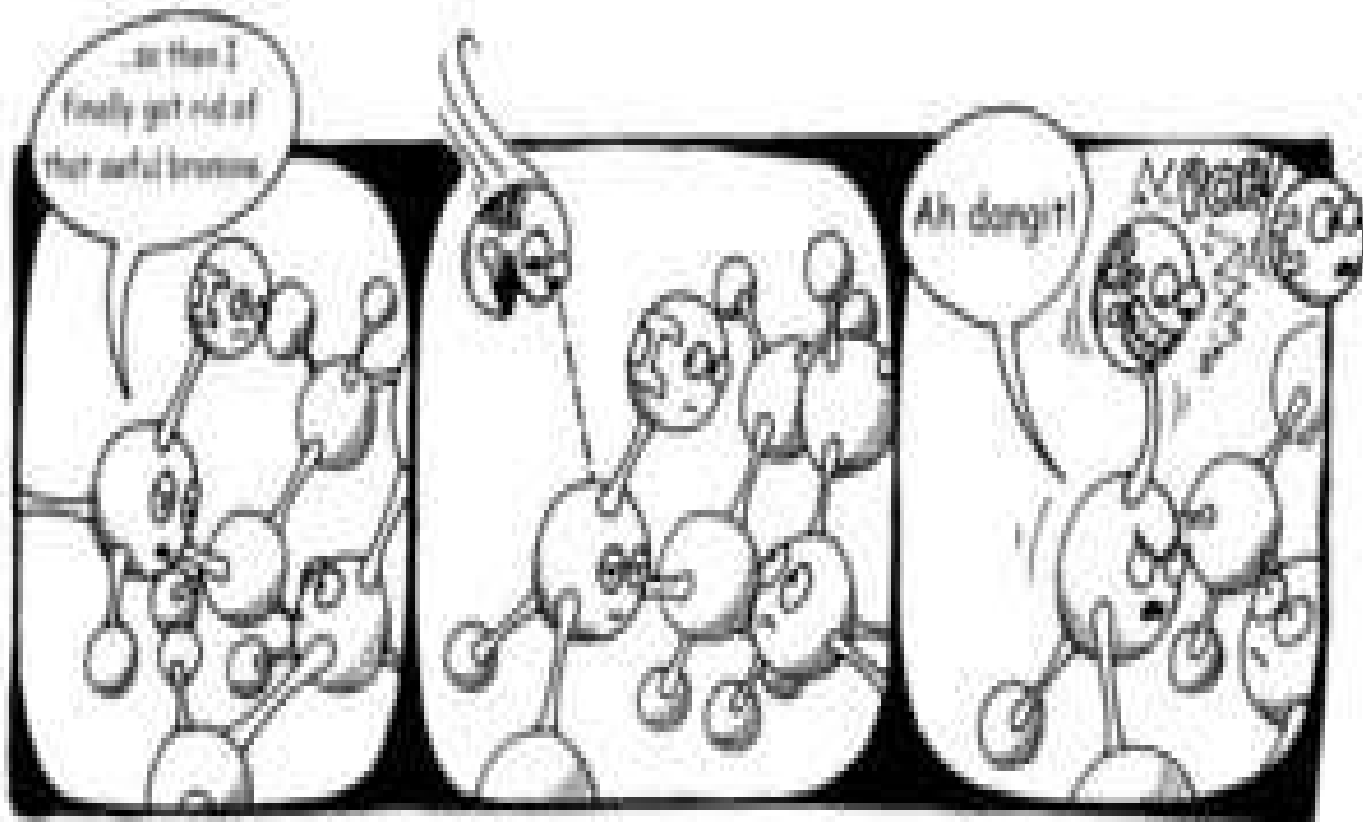


Reaction Rates and Equilibrium

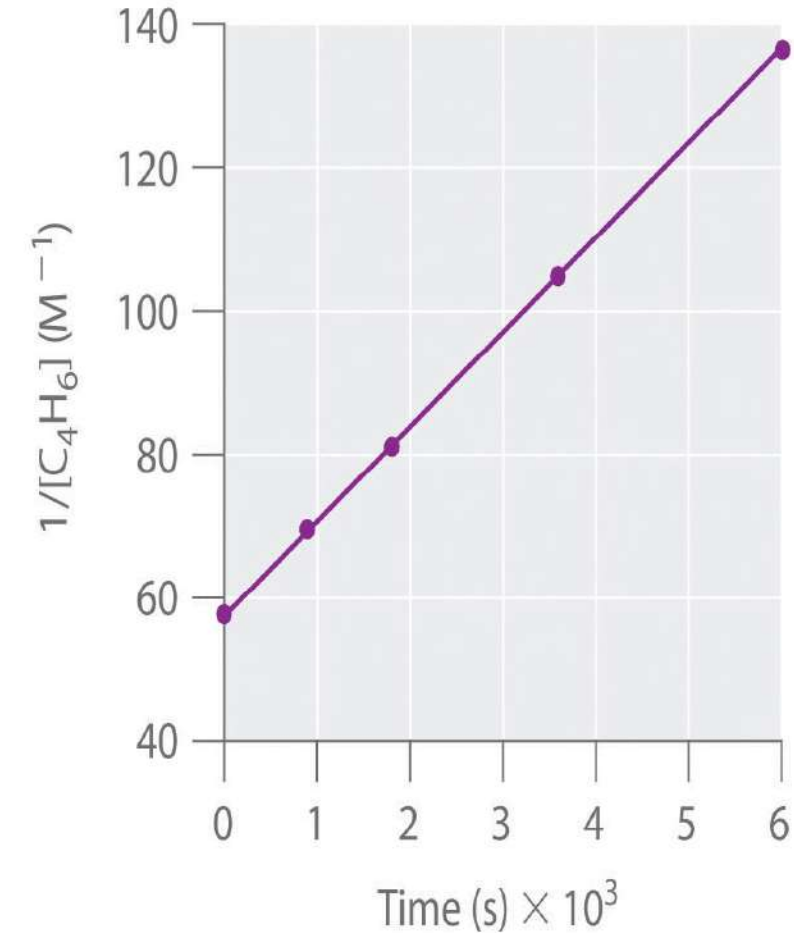
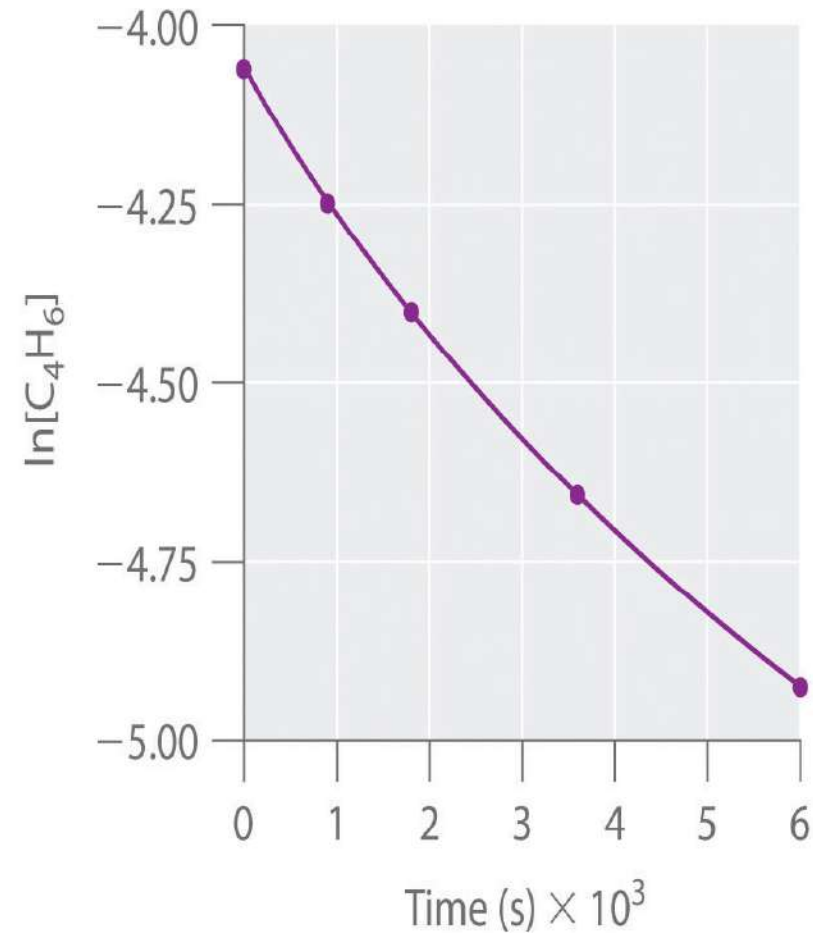
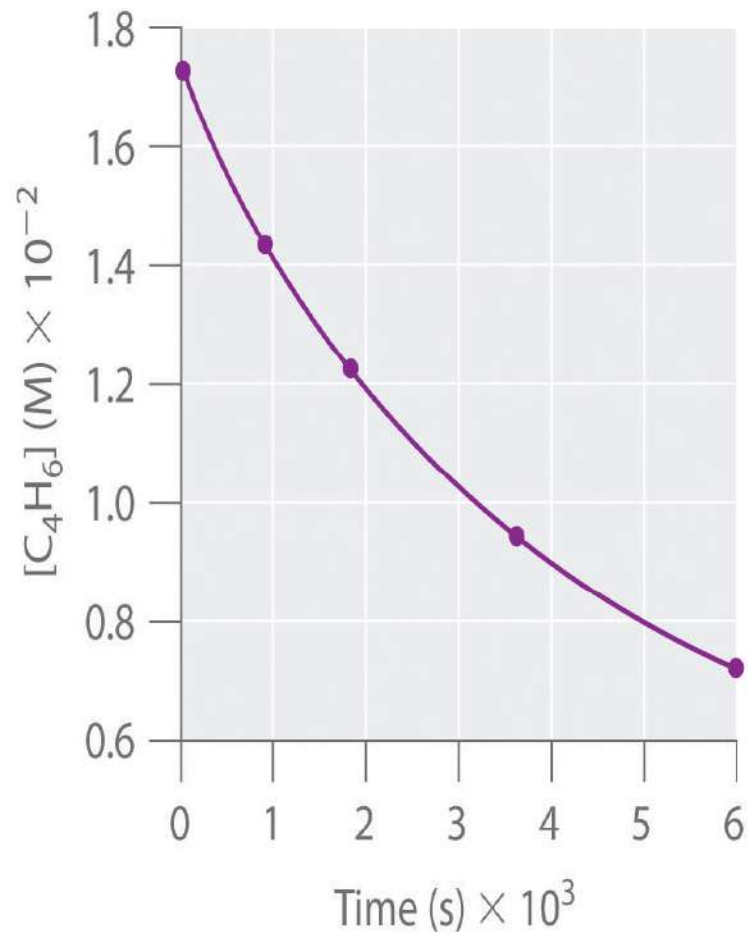


A. Determining reaction rate

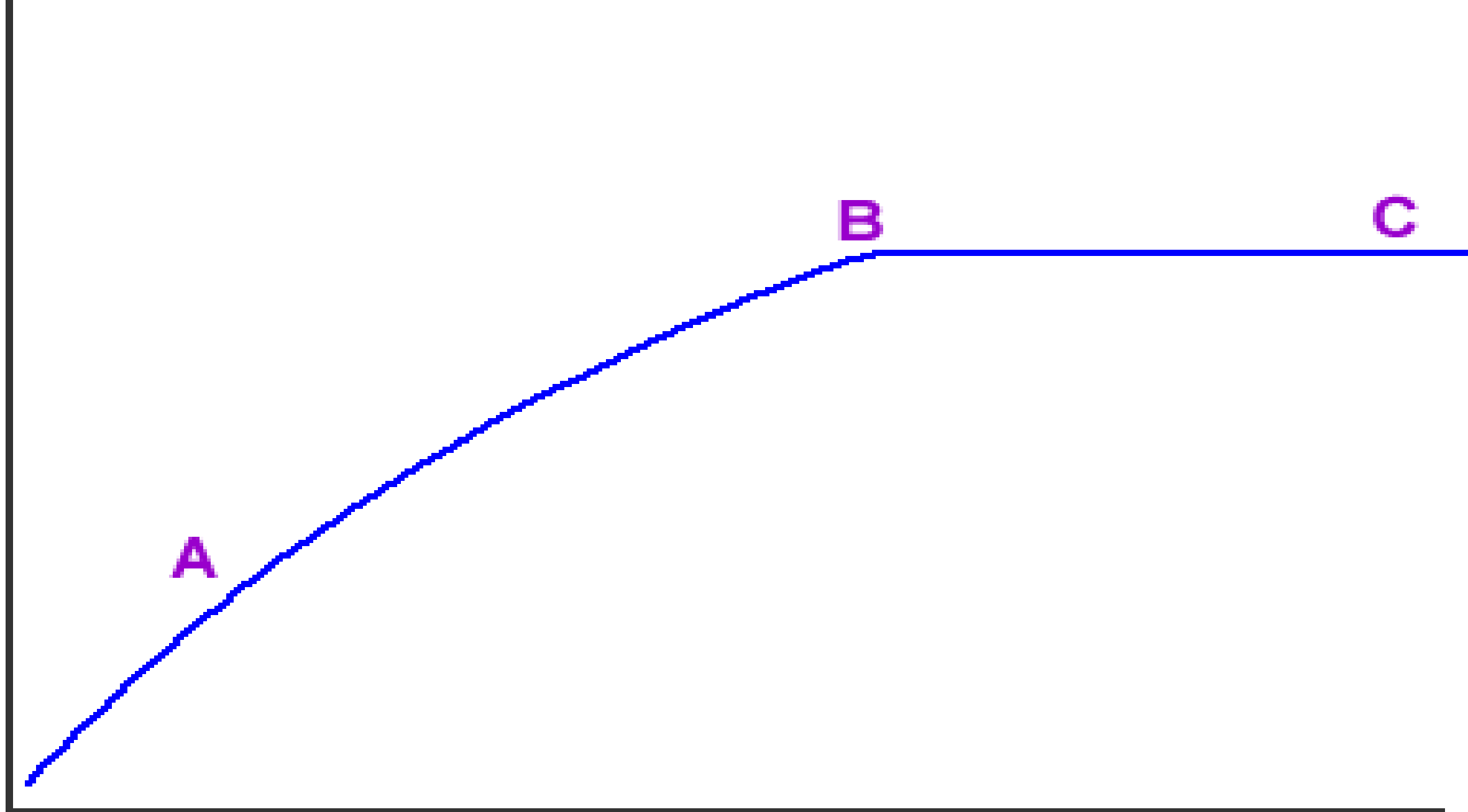
1. What is rate?

Rate is defined as the speed at which something takes place.

2. Graphing rates can deliver important information. A straight line upwards indicates a constant speed. A line curving upward is acceleration. At places where the graph flattens out, the speed remains constant.



Reaction rate



substrate concentration

3. A reaction rate is determined by the amount of product or reactant made per unit of time. When measuring gases, you'd need to detect pressure. Color can be used to indicate a change in concentration. Whatever you are looking at, it must be timed.

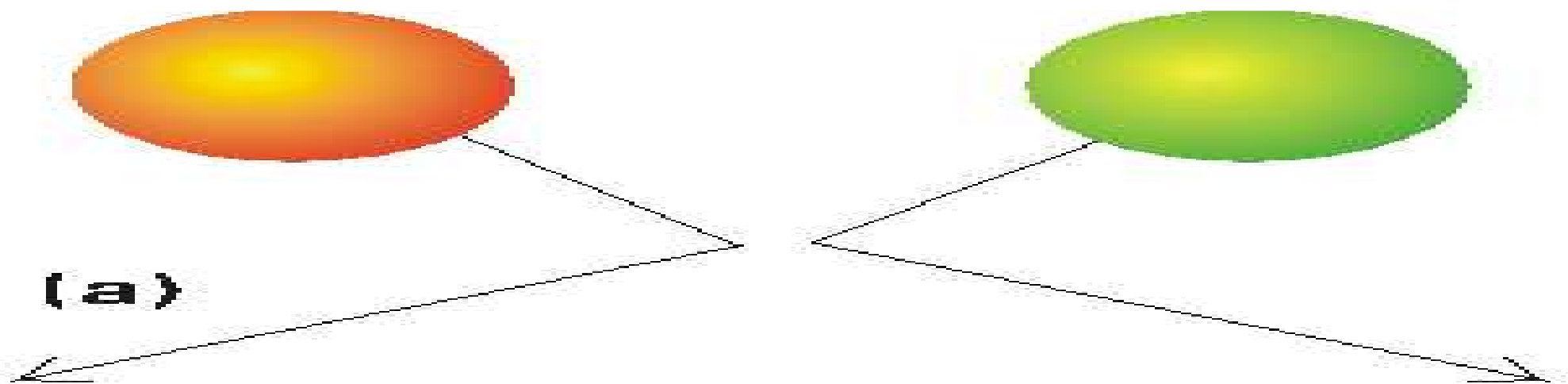
<https://www.youtube.com/watch?v=FofPjj7v414>

Reactions 3:25

https://www.youtube.com/watch?v=_GJKQqTwM9o

B. Factors affecting reaction rate

1. Collision Theory – says that the rate of a chemical reactions depends on the collisions between reacting particles.



<https://www.youtube.com/watch?v=wbGglfHsx-l>

Collision theory 2:2

<https://www.youtube.com/watch?v=cqSfrhSAA7Y>

Collision theory 5:06

<https://www.youtube.com/watch?v=OttRV5ykP7A>

How to speed up a chemical reaction and get a date 4.55

https://www.youtube.com/watch?v=XX9Xo6zm_kM

Chemistry Music Video 22: Rate of reaction 3.28

<https://www.youtube.com/watch?v=7qOFtL3VEBc>

Kinetics: rate calc, rxn mechanism 9.56

<https://www.youtube.com/watch?v=G3WCQmL6bgA>

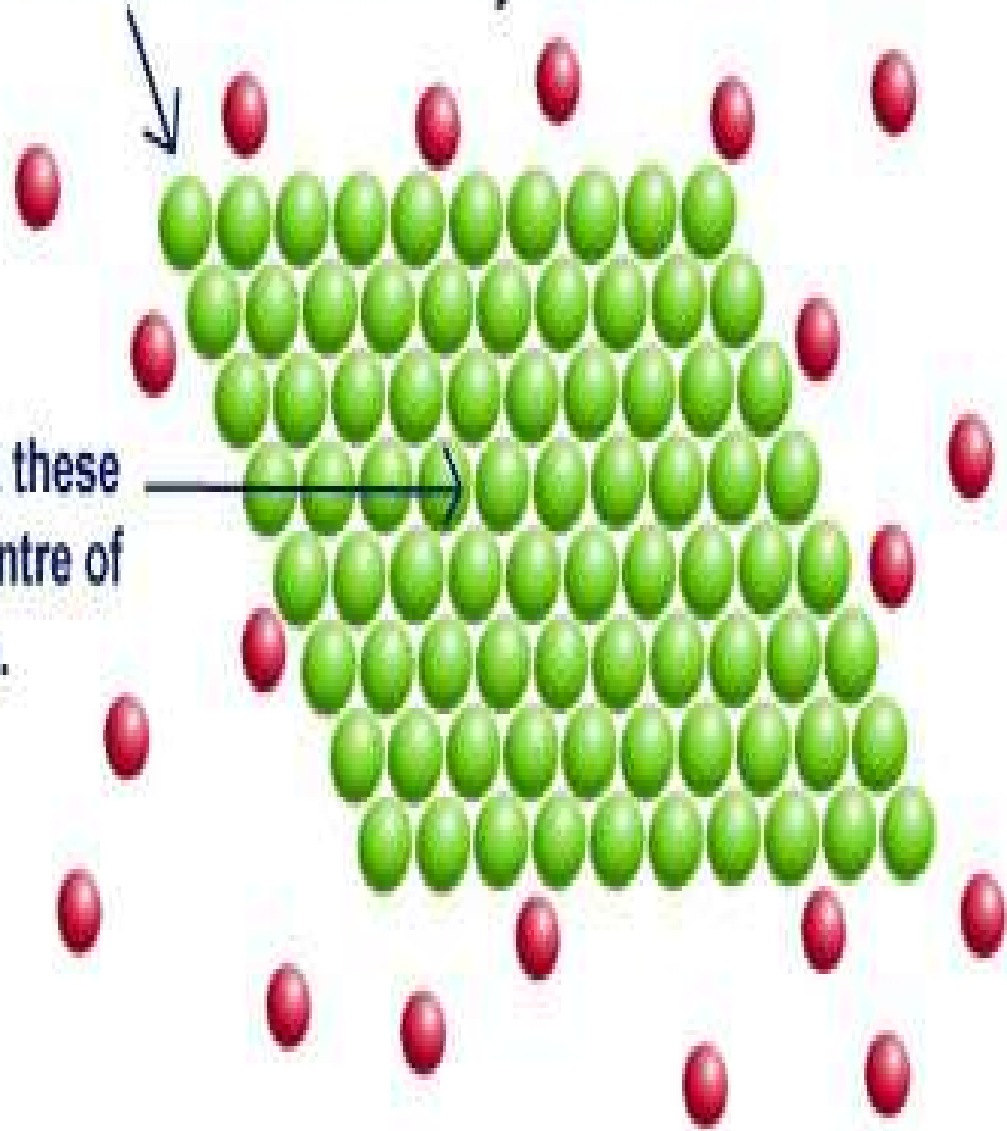
Collision theory/Reaction rates 7.51

2. Surface area – smaller/more surface area is faster

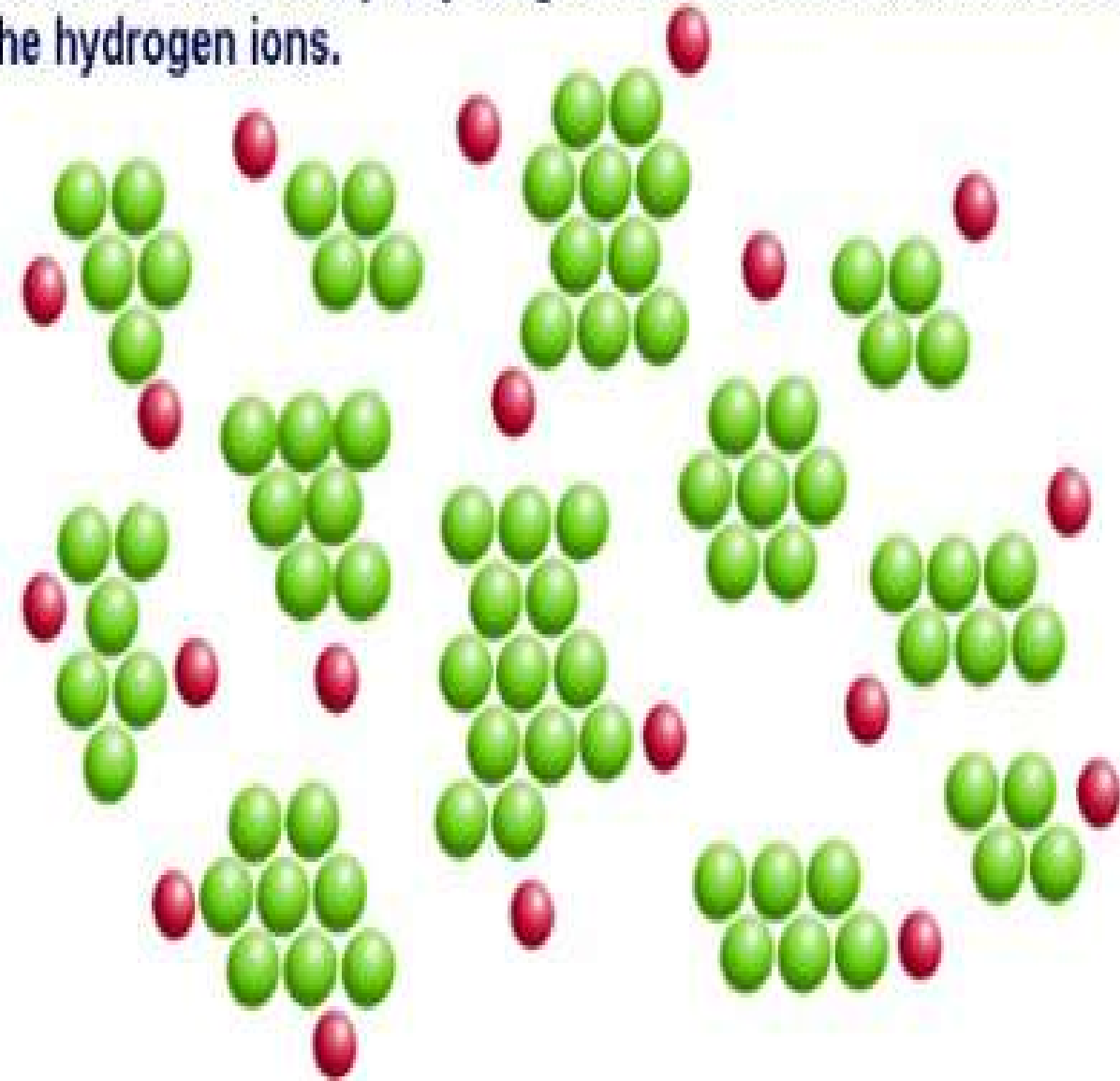
3. Concentration – more is faster

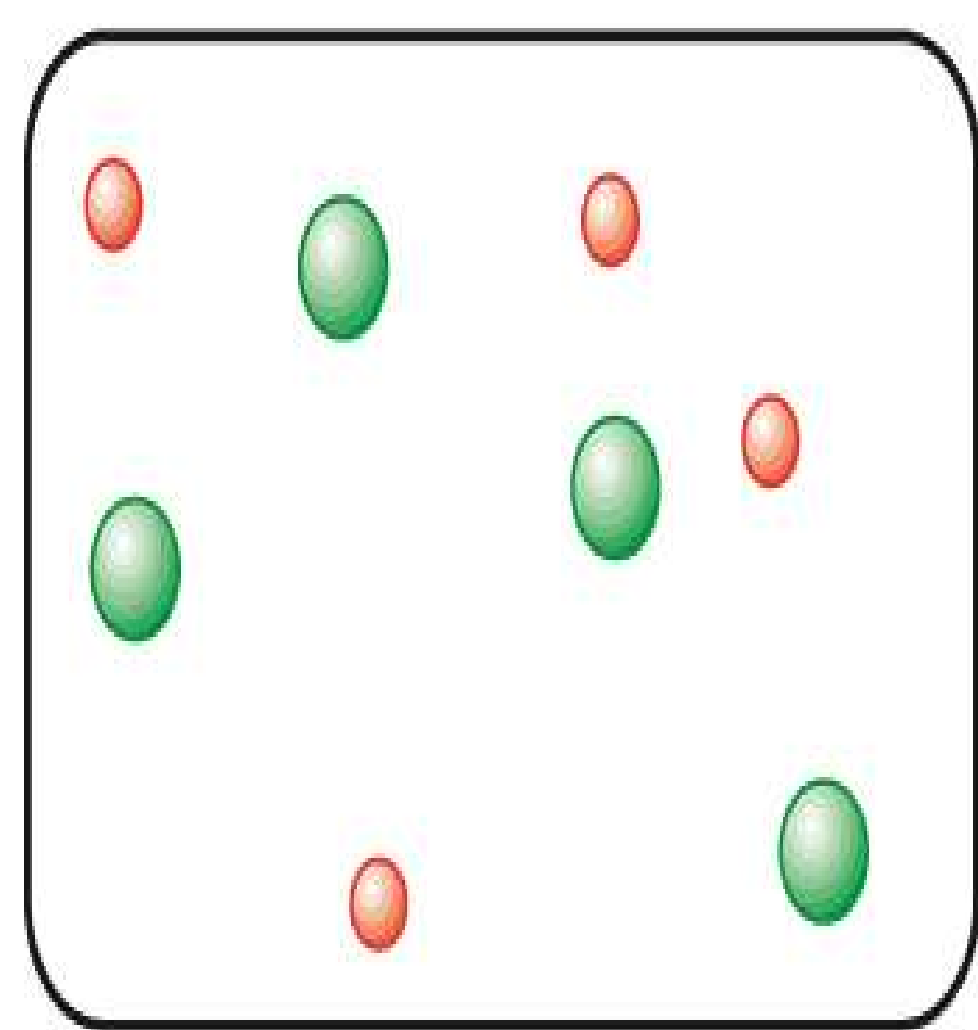
Hydrogen ions can hit the outer layer of atoms...

...but not these
in the centre of
the lump.



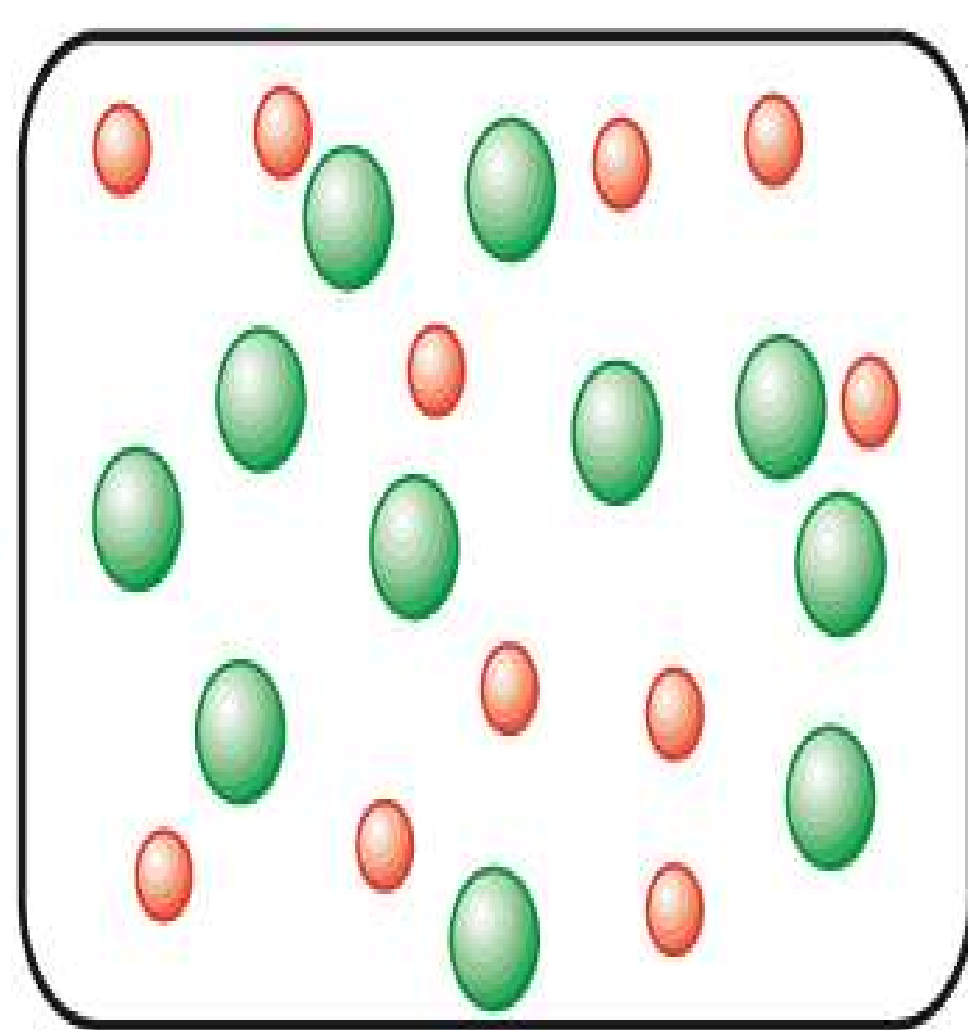
With the same number of atoms now split into lots of smaller bits, there are hardly any magnesium atoms inaccessible to the hydrogen ions.





Here we have a few molecules.
There are few collisions.
The rate of reaction is low.

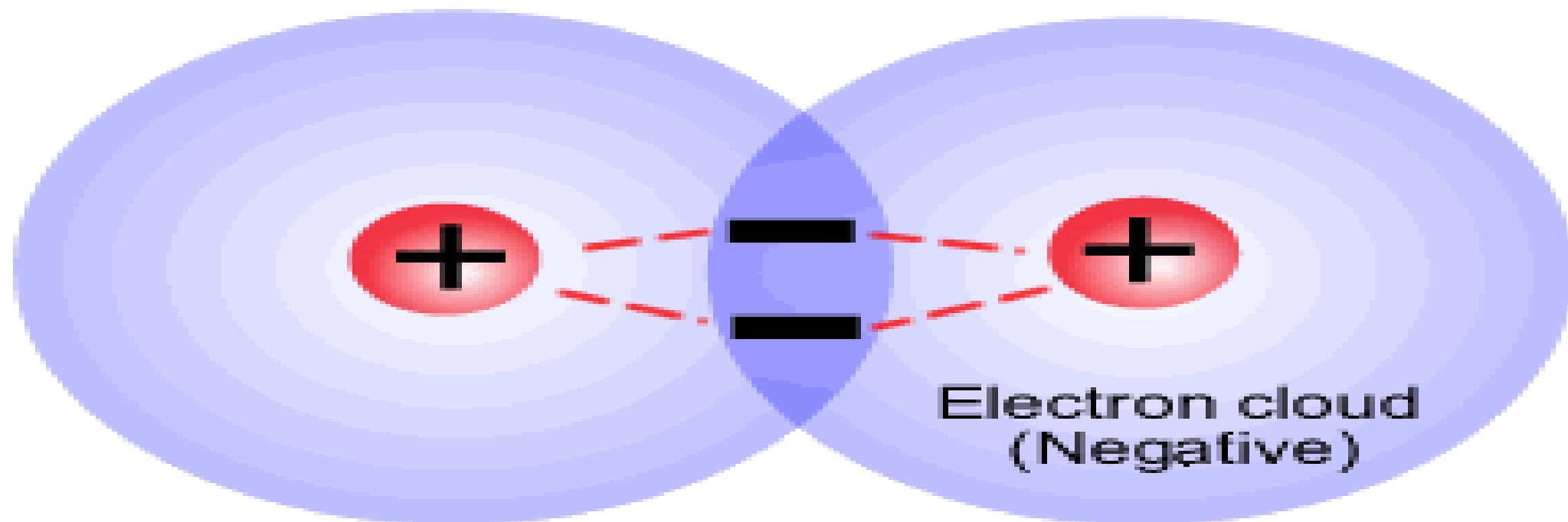
Increase
concentration



Here we have many molecules.
There are more collisions.
The rate of reaction is greater.

4. Who the reactants are.

The electrons experience a force of attraction from both nuclei. This negative - positive - negative attraction holds the two particles together

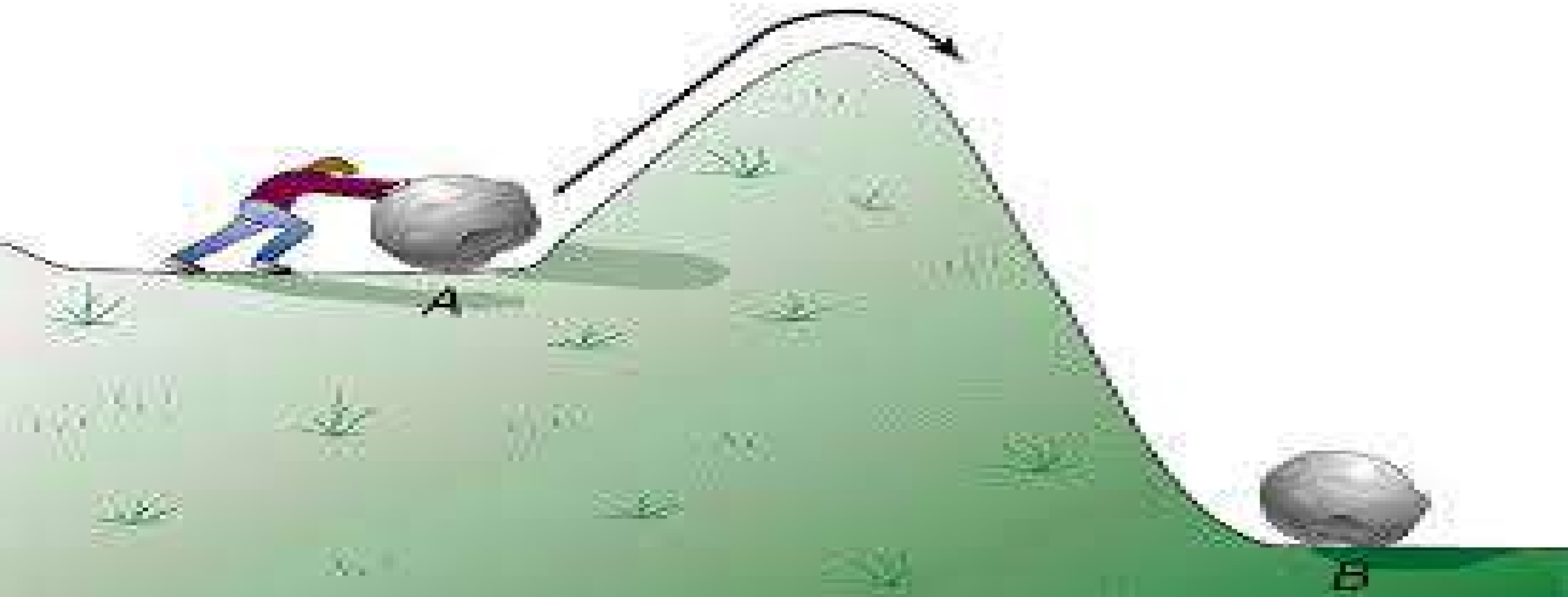


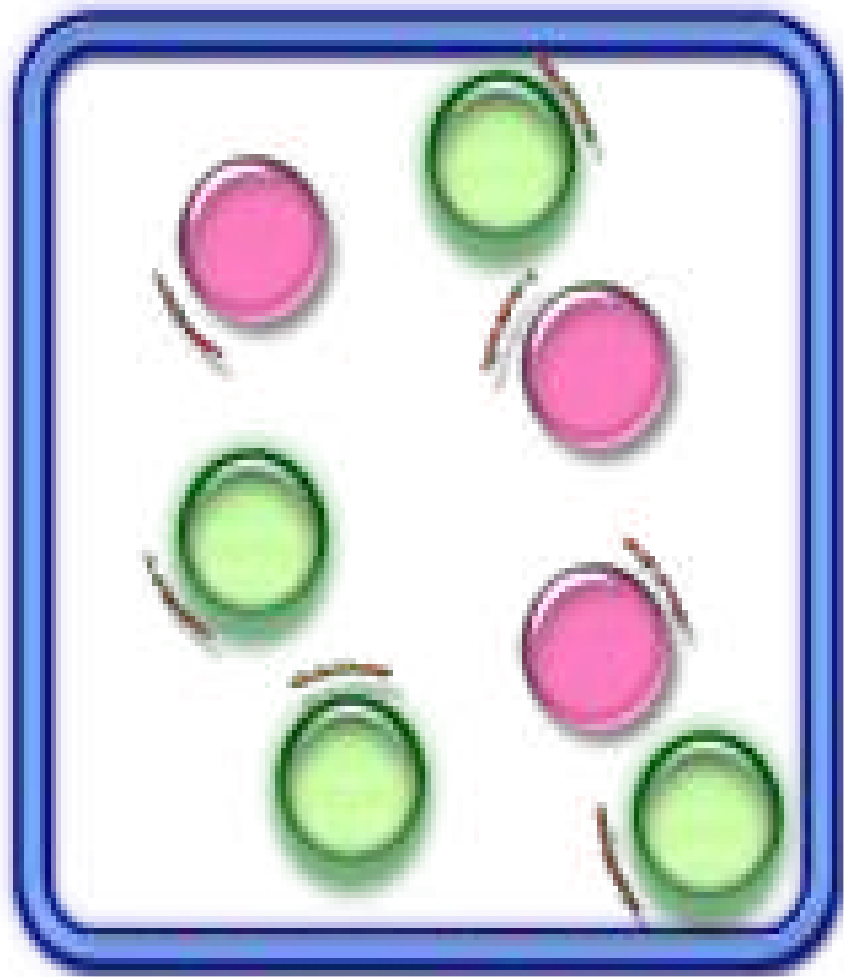
This attraction is called a chemical bond
one pair of electrons constitutes ONE bond

Bond	Energy (kJ/mol)	Bond	Energy (kJ/mol)
H - H	436	N - N	160
C - H	413	N = O	631
N - H	393	N triple N	941
P - H	297	N - O	201
C - C	347	N - P	297
C - O	358	O - H	464
C - N	305	O - S	265
C - Cl	397	O - Cl	269
C = C	607	O - O	204
C = O	805	C - F	552
O = O	498	C - S	259

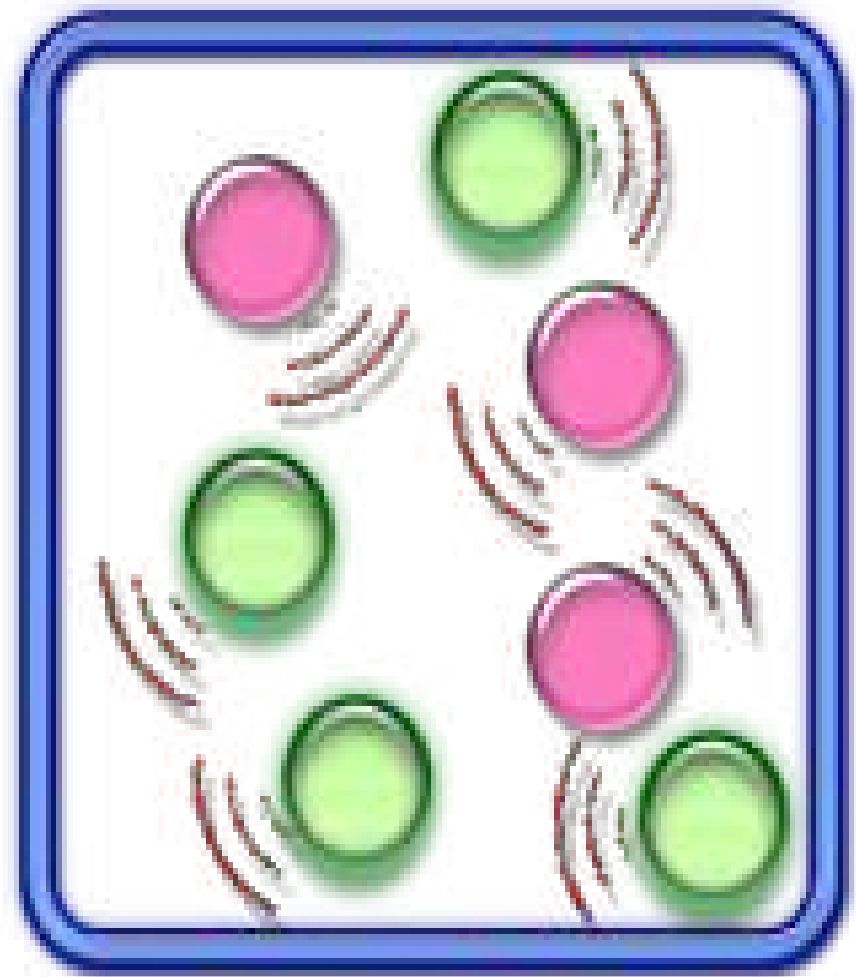
5. Temperature – hotter is faster

(a) A reaction can only take place if the colliding particles hit hard enough to cause a rearrangement of the atoms into new substances. The minimum amount of energy needed to do this is called activation energy.



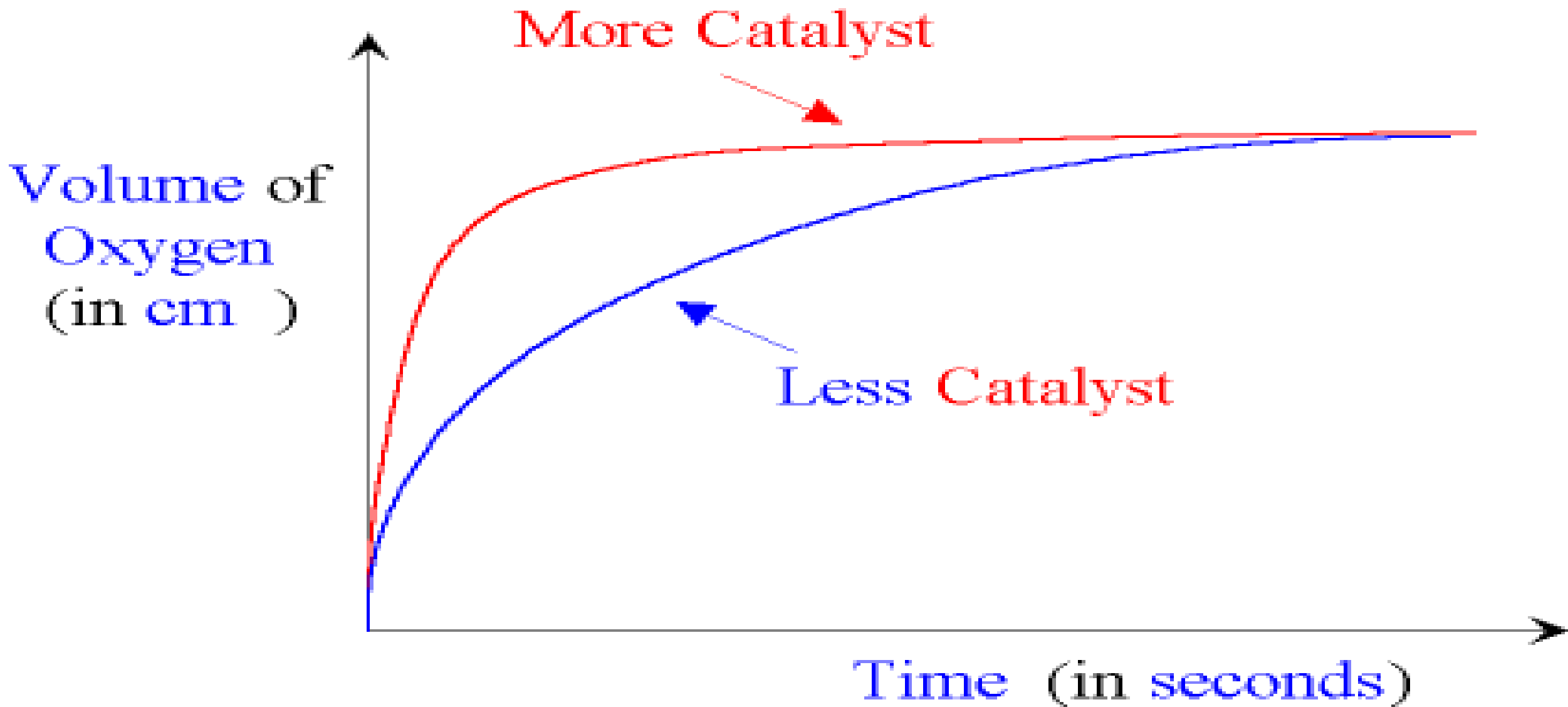


Particles have less energy, less frequent and successful collision



Particles have high energy, more frequent and successful collision

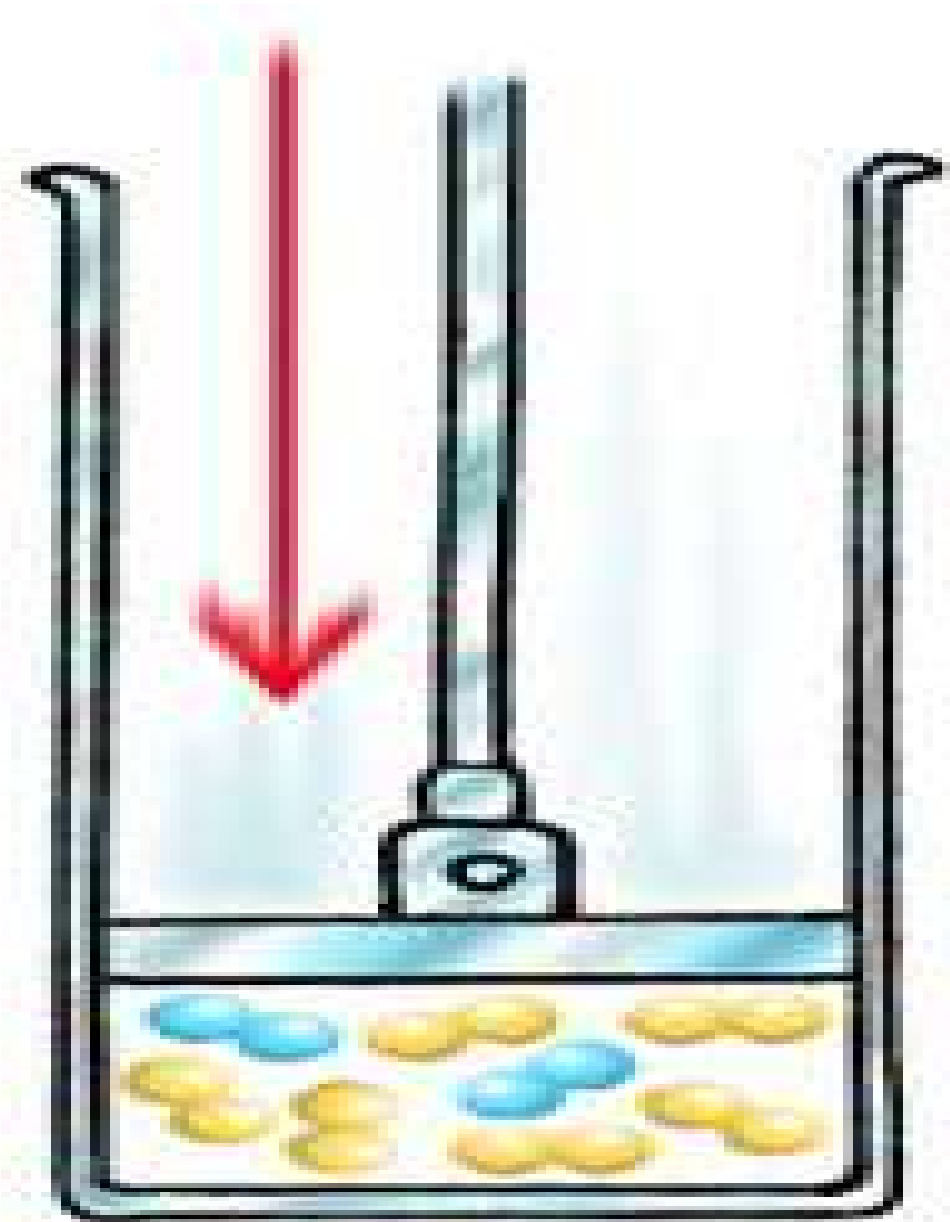
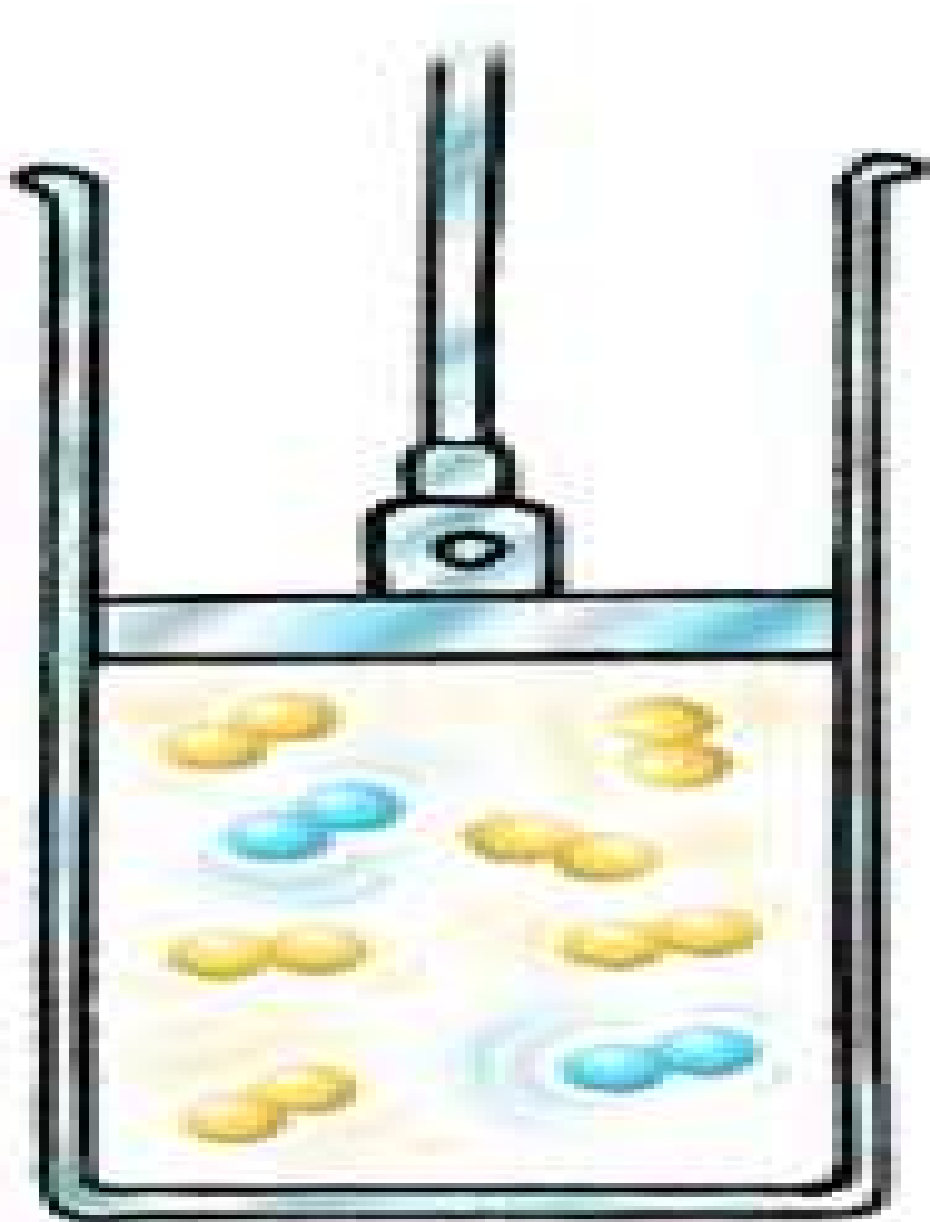
6. Catalysts – these are substances that change the rate of a reaction without themselves becoming a part of the reaction. Enzymes are biological catalysts.



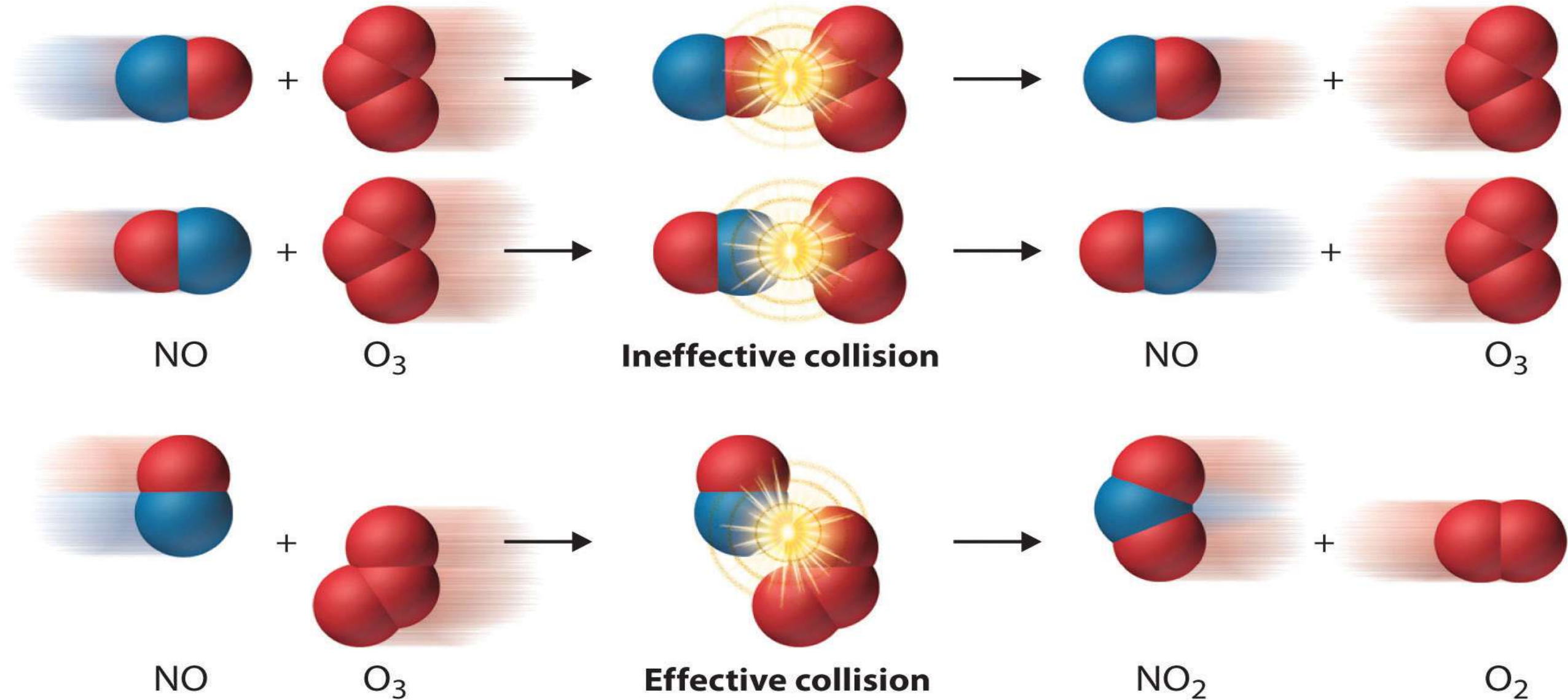
<https://www.youtube.com/watch?v=atYLWAwRQEI>

Big Bang prank Go to 1:50

7. Pressure – more pressure forces the particles together → decreasing the distance/time between collisions → increasing reaction rate.



8. Orientation – if the colliding particles are not facing the correct way when they collide, the collision will not be successful.

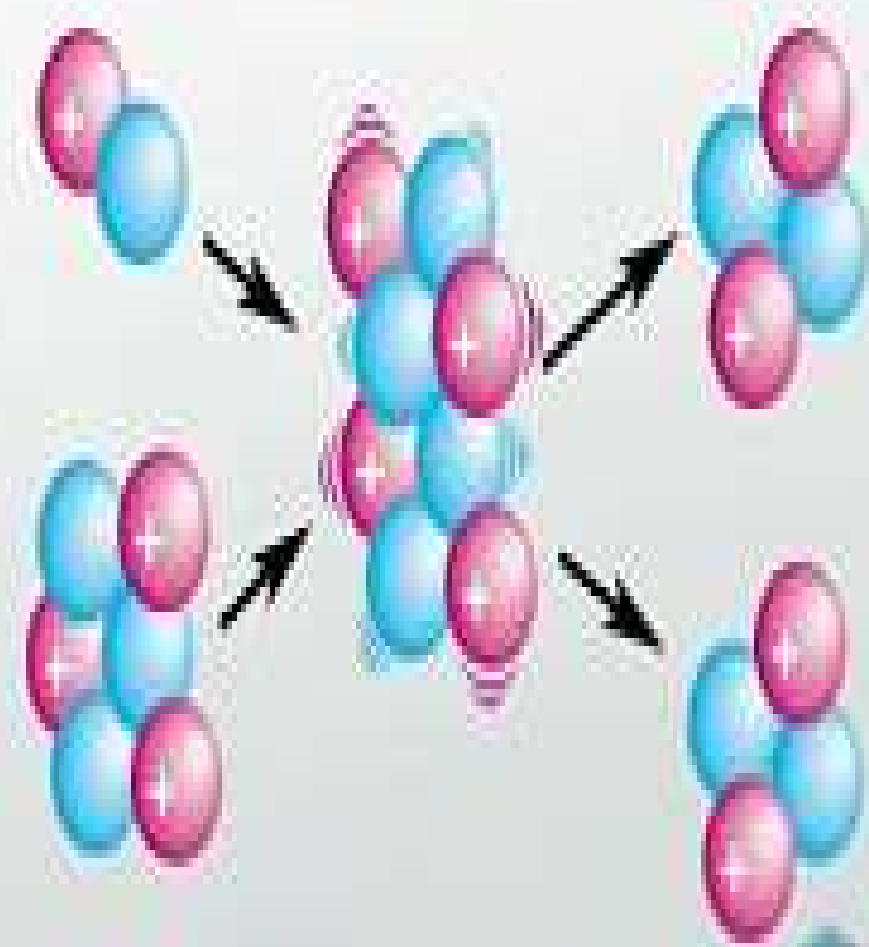


C. Reaction pathways

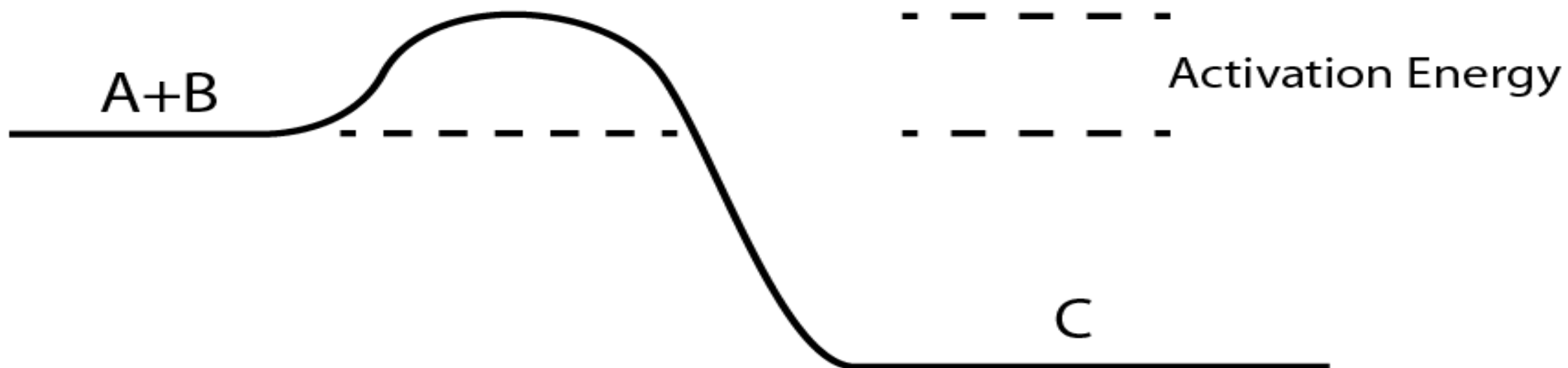
1. A reaction works when collisions occur with enough energy to rearrange bonds. They hit and the energy of the collision is converted to potential energy. This high energy arrangement is called an activated complex. In its short life, old bonds are weakening and new bonds are forming. The reaction can make new bonds (products) or keep the old bonds (activated complex breaks up into original reactants – no reaction). It all depends on if the collision reached the activation energy level or not.

Bonds are broken

New bonds formed

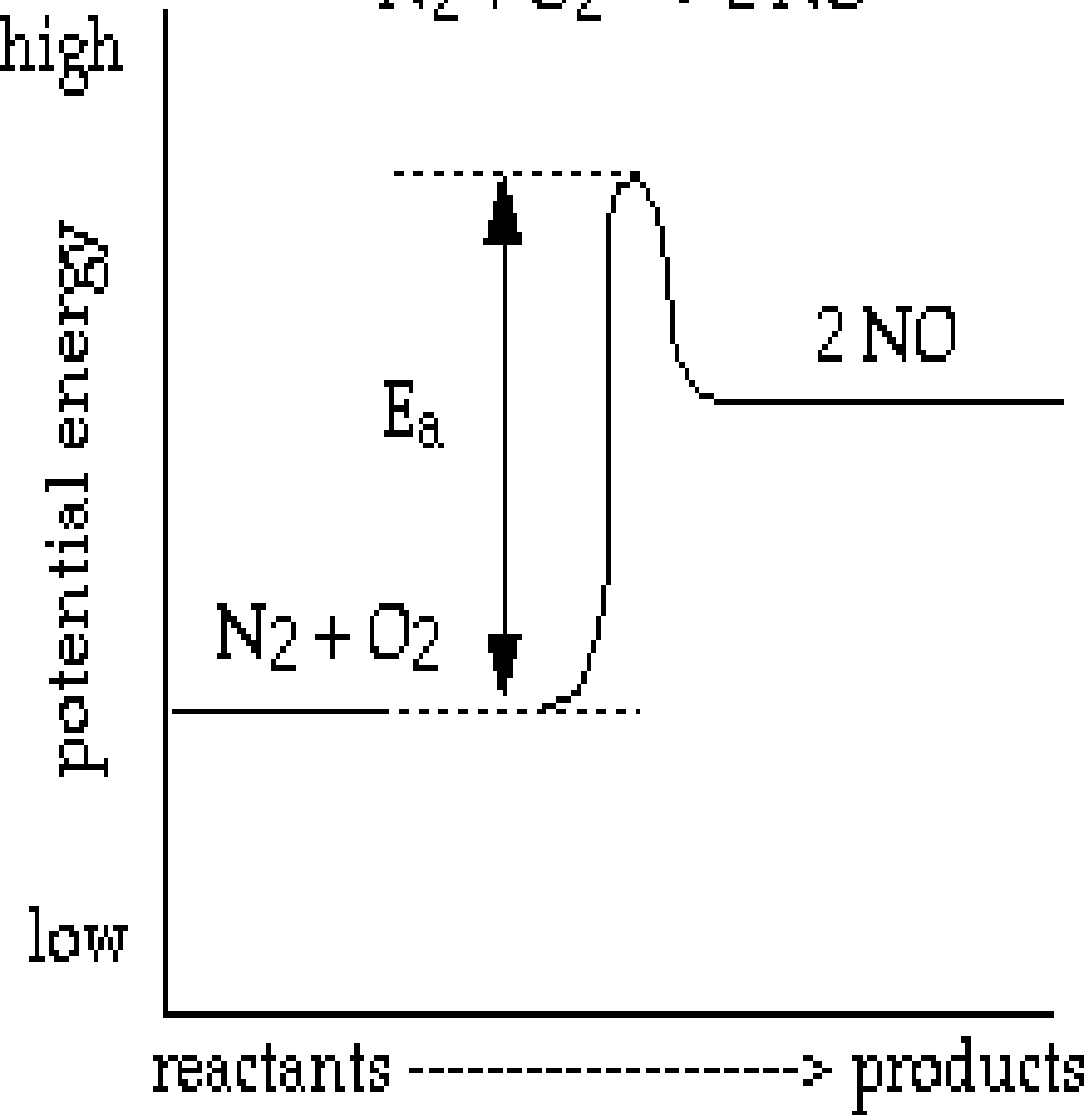


Energy

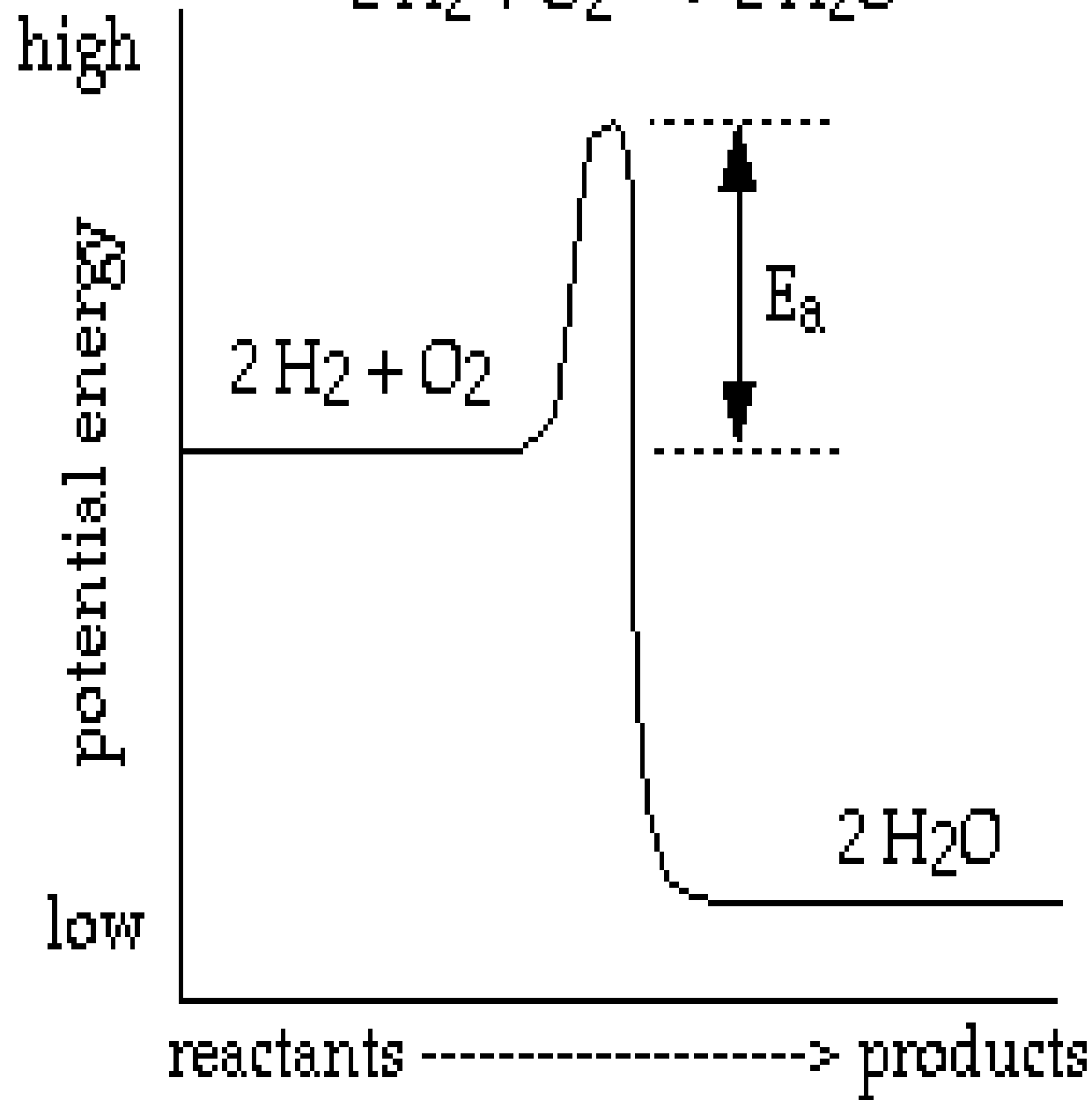


Reaction Progression

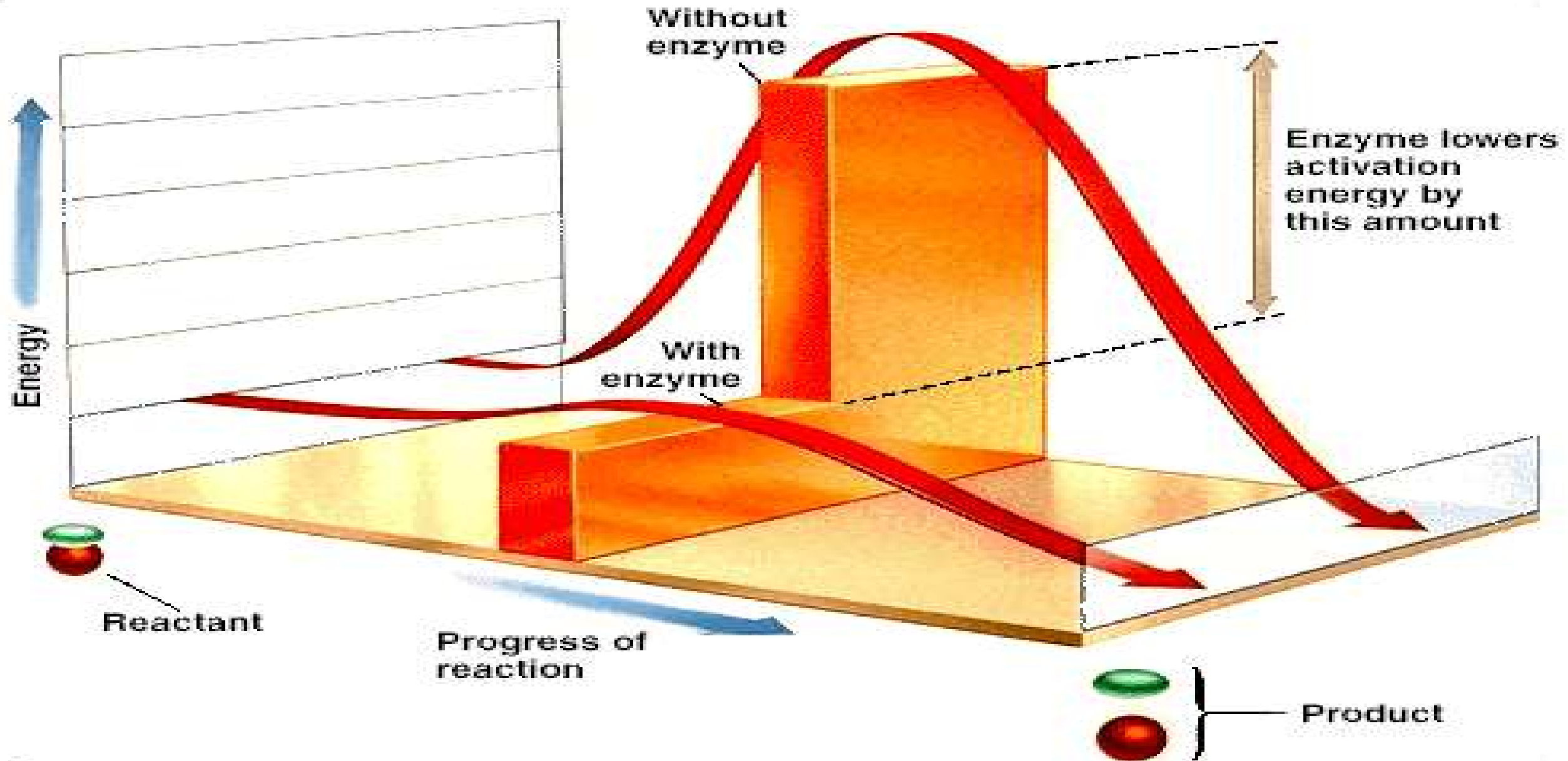
An Endothermic Reaction

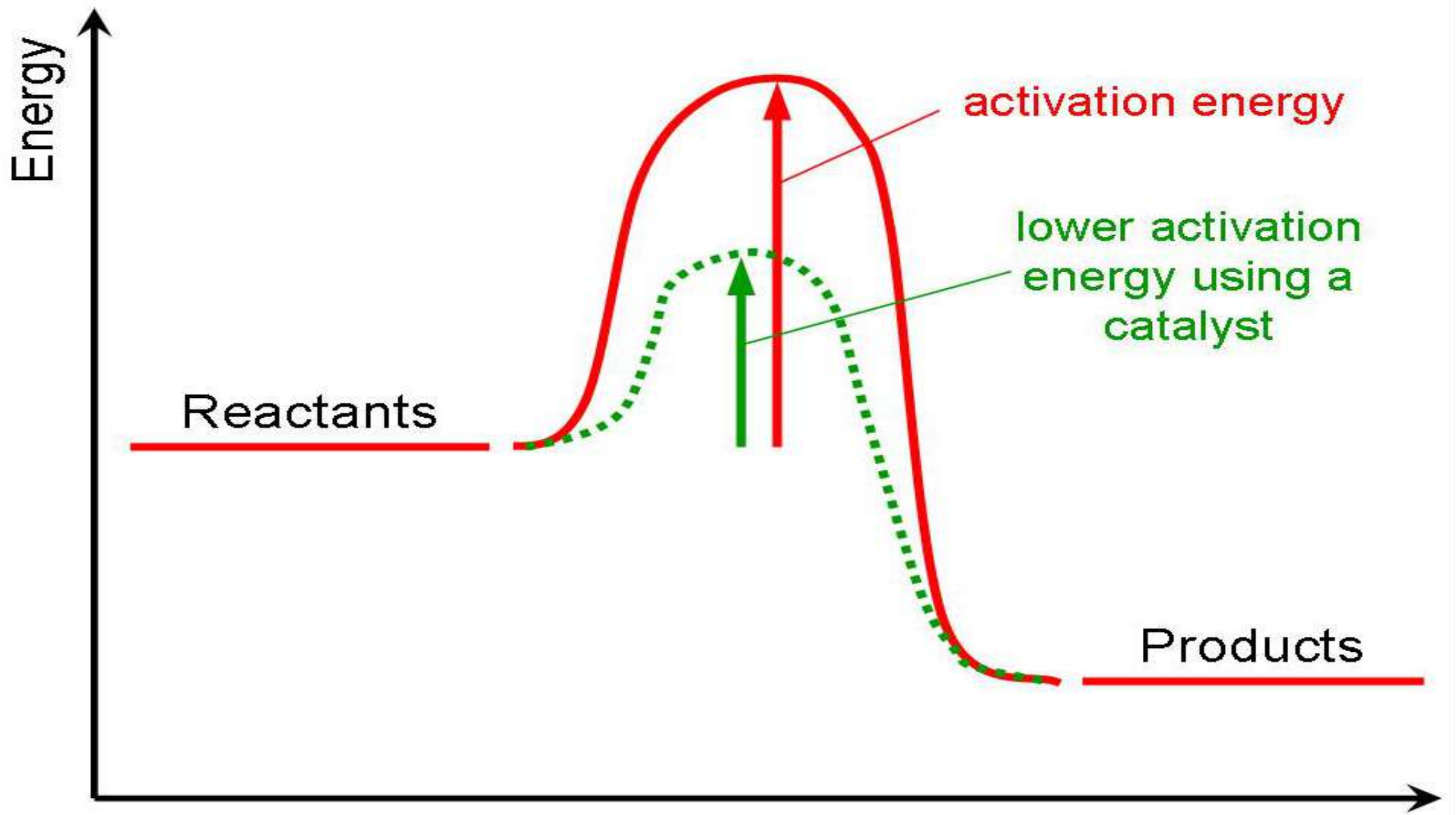


An Exothermic Reaction



2. A catalyst provides a different pathway, with a lower activation energy, for a reaction.



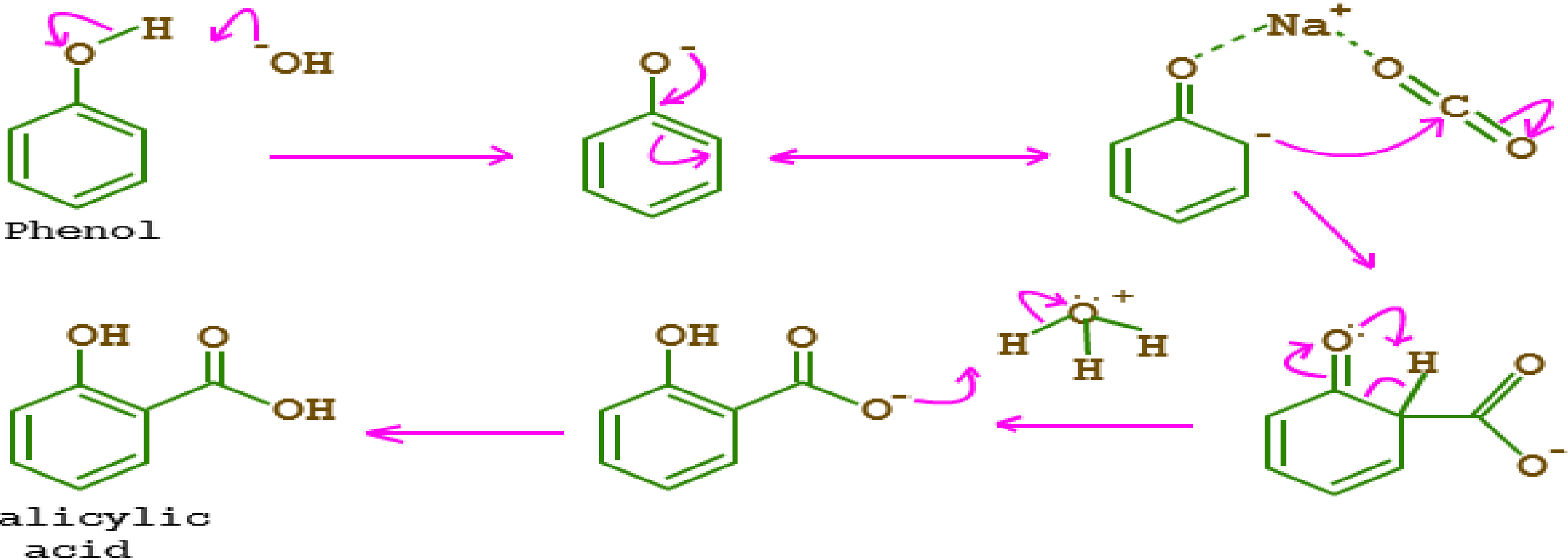
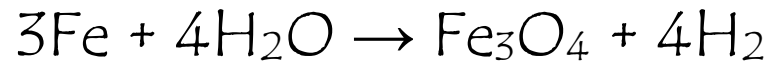


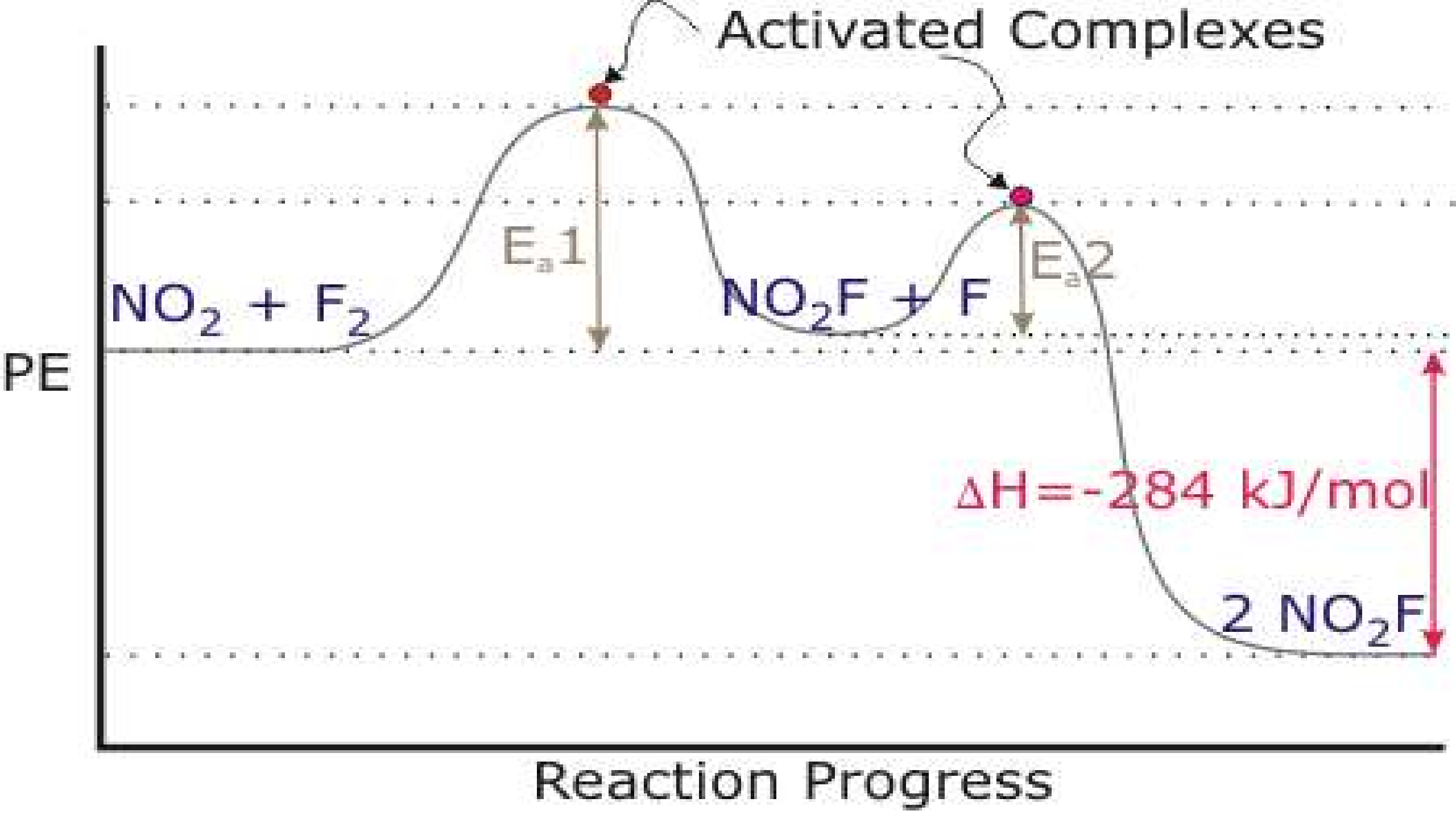
<https://www.youtube.com/watch?v=KYD5LNVWne8>

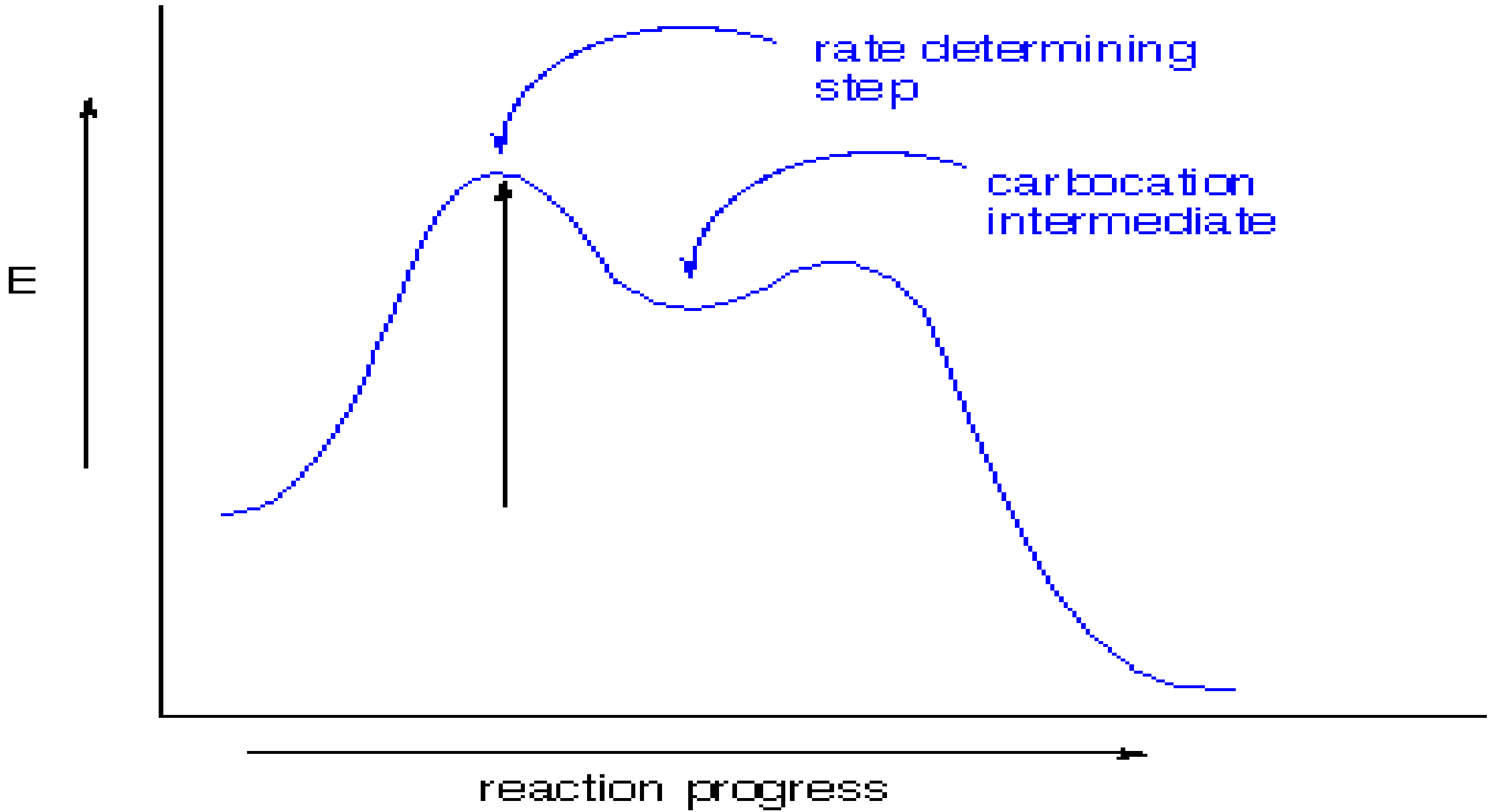
catalysts

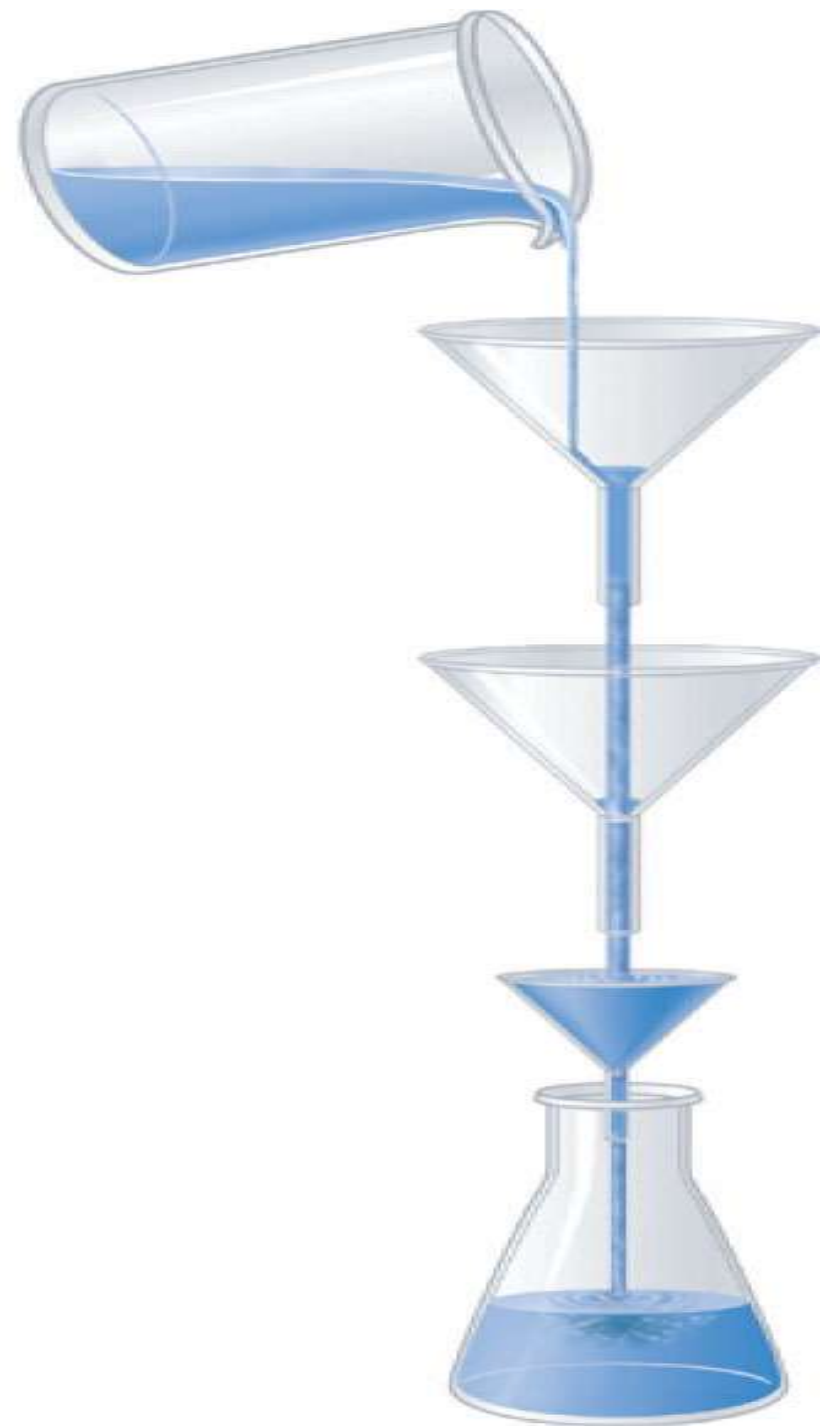
4:09

3. When you look at a reaction, you see the beginning (reactants) and the end (products). There are intermediate steps involved that are not shown. Do you think that 3 Fe's are going to collide with 4 H₂O's at once? The sequence of intermediate steps is called the reaction mechanism. Each step proceeds at a different pace and the slowest one is known as the rate-determining step. Kind of like an assembly line.



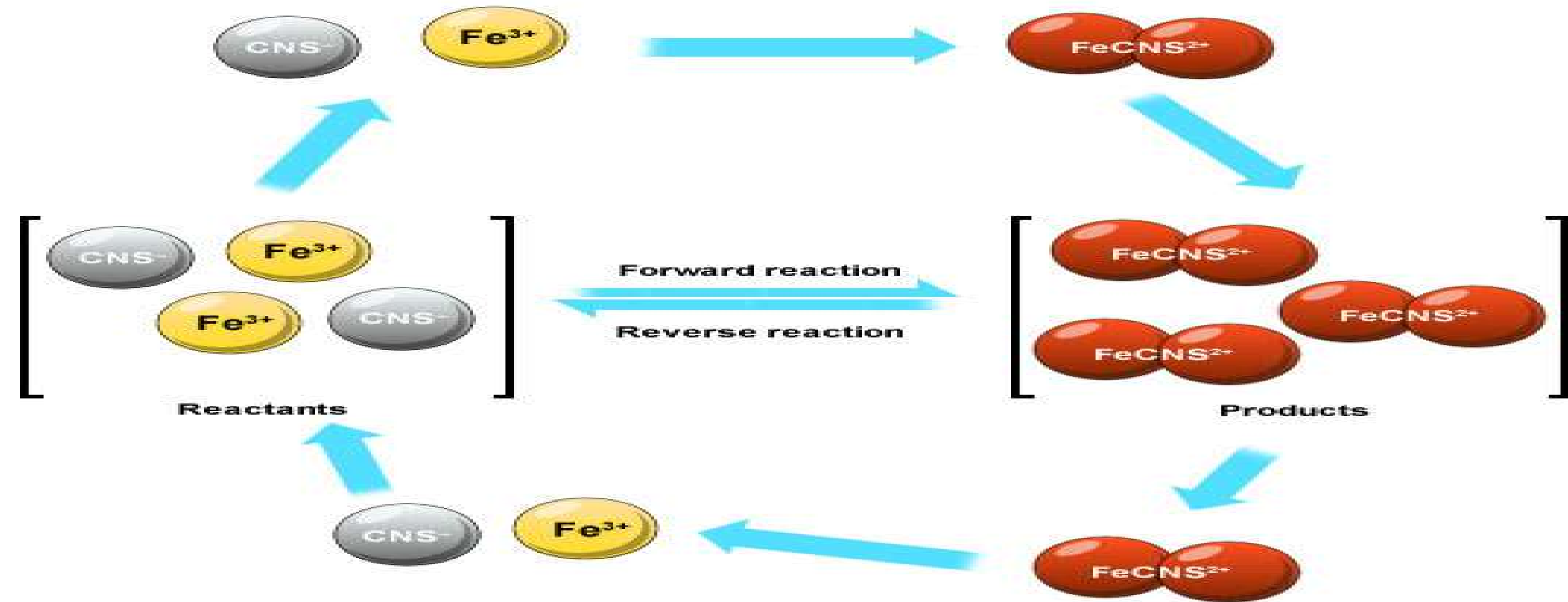




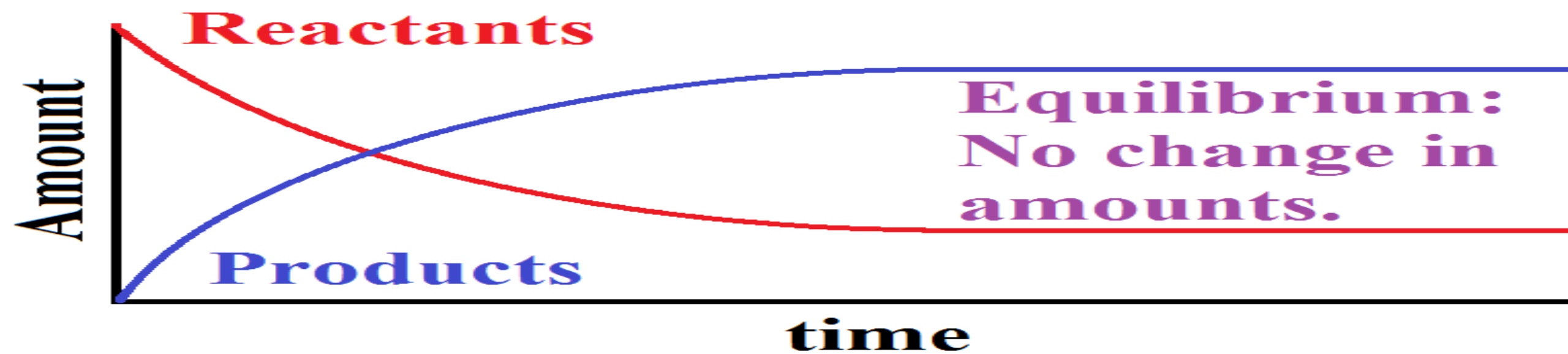
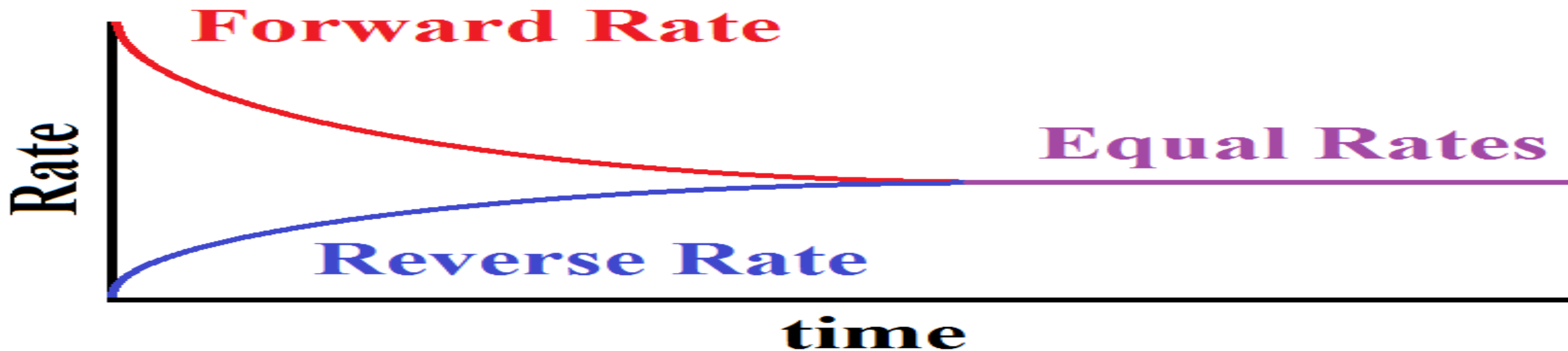


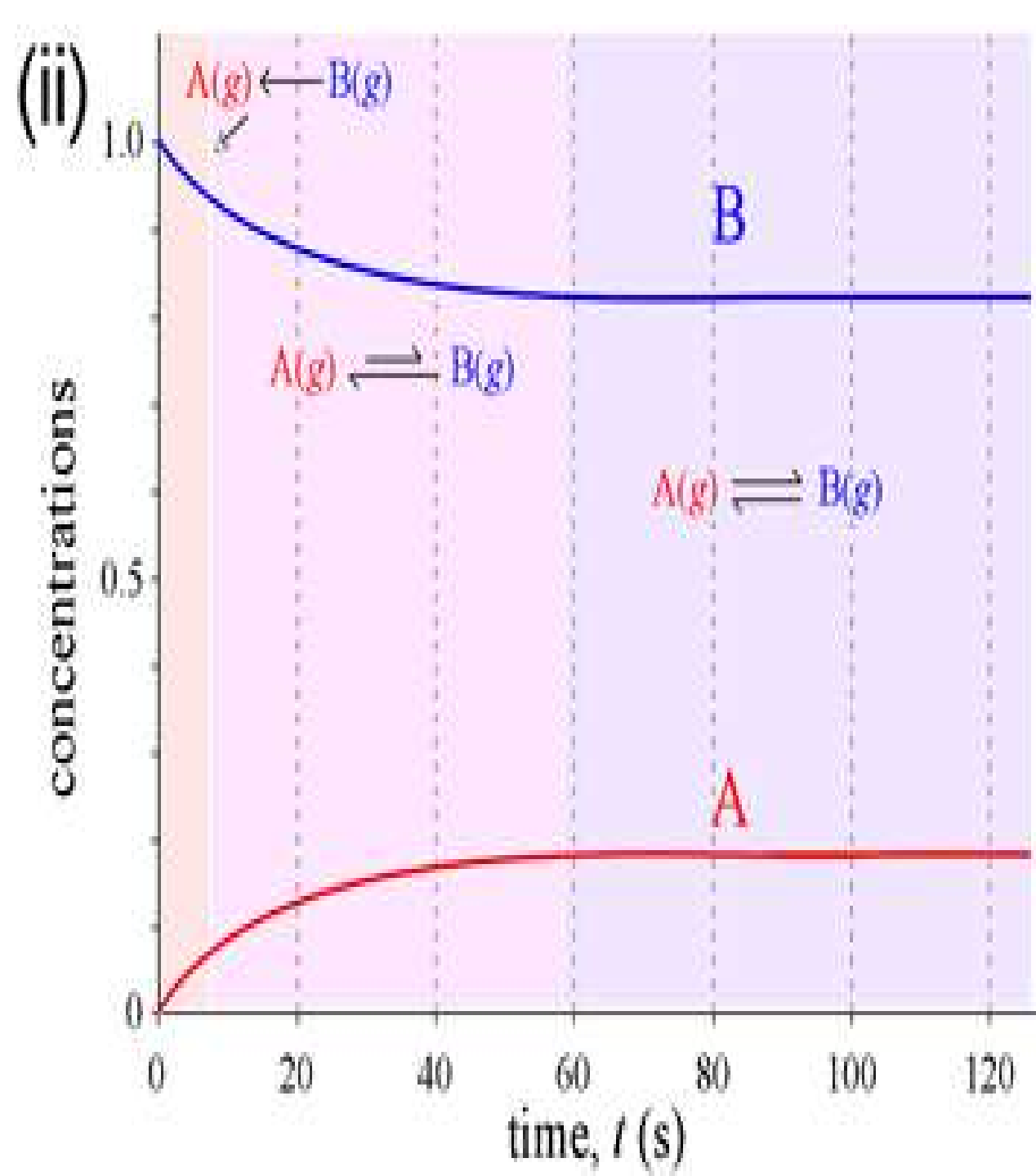
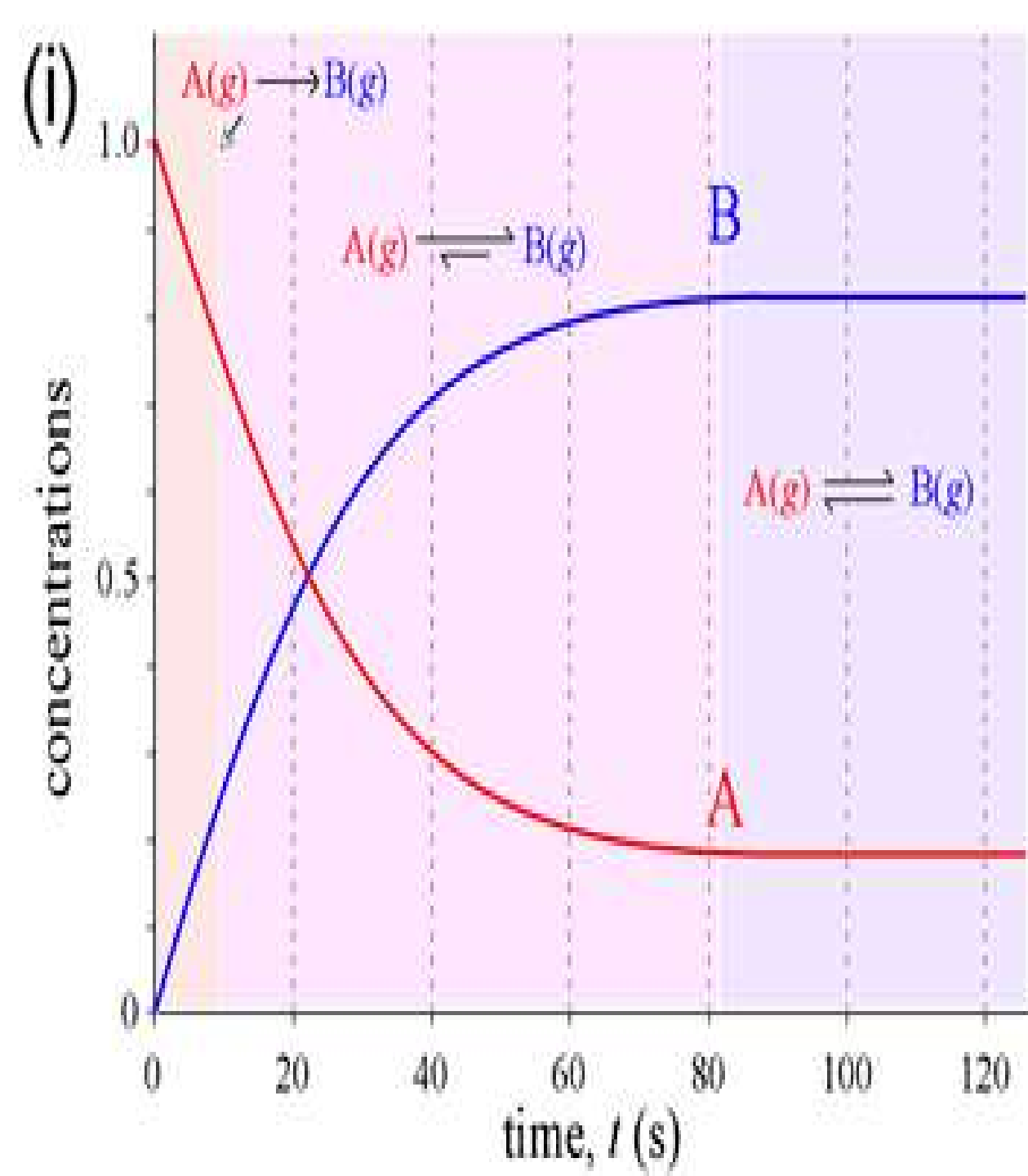
D. What is equilibrium?

Well, you need to understand first, that some reaction have all their reactants used up to form products. These reactions "go to completion". Other reactions have some product and some reactant at all times. What's going on here is that the reaction proceeds from reactant to product AND backwards AT THE SAME TIME.



The reaction proceeds from reactant to product and backwards at the same time, AT AN UNCHANGING RATE.





EX. 50 guys and 50 gals at a dance. So, a technical definition would be that a reaction taking place in a closed container has reached equilibrium when all reactants and products are present and their properties are not changing. Or when reactants are forming products at the same rate as products are forming reactants.





<https://www.youtube.com/watch?v=cHAjhM3y3ds>

Equilibrium , introduces keq 12:45

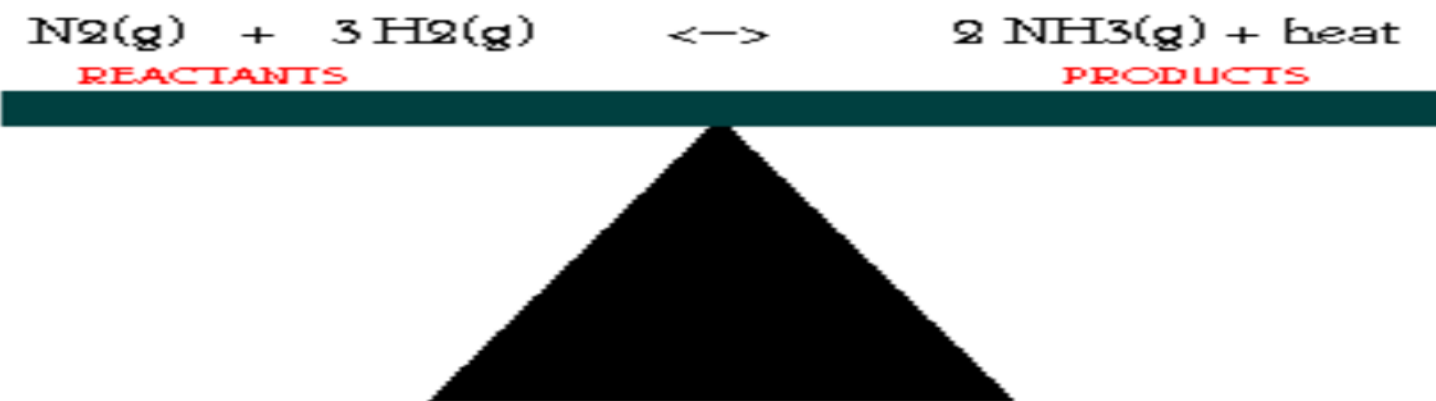
<https://www.youtube.com/watch?v=QsiGDZd1RF8>

Calculating Keq 17:40

E. Predicting changes in Equilibrium

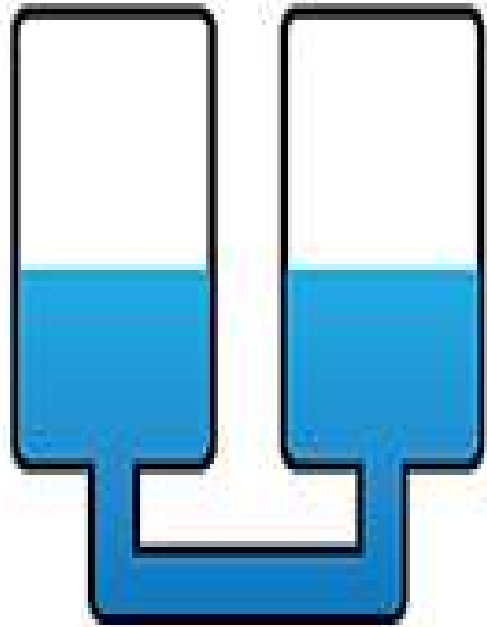
1. Le Chatelier's principle says that if you do something to a system at equilibrium, it will respond in a way to partially undo what has just been done. You can disturb equilibrium by changing concentration, temperature, volume, pressure...

Le Chatelier's Principle "Restoring Balance"



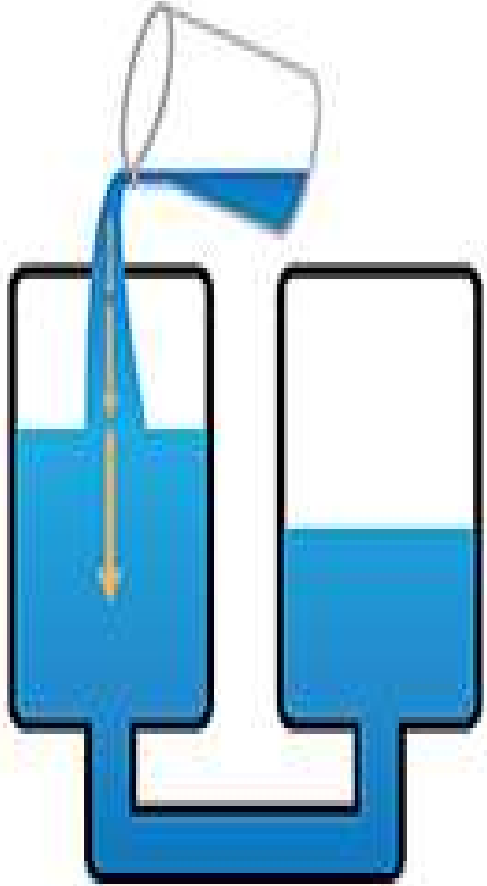
If you add more to the left side (*Reactants*), the lever will tip to the left. In order to restore balance, the system responds by making more of what is on the right (*Products*) and vice versa.

1

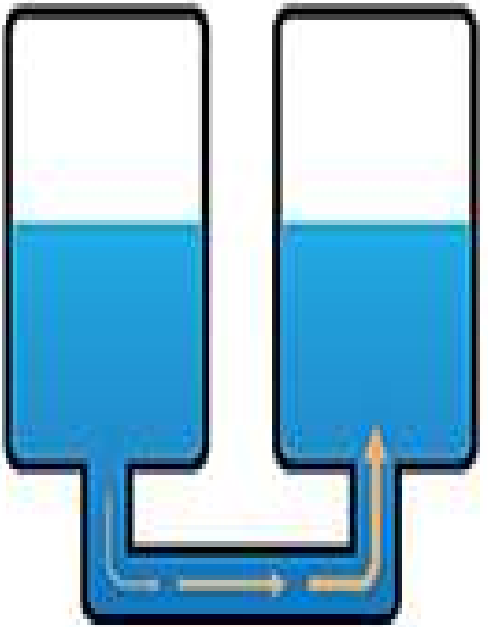


Equilibrium

2

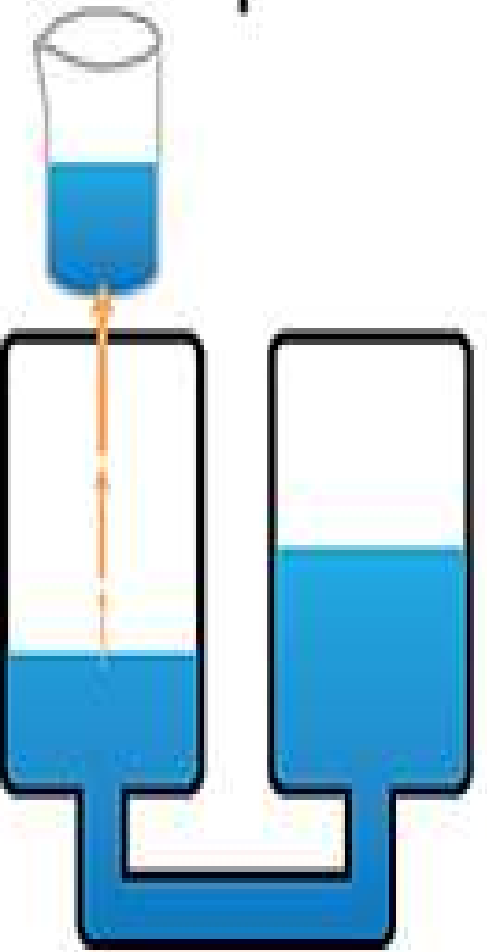


3

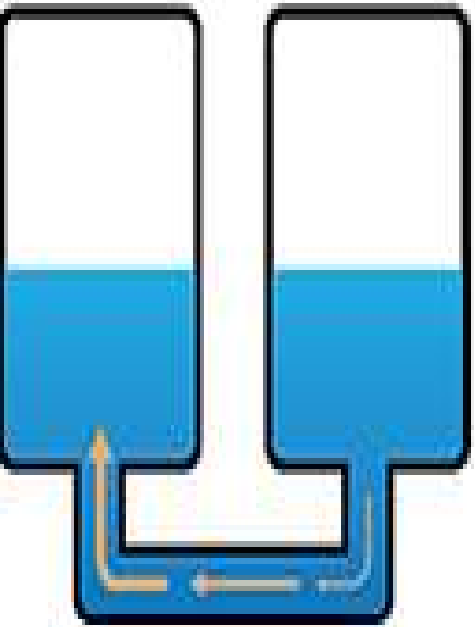


Equilibrium

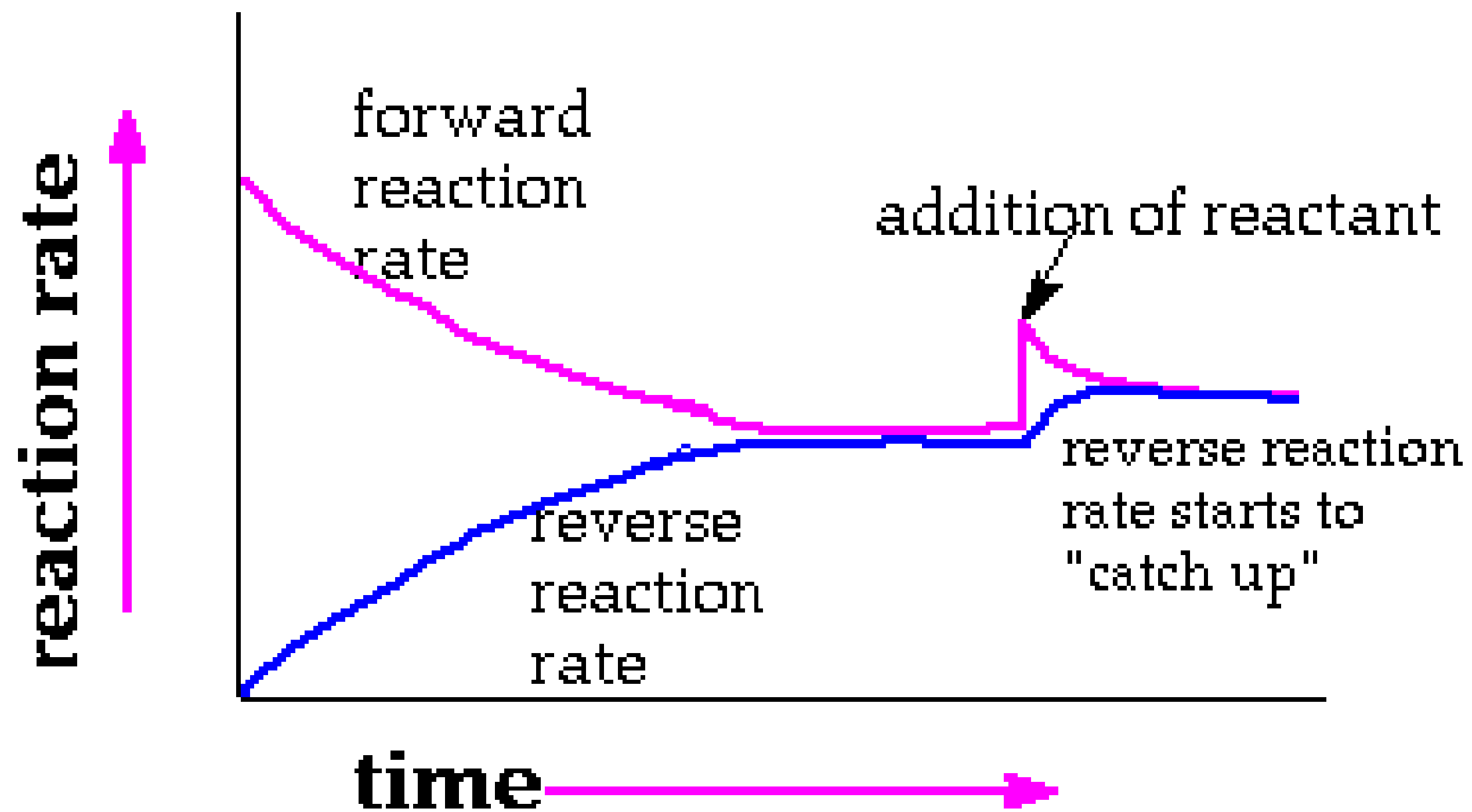
4



5



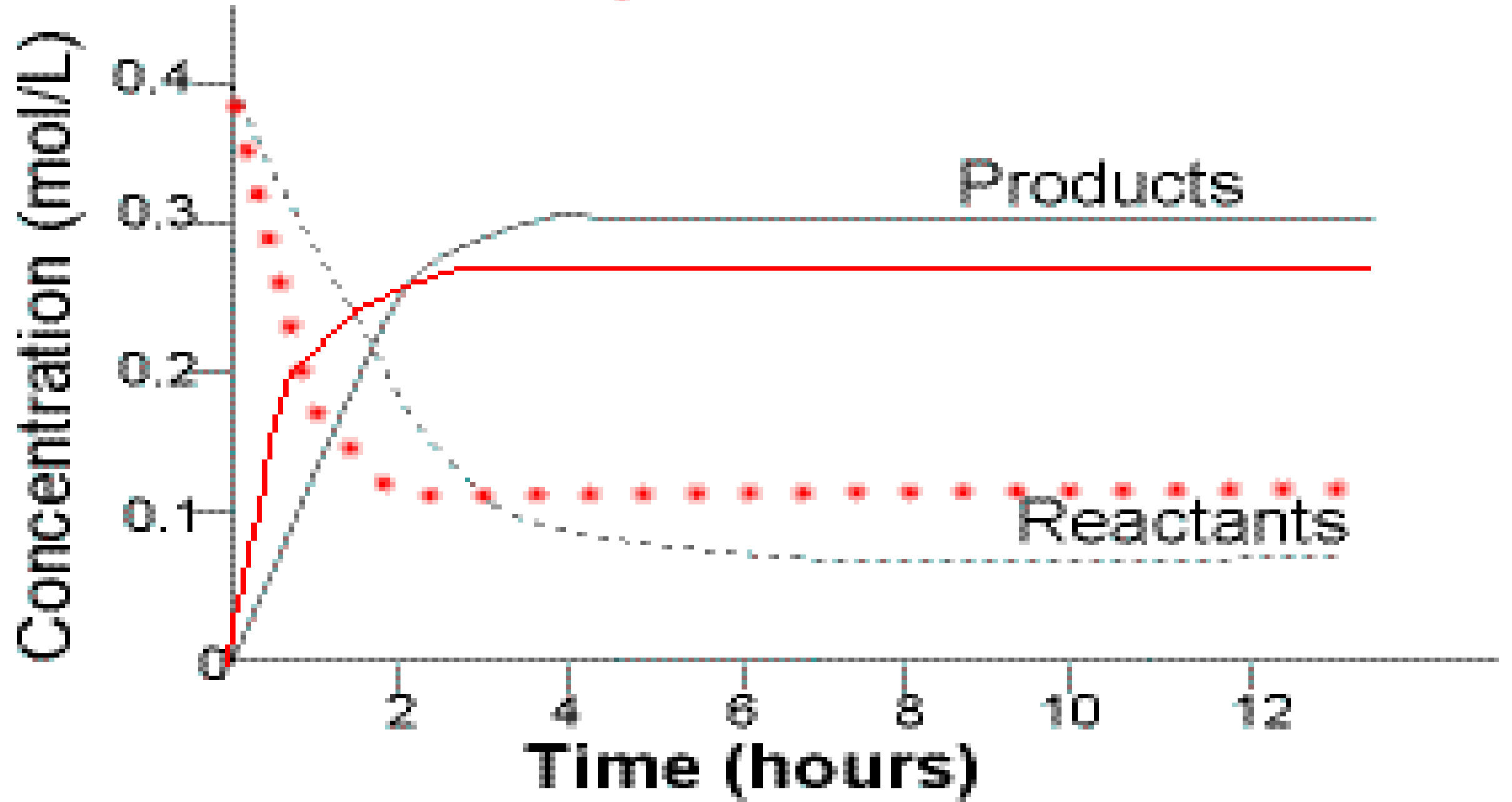
Equilibrium



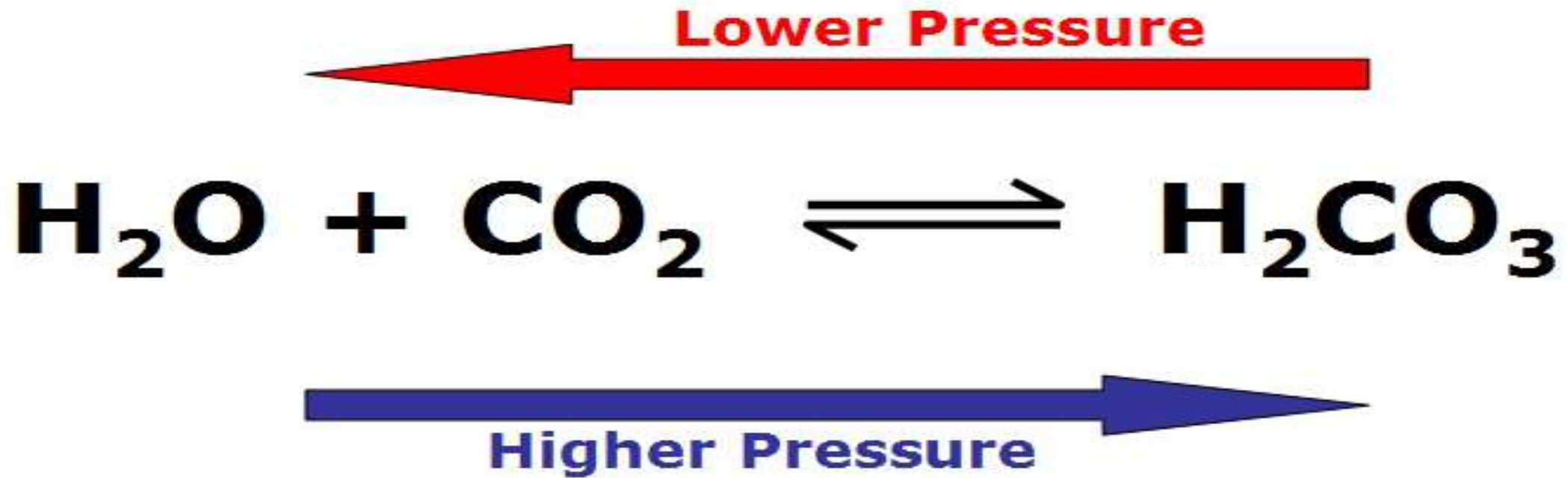
2. Increasing temperature will add heat to the system. This will stress the "hot" side (the side with heat) more. The equilibrium will shift away from the "hot" side.
3. Decreasing temperature will take out heat to the system. The equilibrium will want to replace the lost heat. The equilibrium will shift towards from "hot" side.



increase in temperature: exothermic reaction

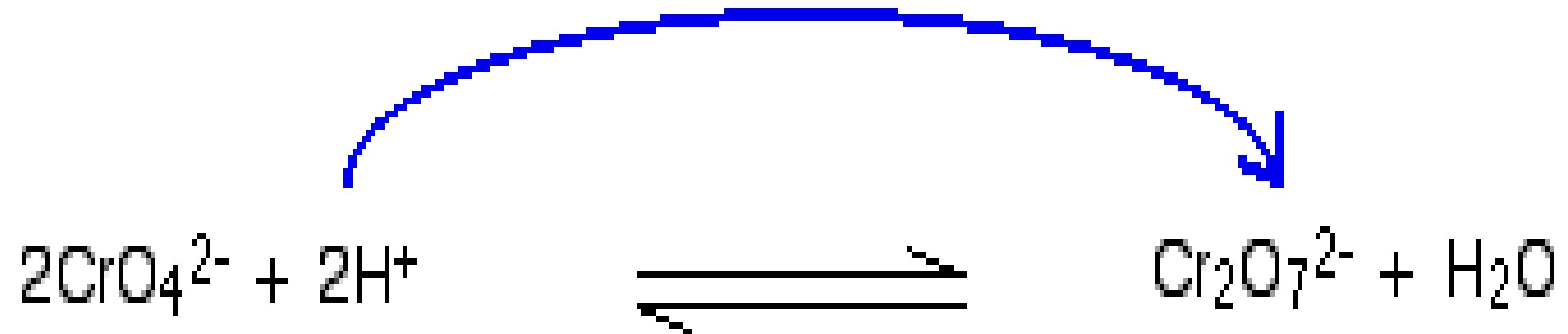


4. Increasing pressure on a system of gases will stress the side with more stuff, more moles. To relieve the stress, the equilibrium will shift towards the side with less moles of particles. Decreasing volume will do the same thing.
5. Decreasing pressure on a system of gases will stress the side with less stuff, less moles. To relieve the stress, the equilibrium will shift towards the side with more moles of particles to replace the loss. Increasing volume will do the same thing.



6. Increasing concentration of any reactant or product will stress the side of the equation that has the substance. The reaction will shift away from the side of the substance to get rid of the "extra".
7. Decreasing concentration of any reactant or product will stress the side of the equation that doesn't have the substance. The reaction will shift towards the side of the substance to replace it.

Adding hydrogen ions forces the position of equilibrium to the right.



https://www.youtube.com/watch?v=PciV_Wuh9V8

7:00