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 two ores of iron with their chemical formula.**		2
		Name of the ore / **Molecular formula** 1.Magnetite – Fe_3O_4 2.Haematite – Fe_2O_3 3.Limonite – $2Fe_2O_3, 3H_2O$ 4.Siderite – $FeCO_3$ 5. Iron pyrite – FeS_2	1 mark each	
	(b)	**Write chemical reaction for formation of slag in blast furnace.** **Chemical reaction for formation of slag :-** $CaO + SiO_2 \longrightarrow CaSiO_3$ Flux Gangue Slag	2	2
	(c)	**Give four purposes of heat treatment of steel** **Purposes of heat treatment of steel:-** 1.To change the structure of steel, 2.To increase surface hardness. 3.To increase resistance to heat & corrosion. 4.To vary strength & hardness. 5.To make steel easily workable. 6.To remove the trapped gases. 7.To improve machinability & mechanical properties. 8.To alter magnetic properties of steel	½ mark each	2
	(d)	**State the two factors affecting on atmospheric corrosion** **Factors affecting on atmospheric corrosion**:- 1) Impurities in the atmosphere 2) Moisture in the atmosphere	1 mark each	2
	(e)	**Give two functions of pigments** **Functions of pigments:-** 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. 5) To reflect heat and light.	1 mark each	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>(f)</td><td>Distinguish between galvanizing and tinning (two points of each) .
<table>
<tr><th>Sr.No.</th><th>Galvanizing</th><th>Tinning</th></tr>
<tr><td>i)</td><td>A process of covering iron or steel with a thin coat of Zinc to protect it from corrosion.</td><td>A process of covering iron or steel with a thin coat of Tin to protect it from corrosion.</td></tr>
<tr><td>ii)</td><td>In galvanising, zinc protects the iron as it is more electropositive than iron.It does not allow iron to pass into solution.</td><td>Tin protects base metal iron from corrosion, as it is less electropositive than iron and higher corrosion resistance.</td></tr>
<tr><td>iii)</td><td>In galvanizing Zn continues to protect the metal by galvanic cell action, even if coating of Zn is broken.</td><td>In tinning tin protects the iron, till the coating is perfect. Any break in coating causes rapid corrosion of iron.</td></tr>
<tr><td>iv)</td><td>Galvanized containers can not be used for storing acidic food stuff, since Zn reacts with food acids forming Zn compounds which are highly toxic i.e. poisonous.</td><td>Tin coated containers and utensils can be used for storing any food stuff since Tin is non toxic and protects the metal from corrosion and does not causes food poisoning.</td></tr>
</table></td><td>1 mark each</td><td>2</td></tr>
<tr><td></td><td>(g)</td><td>Write two applications of metal spraying.
Applications of metal spraying
i) It is used to develop metallic coating on large and irregular surfaces.
ii) It is used to develop metallic coating on non metallic surfaces like glass, plastic etc.
iii) It is used to develop metallic coating on fabricated structures.
iv) In industry it is used to repair worn out machine parts .
v) In chemical industry coating of metal like Al, Zn, Ni, Sn, Pb etc. can be done by metal spraying.</td><td>1 mark each</td><td>2</td></tr>
</table>

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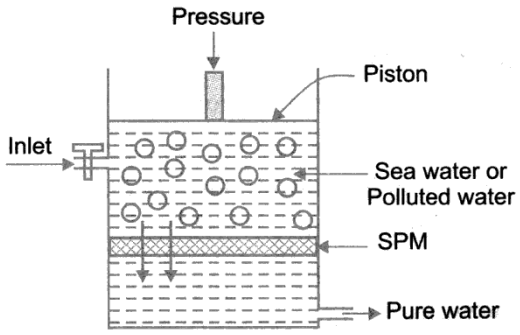
1	(h)	**List two causes of formations of boiler scales.** **Causes of formation of boiler scales:-** **1) Chemical Decomposition**-Calcium bicarbonate & Magnesium bicarbonate decomposes at higher temperature to form insoluble carbonates which precipitates to form scale. $Ca(HCO_3)_2 \longrightarrow CaCO_3 + H_2O + CO_2 \uparrow$ 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**
	(i)	**How can the exhausted permutite or zeolite be regenerated?** Exhausted Permutit or Zeolite can be regenerated by using 10 % brine (NaCl) solution. $CaP + 2NaCl \longrightarrow Na_2P + CaCl_2$ $MgP + 2NaCl \longrightarrow Na_2P + MgCl_2$ **(Any one reaction-1 mark)**	1 1	**2**
	(j)	**Draw the diagram of reverse osmosis cell for desalination of sea water.**  	2	**2**
	(k)	**List any four constituents of cement.** **The constituents of paint are:-** 1) Pigments 2) Drying Oil / Medium / Vehicle 3) Thinners 4) Driers 5) Extenders 6) Plasticizers	1/2 mark each	**2**

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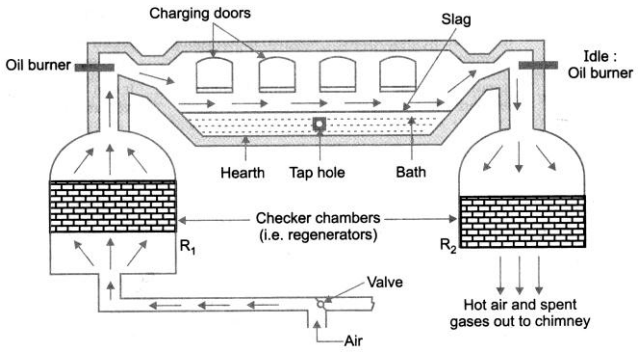
1.	**(l)**	**What is slaking of lime.** The action of water on quick lime is known as slaking of lime. **OR** When 3 parts quick lime & one part of water are mixed together to form slaked lime the process is called slaking of lime. **OR** $CaO + H_2O \longrightarrow Ca(OH)_2$ Quick lime Slaked lime	2	**2**
2		**Attempt any FOUR of the following:**		16
	(a)	**Write the chemical reactions in the zone of heat absorption for extraction of iron in blast furnace** **Chemical reactions in the zone of heat absorption:-** i) $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ ii) $CO_2 + C \rightarrow 2CO$- 39 Kcal iii) $2CO \rightarrow CO_2 \uparrow + C$ iv) $CaO + SiO_2 \rightarrow CaSiO_3$ (Slag) v) $SO_2 + 2C \rightarrow S + 2CO\uparrow$ vi) $P_2O_5 + 5C \rightarrow 2P + 5CO\uparrow$ vii) $MnO_2 + 2C \rightarrow Mn + 2CO\uparrow$ viii) $SiO_2 + 2C \rightarrow Si + 2CO\uparrow$ **(Note: Any four reactions:)**	4 1 mark each	
	b)	**With neat and labeled diagram, describe open hearth process for preparation of steel**  **Procedure:**-1) The charge consists of pig / cast iron (Cold or molten), scrap iron / steel & haematite (Ore). 2) The process consist of heating the charge on the hearth of furnace by the heat produced by burning fuel in air or by producer gas. 3) During the **First Phase of Cycle,** Producer gas / air is passed through previously heated regenerator (R_1) while the products of combustion flow through the regenerator.	4 1 1	

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2		4) The charge is fed through a charging door & heated to 1600^0C to 1650^0C by means of producer gas. Fuel is fired through nozzles. 5) The hot gases formed in (R_1) pass over the hearth to its opposite end & metal charge supported on the hearth is openly exposed to the flames & is converted into molten metal. Metal charge is also heated by the radiations from the walls. 6) After passing over the hearth, the products of combustion pass through R_2 (Checker chamber) & heat it. **7)** After about 25 to 30 minutes the **Second Phase Cycle** starts & the idle burner fires the fuel. 8) Regenerators R_1, R_2 store & release large quantities of heat which would have escaped to the atmosphere & thus wasted. 9) Tap hole in the lowest part of the hearth is always closed with refractory plug until metal is ready to be poured. 10) Before tapping the molten metal into the ladle a sample of the same may be tested for its chemical composition. The process requires 8-10 hours **Reactions:-** a) Oxidation of impurities of Mn, P and Si by haematite. $2Fe_2O_3 + 6Mn \rightarrow 4Fe + 6MnO$ $5\ Fe_2O_3 + 6P \rightarrow 10Fe + 3P_2O_5$ $2Fe_2O_3 + 3Si \rightarrow 4Fe + 3SiO_2$ b) Formation of slag for the removal of Mn, P & Si. $MnO + SiO_2 \rightarrow MnSiO_3$ $P_2O_3 + 3Cao \rightarrow Ca_3(PO_4)_2$ } Slag $SiO_2 + CaO \rightarrow CaSiO_3$ c) Finally C & S from gaseous oxides which leave the furnace as five gases $2\ Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2\uparrow$ $2Fe_2O_3 + 3S \rightarrow 4Fe + 3SO_2\uparrow$	2	

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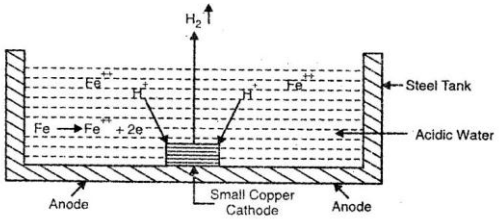
2	(c)	**Differentiate between annealing normalizing**	1 Mark each	4

Annealing	Normalizing
1.It is the process of heating the steel at a temperature (760-925^{0}C) and cooling it slowly in the furnace	1.It is the process of heating the steel at a temperature of 50 ^{0}C above the critical temperature (725^{0}C) and cooling it freely in air at a rate of 5 ^{0}C/Sec.
2.Due to annealing steel becomes more soft, pliable, malleable & ductile	2. Due to normalizing steel becomes homogenous & more soft. The mechanical properties of steel are more improved than annealing.
3.Time required for annealing is more than normalizing	3.Time required for normalizing is less than annealing
4.Consumption of fuel or electric power is more.	4.Consumption of fuel or electric power is less.

	(d)	**Describe mechanism of electrochemical corrosion by evolution of hydrogen gas**	1	4



Steel tank: - Anode
Cu – strip:- Cathode
These types of corrosion occur usually in acidic environments like industrial waste, solutions of non – oxidizing acids.
Consider 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 acts as anode & is corroded most with the evolution of hydrogen gas. 1

Reactions:
At Anode:
$Fe \longrightarrow Fe^{++} + 2e^{-}$ (Oxidation)

These electrons flow through the metal lattice from anode to the cathode that is piece of copper metal where they are accepted by H^+ ions to form H_2 gas 1

At cathode :
H^+ ions are eliminated as H_2 gas
$2H^+ + 2e^{-} \longrightarrow H_2 \uparrow$ (Reduction)
Thus, over all reaction is 1
$Fe + 2H^+ \longrightarrow Fe^{++} + H_2 \uparrow$

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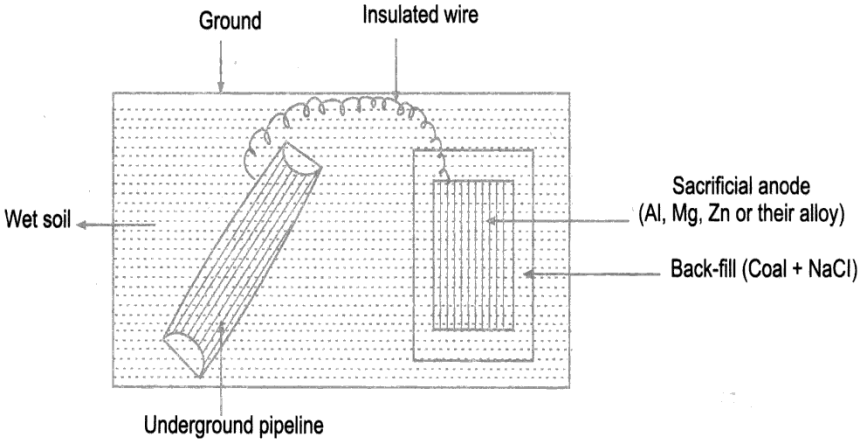
2	**(e)**	**What is atmospheric corrosion? Name the types of oxide films form in atmospheric corrosion with examples. Which oxide film is more protective.**		4
		Atmospheric corrosion: - The corrosion which occurs when metal surface comes in contact with atmospheric gases like O_2, Cl_2, Br_2, I_2, H_2S, CO_2, SO_2, NO_2 etc. is called as atmospheric corrosion **OR** Type of corrosion which is brought about by the atmospheric conditions is called atmospheric corrosion.	1	
		Types of oxide films:-		
		Type of oxide film / **Examples:** **Stable porous oxide film** / Sodium, Potassium, Lithium, Calcium, Magnesium. **Stable nonporous oxide film** / Aluminium, Copper, Chromium etc. **Volatile oxide film** / Mollybdenum **Unstable oxide film** / Gold , Silver, Platinum etc.	2	
		More protective oxide films-1.Stable nonporous oxide film 2.Unstable oxide film	1	
	(f)	**Explain the sacrificial anodic protection with neat labeled diagram. Write it's two applications.**		4
			1	
		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	2	

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<tr><td>3</td><td></td><td>contact the active metal is placed in back fill. (Coal + NaCl) When the sacrificial metal is consumed completely it is replaced by fresh piece.

Applications: 1.This method is applicable to protect buried pipelines, buried cables, hot water tank, ship hull etc.

2. Mg or Zn rods are bolted along the sides of ship, hot water tank or inserted into boiler to prevent corrosion.

Attempt any FOUR of the following.</td><td>1</td><td>16</td></tr>
<tr><td></td><td>(a)</td><td>Describe the four types of impurities present in natural water . Write one example of each .
<table>
<tr><th>Types of impurities</th><th>Examples</th></tr>
<tr><td>Suspended impurities</td><td>Decaying plants, plastic,dust,mud,clay</td></tr>
<tr><td>Dissolved impurities</td><td>Salts like $CaSO_4$, $MgSO_4$, $CaCl_2$,$MgCl_2$, NaCl, $Ca(HCO_3)_2$, $Mg(HCO_3)_2$ etc
Gases like O_2, CO_2, NH_3,H_2S etc.</td></tr>
<tr><td>Colloidal impurities</td><td>Fine dust,fine clay particals, organic matter</td></tr>
<tr><td>Biological impurities</td><td>Aquatic plants &animals, disease causing Bacteria’s, germs ,microorganism etc.</td></tr>
</table></td><td>1
Mark each</td><td>4</td></tr>
<tr><td></td><td>(b)</td><td>List two disadvantages of each using hard water in paper industry and textile industry.
Paper industry- 1) 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.
2) Iron & manganese impurities in hard water affect whiteness of paper

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

2</td><td>4</td></tr>
</table>

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3.		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.		
	(c)	**Calculate total hardness in ppm when 50ml of water sample requires 6.0ml of 0.02M EDTA solution using EBT as in basic medium** We know that, 1000ml 1M EDTA = 1000ml 1M of $CaCO_3$. 1000ml 1M EDTA = 100gm of $CaCO_3$. Therefore, to calculate, 1000ml 1M EDTA = 100gm of $CaCO_3$. 6ml 0.02M EDTA = 100 x 6 x 0.02 / 1000 x1 gm of $CaCO_3$. = 0.012gm of $CaCO_3$. 50ml water sample contains = 0.012gm of $CaCO_3$ 1000ml water sample contains = 0.012x1000/50 gm of $CaCO_3$ = 0.240 gm of $CaCO_3$ To convert gm./lit into mg/lit, we have. 0. 240 x 1000 = 240 mg/lit of $CaCO_3$. = 240 ppm of $CaCO_3$. **Therefore the total hardness of water sample = 240ppm.**	1 1 1 1	4 **4**
	(d)	**Describe ion exchange process of water softening with neat labelled diagram and chemical reactions.** Ion exchange process is the process removing minerals salts present in hard water. **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	

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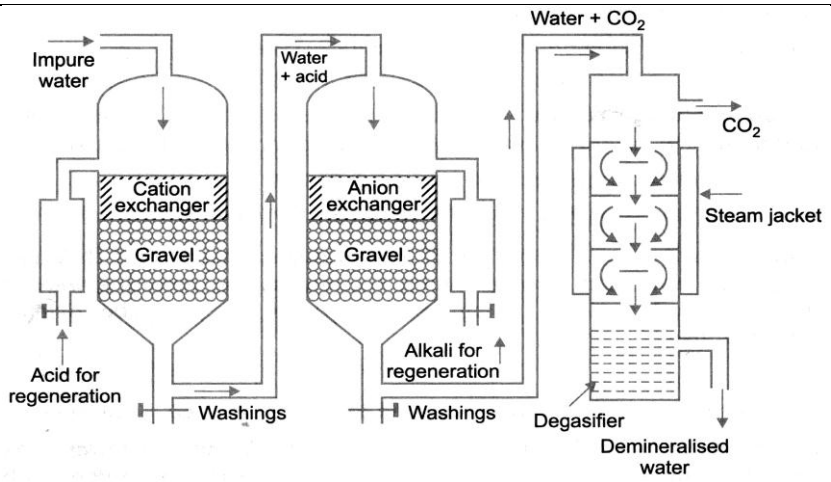
3.			2	
		(Note:Any one reaction of cation and anion exchanger)		4
	(e)	**Describe chlorination process with chemical reaction by using chlorine gas Write its two advantages.**		
		I] By using Cl_2 gas-		
		Cl_2 reacts with water to produce hypochlorous acid & nascent oxygen. Both are powerful germicides.Thus kills germs & microorganisms.	2	
		1) $Cl_2 + H_2O \longrightarrow HOCl + HCl$ [Hypochlorous acid]		
		2) $HOCl \longrightarrow HCl + [O]$ (Nascent oxygen)		
		3) Germs + [O] $\longrightarrow$ Germs are killed	2	
		Advantages:		
		I] Chlorine gas can be directly used as a gas or as chlorine water for sterilisation of water.		
		II] Chlorine gas is very effective for sterilisation of domestic water, swimming pools etc.		
	f)	**Describe setting and hardening of cement. Write chemical reactions taking place in same.**		4
		Setting and Hardening of cement: -		
		The setting and hardening of cement is due to hydration and hydrolysis reaction taking place between the different constituents of cement and water.	1	
		Anhydrous compounds undergo hydration forming insoluble gels and crystalline products.		
		Setting: is defined as stiffening of the original plastic mass due to initial gel formation.	1	
		Hardening: is the development of strength due to crystallization.		
		Following chemical reaction taking place during setting and hardening.		

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3.		Following chemical reaction taking place during setting and hardening. **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:** $C_3S + xH_2O \longrightarrow C_2S .x H_2O + CaO.$ $C_3A + 6 H_2O \longrightarrow C_3A.6 H_2O + Heat.$	1 1	