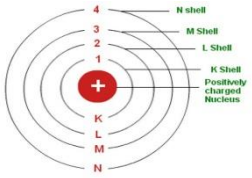
Applied Chemistry Question Bank with Solutions

(For Second Semester Diploma Engg. Students from Summer- 2025 onwards)

Unit-1 : Atomic Structure, Chemical Bonding and Solutions

Sl. No.	Question	Marks	Taxonomy level
1	Write electronics configuration of Cr and Cu^{+}?	2	L3
Ans	The electronic configuration of Cr = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$ $Cu^{+} = 1s^2\ 2s^2\ 2p^6\ 3s2\ 3p6\ 3d^{10}$	1+1	
2	Define an electrovalent bond. Give an example.	2	L2
Ans	The chemical bond which is formed by the transfer of one or more valence electrons from one atom to other is called an electrovalent bond or ionic bond. Example: NaCl (Sodium Chloride) is an electrovalenetor, ionic compound because it contains ions.	**1.5 +0.5**	
3	What is the cause of chemical combination?	2	L2
Ans	All the atoms with incomplete or unstable outer shell have a tendency to lose or gain electrons to acquire a stable electronic configuration of the nearest inert gas or noble gas. Tendency of the atoms to attain a state of minimum energy and maximum stability since net force of attraction and net decrease in energy is the criteria for the formation of the compound.	**1+1**	
4	State the Hund's rule.	2	L1
Ans	Hund's rule states that pairing of electrons does not take place in the degenerate orbitals of p, d and f subshells until each degenerate orbital is singly filled with electrons of parallel spin . Electronic configuration of nitrogen atom as per hund's rule is $N = 1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$	**1+1**	
5	What are the different types of quantum numbers?	2	L1
Ans	The different types of quantum numbers are 1.Principal quantum number(n) 2.Azimuthal quantum number(m_l) 3.Magnetic quantum number(m_s) 4.Spin quantum number(s)	**2**	
6	What are the values of lower shell (n1) and higher shell (n2) for the second line for the Balmer series in H-spectrum?	2	L2
Ans	For second line of Balmer series of hydrogen spectrum, the value n_1=2 and n_2=4.	2	
7	What are the shapes of 'p' and 'd ' orbitals ?	2	L1
Ans	The shapes of p orbital is dumb-bell and the shape of d orbital is double dumb-bell.	2	

8	Define metallic bonding.		2	L1
Ans	Metallic bonding is a type of chemical bonding that arises from electrostatic force of attraction between valence electrons and positively charged metal ions or by sharing of free electrons between several positively charged metal ions.		2	
9	Write the possible values of all the four quantum numbers for an electron in 3d orbital.		2	L2
Ans	For3d orbital, n =3, l = 2, m_l =2l + 1= (2 x 2) +1 =5 i.e, -2,-1,0,+1,+2 m_s = +1/2,-1/2		2	
10	Name the types of bonds present in a. NH_4^+ and b. $AlCl_3$		2	L2
Ans	The types of bond present in a.NH_4^+ and b. $AlCl_3$ are as follows a. NH_4^+ Both covalent and coordinate bond b. $AlCl_3^-$ Electrovalent bond		2	
11	H_2O is liquid but H_2S is gas, why?		2	L4
Ans	a.Due to small size and high electronegativity of oxygen atom, hydrogen bonding exists between H_2O molecules. So, H_2O molecules remain in associated form and hence liquid. b.But due to lesser negativity and larger size of sulphur atom. H_2S molecules do not show hydrogen bonding. So, H_2S molecules remain in isolated form and hence gas.		1+1	
12	State Heisenberg's uncertainty principle.		2	L1
Ans	Heisenberg's uncertainty principle: It is not possible to measure simultaneously both position and momentum of microscopic particle like electron with absolute accuracy. $\Delta x \times \Delta p \geq h/4\pi$ Δx = Uncertainity in position of electron Δp = Uncertainity in movementum of electron h = Planck's Constant		2	
13	What are hybridisation states of carbon atoms in CH_4 and that of nitrogen in NH_3?		2	L2
Ans	The hybridisation state of carbon atom in methane is sp3 and the hybridisation state of nitrogen atom in ammonia is sp3 .		2	
14	Write any two differences between Sigma and Pi bond?		2	L2
Ans	Sigma bond	Pi bond		
	1. A sigma bond is formed by head on overlap of s-s, s-p and p-p orbitals along the internuclear axis. 2. Sigma bond is a strong bond since orbitals overlap to greater extent.	1. A Pi bond is formed by side-wise overlap of p-p orbitals. 2. A Pi bond is a weak bond since the extent of overlap of orbitals is poor.	1+1	
15	Calculate molarity of a solution containing 2.45 gram of H_2SO_4 in 0.5 litre ?		2	L3
Ans	Given mass of solute w = 2.45 gram Volume of the solution V = 0.5 L = 500 ml We know molecular mass of H_2SO_4 is (2 * 1) + 32 + (4 * 16) =			

	98 Molarity M = (w/V) * (1000/molecular mass of the solute) M = (2.45/500) * (1000/98) = 0.05 $molL^{-1}$ Hence molarity of the given solution is 0.0.5 $molL^{-1}$		
16	**Write the postulates of Bohr's atomic model.**	**5**	**L2**
Ans	Bohr's atomic theory is based on Planck's quantum theory The main postulates of this theory as follows (a)An atom consists of massive positively charged nucleus and electrons are moving around the nucleus in a fixed circular path called orbits. (b)As long as electron moves in a particular orbit, it neither emits nor absorbs energy. The non-radiating orbits are called stationary states. (c)Each stationary states or orbit is associated with definite amount of energy. Hence orbits are called energy levels and energy shells. The shells are designated as K,L,M,N etc. (e) Different energy levels are not equally spaced. The energy between two successive energy levels goes on decreasing with increase in the value of shell. (f) Transition of electrons between two stationary states can take place by absorption or emission of the energy. The energy emitted or absorbed discontinues in the form of small packets or quants. The electronic transition occurs (i) from higher shell to lower shell by emission of energy and (ii) from lower shell to higher shell by absorption of energy The amount of energy emitted or absorbed is $\Delta E = E_2 - E_1 = h\upsilon = hc/\lambda$ Where ,E_2 = energy of higher shell E_1 = Energy of lower shell h = Planck's constant v = frequency of energy c = Velocity of light λ = wavelength  When electron jumps from lower shell to higher shell it is said to be in excited state (higher energy state) Only those orbits are permitted for the movement of electrons in which angular momentum is a whole number multiply of $h/2\pi$. $L= mvr= nh/2\pi$ Where n = 1,2,3etc and h is Planck's constant m = mass of the electron , v = tangential velocity , r = the radius of the orbit All the laws of classical physics can be applicable to electron i.e., the position, the momentum, the velocity can be calculated accurately.	**1** **1** **1** **1** **1**	

17	Give a comparison between electrovalent and covalent compounds.		5	L4
Ans	**Electrovalent compounds**	**covalent compounds.**		
	1. These are formed by complete transfer of one or more electrons from one atom to another. 2. These compounds are solids and generally good conductor of electricity in molten or solution state 3. Strong electrostatic force of attraction exists in iconic compound. 4. They have high boiling and melting points 5. These compounds are generally soluble in polar solvents like water and insoluble in organic solvent. ex- NaCl, $CaCl_2$	1. These are formed by sharing of electrons between two atoms. 2. These compounds may be solid or liquidg and generally bad conductor of electricity. or gases. 3. Weak Vander walls force of attraction exists in covalent compound. 4. They have low boiling and melting points. 5. These compounds are generally soluble in non-polar solvents like benzene and insoluble in polar solvents like water. ex- H_2O, NH_3	**1** **1** **1** **1** **1**	
18	Define hydrogen bond. What are the characteristics of the hydrogen bonding?		5	L2
Ans	Hydrogen bond is defined as force of attraction that develops between hydrogen atom of one molecule with the highly electro negative atom of another molecule of the same or different substances. **Characteristics of hydrogen bonding :** Hydrogen bonding has striking effects on the physical properties of the substances. *<u>High boiling and melting points</u>* -Compounds showing the property of hydrogen bonding have high boiling and melting points. e.g., Boiling points at HF is higher than HCl due to hydrogen bonding in HF *<u>Solubility</u>* -Compounds showing the property of hydrogen bonding are highly soluble in water. Ex: Alcohol is soluble in water due to hydrogen bonding, alkanes, alkenes are insoluble in water due to absence of hydrogen bonding. *<u>Physical state</u>* - H_2O is liquid as it remains in associated form due to hydrogen bonding but H_2S is gas as it exists in isolated form due to lack of hydrogen bonding Same is why HF is liquid and H_2S is gas - The strength of certain acids and bases are also due to hydrogen bonding. - Unique properties of ice and water are also due to hydrogen bonding.		**2** **1** **1** **1** **1**	

19	Write notes on Aufbau's principle	5	L2
Ans	According to this principle, the electrons present in various subshell are filled up in increasing order of their energies. That means a subshell with lower energy is filled up first then the subshell with higher energy. The relative energies of various subshell can be determined by (n+l)rule. This rule states that the subshell that have lower (n+l) value has lower energy hence it is filled first. When (n+l) value same for two different subshell then subshell with lower n value is filled first. Comparison between 1s and 2s subshell For 1s, n = 1 l = 0 (n+l) = 1 For 2s,n = 2 l = 0 (n+l) = 2 Hence between 1s and 2s subshell 1s is filled first, due to lower energy content as (n+l) value is less. Similarly, between 2s and 2p, 2s is filled first, due to lesser energy. For 2p, n = 2 l = 1 (n+l) = 3 For 3s ,n = 3 l = 0 (n+l) = 3 Though (n+l) value is same but 2p is filled first as 2p has lower n value. **Let's compare (n+l) values of different subshells :** **Sub Shells 1s2s 2p 3s 3p 3d 4s 4p 4d 4f 5s** n value 1 2 2 3 3 3 4 4 4 4 5 l value 0 0 1 0 1 2 0 1 2 3 0 (n+l) value 1 2 3 3 4 5 4 5 6 7 5 Hence Aufbau order of electron filling in various subshell as follows: 1s < 2s < 2p < 3s < 3p < 3d < 4s < 4p < 4d < 5s	**2** **1.5** **1.5**	
20	What are different terms used to determine the concentration of a solution? Calculate the mole fraction of both solute and solvent in the sample containing 100g of ethyl alcohol and 100gm of water.	5	L3
Ans	The different concentration terms used in solutions are Molarity , Normality , Parts per million , Mass percentage , Volume percentage & Mole fraction Problem : Given mass of ethyl alcohol C_2H_5OH = 100g Mass of water H_2O = 100g Mole fraction of C_2H_5OH = ? Mole fraction of H_2O = ? Molecular mass of C_2H_5OH = (2 * 12) + (5 * 1) + 16 = 24 + 6 + 16 = 46 Molecular mass of H_2O = (2 * 1) + 16 = 18 Number of moles of ethyl alcohol = mass of C_2H_5OH / molecular mass = 100/46 = 2.17 Number of moles of water = mass of water / molecular mass = 100/18 = 5.5 So total number of moles in the solution is 2.17 + 5.55 = 7.72 Mole fraction of solute = moles of solute / Total moles in the	**5**	

	solution = 2.17/7.72 = 0.29 Mole fraction of solvent = moles of solvent / Total moles in the solution = 5.55/7/72 = 0.71 Hence mole fraction of solute found to be 0.29 and mole fraction of solvent found to be 0.71		

Unit-2: Water

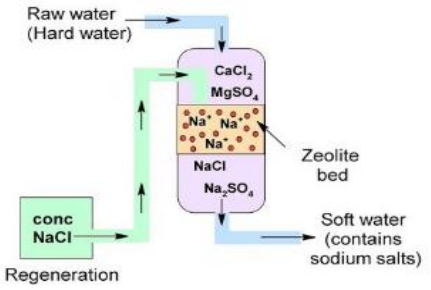
Sl. No.	Question	Marks	Taxonomy level
1	What is Temporary hardness?	2	L1
Ans	a.Hardness of water that can be removed only by boiling is known as temporary hardness. b.Temporary hardness is caused by the presence of dissolved bicarbonates of calcium and magnesium ($Ca(HCO_3)_2$, $Mg(HCO_3)_2$.	**1+1**	
2	What are the salts responsible for permanent hardness of water?	2	L1
Ans	The salts responsible for permanent hardness of water are sulphates and chlorides of calcium and magnesium. These are $CaSO_4$, $MgSO_4$, $CaCl_2$& $MgCl_2$	**1+1**	
3	Why hard water does not form lather with soap?	2	L2
Ans	Soap is the sodium salt of higher fatty acids like stearic acid, palmitic acid etc. Hard water contains bicarbonates, chlorides and sulphates of calcium and magnesium. When soap reacts with hard water , the following reaction takes place and instead of forming lather curdy white precipitate is formed.	**1.5**	
	$2C_{17}H_{35}COONa + CaSO_4/MgSO_4 \text{------} \rightarrow (C_{17}H_{35}COO)2Ca/Mg \downarrow + Na_2SO_4$	0.5	
4	Write any two units to express the hardness of water and write their formulae.	2	L1
Ans	a) Parts Per Million (ppm) The number of parts by weight of calcium carbonate present per million parts by weight of water. 1 ppm = 1 part of CaCO3/106 parts by weight of water (b) French Degree of Hardness (°Fr) Number of parts by weight of CaCO3 present in 100000 (or 105) parts by weight of water. 1 °Fr = 1 part of CaCO3/105 parts by weight of water (c) Degree Clark (0Cl) Number of parts by weight of calcium carbonate in 70000 parts by weight of water. 1 0Cl = 1 part of CaCO3/ 70,000 parts by weight of water	2	
5	Mention the reasons for the formation of corrosion in the boiler.	2	L2
Ans	The formation of corrosion in the boiler is due to the following reasons:- a) Dissolved Oxygen b) Dissolved Carbon dioxide c) Soluble salts	2	
6	What is Priming and Foaming?	2	L1
Ans	Priming: When the boiler is being steamed rapidly, some liquid water particles are mixed with the steam. This process of wet	2	

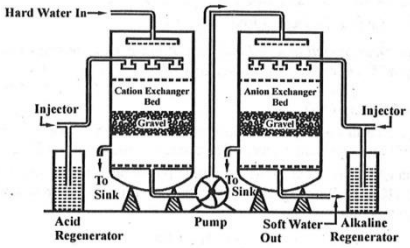
	steam formation is called priming. Foaming: Foaming is the production of persistent foam or bubbles in boilers that do not break easily. Foaming is due to the presence of substance like oils.			
7	A sample of hard water has a hardness of 450 ppm. Express the hardness in °French and °Clark.		2	L3
Ans	1 ppm = 0.1 °French, 450 ppm = 450 x 0.1 = 45 °French, 1 ppm = 0.1 °Cl, 450 ppm = 450 x 0.07 = 31.5 °Cl			
8	100ml of water sample had Temporary hardness =160mg/L. Total hardness =245mg/L. Find the permanent hardness in the water sample.		2	L3
Ans	Total hardness = Temporary hardness + Permanent hardness Permanent hardness = Total hardness – Temporary hardness = 245 mg/L – 160 mg/L = 85 mg/L		2	
9	What are Zeolites?		2	L1
Ans	a. Zeolites are crystalline, microporous, hydrated aluminosilicate materials with 3D structure.They are also called permutit. b. It is basically used to remove the hardness of water.		2	
10	Distinguish between cation-exchange and anion-exchange resins.		2	L4
Ans	**Cation exchange resins**	**Anion exchange resins**		
	1. These are positively charged and contain acidic groups like -COOH, -SO_3H etc. 2. They help to exchange the cations like Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} etc.	1. They are negatively charged and contain basic groups like -$NH_3^{+}OH$, -$N^{+}(CH_3)_3OH$ etc. 2.They help to exchange the cations like Cl^{-}, SO_4^{2-}, NO_3^{-}, PO_4^{3-} etc.	2	
11	How the temporary hardness and permanent hardness of water can be removed?		2	L2
Ans	a. The temporary hardness of water can be removed by boiling. When water is boiled, the soluble calcium and magnesium bicarbonates of the water are broken down into carbonates, which are insoluble and can be filtered out.		1	
	b. Permanent hardness of water can be removed by ion-exchange method.		1	
12	What is lime-soda process?		2	L2
Ans	Soda-lime process is a water treatment method that uses calculated quantity of soda ash (Na_2CO_3) and lime($Ca(OH)_2$) to remove the hardness of water.		1	
	There are two types of lime-soda process. a. Cold soda-lime process (carried out normally at room temperature) b. Hot soda-lime process (carried out at higher temperature i.e., 95-100 °C)		1	

13	What is the role of potash alum in the purification of muddy water?	2	L2
Ans	a. Potash alum, a double salt, works as a coagulant for the purification of muddy water.	1	
	b. It provides Al^{3+} ions, which bind with negatively charged colloidal particles of the water to settle down the mud.	1	
14	Define coagulation.	2	L1
Ans	a. It is a chemical process that requires some chemicals to neutralize the negative charged particles in water, making it more useful. b. The chemicals used for this process are called coagulant. For example, Potash alum, AluminiumSulphate, Ferric Sulphate etc.	2	
15	What is sterilization?	2	L1
Ans	a. The process of killing or removing microorganisms (pathogens) from water by use of chemicals or adoption of some technology is called sterilization. b. Use of chemicals like chlorine, chloramine, chlorine dioxide etc. or, irradiation of UV ray or, any ionizing radiations (X-ray, γ-ray) help for sterilization of water.	2	
16	What are the advantages of hot lime-soda process over cold lime-soda process?	2	L4
Ans	The advantages of hot lime-soda process over cold lime-soda process are: a. The hot lime-soda process is much faster and economical as compared to the cold lime-soda process.	1	
	b. It requires no coagulants. The percentage hardness removal is relatively more than the cold lime-soda process.	1	
17	What are ion-exchange resins? Write their applications.	2	L4
Ans	a.Ion-exchange resins are synthetic organic polymers produced in bead or granular form. b. Applications Ion-exchange resins include water softening,demineralisation,waste water treatment etc.	**1** **1**	
18	Define sedimentation. Write its importance.	2	L2
Ans	The process of separating heavier insoluble solid particles settled at bottom of a container is called sedimentation.Example: When a mixure of sand and water is left to stand,the sand settles at bottom due to sedimntation.	1	
	On account of water purificartion,sedimentation is recommended as pre-treatment of raw water before filtration	1	
19	What are the techniques adopted for softening of hard water?	2	L2
Ans	a.Lime-soda process(cold-lime soda and hot lime-soda process) b.Zeolite Process c.Ion-exchange Process d.Reverse Osmosis Process	2	
20	What is the permissible level of fluoride content in the drinking water? What happens when fluoride content exceeeds the approved permissible level in the drinking water?	2	L2

Ans	The permissible levelof fluoride content in the drinking water is 1.5 mg/l. When fluoride content exceeeds the approved permissible level in the drinking water,it causes dental and skeletal fluorsis.		2	
21	Differentiate between coagualtion and flocculation.		2	L4
Ans	coagualtion	flocculation		
	a.It is a chemical process. b.The substance used in this process is called coagulant, which is generally a salt that breaks down to give ions	a.It is a physical process b.The substance used in this process is called flocculant, which induces the particles to bind together.	2	
22	Why filtration is necessary in purification of drinking water?		2	L4
Ans	Filtration is necessary in purification of drinking water because of the follwing reasons a.It helps to remove excess hardness of water. b.Itheps to remove harmful contantinants. c.It helps to remove poisonous gases. d.It helps to remove pathogens.		2	
23	What are the different sources of water?		2	L1
Ans	Sources of water are mainly classified into two types 1.Surface Water: Eg:-water from River, sea ,Lake etc. 2.Underground Water Eg:-water from well, tube-well, spring etc.			
24	Define TDS of water.Write its unit.		2	L1
Ans	TDS:Total Dissolved Solid It is the total amount dissolved solids present in water. Its unit mg/l(i.e,ppm)		2	
25	What are the harmful effects of high levels of TDS in drinking water?		2	L4
Ans	High levels of TDS in drinking water can cause kidney stones, gastrointestinal issues, dental problem,heart diseases etc.			
26	Mention the role of EDTA in the quantitative measurement of hardness of water.		2	L4
Ans	EDTA: Ethylene Diamine Tetra acetic Acid EDTA plays as a chelating agent that binds to Ca^{2+} and Mg^{2+} ions present in water and forms stable complexes.		2	
27	How alkalinity of a water sample can be estimated?		2	L2
Ans	The alkalinity of water sample can be estimated by titrating the water sample with a known concentration of sulfuric acid to determine how much amount of acid is needed to neutralize the water. The amount of acid consumed is used to estimate the alkalinity of water sample.		2	
28	What are the characteristics of drinking water?		2	L2
Ans	The characteristics of drinking water:- a. It should be colorless, tasteless and odorless. b. It should neutral(pH =0) or slightly alkaline(pH>7).		2	

29	Why water is extensively used in many industries?		2	L2
Ans	Water is extensively used in many industries because it plays a vital role, a.***For Cooling Purposes*** : It is the most common and cheapest medium for heat exchange. b. ***For Steam Production:*** It is used to produce steam, which is further used for power generation c.***For Chemical Synthesis:*** It is used as cheapest universal solvent for synthesis of various chemicals like dyes,drugs,medicine,pesticides etc.		2	
30	Define turbidity of water. How is it measured?		2	L2
Ans	-Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particles. Water with more suspended particles appears cloudy. It is related to total suspended solids(TSS) present in water. - Turbidity of water can be measured by using Nephlo Turbidity Meter under the unit of NTU.			
31	**Difference between Sludge and Scale.**		**5**	**L4**
Ans	**Sludge**	**Scale.**		
	1. The loose and slimy precipitate deposited on inner wall of boiler is known as sludge. 2. It is softer and less permeable. 3. It is poor conductor of heat. 4.It is formed generally at the colder portion of the boiler. 5. It decreases efficiency of the boiler but are less dangerous. 6. There will be fewer chances of explosion due to sludges formation. 7. They are generally formed due to salts like $CaCl_2$, $MgCl_2$, $MgSO_4$, $MgCO_3$ in the water. 8. The precipitate can be removed by blowdown operation, scrapers and brushing	1. The hard adhering coating deposited on inner wall of boiler is known as scale. 2. It is harder and more permeable 3. It is bad conductor of heat. 4. It is formed generally at the hotter part of the boiler. 5. It decreases efficiency of the boiler and more dangerous. 6. There will be more chances of explosion due to scale formation. 7. They are generally formed due to salts like $CaSO_4$, $Mg(OH)_2$, $CaCO_3$, $CaSiO_3$, $Ca_3(PO_4)_2$, CaO. 8. The precipitate can be removed by different methods like thermal shocks, chiselling, hammer treatment along with some chemical like HCl, phosphate, carbonate, calgon, tannin, agar gel, sodium aluminate, EDTA.	1 1 1 1 1	

32	Briefly explain zeolite process of water softening? Write the disadvantages of this process.	5	L2
Ans	Zeolites are microporous, hydrated aluminosicates of sodium, potassium, calcium etc. Hence, they are used as cation exchangers.General Formula:- $Na_2O.\ Al_2O_3.xSiO_2.\ yH_2O$ For water softening process hydrated aluminosilicates of sodium is used, which can reversibly exchange its sodium ions with the cations present in the hard water	1	
	 **Fig. Zeolite Process of Water Purification**		
	Water Softening Process:- The Na^+ ions present in the zeolite get exchanged with the Ca^{2+} and Mg^{2+} present in the raw water.The water coming out of the softening tank is free from hardness causing ions, but having sodium ions $Na_2Ze + CaCl_2 \rightarrow CaZe + 2NaCl$ $NaZe + MgSO_4 \rightarrow MgZe + Na_2SO_4$		
	Regeneration of Zeolite:- When all the exchangeable Na^+ present in the zeolite gets exchanged with hardness causing ions i.e., Ca^{2+} and Mg^{2+} of the raw water, the zeolite gets exhausted and has to be regenerated by using conc. NaCl solution. $CaZe + 2NaCl \rightarrow Na_2Ze + CaCl_2$ $MgZe + 2NaCl \rightarrow NaZe + MgCl_2$		
	Disadvantages:- This process primarily exchanges cations only.It removes only hardness causing ions like Ca^{2+} and Mg^{2+} ions but not Na^+. So, the water obtained after this softening process having Na^+ can cause boiler corrosion (caustic embrittlement).		
	It is not suitable for turbid raw water because the colloidal particles present in the water can clog the micro pores of the zeolite.		
33	How hard water can be softened by ion-exchange process?	5	L2
	Removal of cations from hard water:- At first hard water is first passed through a column of cation-exchange resin in the first tank. So that all the cations (Ca^{2+}, Mg^{2+}) present in the hard water get exchanged H^+ ions of the resins.Ca^{2+} and Mg2+ ions are retained by the resin. The H+, Cl- and ions remain in the cation-free water obtained from the first tank.	2	
	Removal of anions from hard water:- The cation free water is now allowed to pass through a column	2	

	of anion-exchange resin in the second tank. So that all the anions (Cl^-, SO_4^{2-}) present in the hard water get exchanged with OH^- ions of the resin.		
	Regeneration of resins:-	1	
	When all the H+ and OH^- ions of the resins are exchanged by the ions of hard water, then the resins are said to be exhausted. The exhausted cation-exchange resin can be regenerated by the treatment of dil. HCl. Similarly, the exhausted anion-exchange resin can be regenerated by the treatment of dilNaOH.  *Fig. Demineralization of Water*		
34	Give an idea about the Indian Specification for Drinking Water.	5	L2
	The Indian Standard Specification for Drinking Water:- The following various parameters of drinking water quality have been set for public health protecttion in India. 1.**pH:** The pH of drinking water should be between 6.5 and 8.5. 2.**Turbidity:** The maximum turbidity for drinking water is 10 NTU(Nephelometric Turbidity Unit). 3.**Total hardness:** The maximum total hardness for drinking water is 300 ppm as $CaCO_3$. 4.**Calcium:** The maximum calcium content for drinking water is 75 ppm as Ca. 5.**Other parameters:** The maximum levels for other parameters include iron (0.3 ppm),copper (0.05 mg/l), manganese (0.1 ppm), sulfate (250 ppm), fluoride (0.6 to 1.2 ppm) and chloride (250 ppm) . 1ppm = 1 mg/l	1 1 1 1 1	
35	Difference between cold lime-soda process and hot lime-soda process	5	L4
	Cold lime-soda / Hot lime-soda process		
	a. It is carried ourt at room temperature (25-30°C). / a.It is carried out at high temperature(95-100°C). b.It is a slow process.i.e about 24 hrs. / b.It is a rapid process. It take about 15 minutes. c. Coagulant is required in this process. / c.No coagulant is required in this process. d. Residual hardness is 60 ppm. So, this process has low softening capacity. / d.Residual hardness is 15-30 ppm.So, this process has high softening capcity. e.Disssolved gases are not removed. / e.Dissolved gases are removed.	1 1 1 1 1	

36	What are the steps involved in municipal water treatment?	5	L2
Ans	The steps involved in municipal water treatment are: **Step-1:*Primary treatment*** This step involves collecting water from sources and removing suspended solids like dust,dirt,clay and other undissolved particles. **Step-2:*Secondary treatment*** This step removes fine solids and contaminants through coagulation, flocculation, filtration etc. **Step-3:*Tertiary treatment*** This step involves pH adjustment, disinfection,and carbon treatments. **Step-4:*Disinfection*** This step is often the final polishing step and uses ozone or UV light to protect against microorganisms **Step-5:*Storage and Distribution*** Storage usually takes place in an underground/elevated storage tanks .The stored water in the tank is sent through underground pipelines all over town by distribution system	1 1 1 1 1	
37	Write a short note on cold lime-soda process.	5	L2
Ans	A calculated quantity of lime and soda is treated with hard water at room temperature. Lime and soda react with the hardness causing chemicals present in hard water and the precipitates or sludge formed are removed by filtration. **Construction of Apparatus:-** The apparatus consists of a conical shaped steel tank, containing a rotating shaft at the middle and it also contains a wood fibre filter. **Working Process:-** A calculated quantity of lime, soda along with a little quantity of coagulant are introduced into the apparatus. When the shaft rotates water is properly mixed with lime and soda. The soluble hardness causing chemicals present in hard water react with lime and soda to form insoluble sludge. Coagulant aggregates the finely divided sludge particles which settle down in the conical sedimentation tank. The sludge is then removed from time to time through its outlet. Water is now allowed to pass through the wood-fibre filter to get soft water. The residual hardness left in this process is about 50 – 60 ppm.	2 3	
38	What are the main causes and effects boiler scaling?	5	L2
Ans	**Causes of boiler scaling:-** Boiler scaling is caused by water containing high mineral contents. The minerals like calcium and magnesium in water are responsible for scaling of the boiler. **Effects of boiler scaling:-** a. Reduces heat transfer, which can lead to increased fuel consumption.	2 3	

	b. Decreases the efficiency of boiler. c. Increases the periodical maintenance of the boiler. d. Contributes to climate change and environmental pollution.			
39	Discuss a comparative study of zeolite process and ion-exchange process.		5	L4
Ans	zeolite process	Ion-exchange process.		
	a. It involves passing of raw water through a bed of zeolite crystals, which exchange sodium ions for calcium and magnesium. b. It is not suitable for acidic water. c. It is applicable for softening of hard water. d. It has relatively low water softening capacity. e. It has limited applications.	a. It utilizes ion-exchange resins, which exchange sodium ions for calcium and magnesium. b. It is suitable for acidic and alkaline water. c. It is applicable for softening, demineralization and purification etc. d. It has high water softening capacity. e. It has wide range of applications	1 1 1 1 1	
40	A. Make a comparison between lime-soda process and zeolite process. B. Difference between coagulants and flocculants.		5	L4
	A. Comparison between lime-soda process and zeolite process.			
	lime-soda	**zeolite process**		
	a. Large sludge is formed. b. Water obtained from this process is useful for public supplies. c. This process is economical. d. Excessively hard water can be treated. e. Highly turbid/acidic water can be treated.	a.No sludge is formed. b.They have comparatively high molecular weight. b.Water obtained from this process is useful for industrial supplies. c.This process is costlier. d.Hardness <800 mg/l only can be treated easily. e.Turbid water can be treated.	0.5 0.5 0.5 0.5 0.5	
	B. Difference between coagulants and flocculants.			
	coagulants	Flocculants.		
	a.These are cationic. b.They have low molecular weight. c. They neutralize the repulsive electrical charges. d.They act by the process called coagulation. e.Examples: AluminumSulfate, Ferric Sulfate, Ferric Chloride etc.	a.These are cationic,anionic or, non-ionic. c. They facilitates agglomeration of particles to form larger floccules. d. They act by the process called flocculation. e. Examples: Organic polymers polyacrylamide, polyethylene oxide, polyamine etc.	0.5 0.5 0.5 0.5 0.5	

Unit-3 (Engineering Materials)

02 Marks Questions & Solutions ***Taxonomy Level***

1. **What are ores and minerals?** **Level-1 (Remembering)**

   Ans: Minerals- The naturally occurring chemical substances in which metals or their compounds found either in native state or combined state are called minerals. Ores- Ores are the minerals from which metals can be extracted easily and economically.

2. **Define flux and slag?** **Level-2 (Understanding)**

   Ans: Flux- A substance added during the process of smelting to convert the solid gangue into fusible mass (slag) is called flux.

   Slag- It is the fusible mass obtained during the process of smelting when flux combines with the solid impurities.

   Impurity + Flux → Slag

3. **Write the various steps involved in metallurgical processes?** **Level-1 (Remembering)**

   Ans: The following steps are followed during the process of metallurgical operation.

   1. Crushing and Grinding
   2. Concentration or Ore dressing
   3. Oxidation
   4. Reduction
   5. Refining

4. **Define alloy? Give an example.** **Level-1 (Remembering)**

   Ans: An alloy is a homogenous mixture of two or more metals or a metal and a non-metal.

   Ex- Brass & bronze**.**

5. **What are Ferro alloys? Give an example.** **Level-1 (Remembering)**

   Ans: Alloys which contain iron as one of the main component are known as ferro alloys.

   Ex- stainless steel, Nickel Steel etc**.**

6. **What are non-Ferro alloys? Give an example.** **Level-1 (Remembering)**

   Ans: Alloys which do not contain iron as one of the main component known as non-ferro alloys.

   Ex- Alnico , bell metal etc.

7. **What are composite materials?** **Level-1 (Remembering)**

Ans: A composite material is a mixture of two or more micro constituents, which combine to give properties superior to those of the individual constituents.

8. **Define roasting?** **Level-1 (Remembering)**

Ans: It is the process of heating the concentrated ore strongly in the presence of excess air, below melting point of ore. This method is used for extraction sulphide ores.

9. **What is polymerization?** **Level-1 (Remembering)**

Ans: It is the process of uniting or linking together monomer molecules to form a large polymer molecule under specific conditions of temperature, pressure, and catalyst known as polymerization.

10. **What is degree of polymerization?** **Level-1 (Remembering)**

Ans: It is the ratio of the average molecular weight of polymer to the weight of monomer.

11. **Define homopolymer and copolymer.** **Level-1 (Remembering)**

Ans: Homopolymer : Polymers that are derived from single monomers are known as homopolymers.

Copolymer: Polymers that are derived from two different monomers are known as co-polymers.

12. **What are the monomers of nylon-6,6?** **Level-1 (Remembering)**

Ans: Hexa methyelene diamine and adipic acid are the monomers of Nylon- 6,6.

13. **Name the monomers of Bakelite. Write its two uses.** **Level-1 (Remembering)**

Ans: Phenol and Formaldehyde are the monomers of Bakelite.
Uses: It is used in the manufacture of

i. Electrical insulators like plug,switch etc.

ii. Cabinets for Radio & TV.

14. **What is vulcanization of rubber?** **Level-1 (Remembering)**

Ans: The chemical process in which natural rubber is heated with 4 to 6% sulphur or sulphur containing compounds with a view to overcome the drawbacks of natural rubber are called vulcanization.

15. Write two uses of rubber. **Level-1 (Remembering)**

Ans: i. Due to elasticity, strength and toughness, it is used for making rubber bands, tubes for bicycles, automobiles.

ii. Due to excellent abrasion resistance, used for making conveyor belts, shock absorbers mounting heavy machinery.

05 Marks Questions & Solutions ***Taxonomy Level***

1. Define alloy? Write down the composition and uses of Brass and Bronze?

Level-1 (Remembering)

Ans: Alloy: An alloy is a homogenous mixture of two or more metals or a metal and a non-metal.

Brass

COMPOSITION:

Cu: 60 – 90%

Zn: 10 – 40%

USES:

It is used in making: Utensils, Jewellery, Musical instrument, Battery caps, Condenser Tubes, Name plates, etc.

Bronze

COMPOSITION:

Cu: 80 – 95%

Sn: 5 – 20%

USES:

It is used in making imitation jewellery, Water fittings, Statues, Medals, Turbine blades, Pump Valves, Coins, etc.

2. Explain the magnetic separation method of concentration of ores.

Level-2 (Understanding)

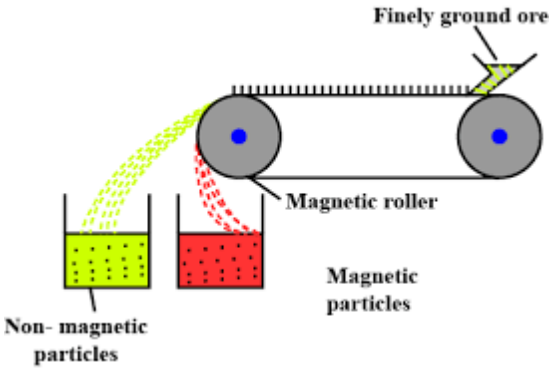
Ans: I. This method of concentration is suitable only when there is a difference in the magnetic behavior between the ores and the impurities.

II. In this method, a belt is tied over two rollers of which one is made of a magnet.

III. The crushed ore is spread over a moving belt in a strong magnetic field.

IV. When the ore falls down, the magnetic substances are attracted by the magnet and collected on one side. The nonmagnetic substances collect on the other side.

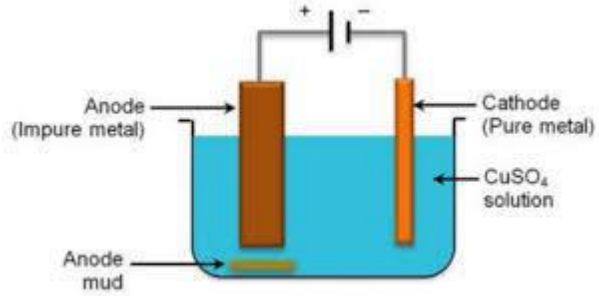
V. This method is used for the concentration of haematite, an ore of the iron. Non magnetic ore like tinstone (SnO_2) can be concentrated from magnetic impurities like tungsten of iron and manganese.



3. **Explain the electrolytic method of purification of impure copper.**

Level-2 (Understanding)

Ans: i. This is most widely used method for the refining of impure metals.
ii. Many metals such as copper, zinc, tin, nickel, silver, gold etc. are refined electrolytically. It is based upon the phenomenon of electrolysis.
iii. In this method impure metal is made anode while pure metal is made cathode.
iv. The crude metal is casted into thick rods and is made as anode. An aqueous solution of salt of the same metal is used as an electrolyte.
v. On passing current through the electrolyte, the pure metal from the anode dissolves into the electrolyte. An equivalent amount of pure metal from the electrolytes deposited on the cathode.
vi. The soluble impurities go into the solution whereas the insoluble impurities settle down at the bottom of the anode and are known as anode mud.
vii. In this way, the pure metal from anode goes into electrolyte and from electrolyte it goes to the cathode.



4. **Differentiate between thermoplastics and thermosetting plastics.**

Level-1 (Remembering)

Ans:

Thermosoftening Plastics (Thermoplastics)	Thermosetting Plastics
These are the product of addition polymerisation reactions.	These are the products of the condensation polymerisation reaction.
Simple linear linkage with minimum or no cross-linking	Three-dimensional network-like structure.
It contains weak covalent bonds compared with bonds present in thermosetting plastics.	It contains a strong covalent bond compared with bonds present in thermoplastics
Soluble in an organic solvent	Insoluble in the organic solvent
These plastics are soft, weak and brittle.	These plastics are hard, strong and more brittle.
It can be heated and reshaped many times	It can be heated and shaped once.
Reclaimed from the waste	It cannot be reclaimed from the waste
Thermosoftening plastics have low molecular weight than thermosetting plastics.	Thermosetting plastics have high molecular weight than them softening plastics.
Ex. Polyethylene, PTFE, Polystyrene	Ex. Nylon 6:6, Bakelite

5. Differentiate between natural rubber and vulcanized rubber.

Level-1 (Remembering)

Ans:

Natural Rubber	Vulcanised Rubber
Natural rubber is the latex of rubber trees that has a mixture of polymers	Vulcanised rubber is the material that forms after the vulcanisation of natural rubber.
A milky colloidal	A hardness rubber material containing cross-links between polymer chains
Less elastic	More elastic
Load-bearing capacity is low	High load-bearing capacity
Long isoprene chain only	It contains a long isoprene chain with a C-S-C chain across two different layers

Unit-4 (Chemistry of Fuels and Lubricants)

02 Marks Questions & Solutions ***Taxonomy Level***

16. Define fuel. Give one example of gaseous fuel. **Level-1 (Remembering)**

Ans: Fuel is defined as a combustible substance which on combustion produces a large amount of heat energy without producing excess by-products.
Example- Coal gas

17. Define calorific values and mention its units. **Level-1 (Remembering)**

Ans: The calorific value of fuel is the amount of heat obtained by complete combustion of unit mass of fuel.
Units of Calorific value are: Cal/gm, Kcal/Kg, KJ/Kg, B.Th./lb (British Thermal Unit/pound) etc.

18. State octane number of gasolines. Mention the octane number of isopentane.
Level-1 (Remembering)

Ans: The octane number of gasoline is the percentage of iso-octane in a mixture of iso-octane and n-heptane. The octane number of isopentane is 90.

19. What is Higher calorific value (HCV) and Lower calorific value(LCV)?
Level-1 (Remembering)

Ans: HCV: It is the total heat generated when a unit quantity of fuel is completely burnt and the products of combustion are cooled down to 150C.
LCV: It is the net heat produced when a unit quantity of fuel is completely burnt and the products of combustion are allowed to escape.

20. Define cetane number and write the formula of cetane .
Level-1 (Remembering)

Ans: Cetane number is the ignition value of diesel fuel that represents the percentage by volume of Cetane in Cetane and liquid -methylnaphthalene mixture.
Cetane or n-Hexadecane: CH_3-$(CH_2)_{14}$-CH_3

21. Write the uses of coal gas. **Level-1 (Remembering)**

Ans: It is used:
i. as a fuel.
Ii. as a reducing agent in metallurgical operations.

22. Write the uses of Producer gas. **Level-1 (Remembering)**

Ans: It is used:

i. For heating open-hearth furnaces in steel & glass manufacture, muffle furnace in coke & coal gas manufacture.
ii. as a reducing agent in metallurgical operations.

23. Write the composition of water gas. **Level-1 (Remembering)**

Ans: It is a mixture of combustible gases CO and H_2 with a little quantity of non-combustible gases like CO_2 and N_2. The average composition of water gas is H_2= 51%, CO=41%, CO_2=4% & N_2=4%.

24. Define lubricant. Give an example of semi- solid lubricant.

Level-1 (Remembering)

Ans: Any substance introduced between the two moving/sliding surfaces with a view to reduce the friction or frictional resistance between them, is known as lubricant. Example of a semisolid lubricant is Grease.

25. What is viscosity index and how does it relate to the quality of a lubricating oil?

Level-1 (Remembering)

Ans: The variation of viscosity of a liquid with temperature is called viscosity index. Viscosity of liquids decreases with increasing temperature and, consequently, the lubricating oil becomes thinner as the operating temperature increases. Hence, viscosity of good lubricating oil should not change much with change in temperature, so that it can be used continuously, under varying conditions of temperature.

26. Define flash point. **Level-1 (Remembering)**

Ans: The flash point of a volatile material is the lowest temperature at which vapors of the material will ignite for a moment when an ignition source brought near to it. The temperature at which a lubricant will ignite when heated and mixed with air, but a flame is not sustained.

27. Define fire point. **Level-1 (Remembering)**

Ans: The fire point of a fuel is the lowest temperature at which the vapour of that fuel will continue to burn for at least 5 seconds when an ignition source brought near to it.

28. What do you mean by Carbon residue of a lubricant?

Level-1 (Remembering)

Ans: Carbon residue of lubricant is an indication of the coke-forming tendency of an oil or in other words it is the tendency to form carbon deposits under high-temperature conditions in an inert atmosphere.

29. What is the key difference between Acid value and Saponification value?

Level-1 (Remembering)

Ans: The key difference between acid value and saponification value is that acid value gives the mass of potassium hydroxide that is required to neutralize one gram of a chemical substance whereas saponification value gives the mass of potassium hydroxide required to saponify one gram of fat.

30. What is TAN? **Level-1 (Remembering)**

Ans: Total Acid Number or TAN is a measurement of acidity that is determined by the amount of potassium hydroxide in milligrams that is needed to neutralize the acids in one gram of oil.

05 Marks Questions & Solutions ***Taxonomy Level***

1. Write the composition, calorific values and applications of LPG & CNG.

Level-1 (Remembering)

Ans: LPG (Liquified Petroleum Gas)

Composition: n-butane=27%, iso-butane=25%, butene=43%, propene=2.5% & propane=2.5%.

Its calorific value is 2800 Kcal / m3.

It is used as

I. a domestic fuel.

II. As an industrial fuel.

III. As a vehicular fuel.

CNG (Compressed Natural Gas):

Composition: CH4=70-90%, C2H6=4-9% & traces of propane and butane.

Its calorific value is 12500 Kcal /m3..

It is used as

I. as a domestic and industrial fuel.

II. as a source of carbon in tyre industry.

III. for the production of H2 gas needed in fertilizer industry.

2. **Write the composition and uses of waer gas and producer gas.**

Level-1 (Remembering)

Ans: Water Gas

(i) It is a mixture of combustible gases CO and H_2 with a little quantity of non-combustible gases like CO_2 and N_2.
(ii) The average composition of water gas is H_2= 51 %, CO = 41 %, CO_2 = 4% & N_2 = 4%,
(iii) Its calorific value is 2800 Kcal / m3 .
Uses: It is used:
i)as a source of H_2 Gas.
ii)as a fuel.
iii)as an illuminating gas.
iv)for welding purposes.

Producer Gas:

(i) It is a mixture of combustible gases, CO and H_2 with large quantities of non-combustible gases
CO_2 and N_2.
(ii) The avg. composition of producer gas is CO = 22-30%, H_2 = 8-12 %, N_2 = 52-55 % & CO_2 = 3%
(iii) Its calorific value is 1,300 Kcal /m3.
Uses: It is used:
i) For heating open-hearth furnaces in steel & glass manufacture, muffle furnace in coke & coal gas manufacture.
ii)As a reducing agent in metallurgical operations.

3. **What are the characteristics of good lubricants.**

Level-1 (Remembering)

Ans:

i. high boiling point
ii. low freezing point
iii. adequate viscosity for proper functioning
iv. high resistance to oxidation and heat
v. non-corrosive properties
vi. stability to decomposition at the operating temperatures
vii. high viscosity index
viii. higher flash and fire points than the operating temperature of the machine
ix. high oiliness
x. lower cloud and pour points than the operating temperature of the machine

4. **Write down the function, types and advantages of Emulsions.**

Level-1 (Remembering)

Ans: In machining operations such as milling, threading, turning and boring, the tools get heated to a very high temperature, particularly at the cutting edge. In a cutting process, the pressure at the knife-edge may sometimes reach as high as 100,000 psi and a lot of heat is generated, which lead to oxidation and rusting of the metal. To prevent overheating and injury to the tool, efficient cooling and lubrication have to be provided. This is usually done by employing emulsions of oil droplets in water, which are called cutting oils or cutting fluids or cutting emulsions.

Oil has a poor specific heat but it has good lubricating properties, whereas water is a poor lubricant but it is an excellent cooling medium because of its high specific heat and high heat of vaporization. Hence the combination of the two in the form of an emulsion can provide both lubrication and cooling effects. The corrosive action of water on the tools, the machines and the work piece are objectionable and is therefore checked by the addition of soaps or other inhibitive alkaline substances.

The two types of emulsions are used for lubricating jobs, as below:

Oil-in-Water Type Emulsions or Cutting Emulsions: These are prepared by mixing together an oil containing about 3 to 20% of a water-soluble emulsifying agent (e.g., water soluble soap, alkyl or aryl sulfonate, alkyl sulphates) and suitable quantity of water. Chemicals like glycols, glycerols and triethanol amine are also added sometimes. Oil-in water type emulsions are used as coolant cum lubricant for cutting tools and in diesel motor pistons and large internal combustion engine.

Water-in-Oil Type Emulsions or Cooling Liquids: These are prepared by mixing together water and an oil containing 1 to 10% of water insoluble emulsifiers (e.g., alkaline earth metal soaps).

A good cutting oil increases the accuracy of the cuts and reduces the cost of the work by-

(a) making possible to achieve higher cutting speeds,
(b) prolonging the life of the cutting tool, and
(c) reducing the power demand and the number of rejects.

5. **Explain the mechanism of lubrication using the concept of hydrodynamic lubrication.**

Level-2 (Understanding)

Ans:

Hydrodynamic is derived from the two words, hydro and dynamic. Hydro meaning liquid and dynamic meaning relative motion. In this mechanism, two moving and sliding surfaces are separated by thick film of lubricant fluid of about 1000A0, applied to prevent direct surface to surface contact and consequently reduce wear and tear of metals

The lubricant film covers/fills the irregularities of moving/sliding surfaces and forms a thick layer between them, so that there is no direct contact between the material surfaces. This consequently reduces the friction. The lubricant chosen should have the minimum

viscosity (to reduce the internal resistance between the particles of the lubricant) and should remain in place and separate the surfaces. Hydrocarbon oils (mineral oils which are lower molecular weight hydrocarbons with about 12 to 50 carbon atoms) are considered to be satisfactory lubricants for thick-film lubrication. In order to maintain the viscosity of the oil in all seasons of year, ordinary hydrocarbon lubricants are blended with selected long chain polymers. In this case fluid is formed by mixing of hydrocarbon oils and anti- oxidants with long chain polymer so as to maintain viscosity. Fluid film lubrication is useful in delicate and light machines like watches, clocks, guns, scientific equipment.

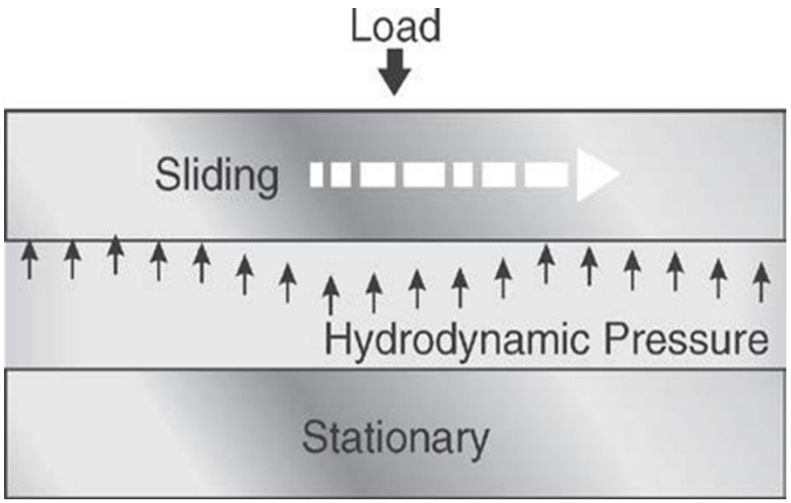
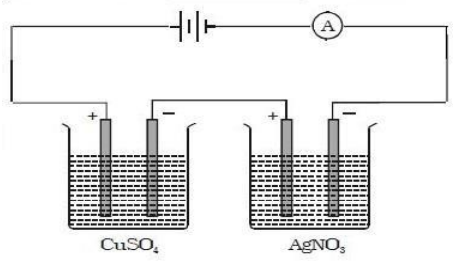


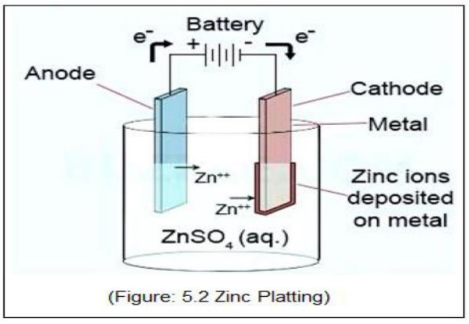
Fig. Thick Film Lubrication

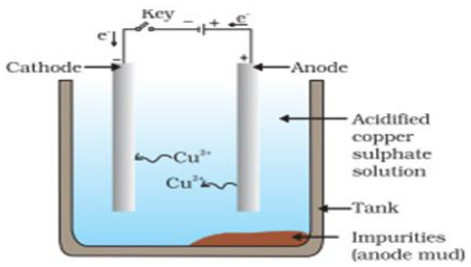
UNIT-5 ELECTROCHEMISTRY		
Sl. No.	**(2 MARKS) SHORT QUESTIONS AND ANSWERS**	**BLOOM'S TAXONOMY LEVEL**
1.	**Define electrolyte. Give an example of it**. Ans: The chemical substances which allow electricity to pass through their molten, fused or solution state are calledelectrolytes. Example: All acids, all alkalies and all salts.	1 (REMEMBERING)
2.	**Define strong electrolytes with examples.** Ans: Strong electrolytes: The electrolytes which undergo almost complete ionization in aqueous solution are strong electrolytes. Example: a) Strong acids like HCl, HNO_3, H_2SO_4, etc. b) Strong alkalies like NaOH, KOH, Ca $(OH)_2$, Mg $(OH)_2$, etc. c) Salt like NaCl, KCl, $CaCl_2$, $MgCl_2$, etc.	1 (REMEMBERING)
3.	**Define weak electrolytes with examples.** Ans: Weak electrolytes: The electrolytes which undergo partial ionization in aqueous solution are weak electrolytes. Example: a) Organic acids like CH_3COOH, HCOOH b) Inorganic acids like H_2CO_3, HCN, etc. c) Base like NH_4OH	1 (REMEMBERING)
4.	**Define electrolysis. Which elements are evolved at the anode and cathode during electrolysis of fused NaCl?** Ans: (i)The process of chemical decomposition of an electrolyte by the passage of electricity through its molten fused or solution state is called electrolysis. (ii)Sodium is deposited at cathode and chlorine gas evolved at anode.	2 (UNDERSTANDING)
5.	**State Faraday's 1st law of electrolysis. Write down the mathematical expression.** Ans: The law state that, during the process of electrolysis, the amount of substance (W) deposited or liberated at the electrode is directly proportional to the quantity of electricity (Q) passed through the electrolytes. Mathematically, $W \alpha Q$ $W \alpha It$ as, $Q = I t$ $W = ZIt$ where, W = Amount of substance in gram Q = Quantity of electricity or Charge in coulomb I = Current in ampere t = time of flow of current in second. Z = Electrochemical equivalent (ECE)	1 (REMEMBERING)
6.	**State Faraday's 2nd law of electrolysis.** Ans: The law stated that, when the same quantity of electricity is passed through differentelectrolytes connected in series, the amounts (W) of substances deposited at various electrodes are directly proportional to their equivalent masses (E).	1 (REMEMBERING)
7.	**State electrochemical equivalent. Mention its unit.** Ans: (i) electrochemical equivalent is numerically equal to the amount of substance deposited or liberated at the electrode when 1 ampere of	1 (REMEMBERING)

	current is passed through an electrolyte for 1 second. (ii) Unit is Gm. equivalent/coulomb	
8.	**Find the electrochemical equivalent of calcium.** Ans: (i) Gm. Equivalent mass of Ca is 40/2=20 (ii) ECE of Ca is 20/96500=0.000207 gm.eqv/c	3 (APPLYING)
9.	**State the process Galvanisation.** Ans: The process of applying a coating of zinc over iron witha view to protect it from rusting is called Galvanization.	2 (UNDERSTANDING)
10	**Define Oxidation with an example.** Ans: (i)Oxidation : It is the process that involves the loss of electrons by an atom, ion or molecule. (ii) $2Na \dashrightarrow 2Na^{+} + 2e^{-}$ 2,8,1 2,8 Sodium loses one electron, oxidation reaction takes place at sodium.	2 (UNDERSTANDING)
11	**Define and classify inhibitors.** Ans: Inhibitors are organic or inorganic substances which decrease the rate of corrosion. The inhibitors are added in small quantities to the corrosive medium. Inhibitors are classified as follows 1. Anodic inhibitors (chemical passivators) 2. Cathodic inhibitors (adsorption inhibitors) 3. Vapour phase inhibitors (volatile corrosion inhibitors)	1 (REMEMBERING)
12	**Define corrosion with any one example.** Ans. The process of deterioration or destruction and consequent loss of a solid metallic material through an unwanted chemical, electrochemical and biochemical attack by its environment at its surface is called corrosion. Examples : (i) Rusting of Iron - When iron is exposed to the atmospheric conditions, a layer of reddish scale and powder of Fe_3O_4 is formed. (ii) Green Film on Copper - [$CuCO_3 + Cu(OH)_2$] on the surface of copper when exposed to moist air containing CO_2.	1 (REMEMBERING)
13	**Define rusting. Write the overall chemical reaction of rusting process.** Ans. Corrosion of Iron is generally known as rusting. The chemical reaction can be represented as $$4Fe + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3$$	2 (UNDERSTANDING)
14	**List the factors influencing rate of corrosion.** Ans: The Following factors influence the rate of corrosion 1)Nature of metals(Position in Galvanic Series, Over Voltage, Purity of Metal, Nature of the Surface Film, Nature of the Corrosion Product, Physical State) 2) Nature of the corroding environment(Temperature, Humidity of Air, Effect of pH, Presence of Impurities in Atmosphere, Presence of Suspended Particles in Atmosphere, Conductivity rate of corrosion increases with increase in conductance of medium.)	3 (APPLYING)
15	**Explain Redox reaction with suitable examples?** Ans: A redox reaction is when there is simultaneous oxidation and reduction. Ex: $CuO+H_2 \rightarrow Cu + H_2O$. CuO is reduced where as H_2 is oxidized	2 (UNDERSTANDING)

16	**Define primary Batteries with one example.** Ans: In the primary batteries, the reaction occurs only once and after use over a period of time battery becomes dead and cannot be reused again. Ex Mercury cell, Leclanché cell	1 (REMEMBERING)
17	**Define secondary Batteries with examples.** Ans: It is the cell after use, can be recharged by passing current through it in the opposite direction so that it can be used again. A good secondary cell can undergo a large number of discharging and charging cycles. Ex: The most important secondary cell is the lead storage battery	1 (REMEMBERING)
18	**Write down the anodic and cathodic material that used in lead- acid battery. List any one use of lead- acid battery?** Ans: It consists of a lead anode and a grid of lead packed with lead dioxide (PbO_2) as cathode. A 38% solution of sulphuric acid is used as an electrolyte. Uses:It is commonly used in automobiles and invertors. Lead-acid batteries can store excess energy from renewable sources like solar and wind power.	1 (REMEMBERING)
19	**Define fuel cell with one example.** Ans: Galvanic cells that are designed to convert the energy of combustion of fuels like hydrogen, methane, methanol, etc. directly into electrical energy are called fuel cells. Ex: Hydrogen oxygen fuel cell	1 (REMEMBERING)
20	**Define solar cell.Write down any one use of solar cell.** Ans: A solar cell, also known as a photovoltaic (PV) cell, is a device that converts sunlight into electricity. The process of converting light into electricity is called the photovoltaic effect. Uses: Solar cells can be used to power small devices like calculators and watches, or to generate electricity for an entire house.	1 (REMEMBERING)
Sl. No.	**(5 MARKS) DESCRIPTIVE QUESTIONS AND ANSWERS**	**BLOOM'S TAXONOMY LEVEL**
1.	**State and Explain Faraday's 1st law of electrolysis.How many grams of copper will be deposited at the cathode by the passage of 20 ampere of current through an aqueous solution of $CuSO_4$ for half an hour?** Ans: (i)The law state that, during the process of electrolysis, the amount of substance (W) deposited or liberated at the electrode is directly proportional to the quantity of electricity (Q) passed through the electrolytes. Mathematically, $W \alpha Q$ $W \alpha It$ as, $Q = I t$ $W = ZIt$ where, W = Amount of substance in gram Q = Quantity of electricity or Charge in coulomb I = Current in ampere t = time of flow of current in second. Z = Electrochemical equivalent (ECE)	3 (APPLYING)

	Electrochemical Equivalent (Z) = $\frac{1 \text{ gram equivalent}}{96500}$ $= \frac{\text{Atomicmass /Valency}}{96500}$ (II)Given Data: I = 20 Ampere t = 1/2 hr = 1800 Sec. Z = $\frac{1 \text{ gram equivalent}}{96500}$ $=\frac{\text{Atomicmass /Valency}}{96500}$ $= \frac{63.5/2}{96500} = \frac{31.75}{96500} = 0.00032$ Applying Faraday's 1st Law of electrolysis W = ZIt = 0.00032 X 20 X 1800 = 11.52 gram.	
2.	**Define Faraday's 2nd law of electrolysis. A given quantity of electricity is passed through two cells containing copper sulphate and silver nitrate solutions respectively. If 0.99 g of silver and 0.29 g of copper are deposited, find the equivalent weight of Ag when that of Cu is 31.6.** Ans: (I)The law stated that, when the same quantity of electricity is passed through different electrolytes connected in series, the amounts (W) of substances deposited at various electrodes are directly proportional to their equivalent masses (E). (ii)Let us consider two electrolytic solutions $AgNO_3$ and $CuSO_4$ taken in two different electrolytic cells. Both the cells are connected in series and the same quantity of electricity is passed through the electrolytes.  (iii)Applying Faraday's 2nd law of electrolysis, Weight of copper deposited(W1) α Equivalent weight of copper (E1) ..... (1) Weight of silver deposited(W2) α Equivalent weight of silver(E2)..... (2) Dividing equation 1 by 2 we get W1/E1=W2/E2 Weight of silver deposited (W2)=0.99 g, Wt. of copper deposited(W1) =0.29 g Equivalent weight of copper (E1)=31.6 Equivalent weight of silver(E2) =? According to Faraday's second law of electrolysis, $= \frac{\text{Weight of copper deposited(W1)}}{\text{Weight of silver deposited(W2)}}$ $= \frac{\text{Equivalent weight of copper (E1)}}{\text{Equivalent weight of silver(E2)}}$ =	3 (APPLYING)

	0.29 /0.99 = 31.6 /E2 => E2= (0.99x31.6)/0.29 = 107.8 gm	
3.	**State Galvanisation. Write the process of Galvanisation based on electroplating.** Ans:(i) The process of applying a coating of zinc over iron with a view to protect it from rusting is called Galvanization. (ii)Apparatus: a) Electrolytic tank b)Zinc Metal c)Iron metal d)Battery (iii) electrolyte: ZnSO4 (Zinc Sulphate) Fig:  (Figure: 5.2 Zinc Platting) Process: (i)During the process of galvanization, zinc plate is used as anode and iron article is used as cathode. (ii)Both the electrodes are connected to the terminals of a battery. (iii)The electrodes are dipped in an aqueous solution of zinc sulphate When electricity is passed, the anode, i.e., zinc plate dissolves in its aqueous salt solution to liberate zinc ion (Zn^{2+}) which get discharged ad deposited over the cathode. (iv) this way a coating of zinc is applied over the surface of the iron article.	2 (UNDERSTANDING)
4.	**Write the short note on electrolytic refining** Ans: Principle of the method of Electrolytic refining- Electrolytic refining is the method of using electricity to refine impure metals. In this process, the anode is made of impure metal, and the cathode is made of a strip of pure metal. A solution is made with a soluble salt of the same substance as the electrolyte. When an electric current is transmitted, metal ions from the electrolyte are deposited as a pure metal in the cathode, and the impure metal from the anode dissolves in the form of ions into the electrolyte. Below the anode, the impurities metals are collected. It is called mud anode. In the electrolytic refining of copper, the electrolyte is a solution of acidified copper sulphate. The anode is impure copper, whereas the cathode is a strip of pure copper on passing electric current, pure copper is deposited on the cathode.	1 (REMEMBERING)

		
5.	**Explain the process of Electroplating.** Electroplating is basically the process of plating a metal onto the other by electrolysis mostly to prevent corrosion of metal or for decorative purposes. The process uses an electric current to reduce dissolved metal cations to develop a lean coherent metal coating on the electrode. Electroplating is often applied in the electrical oxidation of anions on a solid substrate like the formation of silver chloride on silver wire to form silver chloride electrodes.Electroplating is majorly applied to modify the surface features of an object (e.g corrosion protection, lubricity, abrasion), but the process can also be used to build thickness or make objects by electro forming. **<u>The Anode and Cathode</u>** In electroplating practice, the current is usually introduced from an external source and the anode is the positive electrode and cathode is a negative electrode. The cathode is the electrode where the electrochemical reduction reaction occurs. The anode is that where the electrochemical oxidation reaction occurs. The electroplating process uses an anode and a cathode. In electroplating, the metal dissolved from the anode can be plated onto the cathode. The anode is provided with direct current, oxidizing and dissolving its metal atoms in the electrolyte solution. At the cathode, the dissolved metal ions are discharged and get deposited as coating of the metal. Working Process: Let's take an example of a gold coating. In this instance, a layer of gold is to be electrodeposited on metallic jewellery to enhance its appearance. Usually, the gold plate is connected to the anode (+ve charged electrode) of the circuit and the jewellery is kept at the cathode (-ve charged electrode). Both are immersed in a highly developed electrolytic bath (solution). At this stage, a DC current is supplied to the anode that oxidizes the gold atoms and dissolves them into the solution.The dissolved ions of gold are reduced at the cathode and plated on the jewellery.	2 (UNDERSTANDING)
6.	**Define corrosion and explain the difference between chemical and electrochemical corrosion. Provide detailed mechanisms for hydrogen liberation and oxygen absorption in the electrochemical corrosion of metals.** Ans: Corrosion is the degradation of metals due to reactions with their environment. Chemical corrosion occurs when metals react directly with	3 (APPLYING)

<table>
<tr><td></td><td>chemicals, while electrochemical corrosion involves redox reactions and is more common in aqueous environments.
Hydrogen Liberation:
In acidic environments, metals react with hydrogen ions, releasing hydrogen gas and leading to corrosion
($Fe + 2H^+ \rightarrow Fe^{2+} + H_2$).
Oxygen Absorption:
In the presence of oxygen and moisture, metals undergo oxidation (rusting). For iron:
At the anode, Fe is oxidized ($Fe \rightarrow Fe^{2+} + 2e^-$).
At the cathode, oxygen is reduced ($O_2 + 4H^+ + 4e^- \rightarrow 2OH^-$).
$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$
$4Fe(OH)_2 + O_2 + 2H_2O \rightarrow$ 4Fe(OH)3(Yellow Rust)
This type of corrosion is more common in moist and oxygen-rich environments.</td><td></td></tr>
<tr><td>7.</td><td>Differentiate between Dry/Chemical and Wet/Electrochemical Corrosion.
<table><tr><th>Dry/ChemicalCorrosion.</th><th>Wet/Electrochemical Corrosion.</th></tr><tr><td>It occurs in dry condition.</td><td>It occurs in presence of moisture or electrolyte.</td></tr><tr><td>It is due to direct chemical attack of the metal by the environment.</td><td>It is due to formation of large number of anodic and cathodic areas.</td></tr><tr><td>Even a homogeneous metal surface gets corroded.</td><td>Heterogeneous(bimetallic) surface alone gets corroded.</td></tr><tr><td>Corrosion products accumulate at the place of corrosion.</td><td>Corrosion occurs at anode while products are formed elsewhere</td></tr><tr><td>It is self-controlled process</td><td>It is continuous process</td></tr><tr><td>It adopts adsorption mechanism.</td><td>It follows electrochemical reaction</td></tr><tr><td>Eg- formation of mild scale on iron surface</td><td>Rusting of iron in moist atmosphere</td></tr></table></td><td>4(ANALYZING)</td></tr>
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