Expressing Reaction Rates

- Some chemical reactions are fast and others are slow, but chemists need to be more specific.
- What is a rate?
- How do we use rates in everyday life?
- How would we measure the rate of a reaction?

$$\frac{\Delta \text{quantity}}{\Delta \text{time}} \quad -\frac{M}{s}$$

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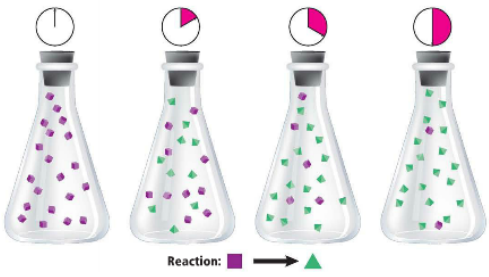
Expressing Reaction Rates



- What happens to the amount of reactants over time? decrease
- What happens to the amount of products over time? increase
- Do you think you would observe the same changes for any reaction? no

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Reaction Rates

- Reaction Rate for chemistry is defined as the change in concentration of reactant or product in a period of time

$\frac{M}{s}$

- What is concentration?
  - amount of solute in a given amount of solvent
    - solute: what's being dissolved
    - solvent: doing the dissolving
    - ex: salt in water -- salt is _____, water is _____
    - unit we typically use if molarity (M) -- moles/liter

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Reaction Rates

- Reaction Rates are determined experimentally by measuring the concentration of reactants and/or products in a chemical reaction.
- Reaction rates CANNOT be calculated from balanced chemical reactions.
- Reaction rates must always be positive.

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Collision Theory

In order for a reaction to occur:

- reactants must collide
- collisions must be in the correct orientation
- collision must have minimum amount of energy for bonds to break

Only a small number of collisions actually meet the requirements and result in a reaction.

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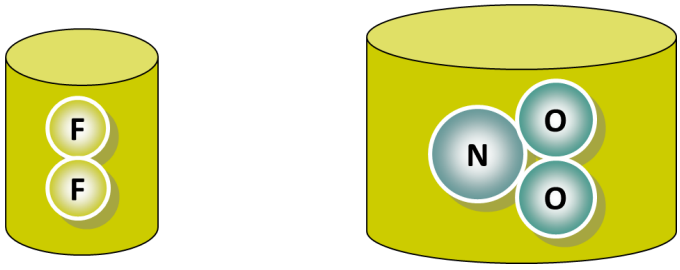
1. Reactants must collide

In order for two molecules to react, they must com in contact with one another.



There's no way they'll ever react if the don't run into one another!

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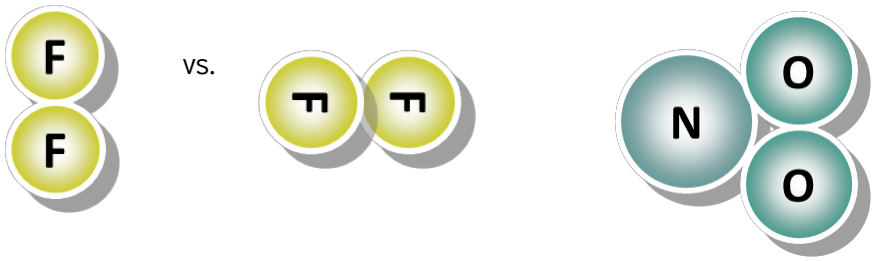
2. Correct Orientation

For a collision to result in a chemical reaction, it must occur with the correct orientation.



There's no way they'll ever react if they don't collide correctly!

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3. Energy

For a collision to result in a chemical reaction, it must occur with the minimum amount of energy for reaction.

There's no way they'll ever react if there isn't enough energy!

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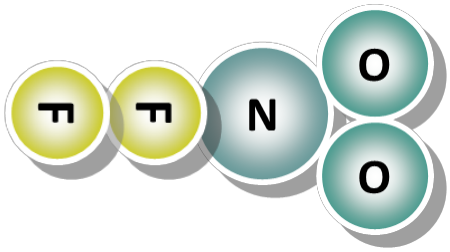
Collision Theory

Activated Complex: a temporary, unstable arrangement of atoms in which old bonds are breaking and new bonds are forming



Transition state is another name for activated complex.

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Collision Theory

- Collisions with correct orientation must also have sufficient amount of energy.
- This amount of energy is called the activation energy.
- Symbol: E_a

QUESTION: How would a high vs low activation energy affect the speed of a reaction?

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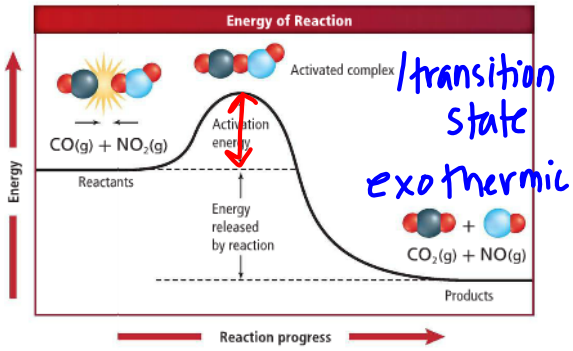
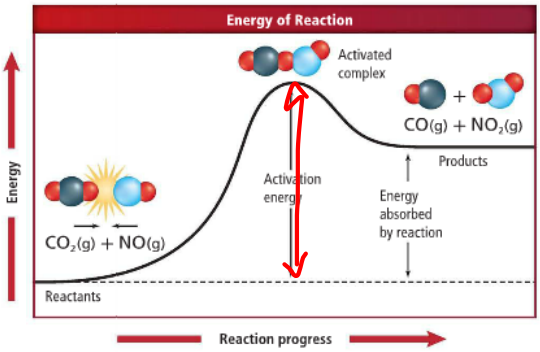
Activation Energy

Reaction #1





Reaction #2

endothermic

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Factors Affecting Reaction Rate

1. Nature of Reactant – reactivity
2. Concentration – ↑ conc, more collisions
3. Surface Area – ↑ S.A., more likely to be correct orientation
4. Temperature – ↑T, more collisions & more energy
5. Catalysts

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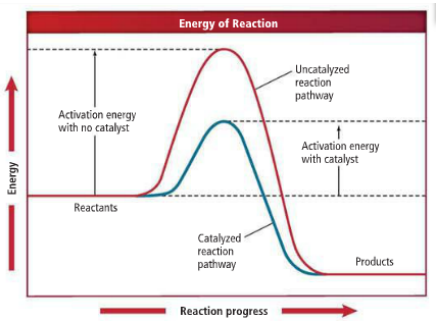
Catalysts

Catalyst: substance that increases the rate of reaction without being used up.

> creates a lower energy reaction pathway

A + B + C --> D + C

"C" is the catalyst it is present in the beginning and the end.



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How to speed up a reaction and get a date.

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