CHEMISTRY

WORKSHEET-16

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-16

(A. Physical Chemistry)

Electrochemistry

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Q.1 By electrolysis of brine solution, which of the following is deposited/released at anode?

A) H_2 C) Cl_2

B) O_2 D) Na

Q.2 Which of the following is reducing agent?

A) $(COOH)_2$ C) CO_2

B) F_2 D) HNO_3

Q.3 Oxidation number of nitrogen in NO_3^{-1} is:

A) + 2 C) + 4

B) + 6 D) + 5

Q.4 Which of the following elements in glucose has zero oxidation state?

A) C C) H

B) O D) Both A and B

Q.5 All of the following statements about (oxidation) state is / are correct EXCEPT:

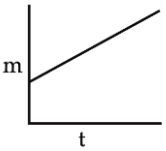
A) It is apparent charge on an atom in a compound

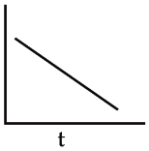
B) Its value is either zero, positive or negative

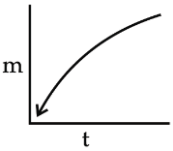
C) It can be variable

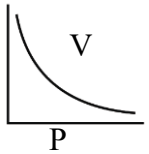
D) Xenon (Xe) can show maximum oxidation state +6 in its compounds

Q.6 Electrolysis of $CuSO_{4(aq)}$ was carried out using Cu – electrode and a steady current. Which graph shows the change in mass of the cathode with time.

A) 

C) 

B) 

D) 

Q.7 In the extraction of A*l* by electrolysis, why is it necessary to dissolve Al_2O_3 in molten cryolite?

A) Cryolite provides the ions needed to carry current

B) To decrease high melting point of the electrolyte

C) Cryolite reacts with Al_2O_3 to form ions

D) Molten Al_2O_3 would not conduct electricity

Q.8 In $FeCl_3$ the oxidation state of C*l* is:

A) Zero C) – 1

B) + 1 D) – 2

Q.9 The process of decomposition of an electrolyte in solution or molten states by the passage of electric current is called electrolysis? All of the following statements about products as a result of electrolysis are correct EXCEPT:

A) They may be get deposited/released on the electrode surface

B) They may go out in the form of gases

C) Electrolytic material may get dissolved into the solution as ions

D) In Nelson cell, Na metal is a primary product

Q.10 Which of the following is not conductor of electricity?

A) $NaCl_{(aq)}$ C) $NaCl_{(s)}$

B) $NaCl_{(molten)}$ D) Silver metal

Q.11 Li^+ has a smaller ionic mobility than K^+ because of the:

A) Larger size of Li^+

B) Greater degree of hydration of Li^+

C) Larger radius to charge ratio of Li^+

D) Smaller nuclear charge of Li^+

Q.12 All of the following is / are characteristics properties of electrolytic cell EXCEPT:

A) It involves conversion of electrical energy into chemical energy

B) In it anode has negative charge and cathode has positive charge

C) It is reverse of addition reaction

D) It is endothermic process

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Q.13 When there is more than one cations in the aqueous solution of an electrolyte, the ions discharge at the cathode can be predicted from the reactivity order of elements given in the electrochemical series. Which of the following is correct order of discharge of positive ions at cathode?

A) $Ag^{+} > Cu^{+2} > H^{+} > Pb^{+2}$ C) $Ag^{+1} > H^{+} > Pb^{+2} > Cu^{+2}$

B) $Cu^{+2} > Ag^{+1} > H^{+} > Pb^{+2}$ D) $H^{+} > Ag^{+1} > Cu^{+2} > Pb^{+2}$

Q.14 Which of the following is correct order of discharge of negative ions on the anode electrode in case of electrolysis of mixture of electrolytes?

A) $I^{-} > Br^{-} > OH^{-} > NO_3^{-1}$ C) $OH^{-} > Br^{-} > I^{-1} > NO_3^{-1}$

B) $Br^{-} > OH^{-} > NO_3^{-1} > I^{-1}$ D) $NO_3^{-1} > Br^{-} > OH^{-} > I^{-1}$

Q.15 Na metal cannot be produced by electrolysis of aqueous solution of NaC*l*.

A) Na reacts with water

B) Na^{+} is more stable than Na atom

C) Na^{+} reacts with Cl^{-} ion in the solution

D) Reduction of H_2O is preferred to Na^{+}

Q.16 Which of the following is wrong about electrolysis?

A) Extraction of sodium by the electrolysis of fused NaCl is carried in Down's cell

B) Ca and Mg metals are extracted by the electrolysis of their fused chlorides

C) It is used for the extraction of blistered copper from electrolytic copper

D) Aluminium is extracted by electrolyzing fused bauxite ($Al_2O_3.2H_2O$) in the presence of fused cryolite (Na_3AlF_6)

Q.17 In which one of the following reactions, hydrogen behaves as an oxidizing agent?

A) $H_2 + Cl_2 \rightarrow 2HCl$ C) $2Na + H_2 \rightarrow 2NaH$

B) $C_2H_4 + H_2 \rightarrow C_2H_6$ D) $N_2 + 3H_2 \rightarrow 2NH_3$

Q.18 When a dilute solution of salt is electrolyzed, a colourless gas is given off at the anode. The gas is:

A) Hydrogen C) Steam

B) Oxygen D) Chlorine

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Q.19 Coinage metals (Cu, Ag and Au) are the least reactive because they have:

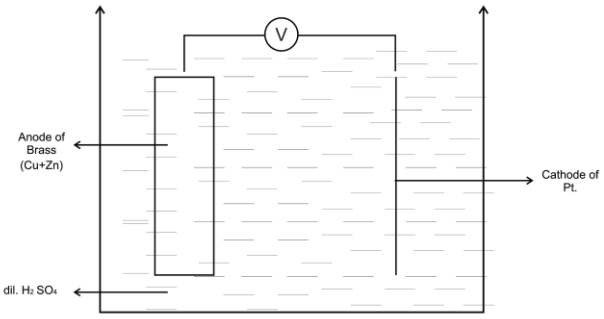
A) Negative reduction potential

B) Negative oxidation potential

C)Positive reduction potential

D) Positive oxidation potential

Q.20 The circuit shown in diagram was set up:



Which electrode reaction will occur?

Options	Anode Reaction	Cathode Reaction
A)	Cu dissolves preferentially	Cu is precipitated
B)	Cu dissolves preferentially	Hydrogen gas is evolved
C)	Zn and Cu both dissolves	Hydrogen gas is evolved
D)	Zn dissolves preferentially	Hydrogen gas is evolved

Q.21 Consider the following redox reaction

$K_2Cr_2O_7+7H_2SO_4+6FeSO_4 \rightarrow$

$K_2SO_4+Cr_2(SO_4)_3+3Fe_2(SO_4)_3+7H_2O$

In this reaction

I) $FeSO_4$ acts as a reducing agent

II) $K_2Cr_2O_7$ acts as an oxidizing agent

III) $Cr^{+6}{}_{(aq)}$ is reduced to Cr^{+3}

IV) Fe^{+3} is oxidized to Fe^{+2}

Which of the following statements is/are correct regarding this redox reaction?

A) I and II only

B) II and III only

C) I , II , III

D) I , II , III , and IV

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Q.22 **All of the following are reducing agents EXCEPT:**

A) $FeSO_4$ C) $(COOH)_2$

B) H_2S D) CO_2

Q.23 **The potential set up when an electrode is in contact with 1M solution of its own ions at 298 K is known as standard electrode potential (or standard reduction potential denoted by E°). All of the following statements about standard electrode potential are correct EXCEPT:**

A) Smaller is the $E°_{red}$, greater is the reducing power of a metal

B) $E°_{red}$ of Li^+ is minimum (-3.04V)

C) Greater is the $E°_{red}$, greater is the oxidizing power of a non-metal

D) $E°_{red}$ of Cl_2 is maximum (+2.87V)

Q.24 **Identify incorrect statement about standard hydrogen electrode:**

A) It is used as a reference electrode

B) Its $E°_{red}$ is zero or less than zero

C) When it is connected to zinc electrode in a galvanic cell, it act as cathode

D) When it is connected to Cu electrode in a galvanic cell, it act as anode

Q.25 **If in a Galvanic cell:**

- **Zn^{+2}/Zn^o E^o_{red} = -0.76 V**
- **Cu^{+2}/Cu^o E^o_{red} = +0.34 V**

Then the standard cell potential (E^o_{cell}) of this Galvanic cell is:

A) + 1.10 volts

B) – 0.42 volts

C) -1.10 volts

D) + 0.42 volts

Q.26 **On the basis of knowledge of electrochemical series, which reaction is not feasible:**

A) $Zn + H_2SO_{4\,(dil)} \rightarrow ZnSO_4 + H_2$

B) $F_2 + KCl \rightarrow 2KF + Cl_2$

C) $Cu + H_2SO_{4\,(dil)} \rightarrow CuSO_4 + H_2$

D) $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

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Q.27 **When elements are arranged in the order of their standard electrode potential on the basis of hydrogen scale, the resulting list of elements is known as Electrochemical series. Mark the incorrect statement about electrochemical series:**

A) Every top metal can displace lower one in redox reaction

B) Every lower non-metal can displace higher one in redox reaction

C) $E^o_{cell} = E^o_{oxid} + E^o_{red}$

D) E^o_{red} increases from bottom to top

Q.28 **Identify the incorrect statement:**

A) Every top metal acts as anode

B) Every lower metal acts as cathode

C) Oxidizing power of an element decreases from top to bottom

D) Reducing power of an element decreases from top to bottom

Q.29 **On the electrolysis of aqueous solution of Na_2SO_4 by using inert electrode, which of the following is deposited/released on the cathode electrode?**

A) Na is deposited

B) O_2 gas is released

C) Either Na or H_2 is released

D) H_2 gas is released

Q.30 **On the electrolysis of H_2SO_4 (dil) solution by using inert electrode, which of the following is deposited or released at anode electrode**

A) H_2 gas is released

B) O_2 gas is released

C) SO_2 gas is released

D) Either O_2 or SO_2 gas is released

Q.31 **A redox reaction is shown below:**

$$\mathbf{C^o + 4HNO_3\ (Conc.) \rightarrow CO_2 + 4NO_2 + 2H_2O}$$

In this reaction oxidation number of N from nitric acid to NO_2 is decreased from ____ to _____.

A) +5 to +2

B) +5 to +4

C) +3 to + 2

D) + 4 to +2

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Q.32 **In sodium sulphate (Na_2SO_4) what is the oxidation number of sulphur:**

A) +2 C) +6

B) +4 D) +8

Q.33 **Solid potassium halides react with concentrated sulphuric acid, according to the following equations.**

Reaction-1:

$$2KCl + H_2SO_4 \longrightarrow K_2SO_4 + 2HCl$$

Reaction-2:

$$2KBr + 2H_2SO_4 \longrightarrow K_2SO_4 + SO_2 + Br_2 + 2H_2O$$

Reaction-3:

$$8KI + 5H_2SO_4 \longrightarrow 4K_2SO_4 + H_2S + 4I_2 + 4H_2O$$

What is the largest change in the oxidation number of sulphur in each of these reactions?

Options	Reaction-1	Reaction-2	Reaction-3
A)	0	0	4
B)	0	2	4
C)	0	2	8
D)	0	4	8

Q.34 **Salt bridge has all of the following functions EXCEPT:**

A) It keeps separate both solutions

B) It maintains electrical neutrality in the cell

C) It maintains flow of electric current through external circuit

D) The positive charge around cathode electrode would prevent the electrons to flow from it

Q.35 **To measure the standard electrode potential of Zinc, it is coupled with:**

A) SHE C) F_2

B) Cl_2 D) Cu

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Q.36 **Which one of the following is not redox reaction?**

A) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B) $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

C) $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

D) $2Mg + O_2 \rightarrow 2MgO$

Q.37 **The element which has greatest value of standard reduction potential (E^o_{red}) in the redox reaction acts as:**

A) Strongest reducing agent

B) Strongest oxidizing agent

C) Weakest oxidizing agent

D) Weakest reducing agent

Q.38 **When a Zn strip is placed in $CuSO_4$ solution, Cu gets precipitated, because standard oxidation potential of Zn is?**

A) < Cu

B) > Cu

C) $< SO_4^{-2}$

D) $> SO_4^{-2}$

Q.39 **Which of the following has highest reduction potential?**

A) Zn

B) Al

C) Au

D) Pb

Q.40 **The reaction which takes place at electrode when electricity is passed through the solution of an electrolyte is called _____.**

A) Hydrolysis

B) Neutralization

C) Electrolysis

D) Galvanizing

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ANSWER KEY (Worksheet-16)							
1	C	11	B	21	C	31	B
2	A	12	B	22	D	32	C
3	D	13	A	23	D	33	C
4	A	14	A	24	B	34	D
5	D	15	D	25	A	35	A
6	A	16	C	26	C	36	B
7	B	17	C	27	D	37	B
8	C	18	B	28	C	38	B
9	D	19	C	29	D	39	C
10	C	20	D	30	B	40	C

ANSWERS EXPLAINED

Standard reduction potentials (E°) of substances at 298K

oxidised form A_{Ox}	$+ n e^-$	reduced form A_{Red}	E°/ V
$Li^+_{(aq)} + e^-$	$\rightleftharpoons$	$Li_{(s)}$	-3.04
$K^+_{(aq)} + e^-$	$\rightleftharpoons$	$K_{(s)}$	-2.92
$Na^+_{(aq)} + e^-$	$\rightleftharpoons$	$Na_{(s)}$	-2.71
$Zn^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Zn_{(s)}$	-0.76
$Pb^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Pb_{(s)}$	-0.13
$2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$H_{2(g)}$	0.00
$N_{2(g)} + 8H^+_{(aq)} + 6e^-$	$\rightleftharpoons$	$2NH^+_{4(aq)}$	+0.27
$Cu^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Cu_{(s)}$	+0.34
$I_{2(s)} + 2e^-$	$\rightleftharpoons$	$2I^-_{(aq)}$	+0.54
$O_{2(aq)} + 2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$H_2O_{2(aq)}$	+0.68
$Fe^{3+}_{(aq)} + e^-$	$\rightleftharpoons$	$Fe^{2+}_{(aq)}$	+0.77
$NO^-_{3(aq)} + 4H^+_{(aq)} + 3e^-$	$\rightleftharpoons$	$NO_{(g)} + 2H_2O_{(l)}$	+0.96
$O_{2(g)} + 4H^+_{(aq)} + 4e^-$	$\rightleftharpoons$	$2H_2O_{(l)}$	+1.23
$Cl_{2(g)} + 2e^-$	$\rightleftharpoons$	$2Cl^-_{(aq)}$	+1.36
$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^-$	$\rightleftharpoons$	$2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$	+1.36
$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^-$	$\rightleftharpoons$	$Mn^{2+}_{(aq)}$	+1.49
$H_2O_{2(aq)} + 2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$2H_2O_{(l)}$	+1.78
$F_{2(g)} + 2e^-$	$\rightleftharpoons$	$2F^-_{(aq)}$	+2.87

Q.1 (C) Chlorine gas (Cl_2) is released at anode.

- In the electrolysis of aqueous solution containing a mixture of ions, following is the increasing order of discharge of negative ions at anode electrode.

$$SO_4^{2-} < NO_3^- < Cl^- < OH^- < Br^- < I^-$$

- In the electrolysis of brine solution, the relative concentration of chloride ions (Cl^-) and hydroxide ions (OH^-) affect the result.
- The concentration of OH^- ions in water is only 10^{-7} moldm^{-3}. In the aqueous solution concentration of Cl^- ions is 0.1 moldm^{-3}.
- Which clearly shows that the concentration of chloride ions is 10^6 times greater than that of OH^- ions.
- Because of this reason chloride ions are preferentially discharged at anode electrode than that of OH^- ions (concentration effect).

	Cations	Anions
$NaCl_{(aq)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$	$Na^+_{(aq)}$	Cl^-
$HOH \longrightarrow H^+_{(aq)} + OH^-_{(aq)}$	$H^+_{(aq)}$	OH^-

At anode $2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$

At cathode $2H^+ + 2e^- \longrightarrow H_2$

Q.2 (A) Oxalic acid **$(COOH)_2$** is reducing agent and oxidation number of carbon **increases** from **+3** to **+4** in **redox reaction**.

Q.3 (D) (NO_3^{-1})

$$x + (-2 \times 3) = -1$$
$$x - 6 = -1$$
$$x = +5$$

so oxidation number of **N** in **NO_3^{-1} = +5**.

Q.4 (A) Oxidation of carbon is zero in glucose such as. **Formula of glucose = $C_6H_{12}O_6$.**

$$x\times 6+1\times 12-2\times 6=0$$
$$6x+12-12=0$$
$$6x+0=6$$
$$x=0$$

$\therefore$ Oxidation number of carbon is zero.

Q.5 (D) Oxidation state of **Xe** can be not only **+6** but it can also be **+8** as shown in the compound **XeO_4**. In this compound oxidation state of **Xe** is **+8**. Therefore, maximum oxidation state of Xenon is +8 not +6.

e.g.

- O.S of Xe in $XeOF_4$ is +6
- O.S of Xe in XeO_4 is +8

Q.6 (A) According to **Faraday's second law** of electrolysis, mass of the metal deposited on the electrode is directly proportional to the quantity of electricity **(i.e. $m \propto Q$)** where **Q = It**. Option A justifies the statement. At the cathode, **Cu^{2+}** ions migrate there and is reduced to form **Cu**. $Cu^{+2}+2e^{-}\rightarrow Cu$. Hence the mass of the cathode electrode increases with time.

Q.7 (B) The main purpose of cryolite is to reduce the melting point of **Al_2O_3 (M.P = 2072°C)**. The minimum melting point is achieved when a mixture of substances is formed **(M.P of mixture = 1009°C)**.

Q.8 (C) In **$FeCl_3$** oxidation of **Fe = +3** while total negative charge on chlorine **= -3**. Charge on chlorine per atom **= -1**. So oxidation number of chlorine in **$FeCl_3$ is -1**.

Q.9 (D) In **Nelson cell** water is reduced preferentially to **Na^{+1}** i.e. **Na** metal is not extracted by electrolysis of brine. **Na metal** is obtained by electrolysis of molten **NaCl** in **Down's cell**.

Q.10 (C) **NaCl** in the solid state does not conduct electricity because free ions are not available. For the passage of electricity, free ions of **NaCl** are obtained when **NaCl** is in the molten state or in the solution form.

Q.11 (B) **Li^+** has a smaller ionic mobility than that of **K^+** because size of **Li^+** is a smaller and **ΔH_{hyd} of Li^+ = -499kJmol^{-1}** which is greater than that of **K^+ ion (ΔH_{hyd} = -305kJmol^{-1}).** So greater is the **ΔH_{hyd}**, smaller is the mobility of ion.

Q.12 (B) In the **electrolytic cell** cathode is shown by **negative (-)** sign while anode is shown by **positive (+)** sign. However, in **galvanic cell** cathode is shown by **positive (+)** sign while anode is shown by **negative sign (-).**

Q.13 (A) Greater is the **E^o_{red}** value, more the ions are preferentially deposited or released at the cathode.

Order of increasing discharge of positive ions = $Pb^{+2} < H^+ < Cu^{+2} < Ag^+$

Q.14 (A) In the electrolysis of a solution containing a mixture of ions.

Following increasing order of discharge of negative ions at anode electrode is given below.

$SO_4^{2-} < NO_3^- < Cl^- < OH^- < Br^- < I^-$

Therefore, the decreasing order of discharge of given negative ions in the given question is:

$I^- > Br^- > OH^- > NO_3^{-1}$.

Q.15 (D) Because E^o_{red} of H_2O is greater **i.e. (H^+ ions = 0.0V)** than that of

Na^+ (E^o_{red} = -2.71V).

Q.16 (C) In fact, electrolytic copper is obtained from blistered copper. **Blistered copper** is obtained by bessemerisation of ore of copper **(Chalcopyrite $CuFeS_2$).** It is impure one. Pure copper obtained by electrolysis of blistered copper is known as electrolytic copper.

Q.17 (C) In this **redox reaction hydrogen** acts as an oxidizing agent because it gains electrons during redox reaction. It is more electronegative **(H = 2.1) than that of Na (0.9).** $\underset{R.A}{2\overset{0}{Na}} + \underset{O.A}{\overset{0}{H_2}} \rightarrow 2\overset{+1}{N}a\overset{-1}{H}$

Q.18 (B) When a dilute solution of salt and water is electrolyzed, a colourless O_2 gas is given off at the anode. Generally OH^- ions are preferentially released in the form of oxygen gas at anode. Because generally it is preferentially released than most of the other negative ions of the salts in dilute solution.

Q.19 (C) Coinage metals **Cu, Ag, Au,** are the least reactive because they have high positive E^o_{red} values as shown **(Cu^{+2} = +0.34V, Ag^+ = 0.78V, Au^{3+} = +1.50V)** greater is the E^o_{red} value of a metal, least is the reactivity.

i.e. $E^o_{red} \propto \frac{1}{\text{reducing power of a metal}}$

Q.20 (D)

- **At anode oxidation takes place such as** $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$. It shows that **Zn** metal is **continuously consumed** and converted into

  Zn^{+2} (E^o_{oxi} of Zn^o =+0.76V).

- **At cathode reduction takes place such as** $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$ ions whereas hydrogen gas is **continuously released at cathode**.

Q.21 (C) In this redox reaction $FeSO_4$ acts as a reducing agent and it is oxidized from Fe^{+2} ($FeSO_4$) to Fe^{+3} {$Fe_2(SO_4)_3$}. $K_2Cr_2O_7$ acts as oxidizing agent. In this redox reaction Cr^{+6} ($K_2Cr_2O_7$) is reduced to Cr^{+3} {$Cr_2(SO_4)_3$}. In this redox reaction Fe^{+3} is not oxidized to Fe^{+2} (which is incorrect statement). In fact, it is reduced from Fe^{+3} to Fe^{+2}.

Q.22 (D) CO_2 is an oxidizing agent while all others are A, B and C are reducing agent. CO_2 has tendency to gain electrons.

Q.23 (D) In fact, $E°_{red}$ of F_2 is maximum (+2.87V). In the electrochemical series F_2 is the strongest oxidizing agent because it can displace all the halogens in the redox reaction i.e F_2 can displace Cl_2, Br_2 and I_2.

Q.24 (B) Standard hydrogen electrode is used as a reference electrode and its E^o_{red} is zero volt.

Q.25 (A) The standard cell potential (E^o_{cell}) of this Galvanic cell is +1.10V. Since it is positive value, so the reaction is spontaneous and feasible. E^o_{cell} can be calculated as:

Given data

- **Zn^{+2}/Zn^{o} E^{o}_{red} = -0.76 V**
- **Cu^{+2}/Cu^{o} E^{o}_{red} = +0.34 V**
- **Since Zn^{+2} ion has smaller E^{o}_{red} value therefore Zn is more electropositive than Cu. So Zn act as reducing agent and loses electron.**
- **On the other hand Cu^{+2} ion has greater reduction potential value therefore, Cu^{+2} is less electropositive than Zn^{+2}.**

E^{o}_{oxid} Zn^{o}/Zn^{+2} = +0.76V

$E^{0}_{cell} = E^{0}_{oxid} + E^{0}_{red}$

$= Zn/Zn^{+2} + Cu^{+2}/Cu^{0}$

= 0.76 + 0.34V

= +1.10V

E^{o}_{cell} of this Galvanic cell = +1.10V which shows that reaction is feasible.

Q.26 (C) **$Cu + H_2SO_{4(dil.)} \rightarrow$ No reaction. According to applications of electrochemical series every top metal can displace lower metal but lower metal cannot displace higher one. Since reduction potential of Cu^{+2}/Cu is +0.34V and that of hydrogen is zero volt, so hydrogen cannot be displaced by Cu. So this is not feasible reaction. Greater is the E^{o}_{red} value, less is electropositive character.**

Q.27 (D) **In fact, E^{o}_{red} decreases from bottom to top. That is why from bottom to top electropositive character (reducing power) of an element increases.**

Conclusion:

- **$E^{o}_{red} \propto \frac{1}{\text{Reducing Power}}$.**

(e.g. Li^{+1} has minimum standard reduction potential (E^{o}_{red} = -3.04V) and it is the strongest reducing agent in the electrochemical series)

Q.28 (C) In fact, oxidizing power of an element **increases** from **top to bottom. i.e. F_2 is the strongest oxidizing agent in the electrochemical series.**

Conclusion:

- **i.e. $E^{o}_{red} \propto$ Oxidizing power (e.g. F_2 has maximum standard reduction potential (E^{o}_{red} = +2.87V) and it is the strongest oxidizing agent in the electrochemical series)**

Q.29 (D) **On electrolysis of aqueous solution of Na_2SO_4 by using inert electrode. H_2 gas is released at cathode electrode while O_2 is released at anode. Its detail is shown below.**

$$Na_2SO_{4(aq)} \rightleftharpoons 2Na^{+1}_{(aq)} + SO^{-2}_{4(aq)}$$

$$HOH \rightleftharpoons H^{+} + OH^{-}$$

- **At cathode**

Since E^{o}_{red} of H^+ ions is greater than that of Na^+ ions. That is why, H^+ ions are preferentially reduced at cathode electrode and hydrogen H_2 gas is released at cathode as shown below

Order of discharge of positive ion = H^+ > Na^+

= E^{o}_{red} = 0.000V > E^{o}_{red} = -2.714V

$\therefore 2H^+ + 2e^- \rightleftharpoons H_{2(g)}$ … (i)

- **At anode**

Order of discharge of an anion at cathode electrode is as follow

$= I^- > Br^- > OH^- > Cl^- > NO_3^{-1} > SO_4^{-2}$

So OH^- ions are preferentially oxidized at anode and O_2 gas is released as shown below

$\therefore\ 4OH^- \rightarrow O_2 + 2H_2O + 4e^- ....(ii)$

Q.30 (B) O_2 is released at anode by electrolysis of dil. H_2SO_4 as shown below

$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{-2}$

$HOH \rightleftharpoons H^+ + OH^-$

OH^- ions are preferentially discharged at anode electrode and oxygen gas is released as shown below.

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

Q.31 (B) In this redox reaction, decrease in oxidation number of N from HNO_3 to NO_2 is from +5 to +4, as shown below.

$C^o + 4HN^{+5}O_3(conc.) \rightarrow C^{+4}O_2 + 4\,N^{+4}O_2 + 2\,H_2O$

R.A O.A

Q.32 (C)

Na_2SO_4	
We know that the oxidation number of one atom of Na is +1. There are two atoms of Na. $2 \times +1 = +2$	We know that one atom of O is assigned -2. There are four atoms of O. $4 \times -2 = -8$

Since the sum of positive charges plus the sum negative charges must be equal 0,

$(+2) + x + (-8) = 0$

$x + 2 - 8 = 0$

$x = +6$

Q.33 (C) In reaction I, II and III, change in the oxidation state of sulphur is 0, 2 and 8 respectively as shown in the table:

Opt.	Reaction-1	Reaction-2	Reaction-3
C)	0	2	8

Q.34 (D) The progress of cell reaction results in the development of positive charge around the anode due to increase in the concentration of Zn^{2+} ion.

- And negative charge around cathode due to decrease in the concentration of Cu^{2+} ions.
- The positive charge around anode would prevent the electrons to flow from it and negative charge around cathode will check the electrons to reach copper rod.
- This would stop the working of the cell.
- The salt bridge does not allow the solution around the electrode to acquire charge. The anions from the electrolyte in the salt bridge move towards anode and the cations move towards cathode to maintain the electrical neutrality of the solutions in anodic as well as cathodic compartments.

Q.35 (A) To measure the standard electrode potential of zinc is coupled with **standard hydrogen electrode (SHE)**.

Q.36 (B) In a redox reaction, there is always transfer of electron/electrons from a reducing agent to an oxidizing agent. But in case of option "B" since there

is no change in oxidation number in overall reaction, so it is not redox reaction.

Q.37 (B) The element which has the greatest value of standard reduction potential is used as strongest oxidizing agent e.g. maximum reduction potential is that of fluorine in electrochemical series as shown in the tabular form:

Element	Electrode	Standard reduction potential (E^o)
F_2	$F_2 + 2e^- \rightarrow 2F^-$	+2.87volts

Q.38 (B) When a Zn strip is placed in $CuSO_4$ solution, Cu gets precipitated, because standard oxidation potential of **Zn > Cu as shown in the tabular form.**

E^o_{oxd} of Zn = +0.76V	E^o_{oxd} of Cu = -0.34V
$Zn \rightarrow Zn^{+2} + 2e^-$	$Cu \rightarrow Cu^{+2} + 2e^-$

Q.39 (C) Au has highest standard reduction potential as compared to other given in the question.

Element	Electrode	Standard reduction potential (E^o)
Zn	$Zn^{+2} + 2e^- \rightarrow Zn$	-0.76V
Al	$Al^{+3} + 3e^- \rightarrow Al$	-1.66V
Au	$\mathbf{Au^{+3} + 3e^- \rightarrow Au}$	**+1.50V**
Pb	$Pb^{+2} + 2e^- \rightarrow Pb$	-0.126V

Q.40 (C) The reaction which takes place at electrode when electricity is passed through the solution of an electrolyte **is called electrolysis.**

STEP

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