Kinetics
Energetics
Redox
Industrial processes/Equilibrium
Organic Chemistry
Acid & Base

Unit 1: Kinetics

- Kinetics - an area of chemistry which primarily focuses on the rates of chemical reactions. Units of chemical reaction: m/s or ms^{-1}

- Factors which affect the rate of a chemical reaction:
    - concentration of the reactants
    - temperature
    - presence/absence of a catalyst
    - surface area of the reactants and/or catalyst

- Collision theory: In order for chemical reaction to occur, particles must collide with each other & the rate of reaction will be determined by the frequency of collisions.

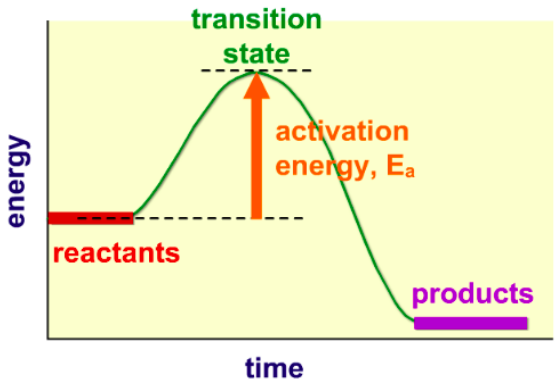
    - However, mostly particles will collide with each other WITHOUT any reaction because for “successful” collisions particles must **collide** with each other at **sufficient energy** and **proper direction**.

- Factors that increase the rate of a reaction **must** influence at least one of the following:
    - Frequency of collisions: more frequent collisions will lead to a faster rate.
    - Increase in effectiveness of collisions in terms of collisions occurring with sufficient energy.
    - Increase in effectiveness of collisions in terms of collisions occurring with the proper orientation.
    - **Activation energy (Ea) - is the energy required to break bonds in the reactants.**

What is activation energy?

The **activation energy** is the energy required to break the bonds in the reactants.

The activation energy of each reaction is different.



What factors affect the rate of reactions?

- increased **temperature**
- increased **concentration** of dissolved reactants, and increased **pressure** of gaseous reactants
- increased **surface area** of solid reactants
- use of a **catalyst**.

Collision rate vs Activation energy

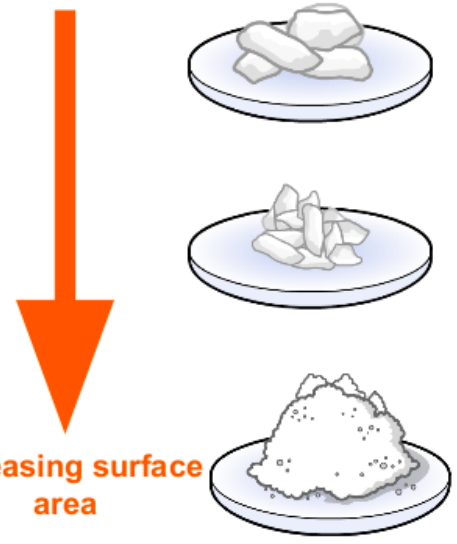
Factors mainly affecting the collision rate	Factors mainly affecting the proportion with required E_a
Concentration/pressure	Temperature
Surface area	Catalyst

Effect of surface area on collisions

Only the particles on the surface of a solid will collide with particles of the other reactant.

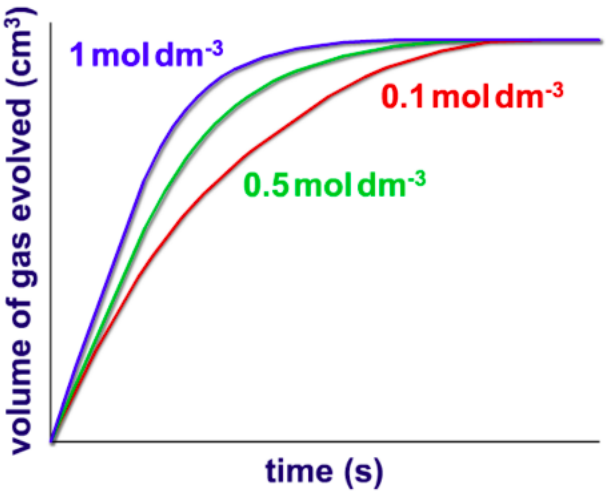
If the **surface area** is increased, more particles will be on the surface and able to collide with particles of the other reactant. This means that there will be more collisions in total and therefore more reactive collisions.

Surface area can be **increased** by **decreasing** the size of the reactant particles. Powders have a very large surface area.



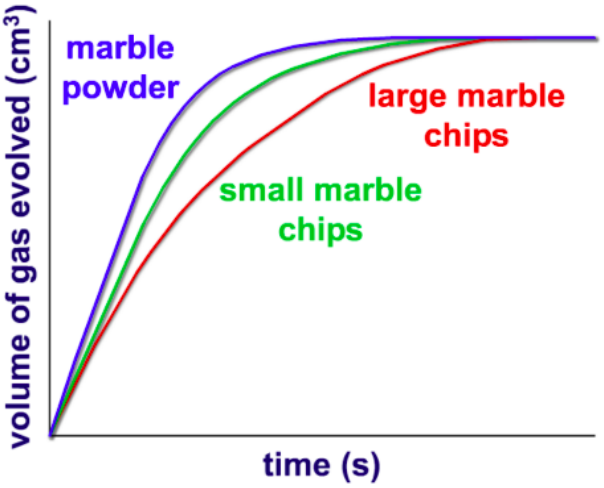
Effect of concentration on rate of reaction

As the concentration of a reactant increases, the rate of reaction increases.



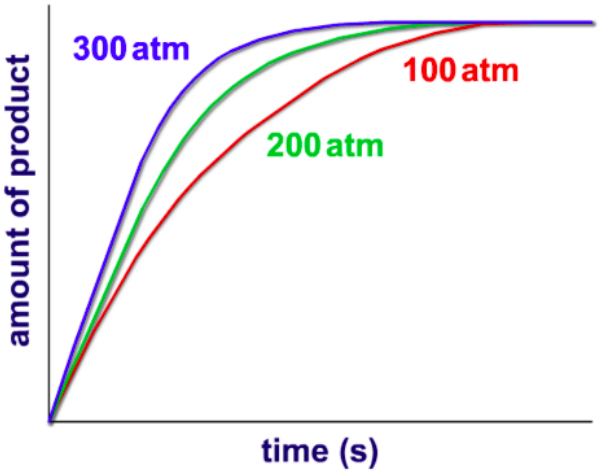
Effect of surface area on rate of reaction

As the surface area of a solid increases, the rate of a reaction involving that solid increases.



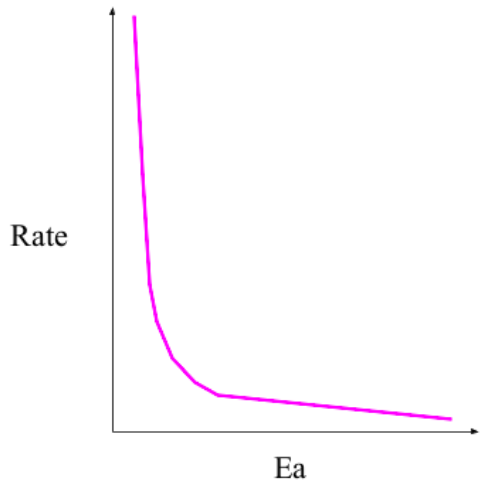
Effect of pressure on rate of reaction

Increasing the pressure in a gas phase reaction increases the rate of that reaction.

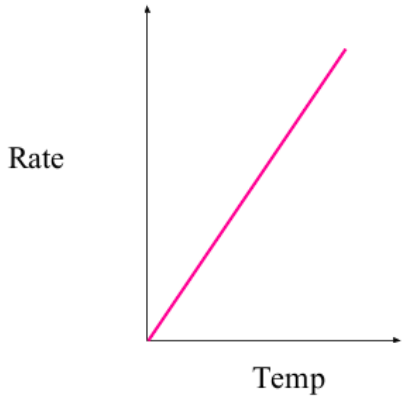


- **Catalyst** – substance that changes the rate of chemical reaction without undergoing a permanent chemical change.
- Catalysts differentiate in **homogeneous** & **heterogeneous** catalysts
- Homogeneous catalysts:
    - homogeneous catalyst is in the same phase as the reacting substances (f.e: single liquid phase)
    - generally catalysts lowers overall Ea (activation energy) for chemical reaction
- Heterogeneous catalysts:
    - heterogeneous catalyst is presented in different phase rather than reacting substances
    - initial step in heterogeneous catalyst is adsorption
    - **adsorption** – binding of molecules to surface, it occurs because ions/atoms at surface of solid are extremely reactive

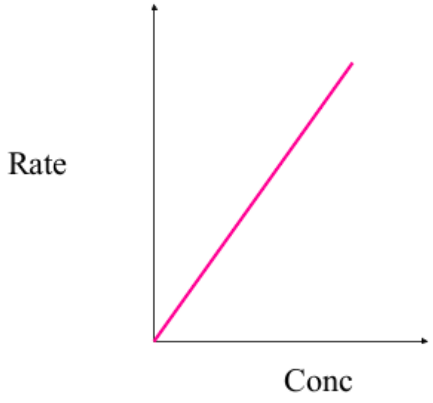
Decreasing the Ea **increases** the rate- **inverse.**



Increasing the temperature **increases** the rate- **direct.**



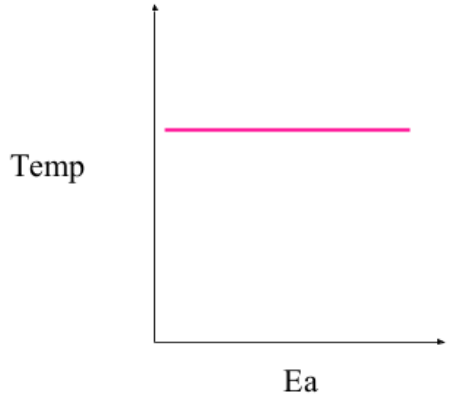
Increasing the concentration **increases** the rate- **direct.**

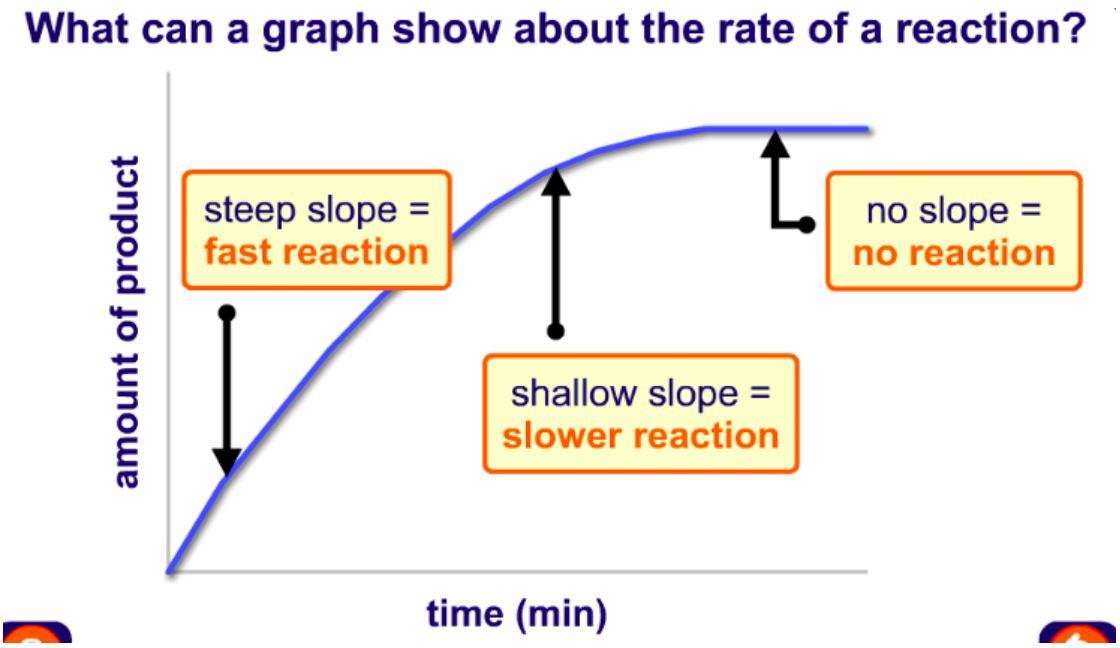


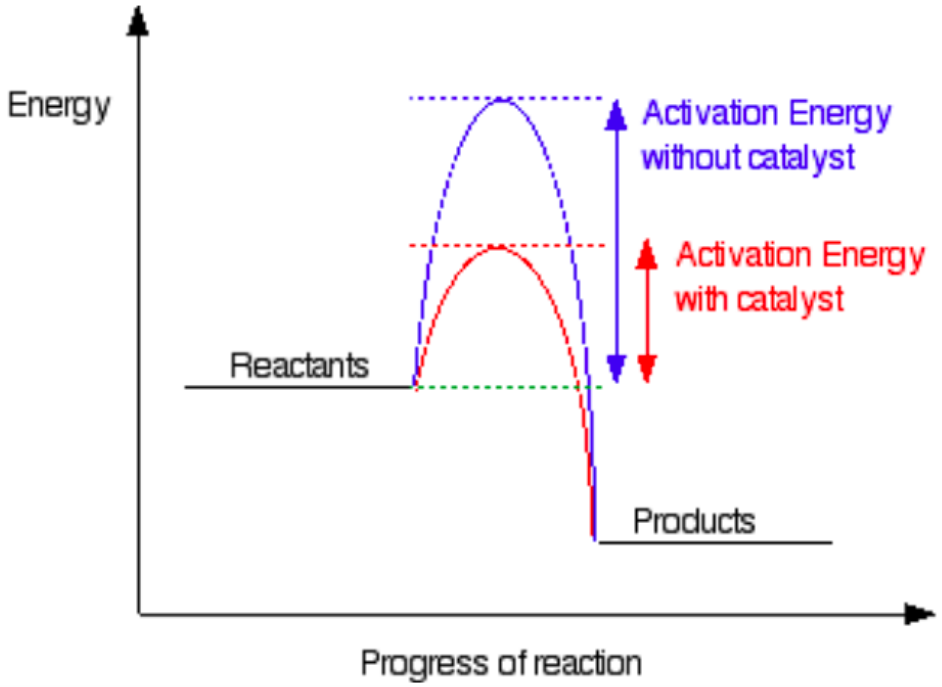
Ea and the temperature

The only way to change the Ea is by adding a catalyst!

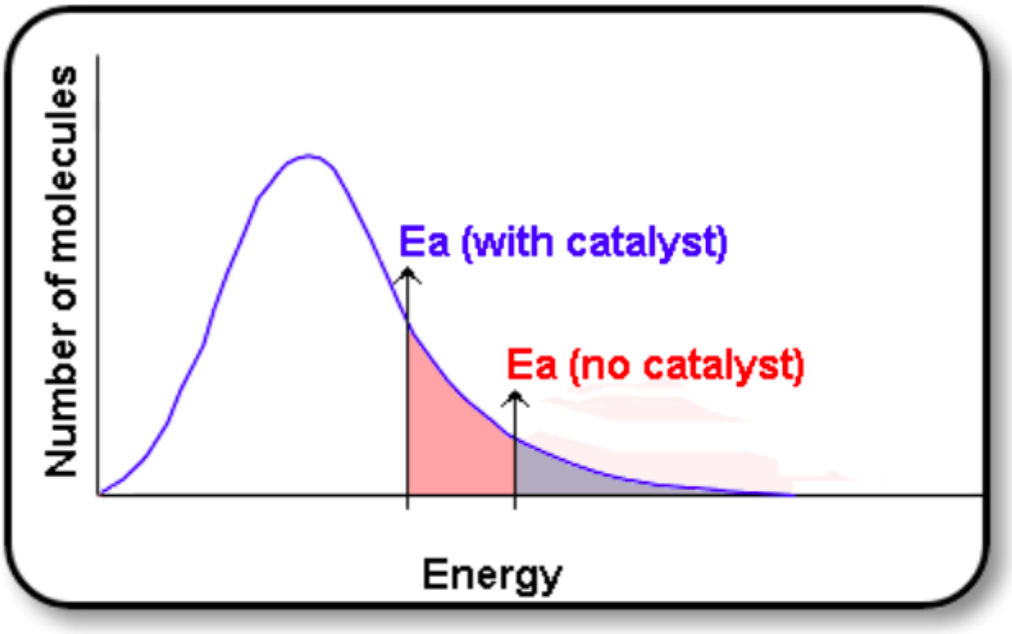
No relationship!







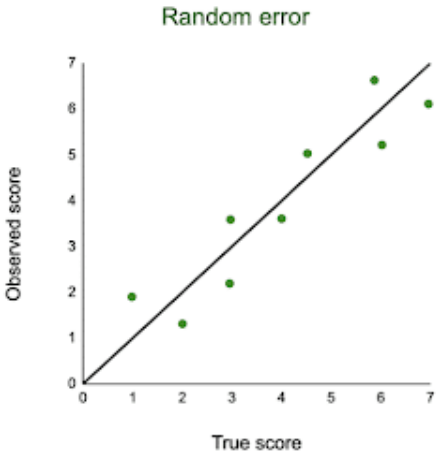
Catalysts - Maxwell-Boltzmann curve



Catalyst - A catalyst increases the rate of the reaction without itself undergoing chemical change. It provides an alternate route for the reaction which has a lower activation energy.

- Enzymes: is **a substance that acts as a catalyst in living organisms, regulating the rate at which chemical reactions proceed without itself being altered in the process**. The biological processes that occur within all living organisms are chemical reactions, and most are regulated by enzymes.
- **Catalase** – enzyme in blood and liver that decomposes hydrogen peroxide (H_2O_2) into water and oxygen.

- **Uncertainties:**
- Random error - above or below true value, usually due to the limitations of the equipment. An error that has an equal probability of being too high or too low.
    - Can be reduced by repeated measurements.
    - Examples:
        - Fluctuations in the balance
        - Changes in the surrounding environment such as temperature variations and air currents
        - Misinterpreting the reading
        - Using a stopwatch to time a reaction
        - Insufficient data
        - Judging a color change



reaction time
or
interpreting the
"end" of a reaction

measurement
uncertainty
(±)

use of different stock solutions

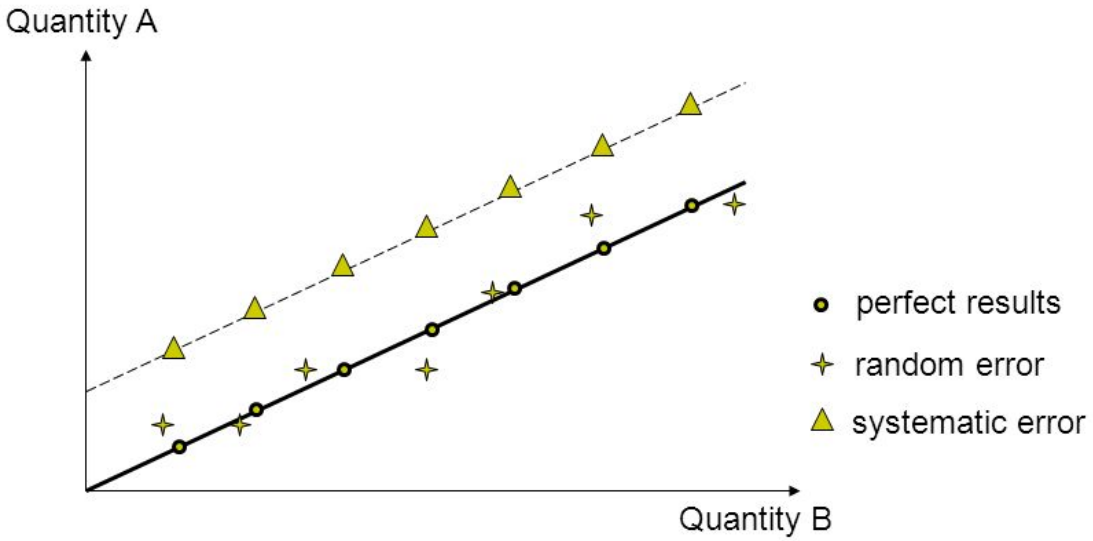
- **Systematic errors** - An error caused by the result of poor experimental design or procedure which causes the result to be skewed in the same direction every time.
    - Can be fixed by better equipment and better experimental design.
    - Can not be reduced by multiple trials.
    - Examples
        - Heat loss in an exothermic reaction
        - Reading from the top of the meniscus
        - Overshooting the endpoint in a titration
        - Mis-calibrated thermometer
        - A cloth tape measure that has been stretched out.

instruments not calibrated correctly (or at all)

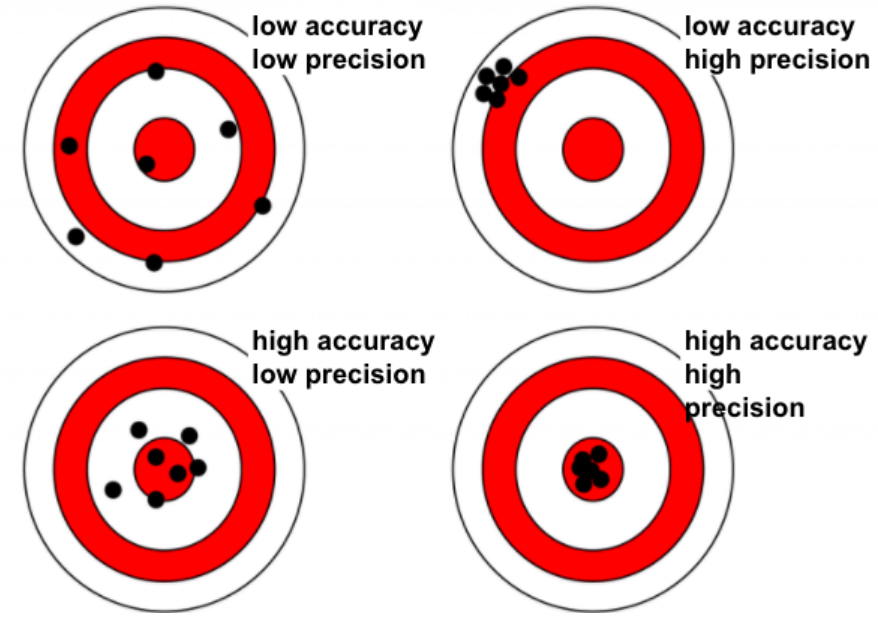
loss of heat in a calorimetry experiment

reaction does not go to completion

- **Representation of random & systematic errors on a graph**

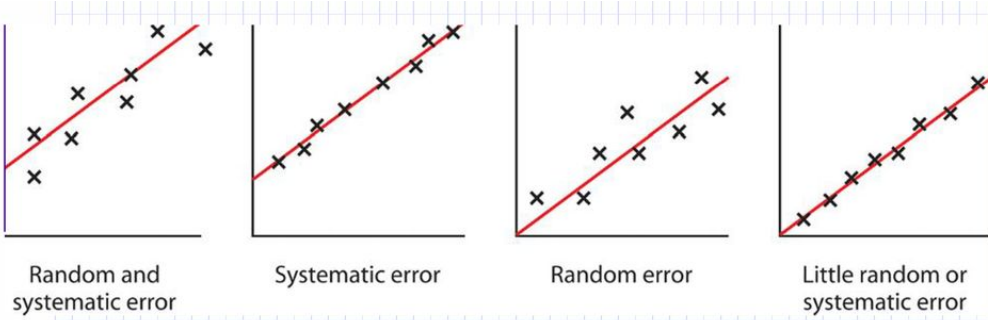


- **Accuracy & precision:**



accuracy	precision
"correctness"of values	reproducibility of values
low accuracy = systematic errors	low precision = random errors
poor accuracy = procedural or equipment flaws	poor precision = poor technique
check by using a different method	check by repeating measurements

- **Summary:**



Random and systematic error

This one has unclustered results and they're not accurate!

Systematic error

These one are nicely clustered as the same instrument was made throughout.

Random error

These results are **not precise** as there was error in reading the instrument

Little random or systematic error

These results are **precise** and **accurate** as the instrument was read well and correctly

Bibliography:

International Baccalaureate Organization. Chemistry Guide, First assessment 2016. Updated 2015.

Brown, Catrin, and Mike Ford. Higher Level Chemistry. 2nd ed. N.p.: Pearson Baccalaureate, 2014. Print.

Unit 2: Energetics

- Energetics - a study of the energy changes involved in chemical reactions, whether exothermic or endothermic.
- Exothermic reactions