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.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.		**Attempt any nine:**		18
	a.	**Name the ores of iron.Write their chemical formulae.**		2

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

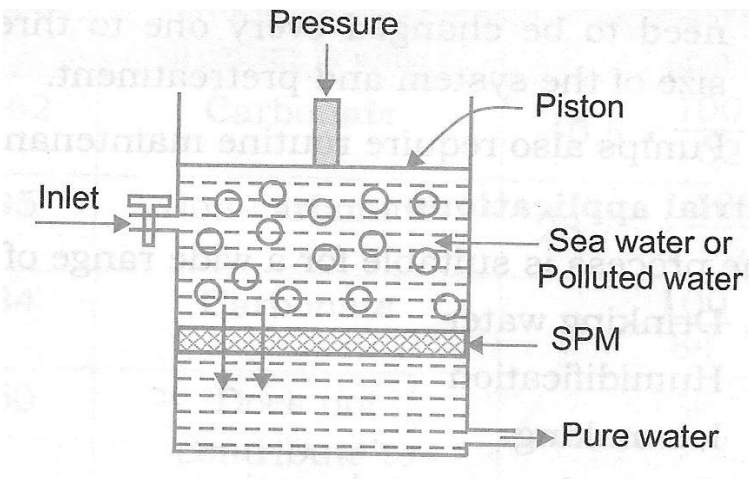
1 mark each

(Note: Any twoores with formula: 1 mark each)

	b)	**Define the terms:** **i) Metallugy** **ii) Slag.** **i)Metallurgy:** It is the process of extraction of a metal from its ore economically & profitably **ii)Slag:** Flux reacts with gangue to form some fusible mass known as Slag.	1 1	2
	c)	**Write the four properties of mild steel.** i) Soft, tough, malleable, ductile. ii) Suitable for welding. iii) Responds to heat treatment. iv) Tensile Strength is low. v) Can be magnetised permanently. vi) Can resist shock and impact. vii) Undergo corrosion quickly. **Note: Any Four**	½ mark each	2
	d)	**Define corrosion.Give its types.** The process of chemical or electrochemical decay or destruction of a metal due to the action of surrounding medium is called as corrosion. **Types:** i) Atmospheric corrosion or Direct chemical corrosion or Dry corrosion. ii) Immersed corrosion or electro chemical corrosion or Wet corrosion.	1 ½ mark each	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.	**e)**	**Write any two characteristics of ideal paint.** i) It should be able to resist the atmospheric conditions. ii) It should have desired consistency. iii) It should have high hiding power. iv) Its film should be washable. v) Its film should not crack or shrink on drying. vi) It should form uniform, nonporous, adherent, durable and glossy film. vii) When paint is applied on a metal, it should resist corrosion. **(Any Two : 2 Marks)**	**1 mark each**	**2**
	f)	**Distiguish between galvanizing and tinning.** **(Note: Any two points: 2 marks)**	**1 mark each**	**2**
	g)	**Write two applications of electroplating.** i) Used for protective coating of metals and non-metals. ii) Used to improve appearance and hardness of metal. iii) Used to increase resistance to corrosion, wear and chemical. iv) Used for coating of non-metals like wood,glass etc. to impart decoration, preservation and strength. v) Used in making surface conductive and utilization of light weight as in case of wood and plastic. **(Note: Two applications : 1 mark each)**	**1 mark each**	**2**

Sr.No.	Galvanizing	Tinning
i)	A process of covering iron or steel with a thin coat of **Zinc** to prevent it from rusting.	A process of covering iron or steel with a thin coat of **Tin** to prevent it from corrosion.
ii)	In galvanising, zinc protects the iron as it is more electropositive than iron.It does not allow iron to pass into solution.	Tin protects base metal iron from corrosion, as it is less electropositive than iron and higher corrosion resistance.
iii)	In galvanizing Zn continues to protect the metal by galvanic cell action, even if coating of Zn is broken.	In tinning , tin protects the iron, till the coating is perfect.Any break in coating causes rapid corrosion.
iv)	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.	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.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1	h)	**Name the types of impurities in natural water.** a) Suspended c) Colloidal b) Dissolved d) Biological.	½ mark each	2
	i)	**Write two advantages and two disadvantages of Zeolite process.** **Advantages: (Any Two)** i. Water having zero hardness can be obtained. ii. Equipment used is compact. iii. It is a clean process as no impurities are precipitated. iv. It requires less time. **Disadvantages: (Any Two)** i. If hard water contains coloured ions like Fe^{2+} or Mn^{2+} such permutits can not be regenerated easily. ii. If hard water contains mineral acids then it may destroy permutits. iii. If hard water is turbid then turbidity may clog the pores of permutit & it restricts the flow of water. iv. This method does not remove anions like CO_3^{2-} or HCO_3^{2-}. Due to these ions CO_2 is released in water and such water is extremely corrosive to boiler material. **(Note: Any two advantages and two disadvantages: ½ mark each)**	½ mark each ½ mark each	2
	j)	**Draw the diagram of reverse osmosis cell for desalination of sea water.**  	2	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.	**k)**	**Name the constituent of Portland Cement.** i. Lime ii. Silica iii. Alumina iv. Iron oxide v. Magnesia vi. Sulphur trioxide vii. Soda and Potash viii. Gypsum **(Note : Any four constituents : ½ mark each)**	**½ mark each**	**2**
	l)	**What is slacked lime? Give the reaction.** **Slacked Lime:** When 3 parts of quicklime is mixed with 1 part of water, the resulting product is a suspension of finely divided calcium hydroxide in water.It is known as slacked lime. **Reaction:** **$CaO + H_2O \rightarrow Ca(OH)_2 + Heat$ (15.9 Kcal)** **Quicklime Slaked lime**	**1** **1**	**2**
2.		**Attempt any four:**		**16**
	a)	**Write the chemical reaction in the zone of heat absorption for extraction of iron in blast furnace.** 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 mark)**	**1 mark each**	**4**
	b)	**Define heat treatment properties of steel. Explain hardening.** 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 its chemical composition.	**1**	**4**

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>2</td><td></td><td>Hardening:
In this method, steel is heated to high temperature (800 – 900^{0}C) & then suddenly cooled by dipping or quenching in some suitable medium.
The quenching medium is either cold water or mineral or animal or vegetable oil, 4-6 % caustic soda , 6-20 % NaCl solution etc.
Purposes :-
i) T improve strength, elasticity, ductility, toughness.
ii) To increase its resistance to wear or abrasion.
iii) To increase machinability (ability to cut other metals).
Limitation:-
Due to this method, steel becomes very hard & brittle.</td><td>3</td><td rowspan="2">4</td></tr>
<tr><td></td><td>c)</td><td>Give difference between pig iron, wrought iron and steel.
<table><tr><th>Pig iron</th><th>Wrought iron</th><th>Steel</th></tr><tr><td>Carbon content 2.5-4.5%</td><td>Carbon content 0.25-0.5%</td><td>Carbon content 0.05-1.5%</td></tr><tr><td>Structure is crystalline</td><td>Structure is Fibrous</td><td>Structure varies according to impurities</td></tr><tr><td>Melting point is lowest i.e. 1100-1200 ^{0} c</td><td>Melting point is highest i.e. 1500 ^{0} c</td><td>Melting point is between 1200-1500 ^{0} c</td></tr><tr><td>Very hard and brittle</td><td>Soft</td><td>Harder than wrought iron</td></tr><tr><td>High Tensile strength</td><td>Medium Tensile strength</td><td>Highest Tensile strength</td></tr><tr><td>It is neither malleable nor ductile</td><td>malleable and ductile</td><td>malleable and ductile if % of C is low.</td></tr><tr><td>It can not be magnetised permanently</td><td>Magnetised but temporarily</td><td>It can be magnetised permanently</td></tr><tr><td>It can not be forged</td><td>It can be forged easily</td><td>It can be forged but not easily</td></tr></table></td><td>1 mark each</td></tr>
</table>

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2				

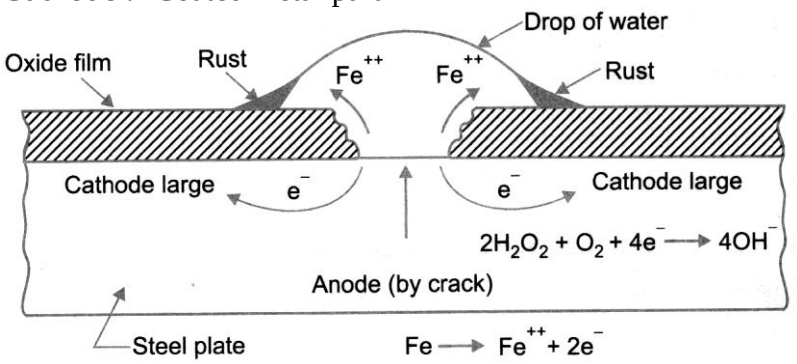
Pig iron	**Wrought iron**	**Steel**
Uses: Casting metal objects like stoves,railings,fire gates,electric poles,bunsen burner-bases etc.	**Uses:** Chains,wires,bolts,crane hooks,nails,railway couplings, carriages,cores of electromagnets,agricultural implements	**Uses:** Girders, Machinery Parts,Bar-Magnets, Razors, Springs

(Note: Any Four points : 4 Marks)

d) **Describe the mechanism of electrochemical corrosion by absorption of oxygen.** — **4**

Anode: - By crack

Cathode :- Coated metal part



1

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**

At Anode:-

$$Fe \longrightarrow Fe^{++} + 2e^-$$ — **1**

The liberated electrons flow from anode to cathode areas. The electrons are reacting with water and dissolved O_2.

At Cathode:-

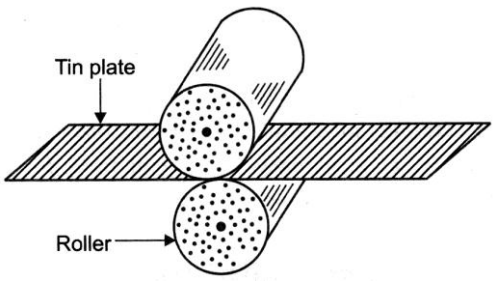
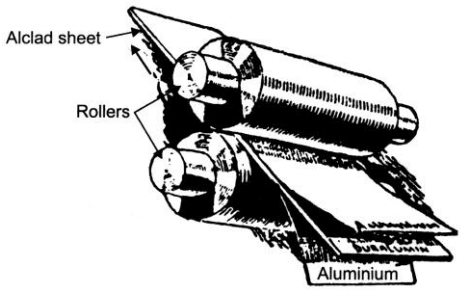
$$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$$

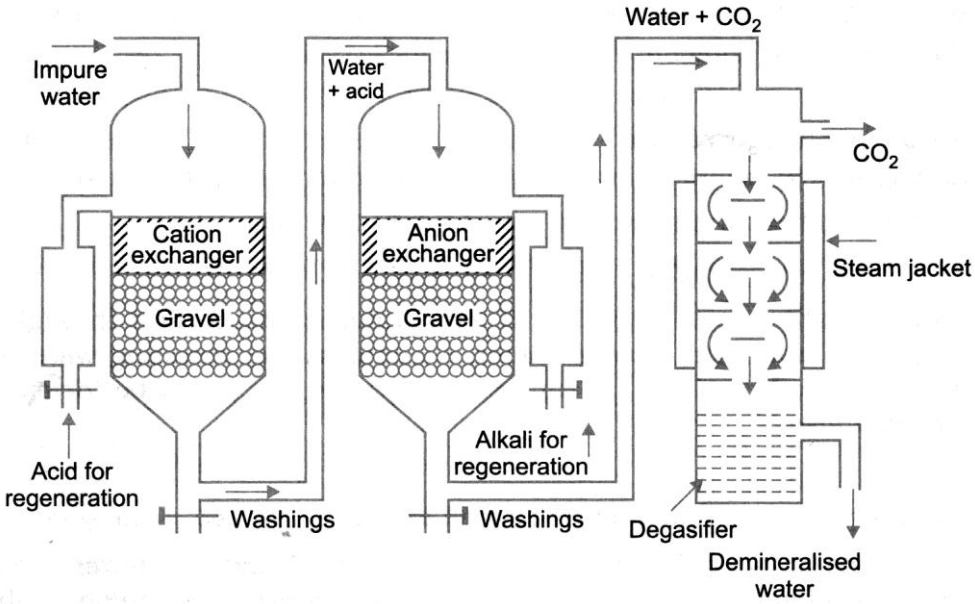
The Fe^{2+} ions at anode and OH^- ions at cathode diffuse and when they meet $Fe(OH)_2$ is precipitated.

$$Fe^{2+} + 2(OH)^- \longrightarrow Fe(OH)_2 \downarrow$$ — **1**

If enough oxygen is present, $Fe(OH)_2$ gets converetd into $Fe(OH)_3$ i.e. yellow rust.

$$4\,Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4\,Fe(OH)_3 \downarrow$$

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
2.	**e.**	**Define atmospheric corrosion.which oxide film is protective? Why?** **Atmospheric corrosion:** The corrosion which is brought about by the atmospheric conditions is called atmospheric corrosion. • **Non – Porous oxide film** is protective. **Reason:** In Non – Porous oxide film, volume of oxide is greater than the volume of metal. Due to absence of any pores in the oxide film, it forms a protective layer and hence the rate of corrosion of metal rapidly decreases. • **Unstable oxide film is protective.** **Reason:** As soon as the film is formed it decomposes to give original metal again.Therefore corrosion is not possible here. **(Note: Any one of these film can be considered)**	**2** **1** **1**	**4**
	f)	**State and explain metal cladding process with diagram.** **Definition:** Metal cladding involves bonding firmly and permanently a dense , homogenous layer of a coating metal to the base metal on one or both sides. **Process:** i) The base metal is sandwiched or cladded between the two sheets of coating metal. ii) This sandwich is then passed through two heavy rollers maintained at high temperature & pressure. iii) Cladded metal is cathodic with respect to the base metal so that electrolytic protection is provided  **OR**  	**1** **2** **1**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.		**Attempt any four :**		**16**
	a)	**Explain ion exchange process of water softening with labelled diagram and write 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.	**4** **2** **1** **1**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.	**b)**	**Write two disadvantages each of using hard water textile and dyeing industry.** **Textile industry** i) If hard water is used in textile industry, then large quantity of soap is wasted while washing the yarn. ii)At the same time, undesirable precipitate is formed which adheres to the fabrics and the exact shades of color are not obtained. iii)Fe and Mn salts may cause spots or stains on fabrics. **(Note: Any two: 2 Marks)** **Dyeing industry** i)Dye is a coloring material used for coloration of textiles, wool, silk, etc.Ca Mg Fe salts in hard water reacts with dyes to form undesirable precipitates which gives impure shades of dyes. ii) Fe salts produces spots or yellow stains on the clothes. **(Note: Any two: 2 Marks)**	**1 mark each** **1 mark each**	**4**
	c)	**What are bad effect of using hard water in boiler unit?** **i) Boiler Corrosion** **ii) Caustic Embrittlment** **iii) Scale and Sludge formation in boilers.** **i) Boiler Corrosion:** It takes place due to dissolved gases like O_2 CO_2, dissolved salts like $MgCl_2$ or acidic or alkaline water. **ii) Caustic embrittlment:** It means corrosion due to highly alkaline water.Water becomes alkaline due to sodium carbonate added for water softening.It reacts with water to form NaOH This NaOH deposits in minute cracks present on the inner side of boiler where it attacks the boiler parts and causes its corrosion. **iii) Scale and Sludge formation in boilers:** **Scale:** H**ard, adherent coating** on the inner surface of the boiler is known as scale. **Sludge: Soft, loose, slimy deposits** are formed inside the boiler are known as sludges. **(Note Any Relevant answer can be considered)**	**1** **1** **1** **1**	**4**

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.	**d)**	**Write quality parameter for potable water.** i. Water should be clear, colorless,odourless and sparkling. ii. It should be pleasant in taste. iii. It should be free from disease causing micro-organisms. iv. It should be reasonably soft. v. Its turbidity should not be more than 10 ppm. vi. Its colour should not exceed 20 ppm. vii. Its dissolved solids should not be more than 500 ppm. **(Note: Any four parameters : 4 Marks)**	**1 mark each**	**4**
	e)	**Descibe chlorination process with chemical reaction by using chlorine gas and bleaching powder.Write its 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. **1) $Cl_2 + H_2O \longrightarrow HOCl + HCl$** [Hypochlorous acid] **2) $HOCl \longrightarrow HCl + [O]$** (Nascent oxygen) **3) Germs + [O] $\longrightarrow$ Germs are killed** **II] By using bleaching powder:** About 1 Kg. of bleaching powder per 1000 litres of water is mixed and resulting solution is allowed to stand for several hours. Following reactions takes place. **$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$** [Bleaching powder] **$Cl_2 + H_2O \longrightarrow HOCl + HCl$** **$HOCl \longrightarrow HCl + [O]$** [Hypochlorous acid] [Nascent oxygen] **Germs + [O] $\longrightarrow$ Germs are killed** Thus bleaching powder helps to kill microorganisms. **Advantages:** I] Chlorine gas can be directly used as a gas or as chlorine water for sterilisation of water. II] Bleaching powder is a good sterilizer for small water works. III] Chlorine gas and Bleaching powder both are very effective for sterilisation of domestic water, swimming pools etc.	**1 ½ mark each** **1 ½ mark each** **1 mark**	**4**

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.	**f)**	**Define Portland Cement.Write its composition.Explain the function of gypsum in cement.**		**4**

Portland Cement:
It is defined as the finely divided greyish mixture of calcium silicates and aluminates with a small amount of gypsum which are capable of setting and hardeneing by chemical reaction with water. **1**

Chemical Composition of Portland cement:-

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%

1

Role of Gypsum in Cement:
Tricalcium aluminate (C_3A) present in cement combines with water very rapidly with evolution of large amount of heat to form $C_3A.\ 6H_2O$ crystals.

$$\mathbf{C_3A + 6H_2O \rightarrow C_3A.\ 6H_2O + Heat}$$
(Crystals)

These crystals prevent the hydration reaction of other constitutionals compounds forming a barrier over them. Because of this, the cement paste becomes stiff and causes flash or initial set.
To avoid this early initial set, gypsum is added in cement.The added gypsum retards the dissolution of C_3A by forming insoluble calcium sulpho – aluminate which does not have quick hydration property. **2**

$$\mathbf{C_3A + x\ H_2O + y\ CaSO_4.\ 2H_2O \rightarrow C_3A.y.\ CaSO_4\ .\ z\ H_2O}$$

This reaction prevents a high concentration of alumina in the cement solution & thereby decreasing the early initial set of the cement.