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
4.		**Attempt any nine of the following:**		
	a)	**a) Define: i) Specific conductivity ii) Equivalent conductivity.**		2
		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	
		(ii) Equivalent conductivity: It is defined as the conductivity of a solution containing 1 gm equivalent of the solute or electrolyte, when placed between two sufficiently large electrodes which are placed 1 cm. apart. **Or** Equivalent conductivity can be defined as the product of specific conductivity and the volume of the solution containing 1 gm equivalent of the solute.	1	
	b)	**Write two applications of polystyrene.** **Application: (any two)** i) In molding articles like toys, combs, buttons, buckets. ii) Radio and T.V. parts, refrigerator parts, battery cases. iii) High frequency electric insulators, lenses, indoor lighting panels etc.	1 mark each	2
	c)	**Define refractories. Give its use.** **Refractories:** Refractories are defined as the non- metallic materials having those chemical and physical properties that make them applicable for structures, or as components of systems used at much higher temperature. **Uses: (any one)** i) Used in construction of the lining of the furnaces, tanks, boilers. ii) Also used in pyrometer tubes, crucibles, ladles, kilns etc. iii) Used for the manufacture of metals, cement, lime, glass, ceramics, paper etc.	1 1 1	2
	d)	**Name the four ores of iron.** **Ores of Iron: (any four)** 1) Magnetite (or Ferroso ferric oxide) 2) Hematite (or Ferric oxide) 3) Limonite (or Hydrated ferric oxide) 4) Siderite (or Ferrous Carbonate) 5) Iron pyrites (or Iron sulphide)	½ mark each	2

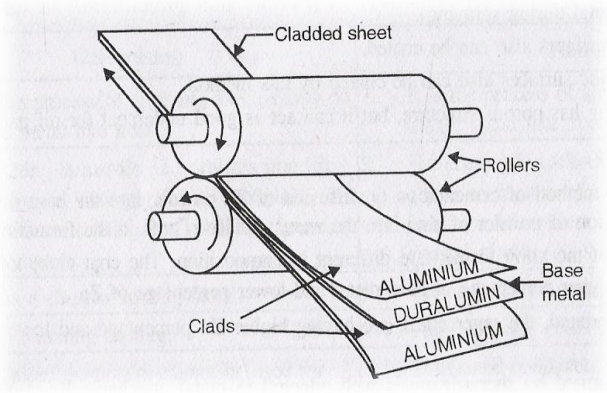
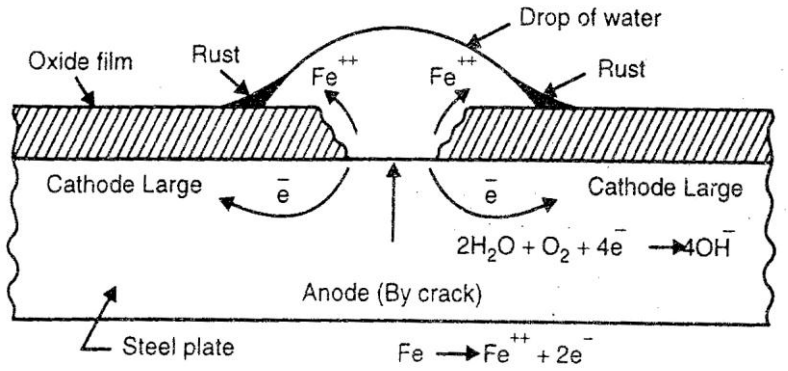
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
4.	e)	**Define alloys. Give its classification.** **Alloy**: An alloy is defined as a homogeneous mixture of two or more elements one of which must be a metal. **Classification:** 1) Ferrous alloys 2) Non-ferrous alloys	1 1	2
	f)	**What is steel? Write its classification based on carbon percentage.** **Steel:** It is an alloy of carbon and iron. **Classification of steel:** 1) Mild or low carbon steel: It contains 0.05 to 0.3 % carbon 2) Medium carbon steel: It contains 0.3 to 0.6 % carbon 3) High carbon steel: It contains 0.6 to 1.5 % carbon	 1 1	2
	g)	**What is atmospheric corrosion?** **Atmospheric corrosion:** Atmospheric corrosion is defined as the decay or destruction of metal due to the gases like hydrogen, oxygen, and sulphur dioxide etc. present in the atmosphere. **Or** "The corrosion which is brought about by atmospheric conditions is called atmospheric corrosion".	 2	2
	h)	**Write factors affecting on rate of atmospheric corrosion.** **Factors affecting atmospheric corrosion:** **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. **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 1	2
	i)	**Define lubrication. Name the types of lubrication.** **Lubrication:** The process of reducing frictional resistance between moving or sliding surfaces, by the introduction of lubricant in between them is known as lubrication. **Types of lubrication**: 1) Fluid film lubrication 2) Boundary lubrication 3) Extreme pressure lubrication	 1 1	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
4.	j)	**Give any two types of lubricants with one example of each. (any two)** **i) Solid lubricants:** **Examples**: graphite, molybdenum disulphide, soap, soap stone, wax, talc, chalk, mica, teflon etc. **ii) Semi-solid lubricants:** **Examples:** greases and vaseline. **iii) Liquid lubricants:** **Examples:** vegetable and animal oils such as castor, olive, coconut, palm, neem, linseed, hazel nut, tallow, lard, whale, codliver oil etc. and fatty acids like oleic acid, stearic acid etc., silicones, blended oils, and mineral oils.	1 mark each	2
	k)	**State two products of blast furnace with at least one use of each. (Consider any two products with one use)** **i) Pig iron:** **Uses:** It is used for casting metal objects such as stoves, lamp posts, drainage covers, pipes, railings, fire gates etc. **ii) Slag:** **Uses:** 1) used as a filler for rail roads, 2) used in cement manufacturing, 3) used as a fertilizer and for soil conditioning **iii) flue gases:** **Uses:** 1) used as a fuel. 2) Mixture of gases is used for pre-heating of air for the blast furnace. (**Note:** Name of product and one use: ½ + ½ mark)	1 mark each	2
5.		**Attempt any four of the following:**		16
	a)	**Define buffer. Write the types of buffer with example.** **Buffer:** It is defined as the solution which maintains a fairly constant pH value, even when small amount of acid or alkali is added to it. **Types:** **1) Acidic buffer**: E**xample**: acetic acid (CH_3COOH) +sodium acetate (CH_3COONa) **2) Basic buffer:** E**xample**: Ammonium hydroxide (NH_4OH) + Ammonium Chloride(NH_4Cl) (**Note: Def:1mark, Names ½ mark each, Examples:1mark each**)	1 1 ½ 1 ½	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
5.	b)	**What are ceramics? Give the classification of ceramics on the basis of application.** **Ceramics:** Ceramics are inorganic, non – metallic materials that are processed & used at high temperature **Classification of ceramics on the basis of application:- (any three)** **i) Structural Ceramics:** These are used for construction of buildings and other structures. Examples: Bricks, Hallow tiles, clinker bricks, ceramic slabs etc. **ii) Facing materials:** Articles used for internal and external facing of building and structures. Examples: facing bricks slabs, oven tiles. **iii) Refractories:** Materials which are used at high temperatures. Examples: refractory bricks used for lining of furnaces. **iv) Fine Ceramics:** Examples- Wash basins, dishes, sink porcelain etc.	1 1 mark each	4
	c)	**Write engineering applications of Kevlar and Bakelite.** **Applications of Kevlar: (Any two)** 1. It is mainly used in aircraft and aerospace industry. 2. It is used to prepare car parts like tyres, brakes, clutch-linings etc. 3. It is widely used to prepare ropes, cables, bullet proof jackets, protective clothings vests etc. 4. Also used for helmets and other high performance materials. **Applications of Bakelite: (any two)** 1. For making electrical insulator parts like switches, plugs switch boards ,heater handles 2. For making moulded articles like telephone parts, cabinets of radio and T.V.sets. 3. As adhesive 4. In paints and varnishes. 5. For impregnating fabrics, wood and paper 6. As a cation exchanger in water softening. 7. For making photograph records, bearings used in propeller shafts or paper industry and rolling mills.	2 2	4
	d)	**Write chemical reaction taking place in zone of reduction of blast furnace of iron.** **Chemical Reactions taking place in the zone of reduction of blast furnace.** 1. Between 300^oC to 500^oC, Fe_2O_3 is converted into Fe_3O_4. $3Fe_2O_3 + CO \longrightarrow 2\ Fe_3O_4 + CO_2\uparrow$	1	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
5.		2. At temperature between 650°C to 700°C, Fe_3O_4 is converted into FeO. $Fe_3O_4 + CO \longrightarrow 3FeO + CO_2\uparrow$	1	
		3. At temperature between 700°C to 800°C, FeO is converted into Fe. $FeO + CO \longrightarrow Fe + CO_2\uparrow$	1	
		4. Lime stone ($CaCO_3$) is decomposed to lime. $CaCO_3 \longrightarrow CaO + CO_2\uparrow$	1	
	e)	**What is a heat treatment properties of steel? Explain hardening.**		4
		Heat treatment of steel: is 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	
		Hardening: It is applied to tools and some important machine parts made of alloy steel. 'In this process, steel is heated to high temperature (800- 900^{0}C) and then suddenly cooled by dipping or quenching in some suitable medium'. The quenching medium used is either cold water or mineral or animal or vegetable oil, 4-6% caustic soda, 6-20% sodium chloride solution etc. By this process steel becomes extremely hard and brittle. The hardness developed depends upon: i) The rate of cooling and ii) the medium used for cooling. The purposes of hardening are: 1) To increase its resistance to wear or abrasion and ability to cut other metals. 2) To improve strength, elasticity, ductility and toughness.	3	
	f)	**What is a composite material? State its advantages.** **Composite material**: A composite material is defined as a material system consisting of a mixture of two or more micro-constituents which are mutually insoluble, differing in form and/or composition and forming distinct phases.	1	4

Que. No.	Sub. Que.	Stepwise Solution	Marks	Total Marks
5.		**Advantages: (any three)** 1. Higher specific strength 2. Lower specific gravity 3. Higher specific stiffness 4. Maintain strength even upto high temperatures 5. Better toughness impact and thermal shock resistances. 6. Cheaply and easily fabricable 7. Better creep and fatigue strength 8. Lower electrical conductivity 9. Lower thermal expansion 10. Better corrosion and oxidation resistance.	1 mark each	16
		Attempt any four of the following:		
6.	a)	**Give composition, properties and applications of Brazing alloy or Rose- metal.** **(consider any one)** **Brazing alloy:** **Composition:** Sn = 92%, Sb = 5.5%, Cu = 2.5% **Property:** It is a low melting point alloy. **Use**: it is used for soldering steel joints. **OR** **Rose- metal:** **Composition:** Bi = 50%, Pb = 28%, Sn = 22% **Property:** It is readily fusible alloy (M.P. = 89^0C). **Use:(any one)** i) used for making fire alarms, fuse wires ii) used for casting dental works. iii) used in automatic sprinkler's system.	2 1 1	4
	b)	**Explain metal cladding process with diagram. Write its applications.** **Metal Cladding 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 cathodic with respect to base metal so that electrolytic protection is provided. Metals used for cladding are like copper, nickel, silver, platinum, and alloys like stainless steel, nickel alloy, lead alloy. The base metals are aluminium, copper, nickel etc.	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
6.			1	
		Applications: (any two) 1) Al clad sheets used in aircraft industry in which a plate of duralumin is sandwiched between two layers of 99.5% pure Al. It is the light and strong alloy. 2) Cu – clad steel wire is obtained by forcing steel rod into closely fitted cu-tube is used for electrical conductors possessing combining strength of steel with the high conductivity of Cu. 3) To develop surface properties like corrosion resistant in steel sheets. 4) The cladding metal provides electrolytic protection to the base metal.	1 mark each	
	c)	**Define electro-chemical corrosion. Write its mechanism with absorption of oxygen.** **Electro-chemical corrosion**: The corrosion which is brought about through ionic reactions in the presence of moisture or solution as a conducting medium when two dissimilar metals are in contact with each other is called as immersed corrosion or electrochemical corrosion.	1	4
		Mechanism absorption of oxygen (O_2) :- 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 area are created on the surface while the coated metal part acts as cathode. 	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
6.		**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:-** **$2H_2O + O_2 + 4e^- \longrightarrow 4(OH^-)$** These in presence of water drop forms OH^- ions. The Fe^{++} ions at anode and OH^- ions at cathode diffuse and when they meet $Fe(OH)_2$ is precipitated. **$Fe^{++} + 2(OH)^- \longrightarrow Fe(OH)_2 \downarrow$** i) If enough O_2 is present ferrous hydroxide is easily oxidizes to ferric hydroxide. **$4\,Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4Fe(OH)_3$** This product called yellow rust actually corresponds to $Fe_2O_3 . H_2O$ $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$	2	
	d)	**Write functions of an ideal lubricant.** **Functions of an ideal lubricant: (any four)** i) It reduces surface wear and tear and deformation, so that direct contact between rubbing surfaces is avoided. ii) It reduces waste of energy in the form of heat, so it acts as a coolant. iii) It reduces expansion of metal by local frictional heat. iv) It reduces unsmooth relative motion. v) It reduces maintenance and running cost of machine. vi) It reduces the power loss in internal combustion (I.C) engine. vii) It acts as seal between the piston and cylinder wall so it prevents the leakage of gases at high pressure.	1 mark each	4
	e)	**Explain the following:** **i) Flash point and fire point** **ii) Acid value and saponification value.** **i) Flash point and fire point:** **Flash point:** 'Flash point of oil is the lowest temperature at which the oil begins to give enough vapors which give momentary flash of light when a flame is applied to it'. The vapors do not burn continuously, but only for a moment when flame is brought near it. **Fire point:** 'Fire point is the minimum temperature at which the oil gives enough vapors which catch fire and burn continuously at least for five seconds when flame is applied to it'. A lubricant having low flash and fire point is not safe. Because due to rubbing of machine parts in contact, some heat is produced even if the lubricant has been applied in between them. So the temperature increases and can catch fire which may cause damage to life and property in a factory. Therefore, good lubricant should have high flash and fire points.	1 1	4

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>6.</td><td></td><td>ii) Acid value and saponification value.
Acid value: It is defined as the number of milligrams of KOH required to neutralize free acid in 1 gram of lubricating oil.
The presence of acids in lubricants causes acidity which is harmful to machine parts, because it causes their corrosion. Good lubricant should not contain free acids. The acid value of good lubricating oil should be less than 0.1.
Saponification value: It is defined as milligrams of KOH required to saponify 1 gram of lubricating oil.
With the help of saponification value we can know whether the oil is vegetable, animal or mineral. A good lubricant should have moderate saponification value.</td><td>1

1</td><td></td></tr>
<tr><td></td><td>f)</td><td>Distinguish between galvanizing and tinning processes of protection of metal from corrosion.

Difference between galvanizing & tinning:
<table>
<tr><th>Galvanizing</th><th>Tinning</th></tr>
<tr><td>1) A process of covering iron or steel with a thin coat of zinc to prevent it from rusting.</td><td>A process of covering steel with a thin coat of tin to prevent it from corrosion.</td></tr>
<tr><td>2) Zinc protects the iron sacrificially since it is more electropositive than iron and does not permit iron to pass into the outside solution.</td><td>Tin protects base metal iron from corrosion due to its noble nature i.e. less electropositive than iron and higher corrosion resistant.</td></tr>
<tr><td>3) In galvanizing articles zinc continues to protect the underlying iron by galvanic cell action even if coating of zinc is punctured or broken at some places.</td><td>In tin coated articles, tin is non-toxic and protects the underlying iron till the coating is perfect. Any break in coating cause rapid corrosion of iron.</td></tr>
<tr><td>4) Galvanized containers cannot be used for storing acidic foodstuff. Since zinc reacts with acids in food, forming zinc compounds which are highly toxic i.e. poisonous.</td><td>Tin coated containers and utensils can be used for storing any foodstuff. Since tin is non-toxic and protects the metal from corrosion and avoids any food poisoning.</td></tr>
</table></td><td>1 mark each</td><td>4</td></tr>
</table>