



**Unit I – Polymer Chemistry**

**1. Define polymer and polymerization.**

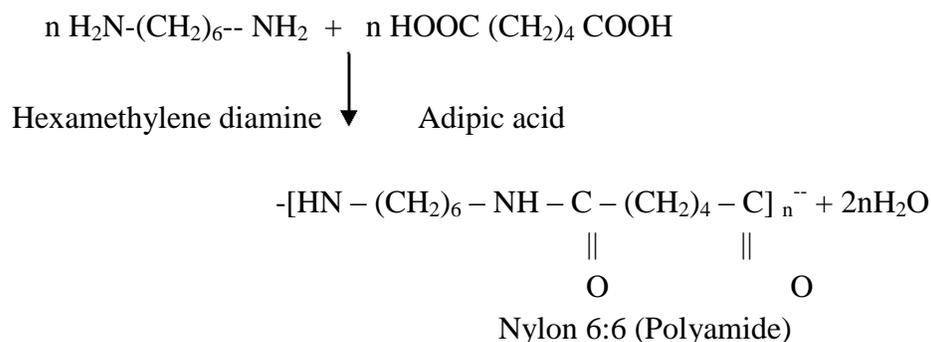
**Polymers** are macromolecules formed by repeated linkage of large number of small molecules called monomers. **Example:**



**Polymerization** is the chemical process in which large numbers of monomers combine together, to form a polymer with or without the elimination of simple molecules like water, HCl, etc.

**2. Define condensation polymerization with suitable example.**

It is a reaction between simple polar groups containing monomers that yield polymers with the elimination of small molecules like H<sub>2</sub>O, HCl, etc.



**3. Define hetero chain polymer.**

If the back bone of the polymer chain is made up of different atoms it is called hetero chain polymer, e.g., polyesters, Nylon 6:6. Polyesters contain carbon and oxygen atoms in the main chain.

**4. Explain functionality of a monomer with a suitable example.**

The number of bonding sites or reactive sites or functional groups in a monomer is known as its functionality.

CH<sub>2</sub> = CH<sub>2</sub> (ethylene) – Functionality is 2 (Two bonding sites are due to the presence of one double bond in the monomer. Therefore ethylene is a bifunctional monomer).



**5. What is degree of polymerization?**

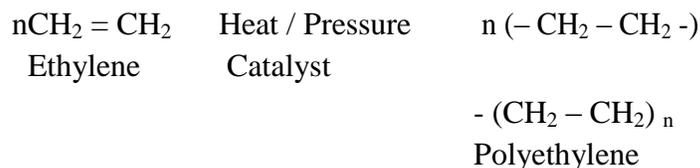
The number of repeating units (n) in a polymer chain is known as the degree of polymerization. It is represented by the following relationship,

$$\text{Degree of polymerization (n)} = \frac{\text{Molecular weight of the polymeric network}}{\text{Molecular weight of the repeating unit}}$$

**6. What is addition polymerization?**

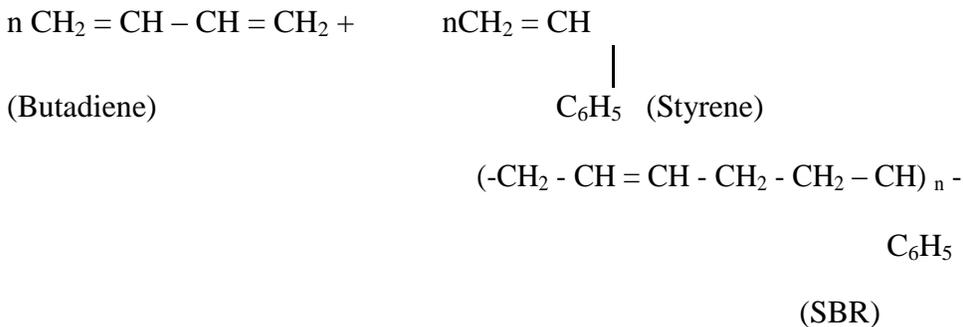
It is a reaction that yields polymer which is an exact multiple of the original monomer molecule. The monomer contains one or more double bonds. This reaction is initiated by the application of heat, light, pressure, or catalyst, for breaking down the double bonds of monomers. In addition polymerization there is no elimination of any molecule.

(e.g) Polyethylene is produced from ethylene:



**7. Explain co-polymerization with an example.**

It is the joint polymerization in which two (or more) different monomers combine to give a co-polymer. Co-polymerization is mainly carried out to vary the properties of polymers such as hardness, strength, rigidity, heat resistance, etc.



**8. Why thermosetting plastics cannot be remolded?**

Thermosetting Plastic consists of three dimensional network structure where the polymer chains are connected by strong covalent bonds by cross linking. They get hardened on heating and cannot be remolded.



### 9. What is Tacticity?

The orientation of monomeric units or functional groups in a polymer molecule can take place in an orderly or disorderly manner with respect to the main chain is known as tacticity.

### 10. Define Tg.

Glass transition temperature (T<sub>g</sub>) is the temperature at which the amorphous solid state (glassy state) is transformed to the melt state.

### 11. What is poly dispersity index?

The ratio of the weight – average molecular weight (M<sub>w</sub>) to that of number – average molecular weight (M<sub>n</sub>) is known as polydispersity index (PDI).  $PDI = M_w / M_n$

### 12. How are the polymers classified on the basis of their tacticity?

- **Iso tactic polymers**

Here functional groups are arranged on the same side of the main chain.

- **Syndio tactic polymers**

Here functional groups are arranged in an alternating fashion.

- **A tactic polymers**

Here functional groups are arranged randomly.

### 14. What are the advantages of solution polymerization?

- Exothermic heat evolved during polymerization is controlled easily.
- Viscosity built up is negligible.
- The mixture can be agitated easily.

### 15. What are the factors affecting Tg?

- The value of T<sub>g</sub> depends on chain length, extent of cross linking, the barrier which hinders the internal rotation of the chain links.
- The values of T<sub>g</sub> of a given polymer varies with the rate of heating or cooling.
- Below T<sub>g</sub> the polymer is hard and brittle.



## Unit – II Thermodynamics

### 1. Define System

A system is defined as any specified portion of matter under study which is separated from the rest of the universe with a bounding surface. A system may consist of one (or) more substances.

### 2. Define Surroundings

The rest of the universe which might be in a position to exchange energy and matter with the system is called surrounding. Ex. Surroundings imply air (or) a water bath in which a system under examination is immersed.

### 3. Define Isolated System

A system which cannot exchange both energy and matter with its surroundings is called an isolated system.

**Example:** Consider a system consisting of 100ml of water in contact with its vapour in a closed vessel. Since the vessel is closed, no matter (liquid or vapour) can enter or leave the vessel. Further, if the vessel is also insulated (as shown in the fig), the vessel cannot lose or gain heat from the surroundings.

### 4. What is an Isothermal Process?

Those processes in which the temperature remains fixed are termed as isothermal processes. This is achieved by placing the system in a thermostat, i.e.  $dT=0$

### 5. Define Cyclic Processes

When the initial and final states of a system in a process are the same, the process is called a cyclic process. In this process, a system undergoes various processes and returns back to its initial state. i.e.  $dE=0, dH=0$ .

### 5. Define Intensive and extensive property

#### Intensive property

The properties which do not depend on the amount of substance but depend only on the nature of the substance present in the system are called intensive properties. **Example:** Temperature, pressure, concentration, and density.

### 6. Extensive property

The properties which depend on the amount of substance present in the system are called extensive properties.



**Example:** Mass, volume, energy, Internal energy (E), enthalpy(H), entropy(S), Free Energy(G).

### 7. Define Internal Energy Change ( $\Delta E$ )

Change in internal energy depends on initial and final states of the system and does not depend on intermediate states. Thus, the internal energy change ( $\Delta E$ ) is defined as the difference in the internal energies of initial and final states of the system. Thus,

$$\Delta E = E_{\text{final state}} - E_{\text{initial state}}$$

For Chemical reaction

$$\Delta E = E_{\text{product}} - E_{\text{reactant}}$$

### 8. Define Enthalpy

Enthalpy is defined as “the sum of internal energy and pressure-volume energy of a system under a particular set of conditions”.

$$\text{i.e. } H = E + PV \quad (1)$$

### 9. Define Enthalpy change

#### Enthalpy Change ( $\Delta H$ )

Like internal energy, enthalpy also cannot be measured, but change in enthalpy ( $\Delta H$ ) can be measured from the differences in the enthalpy of initial and final state of the system.

#### Definition

The enthalpy change ( $\Delta H$ ) is defined as the difference in the enthalpy of initial and final states of the system. Thus,

$$\Delta H = H_2 - H_1 \quad (2)$$

But for chemical reaction

Substituting the values of  $H_2$  and  $H_1$  from equation(1) to equation(2) We get

$$= (E_2 - E_1) - (P_2V_2 - P_1V_1)$$

$$\Delta H = \Delta E - P\Delta V \quad (3)$$

Equation (3) is the equation for change in enthalpy at constant pressure



**10. State the law of conservation of energy.**

The law of conservation of energy states that “ Energy can neither be created or destroyed but it can be transformed from one form to another form “.

**11. Give the mathematical expressions for the First Law of thermodynamics**

The mathematical expression of First Law of thermodynamics is

$$\Delta E = q - w \text{ (or) } dE = q - P\Delta V$$

**12. State II law of thermodynamics. Represent by a mathematical equation. Clausius**

**Statement:** It is impossible to construct a machine which will transfer heat from a lower temperature (cold body) to a higher temperature (hot body).

It is mathematically stated as

$$dS = \frac{dq_{rev}}{T} \text{ (or) } \Delta S = \frac{q_{rev}}{T}$$

**13. Define Entropy**

It is a measure of randomness or dis order ness in a molecular system

**14. Define the term ‘standard free energy’. Illustrate with an example.**

It is defined as “The free energy change for a process at 25<sup>0</sup>C in which the reactants are converted into the products in their standard states.” Thus, the value of  $\Delta G^0$  can be calculated for a reaction from the standard free energies of formation ( $\Delta G^0_f$ )

**15. Calculate the change in entropy accompanying the isothermal expansion of 4 moles of an ideal gas at 300K until its volume has increased three times.**

Entropy change in an isothermal expansion of an ideal gas

**Given:**

$$V_1 = 1, V_2 = 3; n=4; R=1.987\text{cals}$$

$$=8.733 \text{ cal}$$

**16. Define Spontaneity**

It is defined as the tendency of a process to occur naturally is called the spontaneity.

**17. How does the entropy of system changes**

1. When a gas is liquefied



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2. Ice is melted
  - (a) When a gas is liquefied, entropy decreases
  - (b) When ice is melted, entropy increases

**18. What are the conditions for a process to be spontaneous based on the relation**

$$\Delta G = \Delta H - T\Delta S.$$

$\Delta H =$  negative &  $\Delta S =$  positive

$\Delta H =$  negative &  $\Delta S =$  negative at low temperature  
 $\Delta H =$  negative &  $\Delta S =$  positive at high temperature

**19. Predict whether the following reaction is spontaneous at 25°C**



$\Delta H = 31.4 \text{ kcal/mole}$  and  $\Delta S = 32 \text{ cal/deg}$  at 25°C

We know that

$$\Delta G = \Delta H - T\Delta S$$

**Given**

$$\Delta H = 31.4 \text{ kcal}; \Delta S = 32 \text{ cal (or) } 0.032 \text{ k.cals, } T = 25 + 273 = 298 \text{ K}$$

On substituting these values in the above equation

$$\begin{aligned} \Delta G &= \Delta H - T\Delta S \\ &= 31.4 - 298(0.032) = 31.4 - 9.536 \end{aligned}$$

$$\Delta G = 21.9 \text{ k.cals.}$$

Since,  $\Delta G$  is **positive** the reaction is **non-spontaneous**.



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**20.  $\Delta G$  for a reaction at 300K is  $-16.0\text{kcal}$ ;  $\Delta H$  for the reaction is  $-10.0\text{k.cal}$ . What is the entropy change for this reaction?**

**Solution**

We know that

$$\Delta G = \Delta H - T\Delta S$$

**Given:**

$$\begin{aligned}\Delta H &= -10.0 \text{ k.cals}; \Delta G = -16.0 \text{ k.cals}; T = 300 \text{ K} \\ &= 20\text{cals.K}^{-1}\end{aligned}$$

**21. What is the influence of  $\Delta H$  and  $\Delta S$  values in the spontaneity of the reaction?**

- If  $\Delta H$  is negative and  $\Delta S$  is positive then the process will be spontaneous as  $\Delta G$  is negative.
- When both  $\Delta H$  and  $\Delta S$  are positive, at higher temperature,  $\Delta G$  will be negative and the process will be spontaneous.
- 

**22. What is Clausius inequality?**

The cyclic integral of  $\frac{\delta Q}{T}$  is always less than (or) equal to zero.

(or)

The amount of heat transferred to the system divided by its temperature is equal to or less than zero is known as clausius inequality.

**23. According to Clausius, what is  $\frac{\delta Q}{T}$  value for reversible heat engine and Irreversible heat engine.**

$$\oint \frac{\delta Q}{T} < 0$$

- (i) For reversible heat engine
- (ii) For irreversible heat engine

**24. What is Helmholtz work function (A)?**

The part of the internal energy of a system can be used at constant temperature to do useful work. This part of internal energy which is isothermally available is called work function of the system  $A = E - TS$

$$\oint \frac{\delta Q}{T} = 0$$



**25. What is the significance of free energy?**

The decrease of free energy ( $-\Delta G$ ) of a process at constant temperature and pressure is equal to the useful work obtainable from the system.

**26. Write Gibbs-Helmholtz equation? What is its application?**

Gibbs-Helmholtz equation is (or)

**Applications**

- Enthalpy change ( $\Delta H$ ) for the cell reaction can be calculated
- Entropy change ( $\Delta S$ ) can be calculated
- It is used to calculate  $\Delta H$  from values of free energy change at two different temperatures.

**27. Give the relation between (i)  $\Delta H$  &  $\Delta G$ , (ii) Emf &  $\Delta G$**

$$(ii) -\Delta G = nFE$$

**28. What is the significance of Gibbs Helmholtz equation? What are its applications.**

Significance: It relates the free energy change ( $\Delta G$ ) to the enthalpy change ( $\Delta H$ ) and the rate of change of free energy with temperature at constant pressure.

**Applications:**

- Calculation of enthalpy change ( $\Delta H$ ) for the cell reaction

1. Calculation of Emf of the cell

$$\Delta H = -nF \left[ E^\circ - T \left( \frac{\delta E^\circ}{\delta T} \right)_P \right]$$

$$E^\circ = \left[ \frac{-\Delta H}{nF} \right] + T \left( \frac{\delta E^\circ}{\delta T} \right)_P$$

2. Calculation of free energy change ( $\Delta G$ )

$$\Delta G = \Delta H - T\Delta S$$

**29. Prove that  $(\partial S/\partial P)_T = -(\partial V/\partial T)_P$**

Gibbs free energy  $G$  is defined as

$$G = H - TS$$

$$dG = dH - TdS - SdT$$

But  $H = E + PV$

$$dH = dE + PdV + VdP$$



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$$= TdS + VdP \quad (\text{since, } TdS = dE + PdV)$$

$$\text{Thus, } dG = -SdT + VdP \longrightarrow (1)$$

- If P is constant, so that  $dP=0$ , then equation (1) yields
- If T is constant, so that  $dT=0$ , then equation (1) yields
- Differentiating equation (2) w.r.to P at constant T, yields
- Differentiating equation (3) w.r.to T, at constant P yields
- It follows from equation (4) and (5) that

### 30. Write the four Maxwell relations?

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V \quad \left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$$

### 31. What is the significance of Maxwell relations

- Using these relations tedious experimental work can be reduced into simple paper and pencil exercise.
- Maxwell relations are also very useful to deduce many other thermodynamics relations viz. Clapeyron equation, thermodynamic equation of state etc.,

### 32. What is Van't Hoff isotherm . Give its relationship?

A quantitative relationship between the free energy change and equilibrium constant is known as Van't Hoff isotherm.

$$-\Delta G = RT \ln K_{eq} - RT \ln \frac{[P_C]^c [P_D]^d}{[P_A]^a [P_B]^b}$$

### 33. Give some important significance of Van't Hoff equation

- The magnitude of the equilibrium constant also depends on whether partial pressures, molar concentrations or mole fractions are used.
- Two or more equilibria can be combined in order to get a new equilibrium.
- The magnitude of the equilibrium constant depends on how the reaction is written.

(iv)

### 34. The value of equilibrium constant for a reaction is found to be 10,000 at 25°C. Calculate $\Delta G^0$ for the reaction.

We know that

$$\Delta G^0 = -RT \ln K$$

**Given:**

$K=10,000$ ;  $T=25 + 273 = 298\text{K}$ ;  $R=8.314\text{JK}^{-1}\text{mol}^{-1}$  On substituting these value in the above equation

$$\Delta G^0 = -RT \ln K$$

$$\Delta G^0 = -8.314 \times 298 \times 2.303 \log 10,000$$

$$= -5705.8 \times 4$$

$$= -22823.2\text{J/mole}$$

(or)

$$= -22823.2 \times 1.987 / 8.314$$

$$= -5456.6 \text{ cal.}$$

**35. Give the expressions for: a) integrated form of the Van't Hoff equation  
b) Gibbs-Helmholtz equation c) Van't Hoff isotherm**

- Integrated form of Van't Hoff equation

$$\log K_p^2 - \log K_p^1 = \frac{\Delta H}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$

- Gibbs-Helmholtz equation

$$-\Delta G = RT \ln K_{eq} - RT \ln \frac{[P_C]^c [P_D]^d}{[P_A]^a [P_B]^b}$$

$$\therefore \Delta G = \Delta H + T \left[ \frac{\partial(\Delta G)}{\partial T} \right]_P$$

- Van't Hoff Isotherm

### Unit – III Photo Chemistry and Spectroscopy

**1. Define Photochemistry.**

Photochemistry is the study of chemical reactions that are caused by absorption of light radiations.

**2. What are the laws of Photochemistry?**

The Grotthus-Draper law.

The Stark- Einstein law of photochemical equivalence.

Lamberts law.

Beer-Lamberts law.

**3. State Grotthus – Draper law.**

This law states that “when light falls on any substance, only the fraction of incident light which is absorbed by the substance can bring about a chemical change”. It is also called the principle of photochemical activation.



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## 4. State Stark – Einstein law.

This law states that “In the primary photochemical process (first step) each reacting molecule is activated by one quantum of effective light”. This law is also called the principle of quantum activation.

## 5. How is energy of Einstein “E” related to wavelength?

The energy E absorbed per mole of the reacting substance is given by

$$E = N_A h \nu = N_A h c / \lambda$$

$$N_A = \text{Avagadro number} = 6.023 \times 10^{23} / \text{mole}$$

$$h = \text{Planks constant} = 6.625 \times 10^{-34} \text{ joules} \cdot \text{sec}$$

$$C = \text{velocity of light} = 3 \times 10^8 \text{ m/sec}$$

$$E = \frac{6.023 \times 10^{23} / \text{mole} \times 6.626 \times 10^{-34} \text{ J} \cdot \text{sec} \times 3 \times 10^8 \text{ m/sec}}{\lambda \text{ m}} = 0.1197 \text{ J/mol} \lambda$$

## 6. Define Beer - Lamberts law.

This law states that “When a beam of monochromatic radiation is passed through a homogenous absorbing solution, the decrease in the intensity of the radiation dI with the thickness of the absorbing solution dx is directly proportional to the intensity of the incident radiation I as well as the concentration of the solution C.

## 7. What are the limitations of Beer-Lamberts law?

- Beer- Lamberts law is obeyed only if the radiation used is monochromatic.
- It is applicable only for dilute solutions.
- The temperature of the system should not be allowed to vary to a larger extent.
- It is not applied to suspensions.
  
- Deviations may contain if the solution contains impurities.
- Deviations may also occur if the solution undergoes association or dissociation.

## 8. Define Quantum yield or Quantum Efficiency.

Quantum yield ( $\Phi$ ) is defined as “the number of molecules of the substance undergoing photochemical reaction per quantum of radiation absorbed”. The quantum yield for photochemical reaction is defined as



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$$\Phi = \frac{\text{No. of molecules reacting in a given time}}{\text{No. of quanta (photons) of light absorbed in the same time}}$$

## 9. What are the causes of high quantum yield?

- The absorption of radiation in the primary step produces atoms or free radicals, which initiates a series of chain reactions.
- Formation of intermediate products which acts as catalyst.
- The reaction is exothermic so that the heat evolved may activate other molecules which react without absorption of additional radiation.
- The active molecules produced by primary absorption may collide with other molecules, thereby activating them, which in turn further activate other reacting molecules.

## 10. What are the causes of low quantum yield?

- Deactivation of the excited molecules before they form products.
- Excited molecules may lose energy by collision with non excited molecules.
- Molecules may receive insufficient amount of energy.
- Primary photochemical reaction may get reversed.
- The dissociated fragments may recombine to give reactant which results in low quantum yield.

## 11. What are primary and secondary photochemical reactions?

Primary process – the reacting molecules undergo activation by absorption of light.



Secondary process – the activated molecules undergo a photochemical change.  $A^* \longrightarrow B$

## 12. Define Photo-Sensitization.

In some photochemical reactions, the reactant molecules do not absorb radiation and no chemical reaction occurs. Certain reactions are made sensitive by the presence of small quantity of foreign substance which can absorb light and stimulate the reaction without taking part in it.



The substance which absorbs light and induces a photochemical reaction without undergoing chemical reaction is known as photosensitizer and the phenomenon is known as Photo-sensitization.

Examples:-

Atomic Photosensitisers – Mercury, cadmium, Zinc

Molecular Photosensitisers – Benzophenone, Sulphur dioxide, Uranyl sulphate.

### **13. What is quenching?**

During Photosensitization the foreign substance (sensitizer), absorbs light and gets excited. When the excited foreign substance collides with another substance it gets converted in to some other product due to the transfer of its energy to the colliding substance. This process is known as quenching.

### **14. What is fluorescence?**

Certain substances (atoms or molecules) when exposed to radiation of short wavelength (high frequency), emit light of different frequencies compared to those of incident radiations. This process is called fluorescence and stops as soon as the radiation is cut off. Actually decay period is very short i.e.  $10^{-9}$  to  $10^{-4}$  sec. The substance which exhibits fluorescence is called fluorescent substance.

Examples: - Fluorite (naturally occurring  $\text{CaF}_2$ ), Petroleum, Organic dyes like Eosin, fluorescein, Chlorophyll, Quinine sulphate solution, Vapours of Sodium, Iodine, Mercury.

### **15. What is Phosphorescence?**

Many substance (or molecules) when exposed to radiations of short wavelength (high frequency) continue to emit light for sometime ( $10^{-4}$  to few seconds) even after incident light is cut off. This phenomenon is called phosphorescence and is chiefly caused by Ultraviolet or Visible light. The substance which exhibits phosphorescence is called phosphorescent substance. Examples: - Zinc Sulphide, Alkaline earth sulphides ( $\text{CaS}$ ,  $\text{BaS}$ ,  $\text{SrS}$ ).

### **16. Define internal conversion and intersystem crossing.**

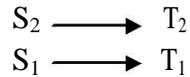
Internal conversion: - It is a type of transition which involves the return of the activated molecule from higher excited state to the lower excited state.



The energy of the activated molecule is dissipated in the form of heat through molecular collisions. This process occurs in less than about  $10^{-11}$  seconds. This is also known as non-radiative transitions



**Intersystem crossing:** - The process in which the energy of the activated molecule is lost through transition between states of different spin multiplicity.

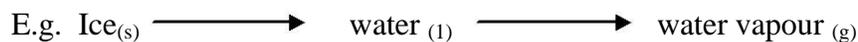


Even though these transitions are forbidden they occur at relatively slow rates.

### Unit – IV Phase Rule and Alloys

**1. Define the term component.**

A component is the „smallest number of independently variable chemical constituents, taking part in the state of equilibrium, by means of which the composition of each phase can be expressed in the form of chemical equation“



The composition of each phase is H<sub>2</sub>O, and only one component is required to describe the composition of each phase. Hence, C = 1.

**2. Illustrate the term phase with a suitable example.**

It may be defined as “any particular portion of a system, which is physically distinct, chemically homogeneous, and mechanically separable from other parts of the system, and has a specific composition and a definite boundary”.

**3. What is meant by the number of degrees of freedom?**

“It is the minimum number of independent variables such as concentration, pressure and temperature, which must be arbitrarily specified in order to represent perfectly the condition of a system”



Applying the phase rule,  $F = C - P + 2$ ; since  $C = 1$ , and  $P = 2$ ,  $F = 1$

Either the temperature or the pressure need to be stated for defining the system completely (on a line). Hence, the degree of freedom is one or system is univariant (or) mono variant.

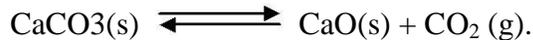
For a system consisting of water vapour only,  $F = C - P + 2$ ; since  $C = 1$ , and  $P = 1$ ,  $F = 2$ . Both temperature and pressure should be stated in order to define the system (in an area). Hence, the system is bivariant, i.e.,  $F = 2$ .



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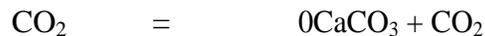
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4. How many phases, components and degrees of freedom are available in this equilibrium?



There are three components, namely,  $\text{CaCO}_3$ ,  $\text{CaO}$ , and  $\text{CO}_2$ , but the composition of each phase can be expressed in the form of a chemical equation using any two constituents. Considering  $\text{CaCO}_3$  and  $\text{CO}_2$  as components to define the system as follows:



Hence,  $C = 2$ .

Applying Phase rule  $F = C - P + 2$ ,

$$F = 2 - 3 + 2 = 4 - 3 = 1$$

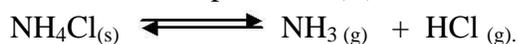
The system is Univariant.

5. Write the number of phases and components in the following heterogeneous system:



Number of Phases (P) = 3

Number of components (C) = 2



6. How many phases, components and degrees of freedom are available in this equilibrium?

The system consists of 2 Phases namely solid  $\text{NH}_4\text{Cl}$ , and a gaseous mixture containing  $\text{NH}_3 + \text{HCl}$ . When  $\text{NH}_3$  and  $\text{HCl}$  are present in equivalent amounts the composition of both the phases can be represented by the same chemical compound  $\text{NH}_4\text{Cl}$ , and hence the system will be a one component system. Hence the degrees of freedom available for this equilibrium

$$F = C - P + 2 = 1 - 2 + 2 = 1$$

7. Calculate the number of phases present in the following systems.



It involves three phases, Solid  $\text{MgCO}_3$ , solid  $\text{MgO}$ , gaseous  $\text{CO}_2$ .



b) Rhombic sulphur<sub>(s)</sub>                      monoclinic sulphur<sub>(s)</sub>

It forms two phases.

c) Ice<sub>(s)</sub>                      Water<sub>(l)</sub>                      Water vapour<sub>(g)</sub>

It forms three phases.

**8. Write the phase rule for a system at constant pressure. (Or) What is the condensed phase rule?**

Systems in which the pressure is kept constant, or those in which the vapour phase is not considered, are known as condensed or reduced systems.

For such systems, the phase rule becomes

$$F'' = C - P + 1 \quad \text{Reduced phase rule}$$

The two variables to be considered are temperature and composition.

**9. What is a eutectic mixture?**

It is a solid solution of two or more components having the lowest freezing point and a fixed composition.

**10. What is metastable equilibrium?**

Sometimes Water can be cooled below 0°C without the formation of ice, and this water is known as super-cooled water. The equilibrium between super-cooled water and the vapour is known as metastable equilibrium.

**11. What are the uses of Eutectic mixture?**

Suitable low melting alloy composition can be predicted with the help the phase diagram of eutectic systems. eg. solders used for joining two metal pieces together.

**12. Mention the applications of Phase rule.**

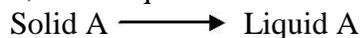
It can be applied to both physical and chemical equilibria.

It is a convenient method of classifying the equilibrium states in terms of phase, components and degree of freedom.

It helps in deciding whether the given number of components and phases remain at a particular temperature in equilibrium or not.

**13. Explain what is melting point, eutectic point and triple point.**

Melting point: It is the temperature at which the solid and liquid phases, having the same composition, are in equilibrium.



Eutectic point: It is the lowest temperature at which two solids and a liquid phase are in equilibrium.





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Triple point: It is the temperature at which three phases are in equilibrium.eg. Water system

Solid       $\longrightarrow$       Liquid       $\longrightarrow$       Vapour

**14. Classify the two component system.**

Based on the solubility and reactivity, the two component systems are classified into three types.

- Simple eutectic formation
- Formation of compound with congruent melting point.
- Formation of compound with incongruent melting point.
- Formation completely miscible solid solutions where components can be separated with fractional crystallization.
- solution solutions with maximum or minimum melting points

**Unit – V Nano Technology**

**1. What are nano particles?**

Nanoparticles are particles having size of which ranges from 1-50 nm.

**2.What are nano materials?**

Nanomaterials are the materials having components with size less than 100 nm at least in one dimension.

**3. Define nano-wires.**

Nano-wire is a material having an aspect ratio ie., length to width ratio greater than 20. They are also referred to as quantum wires.

**4. What is nano –rod?**

Nano- rod is a material having an aspect ratio in the range 1 to 20 with short dimension of the material being 10-100nm.

**5. What are nano clusters?**

Nano clusters constitute an intermediate state of matter between molecules and bulk materials .

**6. What are CNTs?**

Carbon nanotubes (CNT) are allotropes of carbon with a nanostructure having a length - to-diameter ratio greater than 1,000,000.

**7. Define nanochemistry.**

Nanochemistry is defined as the study of manipulation of materials at atomic molecular and macromolecular scales.



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**8. Name the various methods of synthesis of nano-material.**

- Laser ablation
- Chemical vapour deposition
- Precipitation
- Electro- deposition
- Thermolysis

**9. What is CVD?**

CVD is Chemical Vapour deposition. It is a process of chemically reacting volatile compound of a material with other gases, to produce a non-volatile solid that deposits automatically on a suitably placed substrate.

**10. Mention the application of Nano-wires.**

- Nano-wires are used for enhancing mechanical properties of composites.
- It is used to prepare active electronic components such as p-n junction and logic gates.

**11. What are the characteristics of Nano-rods?**

- Nano-rods are two-dimensional materials.
- It also exhibits optical and electrical properties.

**12. What is magic number?**

It is the number of atoms in the clusters of critical sizes with higher stability.

**13. Mention some uses of CNTs.**

- ✚ It is used in battery technology and in industries as catalyst.
- ✚ It is used in composites, ICs.
- ✚ CNTs are used effectively inside the human body for drug delivery.



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