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.		

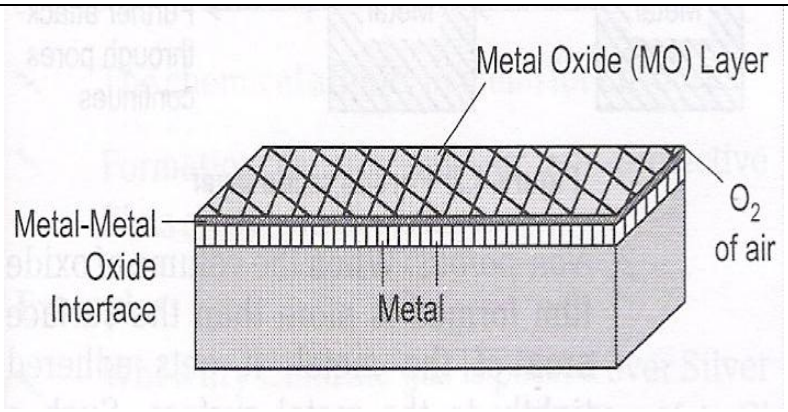
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.		**Attempt any NINE**		**18**
	a.	**What is pig iron? Why it is not directly used in industry?** The molten iron from the blast furnace is called pig iron. It is most impure form of iron containing highest percentage of carbon (2-5%) which makes it hard and brittle hence it is not directly used in industry.	**1** **1**	**2**
	b.	**State any two differences between cast iron and wrought iron.** (any two)	**1 mark each**	**2**
	c.	**Name two methods used for preparing steel.** i) Open hearth process or Siemen-Martin's process ii) Basic oxygen steel (BOS) Process or L-D process	**1 mark each**	**2**
	d.	**Give any two applications of cathodic protection method.** **Applications: (any two)** i) To protect buried water and gas pipelines, buried cables, hot water tank, ship hull etc. from corrosion. ii) To protect condensers, transmission line towers marine piers etc. iii) It is also used where current requirements and resistivity are high.	**1 mark each**	**2**

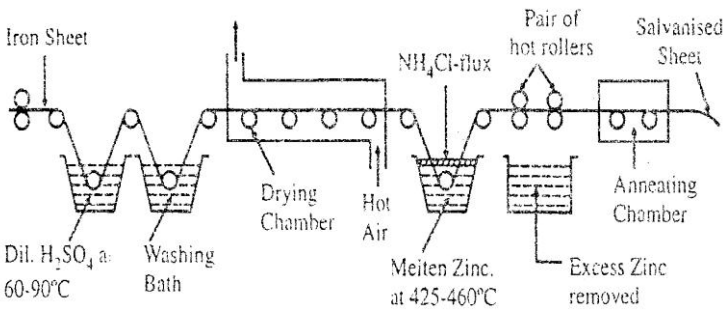
Sr.No.	Cast Iron	Wrought Iron
1.	Carbon content is 2.5 – 4.5%.	Carbon content is 0.25 – 0.5%.
2.	It has crystalline structure.	It has fibrous structure.
3.	Melting point is lowest about 1100-12000C.	Melting point is highest about 15000C.
4.	Very hard and brittle.	Soft.
5.	High tensile strength.	Medium tensile strength.
6.	Neither malleable nor ductile.	malleable and ductile.
7.	Can not be magnetized permanently.	Magnetization though easy but temporarily.
8.	Neither tempered nor welded.	Can not tempered but can be. welded easily
9.	Can be forged.	Can not be forged.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.	**e.**	**Define paint. Write two characteristic of paint.** **Paint:** Paint is a mechanical dispersion mixture of one or more pigments in a vehicle. **Characteristic: (any two)** 1) It should have high covering power. 2) It should form tough, uniform and adherent film. 3) It should have brushing characteristics. 4) It produces glossy film. 5) It should have high hiding power. 6) Its film should be fluid enough to be spread easily over the surface to be protected.	**1** **½ mark each**	**2**
	f.	**Write any two applications of Sherardizing process.** **Applications : (any two)** i) used especially for protecting small steel articles like bolts, screws, nuts, threaded parts washers, ii) to protect valves, gauge, tools etc. against atmospheric corrosion.	**1 mark each**	**2**
	g.	**Write any two advantages of metal spraying process.** **Advantages of metal spraying: (any two)** i) The thickness of coating can be controlled ii) Large and irregular surfaces can be coated efficiently iii) Non metals can be coated iv) Coating can be applied to fabricated structure	**1 mark each**	**2**
	h.	**Name four types of impurities present in natural water.** **Impurities present in natural water:** i) Suspended impurities ii) Dissolved impurities iii) Colloidal impurities iv) Biological impurities.	**½ mark each**	**2**
	i.	**Write two quality parameters of potable water.** **Parameters of potable water: (any two)** i) Water should be clear, colorless & odourless. ii) It should be pleasant in taste. iii) It should be free from disease causing micro-organisms. iv) It should be soft. v) Its turbidity should not be more than 10 ppm. vi) It colour should not exceed 20 ppm. vii) Its dissolved solids should not be more than 500 ppm.	**1 mark each**	**2**

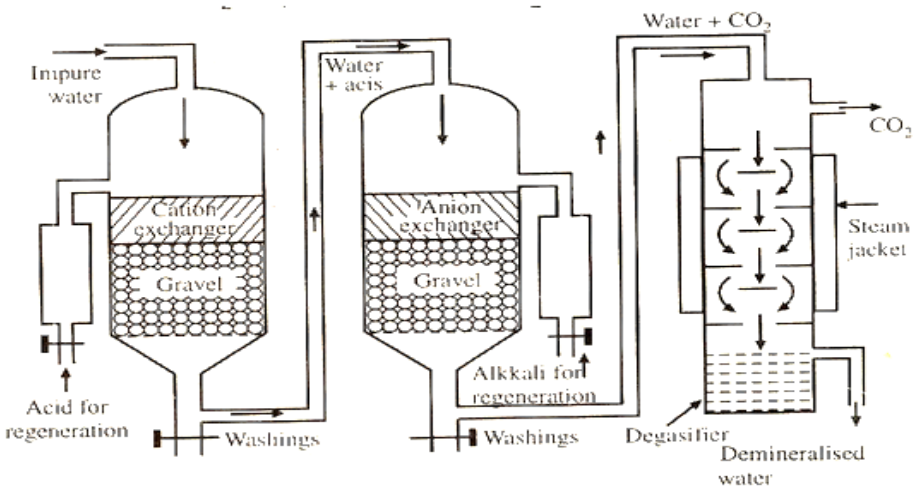
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1	j.	**How does chlorine gas sterilize water?** By using Cl_2 gas- Cl_2 reacts with water to produce hypochlorous acid & nascent oxygen. Both are powerful germicides thus kills germs & microorganisms. i) $Cl_2 + H_2O \longrightarrow HOCl + HCl$ [Hypochlorous acid] ii) $HOCl \longrightarrow HCl + [O]$ (Nascent oxygen) iii) Germs + [O] $\longrightarrow$ Germs are killed	1 1	2
	k.	**Why gypsum is added to cement?** Gypsum is added to cement because it retards the dissolution of C_3A by forming insoluble calcium sulpho-aluminate, which does not have quick hydration property. Thus, it avoids initial or flash set.	2	2
	l.	**What is slaking of lime?** **Slaking of lime:** The action of water on quick lime is known as slaking of lime.	2	2
2.		**Attempt any FOUR**		16
	a.	**Write chemical reactions taking place in the zone of reduction of blast furnace.** **Chemical Reactions taking place in the zone of reduction of blast furnace.** 1. Between 300°C to 500°C, Fe_2O_3 is converted into Fe_3O_4. $\mathbf{3Fe_2O_3 + CO \longrightarrow 2\,Fe_3O_4 + CO_2\uparrow}$ 2. At temperature between 650°C to 700°C, Fe_3O_4 is converted into FeO. $\mathbf{Fe_3O_4 + CO \longrightarrow 3FeO + CO_2\uparrow}$ 3. At temperature between 700°C to 800°C, FeO is converted into Fe. $\mathbf{FeO + CO \longrightarrow Fe + CO_2\uparrow}$ 4. Lime stone ($CaCO_3$) is decomposed to lime. $\mathbf{CaCO_3 \longrightarrow CaO + CO_2\uparrow}$	1 1 1 1	4
	b.	**Why steel is tempered after hardening? Describe tempering method.** By hardening, the hardness of the steel is increased but it becomes very brittle and liable to crack while in use so to minimize this defect, steel is tempered after hardening.	1	4

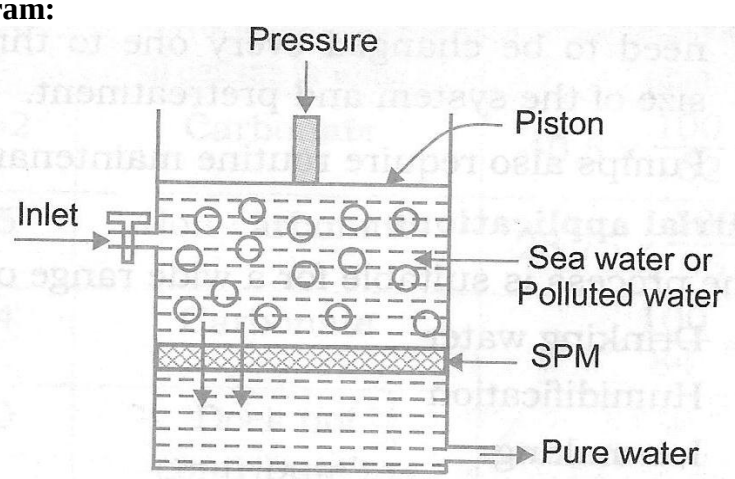
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
2.		Tempering Method: It is the process of reheating the hardened or quenched steel to a definite temperature (between 200-600^{0}C) and then cooling it at a suitable rate. The purposes of tempering are i) To stabilize the structure of metal by reliving stresses and strains. ii) To reduce some of the hardness produced during hardening. iii) To improve ductility of metal. iv) To reduce brittleness and improve tensile strength.	**3**	
	c.	**Write composition, two properties and two applications of high carbon steel.** **Composition:** High carbon steel: 0.6 – 1.5% Carbon **Properties: (any two)** i) It is very hard and tough. ii) It has high tensile strength. iii) It cannot be welded. iv) It can be hardened by heat treatment. v) It is resistant to wear. **Applications: (any two)** i) Used for making wooden tools like files, chisel, hammers, saws, drills etc. ii) Used for making metal cutting tools for lathes like cutters knives, saws, blades, razors etc.	**2** **½ mark each** **½ mark each**	**4**
	d.	**Define atmospheric corrosion. Describe mechanism of atmospheric corrosion by oxygen gas.** **Atmospheric corrosion:** Atmospheric corrosion is defined as the decay or destruction of metal due to the gases like hydrogen, oxygen, and sulphur- di-oxide etc. present in the atmosphere. **Mechanism of Atmospheric corrosion:-** In the mechanism of atmospheric corrosion metal has a tendency to lose electrons while the oxygen has the tendency to accept these electrons, with formation of ions. These ions combine to form a metal oxide film over the metal surface. The mechanism is, $M \rightarrow M^{++} + 2e$ **loss of electrons** $\frac{1}{2} O_2 + 2e^- \rightarrow O^{--}$ **gain of electrons** --- $M + \frac{1}{2} O_2 \rightarrow M^{++} + O^{--} \rightarrow MO$ **(metal oxide film)**	**1** **1** **1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2	e.	 **Describe four factors affecting rate of electrochemical corrosion**. The factors affecting **electrochemical corrosion**. (any four) i) Position of metal in electrochemical series ii) purity of metal iii) Solubility of corrosion product iv) Nature of oxide film v) Relative areas of anode and cathode. vi) Physical state of the metal **The position of the metal in the electrochemical series** : It affects corrosion to large extent. A more electropositive metal displaces a less electropositive metal from the solution of its salt. Metals having positive potential have a great tendency to go in solution as positive metallic ions and hence they get corroded. The metals having negative potentials have less tendency to get corroded. **Purity of metal:** If impurities are present in a metal large number of galvanic cells are formed. In such case if the metal is highly placed in a electrochemical series, then it acts as anode and undergoes corrosion. Therefore corrosion resistance of metal can be improved by increasing its purity. **Solubility of corrosion product** During the process of corrosion of metal, a film of oxide is formed on the metal surface. The corrosion film may be soluble or insoluble. If it is soluble it gets easily removed thus leaving free surface of metal for exposure. If the film formed is insoluble or slightly soluble, it sticks to the metal surface and so resists further corrosion to some extent. In case the film is porous, corrosion goes on but its rate gets decreases after some time.	**1** **1 mark each**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2	e.	**Nature of oxide film:** If the oxide film is non-porous then the metal protects itself from corrosion. But If the oxide film is porous then the corrosion by the gas continues. **Relative areas of anode and cathode:** .the rate of corrosion of metal is less when the area of the cathode is smaller. When cathodic areas are smaller the demands for electrons will be less and this results in decreased rate of dissolution of metal at anodic regions. **Physical state of the metal:** The physical state of metal means orientation of crystals, grain size, stress etc. The larger the grain size, smaller will be its solubility and hence lesser will be its corrosion.		**4**
	f)	**Explain galvanizing process giving diagram.** It is the process of coating iron or steel sheets with a thin coat of zinc to prevent it from rusting. **Process:** The iron or steel sheet to be galvanized is first cleaned with dilute H_2SO_4 to remove any oxide layer or impurities. It is then washed with water to remove acid completely. Then it is dipped in a bath of zinc ammonium chloride solution which helps to adhere the molten zinc and then sheet is passed through drier to dry it completely. Then the sheet is dipped in a bath of molten zinc at 425 ^oC to 460 ^oC temperature and passed through series of rollers to remove excess zinc and to get uniform coating. Finally it is annealed at 650^oC. **Diagram:**  	**2** **2**	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.		**Attempt any FOUR:**		**16**
	a)	**Write two disadvantages each of using hard water in paper industry and for drinking.** **Paper industry-** 1) During the manufacture of paper, the rosin soap is added to the paper pulp to make the paper smooth and glossy. 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 & Mn impurities in hard water affect whiteness of colors. **Drinking-** 1) Hard water is not suitable for drinking because impurities in hard water cause bad effects on digestion process. 2) Calcium oxalate crystals may form which may enter in kidney & bladder to cause kidney stone.	2 2	4
	b)	**Describe EDTA method for determination of total and permanent hardness of water.** **Determination of total hardness of water by EDTA method**: Pipette out 50 ml of the given hard water sample into 250 ml conical flask. Add 5 ml of buffer solution to increase the pH to about 10. Add 3-4 drops of Eriochrome Black-T indicator. The solution turns wine red. Titrate the hard water sample slowly with 0.01M EDTA until the colour changes to blue (end point). Note down the volume of EDTA used up at end point. **Determination of permanent hardness of water by EDTA method:** 50ml of hard water sample is boiled for about 15 to 20 minutes, filtered, diluted with distilled water to make 50 ml. Add 5ml of buffer solution to increase the pH to about 10. Add 3-4 drops of Eriochrome Black-T indicator. The solution turns wine red. Titrate the boiled hard water sample slowly with 0.01M EDTA until the colour changes to blue (end point). Note down the volume of EDTA used up at end point. Using the above data, total and permanent hardness can be calculated.	2 2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.	**c)**	**Calculate hardness of water in ppm, if 100 ml of water sample requires 50 ml of 0.01M EDTA**. We know that, **Step1:** 1ml of 0.01 M EDTA = 1 mg of $CaCO_3$ 50 ml of 0.01 M EDTA = 50 mg of $CaCO_3$ (But 50 ml of EDTA = 100 ml of water sample) **Step2:** 100 ml of water sample contains = 50 mg of $CaCO_3$ 1000 ml of water sample contains = 1000 x 50 / 100 mg of $CaCO_3$ Therefore, 1000 ml of water sample contains = 500 mg of $CaCO_3$ **Hardness of water sample = 500 ppm of $CaCO_3$**	2 2	**4**
	d)	**Describe ion-exchange process for water softening with diagram.** **Ion Exchange Process:** i) Hard water is first passed through the cation exchange resin. It removes all the cations like Ca^{++}, Mg^{++} and releases H^+ ions. $R\text{-}H_2 + CaCl_2 \longrightarrow R\text{-}Ca + 2HCl$ $R\text{-}H_2 + MgSO_4 \longrightarrow R\text{-}Mg + H_2SO_4$ Thus water is free from cations but it is acidic. ii) The acidic water is then passed through anion exchange resin where acid is converted into water $R'\text{-}(OH)_2 + 2HCl \longrightarrow R'Cl_2 + 2H_2O$ $R'(OH)_2 + H_2SO_4 \longrightarrow R'SO_4 + 2H_2O$ Thus water is free from all cations and anions iii) Finally water is made free from dissolved gases like CO_2 , O_2 etc. by passing it through third tower of degasifier **Diagram:**  	1 1 2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.	e)	**Describe treatment of sea water by reverse osmosis process.** **Reverse Osmosis process:** In reverses 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). 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. Thus in reverse osmosis, we separate water from its contaminants rather than contaminants from water. **Diagram:**  	2 2	4
	f)	**Giving balanced chemical reactions explain hardening and setting of cement.** **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. 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. Hardening: is the development of strength due to crystallization. Following chemical reaction taking place during setting and hardening:	2	4

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.		i) Hydrolysis: $C_3S + (x+1)\ H_2O \longrightarrow C_2S.xH_2O + C.H_2O$ (gel) (crystals) $C_4AF + 7\ H_2O \longrightarrow C_3A.6\ H_2O + CF.H_2O$ (crystals) (gel) ii) Hydration: a) $C_3S + x\ H_2O \longrightarrow C_2S.\ xH_2O + CaO$ (gel) (lime) b) $C_3A + 6\ H_2O \longrightarrow C_3A.6\ H_2O$ + heat (crystals)	**2**	