ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

RESOURCES FOR

"HSC-I CHEMISTRY"

ZUEB EXAMINATIONS 2021

PREFACE:

The ZUEB examination board acknowledges the serious problems encountered by the schools and colleges in smooth execution of the teaching and learning processes due to sudden and prolonged school closures during the covid-19 spread. The board also recognizes the health, psychological and financial issues encountered by students due to the spread of covid-19.

Considering all these problems and issues the ZUEB Board has developed these resources based on the condensed syllabus 2021 to facilitate students in learning the content through quality resource materials.

The schools and students could download these materials from www.zueb.pk to prepare their students for the high quality and standardized ZUEB examinations 2021.

The materials consist of examination syllabus with specific students learning outcomes per topic, Multiple Choice Questions (MCQs) to assess different thinking levels, Constructed Response Questions (CRQs) with possible answers, Extended Response Questions (ERQs) with possible answers and learning materials.

ACADEMIC UNIT ZUEB:

2. **Constructed Response Questions (CRQs)**

HOW TO ATTEMPT CRQs:

- Write the answer to each Constructed Response Question/ERQs in the space given below it.
- Use black pen/pencil to write the responses. Do not use glue or pin on the paper.

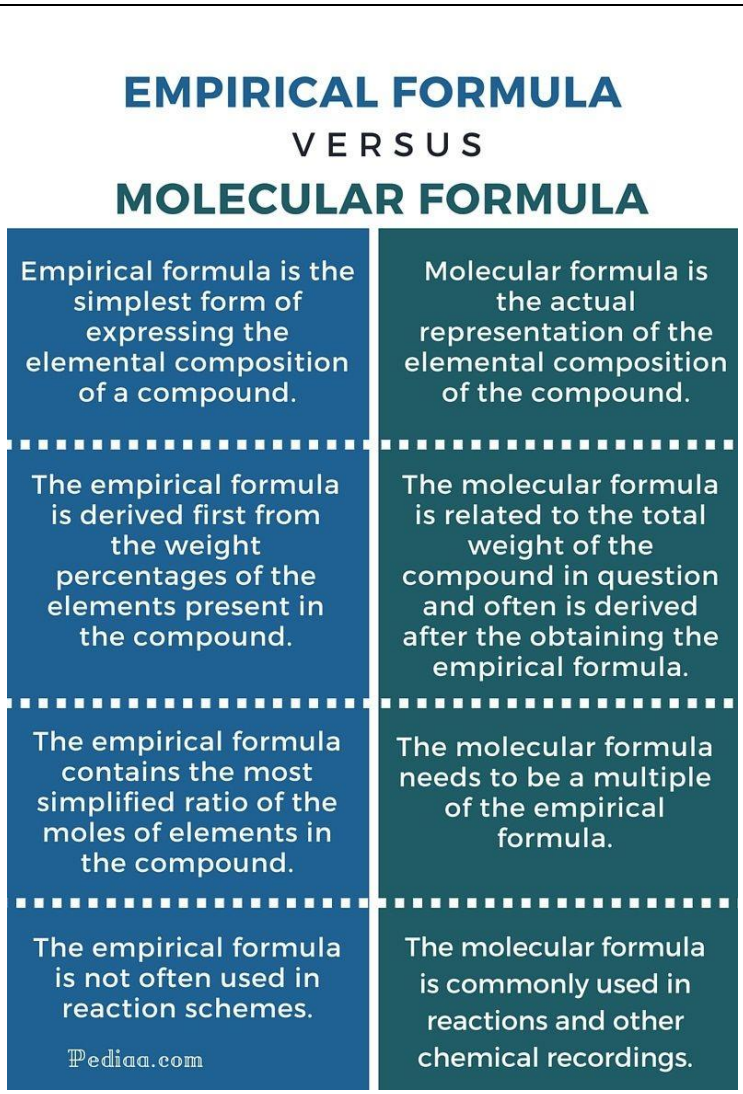
SECTION B (SHORT ANSWER QUESTIONS)

1. **What are buffers? Write their applications?**

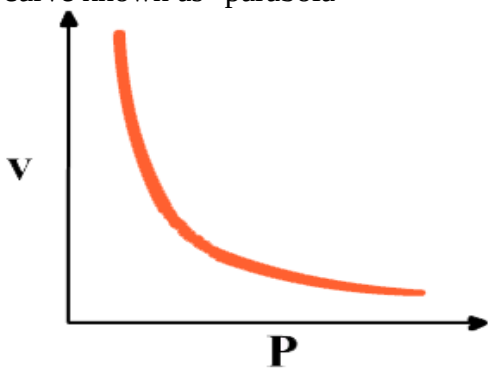
S#	CRQ	ANSWER	CL	DL
		CHAPTER 01		
1.	**Define the following?**	**<u>Significant Figures</u>**: Significant figures are the reliable digits in a number or measurement which are known with certainty. **<u>Error/Deviation:</u>** "The difference between the measured value and the actual value." **<u>Atomic Mass:</u>** "The mass of one atom of the element compared with the mass of one atom of C^{12}" Atomic mass is a ratio therefore it has no unit. Generally atoms mass is expressed in ATOMIC MASS UNIT(a.m.u). One atomic mass unit is equal to 1/12 of the mass of a C^{12} atom. **<u>Molecular Weight:</u>** It is the sum of the atomic masses of all the atoms present in a molecule. **<u>Empirical Formula:</u>** "Empirical Formula is that formula which expresses the relative number of each kind of atoms present in the molecule of a compound" OR "The formula of a compound which expresses the ratio in which atoms of different elements are combined in a molecule" **<u>Mole</u>** It is defined as atomic mass of an element, molecular mass of a compound or formula mass of a substance expressed in grams is called as mole. OR A mole is the amount of pure substance containing the same number of chemical units as there are atoms in exactly 12 grams of carbon-12 (i.e., 6.023×10^{23}). **<u>Stoichiometry</u>**(Calculation Based On Chemical Equations) **The study of relationship between the amount of reactant and the products in chemical reactions as given by chemical equations is called stoichiometry.**		

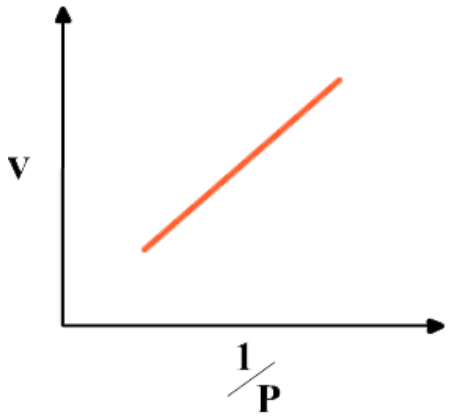
2.	**How to determine empirical formula of a compound?**	Consider an unknown compound whose empirical formula is to be determined is given to us. Now we will use the above five steps in order to calculate the empirical formula. **Step I – Determination of the Elements** By performing test it is found that the compound contains magnesium and oxygen elements. **Step II – Determination of the Masses** Masses of the elements are experimentally determined which are given below. Mass of Mg = 2.4 gm Mass of Oxygen = 1.6 gm **Step III – Estimation of the Percentage** The percentage of an element may be determined by using the formula. % of element = Mass of element x 100 Mass of compound In the given compound two elements are present which are magnesium and oxygen, therefore mass of compound is equal to the sum of the mass of magnesium and mass of oxygen. Mass of compound = 2.4 + 1.6 = 4.0 gm % Mg = Mass of element x 100 Mass of compound = 2.4 / 4.0 x 100 = 60% % O = Mass of element x 100 Mass of compound = 1.6 / 4.0 x 100 = 40% **Step IV – Determination of Mole Fraction**: Mole composition of the elements is obtained by dividing percentage of each element with its atomic mass. Mole ratio of Mg = Percentage of Mg Atomic Mass of Mg = 60 / 24 = 2.5 Mole ratio of Mg = Percentage of Oxygen / Atomic Mass of Oxygen = 40 / 16 = 2.5 **Step V – Determination of Simplest Ratio** To obtain the simplest ratio of the atoms the quotients obtained in the step IV are divided by the smallest quotients. Mg = 2.5 / 2.5 = 1 O = 2.5 / 2.5 = 1 Thus the empirical formula of the compound is MgO		

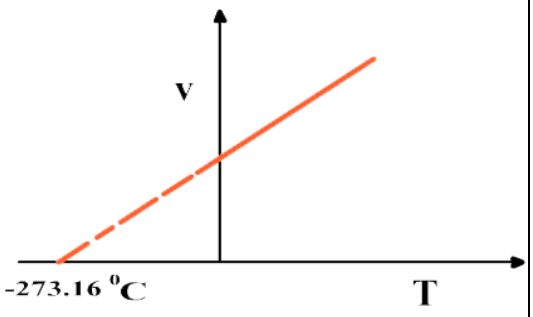
3.	**Ethylene glycol is used as antifreeze. Combustion of 6.38gm of ethylene glycol gives 9.06 gm of CO2 and 5.58 gm of H2O. Ethylene Glycol contains Carbon , Hydrogen and Oxygen find its empirical formula?**	Data : Mass of sample = 6.38gm Mass of CO2 = 9.06gm Mass of H2O = 5.58gm Empirical formula =? Elements present = C,H,O Solution : Mass of Carbon = 1 mole mass of carbon x mass of CO2/1 mole mass of CO2 = 12x9.06/44 = 2.4709 gm. Mass of Hydrogen = 2 mole mass of Hydrogen x mass of H2O /1 mole mass of H2O = 2x 5.58 / 18 = 0.62gm. % of Carbon = Mass of C x100/Mass of Sample = 38.72% % of Hydrogen = Mass of H x100/Mass of Sample =9.717% % of Oxygen = 100 – (% of Carbon + % of Hydrogen) =51.56% Mole ratio of Carbon = % of C / At. Mass of C = 3.22 Mole ratio of Hydrogen = % of H / At. Mass of H = 9.71 Mole ratio of Oxygen = % of O/ At. Mass of O = 3.22 Simple ratio of Carbon = Mole ration of C / Least mole ratio = 1 Simple ratio of Hydrogen = Mole ration of H / Least mole ratio =3 Simple ratio of Oxygen = Mole ration of O / Least mole ratio =1 **Empirical Formula = CH3O**		
4.	**Calculate the mass of CO_2 that can be obtained by heating 100 gm of limestone?**	**Solution** Step I – Write a Balanced Equation $CaCO_3 \rightarrow CaO + CO_2$ Step II – Write Down The Molecular Masses And Moles Of Reactant & Product $CaCO_3 \rightarrow CaO + CO_2$ **Method I – MOLE METHOD** Number of moles of 100 gm of CaCO3 = 100 / 100 = 1.0 mole According to equation 1 mole of $CaCO_3$ gives 1 mole of CO_2 1 mole of $CaCO_3$ will give1mole of CO_2 Mass of CO_2 = Moles x Molecular Mass = 1.0 x 44 = 44 gm **Method II – FACTOR METHOD** From equation we may write as 100 gm of $CaCO_3$ gives 44 gm of CO_2 1 gm of $CaCO_3$ will give 44/100 gm of CO_2 100 gm of $CaCO_3$ will give100 x 44 / 100 gm of CO_2 = 44 gm of CO_2.		

5.	**Write differences between empirical and molecular formula?**			

S#	CRQ	ANSWER	CL	DL
		CHAPTER 02		
6.	**Write down the main postulates of Kinetic Molecular Theory?**	**KINETIC MOLECULAR THEORY OF GASES** **MAIN POSTULATES:** **1) Size of Molecuke:** A gas consists of very small microscopic particles called 'molecules'. Depending upon the nature of gas each gas molecule may consists of an atom or group of atoms. **2) Intermolecular distances:** The molecules are wide separated from each other as compared to their own dimensions. (The diameter of a molecule is about 3×10^{-10} meter.) **3)Random Motion:** Gas molecules move in straight line in all possible directions (random movement) with various speeds. **4) Elasticity :** Gas molecules collide with each other and with the walls of container. There collisions are perfectly		

		elastic in nature. **5) Force of attraction or repulsion :** Molecules of an ideal gas exert no force of attraction or repulsion on one another except during collision. **6) Volume of gas :** The individual volume of a gas molecule is negligible as compare to the total volume of the gas **7) Kinetic Energy :** The average kinetic energy of gas molecules is directly proportional to absolute temperature.(At a given temperature, the molecules of all gases have the same kinetic energy).		
7.	**Describe Boyle's law, and also deduce its mathematical expression?**	**Boyle's law** **Introduction** Boyle's law is a quantitative relationship between volume and pressure of a gas at constant temperature. **Statement** "The volume of a given mass of a gas is inversely proportional to pressure if temperature remains constant ". Mathematical representation of Boyle's law According to Boyle's law $V \alpha 1/P$ $V = (\text{constant})(1/P)$ $PV = \text{constant}$ At P_1 pressure $P_1V_1 = \text{constant}$ ----------(1) At P_2 pressure $P_2V_2 = \text{constant}$ ----------(2) Comparing (1) &(2) $P_1V_1 = P_2V_2$. "At constant temperature, the product of pressure and volume of a gas remains constant " Graphical representation of Boyle's law Graph between P & V at constant temperature is a smooth curve known as "parabola"  Graph between 1/P & V at constant temperature is a straight line.		

		 According to kinetic molecular theory of gases the pressure exerted by a gas is due to the collisions of the molecules with the walls of the container. If the volume of a gas is reduced at constant temperature, the average velocity of the gas molecules remains constant so they collide more frequently wit the walls which causes higher pressure.		
8.	**DescribeCharle's law, and also deduce its mathematical expression?**	**Charles law** **Introduction** It is quantitative relation between volume and absolute temperature of a gas at constant pressure. **Statement** "The volume of a given mass of a gas at constant pressure is directly proportional to absolute temperature" **Second statement** "The volume of a given mass of a gas increases or decreases by 1/273 times of it's original volume at 0 ^{0}C for every degree fall or rise of temperature at given pressure." **Mathematical representation** Let the volume of a gas at T Kelvin is V Then according to Charles's law V ά T V = (constant) T V/T = constant At Initial State V_1/T_1 = k ----------(1) At Final State V_2/T_2 = k ----------(2) Thus $V_1/T_1 = V_2/T_2$ By using above equation ,Charles's law can also be stated as:		

		"The ratio of volume to absolute temperature of a gas at given pressure is always constant" Graph between Volume and absolute temperature of a gas at constant pressure is a "straight line" According to kinetic molecular theory the average kinetic energy of gas molecules is directly proportional to its absolute temperature so if the temperature of the gas is increased the average kinetic energy of the gas molecules is also increased due to which the sample of the gas expanded to keep the pressure constant. It is accordance with the law. **Absolute scale of temperature or absolute zero** If the graph between V and T is extra plotted, it intersects T-axis at -273.16 ^{0}C At -273.16 ^{0}C volume of any gas theoretically becomes zero as indicated by the graph.  But practically volume of a gas can never become zero. Actually no gas can achieve the lowest possible temperature and before -273.16 ^{0}C all gases are condensed to liquid. This temperature is referred to as absolute scale or absolute zero. At -273.16 ^{0}C all molecular motions are ceased.		
9.	**What is Avogadro's Law explain, also deduce its mathematical expression?**	**Avogadro's law** **Introduction** Avogadro's law (sometimes referred to as Avogadro's hypothesis or Avogadro's principle) is a gas law named after Amedeo Avogadro **Statement** **"Equal volumes of ideal or perfect gases, at the same temperature and pressure, contain the same number of molecules."** As an example, equal volumes of molecular hydrogen and nitrogen would contain the same number of molecules, as long as they are at the same temperature and pressure and observe ideal or perfect gas behavior **Mathematical representation** The law can be stated mathematically as: $\frac{V}{n} = k$ Where: V is the volume of the gas. n is the amount of substance of the gas. k is a proportionality constant.		

		One mole of an ideal gas occupies 22.414 litres (dm^3) at STP, and occupies 24.45 litres at SATP (Standard Ambient Temperature and Pressure = 273K and 1 atm). This volume is often referred to as the molar volume of an ideal gas. Real gases may deviate from this value.		
10.	**Derive General gas equation, and also find value of "R" in 1. In atm.dm3/mole.k 2.In J/mole.k**	**GENERAL GAS EQUATION AND EQUATION OF STATE OF A GAS** **According to Boyle's Law :** Volume of a given mass of a gas is inversely proportional to pressure if temperature remains constant . $V \alpha 1/P$ ----------(1) **According to Charles's law:** Volume of a given mass of a gas is directly proportional to absolute temperature if pressure remains constant. $V \alpha T$ ----------(2) **According to Avogadro's law:** Volume of a gas is directly proportional to no of moles. $V \alpha n$ ----------(3) Combining 1,2,and 3 $V \alpha T. 1/P. n$ $V= (constant) nT/P$ $PV/nT = constant$ Here constant is R $PV/nT = R$ Or $PV= n RT$ This is the equation of state of a gas (Ideal Gas Equation) R= Universal gas constant Value of R is equal to 0.0821.atm. dm^3/mole.k (R has different values in different systems of unit) **ANOTHER FORM:** As PV/nT = constant For initial conditions: When temperature is T_1 and pressure is P_1: $P_1V_1/T_1 = constant$ ----------(a) Similarly for final conditions: $P_2V_2/T_2 = constant$ ----------(b) From equation (a) & (b) $P_1V_1/T_1 = P_2V_2/T_2$ This is another form of ideal gas equation in terms of P, V & R		

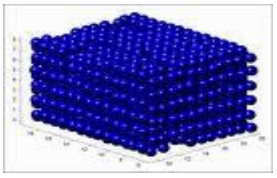
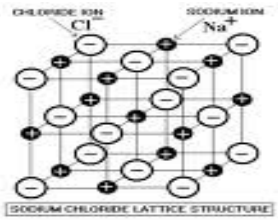
11.	**Write difference between real and ideal gas?**	<table><tr><th>Ideal gases</th><th>Real Gases</th></tr><tr><td>Ideal gases obey all gas laws under all conditions of temperature and pressure.</td><td>Real gases obey gas laws at low pressures and high temperature.</td></tr><tr><td>The volume occupied by the molecules is negligible as compared to the total volume occupied by the gas.</td><td>The volume occupied by tl molecules is not negligible compared to the total volu the gas.</td></tr><tr><td>The force of attraction among the molecules are negligible.</td><td>The force of attraction are negligible at all temperatu and pressures.</td></tr><tr><td>Obeys ideal gas equation PV=nRT</td><td>Obeys Van der Waals equa $\left(P + \frac{an^2}{V^2}\right)(V-nb) = nRT$</td></tr></table>		
12.	**Write a note on Viscosity?**	**Viscosity** **The internal resistance in the flow of a liquid is calledviscosity.** Liquids have the ability to flow, but different liquids have different rates of flow. Some liquids like honey mobil oil etc. flow slowly and are called viscous liquids while ether, gasoline etc. which flow quickly are called less viscous. **Explanation** The viscosity of liquid can be understood by considering a liquid in a tube, a liquid in a tube is considered as made up of a series of molecular layer. The layer of the liquid in contact with the walls of the tube remains stationary and the layer in the center of the tube has highest velocity as shown. Each layer exerts a drag on the next layer and causes resistance to flow. **Factors on Which Viscosity Depends** **1. Size of Molecules** The viscosity of a liquid depends upon the size of its molecules. If the size of the molecules is bigger the viscosity of the liquid is high. **2. Shape of Molecules** Shape of the molecules affects the viscosity. If the shapes of the molecules are spherical they can move easily but if the shapes of the molecules are irregular such as linear or trigonal then the molecules will move slowly and its viscosity will be high. **3. Intermolecular Attraction** If the force of attraction between the molecules of a liquid is greater the viscosity of the liquid is also greater. **4. Temperature** Viscosity of a liquid decreases with the increase of temperature. **Units of Viscosity** Viscosity of a liquid is measured in poise, centipoise or millipoise& S.I unit. is $N.S/m^2$ 1 poise = 1 $N.s.m^{-2}$		

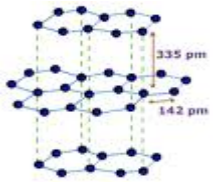
		1 centipoise = 10^{-2} N.s.m^{-2}		
13.	**Write a note on Surface tension?**	**Surface Tension** **Definition** **The force acting per unit length on the surface of a liquid at right angle direction is called surface tension.** Surface tension = force/length $\gamma = F/L$ **2nd Definition** **"Energy per unit area on the surface of a liquid is called SURFACE TENSION"** **γ = energy /area** **Explanation**  Consider a liquid is present in a beaker. The molecules inside the liquid are surrounded by the other molecules of the liquid. So the force of attraction on a molecule is balanced from all direction. But the force of attraction acting on the molecules of the surface from the lower layer molecules is not balanced. The molecules lying on the surface are attracted by the molecules present below the surface Due to this downward pull the surface of the liquid behave as a membrane which tends to contract to a smaller area and causes a tension on the surface of the liquid known as surface tension. **Factors on Which Surface Tension Depends** **1. Molecular Structure of the Liquid** If the force of attraction between the molecules is greater, the surface tension of the liquid is also greater. Those liquids in which hydrogen bond formation take place will have more surface tension. **2. Temperature** Surface tension of a liquid is inversely proportional to the temperature. **3. Hydrogen bonding** Liquids that have H-bond such as water, have high values of surface tension. **4. Pressure** Increase of pressure on the surface of a liquid increases the surface tension. Such effects are not large. **Units** Unit of surface tension · N/m (in S.I system) · Dyne/cm (in C.G.S system)		

		· Joule/m^2 (in S.I system) · Erg/cm^2 (in C.G.S system)		
14.	**Steam produces severe burns, then boiling water, although both have same temperature?**	**Scientific Reasons** Both steam and boiling water have the same temperature i.e. 100 ^oC. But heat content of steam is greater than the boiling water because latent heat of steam is 2.26 x 105 J/kg .That's why steam produces severe burn as compared to boiling water.		
15.	**Evaporation causes cooling?**	Temperature is the measurement of average kinetic energy of molecules. As liquid evaporates high kinetic energy molecules escape from the liquid and lowers the average kinetic energy molecules remain in the liquid. Due to this reason temperature falls down.		
16.	**In mountain areas food takes longer time to cook?**	Boiling point of a liquid depends on the outer atmospheric pressure. At normal atmospheric pressure boiling point of water is 100 ^0C. on mountain areas such as Quetta and Swat, atmospheric pressure is below 760 torr. Due to this reason B.P of water decreases and food takes longer time to cook.		
17.	**Glycerin distilled at 290 ^0C but it decompose at this temperature, how would you distilled it?**	At 760 torr, B.P of glycerin is 290 ^0C but at 290 ^0C temperature glycerine evaporates and it became difficult to distill it. In order to overcome this difficulty it is distilled at 50 torr . At 50 torrit's B.P decreases to 210 ^0C. At 210 ^0C it does not decompose and distilled easily.		
18.	**Evaporation of a liquid is accelerated on heating?**	Rate of evaporation increases with the increase in temperature because on heating kinetic energy of molecules becomes high enough to overcome intermolecular forces of attraction. Thus number of molecules leaving the liquid surface is increased. So the rate of evaporation increases on heating.		
19.	**Falling drop of liquid is spherical?**	Falling drop of a liquid is always spherical in shape due to surface tension. The inward forces on the surface molecules of the liquid droplet tend to cause the surface to volume ratio as small as possible. Since surface to volume ratio is minimum for the spherical shape that's why falling drop of a liquid is spherical.		
20.	**Under similar conditions surface tension of water is higher than the surface tension of ether?**	Surface tension depends upon the strength of intermolecular forces of attraction. Water has higher surface tension due to polar nature of its molecules. In water there exist hydrogen bond as compared to ether, which is non-polar and has no hydrogen bond. We know that hydrogen bond increases intermolecular attraction. Consequently water has high surface tension.		

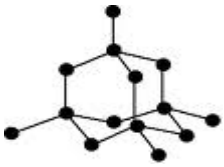
21.	**What is Solid state? Describe its properties?**	**Solid State** It is a state of matter which posses both definite shape and definite volume. In solids the particles are very close to each and tightly packed with a greater force of attraction. **Properties of Solids** **1. Diffusibility** Diffusion also occurs in solids but its rate is very slow. If a polished piece of zinc is clamped with a piece of copper for a long time. After few years we will see that some particles of zinc are penetrated into copper and some particles of copper are penetrated into zinc. It shows that the diffusion in solids is possible but it occurs with a slow rate. **2. Compressibility** In solids the molecules are close to each other so it is not easy to compress a solid. In other words we can say that the effect of pressure on solids is negligible. **3. Sublimation** It is a property of some solids that on heating these solids are directly converted into vapours without liquification. This property of solids is known as sublimation. **4. Melting** When solids are heated, they are changed into liquids and the property is called melting of the solids. **5. Deformity** Solids may be deformed by high pressure. When a high pressure is applied on solids due to which some particles are dislocated the force of attraction is so strong that the rearranged atoms are held equally well with their new neighbours and hence the solid is deformed.		
22.	**What are the types of Solids? And also distinguish between them?**	**Classification of Solids** Solids are classified into two main classes. 1. Crystalline 2. Amorphous **1. Crystalline Solids** In a solid if the atoms are attached with each other with a definite arrangement and it also possesses a definite geometrical shape. This type of solid is called crystalline solid. e.g. NaCl, $NiSO_4$ are crystalline solids. **2. Amorphous Solids** In these solids there is no definite arrangement of the particles so they do not have a definite shape. The particles of such solids have a random three dimensional arrangement. Examples of amorphous solids are glass, rubber, plastic etc. **Difference between Amprphous Solids and Crystalline Solids** The properties of crystalline and amorphous solids are quite different from each other. These differences in properties are given below:		

Property	Amorphous Solids	Crystalline Solids
Geometry	In amorphous solids particles are present without any definite arrangement so they do not have definite shape.	In crystalline solids particles are arranged in a definite order due to which it possesses a definite structure.
Melting Point	Amorphous solids melts over a wide range of temperature.	Crystalline solids have sharp melting point due to uniform arrangement.
Cleavage and Cleavage Plane	Amorphous solids do not break up into smaller pieces with an identical shape.	When a big crystal is broken down into smaller pieces the shape of the smaller crystals is identical with the bigger crystal. This property of crystalline solids is called cleavage and the plane from where a big crystal is broken is called cleavage plane
Anisotropy & Isotropy	In amorphous solids the physical properties are same in all directions. This property of solids is called isotropy.	It is a property of crystalline solid that they show different physical properties in different direction. For example graphite can conduct electric current only through the plane which is parallel to its layers. This property is called anisotropy.
Symmetry in Structure	Amorphous solids are not symmetric	Crystalline solids are symmetric in their structure when they are rotated about an axis, their appearance remains same so they are symmetric in structure

23.	**Describe various types of Crystals, and also write their characteristic properties?**	**Types of Crystals** There are four types of crystals. 1. Atomic crystals 2. Ionic crystals 3. Covalent crystals 4. Molecular crystal **1. Atomic Crystals** Metals are composed of atoms. These atoms are combined with each other by metallic bond and the valency electrons in metals can move freely throughout the crystal lattice. This type of solid is called atomic crystal. **Properties**  The properties of atomic crystals are 1. High melting point. 2. Electrical and thermal conductivity. 3. These are converted into sheets so these are malleable. 4. These are used as wire so these are ductile. **2. Ionic Crystals** Those solids which consists of negativity and positively charged ions held together by strong electrostatic force of attraction are called ionic crystals. **Properties** Ionic crystalline solids possess the following properties. 1. The melting and boiling point of ionic crystals is high. 2. They conduct electricity in molten state. 3. Ionic crystals are very hard. 4. Indefinite growth of crystals is also a property of ionic crystals. **3. Covalent Crystals** In covalent solids, the atoms or molecules are attached with each other by sharing of electrons. Such type of solids are called covalent solids e.g. diamond is a covalent solid in which carbon atoms are attached with each other by covalent bond. The other examples of covalent crystals are sulphur, graphite etc. **Properties** Covalent crystals possesses the following properties. 1. High melting point. 2. High refractive index. 3. Low density.  		



Structure of Graphite



Structure of Diamond

4. Molecular Crystals

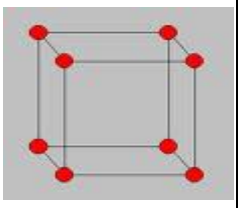
Those solid in which molecules are held together due to intermolecular forces (Vander Wall forces) to form a crystal lattice are called molecular crystals e.g. iodine and solid CO_2 are molecular crystals.

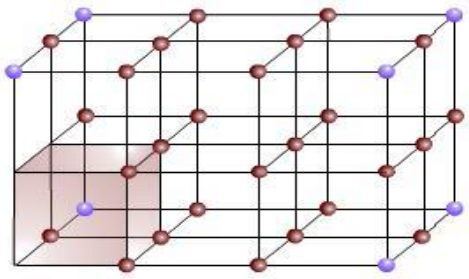
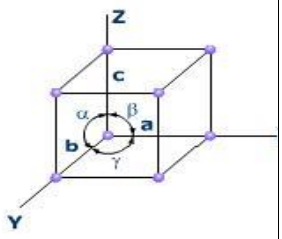
Properties

The general properties of molecular crystals are as follows.
1. Low melting and boiling point.
2. Non - conductor of heat and electricity.

Summery of Crystalline solids

Types of Solids	Constituent Particles	Nature of forces	Examples
Ionic	Positive and negative ions	Strong electrostatic forces of attraction	KCl, $BaSO_4$ KNO_3, LF
Molecular	Molecules	(I) Vander Waal's forces (ii) Dipole interaction (iii) Hydrogen bonding	I_2, CO_2(solid) HCl Ice
Covalent	Atom	Covalent bonds	Diamond, silicon
Metallic	Positive metal ions (kernels) and mobile electrons	Metallic bonds	All metals and some alloys

24.	**Define the following with example (if possible)?**	**Isomorphism** When two different substance have same crystalline structure, they are said to be isomorphous and the phenomenon is called isomorphism. **Examples:** 1) Na_2SO_4 & Ag_2SO_4 both exist in Hexagonal crystalline form. 2) $ZnSO_4$& $NiSO_4$ both exist in Orthorhombic 3) $CaCO_3$& $NaNO_3$ both exist in Trigonal **Properties of Isomorphic Substances** 1) Isomorphic substances have same atomic ratio 2) Empirical formula of isomorphic substances is same For example $CaCO_3$ $NaNO_3$&NaFMgO 1:1:3 1:1:3 1:1 1:1 3) They have different chemical & physical properties. 4) When their solutions are mixed, they form mixed type of crystals. 5) They show property over growth. **Polymorphism** If a substance exist in more than one crystalline form it is called polymorphous and the phenomenon is known as polymorphism. e.g. sulphur exist in rhombic and monoclinic form similarly $CaCO_3$ exist in trigonal and ortho--rhombic form. **UNIT CELL** Crystals made of very small basic patterns or arrangements of atoms or molecules or ions .These basic patterns are joined together to form a crystal.Theses basic patterns are known as "UNIT CELL". All the unit cell of a crystal are identical. **Characteristics of unit cell**  1.A unit cell has a definite shape. 2.Length of edges of a unit cell are definite. 3.Angle between the edges are definite. 4.All unit cells of a substance always contain equal numbers of atoms or molecules or ions **Crystal Lattice** In crystalline solids atoms, ions or molecules are arranged in a definite order and form a three dimensional array of particles which is known as crystal lattice.		

		 Representation of space lattice and unit cell  Representation of dimen of a unit cell		

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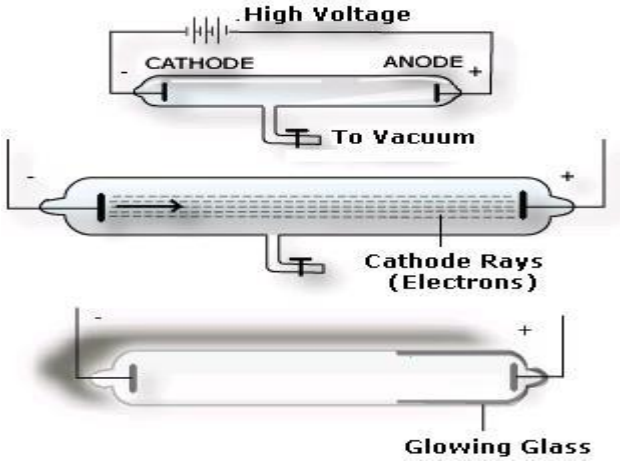
		CHAPTER 03		
25.	**How negative charge particle was discovered through discharge tube experiment?**	**Introduction** The first of the subatomic particles to be discovered was electron. The knowledge about the electron was derived as a result of the study of the electric discharge in the discharge tube by J.J. Thomson in 1896. This work was later extended by W. Crooke  **<u>Working of Discharge Tube & Observations</u>** When a very high voltage about 10,000 volts is applied between the two electrodes, no electric discharge occurs until the part of the air has been pumped out of the tube. When the pressure of the gas inside the tube is less than 1 mm, a dark space appears near the cathode and thread like lines are observed in the rest of 0.01 mm Hg it fills the whole tube. The electric discharge passes between the electrodes and the residual gas in the tube begins to glow. These rays which proceed from the cathode and move away from it at right angle in straight lines are called cathode rays **<u>CONCLUSION:</u>** Different scientist tried different discharge tubes with different electrodes and different gases but results of all the experiment gave same value for charge to mass ratio. This shows that there is something common in all materials. It was concluded that the negatively charge particles electrons and the positively charge particles protons are the fundamental particle of every atom.		

26.	**Write properties of Cathode and Canal rays?**	**Properties of Cathode Rays** • They travel in straight lines away from the cathode and produce shadow of the object placed in their path. • The rays carry a negative charge. • These rays can also be easily deflected by an electrostatic field. • The rays can exert mechanical pressure showing that these consist of material particle which are moving with kinetic energy. • The produce fluorescence when they strike the glass wall of the discharge tube. • Cathode rays produce x-rays when they strike a metallic plate. • These rays consists of material particle whose e/m resembles with electron. • These rays emerge normally from the cathode and can be focused by using a concave cathode. **Properties of Canal Rays** • These rays travel in a straight line in a direction opposite to the cathode. • These are deflected by electric as well as magnetic field in the way indicating that they are positively charged. • The charge to mass ratio e/m of positive particles varies with the nature of the gas placed in the discharge tube. • Positive rays are produced from the ionization of gas and not from anode electrode. Positive rays are deflected in electric field. This deflection shows that these are positively charged so these are named as protons.		
27.	**What is Radioactivity? Also write properties of different type of radiations emitted out radioactive source?**	**RADIOACTIVITY:** **All the elements having atomic number greater than 82 emit invisible radiation all the time. The phenomenon of emission of these powerful rays is called "Natural Radioactivity" or simply Radioactivity and the element that emits such rays is called "Radio Active Elements".** **TYPES OF RADIO ACTIVE RAYS** There are three types of radioactive rays: • **α**-Rays • **β**- Rays • **γ**- Rays **Properties of α- RAYS** 1. These rays consists of positively charged particles. 2. These particles are fast moving helium nuclei. 3. The velocity of α-particles is approximately equal to 1/10th of the velocity of light. 4. Being relatively large in size, the penetrating power of α-rays is very low. 5. They ionize air and their ionization power is high. **Properties of β- RAYS**		

1. These rays consists of negatively charged particles.
2. These particles are fast moving electron.
3. The velocity of β-particles is approximately equal to the velocity of light.
4. The penetrating power of β-rays is much greater than α-rays.
5. These rays ionizes gases to lesser extent.

Properties of γ- RAYS

1. Gamma rays do not consist of particles. These are electromagnetic radiations.
2. They carry no charge so they are not deflected by electric or magnetic field.
3. Their speed is equal to that of light.
4. These are weak ionizer of gases.
5. Due to high speed and non-material nature they have great power of penetration.

28. **What is Planks Quantum theory? Also write differences between continuous and line spectrum?**

Planck's Quantum Theory

In 1900, Max Planck studied the spectral lines obtained from hot body radiations at different temperatures. According to him,

When atoms or molecules absorb or emit radiant energy, they do so in separate units of waves called Quanta or Photons. Thus light radiations obtained from excited atoms consists of a stream of photons and not continuous waves.

The energy E of a quantum or photon is given by the relation

E = h v

Where v is the frequency of the emitted radiation and h the Planck's constant. The value of h = 6.62×10^{-27} erg. sec.

The main point of this theory is that **the amount of energy gained or lost is quantized which means that energy change occurs in small packets or multiple of those packets, hv, 2 hv, 3 hv and so on.**

CONTINEOUS SPECTRUM	**LINE SPECTRUM**
No line of demarcation	Line of demarcation
Source could be any white light	Specific gaseous source is used
Different bands of colors are shown	Specific colored lines are shown

29. **What was Heisenberg uncertainty principle? Also**

UNCERTAINTY PRINCIPLE

INTRODUCTION

In classical physics it is generally assumed that position and

	write its mathematical formula?	momentum of a moving object can be simultaneously measured exactly i.e. no uncertainties are involved in its description. But in microscopic world it is not possible. It is found that however refined our instruments there is a fundamental limitation to the accuracy with which the position and velocity of microscopic particle can be known simultaneously. This limitation was expressed by a German physicist Werner Heisenberg in 1927 and known as 'Heisenberg's uncertainty principle'. **STATEMENT** According to Heisenberg's uncertainty principle: It is impossible to determine both position and momentum of an electron simultaneously. If one quantity is known then the determination of the other quantity will become impossible. **MATHEMATICAL REPRESENTATION** Let Δx = uncertainty in position ΔP = uncertainty in momentum According to Heisenberg's uncertainty principle: The product of the uncertainty in position and the uncertainty in momentum is in the order of an amount involving h, which is Planck's constant. $\Delta P.\Delta x \geq h/2\pi$		
30.	**Write postulates of Bohr's Atomic model?**	Rutherford's model of atom fails to explain the stability of atom and appearance of the line spectra. Bohr in 1913 was the first to present a simple model of the atom which explained the appearance of line spectra. Some of the **postulates of Bohr's theory** are given below. 1. An atom has a number of stable orbits or stationary states in which an electron can reside without emission or absorption of energy. 2. An electron may pass from one of these non-radiating states to another of lower energy with the emission of radiations whose energy equals the energy difference between the initial and final states. 3. In any of these states the electrons move in a circular path about the nucleus. 4. The motion of the electron in these states is governed by the ordinary laws of mechanics and electrostatic provided its angular momentum is an integral multiple of $h/2\pi$ It can be written as $mvr = nh / 2\pi$ Here mvr becomes the angular momentum of the electron. Thus Bohr's first condition defining the stationary states could be stated as "Only those orbits were possible in which the angular momentum of the electrons would be an integral multiple of $h/2\pi$". These stationary states correspond to energy levels in the atom.		
31.	**What is Quantum number? List**	**Quantum numbers** Orbitals of electrons in atoms differ in size shape and		

<table>
<tr><td></td><td>different types of quantum numbers with their utility?</td><td>orientation. Definite energies and angular movements characterize atomic orbitals. The state of an electron in any atom is defined by certain permissible values of energy and angular momentum, which describe its location with respect to its nucleus and its energy level. These permissible states are called orbitals and are expressed by a set of four numbers 'n', 'l', 'm' and 's' called quantum numbers.
1-Principal quantum number (N)
It describe size of an atom
2- Azimuthal Quantum Number (l)
It describe shape of an orbital
3-Magnetic Quantum Number (m)
It describe division of orbital into sub orbital
4- Spin Quantum Numbers (s)
It describe spin of an electron.</td><td></td><td></td></tr>
<tr><td>32.</td><td>State Pauli’s Exclusion principle?</td><td><u>PAULI'S EXCLUSION PRINCIPLE</u>
According to Pauli's exclusion principle:
"In an atom no two electrons can have the same set of four quantum numbers."
Pauli's exclusion principle indicates that two electrons may have three same quantum numbers but the fourth quantum number must be different.
In other words Pauli's exclusion principle can also be stated as:
"An orbital cannot accommodate more than two electrons i.e. maximum number of electrons that an orbital can accommodate is two."</td><td></td><td></td></tr>
<tr><td>33.</td><td>Write down the electronic configuration?</td><td>EXPLANATION
EXAMPLE: We know that 1s-orbital contains two electrons. Their set of quantum numbers is
<table>
<tr><th>Electron</th><th>n</th><th>l</th><th>m</th><th>s</th></tr>
<tr><td>e_1</td><td>1</td><td>0</td><td>0</td><td>+1/2</td></tr>
<tr><td>e_2</td><td>1</td><td>0</td><td>0</td><td>-1/2</td></tr>
</table>
Notice that the fourth quantum number i.e. spin quantum number is different for both electrons.
* Fe^{+2} (Z = 26) No. of e =26-2 =24
$1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^4$
*S^{-2}(Z=16) No. of e = 16 +2 = 18
$1s^2,2s^2,2p^6,3s^2,3p^6$</td><td></td><td></td></tr>
</table>

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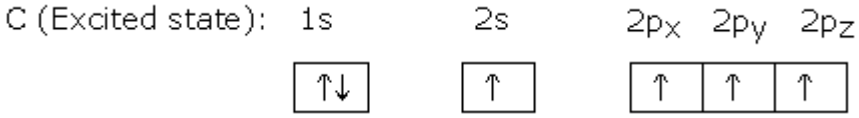
		CHAPTER 04		

34.	**What is dipole moment, discuss dipole moment of diatomic and polyatomic molecules?**	**Dipole Moment** **The product of the charge and the distance present in a polar molecules is called dipole moment and represented by μ.** **OR** **The extent of tendency of a molecule to be oriented under the influence of an electric field is called dipole moment.** **Mathematical Representation of Dipole Moment** Suppose the charge present on a polar molecule is denoted by e and the separation between the two oppositely charged poles of the molecules is d, then the product of these two may be written as $\mu = e \times d$ Where μ is dipole moment. **Dipole Moment in Diatomic Molecules** The diatomic molecules which are made up of similar atoms will be non-polar and their dipole moment is zero but the diatomic molecules made up of two different atoms e.g. HCl or Hl are polar and have some dipole moment. The value of the dipole moment depends upon the difference of electronegativities of the two bonded atom. If the difference of electronegativity between the atoms is greater, the polarity and also the dipole moment of the molecule is greater e.g. The dipole moment of HCl = 1.03 debye Whereas dipole moment of HF = 1.90 debye **Dipole Moment of Poly Atomic Molecules** In poly atomic molecules, the dipole moment of molecules depends upon the polarity of the bond as well as the geometry of the molecule. **Factors effecting Dipole Moment** Greater the polarity(Ionic Character), greater will be the dipole moment. It is also depend upon no. of lone pair of electron present around central atom of molecule. It also depend upon the geometry of the molecule.		
35.	**What is bond energy? Also describe factors effecting bond energy?**	**Bond Energy** **The amount of energy required to break a bond between two atoms in a diatomic molecule is known as Bond Energy.** **OR** **The energy released in forming a bond from the free atoms is also known as Bond Energy.** It is expressed in kilo Joules per mole or k Cal /mole. Examples		

		i). The bond energy for hydrogen molecule is $H - H_{(g)} \rightarrow 2H_{(g)}$ ..... $\Delta H = 435$ kJ/mole OR $H_{(g)} + H_{(g)} \rightarrow H - H$ ..... $\Delta H = -435$ kJ/mole It can be observed from this example that the breaking of bond is endothermic whereas the formation of the bond is exothermic. **ii. The bond energy for oxygen molecule is** $O = O_{(g)} \rightarrow 2\ O_{(g)}$ ..... $\Delta H = 498$ kJ/mole OR $O_{(g)} + O_{(g)} \rightarrow O = O$ ..... $\Delta H = -498$ kJ/mole Bond energy of a molecule also measure the strength of the bond. Generally bond energies of polar bond are greater than pure covalent bond. E.g. $Cl - Cl \rightarrow 2\ Cl$ ..... $\Delta H = 244$ kJ/mole $H - Cl \rightarrow H^+ + Cl^-$ ..... $\Delta H = 431$ kJ/mole The value of **bond energy** also depend upon **bond length**e.g , triple bonds are usually shorter than the double bond therefore the bond energy for triple bond is greater than double bond. **Factors effecting bond energy** • Shorter the bond length greater will be the bond energy. • Smaller the size of bonded atoms greater would be the bond energy. • As the multiple bonds increases, the bond length decreases therefore bond energy will be increases. Greater the ionic character in a molecule, greater would be the bond energy		
36.	**What is hybridization? Describe sp3 hybridization with example**	**Hybridization** **Introduction** The structures of different molecules can be explained on the basis of hybridization. For e.g., in case of carbon, the ground state electronic configuration is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1$. To explain the tetravalency of carbon, it was proposed that one of the electrons from 2s filled orbital is promoted to the 2p empty orbital ($2p_z$), which is in a higher energy state. Thus, four half-filled		

orbitals form in the valence shell this accounts for the bonding capacity of four carbon atoms. This state is known as excited state and the configuration of carbon in the excited state is:



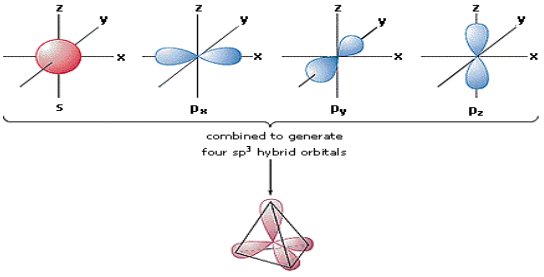
Definition:

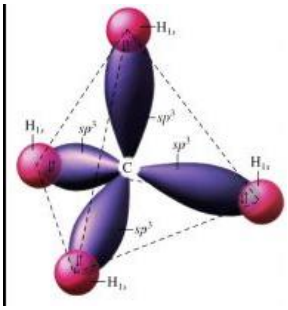
The process in which atomic orbitals of different energy and shape are mixed together to form new set of equivalent orbitals of the same energy and same shape.

There are many different types of orbital hybridization but some of the three main types are discussed below.

1. sp^3Hybridization

The mixing of one s and three p orbitals to form four equivalent sp^3 hybrid orbitals is called sp^3 hybridization. These sp^3 orbitals are directed from the center of a regular tetrahedron to its four corners. The angles between tetrahedrally arranged orbitals are 109.5°.





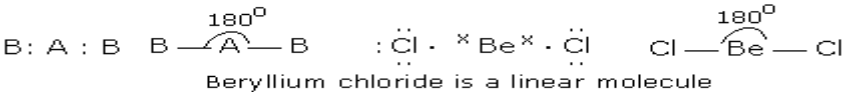
It has two partially filled 2p orbitals which indicate that it is divalent, but carbon behaves as tetravalent in most of its compounds. It is only possible if one electron from 2s orbital is promoted to an empty $2p_z$ orbital to get four equivalent sp^3 hybridized orbitals.

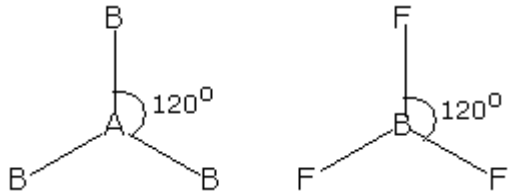
The four sp^3 hybrid orbitals of the carbon atom overlap with 1s orbitals of four hydrogen atoms to form a methane CH_4 molecule.

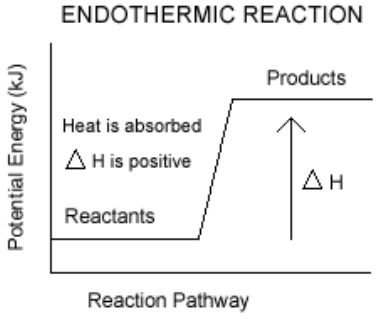
The methane molecule contains four sigma bonds and each H-C-H bond angle is 109.5°.

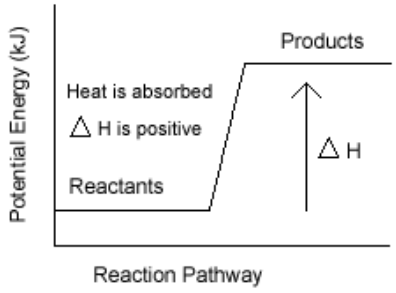
37. State differences between sigma and Pi bond?

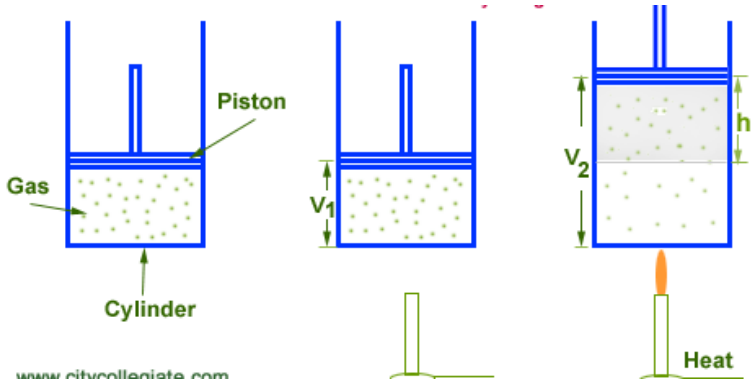
	Sigma bond	Pi bond
1	It is formed by end-to-end overlapping of half-filled atomic orbitals.	It is formed by the sidewise overlapping of half-filled *p* obitals.
2	Overlapping takes place along the inter-nuclear axis.	Overlapping takes place perpendicular to the inter-nuclear axis.
3	The extent of overlapping is large and the bond formed is stronger.	The extent of overlapping is smaller and the bond formed is weaker.
4	There is free rotation around the sigma bond and so no geometrical isomerism is possible.	There is no free rotation about the pi bond and so geometrical isomerism possible.
5	Both *s* and *p* orbitals can participate in sigma bond formation.	Only *p* orbitals participate in the formation of pi bonds.

38.	**Write postulates of VSEPR theory**	**ELECTRON PAIR REPULSION THEORY** Following are the main points of electron pair repulsion theory: 1. There are two types of electron pairs surrounding the central atom. Bond pair.& Lone pair. 2. These bond pairs are known as active set of electrons. 3. These electron pairs (bond pairs or lone pairs) repel each other. 4. Due to repulsion, electron pairs of central atom try to be as far as possible. Hence, they arrange themselves in space in such a manner that the force of repulsion between them is minimized. 5. The force of repulsion between lone pairs and bond pairs is not the same. The order of repulsion is as follows: lone pair-lone pair>lone pair-bond pair>bond pair-bond pair. 6. Pi-electron pairs are not considered as an active set of electrons. 7. The shape of molecule depends upon total number of electron pairs surrounding the central atom. For example: • If central atom has two electron pairs, geometry of molecule will be linear with bond angles of 180°. • If central atom has three electron pairs, geometry of molecule will be trigonal with bond angles of 120°. If central atom has four electron pairs, geometry of molecule will be tetrahedral with bond angles of 109.5°		
39.	**Predict the shape of molecules with respect to EPR theory?**	**Prediction of molecular geometry on the basis of VSEPR** **1-Molecules with two bond pairs** In a beryllium chloride molecule represented by the type AB_2, the central atom A has two electron pairs located on either side of it, the molecule AB_2 takes a linear geometry.  Beryllium chloride is a linear molecule **2-Molecules with three bond pairs** In a molecule having three bond pairs of electrons around its central atom, the electron pairs form an equilateral triangular arrangement around the central atom. These molecules have trigonal planar (or triangularplanar) shape and the three bond pairs are at 120°C with respect of each other. In a molecule of the type AB_3, the three bond pairs of electrons are		

		located around A in a triangular arrangement and the molecule AB_3, has a triangular planar geometry. Some molecules that show triangular planar geometry are BCl_3, BF_3, etc.  borontrifluoride is a **trigonal planar** molecule		

S#	CRQ	ANSWER	CL	DL
		CHAPTER 05		
40.	**Describe thermochemical reactions with graphical representation?**	**THERMOCHEMICAL REACTIONS:** All those chemical reactions which accompanied with mass change as well as energy change are known as thermo-chemical reactions. **TYPES OF THERMO-CHEMICAL REACTIONS:** There are two types of thermo chemical reactions: ENDOTHERMIC REACTIONS EXOTHERMIC REACTIONS **ENDOTHERMIC REACTIONS:** "All those chemical reaction in which heat is absorbed in going from reactancts to product are known as "Endothermic reactions." These reactions can not proceed without addition of heat. **For example:** $2KClO_3 + Heat \rightarrow 2KCl + 3O_2$ $CaCO_3 + Heat \rightarrow CaO + CO_2$ **GRAPHICAL REPRESENTATION**  **EXOTHERMIC REACTION** All those chemical in which heat is realeased in going from reactant to product are known as exothermic reactions. **For example**: $3H_2 + N_2 \rightarrow 2NH_3 + Heat$ $2SO_2 + O2 \rightarrow 2SO_3 + Heat$		

		GRAPHICAL REPRESENTATION ENDOTHERMIC REACTION  		
41.	**Define the following?**	**DEFINITIONS:** **SYSTEM:** 'A specified part of the universe which is under investigation is called the system'. The system is separated from the rest of the universe by a definite (real or imaginary) boundary. **OR** A thermodynamic system is that part of universe which is under thermodynamic study. **FOR EXAMPLE:** 1. A BALLOON FILLED WITH AIR 2. A BEAKER FILLED WITH WATER **TYPES OF SYSTEM:** There are three types of thermodynamic systems. 1. Open system 2. Closed system 3. Isolated system. **OPEN SYSTEM** **A system, which can exchange matter as well as energy with the surroundings is called an open system** **CLOSED SYSTEM** **A system, which can exchange energy but not mass with the surroundings is called a closed system**. **ISOLATED SYSTEM** **A system, which can neither exchange mass nor energy with surroundings, is called an isolated system.** **Homogeneous system** A system is called homogeneous if physical properties and chemical composition are identical throughout the system. A pure gas or consistent mixture of gases e.g., an oxygen cylinder, or a pure liquid or solid in a container are examples of homogeneous systems. **Heterogeneous system** A system is said to be heterogeneous if it consists of parts separated by definite boundaries, each of which has different physical and chemical properties. A mixture of fertilizer granules (N P K) or ice with water are typical examples of		

		this system		
42.	**State First law of Thermodynamics; derive its formula in terms of PV – work done?**	**FIRST LAW OF THERMODYNAMICS** **STATEMENT** "Energy can neither be created nor destroyed but it can be changed from one form of energy to another form of energy" In other words "During any process total energy of system remains constant" **OR** "During any change the total energy of system and its surrounding remains constant . **MATHEMATICAL REPRESENTATION** Consider a thermodynamic system initially have internal energy E_1 absorbs ΔQ amount of heat from its surroundings and performs ΔW amount of work and at the same time its internal energy increases to E_2 Then according to the first law of thermodynamics: Heat supplied = increase in internal energy + work done $Q = \Delta E + W$ **PRESSURE-VOLUME WORK** Consider a cylinder fitted with a frictionless and weightless non-conducting piston of area of cross section "A" . An ideal gas is enclosed in the cylinder. Let the volume of gas at initial state is "V_1". An external pressure "P" is exerted on the piston. If we supply "q" amount of heat to the system then it will increase its internal energy by ΔE. "After a certain limit gas exerts pressure on the piston . If piston is free to move, it will be displaced by "h" and the volume of system increases from V_1 to V_2.  We know that pressure is the force per unit area i.e. $P = F/A$ OR $F = PA$ ..... (i) We also know that the work done by the gas on the piston is		

		given by: $\Delta W = F\ d$ Where d = displacement of piston = h Putting the value of F and ,we get $\Delta W = (PA)\ h$ OR $\Delta W = P\ (Ah)$ But Ah = change or increase in volume = ΔV Hence $\Delta W = P\ \Delta V$ Let us consider a cylinder fitted with a friction less position an ideal gas is enclosed in the cylinder. Then first law of thermodynamics can be written as **$Q = \Delta E + P\ \Delta V$**		

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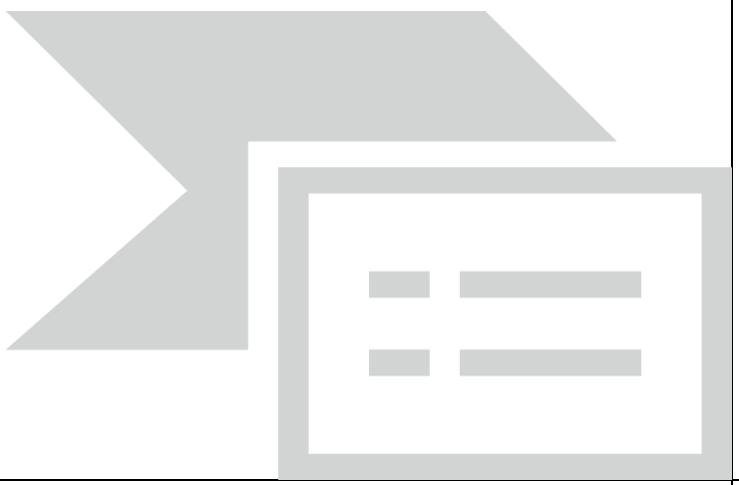
		CHAPTER 06		
43.	**What are Reversible reactions and Irreversible reactions?**	**Irreversible reactions** Chemical reactions which proceed to completion in one direction only are known as irreversible reactions. In irreversible reactions reactants are completely converted into products in a certain interval of time. In these reactions products do not form reactants again. Examples 1. $CaCO_3 \rightarrow CaO + CO_2$ 2. $CaO + H_2O \rightarrow Ca(OH)_2$ 3. $NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$ **Reversible reactions** Chemical reactions which proceed in both directions forward and backward simultaneously are known as reversible reactions. These reaction never go to completion but always continue in both directions. Examples 1. $N_2 + 3H_2 \rightleftharpoons 2NH_3$ 2. $H_2 + I_2 \rightleftharpoons 2HI$ 3. $2SO_2 + O_2 \rightleftharpoons 2SO_3$		
44.	**What is Chemical Equilibrium, explain with graph?**	**CHEMICAL EQUILIBRIUM** Reversible reactions proceed in both directions simultaneously. In a reversible reaction a state is achieved at which the rate of forward reaction becomes equal to the rate of backward reaction. This state is referred to as 'chemical equilibrium'. **EXPLANATION** Consider a reversible reaction $A + B \rightleftharpoons C + D$ in which two reactants A and B are allowed to react together.		

		• At initial stage the reaction proceeds in the forward direction only because no product is formed . • As the reaction starts A and B reacts to form C and D, Now C and D react each other to reproduce **A** and **B** and the reaction now proceeds in both forward and backward directions but the rate of forward reaction and the rate of backward reaction are different. • Finally a state is established at which the rate of backward reaction becomes equal to the rate of forward reaction. This state is called **'chemical equilibrium'**. At equilibrium state, the reaction does not stop. Reactants form products and products again converted into reactants. This process is always continue but with the passage of time, there is no change in the concentration of reactants and products due to same rate of reaction. At this point, it apparently appears as the reaction has stopped because we don't see any change in the concentration of reactants and products with time. Since chemical equilibrium continues and never go to stop, therefore, chemical equilibrium is a dynamic equilibrium. **ACTIVE MASS** Concentration of a substance expressed in mole/dm^3 or in molar unit is called ACTIVE MASS. Active mass in mole/dm^3 is represented by a square bracket [ ]. 		
45.	**What is Law of Equilibrium? Derive its mathematical formula?**	**Law Of Mass Action** According to the law of mass action. "The rate at which a substance reacts is directly proportional to its active mass " Rate α [Reactant] The rate of reaction is directly proportional to the product		

		of the active masses of reactants. Consider a general reversible reaction $A + B \rightleftharpoons C + D$ According to the law of mass action: Rate of reactionα [A][B] **<u>Determination of equilibrium constant by using equilibrium law</u>** Consider a general reaction $aA + bB \rightleftharpoons cC + dD$ According to the law of mass action Rate of forward reaction α [A]a[B]b Rate of forward reaction = $K_f [A]^a[B]^b$ Similarly, Rate of backward reaction α [C] ^{c}[D]^d Rate of backward reaction = $K_b [C]^c [D]^d$ Where K_f = rate constant for forward reaction K_b = rate constant for backward reaction a, b, c, d = number of moles At equilibrium rate of forward reaction becomes equal to the rate of backward reaction, thus, Rate of forward reaction = Rate of backward reaction $K_f[A]^a[B]^b = K_b [C]^c[D]^d$ $K_f / K_b = [C]^c[D]^d/[A]^a[B]^b$ Let $K_f/K_b = K_c$ $K_c = [C]^c[D]^d / [A]^a[B]^b$ This is the expression of equilibrium constant where c represents concentration.		
46.	**Describe the applications of Equilibrium Constatnt (Kc)?**	**<u>APPLICATION OF EQUILIBRIUM CONSTANT</u>** Knowledge of equilibrium constant for a given reaction is very helpful aid in laboratory analysis as well as in industry. Equilibrium constant of a reaction is used for two purposes: • Value of Kc is used to predict the direction of the reaction. • Value of Kc is also used to predict the extent to which a reaction occurs. **<u>To predict the direction of reaction:</u>** The value of K_c is helpful in determining the direction in which a reaction will shift in order to achieve the equilibrium. Consider a reaction Reactants $\rightleftharpoons$ Products First we determined the ratio of initial concentrations of reactants and products.		

$$\text{Ratio} = \frac{[\text{Product}]_{\text{INITIAL}}}{[\text{Reactant}]_{\text{INITIAL}}}$$

There are three possible values of this ratio when it is compared with the value of Kc.

- When ratio=K_c

According to the law of mass action, there is no shifting of reaction and there will be no change in the concentration of reactants and products and the system is already at equilibrium.

- When ratio> K_c

In this condition the reaction will shift in the backward direction to achieve equilibrium state. At equilibrium quantity of product will decrease and the quantity of reactants will increase.

- When ratio<K_c

In this condition the reaction will shift in forward direction to achieve equilibrium state. At equilibrium quantity of product will increase and the quantity of reactants will decrease.

To predict the extent of a reaction :

From the magnitude of equilibrium constant, we can predict not only the direction of a reaction but also the extent to which a reaction proceeds.

There may be three values of equilibrium constant:

- A very high value of equilibrium constant
- A very small value of equilibrium constant
- A moderate value of equilibrium constant

1)When the value of equilibrium constant is very high:

A very high value of equilibrium constant indicates that the forward is almost complete and in other words we can say that the reactants are very unstable and they react spontaneously.

For example

The equilibrium constant for the reaction $2O_3 \rightleftharpoons 3O_2$ is very large i.e. 1×10^{55}.

This indicates that the forward is almost complete and ozone (O_3) is very unstable.

2)When the value of equilibrium constant is very small:

A very small value of equilibrium constant indicates that there is very little tendency for the reaction to occur in the forward direction and in other words we can say that the reactants are very stable.

For example

The equilibrium constant for the reaction $2HF \rightleftharpoons H_2 + F_2$ is very small i.e. 1×10^{-13}.

This indicates that the forward occurs with negligible speed and hydrogen fluoride (HF) is very stable.

		3)When the value of equilibrium constant moderate: When the value of equilibrium constant is neither very high nor very small, we conclude that the reaction occurs both in forward and backward direction and equilibrium will be attained after certain period of time. **For example** The equilibrium constant for the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is 10, which is a moderate value.		
47.	**Define K_P?**	For gaseous equilibrium systems we can use partial pressure of gases instead of concentration. Therefore, "Equilibrium constant determined by using partial pressure of gases in a gaseous chemical equilibrium is denoted by K_p" Consider a general reversible reaction : $aA(g) + b\,B(g) \rightleftharpoons c\,C(g) + d\,D(g)$ For the reaction K_p is $K_p = [P_C]^c[P_D]^d/[P_A]^a[P_B]^b$ Where [P] = partial pressure of gas		
48.	**Describe relation between K_p AND K_c**	**RELATION BETWEEN K_p AND K_c** We know that Kp and K_c are related to each other as: $$K_p = K_c[RT]^{\Delta n}$$ From above relation we conclude three results as follows. **1. If $K_p=K_c$** In this case there is no change in volume For example: $H_2 + I_2 \rightleftharpoons 2HI$ In this example volumes of products are equal to the volumes reactants. **2. If $K_p>K_c$** In this case reaction occur with the increase in volume. For example: $2NH_3 \rightleftharpoons N_2 + 3H_2$ In this example volumes of products are greater than the volumes reactants. **3.If$K_p<K_c$** In this case reaction occur with the decrease in volume. For example: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ In this example volumes of products are less than the volumes reactants.		
49.	**State LE – CHATELIER's PRINCIPLE, how a stress can be applied**	**LE-CHATELIER'S PRINCIPLE STATEMENT:** **If a stress or constraint is applied to an equilibrium system, the equilibrium will shift in such a**		

	on a reaction in equilibrium?	**direction so that the effect of stress is cancelled or minimized.** In other words: **If a system at equilibrium is disturbed by some change, the system will shift in a direction to minimize or undo the effect change.** **<u>MEANING OF STRESS:</u>** Stress on equilibrium is the change in concentration or pressure or temperature. If any one of these is changed at equilibrium, the equilibrium system will disturb. In the coming lines we will discuss the effect of change in the following factors on equilibrium: 1. The effect of change in concentration 2. The effect of change in pressure 3. The effect of change in temperature 4. The effect of catalyst		

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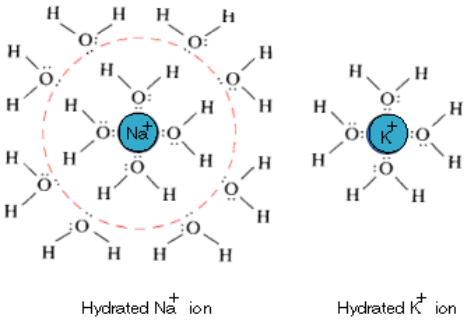
50.	**Write a note on hydrolysis?**	**<u>HYDROLYSIS</u>** **The reaction of cations or anion or both with water in which pH of water is changed, is known as HYDROLYSIS.** **OR** **Reaction of a substance with water in which pH of water is changed, is known as HYDROLYSIS.** EXPLANATION **Example #1** When ammonium chloride is treated with water following reaction takes place $NH_4^+Cl^- + H^+OH^- \rightarrow HCl + NH_4OH$ For latest information , free computer courses and high impact notes visit www.citycollegiate.com In this example products are HCl which is strong acid and NH_4OH which is a weak base. Due to this reason, pH of solution will change towards acidic nature. **Example #2** When sodium carbonate is treated with water following reaction takes place $Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$ In this example products are NaOH which is strong base and H_2CO_3(Carbonic acid) which is a weak acid. Due to this reason pH of solution will change towards basic		

		nature. **Example #3** When NaCl is dissolved in water hydrolysis does not take place because by the addition of NaCl in water, pH of water does not affected. Because of the formation of strong acid and base i.eHCl&NaOH $NaCl + H_2O \rightarrow HCl + NaOH$		
51.	**Write a note on hydration?**	**<u>Hydration & Hydrates</u>** **<u>Hydration:</u>** **When an ionic compound is dissolved in water it splits into positive and negative ions. These ions are surrounded by water molecules. The phenomenon in which water molecules surround a positive or negative ion is called 'HYDRATION'**. Hydration occurs either by the interaction of lone pairs of electrons in water with a cation or by hydrogen bonding with anions. **<u>Hydrates</u>** Many compounds have crystallized water molecules additional to that required for a simple stoichiometry. Water can be bonded to cations by coordinate bonds from oxygen or to anions by hydrogen bonds. These compounds are generally termed as 'HYDRATES'. **<u>EXAMPLES</u>** 1 $CuSO_4 \cdot 5H_2O$ 2 $Na_2CO_3 \cdot 10\ H_2O$ 3 $ZnSO_4 \cdot 7\ H_2O$ 4 $BaCl_2 \cdot 2\ H_2O$ 5 $FeSO4 \cdot 7\ H_2O$ 6 $MgCl_2 \cdot 6\ H_2O$ 7 $K_2SO_4.Al_2(SO_4)_3 \cdot 24\ H_2O$ (Potash Alum) 8 $FeSO_4.(NH_4)2SO_4 .6\ H_2O$ (Mohr's Salt)  **<u>Characteristics Of Hydration</u>** In the process of hydration: • Water molecules as a whole are linked with crystal lattice. • No H--O bond of water is broken. • New bonds are formed between water molecules and cation and anions. • It is an exothermic process. • In this process no new compounds are formed. The ability of an ion to hydrate depends upon two factors:		

		1. Magnitude of charge on the ion. 2. The size of ion. Greater is the ionic charge greater is the ability of ion to make hydrate. Smaller is the ionic size greater is the ability of ion to make hydrate. **Effect of heat on hydrates:** Many hydrates decompose on heating and loose their water of crystallization and become anhydrous.. $CuSO_4.5H_2O \rightarrow CuSO_4 + 5H_2O$		
52.	**State postulates of theory of ionization?**	**Arrhenius Theory Of Ionization** Arrhenius theory of ionization consists of the following postulates. ➢ The substance called electrolytes are believed to contain electrically charged particles called ions. These charges are positive for H+ ion or ions derived from metals and negative for the ions derived from non-metals. Number of electrical charges carried by an ion is equal to the valency of corresponding atom. ➢ Molecules of electrolytes (acids, bases and salts) dissociate into oppositely charged ions on dissolution in water, e.g. $NaCl \rightleftharpoons Na^+ + Cl^-$ $HCl \rightleftharpoons H^+ + Cl^-$ $NaOH \rightleftharpoons Na^+ + OH^-$ ➢ The number of positive and negative charges on the ions must be equal so that the solution as a whole remains neutral. ➢ In solution, the ions are in a state of disorderly or random motion. Upon colliding they may combine to give unionized molecules. Thus ionization is a reversible process in which the solution contains ions of electrolyte together with unionized molecules. $H_2SO_4(aq) \rightleftharpoons 2H^+(aq) + SO_4^{-2}(aq)$ ➢ The extent of ionization or the degree of ionization depends upon the nature of electrolyte.Strong electrolytes such as HCl etc. ionize completely in water. Weak electrolytes such as acetic acid (CH_3COOH) ionize only slightly ➢ When electric current is passed through an electrolytic solution, charges move towards their respective electrodes, i.e. cations towards anode and anions towards cathode.When these ions reached their respective electrodes, they change into neutral species by the gain or loss of electron.(Ionization is not affected by electric current.) ➢ The dissociation of electrolyte depend upon Nature of electrolyte, Degree of dilution and		

		temperature ➢ The electrical conductivity depends upon : The number of ions present in the solution and Speed of ions		
53.	**Balancing of ionic equation in acidic and basic medium?**	**EXAMPLE -01**– Balancing Redox Equations for Reactions Run in Acidic Conditions: **$Cr_2O_7^{2-}(aq) + HNO_2(aq) \rightarrow Cr^{3+}(aq) + NO_3^-(aq)$ (acidic)** **Step 1: Write the skeletons of the oxidation and reduction half-reactions.** $Cr_2O_7^{2-} \rightarrow Cr^{3+}$ (Reduction half) $HNO_2 \rightarrow NO_3^-$ (Oxidation half) **Step 2: Balance all elements other than H and O.** $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$ $HNO_2 \rightarrow NO_3^-$ **Step 3: Balance the oxygen & hydrogen atoms** $Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$ $HNO_2 + H_2O \rightarrow NO_3^- + 3H^+$ **Step 4 Balance the charge by adding electrons, e- to deficient site.** $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ $HNO_2 + H_2O \rightarrow NO_3^- + 3H^+ + 2e^-$ **Step 5 Equalize no. of electrons in both equation and add them.** $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ $3(HNO_2 + H_2O \rightarrow NO_3^- + 3H^+ + 2e^-)$ **OR** $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ $3HNO_2 + 3H_2O \rightarrow 3NO_3^- + 9H^+ + 6e^-$ **$Cr_2O_7^{2-} + 3HNO_2 + 5H^+ \rightarrow 2Cr^{3+} + 3NO_3^- + 4H_2O$** **EXAMPLE -02**– Balancing Redox Equations for Reactions Run in Basic Conditions: $MnO_4^- + CN^- \rightarrow MnO_2 + CNO^-$ (in base) **Step 1: Write the skeletons of the oxidation and reduction half-reactions.** $MnO_4^- \rightarrow MnO_2$ $CN^- \rightarrow CNO^-$		

		Step 2: Balance all elements other than H and O. $MnO_4^- \rightarrow MnO_2$ $CN^- \rightarrow CNO^-$ **Step 3: Balance the oxygen & hydrogen atoms** $MnO_4^- + 2\ H_2O \rightarrow MnO_2 + 4\ OH^-$ $CN^- + 2\ OH^- \rightarrow CNO^- + H_2O$ **Step 4 Balance the charge by adding electrons, e- to deficient site.** $MnO_4^- + 2\ H_2O + 3e^- \rightarrow MnO_2 + 4\ OH^-$ $2\ OH^- + CN^- \rightarrow CNO^- + H_2O + 2\ e^-$ **Step 5 Equalize no. of electrons in both equation and add them.** $2 \times (MnO_4^- + 2\ H_2O + 3e^- \rightarrow MnO_2 + 4\ OH^-)$ $3 \times (2\ OH^- + CN^- \rightarrow CNO^- + H_2O + 2\ e^-)$ The resulting half reactions are: $2MnO_4^- + 4\ H_2O + 6e^- \rightarrow 2MnO_2 + 8\ OH^-$ $6\ OH^- + 3CN^- \rightarrow 3CNO^- + 3H_2O + 6\ e^-$ --- **$2\ MnO_4^- + 3\ CN^- + H_2O \rightarrow 2\ MnO_2 + 2\ OH^- + 3\ CNO^-$**		
54.	**What are buffers? write their applications?**	**Buffer solution** **A solution which resists any change of pH when a small amount of a strong acid or a strong base is added to it, is called a buffer solution or simply as a buffer.** They are the solution whose pH value does not change appreciably upon the addition of small amounts of a strong acid, base and/or water from outside. Thus, buffers have reserve acidity and reserve alkalinity. **Preparation** Buffer solutions usually consist of a mixture of a weak acid and its salt with a strong base e.g., CH_3COOH and CH_3COONa, or that of a weak base and its salt with a strong acid e.g., NH_4OH and NH_4Cl. The solution of any salt of a weak acid and a weak base **Types of Buffers** There are two types of buffers, acid buffer and basic buffer. **Acid buffer** A buffer solution containing a large amounts of a weak acid, and its salt with a strong base, is termed as an acid buffer. Such buffer solutions have pH on the acidic side i.e., pH is less than 7 at 298 K. The pH of an acid buffer is given by the equation. **Basic buffer** A buffer solution containing relatively large amounts of a		

		weak base and its salt with a strong acid, is termed as a basic buffer. Such buffers have pH on the alkaline side i.e., pH is higher than 7 at 298 K. **<u>Applications of Buffers</u>** Buffers find extensive applications in a variety of fields. **1-In biochemical systems** pH plays a very significant role in biochemical reactions. For example, the blood in our bodies is buffered at a pH value of 7.36-7.42 due to bicarbonate - carbonic acid buffer. A mere change of 0.2 pH units can cause death. Certain enzymes get activated only at certain definite pH values. **2-Agriculture** The pH of the soil is very important for having proper crop yield. The soils get buffered due to the presence of salts such as carbonates, bicarbonates, phosphates and organic acids. The choice of fertilizers depends upon pH of the soil. **3-Industry** Practically all industries use buffers in one process or the other. Major industries, which employ buffers are paper, dyes, ink, paints and drugs industries. **4-Analytical chemistry** Buffers find extensive use in analytical chemistry, viz., both in qualitative and quantitative analysis. For example, qualitative analysis of Group III and Group IV is done in solutions buffered by $NH_4Cl + NH_4OH$. Buffers are used in the removal of interfering radicals such as phosphate, oxalate, borate and fluoride etc. The control of pH is very important in the field of food preservation.