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SUBJECT : PHYSICAL CHEMISTRY

Q1.) Define Open and Closed systems with examples?

A1.) **Open System**

An **open system** exchanges both energy and matter with its surroundings. This means that both resources (like heat, light, water, etc.) and substances can flow in and out freely.

**Examples of Open Systems:**

* **A boiling pot of water without a lid:** Heat from the stove enters the pot, and water vapor escapes into the air.
* **A car engine:** Fuel and air enter the engine for combustion, and exhaust gases exit as byproducts.
* **Human body:** We consume food and oxygen and release carbon dioxide, water, and waste. Energy flows in and out as well.

**Closed System**

A **closed system** allows the exchange of energy but not matter with its surroundings. In this case, only energy (like heat) can move across the system’s boundary, while the matter inside remains constant.

**Examples of Closed Systems:**

* **A closed water bottle:** If the bottle is sealed, heat can transfer through the bottle’s walls, but no water or air escapes or enters.
* **Earth (in terms of matter):** Earth receives solar energy and loses some heat to space but generally doesn’t exchange significant amounts of matter with its surroundings (except for minor meteoritic material).
* **Thermos flask:** While it minimizes energy exchange, a well-designed thermos allows minimal heat transfer but doesn’t allow the liquid inside to mix with outside air.

Q2.) differentiate between thermodynamic system and surroundings?

A2.) **Thermodynamic System**

A **thermodynamic system** is the specific part of the universe we are focusing on or studying. This system can be a defined quantity of matter or a defined space where energy and matter interact. The system is separated from the rest of the universe by boundaries that may be real or imaginary.

**Surroundings**

The **surroundings** (or environment) refer to everything outside the system’s boundaries. This includes all space, matter, and energy outside the system that can interact with it.

Q3.) define the term intensive and extensive properties with example?

A3.) **Intensive properties** are properties that do *not depend on the amount of matter* in the system. They remain the same regardless of the system's size or extent.

**Examples of Intensive Properties:**

* **Temperature**: The temperature of a cup of water remains the same whether it's in a small cup or a large pot.

**Extensive Properties**

**Extensive properties** are properties that *depend on the amount of matter* in the system. These properties are proportional to the size, mass, or volume of the system, so they change when the system’s scale changes.

**Examples of Extensive Properties:**

* **Mass**: The mass of water increases if you have more of it.

**Q4**.) state first law of thermodynamics?

A4.) The **First Law of Thermodynamics** is a statement of the conservation of energy principle, which says that energy cannot be created or destroyed, only transformed or transferred.

Q5.) explain the physical significance of entropy?

A5.) The **physical significance of entropy** is that it measures the degree of disorder or randomness in a system. In thermodynamics, it reflects the tendency of energy to spread out and disperse, making processes naturally progress toward states of higher entropy. This is why systems move from ordered to disordered states (like ice melting into water), and why the **Second Law of Thermodynamics** states that the total entropy of an isolated system always increases, guiding the direction of natural processes.

Q6.) explain isothermal and adiabatic processes?

A6.) **Isothermal Process**

An **isothermal process** is a thermodynamic process in which the temperature of the system remains constant throughout. For this to happen, the system must exchange heat with its surroundings to compensate for any work done, keeping the internal energy constant (for ideal gases).

**Adiabatic Process**

An **adiabatic process** is a thermodynamic process in which no heat is exchanged with the surroundings. In an adiabatic process, any change in the system’s energy results only from work done on or by the system, causing the temperature of the system to change.

Q7.) explain internal energy and enthalpy of a system?

A7.) **Internal Energy (U)**

**Internal energy** is the total energy contained within a system due to the microscopic motion and interactions of its particles. It includes kinetic energy from particle motion (vibrations, rotations, translations) and potential energy from intermolecular forces.

**Enthalpy (H)**

**Enthalpy** is a measure of the total heat content of a system at constant pressure. It is defined as the sum of the internal energy and the product of pressure and volume:

H=U+PV

Enthalpy is particularly useful when analyzing heat flow in processes that occur at constant pressure, as it represents the energy required to create the system and make space for it by displacing the surroundings.

Q8.) analyse gibb’s free energy in detail?

A8.) **Gibbs Free Energy (G)** is a thermodynamic potential that helps predict whether a process or chemical reaction will occur spontaneously under constant temperature and pressure. It combines the system’s enthalpy, entropy, and temperature to determine the maximum reversible work available in a process, making it a central concept in chemical thermodynamics.

**Definition of Gibbs Free Energy**

Gibbs Free Energy (G) is defined as:

G=H−TS

where:

* G is the Gibbs free energy,
* H is the enthalpy (total heat content) of the system,
* T is the temperature in Kelvin,
* S is the entropy of the system.

The Gibbs Free Energy thus combines enthalpy (which accounts for the heat content of the system) and the entropy term (TS), which accounts for the energy dispersed due to the system’s disorder.

Q9.) summerize the difference between Cp and Cv?

A9.) **Cp​ (Specific Heat at Constant Pressure)**:

* The amount of heat required to raise the temperature of a unit mass of a substance by one degree Celsius (or Kelvin) at constant pressure.

**Cv​ (Specific Heat at Constant Volume)**:

* The amount of heat required to raise the temperature of a unit mass of a substance by one degree Celsius (or Kelvin) at constant volume.

Q10.) compile the different statement of second law of thermodynamics?

A10.) **Kelvin-Planck Statement**

It is impossible to construct a perpetual motion machine of the second kind, which would convert all the heat absorbed from a heat reservoir into work without any other effect. In other words, not all the heat energy can be completely transformed into work; some energy will always be lost as waste heat.

**2. Clausius Statement**

Heat cannot spontaneously flow from a colder body to a hotter body without external work being performed on the system. This implies that natural processes tend to move towards a state of equilibrium, where energy is more evenly distributed.

**3. Entropy Statement**

In any spontaneous process, the total entropy of an isolated system will always increase or, at best, remain constant in the case of reversible processes. This means that natural processes tend to lead to an increase in disorder or randomness.

**4. Thermal Equilibrium Statement**

If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other. This leads to the concept of temperature as a measure of thermal energy distribution.

**5. Reversible Process Statement**

No real process can be reversible; every process involves some irreversibility, which contributes to an increase in entropy. This statement reinforces the idea that all natural processes are irreversible, leading to a net increase in the universe's entropy.

**6. Spontaneity and Work Statement**

For any spontaneous process, the change in Gibbs Free Energy (ΔG) is negative. This formulation connects the Second Law to chemical reactions and helps predict the spontaneity of reactions under constant temperature and pressure.