CHE201 – PHYSICAL CHEMISTRY

MID TERM MOST IMPORTANT QUESTIONS

1. **Define open, closed and isolated system.**

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

2. **Write some factors that cause a process to become irreversible.**

Some factors that cause a process to become irreversible are Friction, unrestrained expansion and compression, mixing, heat transfer (finite ΔT), inelastic deformation, and chemical reactions.

Examples of irreversible process are: Relative motion with friction, combustion, diffusion, free expansion, throttling, electricity flow through a resistance, heat transfer, and plastic deformation.

3. **Why solid water floats at liquid water?**

Water is one of the few substances whose solid state can float on its liquid state. Water continues to become denser until it reaches 4°C. After it reaches 4°C, it becomes LESS dense. When freezing, molecules within water begin to move around more slowly, making it easier for them to form hydrogen bonds and eventually arrange themselves into an open crystalline, hexagonal structure. Because of this open structure as the water molecules are being held further apart, the volume of water increases about 9%. So molecules are more tightly packed in water's liquid state than its solid state.

4. **Briefly describe Third Law of Thermodynamics.**

Third Law of Thermodynamics:

This law states as "Entropy of a perfect crystalline substance is zero at absolute zero". In other words "it is impossible to reach a temperature of absolute zero".

On Kelvin temperature scale, T= 0K is often referred to as absolute zero.

Importance of Third Law of Thermodynamics:

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

5. **Briefly describe type of specific latent heat.**

There are two types of specific latent heat:
i- vaporization ii- Fusion.

The specific latent heat of vaporization:

The specific latent heat of vaporization is defined as the quantity of heat energy that is necessary to raise one unit of weight (pounds or grams) with no change of temperature in the surroundings.

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Like the name implies, this specific latent heat quantifies the transfer of energy when a substance's state changes from liquid to gas or from gas to liquid.

Specific Latent heat of fusion:

The specific heat of fusion is the quantity of heat that is necessary to raise one unit of weight without any change in temperature. This specific latent heat quantifies the transfer of energy when a substance's state changes from a solid to a liquid or from a liquid to a solid.

6. How viscosity is measured by Ostwald's 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:

$nu=Kt$

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.

7. Differentiate between 4 colligative properties.

Four colligative properties are:

i- Vapor pressure lowering
ii- Freezing point depression
iii- Boiling point elevation
iv- Osmotic pressure

All four colligative properties fit the relationship.

Property	Symbol	Solute concentration	Proportionality constant
Vapor pressure	ΔP	Mole fraction	Po (vapor pressure of pure solvent
Freezing point	ΔTb	Molal	Kb (boiling point constant)
Boiling point	ΔTf	Molal	Kf (freezing point constant)
Osmotic pressure	P	Molar	RT

8. How can we predict the direction of a reaction using equilibrium constant?

i- If Q = Kc, then the system is already at equilibrium
ii- If Q > Kc, 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 product).
iii- If Q < Kc, then essentially we have too little product and the reaction will proceed to the right (to produce more product and decrease the concentration of reactant).

9. Write different methods to measure viscosity.

There numerous ways to measure viscosity. Some of them are: the capillary viscometer, the flow cup, the rotational viscometer, the rolling ball viscometer, the drawing ball viscometer and Ostwald's viscometer.

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10. Write importance of Third Law of Thermodynamics

Importance of Third Law of Thermodynamics:

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

11. Write application of Henry's Law.

- Henry's law only works if the molecules are at equilibrium.
- Henry's law does not work for gases at high pressures (e.g., N_2 (g) at high pressure becomes very soluble and harmful when in the blood supply).
- Henry's law does not work if there is a chemical reaction between the solute and solvent (e.g., HCl(g) reacts with water by a dissociation reaction to generate H_3O and Cl^- ions).

12. What are critical temperature, critical pressure & critical 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.

13. Enlist different physical properties of liquids.

- Molecules in liquids are very close together, with essentially no empty space between them.
- The molecules in liquids are in constant motion, and their kinetic energy (and hence their speed) depends on their temperature.
- Liquids possess definite volume but not a definite shape. This is the reason that they cannot be kept without container.
- As liquids have low intermolecular space as compared to solids, they can flow easily.

14. What is the effect of temperature and wavelength on refractive index?

Temperature:

- Refractive index values are usually determined at standard temperature.
- A higher temperature means the liquid becomes less dense and less viscous, causing light to travel faster in the medium. This results in a smaller value for the refractive index due to a smaller ratio.
- A lower temperature means the liquid becomes denser and has a higher viscosity, causing light to travel slower in the medium. This results in a larger value for the refractive index due to a larger ratio.

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Wavelength of light

- The refractive index varies with wavelength linearly because different wavelengths interfere to different extents with the atoms of the medium.
- It is important to use monochromatic light to prevent dispersion of light into different colors.
- The chosen wavelength should not be absorbed by the medium.
- The sodium D line at 598 nm is the most frequently used wavelength of light for a refractometer.

15. Define mechanical equilibrium, thermal equilibrium & 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.

Thermal Equilibrium:

During thermal Equilibrium between a system and its surroundings, there must be no change in the properties of the system or surroundings when they are separated by a thermally conducting wall. For thermodynamic equilibrium, all three kinds of equilibrium must be present.

16. State Henry's law.

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."

An equivalent way of stating the law is that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid:
$C=kP_{gas}$
Where,
C is the solubility of a gas at a fixed temperature in a particular solvent (in units of M or mL gas/L).
k is Henry's law constant (often in units of M/atm).

17. Name some of the processes that are nearly reversible.

Some examples of nearly reversible processes are: Frictionless relative motion, Expansion and compression of spring, Frictionless adiabatic expansion or compression of fluid, polytrophic expansion or compression of fluid, Isothermal expansion or compression, Electrolysis.

18. What is energy process involved in ionic compound formation?

The energy process involved in ionic compound formation includes the ionization energy required to form cations and the release of lattice energy when the cations and anions come together to form an ionic bond.

19. Write the role of dipole moment in giving shape to the erythrocytes.

A prime example of quaternary dipole interaction that is vital to human health is the formation of erythrocytes. Erythrocytes, commonly known as red blood cells, are comprised of four protein

subunits and a heme molecule. For an erythrocyte to form properly, multiple steps must occur, all of which involve dipole interactions. The four protein subunits-two alpha chains, two beta chains-and the heme group, interact with each other through a series of dipole-dipole interactions which allow the erythrocyte to take its final shape. Any mutation that destroys these dipole-dipole interactions prevents the erythrocyte from forming properly, and impairs their ability to carry oxygen to the tissues of the body. So we can see that without the dipole-dipole interactions, proteins would not be able to fold properly and all life as we know it would cease to exist.

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