THE GURUKUL INSTITUTE

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ELECTROCHEMISTRY

1. Write Nernst equation for single electrode potential.
2. Why is the equilibrium constant K related to only E^0_{cell} and not E_{cell}?
3. Write the relation between cell potential and equilibrium constant.
4. How does the molar conductivity of KCl solution vary with increasing concentration?
5. Write Nernst equation for the electrode reaction:
   $M^{n+} + ne^- \rightarrow M(s)$.
6. Give an example of 'fuel cell'.
7. How does fuel cell operate?
8. Which type of metal can be used in cathodic protection of iron against rusting?
9. How does cathodic protection of iron operate?
10. Electrolysis of KBr (aq) gives Br_2 at anode but of KF (aq) does not give F_2. Give reason for disparity in behavior.
11. Under what condition will a galvanic cell send no current into outer circuit?
12. State Kohlrausch's law for electrical conductance of an electrolyte at infinite dilution.
13. What does the standard electrode potential of a metal being negative ($E^{\circ}_{Zn^{2+}/Zn} = -0.7632$) indicate?
14. In operation of a galvanic cell, at one of the electrodes, oxidation takes place. What is the name of this electrode and what is its polarity?
15. How many Faradays of electricity are required to liberate 2 moles of hydrogen gas in electrolyte of a solution?
16. Why does an alkaline medium inhibit the rusting of iron?
17. At infinite dilution, the molar conductance of Na^+ and SO_4^{2-} ions are 50 Scm^2mol^{-1} and 160 Scm^2mol^{-1} respectively. What will be the molar conductance of sodium sulphate at infinite dilution?
18. What is it that aluminium metal cannot be obtained by electrolysis of an aqueous solution of a salt of aluminium?
19. What is the effect of an increase in concentration of zinc ions on the electrode potential of zinc electrode for which $E^{\circ}_{Zn^{2+}/Zn} = -0.76$ V?
20. Express the relationship among the resistance (R), specific conductivity and cell constant.
21. Name any two metals which can be used for cathodic protection of iron.
22. What is the basis of obtaining electrical energy in fuel cell?
23. Name a metal that can be used in the cathodic protection of iron. Is it more active or less active than iron?
24. How is unit of molar conductivity arrived?
25. Define conductivity and molar conductivity for the solution of an electrolyte.
26. On the basis of the standard electrode potential values stated for acid solution, predict whether Ti^{4+} species may be used to oxidize Fe^{II} to Fe^{III}.

Reaction	E^0/V
$Ti^{IV} + e^- \rightarrow Ti^{3+}$	: +0.01
$Fe^{3+} + e^- \rightarrow Fe^{3+}$	: + 0. 77

27. Calculate the emf of the following cell at 298 K:
    $Fe(s)|\ Fe^{2+}$ (0.1M) || Ag^+ (0.1M) $|Ag(s)$
    Given : $E^o_{Fe^{2+}/Fe}$ = - 0.44V, $E^o_{Ag^+/Ag}$ = 0.80 V, R = 8.31 $JK^{-1}mol^{-1}$, 1F = 96,500 C mol^{-1}.

28. What are fuels cells? Write the electrode reactions of a fuel cell which uses the reaction of hydrogen with oxygen.
29. Predict the products of electrolysis obtained at the electrodes in each case when the electrodes used are at platinum:
    a. An aqueous solution of $AgNO_3$.
    b. An aqueous solution of H_2SO_4.
30. Zinc rod is dipped in 0.1 M solution of $ZnSO_4$. The salt is 95% dissociated at this dilution at 298 K . Calculate the electrode potential.
    Given $E^{\circ}_{Zn^{2+}/Zn} = -0.76V$.
31. Calculate the equilibrium constant for the following reaction at 298 K :
    $Cu(s) + Cl_2(g) \rightarrow CuCl_2(aq)$
    R = 8.314 $JK^{-1}mol^{-1}$, $E^{o}_{Cu^{2+}/Cu} = 0.34\,V$
    $\boldsymbol{E^{o}_{\frac{1}{2}Cl_2/Cl^-}}$ =1.36 V, 1F = 96,500 C mol^{-1}.
32. Calculate the emf of the following cell :
    $Mg(s)\,|Mg^{2+}(0.2\ M)\,||\,Ag^{+}\,(1 \times 10^{-3} M)\,|\,Ag(s)$
    $E^{o}_{Ag^{+}/Ag}$ = 0.80 V, $E^{o}_{Mg^{2+}/Mg} = -2.37V$
33. Write the cell reactions which occur in lead storage battery (i) when the battery is in use and (ii) when the battery is on charging.
34. How does molar conductivity vary with concentration for (i) weak electrolyte and for (ii) strong electrolyte? Give reasons for these variations.
35. State two advantages of H_2-O_2 fuel cell over ordinary cells.
36. Can a nickel spatula be used to stir a solution of $CuSO_4$? Support your answer with reason.
    ($E^{o}_{Ni^{2+}/Ni} = -0.25V$; $E^{o}_{Cu^{2+}/Cu} = 0.34\ V$)
37. Electrolytic conductivity of 0.30 M solution of KCl at 298 K is 3.72 x 10^{-2} S cm^{-1}. Calculate its molar conductivity.
38. State the factors that influence the value of cell potential of the following cell :
    $Mg(s)\,|Mg^{2+}(aq)\,||\,Ag^{+}\,(aq)\,|\,Ag(s)$
39. What is meant by specific conductivity of a solution? The specific conductance of a 0.12 N solution of an electrolyte is 2.4 x 10^{-2} S cm^{-1}. Calculate its equivalent conductance.
40. What is meant by 'molar conductivity' of a solution? The specific conductivity of 0.40 M solution of KCl at 298 K is 4.96 x 10^{-2} S cm^{-1}. Calculate its molar conductivity.
41. Explain why electrolysis of aqueous solution of NaCl gives H_2 at cathode and Cl_2 at anode. Write overall reaction. [Given $E^{o}_{Na^{+}/Na}$ = -2.71 V; $E^{o}_{Cl_2/2cl^-}$ =1.36 V and
    $1/2O_2(g) + 2H^{+}(aq) + 2e^{-} \rightarrow H_2O\ (l)$; $E^{0} = 1.23V$]
42. Blue color of copper sulphate solution is slowly discharged (disappears) when an iron rod is dipped into it. Explain this by calculating $\boldsymbol{\Delta}G^{0}$ with the help of the following data:
    $E^{o}_{Cu^{2+}/Cu} = 0.34\,V$; $E^{o}_{Fe^{2+}/Fe}$ = - 0.44V, 1F = 96,500 C mol^{-1}.
43. Estimate the minimum potential difference needed to reduce Al_2O_3 at 500^{0}C. The free energy change for the decomposition reaction
    $\frac{2}{3}Al_2O_3 \rightarrow \frac{4}{3}Al + O_2$ is $\boldsymbol{\Delta}G$ = +960 kJ.
    (1F=96500 C mol^{-1})
44. For the electrode Pt, H_2 (1 atm) | H^{+} (aq)(xM), the reduction potential at 25℃ is -0.34V. Write the electrode reaction equation and calculate the value of 'x'. How will you deduce pH of the solution from the result?
45. Molar conductivities at infinite dilution for NH_4Cl, NaOH and NaCl solutions at 298 K are respectively 129.8, 217.4 and 108.9S cm^2mol^{-1} and the molar conductivity of a 10^{-2}M solution of NH_4OH is 9.33 Scm^2mol^{-1}.Suggest how this information may be used to calculate the degree of dissociation of NH_4OH in its above mentioned solution.
46. Derive an expression for the pH of electrolyte in the following half cell. Pt, H_2 (1 atm) | H^{+} (aq). The reduction potential is -0.30 V.

47. Molar conductance of 1.5 M solution of an electrolyte is found to be 138.9 Scm^2mol^{-1},What would be the specific conductance of this solution?
48. For what concentration of Ag^+(aq) will e.m.f of given cell be zero at 25℃, if the concentration of Cu^{2+} is 0.1M?
    Cu (s)| Cu^{2+} (0.1M) || Ag^+(aq)| Ag(s)
    [$E^o_{Cu^{2+}/Cu} = 0.342\ V$;$E^o_{Ag^+/Ag}$ = 0.80 V]
49. The E^0 value for two metal electrodes are given below :
    i. Cr^{3+}/ Cr^{2+}= -0.4V;
    ii. Fe^{3+}/Fe^{2+} = + 0.80V
    Comment on the result of treating a solution of Cr(II) with a solution containing Fe (III)ions.
50. Consider the given standard potential (in volts) in 1M solution:
    Fe^{2+}/Fe = - 0.4V; Fe^{3+}/ Fe^{2+} = +0.08 V;
    Mn^{2+} /Mn = -1.2 V; Mn^{3+}/Mn^{2+} = +1.5 V
    a. Comment on the relative stabilities of + 2 and +3 oxidation states of iron and manganese.
    b. Which of the two metals may be easily oxidized to +2 state?
51. Calculate the potential of the following cell reaction at 298 K:
    Sn^{4+}(1.50 M) + Zn (s) → Sn^{2+}(0.5 M) + Zn^{2+} (2.0 M)
    The standard potential (E^0) of the cell is 0.89 V. State whether the potential of cell will increase or decrease if the concentration of Sn^{2+} is increased in the cell.
52. Calculate the standard cell potential of the galvanic cell in which the following reaction takes place:
    2Cr(s) + 3 Cd^{2+}(aq) → 2Cr^{3+}(aq) + 3Cd(s)
    Also calculate the $\Delta_r G^o$ value of the reaction. (Given: $E^0_{Cr^{3+}/Cr} = -0.74V$; $E^0_{Cd^{2+}/Cd} = -0.40\ V$ and F = 96500 C mol^{-1})
53. **a**. At 291 K, molar conductivities at infinite dilution of NH^4Cl, NaOH and NaCl are 129.8, 217.4, 108.9 $ohm^{-1}cm^2$ respectively. If molar conductivity of centinormal solution of NH_4OH is 9.33 $ohm^{-1}cm^2$, what is the degree of dissociation of NH_4OH solution?
    b. The standard reduction potential values of three metallic cations X, Y, Z are 0.52, -3.03, -1.18V respectively. What will be the order of reducing power of the corresponding metals?
54. In the button cell , widely used in watches and other devices, the following reaction takes place:
    Zn(s) +Ag_2O (s) + H_2O(l) → Zn^{2+}(aq) +2Ag(s) + 2OH^-(aq)
    Determine $E°$ and $\Delta_r G^0$ for the reaction. Given : $E^o_{Ag^+/Ag}$ = 0.80 V,$E^\circ_{Zn^{2+}/Zn} = -$ 0.76V.
55. What is corrosion? Describe the electrochemical phenomenon of rusting of iron.
56. Conductivity of 0.00241 M acetic acid is 7.896 x 10^{-5} S cm^{-1}. Calculate its molar conductivity. If Λ^o_m for acetic acid is 390.5 S cm^2mol^{-1}, what is its dissociation constant?
57. Write the Nernst equation and calculate the e.m.f of the following cell at 298 K:
    Cu(s) |Cu^{2+}(0.130M) || Ag^+(1.00 x 10^{-4} M)|Ag(s)
    Given : $E^o_{Ag^+/Ag}$ = 0.80 V
    $E^o_{Cu^{2+}/Cu} = 0.342\ V$
58. When a certain conductivity cell was filled with 0.1M, it has a resistance of 85Ω at 25℃. When the same cell was filled with an aqueous solution of 0.052 M unknown electrolyte the resistance was 96 Ω. Calculate the molar conductivity of the unknown electrolyte at this concentration. (Specific conductivity of 01. M KCl = 1.29 x $10^{-1}cm^{-1}$).
59. Explain with example the terms weak and strong electrolytes.
60. a. The resistance of a conductivity cell containing 0.001M KCl solution at 298 K is 1500 Ω. What is the cell constant, if the conductivity of 0.001 M KCl solution at 298 K is 1.46 x10^{-3} s cm^{-1}?
    b. Predict the products of electrolysis in the following:
    A solution of H_2SO_4 with platinum electrodes.
61. a. Account for the following:
    i. Alkaline medium inhibits the rusting of iron.

ii. Iron does not rusts even if the zinc coating is broken in a galvanized iron pipe.

b. $Cu^{2+} + 2e^- \rightarrow E^o = +0.34V$

i. Construct a galvanic cell using the above data.

ii. For what concentration of Ag^+ ions will the emf of the cell be zero at 25℃, if the concentration of Cu^{2+} is 0.01M? [log 3.919 = 0.593]

62. a. State two advantages of H_2-O_2 fuel cell over ordinary cell.

b. Silver is electrodeposited on a metallic vessel of total surface area 900 cm^2 by passing a current of 0.5 amp for two hours. Calculate the thickness of silver deposited. [Given: Density of silver = 10.5 g cm^{-3}, Atomic mass of silver = 108 u, 1F = 96,500 $Cmol^{-1}$]

63. Give reasons for the following:

i. Rusting of iron is quicker in saline water than in ordinary water.

ii. Aluminium metal cannot be produced by the electrolysis of aqueous solution of aluminium salt.

iii. Resistance of a conductivity cell filled with 0.1M KCl solution is 100 ohm. If the resistance of the same cell when filled with 0.02 M KCl solution is 520 ohms, calculate the conductivity and molar conductivity of 0.02 M KCl solution. Conductivity of 0.1 M KCl solution is $1.29 Sm^{-1}$.

64. Explain with the help of example how weak and strong electrolyte can be distinguished.

65. i. State the products of electrolysis obtained on the cathode and the anode in the following cases:

a. A dilute solution of H_2SO_4 with platinum electrodes.

b. An aqueous solution of $AgNO_3$ with silver electrodes