CHEMISTRY

BOOKS - BETTER CHOICE PUBLICATION

ELECTROCHEMISTRY

Electrochemical Cells

1. What are electrochemical cells? Name the two types of electrochemical cells.

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2. Write four differences between galvanic (or electrochemical) cell and electrolytic cell.

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Galvanic Cells

1. What do you understand by standard reduction potential of electrode?

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2. Give the construction and working of Zn/$CuSO_4$ or Daniel cell.

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3. In a galvanic cell,

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4. What do you understand by normal hydrogen electrode ? Give its structure and working.

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5. What is salt bridge? give its functions.

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6.

Which type of reaction occurs at cathode in a galanic cell ?

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7.

Why electrochemical cell stops working after sometimes ?

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8. Distinguish between emf and potential difference.

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9. Name the factors on which electrode potential depends?

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

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11. What flows in the internal circuit of a galvanic cell ?

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12. What is e.m.f. of the cell, when the cell reaction attains equilibrium ?

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13. Can a Galvanic cell work without a salt bridge?

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14. Can you store copper sulphate solutions in a zinc pot?

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15. An aqueous solution containing 1 M each of Au^{3+}, Cu^{2+}, Ag^{+}, Li^{+} is being electrolysed by using inert electrodes. The value of standard reduction potentials are:

$E^{\circ}_{Ag+/Ag} = 0.8V$, $E^{\circ}_{Cu2+/Cu} = 0.34V \text{and} E^{\circ}_{Au3+/Au} = 1.50V$, $E^{\circ}_{Li+/Li} =$

with increase voltage , the squence of deposition of metals on the cathode will be:

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16. Can we store copper sulphate solution in iron vessel? Give suitable explanation in support of your answer

$\left[E^{\circ}\left(Cu^{2+}/Cu\right) = +0.34V, E^{\circ}\left(Fe^{2+}/Fe\right) = -0.44V\right]$

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17. Can a nickel spoon be used to stir a solution of copper sulphate ? Support your answer with reason.

$\left[E^{\circ}\left(Ni^{2+}/Ni\right) = -0.25V, E^{\circ}\left(Cu^{2+}/Cu\right) = +0.34V\right]$

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18. What is electrochemical series? How it used to determine the e.m.f. of the cell?

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Nernst Equation

1. State and explain Nernst equation.

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2. Derive equilibrium constant from Nernst equation.

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3. How is standard Gibbs energy of a reaction related to its equilibrium constant?

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4. How is standard Gibbs energy of a reaction related to its equilibrium constant?

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Conductance Of Electrolytic Solutions

1. Define Specific conductance.

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2. Define conductance and conductivity?

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3. Define Specific conductance.

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4. Define conductivity and molar conductivity for the solution of an electrolyte. Discuss their variation with concentration.

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5. What is electrical conductivity? Name the metals which have the highest conductivity and the lowest conductivity.

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6. What is electrical conductivity? Name the metals which have the highest conductivity and the lowest conductivity.

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7. What is electrical conductivity in ionic solids due to ?

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8. What are metallic conductors ?

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9. What are electrolyte conductors ?

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10. What is weak electrolyte?

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11. What are metallic conductors ?

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12. How does electrolytic conductance vary with concentration of weak electrolytes ? Explain.

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13. Write two difference between strong and weak electrolytes.

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14. How does electrolytic conductance vary with concentration of weak electrolytes ? Explain.

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15. How does the electrolytic conductance vary with temperature ?

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16. Kohlrausch law can be used to find the molar conductivity of a weak electrolyte at `infinite dilution.

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17. State and explain Kohlrausch's law. How would you determine the molar conductance of a weak electrolyte at infinite dilution?

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18. Assume that you know the molar conductances of NH_4Cl, NaOH and NaCl at infinite dilution. How will you fint the molar conductance of NH_4OH from them ?

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19. Assume that you know the molar conductances of HCl, NaCl and CH_3COO Na at infinite dilution. How will you find the molar conductance of CH_3COOH from them.

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20. Assume that you know the molar conductances of $AgNO_3$, KCl and KNO_3 at infinite dilution. How will you find the molar conductance of AgCl from them.

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21. Suggest a way to determine the $A^\circ m$ value of water.

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Electrolytic Cells And Electrolysis

1. Which allotrope of carbon is used in making electrodes ?

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2. What are inert electrodes ? Give two examples.

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3. Define electrochemical equivalent of substance.

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4. How much amount of substance is deposited by passing one Faraday of electricity.

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5. what is electrolysis?

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6. Predict the products of electrolysis in each of the following: An aqueous solution of $AgNO_3$ with silver electrodes.

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7. Write short note on dry cell.

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8. Write short note on lead storage battery.

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9. Write two difference between primary cells and secondary cells.

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10. Describe $Ni - Cd$ storage cell.

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Fuel Cells

1. What are fuel cells ? Discuss $H_2 - O_2$ fuel cell. List some advantages of fuel cells over other cells.

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2. Which cell was used in Apollo space programme ? What was the product used for ?

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3. What is corrosion?

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4. Discuss the electrochemical theory of corrosion.

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5. CO_2 is always present in natural water. Explain its effect as rusting of iron.

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6. Rusting of iron quicker in saline water than in ordinary water. Explain.

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7. How can iron be protected from rusting by sacrificial protection ?

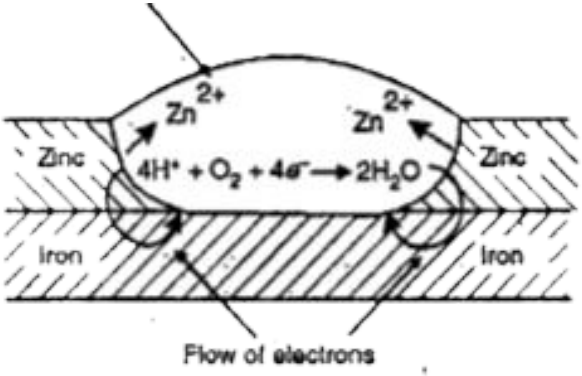

Fig. Sacrifical protection of iron by coating it with zinc

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8. (a) What is galvanisation ?

(b) Give three methods to protect iron from rusting.

(c) Discuss the factors responsible for rusting of iron or corrosion.

(d) Name a chemical which is used for preventing rusting of iron.

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Numerical Problems

1. Derive Nernst equation for the following cell:

$NiNi^{2+}(0 \cdot 2M) \mid \left|Cu^{2+}(0 \cdot 2M)\right|Cu.$

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2. Derive Nernst equation for the following cell:

$Cu\left|Cu^{2+}(0.1M)\right|\left|Ag^{+}(0 \cdot 1M)\right|Ag$

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3. Write Nernst equation and calculate emf for the following cell:

$Zn\left|Zn^{2+}(0\cdot 01M)\right|\left|Ag^{+}(0\cdot 01M)\right|Ag.$

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4. Calculate ΔG° and equilibrium constant for the cell reaction,

$Cl_2+2l^{-}\Leftrightarrow 2Cl^{-}+I_2$

Given that: $E^{\circ}\left(Cl_2,Cl^{-}\right)=1\cdot 36V, E^{\circ}\left(l_2,l^{-}\right)=0\cdot 536V$

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5. A potential difference of 20 V applied to the ends of a column of 0.1 M $AgNO_3$ solution, 4 cm in diameter and 12 cm in length have a current of 20 A. calculate the molar conductance of the solution.

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6. For the cell $Mg|Mg^{2+}||Ag^{+}|Ag$ calculate equilibrium constant at $25^{\circ}C$ and also the maximum work that can be obtained from it.

$E^{\circ}\left(Mg^{2+}, Mg\right) = -2 \cdot 37V$ and $E^{\circ}\left(Ag^{+}, Ag\right) = +0 \cdot 80V$.

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7. The electrical resistance of a column of 0.05 mol L^{-1} NaOH solution of diameter 1 cm and length 50 cm is 5.55×10^{3} ohm. Calculate its resistivity, conductivity and molar conductivity.

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8. A conductivity cell has its electrodes 1 cm apart and each electrode has area of cross-section 2 cm^{2}, when filled with M/50 solution of sodium acetate, the cell shows a resistance of 166.5 ohms. Calculate the molar conductance of sodium acetate solution at the givne concentration.

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9. Calculate ΔG° for the following cell:

$Fe|Fe^{2+}||Cu^{2+}|Cu.$

Given that: `E^(@)(Cu^(2+)//Cu)=+0*34V,E^(@)(Fe^(2+)//Fe)=-0*44V.

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10. E° values for Fe^{3+}/Fe^{2+} and Ag^{+}/Ag are 0.771 V and 0.8 respectively. Is the reaction,

$Fe^{3+} + Ag \rightarrow Fe^{2+} + Ag^{+}$

Spontaneous or not ? Give reason also.

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11. The resistance of a 0.5 M solution of an electrolyte enclosed between two platinum electrodes 1.5 cm apart and having an area of $2 \cdot 0cm^3$ was found to be 30 ohm. Calculate the molar conductivity of the electrolyte.

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12. E° value for Cu^{2+}/Cu and Fe^{2+}/Fe are +0.34 V and -0.44 V respectively. Is the reaction $Cu^{2+} + Fe \rightarrow Cu + Fe^{3+}$ spontaneous or not ? Give reason also.

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13. A 0.05 M NaOH solution offered a resistance of 31.6 ohm ina conductivity cell at 298 K. if the area of the plates of the conductivity cell is 3.8 cm^2 and distance between them 1.4 cm. calculate the molar conductivity of the NaOH solution.

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14. E° values of Ni^{2+}/Ni and Cu^{2+}/Cu are -0.25 V and +0.34 V respectively. Is the reaction:

$Ni + Cu^{2+} \rightarrow Ni^{2+} + Cu$ spontaneous or not ? Give reason also.

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15. The resistance of a 0.5 M solution of an electrolyte in a conductivity 'cell was found to be 25 ohm. Calculate the molar conductivity of the solution, if the electrodes in the cell are 1.6 cm apart and have an area of $3 \cdot 2cm^2$.

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16. Represent the cell in which the following reaction takes place $Mg(s) + 2Ag^+(0.0001M) \rightarrow Mg^{2+}(0.130M) + 2Ag(s)$ Calculate its E_{cell} if E_{cell} = 3.17 V.

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17. Represent the cell in which the following reaction takes place:

$Mg(s) + Cu^{2+}(0.0001M) \rightarrow Mg^{2+}(0.1M) + Cu(s)$.

Calculate its E, if E° is $2.71V$.

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18. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu} = +0.34V$ and $E^{\circ}_{Ag^{+}/Ag} = +0.80V$

(log 0.130=-1.1139).

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19. The molar conductance of NaCl solution at different concentrations at 298 K are given below:

C(mol L–1)	^m(S cm2 mol–1)
0-001	123-7
0-010	1185
0-020	115-75
0-050	111-06

Plot a graph between $\wedge_m$ and c1/2 and determine the value of $\wedge_{0m}$ from it.

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20. Write Nernst equation and calculate e.m.f. of the cell at 298 k.

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

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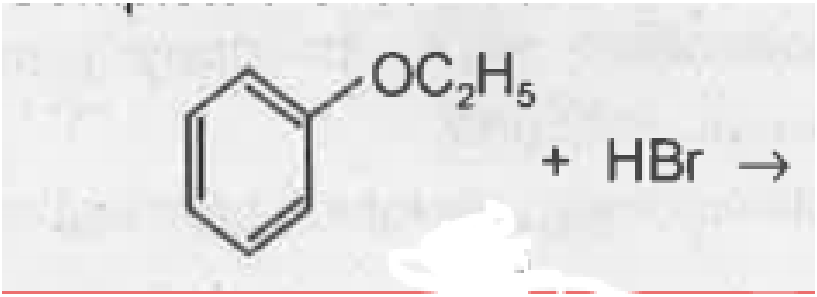
21. Complete the reaction :



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22. Write Nernst equation and calculate the e.m.f of the following cell at 298 K:

$Zn|Zn^{2+}(0.01M)||Fe^{2+}(0.005M)|Fe$

Given that:

$(Zn^{2+}/Zn) = -0.763V$ and $E^{\circ}_{Fe^{2+}/Fe} = -0.44V \quad \log 2 = 0.3010$

.

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23. Fill in the blanks:

$CH_3—CH_2—\underset{\underset{OH}{|}}{CH}—CH_3$ represent ..... .

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24. Calculate the standard Gibbs energy for the cell :

$Zn(s) + Zn^{2+}(aq) \mid |Cu^{2+}(aq)|Cu(s)$

$E_{(Zn^{2+}/Zn)^{\circ}} = -0.76V, E^{\circ}_{(Cu^{2+}/Cu)} = 0.34V, F = 96500C.$

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25. Calculate the standard Gibbs energy for the cell :

$Zn(s)\left|Zn^{2+}(aq)\right|\left|Sn^{2+}(aq)\right|Sn(s)$

$E^{\circ}_{(Zn^{2+}/Zn)} = -0.76V, E^{\circ}_{(Sn^{2+}/Sn)} = -0.16V, F = 96500C.$

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26. Calculate the standard Gibbs energy for the cell :

$Zn(s)\left|Zn^{2+}(aq)\right|\left|Cd^{2+}(aq)\right|Cd(s)$

$E^{\circ}_{(Zn^{2+}/Zn)} = -0.76V, E^{\circ}_{(Cd^{2+}/Cd)} = -0.403V, F = 96500C.$

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27. The λ° values of KNO_3 and $LiNO_3$ are 145.0 and 110.1 S cm^2mol^{-1} respectively. The λ° value of K^+ ion is $73.5\text{S}\ cm^2mol^{-1}$. Calculate $\lambda^{\circ}\left(Li^+\right)$.

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28. Calculate the e.m.f. of the following cell at 298 K.

$Mg_{(s)}\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu_{(s)}$

Given $E^{\circ}\left(Cu^{2+} \mid Cu\right) = 0.34V$ and $E^{\circ}\left(Mg^{+}\left|Mg\right.\right) = -2.37V.$

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29. The λ° values of KCl and KNO_3 are 149.9 and 144.9 S cm^2mol^{-1} respectively. Also λ° for Cl^{-} is 71.44 S cm^2mol^{-1}.The λ° value of NO_3^{-} ion.

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30. Calculate the e.m.f. of the following cell at 298 K,

$Mg\left|Mg^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag$

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31. The λ° values of NaCl and $NanO_3$ are 126.5 and $121.6S \quad cm^2mol^{-1}$ respectively. The λ° value of NO_3^- ion is 76.3 S cm^2mol^{-1} calculate $\lambda^{\circ}(Cl^-)$.

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32. The calculate the e.mf. Of the following cell at 298:

$Fe|Fe^{2+}(0.1M)||Ag^{2+}(0.1M)|Ag$

$E^{\circ}_{(Fe^{2+}/Fe)} = -0.44V, E^{\circ}_{(Ag^+/Ag)} = 0.80V.$

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33. Write the Nernst equation and calculate e.m.f of following cell at 298K.

$Mg(s)|Mg^{2+}(0.130M)||Ag^+(0.0001M)|Ag(s)$ Given

$E^{\circ}_{Mg^{2+}/Mg} = -2.37V, E^{\circ}_{Ag^+/Ag} = 0.80V.$ (log 1.3=0.1130)

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34. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu}=+0.34V$ and $E^{\circ}_{Ag^{+}/Ag}=+0.80V$

(log 0.130=-1.1139).

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35. Write Nernst equation and calculate e.m.f. of the cell at 298 k.

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

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36. Write Nernst equation and calculate the e.m.f of the following cell at 298 K:

$Zn\left|Zn^{2+}(0.01M)\right|\left|Fe^{2+}(0.005M)\right|Fe$

Given that:

$(Zn^{2+}/Zn) = -0.763V$ and $E^{\circ}_{Fe^{2+}/Fe} = -0.44V$ $\log 2 = 0.3010$

.

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37. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)|Cu^{2+}(0.130M)||Ag^{+}(1.0 \times 10^{-4}M)|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu} = +0.34V$ and $E^{\circ}_{Ag^{+}/Ag} = +0.80V$

(log 0.130=-1.1139).

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38. Calculate the e.m.f. of the cell at $25^{\circ}C$

$Cr|Cr^{3+}(0.1M)||Fe^{2+}(0.01M)|Fe$

Given $E^{\circ}_{(Cr^{2+}/Cr)} = -0.75V$, $E^{\circ}_{(Fe^{2+}/Fe)} = -0.44$

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39. What is the amount of electricity required to deposit one mole of aluminium from a solution of $AlCl_3$?

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40. A solution of $Ni(NO_3)_2$ is electrolysed between platinum electrodes using a current of 5 amperes for 20 minutes. What mass of Ni is deposited at the cathode?

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41. What is the amount of electricity required to deposit one mole of aluminium from a solution of $AlCl_3$?

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42. What mass of zinc can be produced by the electrolysis of zinc sulphate solution when a current of 1.5 amperes is passed for 15 minutes

? The atomic mass of zinc=65.4 amu.

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43. What is the amount of electricity required to deposit one mole of Zinc form the solution of $ZnSO_4$?

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44. A solution of $CuSO_4$ is electrolysed for 10 minutes with a current of 1.5 amperes. What is the mass of copper deposited at the cathode?

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45. Calculate the cell e.m.f. and ΔG for the cell reaction at $25^\circ C$ for the cell:

$Zn_{(s)}\left|Zn^{2+}(0.004M)\right|\left|Cd^{2+}(0.2M)\right|Cd_{(s)}$

E° values at $25^\circ C$, $Zn^{2+}/Zn = -0.763V$

$Cd^{+2}/Cd = -0.403V$

$F = 96,500, R = 8.314JK^{-1}mole^{-1}.$

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46. The resistance of a 0.5 M solution of an electrolyte in a conductivity 'cell was found to be 25 ohm. Calculate the molar conductivity of the solution, if the electrodes in the cell are 1.6 cm apart and have an area of $3 \cdot 2cm^2$.

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47. Calculate ΔG and E_{cell} for the cell:

$AI/AI^{3+}(0.01M) \mid \mid Fe^{2+}(0.02M)/Fe$ given that

$E^{\circ}\left(Al^{3+}/Al\right) = -1.66V$ and $E^{\circ}\left(Fe^{2+}/Fe\right) = -0.44V$

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48. The resistance of a 0.5 M solution of an electrolyte enclosed between two platinum electrodes 1.5 cm apart and having an area of $2 \cdot 0cm^3$ was found to be 30 ohm. Calculate the molar conductivity of the electrolyte.

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49. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0 \times 10^{-4}M\right)\right|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu} = +0.34V$ and $E^{\circ}_{Ag^{+}/Ag} = +0.80V$

(log 0.130=-1.1139).

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50. The electrical resistance of a column of 0.05 mol L^{-1} NaOH solution of diameter 1 cm and length 50 cm is 5.55×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity.

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51. Calculate the equilibrium constant for the reaction at 298K 4 Br + O2 + 4H+ → 2 Br2 + 2H2O Given that Ecell = 0.16V

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52. Calculate the equilibrium constant for the reaction at 298K

$Cu(s) + Cl_2(g) \rightarrow CuCl_2(aq)$

Given that

$R = 8.314 JK^{-1} mol^{-1},$

$E^{\circ} Cu^{2+} / Cu = 0.34V,$

$E^{\circ} \frac{1}{2} Cl_2 / Cl^{-} = 1.36V$

$F = 96500C \quad mol^{-1}$

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53. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu}=+0.34V$ and $E^{\circ}_{Ag^{+}/Ag}=+0.80V$

(log 0.130=-1.1139).

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54. Write the Nernst equation and emf of the following cells at 298 K:

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

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55. Calculate the e.m.f. of the cell at $25^{\circ}C$

$Cr\left|Cr^{3+}(0.1M)\right|\left|Fe^{2+}(0.01M)\right|Fe$

Given $E^{\circ}_{(Cr^{2+}/Cr)}=-0.75V, E^{\circ}_{(Fe^{2+}/Fe)}=-0.44$

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56. Calculate the e.m.f. of the following cell at 298 K,

$Mg|Mg^{2+}(0.130M)||Ag^{+}\left(1.0\times10^{-4}M\right)|Ag$

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57. Write Nernst equation and calculate e.m.f. of the cell at 298 k.

$Mg(s)|Mg^{2+}(0.001M)||Cu^{2+}(0.0001M)|Cu(s)$

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58. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)|Cu^{2+}(0.130M)||Ag^{+}\left(1.0\times10^{-4}M\right)|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu}=+0.34V$ and $E^{\circ}_{Ag^{+}/Ag}=+0.80V$

(log 0.130=-1.1139).

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59. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag(s)$$

Given that: $E^{\circ}_{Cu^{2+}/Cu}=+0.34V$ and $E^{\circ}_{Ag^{+}/Ag}=+0.80V$

(log 0.130=-1.1139).

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60. Write the Nernst equation and calculate the e.m.f. of the following cell at 298K.

$$Sn_{(s)}\left|Sn^{2+}_{(0.050M)}\right|\left|H^{+}(0.020M)\right|H_2(1atm/Pt)$$

Given $E^{\circ}_{Sn/Sn^{2+}}=-0.14V$

$$EMF=\left(E^{\circ}_{H^{+}/1/2H_2}-E^{\circ}_{Sn^{2+}/Sn}\right)-\frac{0.0591V}{2}\log\frac{\left[Sn^{2+}\right]}{\left[H^{+}\right]^{2}}.$$

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61. Write The Nernst equation and calculate the e.m.f. of the following cell at 298K.

$Fe_{(s)}\left|Fe^{2+}_{(0.001M)}\right|\left|H^{+}_{(1M)}\right|H_{2(1atm).Pt}$

Given $E^{\circ}_{Fe^{2+}/Fe} = -0.44V$

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62. Calculate the equilibrium constant for the reaction 2Fe3+(aq) + 2I–(aq) → 2Fe2+(aq) + I2(s) E0cell = 0.236V

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63. Calculate the equilibrium constant for the reaction 2Fe3+(aq) + 2I–(aq) → 2Fe2+(aq) + I2(s) E0cell = 0.236V

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64. The resistance of a 0.5M solution of an electrolyte was found to be 30Ω. Calculate the molar conductivity of the solution if the electrods in the cell are 1.5 cm a part and having an area of cross section is 2.0 cm^2.

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65. The resistance of a 0.5 M solution of an electrolyte in a conductivity 'cell was found to be 25 ohm. Calculate the molar conductivity of the solution, if the electrodes in the cell are 1.6 cm apart and have an area of $3 \cdot 2cm^2$.

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66. The resistance of a 0.25 mol or solution of an molar solution of an electrolyte was found to be 75Ω. Calculate the molar conductivity of the solution if the electrods in the cell are 1.8 cm a part and having an area of cross section $3.6cm^2$.

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67. Write Nernst equation and calculate e.m.f. of the cell at 298 k.

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

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68. Write Nernst equation and calculate e.m.f. of the cell at 298 k.

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

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69. Write Nernst equation and calculate the e.m.f. of the following cell at 298 K:

$Cu(s)\left|Cu^{2+}(0.130M)\right|\left|Ag^{+}\left(1.0\times10^{-4}M\right)\right|Ag(s)$

Given that: $E^{\circ}_{Cu^{2+}/Cu}=+0.34V$ and $E^{\circ}_{Ag^{+}/Ag}=+0.80V$

(log 0.130=-1.1139).

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