



# CHEMISTRY

## BOOKS - PEARSON IIT JEE

### FOUNDATION

## Electrochemistry

### Numerical Problems

1. A current of 9.65 A is passed through three different electrolytes NaCl,

$AgNO_3$  and  $CuSO_4$  for 30 min separately.

Calculate the ratio of the metals deposited at the respective electrodes. Also find out the weights of various metals deposited at the respective electrodes



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## Example

1. Aqueous solution of electrolyte is a better conductor than fused electrolyte. Give reason.



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2. Explain the mechanism of electrolysis of molten sodium hydroxide



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3. Distinguish between electrochemical equivalent and equivalent mass of a substance



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4. When any strong electrolyte is subjected to electrolysis, are equal number of moles of products formed at cathode and anode for the passage of same quantity of electricity? Explain.



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5. How does aqueous and acidified  $CuSO_4$  dissociate on the passage of current ? Also write the electrode reactions at the respective electrodes



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6. When concentrated solution of cupric chloride is taken, chlorine gets liberated at anode, in contrast to a dilute solution where oxygen is liberated. However, when aqueous solution of  $CuSO_4$  is taken, only oxygen is liberated at anode irrespective of concentration. How do you account for this ?



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7. Define discharge potential. Draw a comparison with the standard reduction potential (SRP) value of elements in the electrochemical series.



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8. Explain the electrometallurgical process for the extraction of potassium using fused potassium chloride



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9. With reference to the position of various metals in the electrochemical series, identify and justify the method of extraction followed for the metals given below :

(i) Zinc (ii) Copper (iii) Magnesium



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10. Why do platinum and gold occur in free state in nature ?



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## Very Short Answer Type Question

1. What is electrolysis ?



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2. What is a battery ?



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3. What do you mean by voltmeter ?



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4. Current enters or leaves the electrolyte through \_\_\_\_\_



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5. Explain the principle involved in an electrochemical cell



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6. How does temperature affects the extent of dissociation of an electrolyte ?



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7. \_\_\_\_\_ of electrolyte gets oxidised in electrolysis



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## 8. DANIELL CELL



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9. What is cell emf ? Write down the cell reactions involved in Daniel cell



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10. What is electrochemical equivalent of a substance ?





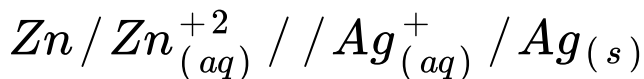
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11. How many electrons constitute one Faraday ?



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12. Write the cell reaction for the following cell representation



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**13.** Explain why, a salt which does not conduct electricity in the solid state becomes a good conductor in molten state.



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**14.** During electrolysis, the cations get discharged at cathode in \_\_\_\_\_ order of their discharge potential



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**15.** How many Faradays of charge are required to deposit 1 g atomic weight of Cu metal from Cu (II) solution of 1 mole concentration ?



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**16.** How much charge is required to deposit one equivalent of any substance ?



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**Short Answer Type Questions**

1. Differentiate strong and weak electrolytes



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2. What is meant by 1 faraday of electricity ?

What happens when we supply 1 faraday to an electrolyte ?



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**Essay Type Question**

1. State and explain Faraday's laws of electrolysis



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Level 1

1. Electrolysis brings about a chemical change



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2. Batteries are voltaic cells



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3. During electrolysis, cations move towards the positive terminal



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4. The negative sign of the reduction potential indicates that reduction occurs at that

electrode when connected to the standard hydrogen electrode.



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5. In the electrochemical series, ions are arranged in an increasing order of discharge potentials



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6. The deposition of different ions at electrodes stops when the supply of electricity is stopped



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7. The extent to which an electrolyte can dissociate into ions is called \_\_\_\_\_



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8.  $Zn^{+2}$  and  $Ag^{+}$  are present in a solution to be electrolysed. The metal that is deposited first at cathode is \_\_\_\_\_



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9. The thickness of \_\_\_\_\_ increases in the electrorefining of copper



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10. During electrolysis of molten  $PbBr_2$ , \_\_\_\_\_ fumes are liberated at the anode.



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11. The electrode potential of standard hydrogen electrode is assigned a value of \_\_\_\_\_



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**12.** Thick sheets of pure copper are obtained at \_\_\_\_\_ in electrorefining



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**13.** In cell representation, oxidation half -cell is represented on the \_\_\_\_\_



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14. On increasing temperature, conduction in metallic conductors \_\_\_\_\_

A. increases

B. decreases

C. remains constant

D. none of these

**Answer: B**



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15. The aqueous solution of non-electrolytes contains \_\_\_\_\_

A. atoms

B. ions

C. electrons

D. molecules

**Answer: D**



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16. The metal deposited first at the cathode when a solution containing  $Fe^{+2}$ ,  $Cu^{+2}$  is electrolysed is \_\_\_\_\_

A. Fe

B. Cu

C.  $Fe^{+3}$

D. both 1 and 2

**Answer: B**



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17. Which of the following electrolytes exhibits maximum conductivity ?

A. 1 M NaCl

B. 1 M KCl

C. 1M  $Ca(NO_3)_2$

D. 1 M  $Al_2(SO_4)_3$

**Answer: D**



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18. Electrolysis of aqueous  $CuSO_4$  with inert electrodes gives \_\_\_\_\_

A. Cu at cathode, anode gets dissolved

B. Cu at cathode,  $O_2$  at anode

C.  $O_2$  at anode,  $H_2$  at cathode

D.  $O_2$  at anode, cathode gets dissolved

**Answer: B**



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19. The amount of copper deposited by the passage of 1 mole of electrons during the electrolysis of aqueous  $CuSO_4$  solution is

A.  $63.5g$

B.  $31.75g$

C.  $159.5g$

D.  $79.75g$

**Answer: B**



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20. Negative sign in the standard electrode potential indicates

A. greater ease of oxidation compared to that of hydrogen

B. greater ease of reduction compared to that of hydrogen

C. lesser ease of oxidation compared to that of hydrogen

D. none of the above

**Answer: A**



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21. The products of electrolysis of dilute aqueous solution of sodium hydride are

- A. Na at cathode and  $H_2$  at anode
- B.  $H_2$  at cathode and  $O_2$  at cathode
- C. Na at cathode and  $O_2$  at anode
- D.  $H_2$  at both cathode and anode

**Answer: D**



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**22.** In a Daniel cells, if  $A(E_0 = -0.76)$  and  $B( = -2.36V)$  half - cells are taken then

- A. B acts as an anode
- B. A acts as an anode
- C. B acts as a cathode
- D. cannot be predicted

**Answer: A**



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**23.** In the electroplating of iron by nickel, nickel sulphate solution is taken as an electrolyte. What is the acid that is added to the electrolyte during the process ?

A. HCl

B. HCN

C.  $HNO_3$



D.  $H_2SO_4$

**Answer: D**



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**24.** Equimolar solution of zinc sulphate and ferric sulphate are subjected to electrolysis. What is the ration of Faradays of electricity required for depositoin of one mole each of zinc and iron ?

A. 1 : 2

B. 2:3

C. 1:3

D. 3:2

**Answer: B**



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25. Emf of a voltaic cell can be given by \_\_\_\_\_

A. SRP of anode - SRP of cathode

B. SRP of cathode + SRP of anode

C. SOP of catode - SOP of anode

D. SOP of cathode + SOP of anode

**Answer: A**



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**26.** The process used in purifying metals by electrolysis is called \_\_\_\_\_

A. electroplating

B. electrometallurgy

C. electrorefining

D. electrodeposition

**Answer: C**



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**27.** In a voltaic cell, if iron and silver electrodes are connected with each other then current flow

A. from iron to silver outside the cell

B. from silver to iron within the cell

C. from silver to iron outside the cell

D. current does not flow in this cell

**Answer: C**



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**28.** The amount of sodium produced by passage of 2 moles of electrons in the electrolysis of fused NaCl is \_\_\_\_\_

A. 23 g

B. 46 g

C. 11.5g

D. 58.5g

**Answer: B**



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**29.** The standard electrode potentials of the electrodes are given below. Arrange them in

decreasin order of ease of oxidations

(1) Electrode  $-I, E^\circ = -2.89V$

(2) Electrode  $-II, E^\circ = -0.16V$

(3) Electrode  $-III, E^\circ = 0.77V$

(4) Electrode  $-IV, E^\circ = -2.93V$

(5) Electrode  $-V, E^\circ = -1.67V$

A. 3 2 5 1 4

B. 4 1 5 2 3

C. 3 5 1 4 2

D. 3 2 1 4 5

**Answer:**



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**30.** Pairs of electrodes and their corresponding standard electrode potentials are given. Arrange the cells constructed by these electrodes in increasing order of emf values

(1) Electrode  $\rightarrow A, E^\circ = -2.92V$  and

Electrode  $\rightarrow B, E^\circ = -2.71V$

(2) Electrode  $\rightarrow C, E^\circ = -0.760V$  and

Electrode  $\rightarrow D, E^\circ = -0.44V$

(3) Electrode  $\rightarrow B, E^\circ = -2.71$  and

Electrode  $\rightarrow D, E^\circ = -0.44V$



(4) Electrode  $\rightarrow A, E^{\circ} = -2.92V$  and

Electrode  $\rightarrow C, E^{\circ} = -0.76V$

A. 2 1 4 3

B. 1 2 4 3

C. 2 4 1 3

D. 2 4 3 1

**Answer:**



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31. 1 faraday = \_\_\_\_\_ coulombs

A. 10000

B. 95000

C. 96.5

D. 96500

**Answer:**



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**32.** Identify the set of metals that require same amount of charge for the equation of one mole of metals

A. Na, Ag, Al

B. Zn, Cu, Ag

C. Al, Cu, Zn

D. Mg, Zn, Cd

**Answer:**



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33. The amounts of metals deposited when 965 C of electricity is passed through NaCl and  $AgNO_3$  solution are \_\_\_\_\_ and \_\_\_\_\_, respectively.

A. 23g, 108 g

B. 11.5 g, 54g

C. 0.23g, 1.08g

D. 2.3g, 10.8 g

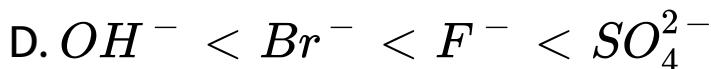
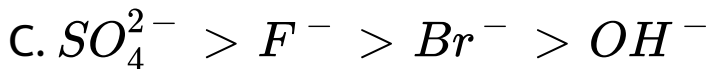
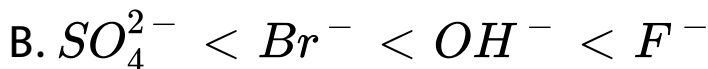
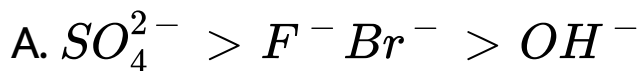
**Answer:**



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34. The order of ease of oxidation of the ions

$F^-$ ,  $OH^-$ ,  $Br^-$ ,  $SO_4^{2-}$  is \_\_\_\_\_



**Answer:**



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35. The electrolytic process by which an oxide of a metal is coated over metal surface is called \_\_\_\_

- A. electrolysis
- B. electroplating
- C. anodising
- D. electrorefining

**Answer:**



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**36.** The standard electrode potentials of four metals A, B, C and D are given below. Based on these values, arrange them in the descending order of ease of deposition of metals from their salt solutions when subjected to electrolysis under standard conditions.

(1)  $\rightarrow -0.9V$  (2)  $\rightarrow -2.71V$

(3)  $\rightarrow 0.77V$  (4)  $\rightarrow 0.8V$

A. 4 3 2 1

B. 2 1 3 4

C. 3 4 1 2

D. 4 3 1 2

**Answer:**



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**37.** Which of the following concentrations of the electrolyte corresponds to maximum conductivity ?

A. 1 M HCl



B. 1 M  $HNO_3$

C. 1 M  $HClO_4$

D. 1 M  $H_2SO_4$

**Answer:**



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**38.** Identify the false statement among the following

- A. Oxidation takes place at positive electrode in electrolytic cell, whereas reduction at negative electrode in voltaic cell
- B. Deposition of metals takes place in both electrolytic and galvanic cells
- C. Direction of flow of current is from cathode to anode in electrolytic cells
- D. Both a and b

**Answer:**



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**39.** When an aqueous solution of zinc sulphate is subjected to electrolysis, 280 mL of oxygen gas at STP is liberated at anode. Calculate the quantity of electricity passed through the electrolyte

A. 0.05 F

B. 0.5 F

C. 0.005 F

D. 5F

**Answer:**



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**40.** Ratio of number of Faradays of electricity required to deposit magnesium, aluminium and sodium in equimolar ratio on electrolysis of their respective molten salt is \_\_\_\_\_

A. 2 : 3 : 2

B. 2: 1: 1

C. 2: 3: 1

D. 4: 6: 1

**Answer:**



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**41.** The ratio of volumes of  $H_2$  and  $O_2$  liberated on electrolysis of water is \_\_\_\_

A. 1: 2

B. 1 : 3

C. 2 : 1

D. 3 : 1

**Answer:**



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**42.** Assertion (A) : Passage of 48,250C of electricity through cupric sulphate and ferrous sulphate solutions results in the deposition 0.5 moles each of iron and copper at the

respective cathodes.

Reason (R): Number of equivalents of a metal deposited at cathode is equal to the number of faradays of electricity passed through the electrolyte.

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true and R is not the correct explanation of A

C. A is correct and R is wrong

D. A is wrong and R is correct

**Answer:**



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**43.** 100 mL of 0.05 M aqueous  $CuSO_4$  solution is subjected to electrolysis. Calculate the quantity of electricity required for the deposition of entire copper at the cathode.

A. 0.005 F

B. 0.01 F

C. 0.1 F



D. 0.05 F

**Answer:**



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**Level 2**

1. NaCl conducts electricity in water, but it cannot conduct electricity in benzene. Give a reason



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2. Iron is coated with two metals A and B separately. When the coating is partially worn away, it is still protected when coated with A and not by B. Explain with reference to electrochemical series.



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3. What are the products of electrolysis of  
(i) concentrated KBr and

(ii) dilute KBr solution ?

Give reasons in support of your answer



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4. What happens when zinc pieces are added to aqueous copper sulphate solution and copper pieces are added to aqueous zinc sulphate solution ? Justify



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5. Identify the cathode, anode and calculate cell emf when a cell is constructed with  $A(E^\circ = -0.44V)$  and  $B(E^\circ = 0.337V)$



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6. What is the role of moisture in rusting of iron ?



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7. An external voltage opposing the cell potential is applied to a Daniel cell with zinc and copper electrodes. What happen when the external emf is increased from 0.8V to 1.1 V and then 1.54 V ?



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8. What should be used as the anode, cathode and electrolyte in the process of electroplating of iron by nickel and why ?





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9. During the electrolysis of silver nitrate using copper anode, the colour changes to blue and the intensity of the colour increases. Explain with the help of electrochemical series. What would you observe if  $ZnSO_4$  is taken instead of  $AgNO_3$  ?



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**10.** How does galvanisation of iron protect iron from rusting even when protective zinc coating is partially worn away ?



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**11.** If a metal is to be electroplated with silver, what would happen if a solution of silver nitrate alone is used as an electrolyte ? What is the preferable electrolyte and why is it used ?





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**12.** A current  $5.00\text{ A}$  liberates  $0.252\text{ g}$  of hydrogen in certain time. How many grams of oxygen, aluminium and sodium can be liberated or deposited by the same current in the same time ?



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**13.** Two monovalent metals A and B are treated with dilute sulphuric acid. A liberates



hydrogen and metal B does not. Predict the half-cell reactions and cell representation when these metals are coupled with H-electrode. Justify your answer with respect to standard electrode potential



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**14.** The standard oxidation potential of silver electrode is given as  $-0.799V$ . The standard reduction potential of copper electrode is given as  $0.33 V$ . Find out the emf of the cell

constituted by these two electrodes. Also write the half-cell reactions involved in the cell and given cell representation



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**15.** Why is it not possible to measure the single electrode potential ?



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**16.** Electrolysis of molten magnesium chloride results in the formation of 0.4 g magnesium. Calculate the volume of chlorine liberated during the reaction at STP. When an electrolytic cell consisting of molten  $AlCl_3$  and molten  $NaCl$  are connected in series with the above cell, calculate the amount of aluminium and sodium deposited at cathode.



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17. What is the amount of silver deposited by passing 2 A for 20 min through molten silver nitrate ? If the same quantity of electricity is passed through a molten salt solution of gold, 1.6 g of gold is deposited at cathode, then find out its equivalent mass and oxidation state of gold in gold salt. (atomic weight of Au = 197, Ag = 108)



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**18.** A brass strip of dimensions 4 cm and 6 cm has to be coated with a silver layer of 2 min thickness. Calculate the amount of charge required for the deposition of silver and the amount of magnesium deposition in another electrolytic cell when same amount of charge is passed (density of Ag = 10.5 g/cc)



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**19.** An aqueous solution of ferrous sulphate is taken and subjected to electrolysis. Calculate the number of electrons flowing through the circuit when 0,7 g of iron is deposited at cathode (atomic mass of Fe = 56)



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**20.** Compare the conductivity of same amount of NaCl dissolved in water and in alcohol (assume that volumes of solvents are equal)





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21. Why does conductivity of metallic conductor decrease with an increase in temperature, whereas in case of electrolytic conductors the conductivity increases with an increase in temperature ?



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22. Three electrolytic cell A, B and C are connected in series that consist of

concentrated aqueous solution of sodium chloride (brine solution), fused zinc sulphate and aqueous silver nitrate solution . If 1.4l of chlorine is produced of all gaseous products liberated in B and C at their respective electrodes at STP and the charge required for the deposition.



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**23.** During electrolysis of aqueous copper sulphate solution using platinum electrodes,



the blue colour of the electrolytic solution fades and towards the end of the process bubbles appear at the cathode. Why ? Also comment on the change in pH of solution due to electrolysis



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**24.** Little litmus is placed in the cathode and the anode compartments of Hoffmann's voltameter containing acidulated water and

then electrolysis is carried out. What do you observe and why ?



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**25.** An aqueous solution of copper sulphate is subjected to electrolysis using platinum electrodes. Calculate the number of electrons flowing through the circuit when 0.3175 g of copper is deposited. Also calculate the number of molecules present in anodic product (atomic mass of copper = 63.5)



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### Level 3

1.  $AgNO_3$  is soluble salt of silver, but it is preferable to use  $(NaCN + AgCN)$  as an electrolyte for silver plating. Give a reason in support of your answer.



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2. Lithium batteries are very expensive. Explain why they are still preferred



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3. Some batteries are rechargeable, whereas others must be thrown away after they get discharged. Justify with respect to the concept of electrochemical cells.



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4. Explain the effect of change in temperature on the conductivity of the following conductors. Justify with appropriate reasons



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5. Why does single electrode potential depend upon the concentration of the electrolyte ?



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6. Thermal stability of metal oxides can be compared using electrochemical series. Explain.



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7. How does magnesium connected by a wire to buried iron pipeline protect it from corrosion ?



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8. How does dilution affect the conductivity of strong electrolytes and weak electrolytes ?



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9. What do you observe when electrolysis of copper sulphate is done using strip as anode ?

Give reasons.



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**10.** Rusting is an electrochemical process. Justify. If two iron articles are coated with tin and zinc respectively, in which case will the rusting of iron be more rapid, if the coating is worn out in one place. Give a reason.



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