Applied Chemistry

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
		Important Instructions to examiners: 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme. 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate. 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills). 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn. 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer. 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding. 7) For programming language papers, credit may be given to any other program based on equivalent concept.		

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1.		**Attempt any NINE of the following:**		18
	a.	**Name the type of metal oxide film formed due to corrosion by Aluminum metal.** Stable Non-porous (protective) metal oxide film is formed due to corrosion by Aluminum metal.	2	2
	b)	**Write two uses of slag**. 1) It is used as filler for rail roads. 2) It is used in the manufacturing of cement for road making. 3) It is used as a fertilizer & for soil conditioning. **(Note: Write any two points)**	1 mark each	2
	c)	**Explain why steel is tempered after quenching.** Steel which is taken out of quenching medium becomes very hard & brittle & has unequally distributed stresses. So to minimize it, tempering is done.	2	2
	d)	**Explain the function of gypsum in Portland cement.** To avoid early initial set, gypsum is added in cement. The added gypsum decreases the dissolution of C_3A by forming insoluble calcium sulpho–aluminate which does not have quick hydration property. $C_3A + H_2O + CaSO_4.2H_2O \rightarrow C_3A.CaSO_4.2H_2O$ + Heat. This reaction prevents a high concentration of alumina in the cement solution & decrease the early initial set of the cement.	2	2
	e)	**Name two ores of iron with chemical formula.** **(Note: Write any two ores)**	½ mark each	2

Type	Name	Molecular formula
Oxide	Magnetite	Fe_3O_4
	Haematite	Fe_2O_3
	Limonite	$2Fe_2O_3.3H_2O$
Carbonate	Siderite	$FeCO_3$
Sulphide	Iron pyrite	FeS_2

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1.	**f)**	**List two causes of formation of boiler scale.** **1) Chemical Decomposition**-Calcium bicarbonate & Magnesium bicarbonate decomposes at higher temperature to form insoluble carbonates which precipitates to form scale. $Ca(HCO_3)_2 \longrightarrow CaCO_3 + H_2O + CO_2 \uparrow$ Scale **2) Decrease in solubility of salts –** Some salts present in hard water becomes insoluble at higher temperature. e.g. $CaSO_4$, $CaSiO_3$, $MgSiO_3$. These salts form hard scale at high temperature.	1 mark each	2
	g)	**Name two constituents of paint and one function of each.** **1) Pigments** **Functions:-** 1) Provide opacity and colour to paint film. 2) Give strength to the film. 3) Give protection to the paint film 4) Provide resistance to paint film against abrasion, moisture and weather. **2) Drying Oil / Medium** **Functions:-** 1) It is a main film forming constituent. 2) it provides durability and water proofness to the film. 3) It improves toughness and adhesion of the paint film. 4) It forms protective film by oxidation.	1 mark each	2

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1	**g)**	**3) Thinners** **Functions:-** 1) They are suspended pigments. 2) They dissolve film forming materials. 3) They reduce viscosity of paints for proper handling and to impart better covering power. 4) They help the drying of film by evaporation. **4) Driers** **Functions of driers:** 1) They improve drying quality of paint film. 2) They act as oxygen carrier catalysts. 3) They accelerate the drying of oil film. **5) Extenders** **Function:-** 1) They reduce the cost of paint. 2) They increase durability of paint. 3) They help to reduce the cracking of dry paint. 4) They acts as carriers for pigmented colour. **6) Plasticizers** 1) To give elasticity to the film. 2) To prevent cracking of the film. **(Note: Write any two points)**		
	h)	**Explain why we have to take more care during slaking of quick lime.** We have to take more care during slaking of quick lime because large amount of heat is evolved and lumps of it burst with explosive force as the steam generated escapes.	2	2

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>1.</td><td>i)</td><td>Explain metal cladding. Give its limitations.
Metal cladding involves bonding firmly and permanently, a dense homogenous layer of a coating metal to the base metal on one or both sides.
Limitations: 1) By this method only plane surfaces can be protected.
2) If cladding is not perfect the irregular surfaces provide galvanic cell action in presence of moisture so corrosion cannot be prevented.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td>j)</td><td>Explain why chlorination is used for stabilization of water in Army.
Chlorination is used for stabilization of water in Army because Cl_2 reacts with water to produce hypochlorous acid & nascent oxygen which kills germs and microorganisms, removes irritating smell and gives good taste to water.</td><td>2</td><td>2</td></tr>
<tr><td></td><td>k)</td><td>
<table>
<tr><th>Galvanizing</th><th>Sherardizing</th></tr>
<tr><td>1) It is the process of coating iron or steel sheets with a thin coat of Zn by hot dipping.</td><td>It is the process of coating small iron or steel article by alloying at the surface of base metal (iron)</td></tr>
<tr><td>2) This process is carried out in large tanks by dipping iron sheet in a bath of molten Zinc at a temp of about 425 – 460^{0}C by covering the bath with a flux of NH_4Cl.</td><td>This process is carried out in rotating closed drum like furnace by packing the small iron or steel article in Zinc powder at a temp of about 350 – 400^{0}C in reducing atmosphere.</td></tr>
<tr><td>3) In galvanizing a layer of Zn – Fe alloy is formed to which the outer layer of Zinc sticks.</td><td>In sherardizing Zinc gets diffused into iron forming Fe – Zn alloy at the surface only.</td></tr>
</table>
(Continued on next page)</td><td>1 mark each</td><td>2</td></tr>
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		4) This process is widely used for protecting iron exposed to the atmosphere as in the case of roofs, wire fences, pipes & fabricated articles from galvanized sheets like buckets, tubes etc. | This process is used for protecting small iron and steel articles like bolts, screws, nails nuts etc. There is very little change in dimensions of small articles due to the formation of very thin layer of Zinc.		
		(Note: Write any two points)		
	l)	**Name two properties and two applications of high carbon steel.**		
		Properties:	1	2
		1) It has carbon content 0.6 – 1.5%		
		2) It is quite hard.		
		3) It is unweldable.		
		4) It gets desired hardness on heat treatment.		
		5) Its tensile strength is highest.	1	
		Applications:		
		High carbon steel is used in making Wooden working tools, chisels, saws, drills, metal cutting tools for lathes, cutters, knives, blades, razors etc.		
		(Note: Write any two points each)		
2.		**Any FOUR of the following.**		16
	a)	**Write chemical reactions in the zone of reduction for extraction of iron in blast furnace.**		
		The reduction is done in stages as given below:-	1 mark each	4
		$Fe_2O_3 \longrightarrow Fe_3O_4 \longrightarrow FeO \longrightarrow Fe$		

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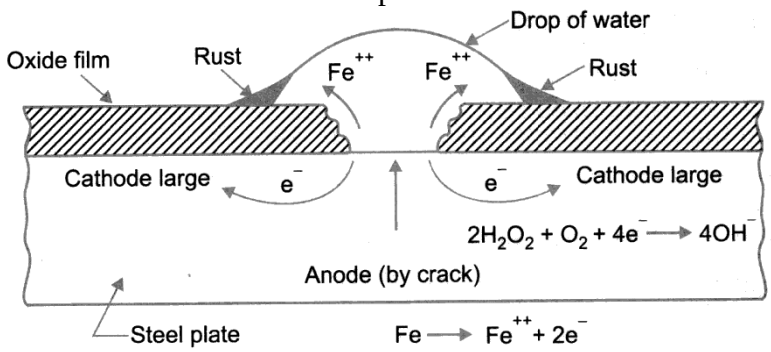
2.	**a)**	i) In between 300 – 500^{0}C, when charge is heated, Fe_2O_3 (Ferric oxide) is reduced to Fe_3O_4 (Ferroso ferric oxide). $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$. This Fe_3O_4 is stable upto 650^{0}C in presence of CO, CO_2 & free coke. ii) In between 650 – 700^{0}C, Fe_3O_4 is reduced to FeO $Fe_3O_4 + CO \longrightarrow 3FeO + CO_2$. iii) At temperature between 700 – 800^{0}C, FeO is reduced to metallic iron. $FeO + CO \longrightarrow Fe + CO_2$. iv) Simultaneously, the limestone present in the charge is also decomposed to produce lime. $CaCO_3 \longrightarrow CaO + CO_2$. v) The metal produced is spongy; simultaneously a part of metallic iron reacts with CO to form Fe_2O_3 or Fe_3O_4. $2Fe + 3CO \longrightarrow Fe_2O_3 + 3C$. $3Fe + 4CO \longrightarrow Fe_3O_4 + 4C$. **(Note: Write any four points)**		
	b)	**Write mechanism of electro chemical corrosion by absorption of O_2 gas.** **Anode: -** By crack **Cathode :-** Coated metal part  **Process:** i) The surface of iron is usually coated with a thin film of iron oxide. However if this iron oxide film develops some cracks, anodic areas are created on the surface while the coated metal part acts as cathode.	1 1	4

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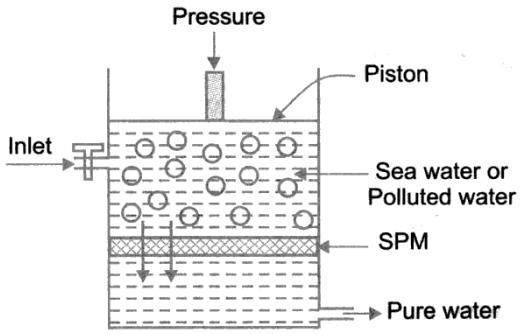
2.	**b)**	At Anode:- $Fe \longrightarrow Fe^{++} + 2e^{-}$ The liberated electrons flow from anode to cathode areas. The electrons are reacting with water and dissolved O_2. At Cathode:- $2H_2O + O_2 + 4e^{-} \longrightarrow 4OH^{-}$ The Fe^{2+} ions at anode and OH^{-} ions at cathode diffuse and when they meet $Fe(OH)_2$ is precipitated. $Fe^{2+} + 2(OH)^{-} \longrightarrow Fe(OH)_2$ If enough oxygen is present, $Fe(OH)_2$ gets converetd into $Fe(OH)_3$ i.e. yellow rust. $4 Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4 Fe(OH)_3$	2	4
	c)	**Explain reverse osmosis method with labeled diagram for distillation of sea water.**  In reverse osmosis the flow of solvent takes place in reverse direction i.e. from higher concentration solution to lower concentration solution through the semi permeable membrane (SPM). Thus in reverse osmosis, we separate water from its contaminants rather than contaminants from water. Sea water is filled in reverse osmosis cell. A pressure of 200-800 psi is applied on it to force the solvent to pass through SPM.SPM has such porosity that it allows only H_2O molecules to pass through & higher sizes ions are prohibited from passing.	1 3	

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2.	**d)**	**Write the chemical composition of Portland cement.**		16

Sr. No.	Name of Constituent	Percentage
1	Lime (CaO)	60 – 67%
2	Silica (SiO_2)	17 – 25%
3	Alumina (Al_2O_3)	3 – 8%
4	Iron Oxide (Fe_2O_3)	0.5 – 6%
5	Magnesia(MgO)	0.1 – 4%
6	Sulpher trioxide (SO_3)	1 – 2%
7	Soda and Potash (Na_2O+K_2O)	0.5 - 1.3%
8	Gypsum ($CaSO_4.2H_2O$)	3 – 4%

½ mark each — 4

e) **List two disadvantages of using hard water in paper and textile industry.**

Paper industry- 1) If hard water used in textile industry then large quantity of soap is wasted. — 2

2) If hard water is used in paper manufacturing, then Ca^{2+} and Mg^{2+} ions react with the paper material. Hence, paper will not have desired smoothness and glossiness.

3) Iron & manganese impurities in hard water affect whiteness of colors.

Textile industry-1) If hard water used in textile industry then large quantity of soap is wasted while washing the yarn. — 2

2) At the same time, undesirable precipitate is formed which adheres to the fabrics and the exact shades of color are not obtained.

3) Iron & manganese salts may cause stains on fabrics. — 1

(Note: Write any four points) — 4

f) **Define heat treatment. Give four purposes of heat treatment.**

Definition: Heat treatment of steel may be defined as the process of heating steel to a certain high temperature and then cooling it at a controlled rate, in order to develop certain desirable physical properties in it without changing it chemical composition. — 1

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2.	**f)**	**Purpose:-** • To change the structure of steel, • To increase surface hardness. • To increase resistance to heat & corrosion. • To vary strength & hardness. • To make steel easily workable. • To remove the trapped gases. • To improve machinability & mechanical properties. • To alter magnetic properties of steel.	3	
3.		**Any FOUR of the following.**		16
	a)	**Explain atmospheric corrosion. Describe two factors affecting rate of it.**		4
		Atmospheric corrosion: - This type of corrosion occurs when metal surface comes in immediate contact directly with atmospheric gases like O_2, Cl_2, Br_2, I_2, H_2S, CO_2, SO_2, NO_2 etc. **OR** Type of corrosion which is brought about by the atmospheric conditions is called atmospheric corrosion.	2	
		Factors:- **1) Impurities in the atmosphere:-** Corrosion rate is fast in the presence of all impurities such as H_2S, SO_2, CO_2, Cl_2, gases along with vapors of HCl & H_2SO_4 etc. Atmospheric air in industries areas contains these impurities.	1	
		2) Moisture in the atmosphere:- Atmospheric gases & chemical vapors dissolve in moisture and reaction between such dissolved gases and metal becomes faster. Therefore moisture acts as conducting medium and enhances the corrosion.	1	

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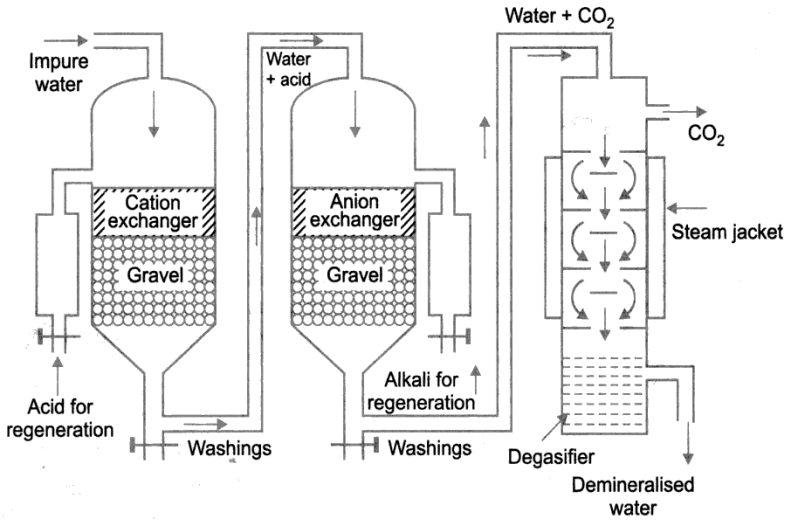
3.	**b)**	**Write chemical reactions taking place during in setting and hardening of cement.** **1] Hydrolysis:** $C_3S + (x+ 1) H_2O \longrightarrow C_2S. xH_2O + C.H_2O.$ $C_4AF + 7 H_2O \longrightarrow C_3A. 6H_2O + CF.H_2O.$ **2] Hydration:** $C_3S + xH_2O \longrightarrow C_2S .x H_2O + CaO.$ $C_3A + 6 H_2O \longrightarrow C_3A.6 H_2O + Heat.$	2 2	4
	c)	**Describe ion exchange process of softening with net labeled diagram and chemical reactions.** Ion exchange process is the process removing minerals salts present in hard water.  	2	4

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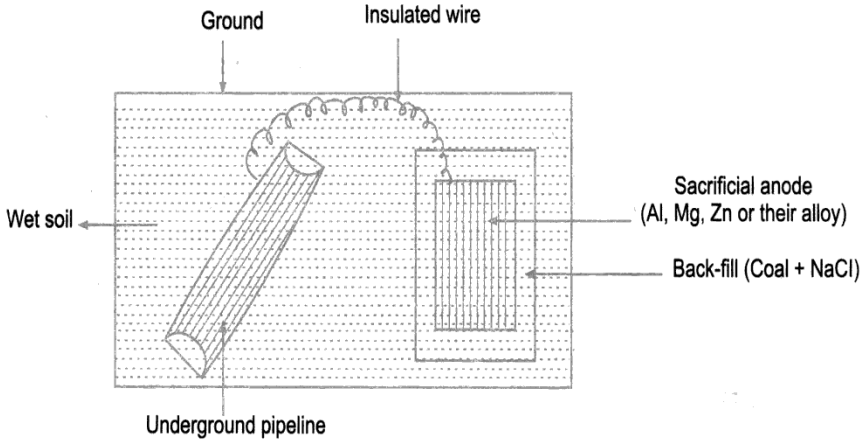
3.	**c)**	**Working and chemical reactions**: It consists of two cylindrical towers. The first tower consists of cations exchanger (RH_2) & another one consists of anion exchanger $R'(OH)_2$. Hard water is first allowed to pass through a tower containing cation exchanger which removes all the cations like Ca^{2+}, Mg^{2+} etc. $RH_2 + CaCl_2 \longrightarrow RCa + 2HCl$ $RH_2 + MgSO_4 \longrightarrow RMg + H_2SO_4$ This acidified water is then passed through tank containing anion exchange resins. Here all the anions are replaced by OH^- ions. $R'(OH)_2 + 2HCl \longrightarrow R'Cl_2 + 2H_2O$ $R'(OH)_2 + H_2SO_4 \longrightarrow R'(SO_4) + 2H_2O$ Thus water becomes free from all ions. This water is then passed through a degasifier to remove gases like CO_2.	2	4
	d)	**Explain why tinned containers preferred over galvanized containers for storing food stuffs.** Tinned containers preferred over galvanized containers for storing food stuffs. Because Tin metal is less active and have corrosion resistance. It is nontoxic and does not react with food stuff and does not causes food poisoning. Whereas zinc is more electropositive (active metal) than iron hence it reacts with weak organic acids present in food stuffs to produce poisonous compound.	2 2	4
	e)	**Describe details about the electrochemical protection by sacrificial anodic method with the help of diagram. Write its applications.**  		4

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3.	**e)**	The metallic structure to be protected from corrosion is connected to the anodic metal by an insulating wire. The more active metals like Zn, Al, Mg etc. acts as anode and get corroded hence it is known as sacrificial anode. For the purpose of increasing electrical contact the active metal is placed in back fill. (Coal + NaCl) When the sacrificial metal is consumed completely it is replaced by fresh piece.	2	
		Applications: This method is applicable to protect buried pipelines, buried cables, hot water tank, ship hull etc. Mg or Zn rods are bolted along the sides of ship, hot water tank or inserted into boiler to prevent corrosion.	1	
	f)	**On analysis of a sample of water it is found that 100ml water sample requires 20ml of 0.01m EDTA solution using butter and EBT indicator. Calculate hardness of water sample in ppm.**		4
		We know that, 1000ml 1M EDTA = 1000ml 1M of $CaCO_3$. 1000ml 1M EDTA = 100gm of $CaCO_3$.	1	
		Therefore, to calculate, 1000ml 1M EDTA = 100gm of $CaCO_3$. 20ml 0.01M EDTA = 100 x 20 x 0.01 / 1000 x1 gm of $CaCO_3$. = 0.02gm/lit of $CaCO_3$.	2	
		To convert gm./lit into mg/lit, we have. 0.02 x 1000 = 20 mg/lit of $CaCO_3$. = 20 ppm of $CaCO_3$.	1	
		Therefore hardness of water sample = 20ppm.		