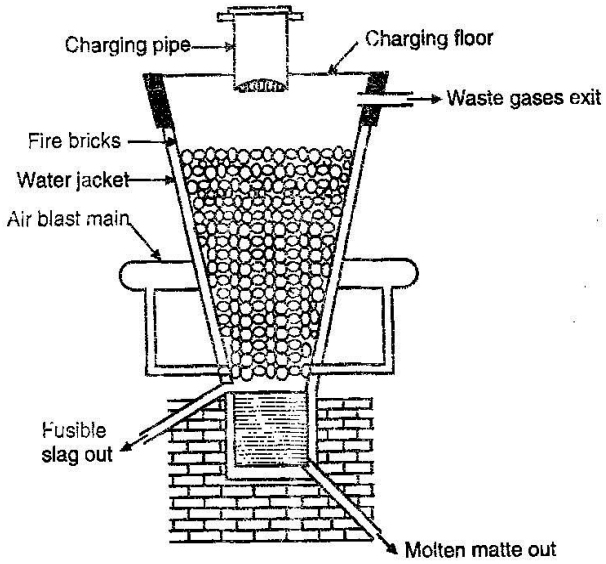
**Applied Science(Chemistry)**

| Que. No. | Sub. Que. | Model Answer | Marks | Total Marks |
|---|---|---|---|---|
| | | **Important Instructions to examiners:**<br>1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.<br>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.<br>3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).<br>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.<br>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.<br>6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.<br>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 any two ores of aluminium with their chemical formulae.**<br>**Ores of Aluminum:(Any two)**<br>Bauxite - $Al_2O_3 .2H_2O$.<br>Corundum- $Al_2O_3$,<br>Feldspar - $KAlSi_3O_8$,<br>Mica $[KAlSi_2O_{10}(OH)_2]$<br>Cryolite - $Na_3AlF_6$<br>Alunite ( Alumstone) $K_2SO_4 .Al_2(SO_4)_3 .4Al(OH)_3$ | **1 mark each** | **2** |
| | b) | **Draw neat labelled diagram of blast furnace for copper smelting.**<br>  <br> | **2** | **2** |
| | c) | **What happens when aluminium strip is dipped in hydrochloric acid?**<br>**(Give balanced equation)**<br>Al – dissolves in HCl to form $AlCl_3$ and liberate $H_2$.<br>**Reaction**<br>$$\mathbf{2Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3H_2 \uparrow}$$ | **1**<br>**1** | **2** |
| | d) | **Define corrosion.Mention types of corrosion.**<br>**Definition:** Any process of chemical or electrochemical decay or destruction of a metal due to the action of surrounding medium is called as corrosion.<br>**Types of corrosion:**<br>1) Atmospheric corrosion (or direct chemical corrosion or Dry corrosion )<br>2) Immersed corrosion (or electro chemical corrosion or wet corrosion) | **1**<br>**½ mark each** | **2** |

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| **1.** | **e)** | **Galvanized containers are not used for storage of food. Give reason.**<br>Galvanized utensils (zinc coated) cannot be used for preparing and storing food stuff, which are acidic in nature because zinc gets dissolved in dilute acids in food forming poisonous zinc compounds which will poison the content. | **2** | **2** |
| | **f)** | **Name most protective oxide film. Name two metals forming such oxide film.**<br>**Non-porous oxide film** is most protective oxide film.<br>**Examples:** Aluminium, Copper, Chromium etc. | **1**<br>**1** | **2** |
| | **g)** | **Write two applications of metal cladding process**.<br>**Applications :**<br>1)Al clad sheets used in aircraft industry in which a plate of duralumin is sandwiched between two layers of 99.5% pure Al<br>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. | **1 mark each** | **2** |
| | **h)** | **State Ohm's law and give mathematical expression.**<br>**Ohm's Law:-** The strength of **current** (I) passing through a conductor is directly proportional to the **potential difference (E)** applied across the conductor & inversely proportional to the **resistance (R)** of a conductor.<br>Thus, mathematically<br>**I = E / R** | **1**<br>**1** | **2** |
| | **i)** | **Define Primary cell and Secondary cell**<br>**Primary cells:** The non rechargeable cell is called primary cell.<br>**Secondary cells :** The rechargeable cell is called secondary cell.<br>**OR**<br>These are the cells in which the cell reaction can be reversed by passing direct electric current in the opposite direction. | **1**<br>**1** | **2** |
| | **j)** | **Define equivalent conductivity and give its unit.**<br>**Equivalent conductivity** :- It is the conductivity of the solution containing 1 gm equivalent of solute / electrolyte when placed between two sufficiently large electrodes which are 1 cm apart.<br>**OR**<br>The product of specific conductivity and the volume of the solution containing 1 gm equivalent of the solute is called as Equivalent conductivity.<br>**Unit: ohm$^{-1}$ cm$^2$ / eqvt. Or mhos.cm$^2$ /eqvt** | **1**<br>**1** | **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>k)</td><td>Give two points of difference between Dielectrics and insulators. (any two)
<table>
<tr><th>Dielectrics</th><th>Insulators</th></tr>
<tr><td>1. The materials which are used to prevent the loss of electricity through certain parts of an electrical system are known as dielectrics</td><td>1. Insulators or insulating materials are the substances which retard the flow of heat or electricity or sound through them.</td></tr>
<tr><td>2. The main function is storage of electrical charge.</td><td>2. The main function of such materials is that of insulation.</td></tr>
<tr><td>3. All dielectrics are insulators because they avoid the flow of electric current through them.</td><td>3.All insulators are not dielectrics because they can not store charges like dielectrics.</td></tr>
</table></td><td>1 mark each</td><td>2</td></tr>
<tr><td></td><td>l)</td><td>Write any two applications of epoxy resins.<br>Applications :- (Any two)<br>1. Epoxy resins are best suited for bonding of insulating materials such as porcelain, wood, metal, ceramic, glass articles.<br>2. Laminates as well as insulating varnishes have been prepared from epoxy resins.<br>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..</td><td>1 mark each</td><td>2</td></tr>
<tr><td>2.</td><td></td><td>Attempt any FOUR</td><td></td><td>16</td></tr>
<tr><td></td><td>a.</td><td>Why is copper electrorefined? Describe the process of electrorefining.<br><br>The impure copper contains about 2% impurities of CuO, Fe, Zn, Ni, As etc. However these impurities derceases the electrical conductivity of copper. Cu required for conducting electricity must be perfectly pure. Hence copper is electrorefined.</td><td>1</td><td>4</td></tr>
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| Que. No. | Sub. Que. | Model Answer | Marks | Total Marks |
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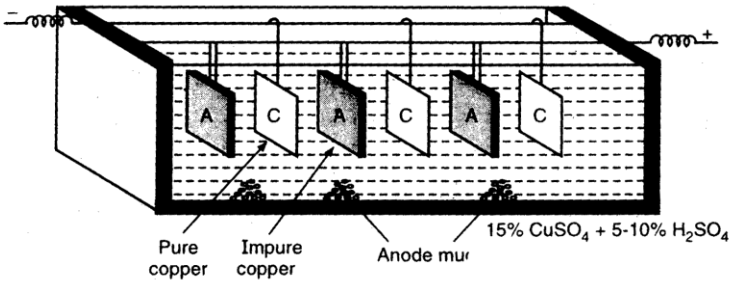
| **2.** | | **Electro – refining of Copper:-**<br>Anode electrode: - Impure copper<br>Cathode electrode: Pure copper<br>Electrolyte: - 15% $CuSO_4$ + 5-10% $H_2SO_4$ | | |
| | |  <br> | **1** | |
| | | 1) It is carried out in the large lead lined tank .Impure copper is placed into large plates which are suspended into tank at intervals & acts as anodes. Cathodes are thin plates of pure copper & each is suspended between two plates of anode. The electrolyte is 15% $CuSO_4$ Solution.<br>2) By the passage of electric current, Cu from the anode with traces of more active metals like Zn, Fe, Ni present as impurities go into the solution as metallic ions, whereas less active metals like Ag, Au & Pt are not ionized & settle below the anode as anode mud<br>3) At the applied voltage, $Cu^{++}$ ions alone are discharged at the cathode & thus pure copper is deposited on the cathodes | **2** | |
| | **b.** | **Name and describe the process used for concentration of alumina containing impurities of iron.**<br><br>**Baeyer's process** is used for for concentration of alumina containing impurities of iron. | **1** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| **2** | b. | **Process:**<br>i) The powered bauxite ore is roasted to convert FeO to $Fe_2O_3$.<br>ii) This roasted ore is then heated with conc. NaOH. Aluminium oxide dissolves forming sodium meta aluminate, while $Fe_2O_3$ remains undissolved.<br>$\mathbf{Al_2O_3 + 2NaOH \longrightarrow 2\ NaAlO_2 + H_2O}$<br>Sodium meta aluminate<br>iii) Undissolved $Fe_2O_3$ is removed by filtration.<br>iv) The filtrate is diluted with water to form a precipitate of Aluminium hydroxide [$Al(OH)_3$].<br>$\mathbf{NaAlO_2 + 2H_2O \longrightarrow NaOH + Al(OH)_3 \downarrow}$<br>v) The precipitate of $Al(OH)_3$ is then filtered out, dried and heated at $1500^oC$ to get pure alumina.<br>$\mathbf{2Al(OH)_3 \longrightarrow Al_2O_3 + 3H_2O}$ | **1**<br>**1**<br>**1** | |
| | c. | **Write composition, properties and applications of Tinmann's solder.**<br>**Composition** = Sn = 66 %<br>Pb = 34 %<br>**Properties:** It melts at $180^0C$ .<br>**Application:**<br>It is used for joining articles of tin. | **2**<br>**1**<br>**1** | **4** |
| | d. | **Write two properties and two uses of urea-formaldehyde resin.**<br>**Properties (Any two)**<br>1) The bond film produced by Urea – Formaldehyde resin is quite rigid & transparent.<br>2) It is good resistant to moisture, insects & fungi.<br>3) However action of acids & alkalies deteriorate the resin film after some time.<br>4) It can be used in cold but a little heating helps in accelerating the setting process.<br>**Uses :- (Any two)**<br>1) Used for bonding wooden surfaces.<br>2) Used for bonding water proof plywood laminates<br>3) Bonding articles in aircraft & ship building industries etc. | **1 mark each**<br>**1 mark each** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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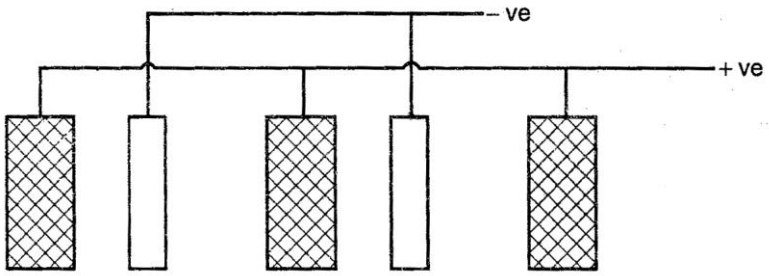
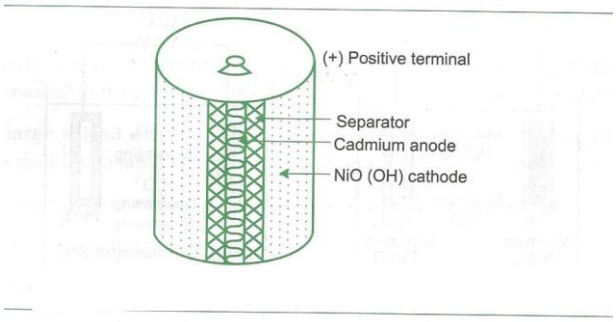
| 2 | e. | **Explain construction and working of Ni-Cd cell with labeled diagram.**<br>  <br>  <br>**(Consider any of these two diagrams.)**<br>**Construction:**<br>Positive plates are made up of nickel plated tubes, containing a mixture of nickel oxide ($NiO_2$) & hydroxide + 17% flakes of graphite or metallic nickel for increasing conductivity. They also contain an activated additive 2% $Ba(OH)_2$ which increases the life of plates.<br>Negative plates consist of spongy Cadmium.<br>The electrolyte is 20- 15% solution of KOH to which small quantity of lithium hydroxide (LiOH) is added to increase the capacity of cell.<br>**Working:**<br>**A) Discharging:-**<br>Positive Plate: $\mathbf{NiO_{2(s)} + 2H_2O\ (l) + 2e^- \rightarrow Ni\ (OH)_{2\ (s)} + 2OH^-}$<br>Negative Plate: $\mathbf{Cd_{\ (s)} + 2OH^-_{(aq)} \rightarrow Cd\ (OH)_{2(s)} + 2e^-}$<br>Net reaction: $\mathbf{NiO_{2\ (s)} + Cd_{(s)} + 2H_2O \rightarrow Ni(OH)_{\ 2} + Cd(OH)_2}$<br>**B) Charging:-**<br>Positive Plate: $\mathbf{Ni(OH)_{2(s)} + 2OH^-_{(a)} \rightarrow NiO_{2(s)} + 2H_2O + 2e^-}$<br>Negative Plate: $\mathbf{Cd(OH)_{\ 2(s)} + 2e \rightarrow Cd_{(s)} + 2OH_{(s)}}$<br>Net reaction: $\mathbf{Ni(OH)_2 + Cd(OH)_2 \rightarrow NiO_{2(s)} + Cd_{(s)} + 2H_2O}$<br>Thus, discharging & charging reactions can be shown simultaneously as: -<br>$\mathbf{NiO_{2(s)} + Cd_{\ (s)} + 2H_2O \rightarrow 2Ni(OH)_{\ 2} + Cd(OH)_2}$<br>Cell has an e.m.f. of 1.4 v when fully charged. | **1**<br><br>**1**<br><br>**2** | **4** |

| Que. No. | Sub. Que. | Model Answer | Marks | Total Marks |
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| **2.** | **f.** | **With the help of chemical reactions, describe discharging and charging process of lead acid cell.**<br><br>**Discharging:** - While discharging chemical energy gets converted into electrical energy.<br>**At anode**: - The lead electrode loses electrons, which flow through the wire.<br>$$Pb \rightarrow Pb^{2+} + 2e^-$$<br>The Pb2+ ions then reacts with sulphate $SO_4^{2-}$ ions.<br>$$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4 \downarrow + 2e^-$$<br>The electrons released from the anode flow to the cathode electrode.<br>**At cathode:-** Lead undergoes reduction at the cathode from oxidation state +4 ($PbO_2$) to +2 ($PbSO_4$).<br>$$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O .$$<br>The $Pb^{++}$ ions then combine with $SO_4^{--}$ ions.<br>$$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4 \downarrow$$<br><br>**Net reaction during Discharging: -**<br>$$Pb + PbO_2 + 4H^+ + 2SO_4^{2-} \rightarrow 2PbSO_4 \downarrow + 2H_2O + Energy$$<br>Lead sulphate is precipited at both the electrodes. As sulphuric acid is utilized & $H_2O$ is formed in the process, concentration of $H_2SO_4$ will decrease, then battery should be charged.<br><br>**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.<br>**At anode**<br>$$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$$<br>**At cathode**<br>$$PbSO_4 + 2H_2O + 2e^- \rightarrow PbO_2 + 4H^+ + 2SO_4^{2-}$$<br>Net reaction during Charging:<br>$$2PbSO_4 + 2H_2O + Energy \rightarrow Pb + PbO_2 + 4H^+ + 2SO_4^{2-}$$<br>Thus $H_2SO_4$ is regenerated & specific gravity will go on increasing. When it comes to 1.215, cell is said to be charged fully.<br>The net reaction of Discharging & Charging is :<br><br>$$Pb + PbO_2 + 2H_2SO_4 \rightleftharpoons 2PbSO_4 + 2H_2O$$ | **2 mark**<br><br>**2 mark** | **4** |

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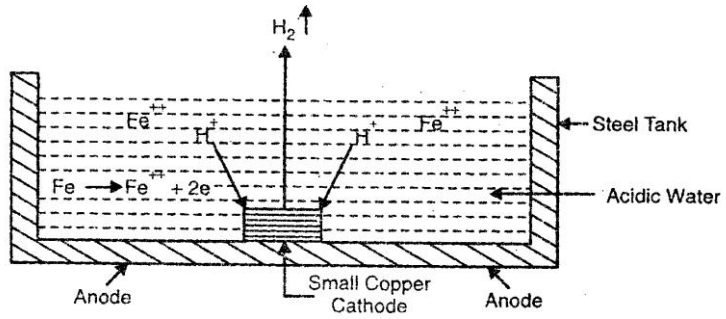
| **3** | | **Attempt any FOUR** | | **16** |
| | **a.** | **Describe the factors that affect the rate of atmospheric corrosion.**<br>**Factors affecting atmospheric corrosion:-**<br>**1) Impurities in the atmosphere:-**<br>Corrosion rate is fast in the presence of all impurities such as $H_2S$, $SO_{2,}$, $CO_2$, $Cl_2$, gases along with vapors of HCl & $H_2SO_4$ etc. Atmospheric air in industries areas contains these impurities.<br>**2) Moisture in the atmosphere:-**<br>Atmospheric gases & chemical vapours dissolve in moisture and reaction between such dissolved gases and metal becomes faster. Therefore moisture acts as conducting medium and enhances the corrosion. | **2**<br>**2** | **4** |
| | **b.** | **Describe with diagram hydrogen evolution mechanism of electrochemical corrosion.**<br>**Steel tank: - Anode**<br>**Cu – strip:- Cathode**<br>  <br><br>This types of corrosion occurs usually in acidic environments, like industrial waste, solutions of non – oxidizing acids (like HCl).<br>**Process:** 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 is corroded most with the evolution of hydrogen gas.<br>**The reactions:**<br>**At Anode:**<br>**$Fe \longrightarrow Fe^{++} + 2e^-$**<br>These electrons flow through the metal from anode to the cathode<br>**At cathode**<br>**$H^+$ ions are eliminated as $H_2$ gas**<br>**$2H^+ + 2e^- \longrightarrow H_2 \uparrow$**<br>Over all reaction is<br>**$Fe + 2H^+ \longrightarrow Fe^{++} + H_2 \uparrow$** | **1**<br>**1**<br>**1**<br>**1** | **4** |

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| | c. | **Describe sherardising process for protection of metal from corrosion. Give its two applications.**<br>**Process:**<br>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.<br>ii) The drum is slowly rotated for 2-3 hrs. and its temp. is kept between $350^0 – 400^0$C.<br>iii) During this process Zn gets diffused slowly into iron forming Fe - Zn alloy at the surface which protects iron surface from corrosion.<br><br>**Applications:(Any two)**<br>used for protecting small steel articles **like bolts, screws, nuts, threaded parts ,washers, valves, gauge, tools etc**. | **2**<br><br>**1 mark each** | **4** |
| | d. | **Give four advantages and four limitations of fuel cell.**<br>**Advantages of fuel Cell(Any four)**<br>1. High efficiency of energy conversion (75 to 82.8%) from chemical energy to electrical energy.<br>2. No emission of gases & pollutants within permissible limits.<br>3. Fuel cells offer excellent method for efficient use of fossil fuels.<br>4. $H_2 – O_2$ systems produce drinking water of potable quality.<br>5. Low noise pollution & low thermal pollution.<br>6. Modular & hence parts are exchangeable.<br>7. Low maintenance costs.<br>8. Fast start up time of low temperature systems.<br>9. The regenerative $H_2 – O_2$ system is an energy storage system for space applications.<br>10. Low cost fuels can be used with high temperature systems.<br>11. The regeneration of heat will increase the efficiency of high temperature systems.<br>12. Fuel cells are suitable for future nuclear solar hydrogen economy.<br>13. Hydrogen & air electrodes are useful in other battery systems. e.g. Ni – Hydrogen, zinc – air, aluminium – air etc.<br>14. Saves fossil fuels.<br>15. Fuel cell automotive batteries can render electric vehicles efficient & refillable | **½ mark each** | **4** |

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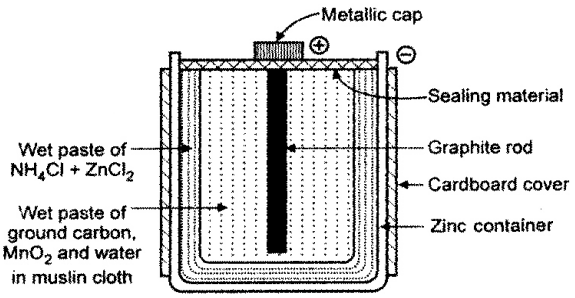
| **3.** | **d.** | **Limitations(Any four)**<br>1. High initial cost.<br>2. Large weight & volume of gas fuel storage systems.<br>3. High cost of pure hydrogen.<br>4. Lack of infrastructure for distributing hydrogen.<br>5. Liquification of hydrogen requires 30% of the stored energy.<br>6. Life time of the cells is not accurately known. | **½ mark each** | |
| | **e.** | **Explain construction and working of Dry cell with labeled diagram**<br>**Construction:-**<br>  <br><br>It consists of zinc container (vessel) which acts as an anode.<br>Cathode is a Graphite rod. It acts as inert electrode. The Graphite rod is surrounded by a paste of $MnO_2$ (Manganese dioxide) & powdered Carbon (Black).<br>The cell is filled with a paste of $NH_4Cl$ & $ZnCl_2$ prepared in water.<br>The cell is sealed at the top by wax or resin. | **1**<br>**1** | **4** |

| Que. No. | Sub. Que. | Model answers | Marks | Total Marks |
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| **3.** | **e.** | **Working**<br>**At zinc anode: -**<br>Dissolution of zinc electrode to form zinc ions.<br>**$Zn \longrightarrow Zn^{++} + 2e^-$ (oxidation)**<br>Zn++ combines with ammonia to form its complex.<br>**$Zn^{2+} + 4\ NH_3 \rightarrow Zn(NH_3)_4^{++}$**<br>**At the graphite cathode: -**<br>Manganese dioxide (MnO2) reaction with $NH_4^+$ (ammonium) ions to liberate ammonia.<br>**$2NH_4^+ + 2\ MnO_2 + 2\ e^- \rightarrow Mn_2O_3 + H_2O + 2NH_3 \uparrow$**<br>Ammonia thus produced is liberated as a gas but it combines with $Zn^{2+}$ to form a $Zn(NH_3)_4^{++}$ ions complex at the zinc anode.<br>The cell develops a potential 1.5 volts. | **2** | |
| | **f.** | **Give any four applications of electrically conducting polymers.**<br>**Applications: (Any four)**<br>i) **Rechargeable batteries:** These batteries are small in size.<br>ii) **In analytical sensors:** They are suitable to use as sensors for pH, $O_2$, $NO_2$, $SO_2$,$NH_3$ Glucose and oxidizing chemicals for the study of their even very low concentration.<br>iii) **As antistatic material:** To avoid static electricity in plastic carpets in offices, theatres polyanilline can be used as antistatic material.<br>iv) **Coating an insulator** with conductive polymer is important for explosive industry, computer industry as antistatic material.<br>v) **In optical filters:** Radiations from computer screens, other electrical devices can be absorbed by conducting polymers.<br>vi) **In electronics:** They are used for photodiodes, light-emitting wall papers, and LED and data storage.<br>vii) **Photovoltaic cell:** Conducting polymers can be used in construction of photovoltaic cells. | **1 mark each** | **4** |