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 of the following:**		18
	a)	**Name any two sulphide ores of copper along with formulae.**		2

Type of ore	Name	Chemical formula
Sulphide	Copper glance	Cu_2S
	Copper pyrite	$CuFeS_2$

1 Mark each

b) **Enlist any two uses of aluminium in field of industries.** 2

1) For preparing utensils, surgical instruments, heating appliances, parts of aeroplanes, containers for chemical industry etc.
2) For making electric wires and cables for transmission lines.
3) Aluminium foils are used for wrapping cigarettes, sweets and confectionary.
4) Al – powder is used for making silvery paints.
5) As a reducing agent in the production of Cr, Mn etc.
6) In thermite welding process.
7) As a deoxidizer in the manufacture of steel.
8) For winding the moving coils of dynamos and motors.
9) Highly pure Al is used as an absorber in the preparation of antibiotics (chloromycines).
10) Al – powder + NH_4NO_3 mixture is used in bombs.
11) For making many useful alloys.
12) For chemical plants and transporting and storing nitric acid.
13) As refractory for lining of furnace and for making refractory bricks.

1 Mark each

c) **Define corrosion. State the types of corrosion.** 2

Corrosion:
Any process of chemical or electrochemical decay or destruction of a metal due to the action of surrounding medium is called as corrosion. 1

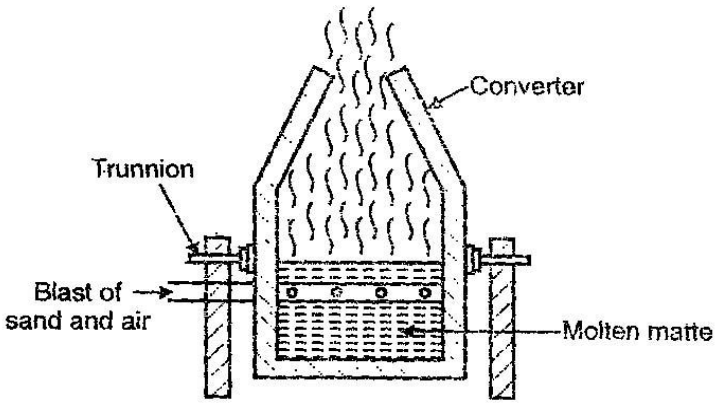
Types of corrosion:
1) Atmospheric corrosion or direct chemical corrosion or Dry corrosion.
2) Immersed corrosion or electro chemical corrosion or wet corrosion.

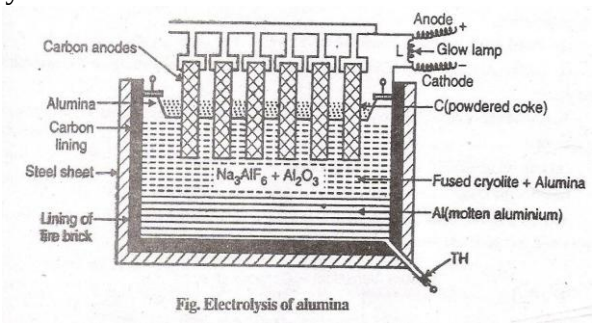
1/2 Mark each

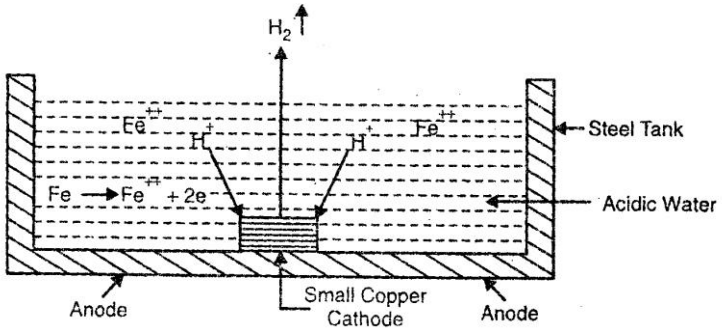
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.	**d)**	**State the type of oxide film which is more protective towards corrosion with one example.** **More protective oxide films** — **Examples:** **Stable nonporous oxide film** — Aluminium, Copper, Chromium etc. **Unstable oxide film** — Gold , Silver, Platinum etc. **(Note: Any one film [1 mark]with any one example [1 mark])**	2	2
	e)	**Define electrochemical corrosion.** **Electrochemical 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 electro chemical corrosion.	2	2
	f)	**"Metal cladding can be done only on plain surfaces." Give reason.** The process of metal cladding involves bonding firmly and permanently, a dense homogenous layer of a coating metal to the base metal on one or both sides. In this process base metal is sandwiched or cladded between the two sheets of coating metal & this sandwich is then passed through a pair of heavy rollers maintained at high temperature & pressure. We can not pass odd shaped articles or irregular surfaces through a pair of heavy rollers. Secondly if we try to do cladding on irregular surfaces then it will not be perfect & will cause corrosion through galvanic cell action in presence of moisture. Hence the metal cladding can be done only on plain surfaces.	2	2
	g)	**Define fuel cell.** **Fuel cell:-** Fuel cell is a electrochemical cell which converts the chemical energy of fuels directly into electrical energy by an electrochemical process in which the fuel is oxidized at anode.	2	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1.	**h)**	**Define equivalent and specific conductance** **i) Equivalent conductance (λv)** : It is the conductance of the solution containing 1 gm equivalent of solute / electrolyte when placed between two sufficiently large electrodes which are 1 cm apart **ii) Specific conductance (k):** Specific conductance is the conductance of offered by 1 cm^3 of the substance or 1 ml solution. **OR** The conductance offered by a solution or a conducting material having unit length & unit area of cross section is known as specific **conductance**.	**1** **1**	**2**
	i)	**State two applications of lead acid storage cell.** **Applications of lead acid storage cell:** 1. Lead acid storage cellis commonly used in automobiles. 2. To Supply current for electric vehicles 3. In Gas engine ignition 4. In telephone exchanges 5. In railway trains & mines 6. In laboratories , hospitals 7. In broad casting stations, power stations 8. For distribution work 9. In inverters	**1 Mark each**	**2**
	j)	**Define liquid crystal polymers.** Liquid crystal polymers are a class of aromatic polyester polymers which are capable of forming regions of highly ordered structure (like crystal) even in the liquid phase.	**2**	**2**
	k)	**Differentiate between dielectrics and insulator.** **(Any two points)**	**1 Mark each**	**2**

Dielectrics	**Insulators**
1. The materials which are used to prevent the loss of electricity through certain parts of an electrical system are known as dielectrics	1. Insulators or insulating materials are the substances which retard the flow of heat or electricity or sound through them
2.The main function is storage of electrical charge.	2. The main function of such materials is that of insulation
3. All dielectrics are insulators because they avoid the flow of electric current through them.	3.All insulators are not dielectrics because they can not store charges like dielectrics
4.**Examples-** Air, N_2 gas , CO_2 gas, Silicon fluid etc	4.**Examples-** Rubber, Plastics etc.

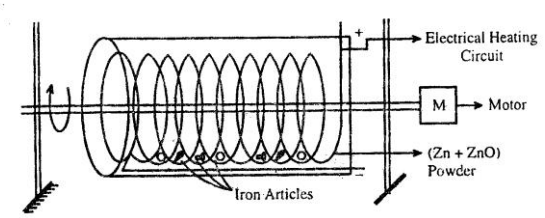
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
1	l)	**Give two applications of epoxy resins** **Applications :- (Any two)** 1. Epoxy resins are best suited for bonding of insulating materials such as porcelain, wood, metal, ceramic, glass articles. 2. Laminates as well as insulating varnishes are prepared from epoxy resins. 3. A trade name for common epoxy resin type adhesive is araldite which is used in air-craft industry, automobiles, bicycles, golf club, snow boards etc. 4. Due to their electrical resistance they are widely used in making insulators, bushings etc. for high voltage.	**1** **Mark each**	**2**
2.	**a)**	**Attempt any FOUR of the following:** **Write the process of Bessemerisation of copper.** **Diagram:** Bessemer converter  After smelting the molten matte is then transferred to a Bessemer converter which is a pear shaped furnace made up of steel and internally lined with lime or magnesia. It is mounted on turnnions and can be tilted in any position. Furnace is provided with pipes known as twyers through which sand and hot air is blown into it.	**1** 1	16 4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.		Following chemical reactions takes place in the Bessemer converter (a) Conversion of FeS to slag $2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2 \uparrow$ $FeO + SiO_2 \longrightarrow FeSiO_3$ (b) Partial oxidation of Cu_2S to Cu_2O $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2 \uparrow$ (c) Reduction of Cu_2O by Cu_2S to metallic copper $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2 \uparrow$ The molten metal obtained from the Bessemer converter is then poured into sand moulds and allowed to cool. On cooling dissolved SO_2 escapes out causing blisters on the surface of copper hence it is called as blister copper. It is 96 to 98% pure.	**2**	
	b)	**Describe the process electrolytic reduction of AC.** The pure alumina is bad conductor of electricity & its melting point is 2000^0c. Hence electrolytic reduction of alumina is carried out in presence of cryolite because the presence of cryolite decreases the melting point of alumina & also increases its electrical conductivity.	**1**	**4**
		 Fig. Electrolysis of alumina	1	
		Process: Figure shows electrolytic reduction of alumina(Al_2O_3) i. Alumina is dissolved in fused cryolite and electrolyzed in an iron tank lined inside with carbon which acts as cathode ii. The anode consists of number of carbon rods, suspended vertically from the copper clamps. iii. The electrolyte is a mixture of alumina and cryolite. The temp of electrolyte bath is kept at about $900\text{-}1000^0$C iv. On passing current, alumina decomposes to aluminium and oxygen. $2\,Al_2O_3 \longrightarrow 4Al + 3O_2 \uparrow$ vi The molten aluminium gets collected at the bottom of the cathode, while oxygen formed at anodes gets oxidized to CO and CO_2. The process is continuous and fresh quantity of Al_2O_3 is added time to time.	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**c)**	**Give composition properties and uses of Rose metal** **Rose metal:** **Composition:** Bi = 50% Pb = 28% Sn = 22% **Properties: (any one)** **1.**It is easily fusible alloy **2.** It's melting point is 89 ^{0}C **Uses: (any one)** **1**. It is used for making fire – alarms, fuses wires. **2**. It is used for casting dental works **3**. It is used in automatic sprinkler system. 4. It is used in electrical fuse wires	**2** **1** **1**	**4**
	d)	**Describe the hydrogen evolution mechanism of immersed corrosion.**  **Steel tank: - Anode , Cu – strip:- Cathode** These types of corrosion occur usually in acidic environments like acidic industrial waste, solutions of non – oxidizing acids. **Process:** Consider a **steel** tank containing acidic industrial waste and small piece of copper scrap. The portion of the steel tank in contact with copper becomes anodic and is corroded most with the evolution of hydrogen gas at cathodic area (copper piece). **At anode** $Fe \longrightarrow Fe^{++} + 2e^-$ (Oxidation) These electrons flow through the metal from anode to the cathode **At cathode** H^+ ions are eliminated as H_2 gas $2H^+ + 2e^- \longrightarrow H_2 \uparrow$(Reduction) Thus, over all reaction is $Fe + 2H^+ \longrightarrow Fe^{++} + H_2 \uparrow$	**1** 1 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>2.</td><td>e)</td><td>Differentiate between galvanizing and tinning.(Any four points)

<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 prevent it from rusting.</td><td>A process of covering iron or steel with a thin coat of Tin to prevent 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.</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>4</td></tr>
<tr><td></td><td>f)</td><td>Describe sherardizing process for protection of small articles of iron from corrosion. Write its applications.

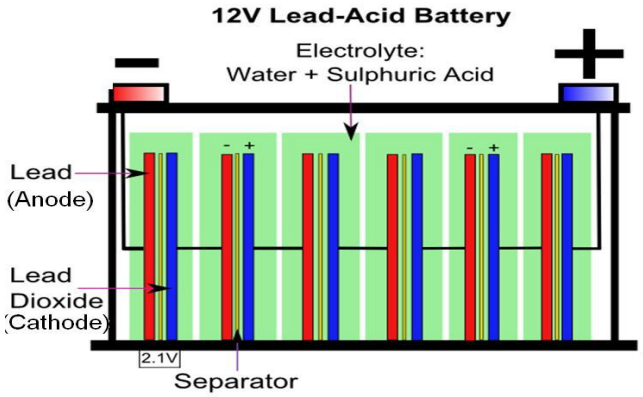
 

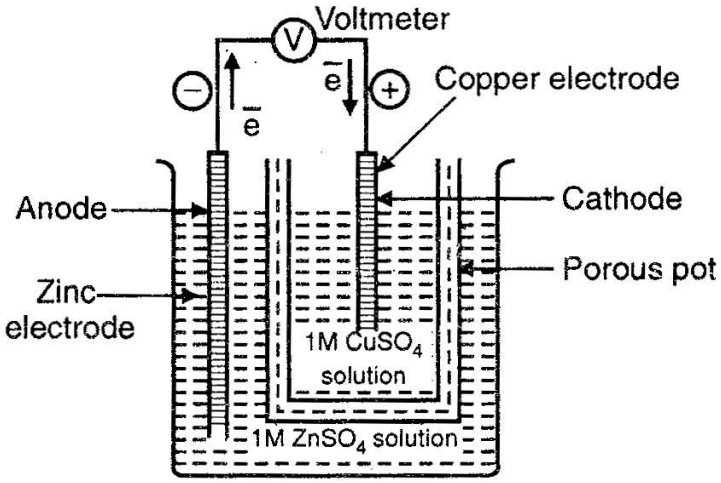
i) The iron articles (bolts, screws, nails etc) to be coated are first cleaned and then packed with Zn dust and ZnO powder in a steel drum, which is provided with electrical heating arrangement.
ii) The drum is slowly rotated for 2-3 hrs. and it’s temp. is kept between 350 – 400^{0}C.
iii) During this process Zn slowly diffuses into iron surface forming Fe - Zn alloy at the surface which protects iron surface from corrosion.
Applications: It is used for protecting small steel articles like bolts, screws, nuts, threaded parts, washers, valves, gauge, tools etc.</td><td>1

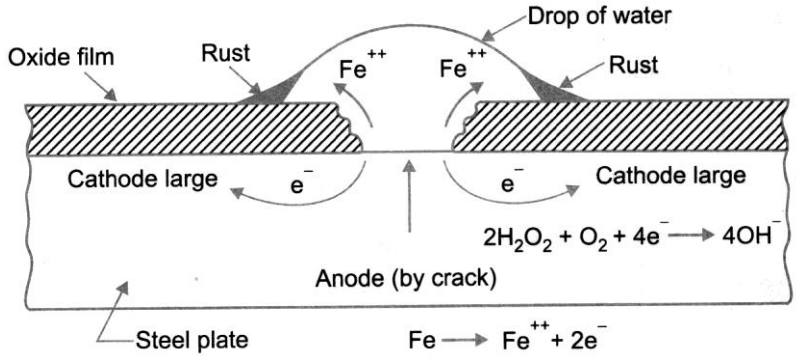
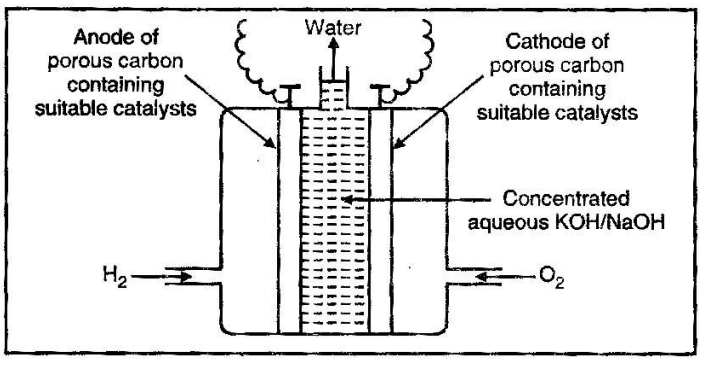
1

2

1</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.		**Attempt any FOUR of the following:**		**16**
	a)	**Describe the construction & working of lead acid storage cell.**		**4**
			**1**	
		Construction:- 1. It consist of several lead plates which are connected to each other & are acting as a Anode (-ve electrode) 2. It consist of several lead oxide plates which are connected to each other & are acting as a Cathode (+ve electrode) 3. 20% H_2SO_4 Solution having sp.gravity1.15 at 25 ^{0}C is used as an electrolyte 4. Lead & lead oxide plates are separated from each other by strips of insulating materials like wood or rubber or glass fiber.	**1**	
		Working:- **i) Discharging: -** While discharging chemical energy gets converted into electrical energy. **At Anode: -** $Pb \rightarrow Pb^{2+} + 2e^-$ (Oxidation) $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4 \downarrow$ At Cathode:- $PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$ (Reduction) $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4 \downarrow$ Net reaction during discharging: - $Pb + PbO_2 + 4H^+ + 2SO_4^{2-} \rightarrow 2PbSO_4 \downarrow + 2H_2O$ Lead sulphate is precipited at both the electrodes.The voltage of each cell is 2.0 volts at 25^{o}C. **ii) Charging: -** To recharge a lead storage cell, the reactions taking place during discharging are reversed by passing an external e.m.f. greater than 2 volts from a generator.	**1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
3.		**At Cathode:** $PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$ **At Anode:** $PbSO_4 + 2H_2O \rightarrow PbO_2 + 4H^+ + SO_4^{2-} + 2e^-$ **Net reaction during Charging:** $2PbSO_4 + 2H_2O \rightarrow Pb + PbO_2 + 4H^+ + 2SO_4^{-2}$ During the process of charging, the electrodes of the cell are restored to their original conditions (to Pb and PbO_2 respetively).	**1**	
	b)	**Explain construction and working of Daniel cell**  	**1**	**4**
		Construction:- It consists of zinc electrode dipped in $ZnSO_4$ Solution & Copper electrode dipped in $CuSO_4$ solution. The two solutions are separated by a porous pot. The two solutions can seep through the pot & so comes in contact with each other automatically. Thus, porous partition acts as a salt bridge.	1	
		Working:- The tendency of Zn to form Zn^{++} is greater than the tendency of Zn^{++} to get deposited as Zn on the electrode. Therefore Zn goes into the solution forming Zn^{++}. On the other hand tendency of Copper to go into the solution is less than the tendency of Cu^{++} to get deposited as Cu & hence copper electrode becomes positively charged. The emf of cell is 1.1 volt.	1	
		Cell reactions- At Anode $Zn \longrightarrow Zn^{++} + 2e^-$ At Cathode $Cu^{++} + 2e^- \longrightarrow Cu$ Net Reaction $Zn + Cu^{++} \longrightarrow Zn^{++} + Cu$	1	

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.	c)	**Describe the mechanism of electro-chemical corrosion by absorption of oxygen gas.** **Anode:** - Portion of 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. **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. $Fe^{2+} + 2(OH)^- \longrightarrow Fe(OH)_2 \downarrow$ If enough oxygen is present, $Fe(OH)_2$ gets converetd into $Fe(OH)_3$ i.e. yellow rust. $4\,Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4\,Fe(OH)_3 \downarrow$	1 1 1 1	**4**
	d)	**Draw neat labeled diagram of fuel cell and write any two advantages and two limitations**  	2	4

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.		**Advanteges:- (Any two)** 1. High efficiency of energy conversion (75 to 82.8%) from chemical energy to electrical energy. 2. No emission of gases & pollutants within permissible limits. 3. Fuel cells offer excellent method for efficient use of fossil fuels. 4. $H_2 - O_2$ systems produce drinking water of potable quality. 5. Low noise pollution & low thermal pollution. 6. Modular & hence parts are exchangeable. 7. Low maintenance costs. 8. Fast start up time of low temperature systems. 9. The regenerative $H_2 - O_2$ system is an energy storage system for space applications. 10. Low cost fuels can be used with high temperature systems. 11. The regeneration of heat will increase the efficiency of high temperature systems. 12. Fuel cells are suitable for future nuclear solar hydrogen economy. 13. Hydrogen & air electrodes are useful in other battery systems. e.g. Ni – Hydrogen, zinc – air, aluminium – air etc. 14. Saves fossil fuels 15. Fuel cell automotive batteries can render electric vehicles efficient & refillable	**1**	
		Limitations :-(Any two) 1. High initial cost. 2. Large weight & volume of gas fuel storage systems. 3. High cost of pure hydrogen. 4. Lack of infrastructure for distributing hydrogen 5. Lquification of hydrogen requires 30% of the stored energy. 6. Life span of the cell is not accurately known	**1**	
	e)	**Define adhesives with two examples. Write any two advantages** **Adhesives:-** Any substance which is capable of holding the materials together by surface attachment is called as an adhesive.	**1**	4
		Examples :-(Any two) Epoxy resins, Urea formaldehyde, Phenol formaldehyde	**1**	
		Advantages:- (any two) i) Adhesives have advantages of joining material such as glass & metal, metal – metal, metal & plastic, plastics-plastic, ceramic & ceramic. ii) Surfaces are easily & rapidly attached to each other by adhesives. iii) Adhesives introduce heat as well as electrical insulating layers in between the bonding surfaces iv) The process of applying adhesives is very simple, so it does not require highly specialized person.	**2**	

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.		v) In several cases of bonding by adhesives, no high heat is required. vi) Adhesive bonding requires less after finishing as compared with other joining processes such as welding, soldering etc. vii) Metal joined by an adhesive can resist corrosion. viii) Adhesive joints are leak proof for gases & liquids. So adhesive bonding is used in preparing water light wood boats ix) The structural members joined by adhesives are free from any residual stress which makes it possible to fully utilize the inherent strength of any material.		
	f)	**State two properties and two uses of silicone fluids.** **Properties :- (Any two)** **1.** They can be used in temperature range of -90 ^{0}C to 220 ^{0}C **2.** They have excellent dielectric properties over a wide range of temperature **3.** They have high heat stability & good oxidation resistance **4.** They are non corrosive to metals up to 200 ^{0}C, fire proof .non toxic, chemically inert & odourless **5.** They have excellent water repellency **6.** Their viscosity does not change readily with the change in temperature. **7.** They are chemically inert. **8.** They are non-greasy, non-irritating and odourless. **9.** They have tendency to break down and give considerable amounts of gases (H_2) and residue which mainly contains carbon, silicon, carbide and SiO_2. Beacause of this drawback silicone fluids are not suitable to be used as switchgear oils. **Uses:- (Any two)** 1) **As a lubricant**: excellent lubrication for plastic and elastomeric surfaces. 2) **In polishes and chemical specialities**: It is used in automobile and furniture polishes due to its high gloss and water repellency. 3) **As a mechanical fluid:** It is used as hydraulic or transformer oils, damping mediums. 4) **As coolant:** They are used as coolant in radio, pulse and aircraft transformers.	**2** **2**	**4**

Que. No.	Sub. Que.	Model answers	Marks	Total Marks
3.	**f)**	5**) As a foam preventive:** effectively control foam in many machines like photocopiers and laser printers. 6) Also used in cosmetic and pharmaceutical industries. 7) **In electrical and chemical specialities:** Used as an insulator in medium and high voltage applications i.e. in transformers. 8) **As a release material**: an odourless, non-toxic, non-carbonizing moulds release for rubber, plastics and metal die castings.		