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CBSE Test Paper

Class 12 Chemistry (Electrochemistry)

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1. In the primary batteries
   a. the reaction occurs only once and after use over a period of time battery becomes dead and cannot be reused again
   b. the reaction occurs only once and after use it can be recharged and reused again
   c. the reaction is reversed periodically and after use over a period of time and so can be reused again
   d. electrode reactions can be reversed by an external energy source and can be used again and again
2. The highest electrical conductivity of the following aqueous solutions is of
   a. 0.1 M acetic acid
   b. 0.1 M chloroacetic acid
   c. 0.1 M fluoroacetic acid
   d. 0.1 M difluoroacetic acid
3. Rust is a mixture of:
   a. FeO and $Fe(OH)_3$
   b. Fe_2O_3 and $Fe(OH)_3$
   c. Fe_3O_4 and $Fe(OH)_3$
   d. FeO and $Fe(OH)_2$
4. A current of 0.5 ampere when passed through $AgNO_3$ solution for 193 seconds deposited 0.108 g of Ag. The equivalent weight of Ag is:
   a. 54
   b. 10.8
   c. 108
   d. 1

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5. Emf of the cell
   $Mg(s)|Mg^{2+}(0.001M)||Cu^2 + (0.0001M)|Cu(s)$
   at 298 K is [Given $E^0 = \frac{Mg^{2+}}{Mg} = -2.37V$, $\frac{E^0 Cu^{2+}}{Cu} = +0.34V$]
   a. 2.50 V

b. 2.38 V
c. 2.60 V
d. 2.68 V

6. What does the positive value of standard electrode potential indicate?

7. Write Nernst equation for the electrode reaction:
$M^{n+}(aq) + ne^- \rightarrow M(s)$

8. Name the cell used for low current devices like hearing aids, watches etc. Also give the half cell reactions for such a cell?

9. Under what condition will a galvanic cell send no current into outer circuit? Explain.

10. Define conductivity and molar conductivity for the solution of an electrolyte.

11. How does fuel cell operate? Why we prefer it over other conventional fuel cells? Write complete reaction which takes place with respect to Hydrogen-Oxygen fuel cells.

12. How much time would it take in minutes to deposit 1.18 g of metallic copper on a metal object when a current of 2.0 A is passed through the electrolytic cell containing Cu^{2+} ions?
[Cu = 63.5g/mol, 1F = 96, 500C mol^{-1}]

13. How much electricity is required in coulomb for the oxidation of
    i. 1 mol of H_2O to O_2.
    ii. 1 mol of FeO to Fe_2O_3.

14. What is understood by a normal hydrogen electrode? Give its significance?

15. a. What is Nickel Cadmium cell? State its one merit over lead storage cell. Write the overall reaction that occurs during discharging of this cell.
    b. Silver is electro deposited on a metallic vessel of total surface area 900 cm^2 by passing a current of 0.5 ampere for 2 hours.
    Calculate the thickness of silver deposited, given its density is 10.5gcm^{-3}. (At. mass of Ag = 108 g mol^{-1}).

CBSE Test Paper-02
Class 12 Chemistry (Electrochemistry)
Solutions

1. a. the reaction occurs only once and after use over a period of time battery becomes dead and cannot be reused again

   Explanation: In Primary batteries the electrode reactions cannot be reversed by an external energy source. so they are not chargeable.

2. d. 0.1 M difluoroacetic acid

   Explanation: Acidity increases on attaching electron withdrawing group because of stability of conjugate base. Conduction of electric charge depends on the ions. so higher the number of ions higher is electrical conductivity. As fluoro group causes negative inductive effect increasing ionisation, it gives stable ions in solution. also in difluoroacetic acid, the presence of 2 fluorine atom increases the negative inductive effect.

3. b. Fe_2O_3 and $Fe(OH)_3$

   Explanation: Fe_2O_3 and $Fe(OH)_3$ rust has general formula $Fe_2O_3.xH_2O$. it is formed when iron compounds corrode in the presence of air and oxygen. So it is a mixture of oxides and hydroxides.

4. c. 108

   Explanation: Data:

   i. Current in ampere (I)= 0.5 amp
   ii. Time in seconds =193 s
   iii. Mass of Ag metal deposited (w) = 0.108g

   Formula:

   w = Z I t ....(i)

   $Z = \frac{Equivalent weight}{96500C}$ ....(ii)

   Substitute (ii) in (i),

   $w = \frac{Equivalent weight}{96500C} \times I \times t$

   or Equivalent weight $= \frac{w \times 96500C}{I \times t}$

   Equivalent weight $= \frac{0.108g \times 96500C}{0.5amp \times 193sec} = \frac{0.108 \times 96500}{0.5 \times 193} \times \frac{g \times C}{amp \times sec}$

$= \frac{0.108 \times 96500}{96.5} \times \frac{g \times C}{C} = 108g$ [∵ 1C=$1amp \times 1sec$]

Equivalent weight of Ag = 108 g

5. a. (d) 2.68 V

Explanation: $E_{cell} = E^0_{cell} - \left(\frac{0.0591}{n}\right) \log Q$

$$E_{cell} = E^0_{cell} - \frac{0.0591}{n} \log \frac{[Mg^{2+}]}{[Cu^{2+}]}$$

$$E^0_{cell} = \frac{E^0 Cu^{2+}}{Cu} - \frac{E^0 Mg^{2+}}{Mg} = +0.34 - (-2.37) = 271V$$

$$E_{cell} = 2.71 - \frac{0.0591}{2} \log \frac{10^{-3}}{10^{-4}} = 2.71 - \frac{0.0591}{2} \log 10 = 2.68 \text{ V}$$

6. The positive value of standard electrode potential indicates that the element gets reduced more easily than H^+ ions and its reduced form is more stable than Hydrogen gas.
7. Nernst Equation is given by:

$$E_{(M^{n+}/M)} = E^{\ominus}_{(M^{n+}/M)} - \frac{2.303RT}{nF} \log \frac{[M]}{[M^{n+}]}$$

[M] is unity because it is solid metal.

Therefore

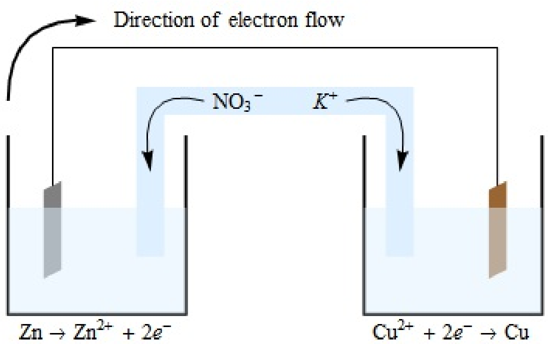
$$E_{(M^{n+}/M)} = E^{\ominus}_{(M^{n+}/M)} - \frac{2.303RT}{nF} \log \frac{1}{[M^{n+}]}$$

8. This cell is mercury cell – Half cell reactions are Anode

$Zn(Hg) + 2OH^- \rightarrow ZnO + H_2O + 2e^-$ and those

$HgO + H_2O + 2e^- \rightarrow Hg(e) + 2OH^-$

9. If salt bridge is not used galvanic cell will send no current in outer circuit after sometime. This can be understood by taking the example of copper-zinc cell as shown in the figure.



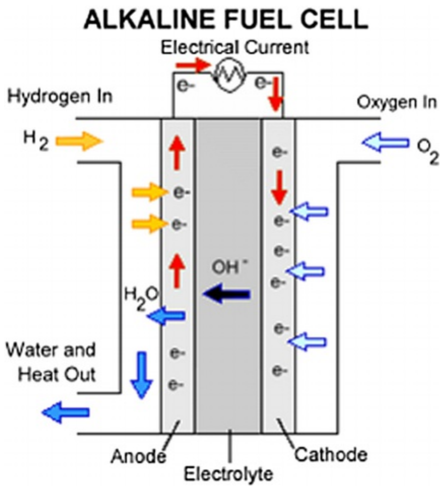
The purpose of a salt bridge is not to move electrons from the electrolyte, rather it is used to maintain charge balance because the electrons are moving from one-half cell to the other.

The electrons flow from the anode to the cathode. The oxidation reaction that occurs at the anode generates electrons and positively charged ions. The electrons move through the wire, leaving the unbalanced positive charge in this vessel. In order to maintain neutrality, the negatively charged ions in the salt bridge will migrate into the anodic half cell. A similar (but reversed) situation is found in the cathodic cell, where Cu^{2+} ions are being consumed, and therefore electroneutrality is maintained by the migration of K^{+} ions from the salt bridge into this half cell.

If there is no salt bridge, after some time, accumulation of extra charges (Zn^{2+} in anodic side of cell and SO_4^{2-} in cathodic side of the cell) are responsible for the zero potential difference of the cell.

10. **Conductivity:** The property by virtue of which the substance allow the passage of an electric current. The reciprocal of the resistance of a circuit is called the conductivity.
$G = \kappa \frac{a}{l} = \kappa \cdot 1 = \kappa$
Molar conductivity: Molar conductivity is conductance of all the ions produced by 1 mole of electrolyte, when electrodes are units distance apart and have sufficient area of cross section to hold electrolyte.
$\Lambda_m = \kappa \frac{A}{l}$
11. **Fuel Cells:** We know that a galvanic cell directly converts chemical energy into electricity and is highly efficient. It is now possible to make such cells in which reactants are fed continuously to the electrodes and products are removed continuously from the electrolyte compartment. Galvanic cells that are designed to convert the energy of combustion of fuels like hydrogen, methane, methanol, etc. directly into electrical energy are called **fuel cells.**

One of the most successful fuel cells uses the reaction of hydrogen with oxygen to form water (as shown in Fig.).



The cell was used for providing electrical power in the Apollo space programme. The water vapours produced during the reaction were condensed and added to the drinking water supply for the astronauts. In the cell, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide solution. Catalysts like finely divided platinum or palladium metal are incorporated into the electrodes for increasing the rate of electrode reactions.
The electrode reactions are given below:

Cathod: O_2 (g) + $2H_2O$(l) + $4e^-$ $\rightarrow$ $4OH^-$(aq)

Anode: $2H_2$(g) + $4OH^-$(aq) $\rightarrow$ $4H_2O$(l) + $4e^-$

Overall reaction is:

$2H_2$(g) + O_2(g) $\rightarrow$ $2H_2$(g)

The cell runs continuously as long as the reactants are supplied. Fuel cells produce electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%. There has been tremendous progress in the development of new electrode materials, better catalysts and electrolytes for increasing the efficiency of fuel cells. These have been used in automobiles on an experimental basis. Fuel cells are pollution free and in view of their future importance, a variety of fuel cells have been fabricated and tried.

12. by applying formula

$m = Z \times I \times t$

$1.18 = \frac{63.5}{2 \times 96500} \times 2 \times t$

$t = \frac{1.18 \times 2 \times 96500}{2 \times 63.5}$ = 1793.23 sec

$= \frac{1793.23}{60}$ = 29.88 min.

13. i. According to the question,

$H_2O \rightarrow H_2 + \frac{1}{2}O_2$

Now, we can write:

$O^2 \rightarrow \frac{1}{2}O_2 + 2e^-$

Electricity required for the oxidation of 1 mol of H_2O to O_2 = 2 F

$= 2 \times 96487C$

= 192974 C

ii. According to the question,

$Fe^{2+} \rightarrow Fe^{3+} + e^{-1}$

Electricity required for the oxidation of 1 mol of FeO to Fe_2O_3 = 1 F

= 96487 C

14. It is used as reference electrode. Its electrode potential is taken as 0.00 volt. Hydrogen electrode consists of platinum wire coated with finely divided platinum black containing pure hydrogen gas at 1 atm and solution of HCl (1 M) so as to maintain equilibrium between H^+ ions and H_2(g).

At cathode

$2H^+ + 2e \rightarrow H_2$

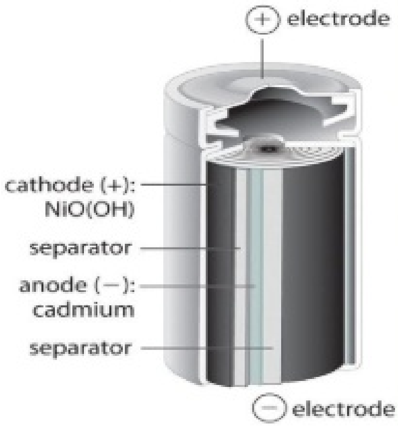
At anode

$H_2 \rightarrow 2H^{2+} + 2e^-$

significance: In the measurement of electrode potential.

15. a. **Nickel Cadmium cell:**

It is a rechargeable cell. It consists of a cadmium anode and a metal grid containing NiO_2 acting as a cathode as shown in the figure. The electrolyte in this cell is KOH. The reaction taking place during discharging and charging are shown in the figure.



1-Ni-Cd (Nickel Cadmium battery)

Battery reactions:

At the negative

$$Cd + 2OH \underset{disch\arg e}{\overset{ch\arg e}{\longleftrightarrow}} Cd(OH)_2 + 2e-$$

At the positive

$$NiOOH + H_2O + 2e- \underset{disch\arg e}{\overset{ch\arg e}{\longleftrightarrow}} Ni(OH)_2 + OH$$

Overall reaction

$$2NiOOH + Cd + 2H_2O \underset{disch\arg e}{\overset{ch\arg e}{\longleftrightarrow}} 2Ni(OH)_2 + Cd(OH)_2$$

In these reactions, there is no formation of gaseous products. The reaction products generally remain sticking to the electrodes and can be reconverted by recharging the cell. The charging process is similar to lead storage battery.

It produces a potential of about 1.4 V. It has longer life than the lead storage cell but more expensive than lead storage battery. However, it has some advantages because it is smaller and lighter. It can be used in portable and cordless appliances.

b. We have,

$$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$$

Thus, quantity of electricity required to deposit 1 mole of Ag(108 g)

$$Q = nF = 1mole \times 96500\,C\,mol^{-1}$$

$$= 96500\,C = 9.65 \times 10^{4} C$$

Quantity of electricity actually passed = Current in amperes × Time in seconds

$$= 0.5A \times (2 \times 60 \times 60)\,s$$

= 3600 C

$\therefore$ 3600C of charge produce silver $= \frac{108g}{9.65 \times 10^{4} C} \times 3600C \ = 4.03\ g$

Volume of silver deposited $= \frac{\text{Mass}}{\text{Density}} = \left(\frac{4.03g}{10.5\ g\,cm^{-3}}\right) = 0.384\ cm^{3}$

Therefore,thickness of the silver deposited $= \frac{\text{Volume}}{\text{Surface Area}} = \frac{(0.384\,cm^{3})}{(900\,cm^{2})}$

$$= 4.27 \times 10^{-4}\ cm$$