

SUBJECTIVES OF CURRENT PAPER

CHE201 - Physical Chemistry

Final-Term File 2024 By

SULMAN ALI (BS-ZOOLOGY)

(0341-7547044)

Differentiate between open, closed and isolated system?

The macroscopic part of the universe under study in thermodynamics is called the System. The parts of the universe that can interact with the system are called the surroundings. 1= Open system is one where transfer of matter between system and surroundings can occur. 2= Closed system is one where no transfer of matter can occur between system and surroundings. 3= Isolated system is one that does not interact in any way with its surroundings. An isolated system is obviously a closed system, but not every closed system is isolated.

What are the properties of colloids?

- ❖ Particle Size: Dispersant particles range from 1 nm to 500 nm in diameter.
- ❖ Stability: Mixture does not separate under normal gravity.
- ❖ Filtration: Cannot be filtered by common fiber filters.
- ❖ Homogeneity: Usually close to homogeneous.
- ❖ Tyndall Effect: Light scattering makes the pathway visible.
- ❖ Saturation: No sharp saturation point.
- ❖ Coagulation: Dispersant can clump with heat or ionic particles.
- ❖ Colligative Properties: Minimal effect from dispersant.

Stopped-Flow Mechanism: short and long

The stopped-flow mechanism is a technique used to study solution-based kinetics on a millisecond timescale with minimal reactant volume. It involves two reactants in separate reservoirs that are mixed rapidly in a chamber by syringe pumps. The reaction is monitored by observing absorbance changes over time. The process is halted when the "stop syringe" fills and reaches a block, stopping the flow and reaction. This allows precise calculation of the initial reaction rate.

For example: For example, an enzyme catalyzed reaction can be stopped by adding an acid, base, or salt solution that denatures (destroys the activity of) the protein enzyme.

Elementary Steps for Reaction Mechanism:

Definition: Elementary steps are fundamental processes in a reaction mechanism explaining how the overall reaction proceeds.

The elementary steps used for mechanisms of chain reactions can be grouped into the following categories: 1= Initiation step, 2= Chain propagation steps, 3= Chain branching steps, 4= Chain inhibition steps, 5= Chain termination steps.

Types:

- ❖ **Unimolecular Step:** Involves one molecule, first-order rate law.
- ❖ **Bimolecular Step:** Involves two molecules, second-order rate law.
- ❖ **Trimolecular Step:** Involves three molecules, third-order rate law.

Characteristics of Reaction Rate

- **Definition:** Measures the change in concentration of reactants or products per unit time.
- **Speed Variation:** Reactions can be instantaneous or take years.
- **Influencing Factors:** Depends on the type of molecules and concentration levels.
- **Examples:** Fossilization is a slow reaction; some reactions happen in less than a second.

Phase and surface area effect on reaction rate:

Phase and surface area significantly impact reaction rates. Reactants in the same fluid phase collide more often, speeding up reactions. In heterogeneous reactions, where reactants are in different phases, collisions occur only at interfaces, reducing the rate. Increasing surface area, as in gasoline droplets, enhances reaction rates by increasing collision opportunities.

What are azeotrope?

- ❖ An azeotrope is a mixture that exhibits the same concentration in the vapor phase and the liquid phase.
- ❖ This is in contrast to ideal solutions with one component typically more volatile than the other; this is the reason we use distillation to separate materials.
- ❖ If the mixture forms an azeotrope, the vapor and the liquid concentrations are the same, which preventing separation via this approach.
- ❖ Azeotropes are a mixture of at least two different liquids.
- ❖ Their mixture can either have a higher boiling point than either of the components or they can have a lower boiling point.
- ❖ Azeotropes occur when fraction of the liquids cannot be altered by distillation.

Limitation of thermodynamics:

Thermodynamics has limitations in understanding reaction mechanisms and rates. Thermodynamics provides insight into the direction and equilibrium of chemical reactions by predicting free energy changes but does not address reaction rates or mechanisms. It tells us the final state but not how long it takes to reach equilibrium or the details of the reaction mechanism. Reaction rates and mechanisms must be studied experimentally, as they vary significantly even among similar reactions, as seen in the different mechanisms for the formation of hydrogen halides. Thus, thermodynamics alone cannot predict kinetic or mechanistic details.

Effect of Temperature and Pressure on Heat Capacity

Temperature: As temperature increases, specific heat capacity often rises because the added heat energy not only increases kinetic energy but also enables molecular vibrations and rotations. At lower temperatures, these modes are less accessible, so specific heat capacity is lower.

Pressure: Conventional thermodynamics suggests that heat capacity decreases with increasing pressure. However, model calculations show that heat capacity might increase, decrease, or remain unchanged depending on the model used.

Bomb Calorimeter vs. Ice Calorimeter

Bomb Calorimeter: Used for determining heats of combustion by combusting a sample in a fixed volume under high pressure. The process occurs in a vessel called a "bomb," and the reaction is ignited electrically. It measures the heat released during combustion.

Ice Calorimeter: Measures heat capacities and heats of reactions by observing the volume change due to ice melting. A warm sample is placed in an insulated chamber surrounded by ice and water. Heat loss causes ice to melt, and the resulting volume change in mercury provides the heat measurement.

The key difference is that the bomb calorimeter measures heat of combustion at constant volume, while the ice calorimeter measures heat capacities and reactions based on ice melting and volume change.

Explain when how enzymes decrease activations energy 5 marks

Enzymes decrease activation energy by providing an alternative reaction pathway with a lower energy transition state. As biological catalysts, enzymes bind to substrates and stabilize the transition state, reducing the energy required for the reaction to proceed. This results in a lower activation energy barrier, making it easier for reactants to collide and react. Consequently, the reaction rate increases in both the forward and reverse directions because less energy is needed for molecules to overcome the activation barrier. This increase in reaction rate is reflected in the higher rate constant (k).

Application of precipitation reaction:

Precipitation reactions are useful in determining whether a certain element is present in a solution. • If a precipitate is formed when a chemical reacts with lead, for example, the presence of lead in water sources could be tested by adding the chemical and monitoring for precipitate formation. • In addition, precipitation reactions can be used to extract elements, such as magnesium from seawater. • Precipitation reactions even occur in the human body between antibodies and antigens; however, the environment in which this occurs is still being studied.

Points of Maxwell distribution peak?

A sketch of a Maxwell distribution is given here.

- ❖ The peaks are not symmetrical.
- ❖ There are more molecules at higher speed than at lower speeds.
- ❖ When the temperature increases, the peak shifts to the right. A more carefully plotted diagram is done

Which characteristics can be monitored for measurement of the rate of reaction?

1. Concentration: Changes in the concentration of reactants or products.
2. Pressure: Changes in pressure for gas-phase reactions.
3. Mass or Volume: Changes in mass or volume for reactions forming precipitates or gases.
4. pH: Changes in acidity or basicity.
5. Temperature: Changes in temperature.
6. Color: Changes in color, particularly observable through spectrophotometry.
7. Conductivity: Changes in conductivity for reactions involving ions.
8. Luminescence: Changes in light emission.
9. Reaction Kinetics: Direct observation of the rate of reactant consumption or product formation

What are the properties of lipids?

Lipids are hydrophobic or amphiphilic, storing energy efficiently, and forming cell membranes. They include fats, oils, and phospholipids. Lipids are insoluble in water but soluble in organic solvents, and they play key roles in cellular signaling and structure.

Application of kinetic energy:

- ❖ Kinetic energy has various applications:
- ❖ Transportation: Powers vehicles like cars, trains, and planes.
- ❖ Sports: Athletes convert muscle energy into kinetic energy.
- ❖ Industry: Used in machinery, conveyors, and assembly lines.
- ❖ Renewable Energy: Wind turbines and hydroelectric plants harness kinetic energy.
- ❖ Impact: Important in analyzing collisions and designing safer structures.
- ❖ Projectile Motion: Determines velocity and range of projectiles in physics and engineering.

Describe Mass Percent, Volume Percent, Mass/Volume Percent:

1. Mass Percent: The mass percent is used to express the concentration of a solution when the mass of a solute and the mass of a solution is given:

2. Volume Percent: The volume percent is used to express the concentration of a solution when the volume of a solute and the volume of a solution is given:

3. Mass/Volume Percent: Another version of a percentage concentration is mass/volume percent, which measures the mass or weight of solute in grams (e.g., in grams) vs. the volume of solution (e.g., in mL).

Factors effect the in finding the rate of reaction:

Factors affecting the rate of reaction include concentration of reactants, temperature, presence of catalysts, surface area of solid reactants, and nature of reactants. Higher concentration, increased temperature, and catalysts generally speed up reactions, while larger surface areas enhance reactant collisions, increasing reaction rates.

Define following Syrup, Brine, Saline, Seltzer:

Some solutions are so common to us that we give them a unique name. 1= A solution of water and sugar is called syrup. 2= A solution of sodium chloride (common table salt) in water is called brine. 3= A sterilized specific concentration (0.15 molar) of sodium chloride in water is called saline. 4= A solution of carbon dioxide in water is called seltzer, and a solution of ammonia gas in water is called ammonia water.

Process of Fractional Distillation:

The process of fractional distillation involves heating a mixture of substances (e.g., water and ethanol). The mixture boils, and substances vaporize at their boiling points (ethanol at 78.4°C and water at 100°C). The vapor rises through a fractional distillation column and cools as it moves into a second column. Condensers cool the vapor, causing condensation back to liquid. The separated liquid is collected in a container at the end of the second column. This method is used in petroleum refineries to separate crude oil and purify water naturally.

How viscosity is measured by Ostwald's viscometer?

Ostwald Viscometer: An Ostwald Viscometer consists of two reservoir bulbs and a capillary tube. •The viscometer is filled with liquid until the liquid reaches the mark A with the aid of a pipette to accurately measure out the volume of needed liquid. • The viscometer is then put into a water bath which equilibrates the temperature of the test liquid. • As noted before, the equilibration is important to maintain a constant temperature as to not affect the viscosity otherwise. • The liquid is then drawn through the side 2 of the U-tube by use of suction and lastly, the flow is time between marks C and B. • The viscosity is calculated with Equation $\eta = Kt$ Where K is the value of a liquid with known viscosity and density such as water. Once the value of K is known, the viscosity can be determined by measuring the amount of time the test liquid flows between the two graduated marks.

Discuss different methods of measurement of viscosity?

Viscosity is defined as a liquid's resistance to flow. Viscosity is also often referred as the thickness of a fluid. Measuring Viscosity: There are numerous ways to measure viscosity.

1-One of the most elementary ways is to allow a sphere, such as a metal ball, to drop through a fluid and time the fall of the metal ball: The slower the sphere falls, the lower the viscosity that is measured.

2-Another more advanced design of measuring viscosity known as the Ostwald Viscometer that is much more accurate than dropping a metal ball. Is k agy oper wala Ostwald Viscometer wala likh dyen agr ajaye to.

Define Tyndall effect:

The mixture may appear cloudy or almost totally transparent, but if you shine a light beam through it, the pathway of the light is visible from any angle. This scattering of light is called the Tyndall effect.

Henry's law:

Henry's law is one of the gas laws formulated by William Henry in 1803 and states:

"At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid."

Define the following terms. 1= critical volume, 2= critical pressure, 3= critical temperature:

The Critical Volume: The volume occupied by a unit mass of a gas or vapors in its critical states.

The Critical Pressure: The pressure required to liquefy a gas at its critical temperature.

The Critical Temperature: The temperature at and above which vapors of the substance cannot be liquefied, no matter how much pressure is applied.

Describe some reversible reaction which are in surrounding?

Reversible Process: A reversible process is defined as a process that can be reversed without leaving any trace on the surroundings. Examples: 1= Frictionless relative motion. 2= Expansion and compression of spring. 3= Isothermal expansion or compression. 4= Electrolysis

Viscosimeter mechanism:

A viscosimeter measures fluid viscosity by observing the flow rate through a capillary tube or the resistance to motion of an object in the fluid. Common types include capillary, rotational, and falling ball viscosimeters, each using different methods to quantify fluid resistance and viscosity.

Drawbacks of Thermodynamics:

Thermodynamics has drawbacks: it predicts reaction direction and equilibrium but not reaction rates or mechanisms. It doesn't account for time, requiring kinetics for speed analysis. Additionally, stoichiometric equations reveal nothing about process details, necessitating experimental study to understand specific reaction pathways and dynamic behaviors.

Equilibrium thermodynamics and irreversible thermodynamics:

Equilibrium thermodynamics studies systems in a state of equilibrium, focusing on macroscopic properties without relying on molecular theories. It analyzes energy, work, and heat exchanges within a system at equilibrium, ensuring no net change occurs over time. This field contrasts with non-equilibrium thermodynamics, which deals with processes and systems not in equilibrium.

Irreversible thermodynamics studies non-equilibrium systems where processes involve entropy production and energy dissipation. Unlike reversible processes, these cannot return to their initial states without external intervention, reflecting real-world phenomena like heat flow, chemical reactions, and fluid dynamics.

Ideal gas equation and how it can be corrected:

The ideal gas equation is $PV = nRT$, where P is pressure, V is volume, n is the number of moles, R is the gas constant, and T is temperature. It assumes no intermolecular forces and that gas molecules occupy no volume. Real gases deviate from this behavior at high pressures and low temperatures. Corrections are made using the Van der Waals equation: $(P + \frac{a}{V^2})(V - b) = nRT$, where a and b account for intermolecular forces and molecular volume, respectively.

How temp and wavelength effect on refractive index:

Temperature and wavelength both affect the refractive index of a material. As temperature increases, the refractive index usually decreases due to reduced material density. Conversely, the refractive index is wavelength-dependent; it typically decreases with increasing wavelength, a phenomenon known as dispersion. Shorter wavelengths experience greater refraction, while longer wavelengths experience less. Thus, both higher temperatures and longer wavelengths generally result in a lower refractive index.