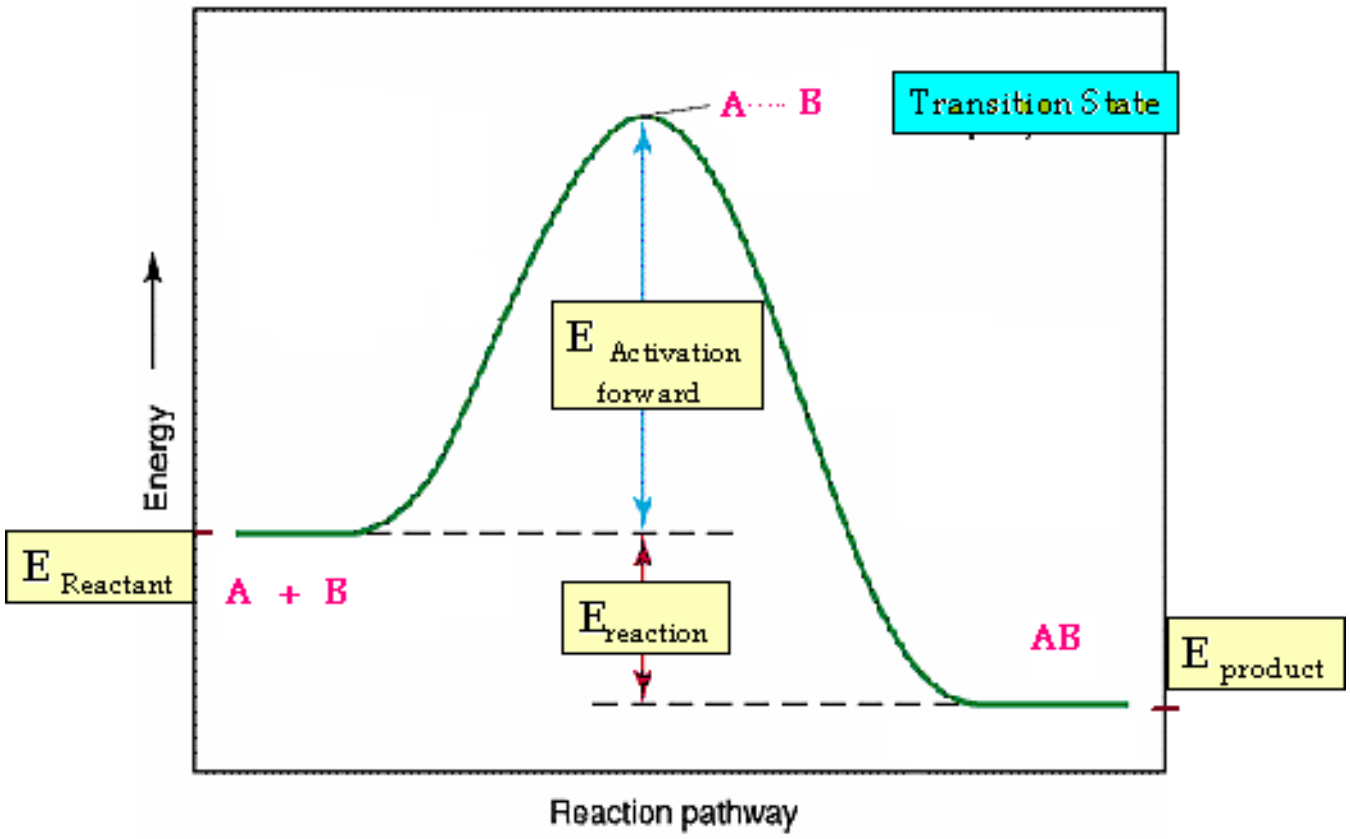
Why Catalyst?

Without Catalyst: $A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} B$

With Catalyst C: $A + C \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} B + C$

Where k2 > k1 because of the catalyst C. In general the catalyst, is not destroyed by the reaction.

Kinetic Vs. Thermodynamic Reaction Profile



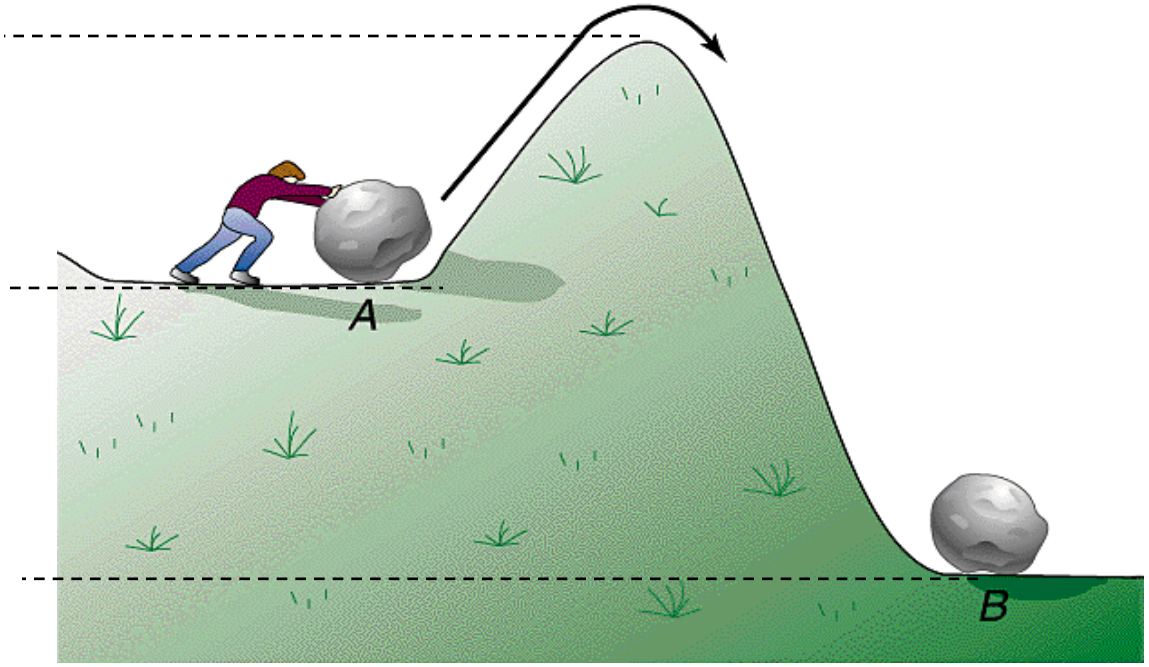
Reaction path for conversion of A + B into AB

Activation Energy

Definition

Activation Energy : The energy required to overcome the reaction barrier. *Usually given a symbol* E_a *or* ΔG

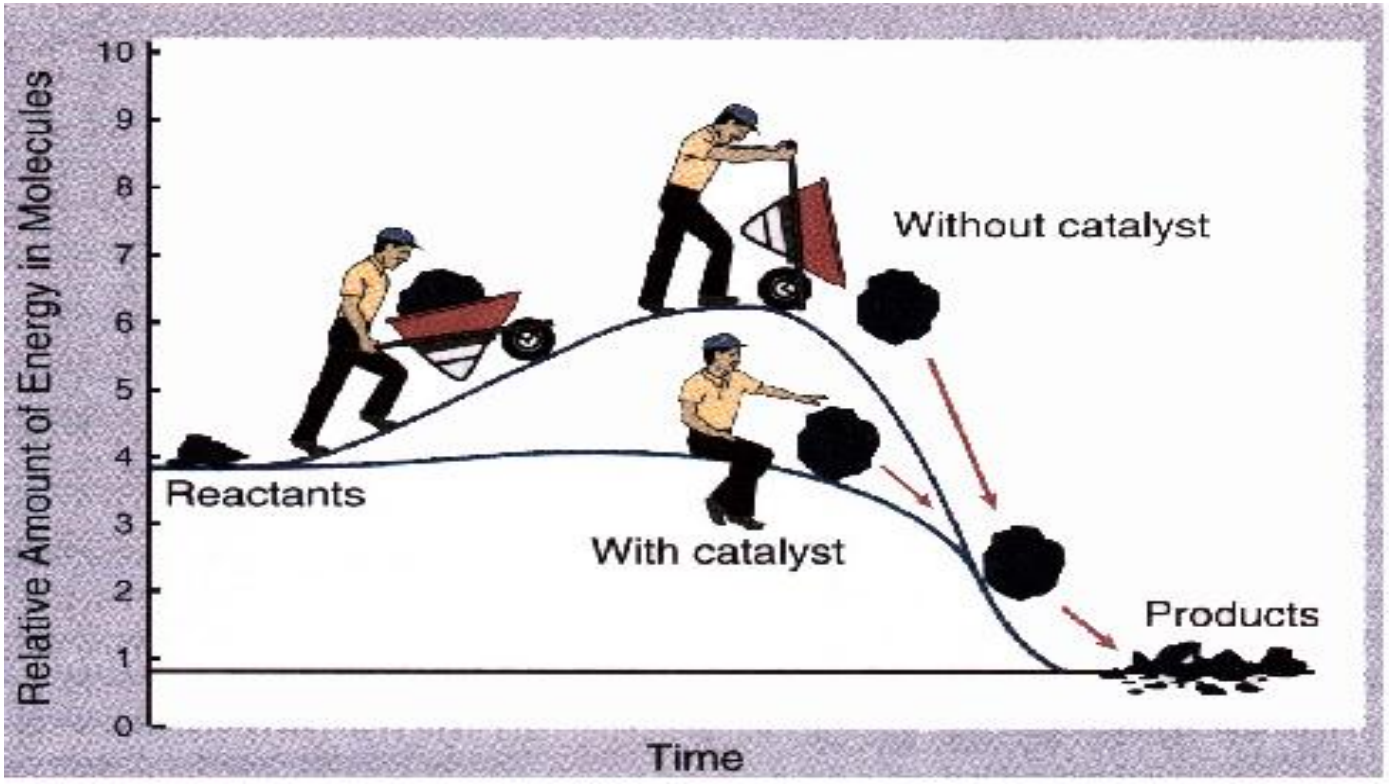
The Activation Energy (*Ea*) determines how fast a reaction occurs, the *higher Activation barrier,* ***the slower the reaction rate. The lower the Activation barrier, the faster the reaction***



Activation Energy

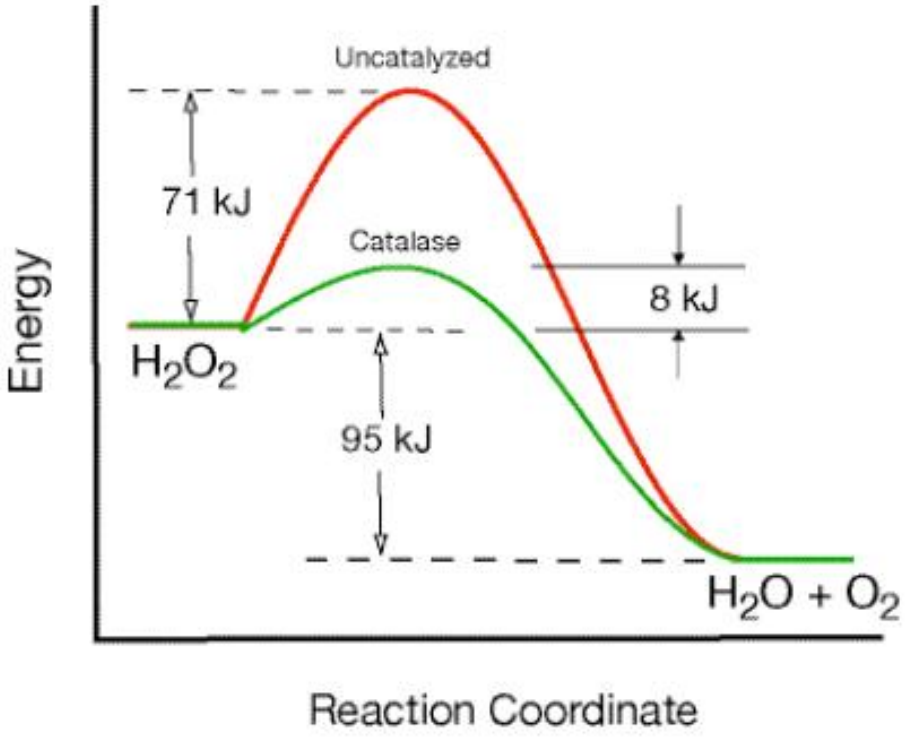
Catalyst Affect

Catalyst lowers the activation energy for both forward and reverse reactions.



Function of a Catalyst

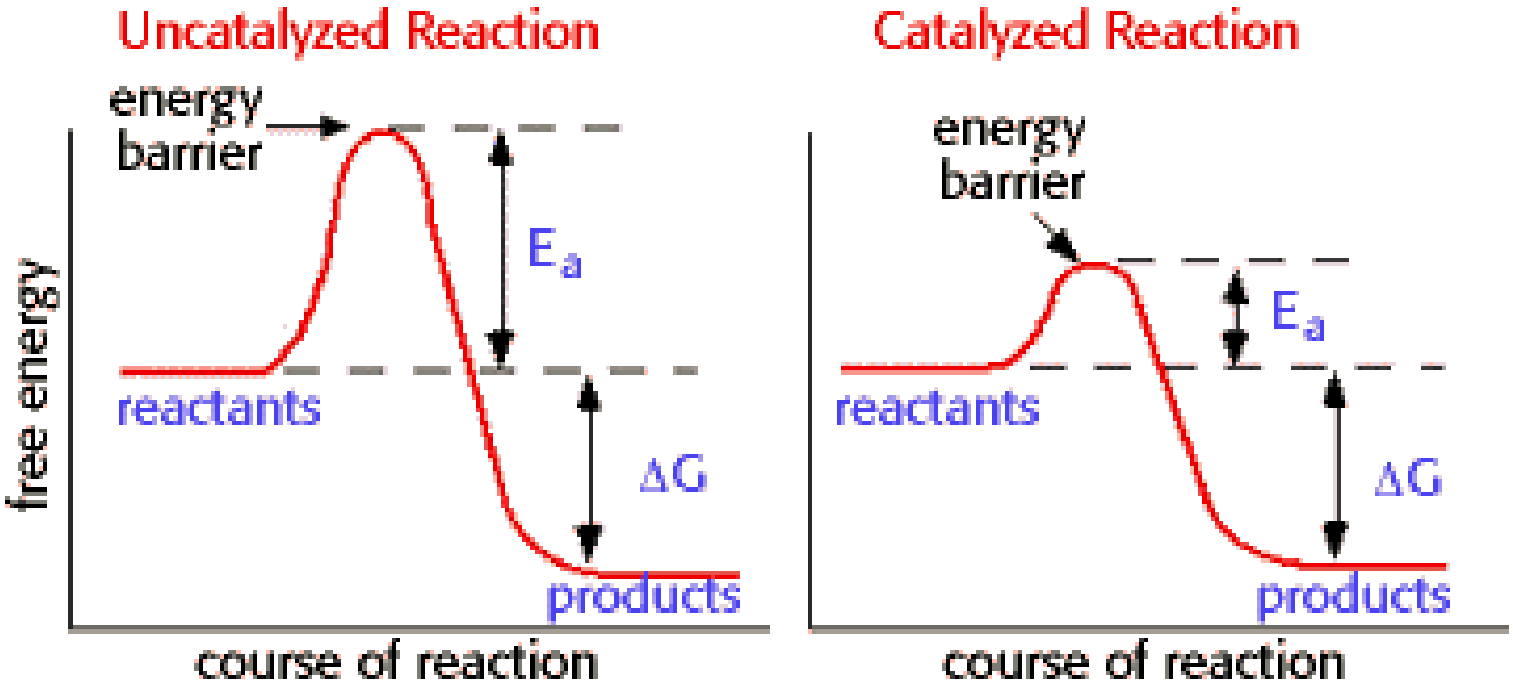
A catalyst lowers Ea and therefore accelerates the reaction.



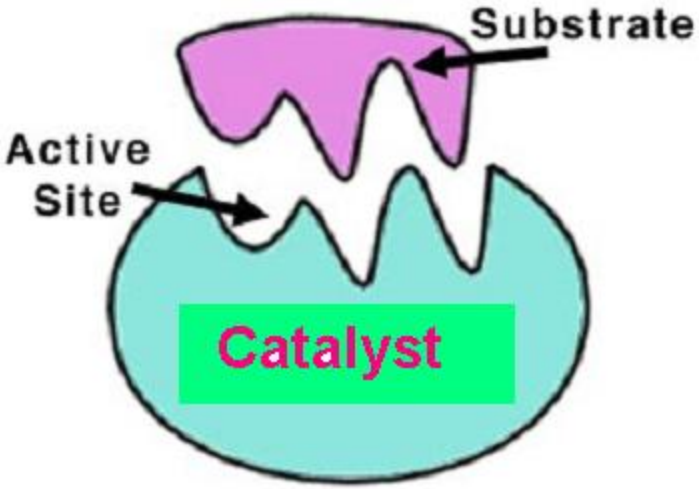
In the case above Ea is lowered from 71 to 8 kJ/mole

Activation Energy

Catalyst Affect



This means , the catalyst changes the reaction path by lowering its activation energy and consequently the *catalyst increases the rate of reaction.*



Substrate has to be adsorbed on the active sites of the catalyst

SIFAT-SIFAT KATALIS

1. Katalis tidak mengalami perubahan yang permanen dalam reaksi, berpengaruh pada sifat kinetik seperti mekanisme reaksi.
2. Katalis mempercepat laju reaksi tetapi tidak mengubah jenis maupun jumlah hasil reaksi.
3. Katalis dapat menurunkan energi aktivasi, tetapi tidak mengubah entalphi reaksi.
4. Katalis mengubah mekanisme reaksi dengan menyediakan tahap-tahap yang mempunyai energi pengaktifan lebih rendah.
5. Katalis bersifat spesifik, satu katalis hanya sesuai untuk satu jenis reaksi, artinya hanya dapat mengkatalisis reaksi tertentu.
6. Katalis hanya diperlukan dalam jumlah sedikit.
7. katalis tidak mengubah kesetimbangan reaksi

Characteristics of catalysts:

1. Activity. The ability of a catalyst to increase the rate of a chemical reaction is called activity. A catalyst may accelerate a reaction to as high as 10^{10} times.

2. Selectivity. The ability of the catalyst to direct a reaction to give a particular product.

3. Small quantity. Only small quantity is need for a reaction.

4. Specific. One catalyst is need for specific reaction only

5. Physical properties may change during a reaction but no it ***does not take part in the reaction.***

6. Catalyst doesn't influence on the general **stoichiometric coefficients.**

7. Catalysts decrease **activation energy** thus increase the chemical rate.

8. Catalysts don't influence on the **equilibrium constant**. They only reduce time of reaching the equilibrium and increase the rate of forward and back reaction.


Thanks for attention