Q.1 Attempt any NINE of the following: **[18]**

Q.1(a) State the composition of Rose metal. **[2]**

(A) **Composition:** Bi = 50%
Pb = 28%
Sn = 22%

Q.1(b) Explain cathodic protection. Give one example. **[2]**

(A) **Cathodic protection**: "It is the method in which the metal to be protected is forced to behave as a cathode."

Examples:

(i) To protect buried water or gas pipelines.
(ii) To protect buried cables.
(iii) To protect hot water tank, etc.
(iv) Mg or Zn rods are bolted along the sides of ship, hot water tanks or inserted into boiler to prevent corrosion.
(v) To protect open water box coolers.
(vi) To protect water tanks.
(vii) To protect transmission line towers, etc.

Q.1(c) Define paint. Give its two properties. **[2]**

(A) **Paint:** Paint is a mechanical dispersion mixture of one or more pigment in a vehicle.

Properties of paint:

(i) Paint imparts opacity and colour to the surface on which it is applied.
(ii) It protects the surface against UV rays.
(iii) Paint provides resistance against abrasion, moisture and weather.
(iv) Paint imparts luster, gloss and durability to the surface on which it is applied.

Q.1(d) Write the difference between dielectrics and insulator. **[2]**

(A)

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

Q.1(e) Give two application of epoxy resins. **[2]**

(A) **Applications :**

(i) Epoxy resins are best suited for bonding of insulating materials such as porcelain, wood, metal, ceramic, glass articles.
(ii) Laminates as well as insulating varnishes are prepared from epoxy resins.

(iii) A trade name for common epoxy resin type adhesive is araldite which is used in aircraft industry, automobiles, bicycles, golf club, snow boards etc.

(iv) Due to their electrical resistance they are widely used in making insulators, bushings etc. for high voltage.

Q.1(f) Write two ores of copper with their chemical formulae. **[2]**

(A)

	Name of the ore	Chemical formula
(i)	Cuprite or ruby copper	Cu_2O
(ii)	Copper glance	Cu_2S
(iii)	Copper pyrite	$CuFeS_2$
(iv)	Malachite	$CuCO_3.Cu(OH)_2$
(v)	Azurite	$2CuCO_3.Cu(OH)_2$

Q.1(g) Which oxide film is most protective against corrosion? Why? **[2]**

(A) **Non-porous stable oxide film** is most protective oxide film.

This oxide film is extremely adherent and non-porous (protective). Due to the absence of pores or cracks in the oxide film, it forms barrier for further action and therefore, the rate of corrosion of metal decreases rapidly.

Q.1(h) Why does a dry cell become dead after a long time, even if it has not been used? **[2]**

(A) Dry cell become dead after a long time, even if it has not been used because acidic NH_4C1 corrodes the zinc vessel.

Q.1(i) Why aluminium cannot be obtained by heating alumina with coke? **[2]**

(A) Alumina cannot be reduced to metallic aluminium by carbon, because aluminium has a great affinity for oxygen and thus the reduction of alumina (Al2O3) by carbon under ordinary conditions is not possible. Further, at high temperatures, aluminium reacts with carbon to form Al_4C_3. Electrolytic reduction of alumina laso has the following difficulties.

(i) Pure a alumina has a very high melting point (2000°C). In case the electrolysis is carried out at 2000°C, aluminium obtained vapourises, because its m.p. is 1800°C.

(ii) Alumina is a bad conductor of electricity.

Q.1(j) Explain characteristic of good paint. **[2]**

(A) **Characteristics of a good paint**

A good paint should possess the following properties :

(i) It should be fluid enough to be spread easily over the surface to be protected.

(ii) It should possess high covering power.

(iii) It should have brushing characteristics. Brushes may be made according to the type of paint to be applied.

(iv) It should form a quite tough, uniform, adherent and durable film.

(v) It should protect the painted surface from corrosion effects of the environment.

(vi) Its film should not get cracked on drying.

(vii) Its film should be glossy and washable.

Q.1(k) Define the terms: **[2]**

(i) Specific conductance (ii) Equivalent conductance

(A) **(i) Specific conductance (k) :** Specific conductance is the conductance of a 1 cm^2 of the substance or solution.

OR

The conductance offered by a solution of unit length & area of unit cross section is known as specific conductance.

(ii) Equivalent conductance (λv) : It is the conductance of the solution containing 1 gm equivalent of solute / electrolyte when placed between two sufficiently large electrodes 1 cm apart.

Q.1(l) Write two applications of Teflon. **[2]**

(A) Teflon or Fluon Polytrifluoro-chloro-ethylene:

(i) It is an ideal dielectric material with dielectric constant of 2 to 2.2.

(ii) It is generally most thermally and chemically stable. It is stiff and so must be used in thin layers.

Q.2Attempt any FOUR of the following : **[16]**

Q.2(a) Explain the electrolytic refining of aluminium. **[4]**

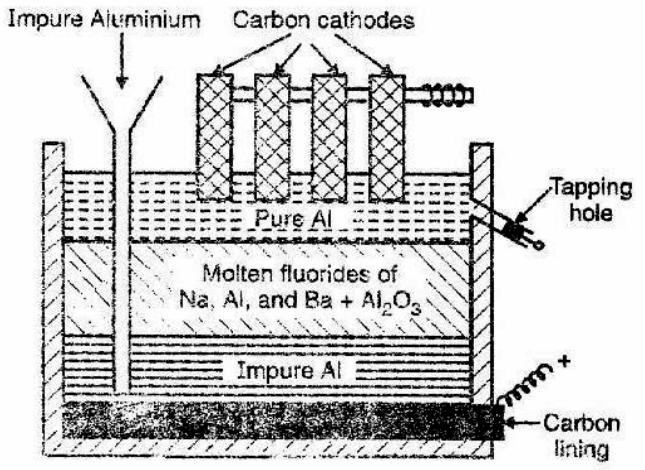
(A) Process:

(i) The electrolytic cell consists of an iron tank lined at the bottom with carbon, which serve as anode. A number of graphite rods serve as cathode.

(ii) The cell is filled with three liquid layers of different densities.

- The top most layer consists of molten pure aluminium which acts as cathode.
- The middle layer is of electrolyte which consists of a mixture of molten fluorides of Al, Ba & Na.
- The bottom layer consists of molten impure aluminium.

(iii) On passing electric current, the aluminum ions from the middle layer discharged at the cathode and get collected in the top most layers. Same amount of aluminum ions from the bottom layer goes into the middle layer. Pure Al collected at the top is tapped out from time to time. Crude or impure Al is added to the bottom layer from time to time. The process is thus continued.



Q.2(b) Write charging and discharging chemical reactions of lead acid storage cell. **[4]**

(A) (i) Discharging:

At Anode:

$Pb \rightarrow Pb^{2+} + 2e^-$ (Oxidation)

$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

At Cathode:

$PbO_2 + 4\,H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$ (Reduction)

$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

Net reaction during discharging:

$Pb + PbO_2 + 4H^+ + 2SO_4^{2-} \rightarrow 2PbSO_4 + 2H_2O$

(ii) Charging:

At Cathode:

$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$

At Anode:

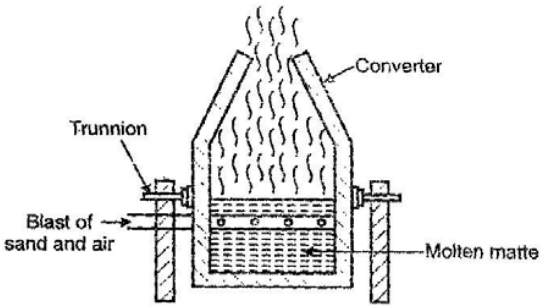
$PbSO_4 + 2\ H_2O \rightarrow PbO_2 + 4\ H^+ + SO_4^{2-} + 2e^-$

Net reaction during Charging:

$2PbSO_4 + 2H_2O \rightarrow Pb + PbO_2 + 4\ H^+ + 2SO_4^{2-}$

Q.2(c) Describe Bessemerisation process for extraction of copper. [4]

(A)



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 trunnions 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.

Following chemical reactions takes place in the Bessemer converter.

(a) Conversion of FeS to slag

$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2 \uparrow$

$FeO + SiO_2 \rightarrow FeSiO_3$

(b) Partial oxidation of Cu_2S to Cu_2O

$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2 \uparrow$

(c) Reduction of Cu_2O by Cu_2S to metallic copper

$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2 \uparrow$

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.

Q.2(d) Describe Bayer's process for extraction of Aluminium. [4]

(A) (i) The powered bauxite ore is roasted to convert ferrous oxide (FeO) to ferric oxide (Fe_2O_3).

(ii) This roasted ore is then heated with conc. NaOH.

Aluminium oxide dissolves forming sodium meta aluminate, while Fe_2O_3 remains undissolved.

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Sodium meta aluminate

(iii) Undissolved Fe_2O_3 is removed by filtration.

(iv) The filtrate is diluted with water to form a precipitate of aluminium hydroxide $[Al(OH)_3 \downarrow$

(v) The precipitate of $Al(OH)_3$ is then filtered out, dried and heated at 1500°C to get pure alumina.

$2Al(OH)_3 \xrightarrow[1500°C]{\Delta} Al_2O_3 + 3H_2O \uparrow$

Q.2(e) Define adhesives. Write three characteristics of adhesives. [4]

(A) Characteristics :

(i) Adhesive should form rigid, strong and durable bound.

(ii) It should be economical in use.

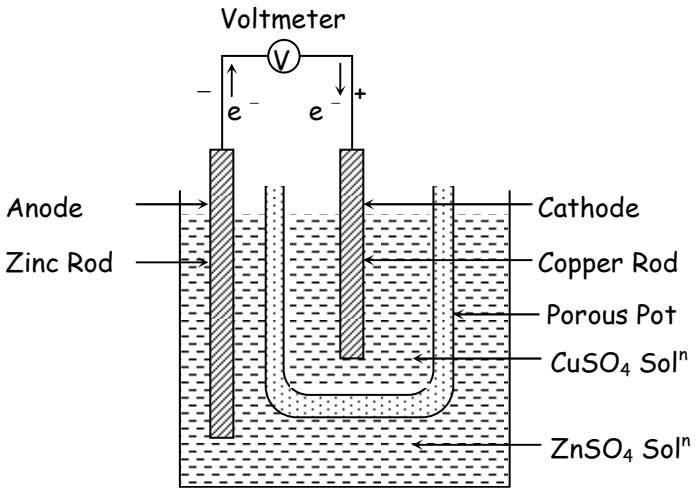
(iii) It should be odorless.

(iv) It should not lose the adhesion property on storage.

(v) It should be resistant to heat, chemicals and water.

Q.2(f) Describe construction and working of Daniel cell with the help of diagram. [4]

(A)



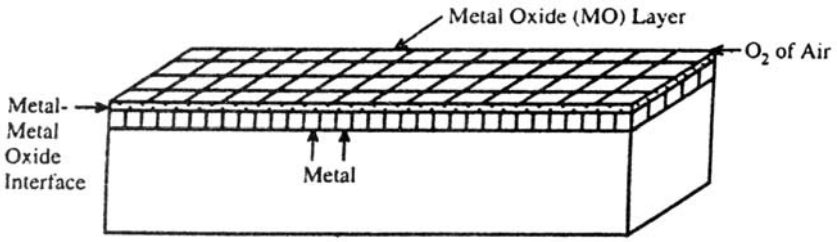
Construction: It consists of zinc electrode dipped in $ZnSO_4$ Solution & copper electrode dipped in $CuSO_4$ solution.

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.

Q.3Attempt any FOUR of the following : [16]

Q.3(a) Write the mechanism of corrosion of metal due to action of oxygen. [4]

(A)



Mechanism of Atmospheric Corrosion

Corrosion is represented by the equation.

$2M + O_2 \rightarrow 2MO$

(Metal) (Oxygen) (Metal Oxide)

Further action depending upon the film so produced.

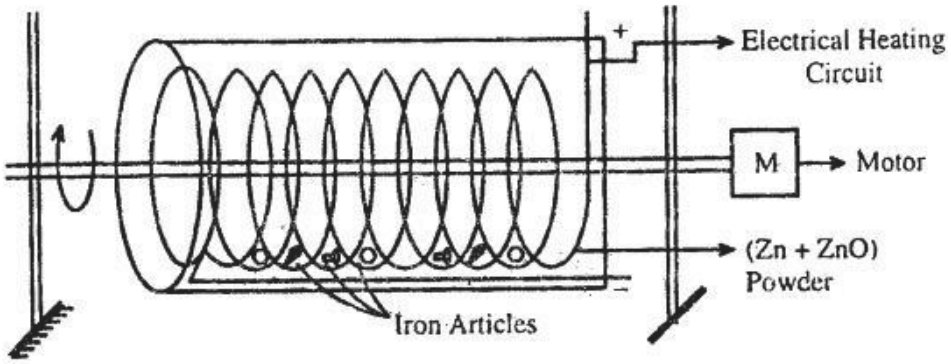
$M \rightarrow M_2^+ + 2e^-$ (loss of electrons)

$O + 2e^- \rightarrow O2^-$ (gain of electrons)

$M + O \rightarrow M_2^+ + O2^-$ MO (Metal oxide)

Q.3(b) Define cementation. Explain sherardizing process. [4]

(A) "Cementation is the process in which metal coatings are obtained by heating the base metal in a revolving drum containing a powder of the coating metal."



(i) The 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 – 400OC.
(iii) During this process Zn slowly diffuses into iron surface forming Fe - Zn alloy at the surface which protects iron surface from corrosion.

Q.3(c) Classify electro chemical cells. Give examples of each type. **[4]**

(A) Electrochemical cells are classified as:

1) Primary cells.
2) Secondary cells.

Examples of primary cells:

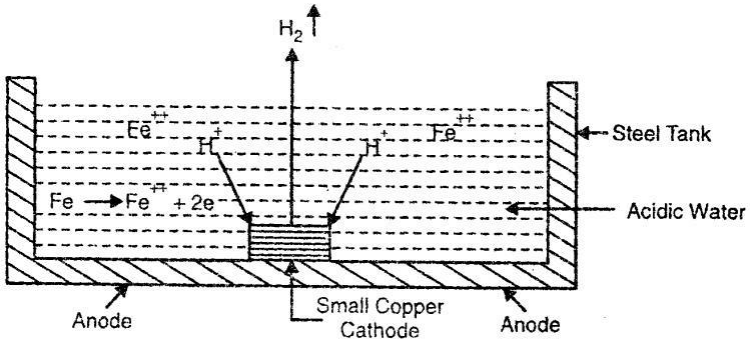
Dry Cell (Leclanche's cell).
Daniel Cell.

Examples of secondary cells:

Lead-acid storage cell.
Ni-Cd battery.

Q.3(d) Explain mechanism of immersed corrosion with evolution of hydrogen gas. **[4]**

(A)



Steel tank : Anode Cu
Strip : Cathode

Such type of corrosion occurs usually in acidic environments like acidic industrial waste, solutions of non – oxidizing acids. Consider 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.

Q.3(e) Write two characteristics and two use of Ni-Cd battery. **[4]**

(A) Characteristics :

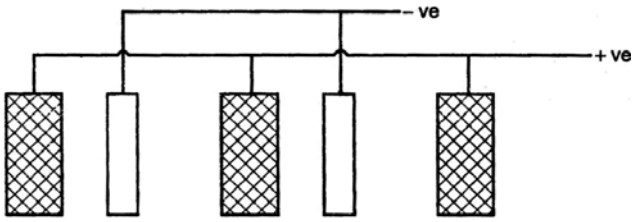
(i) The e.m.f. of cell is 1.4 V when fully charged.
(ii) It has low internal resistance and longer life span (5 years).
(iii) It is expensive in cost.
(iv) It can be recharged because no products are lost and no gas is evolved. The reaction products stick to the electrodes.

Uses :

(i) It is used in industrial services such as trucks, mine locomotives.
(ii) It is used in railway car lighting and air conditioning because of its long life & low maintenance cost.
(iii) It is widely used in calcuators.

Q.3(f) Give construction and working of hydrogen-oxygen fuel cell. [4]

(A)



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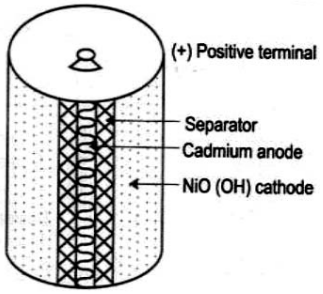

Construction:

(i) 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.

(ii) They also contain an activated additive 2% $Ba(OH)_2$ which increases the life of plates. Negative plates consist of spongy Cadmium.

(iii) The electrolyte is 20- 15% solution of KOH to which small quantity of lithium hydroxide (LiOH) is added to increase the capacity of cell.

Working:

(A) Discharging:

Positive Plate:

$NiO_2(s) + 2H_2O\ (l) + 2e^- \longrightarrow Ni\ (OH)_2\ (s) + 2OH^-$

Negative Plate:

$Cd\ (s) + 2OH^-\ (aq) \longrightarrow Cd\ (OH)_2(s) + 2e^-$

Net reaction:

$NiO_2\ (s) + Cd(s) + 2H_2O \longrightarrow Ni(OH)_2 + Cd(OH)_2$

(B) Charging:

Positive Plate:

$Ni(OH)_2(s) + 2OH^-\ (a) \longrightarrow NiO_2(s) + 2H_2O + 2e^-$

Negative Plate:

$Cd(OH)_2(s) + 2e^- \longrightarrow Cd(s) + 2OH(s)$

Net reaction:

$Ni(OH)_2 + Cd(OH)_2 \longrightarrow NiO_2(s) + Cd(s) + 2H_2O$

Thus, discharging & charging reactions can be shown simultaneously as:-

$NiO_2(s) + Cd\ (s) + 2H_2O \rightleftharpoons 2Ni(OH)_2 + Cd(OH)_2$

OR

(A) Discharging:

Positive Plate:

$NiO(OH) + 2H_2O + 2e^- \longrightarrow 2Ni\ (OH)_2 + 2OH^-$

Negative Plate:

$Cd + 2OH^- \longrightarrow Cd\ (OH)_2 + 2e^-$

Net reaction:

$NiO(OH) + Cd + 2H_2O \longrightarrow 2Ni(OH)_2 + Cd(OH)_2$

(B) Charging:

Positive Plate:

$Ni(OH)_2 + 2OH^- \longrightarrow NiO(OH) + 2H_2O + 2e^-$

Negative Plate:

$Cd(OH)_2 + 2e^- \longrightarrow Cd + 2OH^-$

Net reaction:

$Ni(OH)_2 + Cd(OH)_2 \longrightarrow NiO(OH) + Cd + 2H_2O$

Thus, discharging & charging reactions can be shown simultaneously as:

$NiO(OH) + Cd\ (s) + 2H_2O \rightleftharpoons 2Ni(OH)_2 + Cd(OH)_2$

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