

CHE201 important notes for Mid term 2017

Define Physical Chemistry?

Physical chemistry is the study of the underlying physical principles that govern the properties and behavior of chemical systems.

Difference between Microscopic and Macroscopic Concept of molecules?

Microscopic:

The microscopic viewpoint is based on the concept of molecules.

Macroscopic:

The macroscopic viewpoint studies large-scale properties of matter without explicit use of the molecule concept.

Define Thermodynamics?

(Greek words for “thermo=heat” and “dynamics=power”) is the study of heat, work, energy, and the changes they produce in the states of systems.

Thermodynamics studies the relationships between the macroscopic properties of system. Thermodynamics is sometimes defined as the study of the relation of temperature to the macroscopic properties of matter.

Difference between Equilibrium and Irreversible Thermodynamics?

Equilibrium Thermodynamics

It deals with systems in equilibrium. It is a macroscopic science and is independent of any theories of molecular structure

Irreversible Thermodynamics:

It deals with non-equilibrium systems and rate processes.

Difference between System and Surrounding?

System:

The macroscopic part of the universe under study in thermodynamics is called the System.

Surrounding:

The parts of the universe that can interact with the system are called the surroundings.

Difference between open, closed and isolated system?

Open system: Open system is one where transfer of matter between system and surroundings can occur.

Closed system:

Closed system is one where no transfer of matter can occur between system and surroundings.

Isolated system:

Isolated system is one that does not interact in any way with its surroundings.

Difference between mechanical and material equilibrium?

Mechanical equilibrium:

No unbalanced forces act on or within the system; hence the system undergoes no acceleration, and there is no turbulence within the system.

Material equilibrium:

No net chemical reactions are occurring in the system, nor is there any net transfer of matter from one part of the system to another or between the system and its surroundings.

Difference between Homogenous and Heterogeneous?

Homogenous:

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If a system is not homogeneous, it may consist of a number of homogeneous parts. A homogeneous part of a system is called a phase.

Heterogeneous:

A system composed of two or more phases is heterogeneous.

Define Pressure?

Pressure is defined as the magnitude of the perpendicular force per unit area exerted by the system on its surroundings:

$$P = F/A$$

Define atomic weight or relative atomic mass?

The ratio of the average mass of an atom of an element to the mass of some chosen standard is called the atomic weight or relative atomic mass.

The standard used since 1961 is 1/12 times the mass of the isotope ^{12}C .

The ratio of the average mass of a molecule of a substance to 1/12 times the mass of a ^{12}C atom is called the molecular weight or relative molecular mass M_r of that substance.

Difference between ideal gas and real gas?

Ideal Gas:

A gas which shows the gas laws at all temperatures and pressure.

Real Gas:

A gas which does not obey the gas laws at all temperatures and pressure.

Define Boyle, s Law?

Robert Boyle: (1627-1691) the first modern chemist, known as the father of chemistry.

Boyle investigated the variation of the volume occupied by a gas as the pressure exerted upon it was altered and noted that the volume of a fixed quantity of gas, at constant temperature is inversely proportional to the pressure.

Where 'k' is constant.

Boyle's law is understandable from the picture of a gas as consisting of a huge number of molecules moving essentially independently of one another.

Define Charle, s Law?

A French scientist, Jacques Charles discovered that the volume of a fixed amount of gas, as constant pressure, is proportional to the absolute temperature.

$V \propto T$

$V/T = \text{Constant}$

Charles' law is obeyed most accurately in the limit of zero pressure

But even in this limit, gases still show small deviations.

Define Avogadro's Hypothesis?

In 1811 Avogadro stated that,

At constant temperature and pressure, the volume of a gas is directly related to the number of moles.

$$V = Kn$$

$$V_1 = K_1 \quad V_2 = K_2$$

Equal volumes of gases at the same temperature and pressure contain equal numbers of molecules.

Van der Waals Equation for real gases?

As the ideal gas equation deviates from gas laws

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So van der Waals in 1873 modified the ideal-gas equation to give the van der Waals equation for real gases.

Modified from ideal gas equation.

Difference between Attractive and Repulsive effect?

Attractive Effect:

Attractive forces between gas particles (attractive effect).

Pressure = Force per unit area of container exerted by gas molecules

Dependent on:

Frequency of collision.

Force of each collision.

Both factors affected by attractive forces.

Repulsive Effect:

Non-zero volumes of gas particles (repulsive effect).

Difference between Critical temperature, Pressure and Volume?

Critical Temperature:

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

Critical Pressure:

The pressure required to liquefy the gas at critical temperature is called critical pressure.

Critical Volume:

The volume occupied by 1 mole of a gas under critical conditions is called the critical volume.

Define Zeroth Law of Thermodynamics?

Two systems that are each found to be in thermal equilibrium with a third system will be found to be in thermal equilibrium with each other.

This generalization from experience is the Zeroth law of thermodynamics.

The Zeroth law allows us to assert the existence of temperature as a state function.

Define First law of Thermodynamics?

The first law of thermodynamics is a statement of the conservation of energy.

It is also called the Law of Conservation of Energy.

Energy can be changed from one form to another, but it cannot be created or destroyed. The total amount of energy and matter in the Universe remains constant, merely changing from one form to another.

Define Enthalpy of a reaction?

The energy change associated with a chemical reaction is called the enthalpy of reaction and abbreviated ΔH .

$$H = E + PV$$

Enthalpy is a "State Function".

Define Entropy of a Reaction?

Can be thought of as a measure of the disorder of a system.

In general, greater disorder means greater entropy.

Entropy is a state function just as enthalpy.

Difference between Clausius and Kelvin-Planck Statements?

Clausius Statement:

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It is impossible to construct a device that operates in a cycle and whose sole effect is to transfer heat from a cooler body to a hotter body.

Kevin-Planck Statement:

It is impossible to construct a device that operates in a cycle and produces no other effects than the performance of work and the exchange of heat with a single reservoir

Define Second law of Thermodynamics?

The total entropy of an isolated system can only increase over time. It can remain, constant in ideal cases where the system is in a steady state (equilibrium) or undergoing a reversible process. The increase in entropy accounts for the irreversibility of natural processes, and the asymmetry between future and past.

Describe Importance of third law of thermodynamics?

1. It helps in calculating the thermodynamic properties.
2. It is helpful in measuring chemical affinity. Because of this it is known as Nernst Theorem.
3. It explains the behavior of solids at very low temperature.
4. It helps in analyzing chemical and phase equilibrium.

Define Thermochemistry?

The quantitative study and measurement of heat and enthalpy changes is known as thermochemistry.

The heat that flows across the boundaries of a system undergoing a change is a fundamental property that characterizes the process.

Define Enthalpy of Vaporization?

The quantity 40.7 is known as the enthalpy of vaporization (often referred to as "heat of vaporization") of liquid water.

Define Enthalpy of Formation?

The standard enthalpy of formation of a compound is defined as the heat associated with the formation of one mole of the compound from its elements in their standard states.

The enthalpy change for a chemical reaction is the difference

$$\Delta H = \text{Products} - \text{Reactants}$$

The standard heat of formation of a compound is always taken in reference to the forms of the elements that are most stable at 25°C and 1 atm pressure.

Define Hess's Law?

Germain Henri Hess (1802-1850) was a Swiss-born professor of chemistry at St. Petersburg, Russia. He formulated his famous law, which he discovered empirically, in 1840.

If a chemical equation can be written as the sum of several other chemical equations, the enthalpy change of the first chemical equation equals the sum of the enthalpy changes of the other chemical equations.

Define Calorimetry?

The measurement of q is generally known as Calorimetry or measuring ΔH in the laboratory is called Calorimetry.

The most common types of calorimeters contain a known quantity of water which absorbs the heat released by the reaction.

Difference between Bomb calorimeter and ice calorimeter?

Bomb Calorimeter:

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Most serious calorimetry carried out in research laboratories involves the determination of heats of combustion, since these are essential to the determination of standard enthalpies of formation of the thousands of new compounds that are prepared and characterized each month.

Ice calorimeter The ice calorimeter is an important tool for measuring the heat capacities of liquids and solids, as well as the heats of certain reactions.

This simple yet ingenious apparatus is essentially a device for measuring the change in volume due to melting of ice.

Define Heat Capacity?

The heat capacity of a defined system is the amount of heat (usually expressed in calories, kilocalories, or joules) needed to raise the system's temperature by one degree (usually expressed in Celsius or Kelvin).

It is expressed in units of thermal energy per degree temperature.

Define Specific Heat Capacity?

The amount of heat needed to increase the temperature of one gram of a substance by one degree is the specific heat capacity.

It is expressed in joules per gram per degree Celsius.

Difference between reversible and irreversible processes?

Reversible Process:

A reversible process is defined as a process that can be reversed without leaving any trace on the surroundings.

Reversible processes do not occur and they are only idealizations of actual processes.

Irreversible Process:

An irreversible process is one in which heat is transferred through a finite temperature.

Processes that are not reversible are called irreversible.

Difference between Spontaneous and non-Spontaneous Processes?

Spontaneous Process:

Spontaneous processes do not require energy input to proceed. A spontaneous process is capable of proceeding in a given direction without needing to be driven by an outside source of energy.

Non-Spontaneous Process:

A non spontaneous process will not take place unless it is "driven" by the continual input of energy from an external source. A process that is spontaneous in one direction under a particular set of conditions is non spontaneous in the reverse direction. For example At room temperature and typical atmospheric pressure, ice will spontaneously melt, but water will not spontaneously freeze.

Define Equilibrium?

Equilibrium is when the rate of the forward reaction equals the rate of the reverse reaction.

All reactant and product concentrations are constant at equilibrium.

Equilibrium is the state in which the reactants and products experience no net change over time.

Difference between Homogenous and heterogenous Equilibrium?

Homogenous Equilibrium:

A homogeneous equilibrium has everything present in the same phase.

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The usual examples include reactions where everything is a gas, or everything is present in the same solution.

Heterogenous Equilibrium:

A heterogeneous equilibrium has things present in more than one phase.

The usual examples include reactions involving solids and gases, or solids and liquids.

Describe Applications of Equilibrium Constants?

1. The magnitude of the equilibrium constant, K , indicates the extent to which a reaction will proceed:

If K is a large number, it means that the equilibrium concentration of the products is large. In this case, the reaction as written will proceed to the right (resulting in an increase in the concentration of products)

If K is a small number, it means that the equilibrium concentration of the reactants is large. In this case, the reaction as written will proceed to the left (resulting in an increase in the concentration of reactants).

Knowing the value of the equilibrium constant, K , will allow us to determine:

The direction a reaction will proceed to achieve equilibrium

The ratios of the concentrations of reactants and products when equilibrium is reached

2. Predicting the Direction of a Reaction

If $Q = K_c$, then the system is already at equilibrium

If $Q > K_c$, then essentially we have too much product and the reaction will proceed to the left (to reduce the concentration of product and increase the concentration of reactant)

If $Q < K_c$, then essentially we have too little product and the reaction will proceed to the right (to produce more products and decrease the concentration of reactant)

3. Calculation of the Equilibrium Concentration of a Reactant or Product

Many types of equilibrium problems deal with determining how much of a product (or reactant) we will have once a reaction reaches equilibrium.

4. Solving equilibrium concentrations of all components in a reaction

Define Gibbs free energy?

The Gibbs free energy of a system at any moment in time is defined as the enthalpy of the system minus the product of the temperature times the entropy of the system.

$$G = H - TS$$

The Gibbs free energy of the system is a state function because it is defined in terms of thermodynamic properties that are state functions.

Define fugacity?

Fugacity Measures Non ideality of a Gas.

Fugacity is the effective pressure for a non-ideal gas.

The pressures of an ideal gas and a real gas are equivalent when the chemical potential is the same.

Define Activity?

Activity is a measure of the effective concentration of a species under non-ideal (e.g., concentrated) conditions. This determines the real chemical potential for a real solution rather than an ideal one.

Activities and concentrations can both be used to calculate equilibrium constants and reaction rates.

Describe Le Chatelier's Principle?

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If a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change.

Hence, Le Châtelier's principle states that any change to a system at equilibrium will adjust to compensate for that change.

In 1884 the French chemist and engineer Henry-Louis Le Châtelier proposed one of the central concepts of chemical equilibria, which describe what happens to a system when something briefly removes it from a state of equilibrium.

Le Chatelier's principle describes what happens to a system when something momentarily takes it away from equilibrium. We focus on three ways in which we can change the conditions of a Chemical reaction at equilibrium:

- (1) Changing the concentration of one of the components of the reaction
- (2) Changing the pressure on the system
- (3) Changing the temperature at which the reaction is run.

Define Properties of Liquids?

1. The intermolecular attractive forces are strong enough to hold molecules close together.
2. Liquids are more dense and less compressible than gases.
3. Liquids have a definite volume, independent of the size and shape of their container.
4. The attractive forces are not strong enough, however, to keep neighboring molecules in a fixed position and molecules are free to move past or slide over one another.

Define Physical Properties of Liquids?

1. Density
2. Compressibility
3. Thermal expansion
4. Diffusion
5. Viscosity/Fluidity
6. Surface tension
7. Capillary action

Define Surface Tension?

Surface tension is the energy required to increase the surface area of a liquid by a unit amount. Or The magnitude of the force that controls the one another, and is thus called shape of the liquid is called the surface tension.

Define Viscosity?

Viscosity is defined as a liquid's resistance to flow.

Viscosity is also often referred as the thickness of a fluid.

At a molecular level, viscosity is a result the interaction between the different molecules in a fluid.

This can be also understood as friction between the molecules in the fluid.

Define Refractive index?

The refractive index is a ratio of the speed of light in a medium relative to its speed in a vacuum.

This change in speed from one medium to another is what causes light rays to bend.

This is because as light travels through another medium other than a vacuum, the atoms of that medium constantly absorb and reemit the particles of light, slowing down the speed light travels at

Define the factors that affect refractive index?

The two factors which affect the value of the refractive index are:

1. Temperature

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2. Wavelength of light

Define Dipole Moment?

When atoms in a molecule share electrons unequally, they create what is called a dipole moment. This occurs when one atom is more electronegative than another, resulting in that atom pulling more tightly on the shared pair of electrons, or when one atom has a lone pair of electrons and the difference of electronegativity vector points in the same way.

Or

Dipole moment (μ) is the measure of net molecular polarity, which is the magnitude of the charge Q at either end of the molecular dipole times the distance r between the charges.

$$\mu = Q \times r$$

Define Cohesion?

Cohesion is intermolecular forces between like molecules; this is why water molecules are able to hold themselves together in a drop.

Water molecules are very cohesive because of the molecule's polarity.

This is why you can fill a glass of water just barely above the rim without it spilling.

Define Colligative Properties?

Colligative properties are the physical changes that result from adding solute to a solvent.

Colligative Properties depend on how many solute particles are present as well as the solvent amount, but they do NOT depend on the type of solute particles, although do depend on the type of solvent.

Difference between ideal and non-ideal solutions?

Ideal Solution:

An ideal solution is defined as one which obeys Raoult's Law. "An ideal solution shows thermodynamic mixing characteristics identical to those of ideal gas mixtures [except] ideal solutions have intermolecular interactions equal to those of the pure components."

Non-Ideal Solution:

The solutions which deviate from ideal behavior are called non ideal solution or real solutions and they do not obey Raoult's law over entire range of composition.

It has been found that on increasing dilution, a non ideal solution tend to be ideal.

Define Raoult, s law?

Raoult's law states that the vapor pressure of a solvent above a solution is equal to the vapor pressure of the pure solvent at the same temperature scaled by the mole fraction of the solvent present:

$$P_{\text{solution}} = X_{\text{solvent}} P_{\text{solvent}}$$

In the 1880s, French chemist François-Marie Raoult discovered that when a substance is dissolved in a solution, the vapor pressure of the solution will generally decrease.

Define Vapor Pressure?

The vapor pressure of a solvent in a solution is always lower than the vapor pressure of the pure solvent.

The vapor pressure lowering is directly proportional to the mole fraction of the solute.

Define Osmotic Pressure?

Osmosis is the diffusion of a fluid through a semi permeable membrane.

When a semi permeable membrane separates a solution from a solvent, then only solvent molecules are able to pass through the membrane.

The osmotic pressure of a solution is the pressure difference needed to stop the flow of solvent across a semi permeable membrane.

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Define 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."

$$C = kP_{\text{gas}}$$

Define Electrolyte Solution?

An electrolyte solution is a solution that generally contains ions, atoms or molecules that have lost or gained electrons, and is electrically conductive.

For this reason they are often called ionic solutions, however there are some cases where the electrolytes are not ions.

Define Ionic Solutions?

Using the rule "like dissolves like" with the formation of ionic solutions, we first assess two things:

1. The strength of the ion-dipole forces of attraction between water and the ionic compound and
2. The strength of the interionic bond of the ionic compound.

Define Arrhenius's theory?

Arrhenius's theory states that ions exist in a solid substance and dissociated from each other once the solid dissolves.

Arrhenius's theory did not take into account the fact that strong electrolytes are not as great as he originally thought and the values of the van't Hoff factor i relied on the concentration of the solution.

Difference between Mass percent and Volume percent?

Mass Percent:

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

Volume Percent:

The volume percent used to express the concentration of a solution when the volume of the solute and volume of the solution given.

