

# Chapter 19: Chemical Reactions

## Section 4: Reaction Rates and Equilibrium

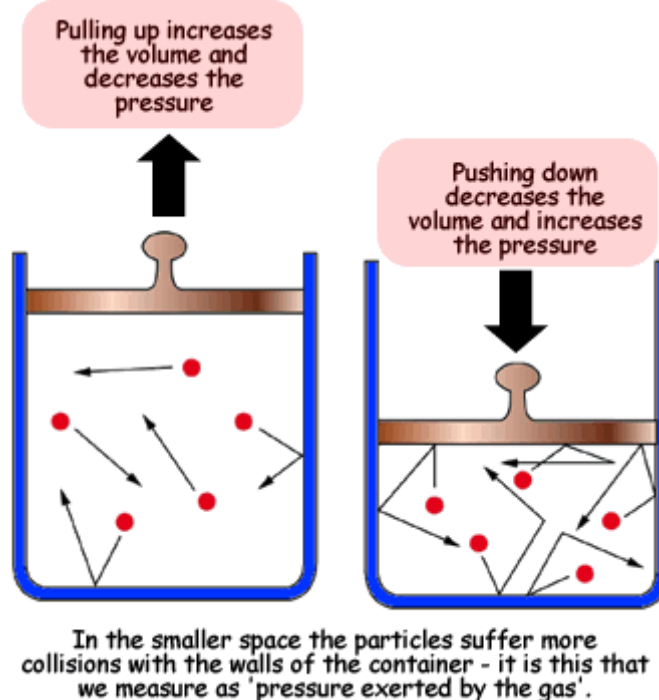
**Reaction rate:** the rate at which reactants change into products.

- some chemical reactions take place rapidly while others proceed so slow that you hardly notice.

**Collision model:** states that atoms, ions, and molecules must collide in order to react.

- Factors that affect reaction rates
  - *Temperature:* a measure of the average kinetic energy of all its particles
    - Higher temperatures have faster particles that collide more frequently with greater energy.
    - Perishable foods such as milk, eggs, and vegetables are stored in a fridge because lower temperatures decrease the rates of chemical reactions that cause spoilage.
  - *Concentration:* the number of particles of a substance per unit volume expressed as moles per liter (mol/L)
    - The more concentrated a solution results in the more reacting particles per unit volume causing more opportunities for collisions between reacting particles.
  - *Volume and pressure:* for chemical reactions involving gases because both relate to the concentration of the reacting gases
    - Decreasing the volume of a container increases the concentration of the gas (temperature being constant)
      - This will increase the concentration of the gas which in turn increases the rate at which the particles collide with each other and the walls of the

container. Pressure will increase inside the container causing the reaction rate to increase.

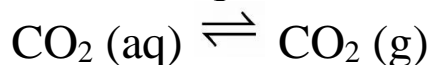


- *Surface area*: the more surface area exposed will result in greater reaction rates
  - Think of a sugar cube versus granulated sugar. Which will dissolve faster? The granulated sugar has more surface area for the water to collide with more frequently (sugar dissolving in water is a physical change)
- *Catalysts and inhibitors*
  - **Catalyst**: a substance that speeds up a chemical reaction without being permanently changed itself
    - When added to a reaction, the mass of the product remains the same but forms more rapidly.
    - Your body utilizes catalysts called enzymes.
  - **Inhibitors**: used to slow down the rates of chemical reactions or prevent a reaction from happening at all
    - Food preservatives are inhibitors.

- Remember! Catalysts and inhibitors do NOT change the amount of product produced. It only changes the rate of production.

**Reversible reaction:** reaction that can occur in both the forward and reverse directions.

- **Equilibrium:** a state in which forward and reverse reactions or processes proceed at equal rates
  - indicated with a double reaction arrows.
  - Reactants  $\rightleftharpoons$  Products
  - Can involve physical and chemical changes.
  - *Example:* the carbon dioxide in pop before you open the bottle is in constant equilibrium between aqueous and gas



**Le Chatelier's principle:** states that if a stress is applied to a system at equilibrium, the equilibrium shifts in the direction that opposes the stress

- A stress is any kind of change that disturbs the equilibrium.
  - changing concentration by adding or removing a reactant or product
  - changing temperature by adding or removing heat
  - changing volume and pressure
    - Opening a pop bottle
- When a forward or reverse reaction rate increases or decreases in response to a stress, the equilibrium is said to “shift”