

# Chemistry 122

## Chapter 18: Reaction Rates and Equilibrium

# First Five Minutes...

- Read the opening paragraph on page 541

The heat given off by the corrosion reaction of an iron-magnesium alloy with salt water can produce a hot meal. The rate of reaction is increased by adding salt water, so heat is produced rapidly. You will learn some ways in which the rate of a reaction can be increased.

- Answer the following questions
  - How can the rate of the corrosion of iron-magnesium alloy be increased?

By adding salt water

- Name some situations where salt affects the rate of corrosion of metals.

Vehicles on salted roads in the winter, metals on boats, and houses near the ocean.

# Rates of Reaction(<math><10^{-6}</math>s or >math>10^6</math> years)

Very Slow

Moderate

Very Fast

# Rates of Reaction

- A rate is a measure of the speed of any change that occurs within an interval of time
  - You are probably familiar with the term 'rate of change'
  - In chemistry, the rate of chemical change or the reaction rate is usually expressed as the amount of reactant changing per unit time (km/h, m/s) **ex fig 18.1 8.70 m/s**
  - Examine Figure 18.2
    - What changes are taking place and list in order of slowest to fastest?

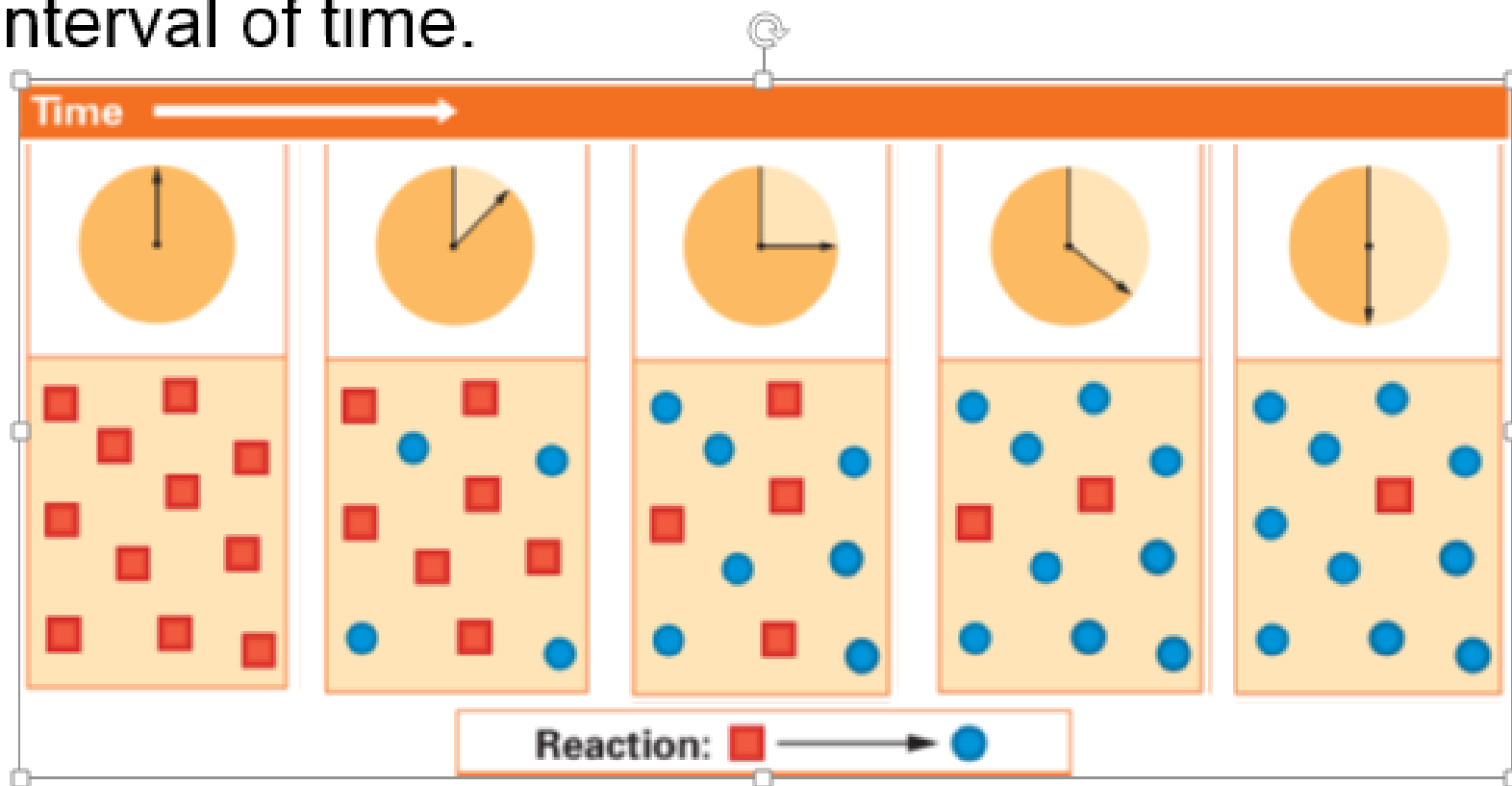
Aging, ripening, burning

Examine Figure 18.3

Rates of change are usually measured by the decrease in concentration of one of the reactants or the increase in concentration of one of the products

If we assume equal time intervals between the boxes, what can you infer about this particular rate of reaction? **The rate is slowing down**

Rates of chemical reactions are often measured as a change in the number of moles during an interval of time.

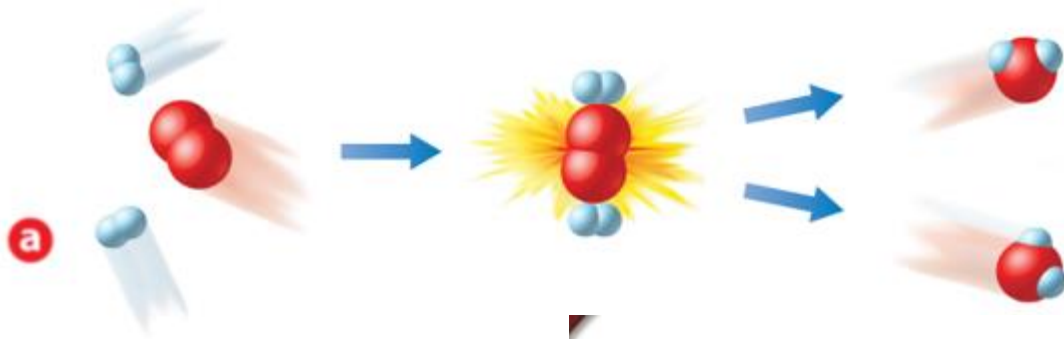


# Collision Theory

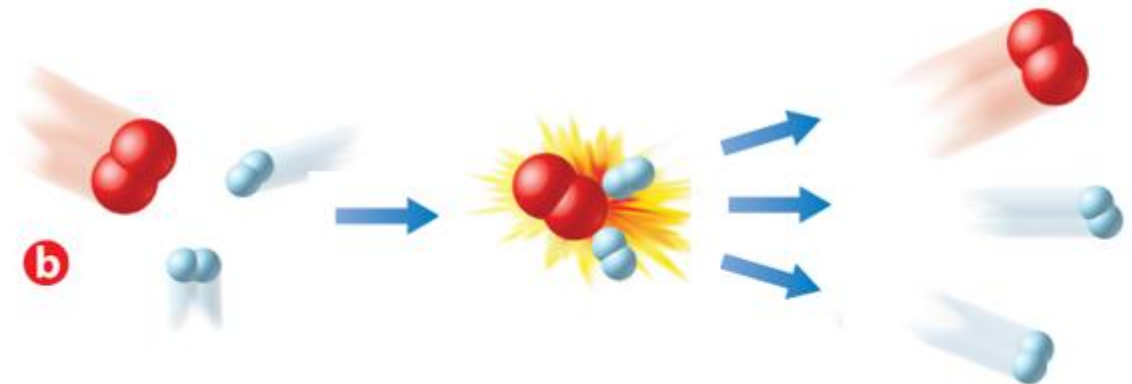
- How quickly a reaction occurs is related to the properties of atoms, ions and molecules.
- **Collision theory** is based on the idea that if a particular particle has sufficient energy, it will collide with another particle and a new substance will form.
- If particles do not have enough energy, they will simply bounce off one another unchanged.

Examine the difference between an effective and ineffective collision – Figure 18.4

### Effective Collision



### Ineffective Collision



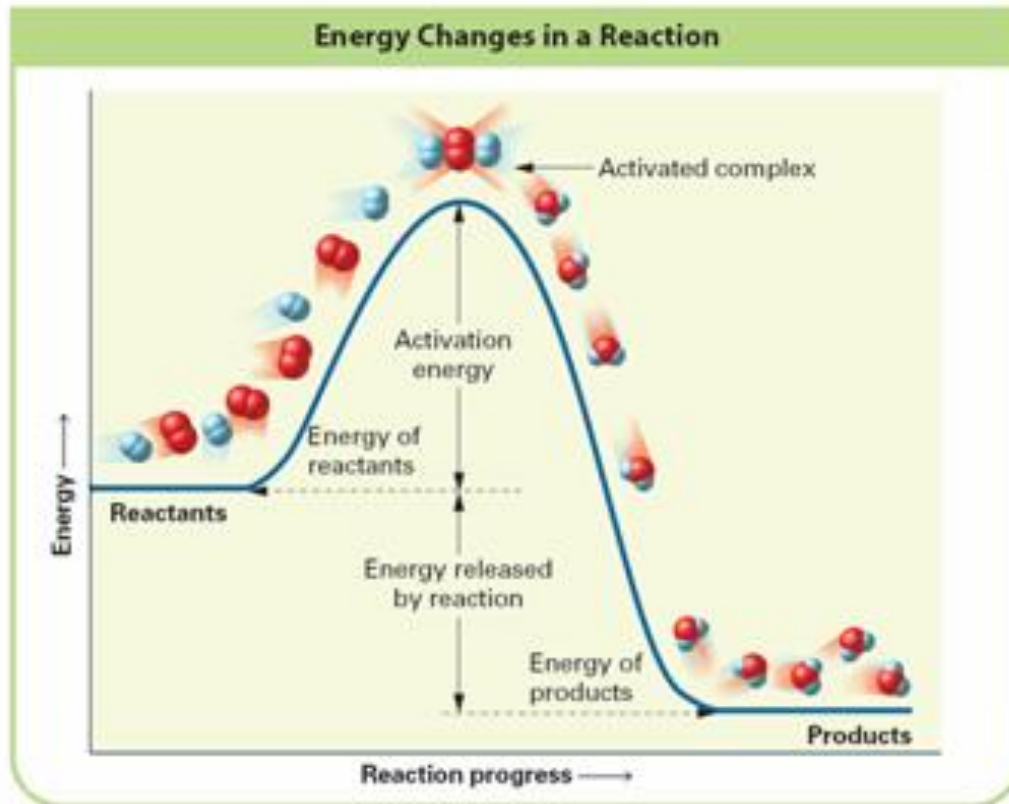
# Activation Energy

- When it comes to formation reactions, enough energy must be supplied in order for two particles to bond.
- With decomposition, if enough energy is supplied, the bonds holding a molecule together will break apart and simpler substances will form.
- The minimum amount of energy required for colliding particles to react is called '**activation energy**'.
  - It can be interpreted as the barrier to which colliding particles have to overcome in order to proceed with the chemical reaction.



# Activation Energy

The minimum energy that colliding particles must have in order to react is called the **activation energy**.



# The Activation Energy Barrier

- Examine Figure 18.5, p. 543.
- The activation energy determines how rapidly a reaction occurs at a given temperature (why is this important to consider?)
  - How does a large activation energy influence the rate of reaction?  
It causes the reaction to be slow
  - In the diagram, which are at a higher energy, the reactants or products?  
The reactants are at higher energy
  - Is energy absorbed or released when moving from the reactants to the activation complex?  
Energy is absorbed
  - Does the presence of an activated complex guarantee the completion of the chemical reaction?  
No, the could also revert to the reactants
  - Will changing the temperature of the reactants change the activation energy?  
No, it will only increase the number of reactants having the activation energy needed to react.

# The Activated Complex

- During the specific time when particles reach the activated complex, they are considered to be unstable.
- It only forms if the particles in question have *enough kinetic energy to reach the peak* and they are *oriented properly*.
- Its lifespan over the course of the chemical reaction is extremely small.
  - The formation of products or the re-formation of reactants is both possible at this moment.
  - As a result, the **activated complex** is also called the **transition state**.

# Factors Affecting Reaction Rates

- Every chemical reaction occurs at its own rate.
- The conditions can be manipulated to speed up or slow down a reaction.

The rate of reaction depends on :

- **temperature,**
- **concentration,**
- **particle size(surface area)**
- **presence of a catalyst.**
- All can be attributed to the rationale of collision theory.
- Which variable is being demonstrated in Figure 18.6?

The concentration of oxygen is increased

# Temperature

- Typically, **raising** the temperature speeds up reactions and lowering it slows it down.
- The particles speed up and possess enough kinetic energy to have more successful collisions.
- The number of particles possessing enough kinetic energy also increases.
- The # of faster particles increase as well as successful collisions = faster reaction rate.
- Can you think of an everyday example where temperature is used to slow down rate of reaction?

refrigeration

# Concentration

- Decreasing the amount of space particles can move is referred to as an increase in concentration.
- The likelihood of a particle colliding with another particle increases.
- This leads to a faster reaction rate.
- Increasing concentration = increased reaction rate.

# Concentration

- In air, a lighted splint glows and soon goes out.
- When placed in pure oxygen (higher oxygen concentration), the splint bursts into flame.



# Particle Size

- Surface area – or particle size – influences rates of reaction.
- The total surface area of the particles involved in a reaction contribute to its reaction rate.
  - **The higher the surface area, the more of it is exposed to whatever it is reacting with**
  - This increases the number of particles involved in the reaction as well as effective collisions.
  - In chemistry, it is common to increase the surface area of a particle by dissolving it in water.
  - If you want it to remain a solid, grind the particles up.



## Particle Size

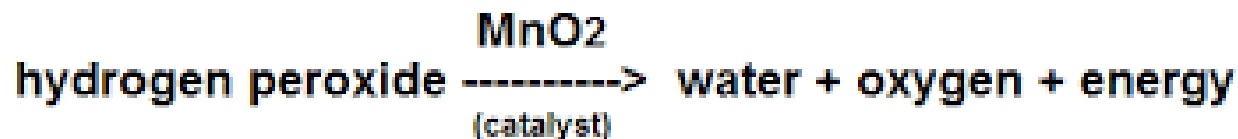
The minute size of the reactant particles (grain dust), and the mixture of the grain dust with oxygen in the air caused the reaction to be explosive, destroying the grain elevator.



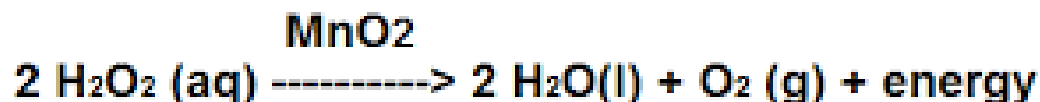
# Catalysts

- Catalysts increase the rate of reaction without being used up during the reaction.
- The presence of a catalyst **reduces the amount of energy required** for a reaction to proceed.
- When the activation-energy barrier is reduced, more particles reach the barrier at a given time, and the reaction occurs more quickly.
- Catalysts do not appear as a reactant – instead, they are written over the arrow.
- In the human body, the presence of enzymes allow chemical reactions to occur at lower temperatures.

### Word Equation:



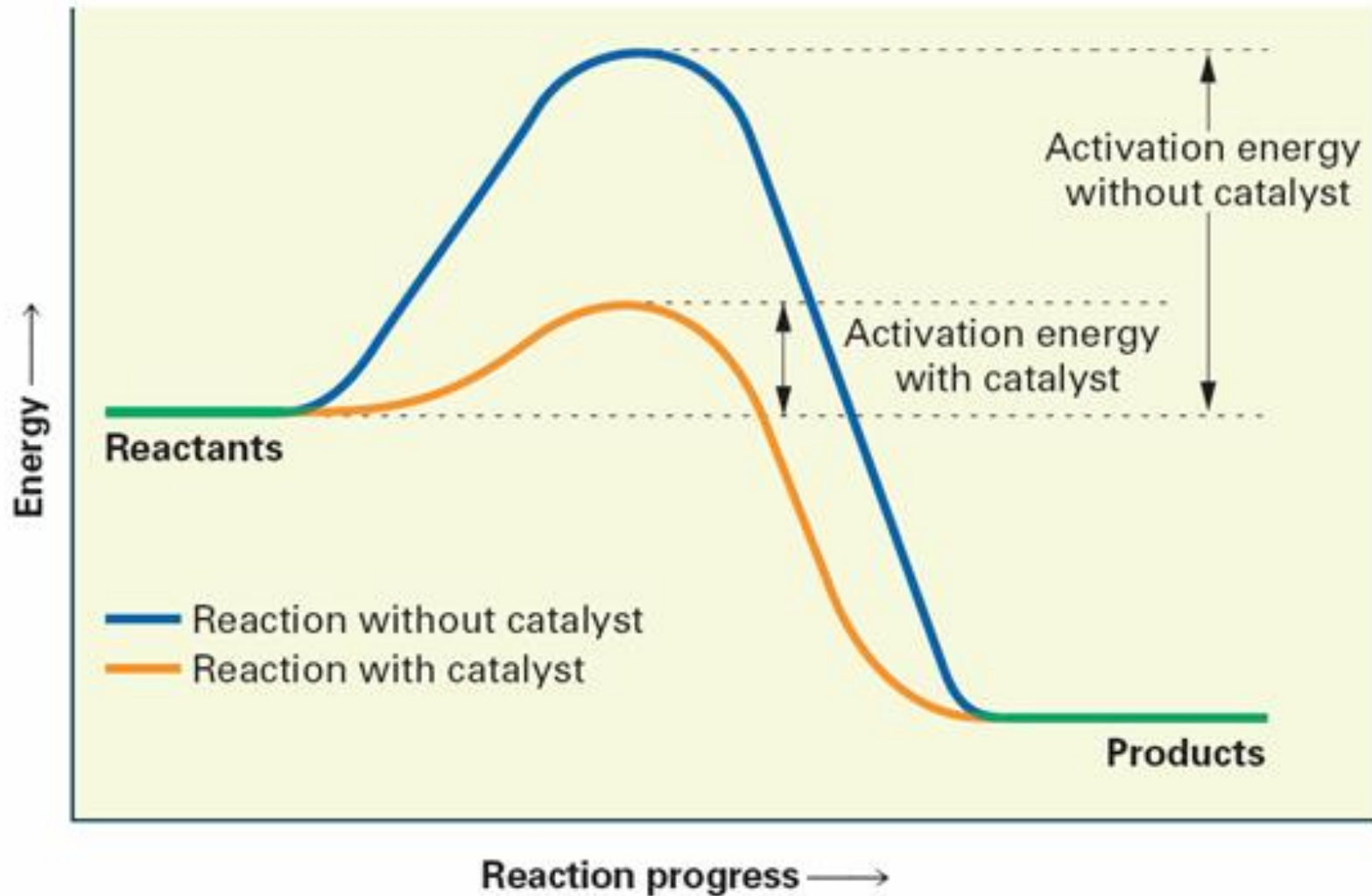
### Chemical Equation:



618 x 256 - mychemistrynotes.wordpress.com



## The Effect of a Catalyst on Activation Energy



# Catalysts in an Activation Energy Diagram

- Examine Figure 18.8, p. 547
- How does the catalyst influence the position of the activated complex?  
It lowers the activation energy
- Does the catalyst influence the amount of energy released in the reaction?  
No, it just lowers the activation energy
- Which pathway shows reactants being converted more rapidly to products?  
The orange line for the reaction with catalysts
- How do you think the presence of an inhibitor would influence the pathways?  
The activation energy would be higher than the graph for the reaction with a catalyst but no higher than the activation without a catalyst

# Inhibitors

- An inhibitor blocks the catalyst from doing its job.
- They may react with the catalyst or "poison" by destroying it.
- As a result, the reaction slows down or may even stop.
- Can you think of a biological process that acts as an inhibitor? What do you think it means to be lactose intolerant?

# Remainder of class...

- Guided reading for section 18.1
- Questions 1 – 5, p. 547.
- Assignment – Research what a catalytic converter is. What metals are used in their manufacture? What reactions do they provide more effective pathways to?