INDIAN SCHOOL AL WADI AL KABIR

CLASS: XII	DEPARTMENT: SCIENCE 2024 – 2025 SUBJECT: CHEMISTRY	DATE :09/11/2024
WORKSHEET No: 7	TOPIC: ELECTROCHEMISTRY	NOTE: A4 FILE FORMAT
CLASS & SEC:	NAME OF THE STUDENT:	ROLL NO.

Objective Type Questions

1. Which cell will measure standard electrode potential of copper electrode?
(a) Pt (s) H_2(g,0.1 bar) H^+ (aq.,1 M) Cu^{2+}(aq.,1M) Cu
(b) Pt(s) H_2(g, 1 bar) H^+ (aq.,1 M) Cu^{2+} (aq.,2 M) Cu
(c) Pt(s) H_2(g, 1 bar) H^+ (aq.,1 M) Cu^{2+} (aq.,1 M) Cu
(d) Pt(s) H_2 (g,1 bar) H+(aq.,0.1 M) Cu^{2+} (aq.,1 M) Cu

2. Using the data given below to find out the strongest oxidising agent.
$E^o(Cr_2O_7^{2-}/Cr^{3+})$ = 1.33V, $E^o(MnO_4^-/Mn^{2+})$ = 1.51V $E^o(Cl_2/Cl^-)$ = 1.36V $E^o(Cr^{3+}/Cr)$ = -0.74V
(a) Cl^-
(b) Mn^{2+}
(c) MnO_4^-
(d) Cr^{3+}

3. The quantity of charge required to obtain one mole of aluminium from Al_2O_3 is ____________.
(a) 1F
(b) 6F
(c) 3F
(d) 2F

4. $\wedge^0 m(NH_4OH)$ is equal to _______________.

(a) $\wedge^0 m(NH_4OH) + \wedge^0 m(NH_4Cl) - \wedge^0(HCl)$
(b) $\wedge^0 m(NH_4Cl) + \wedge^0 m(NaOH) - \wedge^0(NaCl)$
(c) $\wedge^0 m(NH_4Cl) + \wedge^0 m(NaCl) - \wedge^0(NaOH)$
(d) $\wedge^0 m(NaOH) + \wedge^0 m(NaCl) - \wedge^0(NH_4Cl)$

5. A certain current liberates 0.504 g of hydrogen in 2 hr. How many grams of copper can be liberated by the same current flowing for the same time in $CuSO_4$ solution?
(a) 12.7g (b) 16g (c) 31.8g (d) 63.5g

6. If the Ecell^0 for a given reaction has a negative value, then which of the following gives the correct relationships for the value of $\Delta G°$and Keq?
(a) $\Delta G° > 0$; Keq < 1 (b) $\Delta G° > 0$; Keq > 1 (c) $\Delta G° < 0$; Keq > 1 (d) $\Delta G° < 0$; Keq < 1

7. Standard reduction potentials of the half reactions are given below:
$F_{2(g)} + 2e^- \longrightarrow 2F^-(aq)$; $E°$ = +2.85 V
$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-(aq)$; $E°$ = +1.36 V

$Br_{2(l)} + 2e^- \longrightarrow 2Br^-(aq)$; $E° = +1.06$ V
$I_{2(s)} + 2e^- \longrightarrow 2I^-(aq)$; $E° = +0.53\ V$
The strongest oxidising and reducing agents respectively are:
(a) F_2 and I^- (b) Br_2 and Cl^- (c) Cl_2 and Br^- d) Cl_2 and I_2

8. The standard reduction potential for $Fe^{2+}|Fe$ and $Sn^{2+}|Sn$ electrodes are −0.44 V and −0.14 V respectively. For the cell reaction, $Fe^{2+} + Sn \longrightarrow Fe + Sn^{2+}$, the standard e.m.f. is:
a) + 0.30 V b) 0.58 V c) + 0.58 V d) − 0.30 V

<u>Questions 9- 10 are *Assertion Reason* type questions</u>

(a) If both *Assertion* and *Reason* are correct and *Reason* is the correct explanation of *Assertion*.
(b) If both *Assertion* and *Reason* are correct but *Reason* is not the correct explanation of *Assertion*.
(c) If *Assertion* is correct and *Reason* is wrong.
(d) If *Assertion* is wrong and *Reason* is correct.

9. Assertion: EAg^+/Ag increases with increase in concentration of Ag^+ ions.
Reason: $E\ Ag^+/Ag$ has a positive value.

10. Assertion: Mercury cell does not give steady potential.
Reason: In the cell reaction of mercury cell, ions are not involved in solution.

<u>2 Marks questions</u>

11. The conductivity of 0.20 M solution of KCl at 298 K is 0.0248 S cm-1. Calculate its molar conductivity.

12. How much charges in terms of Faraday is required to produce?
(i) 20.0 g of Ca from molten $CaCl_2$
(ii) 40.0 g of Al from molten Al_2O_3

13. Write the half-cell reactions for the galvanic cell in which the cell reaction is $Cu + 2Ag^+ \rightarrow 2Ag + Cu^{2+}$
Depict the cell notation too.

14. What are Fuel cells? Write cell reaction.

15. State Kohlrausch's law and mention its applications.

16. What is corrosion? Give the mechanism of rusting on the basis of electrochemical theory.

17. Calculate the potential of hydrogen electrode in contact with a solution whose pH is 10.

<u>3 Marks Questions</u>

18.(a) In an aqueous solution, how does specific conductivity of electrolytes change with the addition of water?
(b) Write the Nernst equation for the cell reaction in the Daniel cell. How will the E_{Cell} be affected when the concentration of Zn^{2+} ions is increased?

19.(a) What advantage do the fuel cells have over primary and secondary batteries?

(b) Write the cell reaction of a lead storage battery when it is discharged

20. A current of 1.50A was passed through an electrolytic cell containing $AgNO_3$ solution with inert electrodes. The weight of silver deposited was 1.50 g. How long did the current flow?

21. Represent the cell in which the following reaction takes place. The value of E° for the cell is 1.260V. What is the value of Ecell?

$2Al + 3Cd^{2+}(0.1M) \longrightarrow 3Cd + 2Al^{3+}(0.01M)$

22. Calculate the EMF of the cell for the reaction

$Mg(s) + 2Ag^{+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2Ag_{(S)}$

Given: $E^0 Mg^{2+}/Mg = -2.37V$ $E^0 Ag^{+}/Ag = -0.80V$ $[Mg^{2+}] = 0.001M$; $[Ag^{+}] = 0.0001$ M $\log 10^5 = 5$

Case study-based Questions (4 marks)

23. Read the passage given below and answer the following questions:

The standard electrode potentials are very important and we can extract a lot of useful information from them. If the standard electrode potential of an electrode is greater than zero then its reduced form is more stable compared to hydrogen gas. Similarly, if the standard electrode potential is negative then hydrogen gas is more stable than the reduced form of the species. It can be seen that the standard electrode potential for fluorine is the highest in theTable indicating that fluorine gas (F2) has the maximum tendency to get reduced to fluoride (F-) and therefore fluorine gas is the strongest oxidizing agent and fluoride ion is the weaker reducing agent. Lithium has the lowest electrode potential indicating that lithium metal is the most powerful reducing agent in an aqueous solution.

(i) Which metal is used as electrode which do not participate in the reaction but provides surface for conduction of electrons?

(a) Cu (b) Pt (c) Zn (d) Fe

(ii) Standard Electrode Potential is _________

(a) the reduction potential of a molecule under specific and standard conditions.
(b) extensive property.
(c) measured by calorimeter.
(d) oxidation potential.

(iii) The standard hydrogen electrode can be represented as

(a) Pt (s) / Pt^{+2} (aq) / H_2 (g) / H^+ (aq.)

(b) Pt (s) / H_2 (g, 1 bar) / H^+ (aq, 1M)

(c) Pt (s) / H_2 (g, 2 bar) / H^+ (aq, 1M)

(d) Pt (s) / H_2 (g, 4 bar) / H^+ (aq, 2M)

(iv) To calculate the standard emf of the cell, which of the following options is correct if E° is reduction potential values?

(a) emf = E°cathode – E°anode (b) emf = E°anode – E°cathode
(c) emf = E°anode + E°cathode (d) None of these

24. A Galvanic cell is made up of two electrodes anode and cathode, i.e., two half cells. One of these electrodes must have a higher electrode potential (higher tendency to lose electrons) than the other electrode. As a result of this potential difference, the electrons flow from an electrode at a higher potential to the electrode at a lower potential. There is a difference between electromotive force and potential difference.

(i) Molten NaCl conducts electricity due to the presence of :

a) Free electrons b) Free molecules c) Free ions d) Atoms of Na and Cl

(ii) In a galvanic cell

(a) the flow of electron is from anode (negative zinc electrode) towards cathode (positive copper electrode)

(b) the flow of electron is from cathode (positive copper electrode) towards anode (negative zinc electrode)
(c) the electric current flows from anode to cathode.
(d) the electrons are transferred from the oxidizing agent to the reducing agent.

(iii) The $E°$ for half-cell Fe/Fe^{2+} and Cu/Cu^{2+} are -0.44 V and $+0.32$ V respectively, then

a) Cu^{2+} oxidises Fe b) Cu oxidises Fe c) Cu reduces Fe^{2+} d) Cu^{2+} oxidises Fe^{2+}

(iv) Which of the following expression is correct?
(a) $\Delta G° = -nFE^0$cell
(b) $\Delta G° = +nFE^0$cell
(c) $\Delta G° = -2.303\ RT\ nFE^0$cell
(d) $\Delta G° = -nF \log Kc$

<u>5 Marks Questions</u>

25. (a) State two advantages of H_2—O_2 fuel cell over ordinary cell.
(b) Why does the cell voltage of a mercury cell remain constant during its life time?
(c) Write the reaction occurring at anode and cathode and the products of electrolysis of aq KCl.

26. (a) Molar conductivity of substance "A" is 5.9×10^3 S/m and "B" is 1×10^{-16} S/m. Which of the two is most likely to be copper metal and why?
(b) What is the quantity of electricity in Coulombs required to produce 4.8 g of Mg from molten $MgCl_2$? How much Ca will be produced if the same amount of electricity was passed through molten $CaCl_2$? (Atomic mass of Mg = 24 u, atomic mass of Ca = 40 u).
(c) What is the standard free energy change for the following reaction at room temperature? Is the reaction spontaneous?
$Sn(s) + 2Cu^{2+}(aq) \longrightarrow Sn^{2+}(aq) + 2Cu(s)$

<u>Answers</u>

1.	(c) Pt(s) H_2(g, 1 bar) H^+ (aq.,1 M) Cu^{2+} (aq.,1 M) Cu
2.	(c) MnO_4^-
3.	(c) 3F
4.	(b) $\Lambda^0_m(NH_4Cl) + \Lambda^0_m(NaOH) - \Lambda^0(NaCl)$
5.	(b) 16g
6.	(a) $\Delta G° > 0$; Keq < 1
7.	(a) F_2 and I^-
8.	(d) − 0.30 V
9.	(b)If both *Assertion* and *Reason* are correct but *Reason* is not the correct explanation of *Assertion*.
10	(d) If *Assertion* is wrong and *Reason* is correct
11	K= 0.0248 Scm^{-1} c = 0.20 M Therefore, Molar conductivity= $\Lambda_m = \frac{K\times1000}{c} = \frac{0.0248\times1000}{0.2} = 124 Scm^2mol^{-1}$
12	(i) $Ca^{2+} + 2e^- \longrightarrow Ca$ (40g) Electricity required for production of 40g of Ca = 2F Electricity required for production of 20g of Ca = 1F or 96500C (ii) $Al^{3+} + 3e^- \longrightarrow Al$(27g) Electricity required for production of 27g of Al = 3F Electricity required for production of 40g of Al= 3F x40 /27 = 4.4F or 4288888.9C

13	Cathode: $2Ag^{+} + 2e^{-} \rightarrow 2Ag$ At Anode: $Cu \rightarrow Cu^{2+} + 2e^{-}$ Cu|Cu2+(aq)||Ag+(aq)|Ag(s)
14	A device in which the chemical energy produced as a result of the oxidation of a fuel is converted in to electricity is called a fuel cell. Anode $2H_{2(g)} + 4OH^{-}_{(q)} \rightarrow 4H_2O_{(l)} + 4e^{-}$ Cathode $O_{2(g)} + 2H_2O_{(l)} + 4e^{-} \rightarrow 4OH^{-}_{(aq)}$ Net reaction $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$
15	Kohlrausch's law – At infinite dilution the molar conductivity of an electrolyte is sum of the molar conductivities of individual ions. (i). To find the limiting molar conductivity of weak electrolyte (ii).to find degree of dissociation (iii).to find ionization constant
16	In the process of corrosion, due to the presence of air and moisture, oxidation takes place at a particular spot of an object made of iron. That spot behaves as the anode. The reaction at the anode is given by, $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^{-}$ At cathode: The electrons which are released participate in the reduction reaction and combine with H^+ ions released from carbonic acid (H_2CO_3) formed by the combination of CO_2andH_2O present. $H_2O + CO_2 \leftrightarrow H_2CO_3$ $H_2CO_3 \leftrightarrow 2H_+ + CO_3^{2-}$ Cathode: $O_2(g) + 4H^{+}_{(aq)} + 4e^{-} \rightarrow 2H_2O_{(l)}$ $2Fe(s) + O_{2(g)} + 4H^{+}(aq) \longrightarrow 2Fe^{2+}(aq) + 2H_2O_{(l)}$ The ferrous ions are further oxidised by atmospheric oxygen to ferric ions which come out as rust in the form of hydrated ferric oxide($Fe_2O_3.\ x\ H_2O$) and with further production of hydrogen ions
17	Therefore, $[H^+] = 10^{-10}$M Now, using Nernst equation: $H_{\left(H^{+}/\frac{1}{2}H^{2}\right)} = E^{\circ}_{\left(H^{+}/\frac{1}{2}H^{2}\right)} - \frac{RT}{nF} \ln \frac{1}{[H^{+}]}$ $= E^{\circ}_{\left(H^{+}/\frac{1}{2}H^{2}\right)} - \frac{0.0591}{1} \log \frac{1}{[H^{+}]}$ $0 - \frac{0.0591}{1} \log \frac{1}{[10^{-10}]}$ $= -0.0591 \log 10^{10} = -0.591\ V$
18	(a) When water is added to an aqueous solution the number of ions per unit volume decreases i.e. the concentration of ions decreases and hence thereby conductivity gets decreased. Daniel Cell : $Zn\ (s)\ \lvert Zn^{2+} \rvert\ \lvert Cu^{2+} \rvert\ Cu\ (s)$ Anode :$Zn(s) \rightarrow Zn^{2+} + 2e^{-}$ Cathode : $Cu^{2+} + 2e^{-} \rightarrow Cu(s)$ Overall cell reaction : $Zn(s) + Cu^{2+} \rightleftharpoons Zn^{2+} + Cu(s)$ $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]}$ $E_{cell} = E^{0}_{cell} - \frac{0.059}{2} log \frac{[Zn^{2+}]}{[Cu^{2+}]}$ Therefore, with increasing concentration of Zn^{2+}, the cell potential decreases. (b)

19	(a) Primary batteries contain a limited amount of reactants and are discharged when the reactants have been consumed. Secondary batteries can be recharged but take a long time to recharge. Fuel cell runs continuously as long as the reactants are supplied to it and products are removed continuously. (b) When a lead storage battery is discharged then the following cell reaction takes place $Pb+PbO_2+2H_2SO_4 \rightarrow 2PbSO_4+2H_2O$
20	Current I = 1.50 A W = 1.50 g t = ? Molar mass (M) = 108 / m o l 1 F = 96500 C / m o l $W = ZIT$ 1.50 = 108/ 96500 × 1.50 × t t = 96500 /108 = 893.52 s
21	$2Al(s)\|2Al^{3+}(0.01M)\|\|3Cd^{2+}(0.1M)\|3Cd(s)$ $E_{cell} = 1.260 - \frac{0.0591}{6}\log\left(\frac{(0.01)^2}{(0.1)^3}\right)$ Ecell=1.260+0.00985= 1.270V
22	E^0Cell = E^0right – E^0left = 0.80 – (-2.37 V) = 3.17 $= 3.17 - \frac{0.059}{2}\log\frac{[10^{-3}]}{[10^{-4}]^2}$ $= 3.17 - \frac{0.059}{2}\log 10^5$ $= 3.17 - \frac{0.059x5}{2}$ Ecell = 3.0225 V
23	(i) (b) Pt (ii) (a) the reduction potential of a molecule under specific and standard conditions. (iii) (b) Pt (s) / H2 (g, 1 bar) / H+ (aq, 1M) (iv) (a) emf = E°cathode – E°anode
24	(i) (c) Free ions (ii) (a) the flow of electron is from anode (negative zinc electrode) towards cathode (positive copper electrode) (iii) a) Cu^{2+} oxidises Fe (iv) a) $\Delta G° = -nFE^0$cell
25	(a) Fuel cells are more advantageous over the ordinary cells as: Fuel cells can produce electricity continuously for as long as the fuel, which is hydrogen, and the oxidant, which is oxygen are supplied. These cells do not cause pollution and the source of the fuel and the oxidant are both environment-friendly. (b) The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its life time (c) cathode: $H_2O_{(l)}$ + e- → ½ H2 $_{(g)}$ + $OH^-{}_{(aq)}$ anode: Cl^- (aq) -----→ ½ Cl_2 (aq) + e- KCl (aq) + H_2O (l) ------→K^+ (aq) +OH^- (aq) + ½ H_2 (g) + ½ Cl_2 (g)
26	a. "A" is copper, metals are conductors thus have high value of conductivity. b.Mg^{2+} + 2e- ----→ Mg 1 mole of magnesium ions gains two moles of electrons or 2F to form 1 mole of Mg 24 g Mg requires 2 F electricity 4.8 g Mg requires 2 x4.8/24 = 0.4 F = 0.4 x96500 = 38600C (1)

	Ca^{2+} + 2e-----→Ca 2 F electricity is required to produce 1 mole =40 g Ca 0.4 F electricity will produce 8 g Ca c.F = 96500C, n=2, Sn^{2+} (aq) + 2e– → Sn(s) E^0 = –0.14V Cu^{2+}(aq) + e- → Cu+ (aq) E^0 = 0.34 V E^ocell = E^ocathode – E^o anode = 0.34 – (-0.14) = 0.48V ΔG^o = -nFE^ocell = -2 x96500x 0.29 = 92640J/mol (spontaneous)

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