Section-II (Applied chemistry)

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
4	a)	i) **Specific conductivity**: It is defined as "the conductivity offered by a solution of length one cm. and area of unit cross section. Or It is the conductance of a one centimeter cube of the substance or solution.	1	2
		ii) **Buffer solution**: A buffer solution is that solution which maintains a fairly constant pH value, even when small amounts of acid or base are added to it.	1	
	b)	**i) Primary cell**: A cell in which net cell reactions cannot be reversed on applying higher e.m.f. is called as primary cell.	1	2
		ii) **Secondary cell**: A cell in which net cell reactions can be reversed on applying higher e.m.f. is called as Secondary cell.	1	
	c)	**Advantages of fuel cell –** 1. They have high efficiency of energy conversion 2. No emission of gases and pollutants within permissible limits. 3. They can be operated on air. 4. They have low maintenance cost. (Note: Give marks for other advantages if written down.)	½ mark each	2
	d)	**Properties of inert gases-** 1. They have excellent dielectric properties. 2. They have low density and have coolant property. **Applications of inert gases-** 1. Nitrogen and carbon dioxide are used as dielectrics. 2. Nitrogen is used in transformers, electrical capacitors as insulating material. 3. Hydrogen is used as a coolant. (Note: Two properties for 1 mark and two applications for 1 mark.)	1 1	2

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4.	e)	**Adhesive**:-It is defined as any substance capable of holding materials together by surface attachment.	1	2
		Characteristics of good adhesive:-	1	
		1) Should have good degree of tackiness. (stickiness)		
		2) Should bond and dry rapidly, durable.		
	f)	**Chemical Formulae :- (any two)** Alumina : Al_2O_3 Cuprite : Cu_2O Cryolite : Na_3AlF_6 Copper glance: Cu_2S	1 mark each	2
	g)	**Composition of Woods metal :**	1	2
		Bi : 50 % , Pb : 25 % , Cd : 12.5 % , Sn : 12.5 %		
		Applications of Woods metal –	1	
		1. It is used as safety plugs and electric fuses.		
		2. It is used for taking impressions of coins.		
	h)	**Corrosion:** Any process of chemical or electrochemical decay or destruction of a metal due to action of surrounding medium is called corrosion.	1	2
		Types of corrosion:		
		1) Atmospheric / Chemical corrosion. (Dry corrosion)	½	
		2) Immersed / Electrochemical corrosion (wet corrosion)	½	
	i)	**Different types of oxide films :**		2
		1. Stable oxide film : i) porous oxide film ii) Non porous oxide film	1	
		2. Unstable oxide film.		
		3. Volatile oxide film.		

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4.	i)	A stable **non- porous** metal oxide film is less corrosive because as it is non- porous, the gases do not diffuse to the inner layers of metal, hence the inner metal gets protected. For example –oxide films of metals like, **aluminum, nickel chromium** etc.	1	
	j)	**Similarities between galvanizing and Sheradizing –** 1. In both galvanizing and Sheradizing iron or steel articles are coated by zinc. 2. In both Fe- Zn alloy is formed.	1 mark each	2
	k)	**pH:** It is defined as negative logarithm to the base ten of hydrogen ion concentration. $pH = - \log_{10} [H^+]$ Corrosion of metal depends on pH –value, if pH value is more acidic higher is the rate of corrosion and vice a versa.	1 1	2
5.	a)	**Application of P^H in Engineering:- (Consider any four)** **1) Pharmaceutical Industry:-** In large number of pharmaceutical industries like preparation of drugs, antibiotics, etc & soft drink industries the P^H control is necessary. **2) Analytical Industry:-** In qualitative & quantitative analysis, the increase in acidity or alkalinity controls the precipitation of certain substances due to common ion effect. Similarly, P^H control is very important in chromatographic separation of amino acids by using ion exchange resins P^H control is necessary in electroplating.	1 mark each	4

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5	a)	**3) City Water Supply:-** In city water supply the treatment of sewages by coagulation process, P^H control is necessary. The added coagulants in water are not fully hydrolyzed & they are ineffective in bringing about sedimentation of fine, suspended & colloidal impurities. **4) Food Processing Industries :-** The wastes from the food processing industries, such as breweries, distilleries, dairies & sugar industries etc mostly contain organic matter, which is putrecible. Hence, in the receiving water, the oxygen is reduced. In such industries also P^H control is essential. **5) Caustic or Boiler Corrosion :-** In boiler feed water having lower P^H value (acidic) the rate of corrosion as well as scale forming tendency increases. If it is too alkaline, it causes caustic corrosion. In high pressure boilers, it can be avoided by adjusting the P^H between 7 to 10. **6) Effluents :-** i) Effluents from chemical industries are either acidic (P^H 2.7) or alkaline (P^H 7.7), mine water & wastes from industries like pickle waste, yeast manufacturing, reclaimed rubber & phosphate industry are acidic in nature.ii) Drainage from coal mines contain sulphur & sulphuric acid. Due to these wastes effluent becomes acidic.iii) Waste from soft drink industries tanneries & synthetic rubber industries are alkaline.iv) Hence the P^H must be adjusted to 7 before discharging the effluents into rivers & streams otherwise extremely acidic or alkaline wastes causes corrosion of bridges & structure in the river. (Note: Give marks to the related applications)		

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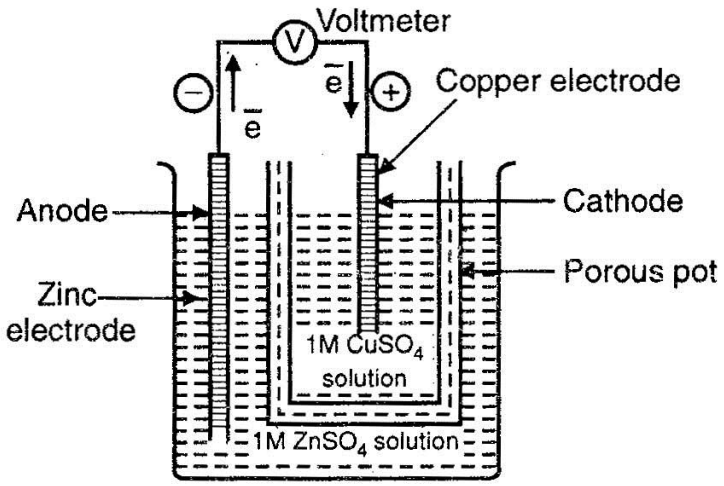
5.	b)	**Daniel Cell :-** Electrochemical or galvanic cell is Daniel Cell. **Construction:-** 1) It consists of zinc electrode dipping in $ZnSO_4$ Solution & copper electrode dipping in $CuSO_4$ solution. 2) In other words each electrode may be regarded as a half cell. 3) The two solutions are separated by a porous pot. 4) The two solutions can seep through the pot & so comes in contact with each other automatically. Thus, porous partition acts as a salt bridge.  **Working :-** The electrode reactions in Daniel Cell are :- At anode (-ve electrode) :- $Zn \longrightarrow Zn^{++} + 2e$ (oxidation) At Cathode (+ve electrode) :- $Cu^{++} + 2e^{-} \longrightarrow Cu$ (Reduction) Net Reaction $Zn + Cu^{++} \longrightarrow Zn^{++} + Cu$ The tendency of Zn to form Zn^{++} is greater than the tendency of Zn^{++} to get deposited as Zn on the electrode. Therefore Zn goes into the solution forming Zn^{++}.	1 1 2	4

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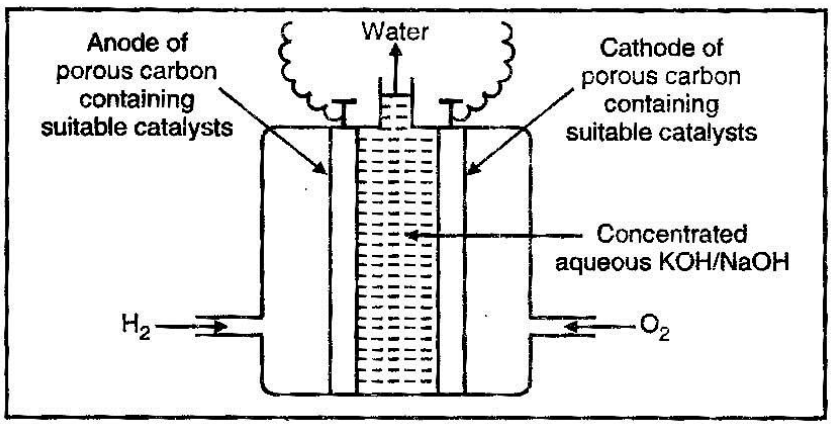
5.	b)	Thereby Zn metal electrode acquires negative charge. On the other hand tendency of copper to go into the solution is less than the tendency of Cu^{++} to get deposited as Cu & hence copper electrode becomes +vely charged. The emf of cell is 1:1 volt. **Cell may be represented as follows :-** $Zn \mid ZnSO_4 \mid\mid CuSO_4 \mid Cu^+$		
	c)	**1) Hydrogen – Oxygen Fuel Cell / H_2 - O_2 Fuel Cell:-** **Construction :-**  i) One of the simplest & most successful fuels is hydrogen – oxygen fuel cell. i) It consists of an electrolytic solution such as 25% KOH or NaOH solution, & two inert porous electrodes. (like porous carbon) containing suitable catalyst. iii) Hydrogen & oxygen gases are bubbled through the anode & cathode compartment respectively. **Working :-** The following electrode reactions takes place :-	1 1	4

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5.	c)	**Reactions:** **At anode :-** $2H_2 + 4OH^- \longrightarrow 4H_2O + 4e^-$ **At cathode :-** $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ **Overall reaction:** $2H_2 + O_2 \longrightarrow 2H_2O$ In actual practice the e.m.f. of cell is 0.8 to 1.0V. It may be noted that the only product discharged by the cell is water. Usually a large number of these cells are stacked together in series to make a battery, called fuel cell battery or fuel battery.	2	
	d)	**Advantages of secondary cells over primary cells:** 1. Secondary cells can be recharged number of times 2. Secondary cells life is longer. **Reactions taking place in Ni-Cd cell:** **A) Discharging :-** Positive Plate : $NiO_{2(s)} + 2H_2O(l) + 2e \rightarrow Ni(OH)_{2(s)} + 2OH^-$ Negative Plate : $Cd_{(s)} + 2OH^-_{(aq)} \rightarrow Cd(OH)_{2(s)} + 2e^-$ Net reaction : $NiO_{2(s)} + Cd_{(s)} + 2H_2O \rightarrow Ni(OH)_2 + Cd(OH)_2$ **B) Charging :-** Positive Plate : $Ni(OH)_{2(s)} + 2OH^-_{(a)} \rightarrow NiO_{2(s)} + 2H_2O + 2e^-$ Negative Plate : $Cd(OH)_{2(s)} + 2e \rightarrow Cd_{(s)} + 2OH_{(s)}$ Net reaction : $Ni(OH)_2 + Cd(OH)_2 \rightarrow NiO_{2(s)} + Cd_{(s)} + 2H_2O^-$	1 1 ½ 1 ½	4

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5.	e)	**1)Teflon :-** **Properties :- (consider any two properties)** 1) It is an ideal dielectric material with dielectric constant of 2.0 - 2.2 2) Thermally & chemically stable. 3) Stiff & so must be used in thin layers. 4) Withstand higher temperature. 5) Excellent electrical properties. 6) Available in the form of tapes, rods, sheets, tubing's & moulds. 7) Readily machined but can be moulded with difficulty. **Application :-** 1) Teflon used as capacitor dielectrics & insulating material for all kinds of windings. 2) Heat resistant materials are made by combing Teflon with glass cloth. **2) Silicone Fluid** :- **Properties :- (consider any two properties)** 1) They are relatively low molecular weight silicones or silicone polymers. 2) They possess great wetting power for metals, low surface tension. 3) They exhibit very small variations in viscosity with temp. **Applications :-** 1) Used a high temp lubricants, antifoaming agent, water repellent fluids. 2) Silicone fluids are modified & used as silicone greases & silicone compounds.	1 1 1 1	4

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5.	f)	**Ceramics: -** "Ceramics are inorganic non – metallic materials that are processed & used at high temperature." In restricted sense, those articles which are made of clay are mainly known ceramic. **Properties of Porcelain :- (any three)** 1) High softening point i.e. above 1800^0C. 2) Perfectly stable upto softening point. 3) Coefficient of expansion 0.45 x 10^{-5} & is able to withstand sudden change in temp. 4) Got neutral reaction. 5) Highly resistant to corrosion & resistant to abrasion. 6) Stable in oxidizing & reducing atmospheres resistant to the action of chemical. 7) Good strength upto softening point. 8) Low electrical conductivity 9) High thermal conductivity 10) Pure sillimanite is colourless but generally brown in colour due to presence of iron in it. **Uses :- (any three)** 1) Because of it refractory properties, it is used in making refractory blocks, bricks crucibles, saggers & other refractory fittings. 2) Manufacture of electrical insulators, spark plugs, transformer bushings, pin type insulators. 3) Resistance to chemical action, used for making jars & components for chemical reactions. 4) Used for many dental applications.	1 1 ½ 1 ½	4

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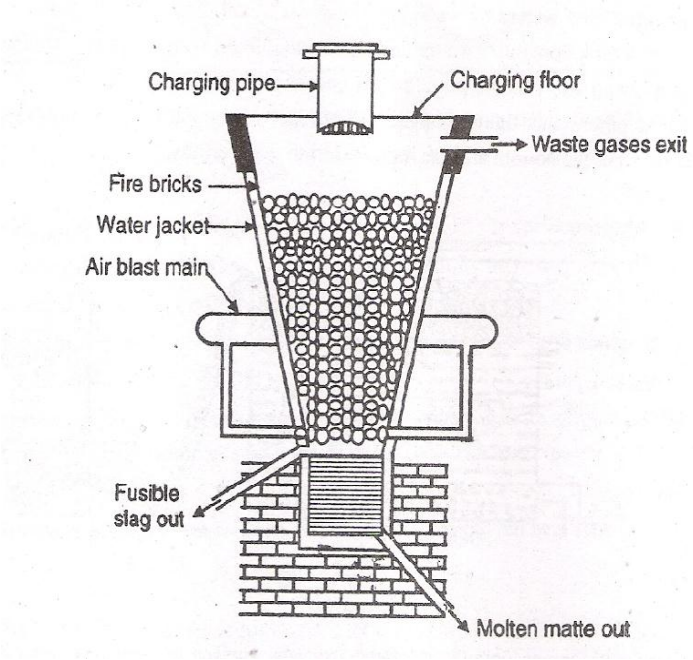
6.	a)	**Smelting of copper ore in a blast furnace** The roasted ore is mixed with coke and sand and heated in presence of excess of air in a water jacketed blast furnace. The modern copper blast furnace is shown in the figure. The roasted ore is mixed with waste coke and sand which is placed on charging floor. Then it is fed into the furnace through a charging pipe and hot air is blasted. The cuprous sulphide is taken out from bottom outlet.  Fig: 1. In roasting there is oxidation of ferrous sulphide to form ferrous oxide which then combines with sand to form fusible slag. $2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$ $FeO + SiO_2 \rightarrow FeSiO_2$ 2. Then cuprous oxide reacts with ferrous sulphide to form ferrous oxide $Cu_2S + 3O_2 \rightarrow Cu_2O + 2SO_2$ $2Cu_2O + FeS \rightarrow Cu_2S + FeO$	1 1 1 1	4

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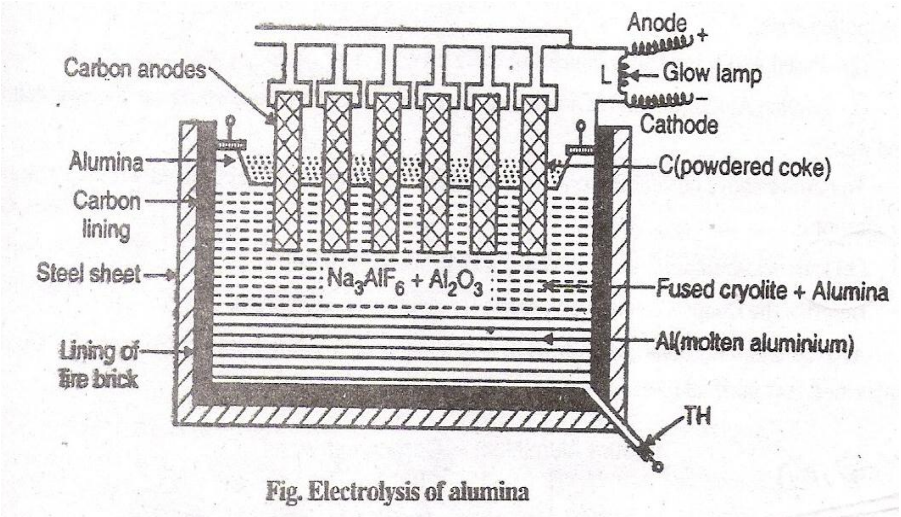
6.	b)	**Electrolytic reduction of Alumina(Al_2O_3)** **Process**: Figure shows electrolytic reduction of alumina(Al_2O_3) i) Alumina is dissolved in fused cryolite and electrolyzed in an iron tank lined inside with carbon which acts as cathode. ii) The anode consists of number of carbon rods, suspended vertically from the copper clamps. iii) The electrolyte is a mixture of alumina (20%), cryolite (60%) and calcium fluoride (20%). iv) The temp of both is kept at about 900-1000c v) On passing current, alumina decomposes to aluminium and oxygen. $2\ Al_2O_3 \rightarrow 4Al + 3O_2$ vi) The molten aluminium sinks to the bottom (cathode), while oxygen appears at anodes gets oxidized to CO and CO_2. vii) The process is continuous and fresh quantity of Al_2O_3 is added time to time.  Fig. Electrolysis of alumina	2 2	4

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6.	c)	**Solders :-** Solders are low melting alloys of tin and Pb. These can be soft or hard depending upon the percentage of tin & Pb. As the percentage of Pb increases and that of tin degreases solder becomes soft. **Classification: (Any three)** **i) Soft Solders: -** They melt at low temperatures. They are used for soldering electrical connections. Sealing tin cans & joining Pb pipes. **ii) Brazing alloys :-** Brazing alloys are used for soldering steel joints. **iii) Tinmann's Solder :-** It melts at 180^0C and used for joining articles of tin. **v) Plumber,s Solder:** It begins to solidify at 240^oC & passing through a pasty stage solidifies at 180^oC . This range of solidification enables the plumber to make wiped joints.	1 1 mark each	4
	d)	**Cladding**: Metal cladding involves bonding firmly and permanently, a dense, homogeneous layer of a metal to the base metal on one or both sides. **Process:** In this method the base metal to be protected from corrosion is sandwiched or cladded between the two sheets of coating metal. Then it is passed through two heavy rollers at high temperature. The coated metal is catholic with respect to base metal so that electrolytic protection is provided.	2	4

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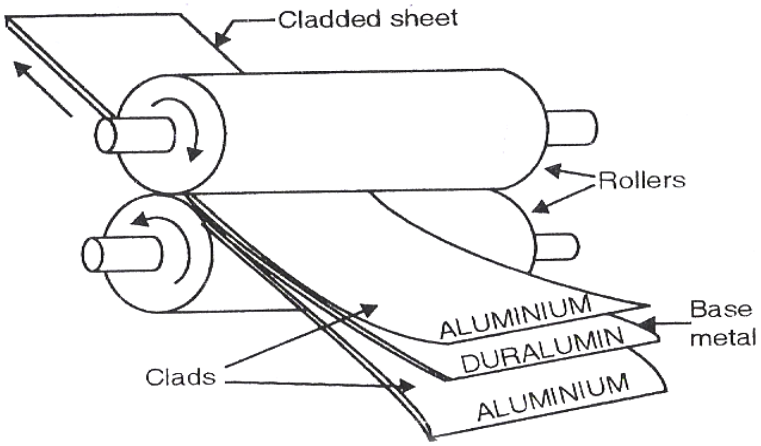
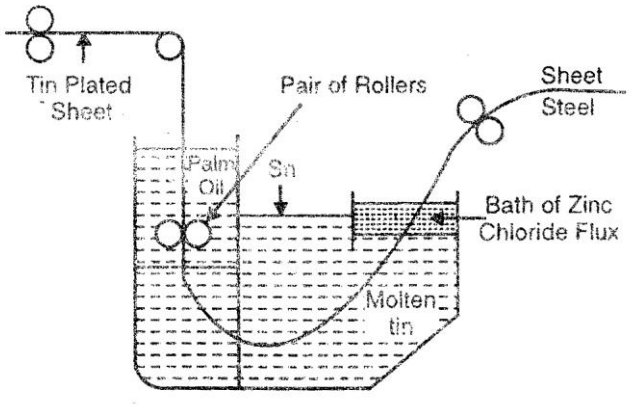
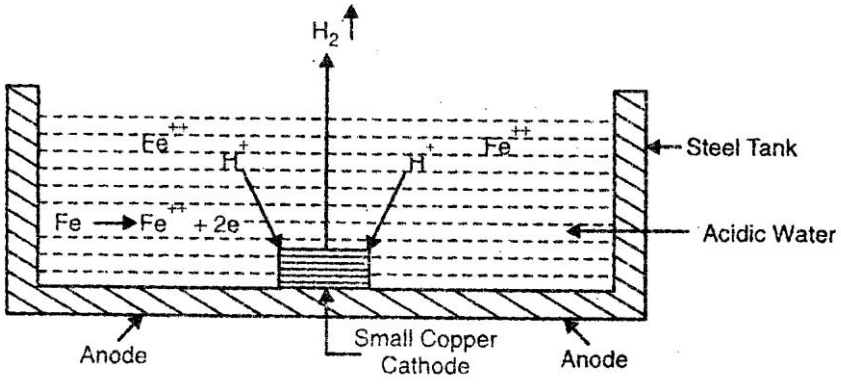
6)	d.	 **Uses:** 1. Alclad sheets are used in aircraft industry. 2. Copper cladded utensils are used for domestic and industrial purposes.	1 1	
	e)	**Tinning:** The process of covering iron or steel sheets with a thin coat of tin (Sn) to prevent it from rusting is called tinning. **Process:** (1) The sheet of steel, which is to be tinned, is cleaned with sulphuric acid, washed and dried. (2) It is then dipped in a bath containing molten zinc chloride flux. The flux helps the molten metal to adhere to the metal sheet. (3) It is then passed through a tank of molten tin. (4) It is then passed through a pair of rollers and palm oil. The palm oil protects the coated sheet from oxidation.	1 2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Mark
	f)	**Diagram:**  **Mechanism of Immersed corrosion by Hydrogen evolution:-**  A steel tank containing acidic industrial waste and small piece of copper scrap in contact with steel. The portion of the steel tank in contact with copper is corroded most with the evolution of evolution of hydrogen gas. The reactions are $Fe \longrightarrow Fe^{++} + 2e^-$ These electrons flow through the metal from anode to the cathode	1 2 2	4

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		At cathode H^+ ions are eliminated as H_2 gas $2H+ + 2e^- \longrightarrow H_2 \uparrow$ Thus, over all reaction is $Fe + 2H+ \longrightarrow Fe^{++} + H_2 \uparrow$ Anodes are usually very large areas whereas cathodes are small areas. e.g. In acidic environments like industrial waste, Solutions of non – oxidizing acids (like HCl)		