Electrochemistry JEE Main PYQ - 3

Total Time: 1 Hour : 15 Minute **Total Marks:** 120

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Electrochemistry

1. (+4, -1)

The hydrogen electrode is dipped in a solution of pH = 3 at 25°C. The potential of the electrode will be $-$ _____ $\times 10^{-2}$ V.

$\left(\frac{2.303RT}{F} = 0.059\,\text{V}\right)$

---

2. The number of correct statements from the following is _____ (+4, -1)

A. E^{cell} is an intensive parameter

B. A negative E^{θ} means that the redox couple is a stronger reducing agent than the H^{-} H_2 couple.

C. The amount of electricity required for oxidation or reduction depends on the stoichiometry of the electrode reaction.

D. The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte.

---

3. The standard electrode potential $\left(\frac{M^{3+}}{M^{2+}}\right)$ for V, Cr, Mn & Co are −0.26 V, −0.41 V, +1.57 V and +1.97 V, respectively. The metal ions which can liberate H_2 from a dilute acid are (+4, -1)

a. V^{2+} and Cr^{2+}

b. V^{2+} and Mn^{2+}

c. Cr^{2+} and Co^{2+}

d. Mn^{2+} and Co^{2+}

---

4. $Pt(s)|H_{2_{(g)}}(1bar)|H^{+}_{(aq)}(1M)||M^{3+}_{(aq)}, M^{+}_{(aq)}|Pt(s)$ (+4, -1)

The E_{cell} for the given cell is 0.1115 V at 298 K when $\frac{[M^{+}(aq)]}{[M^{3+}(aq)]} = 10^{a}$

The value of a is _____

Given: $E^{\theta}_{M^{3+}/M^{+}} = 0.2\ V$

$\frac{2.303RT}{F} = 0.059V$

---

5. For given cell, at T K (+4, -1)

Pt | H_2(g) | H^{+} || Fe^{3+} ; Fe^{2+} | Pt

(1 bar) (1 M)

E_{cell} = .712 V

E°_{cell} = .770 V

if $\frac{[Fe^{2+}]}{[Fe^{3+}]}$ is t $\left(\frac{2.303\,RT}{F} = .058\right)$

then find $\left(\frac{t}{5}\right)$

---

6. For the given reactions **(+4, -1)**

$Sn^{2+} + 2e^- \rightarrow Sn$

$Sn^{4+} + 4e^- \rightarrow Sn$

the electrode potentials are;

$E^{\circ}_{Sn^{2+}/Sn} = -0.140V$ and $E^{\circ}_{Sn^{4+}Sn} = -0.010\ V$.

The magnitude of standard electrode potential for Sn^{4+}/Sn^{2+} i.e.

$E^{\circ}_{Sn^{4+}/Sn^{2+}}$

is _____ × 10^{-2} V. (Nearest integer)

---

7. For the reaction taking place in the cell: **(+4, -1)**

Pt(s) | H_2(g) | H^+ (q) || Ag^+(aq) | Ag(s),

E^{o}_{cell} = + 0.5332 V.

The value of $\Delta_f G^o$ is _____kJ mol–1 [in nearest integer]

---

8. The limiting molar conductivities of NaI, $NaNO_3$ and $AgNO_3$ are 12.7, 12.0 and 13.3 mS m^2 mol^{-1}, respectively (all at 25°C). The limiting molar conductivity of AgI at this temperature is ____ mS m^2 mol^{-1}. **(+4, -1)**

---

9. The cell potential for the given cell at 298 K $\mathrm{Pt|H_2(g,\ 1\ bar)|H^+(aq)||Cu^{2+}(aq)|Cu(s)}$ is 0.31 V. The pH of the acidic solution is found to be 3, whereas the concentration of Cu^{2+} is 10^{-x} M. The value of x is _____. **(+4, -1)**

(Given : $E^{\Theta}_{Cu^{2+}/Cu}$ = 0.34 V and $\frac{2.303RT}{F}$ = 0.06 V)

---

10. The amount of charge in F (Faraday) required to obtain one mole of iron from Fe_3O_4 is _____ . (Nearest integer) **(+4, -1)**

---

11. The quantity of electricity of Faraday needed to reduce 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+} is **(+4, -1)**

---

12. The solubility product of a sparingly soluble salt A_2X_3 is 1.1×10^{-23}. If the specific conductance of the solution is 3×10^{-5} S m^{-1}, the limiting molar conductivity of the solution is $x \times 10^{-3}$ S m^2 mol^{-1}. The value of x is _____. **(+4, -1)**

---

13. The cell potential for $\mathrm{Zn|Zn^{2+}(aq)||Sn^{x+}|Sn}$ is 0.801 V at 298 K.The reaction quotient for the above reaction is 10^{-2}. The number of electrons involved in the given electrochemical cell reaction is _____. (Given: $E^{\circ}_{Zn^{2+}}$|Zn=-0.763V,$E^{\circ}sn^{X+}$|sn=+0.008V and 2.303RT/F=0.06V) **(+4, -1)**

---

14. A compound'A' on reaction with 'X' and 'Y' produces the same major product but differentby product'a' and 'b'. Oxidation of'a' gives a substance produced by ants. **(+4, -1)**

a. $KMnO_4/H+$ and dil. $KMnO_4$, 273 K

b. $KMnO_4$(dilute), 273 Kand $KMnO_4/H^+$

c. $KMnO_4/H^+$ and O_3, H_2O/Zn

d. O_3, H_2O/Zn and $KMnO_4/H_+$

---

15. Equal weights of methane and oxygen are mixed in an empty container at 25 . The fraction of the total pressure exerted by oxygen is: **(+4, -1)**

a. (A) $\frac{1}{3}$

b. (B) $\frac{1}{2}$

c. (C) $\frac{2}{3}$

d. (D) $\frac{1}{3} \times \frac{273}{298}$

---

16. An ideal gas (C_p / C_v =) is taken through a process in which the pressure and the volume vary as $P = aV^b$.Find the value of b for which the specific heat capacity in the process is zero. **(+4, -1)**

a. (A) 2

b. (B) –

c. (C) 1 /

d. (D) –1 /

---

17. An organic liquid 'A' containing , and with boiling point 78 , possessing a rather pleasant odour on heating with concentrated sulphuric acid gives a gaseous product 'B' with the empirical formula, $_2$ 'B' decolourises bromine water as well as alkaline $_4$ solution and takes up one mole of $_2$ (per mole of) in the presence of finely divided nickel at high temperature. Identify the substance and . **(+4, -1)**

a. (A) Ethyl Alcohol, Ethene

b. (B) Ethene, Ethyl Alcohol

c. (C) Ethene, Ethene

d. (D) Ethyl Alcohol, Ethyl Alcohol

---

18. A gas absorbs a photon of 355 nm and emits at two wavelengths. If one of the emissions is at 680 nm, the other is at: **(+4, -1)**

a. (A) 325 nm

b. (B) 743 nm

c. (C) 518 nm

d. (D) 1035 nm

---

19. For lead storage battery pick the correct statements: **(+4, -1)**

A. During charging of battery, $PbSO_4$ on anode is converted into PbO_2

B. During charging of battery, $PbSO_4$ on cathode is converted into PbO_2

C. lead storage battery consists of grid of lead packed with PbO_2 as anode

D. lead storage battery - 38% solution of sulphuric acid as an electrolyte

choose the correct answer from the options given below:

a. B, C,only

b. A, B, D, only

c. B, C, D only

d. B, D only

---

20. At $298\,K$, a 1 litre solution containing $10\,m\,mol$ of $Cr_2O_7^{2-}$ and $100\,m\,mol$ of Cr^{3+} shows a pH of 30. **(+4, -1)**

Given: $Cr_2O_7^{2-} \rightarrow Cr^{3+}; E^{\circ} = 1330V$ and $\frac{2303RT}{F} = 0059V$.

The potential for the half cell reaction is $x \times 10^{-3}V$. The value of x is ___ .

---

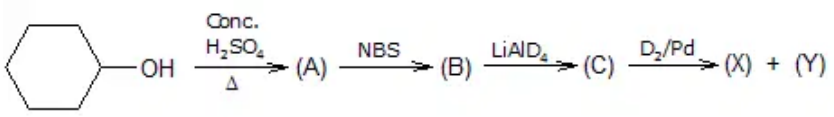
21. **The resistivity of a $0.8M$ solution of an electrolyte is $5 \times 10^{-3}\Omega cm$ Its molar conductivity is ____ $\times 10^4\,\Omega^{-1}\,cm^2\,mol^{-1}$** **(+4, -1)**

---

22. $1 \times 10^{-5} M\ AgNO_3$ is added to $1\ L$ of saturated solution of $AgBr$ The conductivity of this solution at $298\ K$ is ___ [Given : $K_{SP}\ (AgBr) = 49 \times 10^{-13} at 298\ K\ \lambda^0_{Ag^+} = 6 \times 10^{-3} S\ m^2\ mol^{-1}$ $\lambda^0_{Br^-} = 8 \times 10^{-3} S\ m^2\ mol^{-1}$ $\lambda^0_{NO_3^-} = 7 \times 10^{-3}\ S\ m^2\ mol^{-1}$] **(+4, -1)**

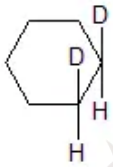
---

23. Consider the following reaction sequence, **(+4, -1)**

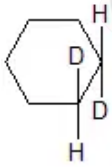


Product (X) may be:

a. (A)



b. (B)



c. (C) Both of 'A' and 'B'

d. (D) None of these

---

24. The decomposition of N_2O_5 in CCl_4 at 318 K has been studied by monitoring the concentration of N_2O_5 in the solution. Initially the concentration of N_2O_5 is 2.33 mol L^{-1} and after 184 minutes, it is reduced to 2.08 mol L^{-1}. The reaction takes place according to the equation:$2\ N_2O_5\ (g) \quad 4NO_2\ (g) + O_2\ (g)$Calculate the average rate of this reaction in term of seconds. What is the rate of production of NO_2 during this period? **(+4, -1)**

a. (A) 1.13×10^{-5} mol L^{-1} s^{-1} and 2.73×10^{-3} mol L^{-1} min^{-1}

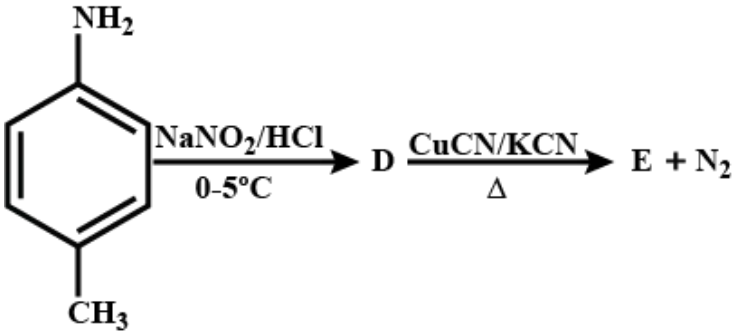
b. (B) 1.13×10^{-5} mol L^{-1} s^{-1} and 2.74×10^{-3} mol L^{-1} min^{-1}

c. (C) 1.13×10^{-5} mol L^{-1} s^{-1} and 2.75×10^{-3} mol L^{-1} min^{-1}

d. (D) 1.13×10^{-5} mol L^{-1} s^{-1} and 2.76×10^{-3} mol L^{-1} min^{-1}

---

25. In the reaction, the product E is: **(+4, -1)**

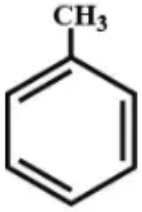


a. (A)

b. (B)

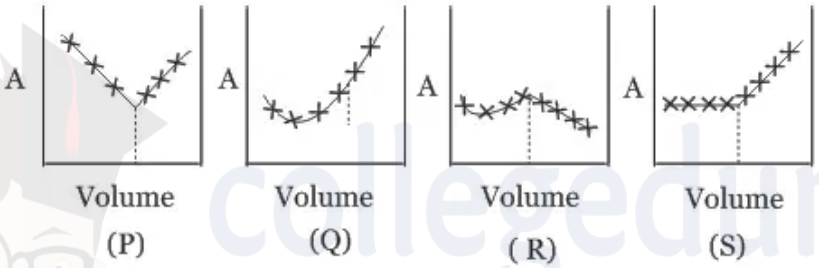
c. (C)

d. (D)



---

26. $AgNO_3$ (aqueous) was added to an aqueous KCl solution gradually and the conductivity of the solution was measured. The plot of conductance (Λ) versus the volume of $AgNO_3$ is: **(+4, -1)**



a. (A) P

b. (B) Q

c. (C) R

d. (D) S

---

27. Given: **(+4, -1)**

(i) $^{2+}$ + 2 $^{-}$, ^{0} = 0.337

(ii) $^{2+}$ + $^{-}$ $^{+}$, ^{0} = 0.153

Standard electrode potential, for the reaction, + $^{-}$, will be (in volts):

---

28. The standard enthalpies of formation of $CO_2(g), H_2O(l)$ and glucose(.v) at 25°C- are 400 kJ/ mol. -300 kJ/mol and - 1300 kJ/mol, respectively. The standard enthalpy of combustion per gram of glucose at 25°C is **(+4, -1)**

a. #ERROR!

b. - 2900 kJ

c. - 16.11 kJ

d. #ERROR!

---

29. When an electric current is passed through acidified water, $112\,mL$ of hydrogen gas at N.T.P. was collected at the cathode in 965 seconds. The current passed, in ampere, is : **(+4, -1)**

a. 1

b. 0.5

c. 0.1

d. 2

---

30. Galvanization is applying a coating of : **(+4, -1)**

a. Pb

b. Cr

c. Cu

d. Zn

Answers

1. Answer: 18 - 18

Explanation:

The potential of a hydrogen electrode in a solution is determined by the Nernst equation. For the hydrogen electrode, the reaction is:
$\mathrm{H_2}(g) \rightleftharpoons 2\mathrm{H^+}(aq) + 2e^-$
The Nernst equation is:
$E = E^\circ - \frac{2.303RT}{nF} \log\left(\frac{[\mathrm{H^+}]^2}{P_{\mathrm{H_2}}}\right)$
For a standard hydrogen electrode, $E^\circ = 0$ V, the pressure of $\mathrm{H_2}$ gas is 1 atm, and $n = 2$. At a given \text{pH}, $[\mathrm{H^+}] = 10^{-\mathrm{pH}}$. Therefore, the equation simplifies to:
$E = -\frac{2.303RT}{F} \frac{\log(10^{-\mathrm{pH}})^2}{2}$
This further simplifies to:
$E = -\frac{0.059}{1}\ \mathrm{V} \times \mathrm{pH}$
Given $\mathrm{pH} = 3$, substitute into the equation:
$E = -0.059 \times 3\ \mathrm{V}$
Thus,
$E = -0.177\ \mathrm{V}$
Expressed as $-17.7 \times 10^{-2}\ \mathrm{V}$, this value confirms it is within the specified range of 18,18 when considering absolute value: $17.7 \approx 18$.
Therefore, the potential of the electrode is:
$-17.7 \times 10^{-2}\ \mathrm{V}$.

---

2. Answer: 4 - 4

Explanation:

A. E_{cell} is an intensive parameter.

- This statement is **correct**. Intensive properties are independent of the amount of substance present.
- E_{cell} depends on the nature of the redox reaction, concentrations, and temperature but not on the size of the electrochemical cell.

B. A negative E° means that the redox couple is a stronger reducing agent than the $\mathrm{H^+}/\mathrm{H_2}$ couple.

- This statement is **correct**. A negative standard electrode potential (E°) indicates that the redox couple has a greater tendency to lose electrons (be oxidized) compared to the

standard hydrogen electrode ($E^\circ = 0\,\text{V}$).
- Thus, the redox couple with a negative E° is a stronger reducing agent.

C. The amount of electricity required for oxidation or reduction depends on the stoichiometry of the electrode reaction.

- This statement is **correct**. The amount of electricity required is proportional to the number of electrons transferred in the balanced half-reaction, as described by Faraday's laws of electrolysis.

D. The amount of chemical reaction that occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte.

- This statement is **correct**. This is a direct statement of Faraday's first law of electrolysis, which states that the chemical reaction at the electrode is proportional to the electric charge passed.

Final Answer:

All four statements (A, B, C, and D) are correct.

---

3. **Answer: a**

Explanation:

- Metal cations with negative values of reduction potential ($\text{M}^{3+}/\text{M}^{2+}$) or positive values of oxidation potential (\text{M}^{2+}/\text{M}^{3+}\)) can reduce H^+ ions and liberate H_2 gas from dilute acid.
- For the given metals:
  V^{2+} has a reduction potential of $-0.26\,\text{V}$.
  Cr^{2+} has a reduction potential of $-0.41\,\text{V}$.
- Both values are negative, meaning V^{2+} and Cr^{2+} can reduce H^+ ions to liberate H_2 gas.
Final Answer: (3) V^{2+} and Cr^{2+}.

---

4. **Answer: 3 - 3**

Explanation:

The value of a is 3.

---

5. **Answer: 2 - 2**

Explanation:

The correct answer is : 2
.712 = .770 - $\frac{.058}{2}\log[\frac{Fe^{2+}}{Fe^{3+}}]^2$
-.058 = .-058 $\log\frac{[Fe^{2+}]}{[Fe^{3+}]}$
$\frac{Fe^{2+}}{Fe^{3+}} = 10 = t$
$\frac{t}{5} = 2$

---

6. **Answer: 16 - 16**

Explanation:

The correct answer is 16
$Sn \rightarrow Sn^{2+} + 2e - E_1^\circ = 0.140\ V$
$Sn^{4+} + 4e^- \rightarrow Sn\ E_2^\circ = 0.010\ V$
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}\ E_{cell}^\circ$
$E_{cell}^\circ = \frac{n_2E_2^\circ + n_1E_1^\circ}{n} = \frac{4(0.010)+2(0.140)}{2}$
$E_{cell}^\circ = 0.16\ V = 16 \times 10^{-2}\ V$

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

7. **Answer: 51 - 51**

Explanation:

The correct answer is 51

$Pt(s)|H_2(g)\ H^+(aq)||Ag^+(aq)|Ag(s)$

$\frac{1}{2}H + 2 + Ag^+ \rightarrow Ag + H^+$

n = 1

E^{O}_{Cell} = 0.5332

$\Delta G^o = -nFE^o = -1 \times 96500 \times 0.5332$

$= -51.453$ kJ/mole ≃ 51 kJ/mole

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here

- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

8. **Answer: 14 - 14**

Explanation:

The limiting molar conductivity of AgI,

$\Lambda^0_m(AgI) = \Lambda^0_m(NaI) + \Lambda^0_m(AgNO_3) - \Lambda^0 m(NaNO_3)$

$\Lambda^0_m(AgI) = 12.7 + 13.3–12.0$

$\Lambda^0_m(AgI) = 26–12$

$\Lambda^0_m(AgI) = 14\ mSm^2\ mol^{-1}$

So, the answer is $14\ mSm^2\ mol^{-1}$.

---

9. **Answer: 7 - 7**

Explanation:

The correct answer is 7

$Q = \frac{[H^+]^2}{[Cu^{+2}]pH_2} = \frac{10^{-6}}{C} pH_2 = 1$

$E = E^{\circ}_{cell} - \frac{0.06}{n} logQ$

$0.31 = 0.34 - \frac{0.06}{2} log\ \frac{10^{-6}}{C}$

$log\ \frac{10^{-6}}{C} = 1$

C = 10^{-7} M

x = 7

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

10. **Answer: 3 - 3**

Explanation:

For Fe_3O_4, $x = +\frac{8}{3}$
Where, x is oxidation state of Fe.
$Fe_3O_4 + 8H + +8e^- \rightarrow 3Fe + 4H_2O$
Charge required $= \frac{8}{3} \times F$
$= \frac{8F}{3}$
$\simeq 3F$
So, the answer is $3F$.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

11. Answer: 6 - 6

Explanation:

$\overset{+6}{C}r_2O_7^{2-} \rightarrow 2Cr^{3+}$

$\because$ Each Cr is converting from $+6$ to $+3$

$\therefore$ 6 faradays of charge is required.

So, the answer is 6.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here

- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

12. Answer: 3 - 3

Explanation:

$$A_2X_3 \rightleftharpoons 2A + 3x$$
$$2S \quad 3S$$

$K_{sp} = (2s)^2(3s)^3$

$= 1.1 \times 10^{-23}$

$S \approx 10^{-5}$

For sparingly soluble salts

$\wedge m = \wedge^{\circ} m$

$\wedge m = \frac{k}{S \times 10^3}$

$= \frac{3 \times 10^{-5}}{10-5 \times 10^{-3}}$

$= 3 \times 10^{-3} Sm^2 mol^{-1}$

So, the answer is 3.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical

cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

13. **Answer: 4 - 4**

Explanation:

$$A : Zn \rightarrow Zn^{2+} + 2e^-$$

$$C : Sn^{x+} + xe^- \rightarrow Sn$$

$$E^\circ_{Cell} = E^\circ_{Zn|Zn^{2+}} + E^\circ_{Sn^{x+}|Sn}$$

$$\Rightarrow 0.763 + 0.008 = 0.771\ V$$

From Nernst equation,

$$E_{Cell} = E^\circ_{Cell} \frac{-2.303RT}{nF} \log Q$$

$$0.801 = 0.771 - \frac{0.06}{n} \log 10^{-2}$$

$$0.03 = \frac{0.06}{n} \times 2$$

$$n = 4$$

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

14. Answer: d

Explanation:

Ants produces formic acid in their venom gland.

(a)

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

15. Answer: a

Explanation:

Explanation:
Let the equal weights of methane and oxygen be grams.No. of moles is given as:Number of moles $= \frac{\text{Given Mass}}{\text{Molar mass}}$Molar mass of $_2 = 32$ $^{-1}$ Molar mass of $_4 = 16$ $^{-1}$ Number of moles of oxygen, $_2 = \frac{}{32}$And, number of moles of methane, $_4 = \frac{}{16}$Mole fraction is given as: Mole fraction of $_2 = \frac{1}{3}$According to Dalton's law of partial pressure:The fraction of total pressure exerted by oxygen = Mole fraction of $_2$ Therefore, the fraction of total pressure exerted by $_2$ is $\frac{1}{3}$.Hence, the correct option is (A).

---

16. Answer: b

Explanation:

Explanation:
For the specific heat capacity to be 0, heat supplied must be 0 . That is Q = 0.Thus W = ΔU
$W = \int -PdV = \int aV^b\,dV = -\frac{a}{b+1}(V_2^{b+1} - V_1^{b+1})$Since,$P = aV^b$ $W = -\frac{P_2V_2 - P_1V_1}{b+1}$Also,
$\Delta U = \frac{nR}{-1}(T_2 - T_1) = \frac{P_2V_2 - P_1V_1}{-1}$Equating the two, we get,b + 1 = 1 − Thus b = − Hence, the correct option is (B).

---

17. Answer: a

Explanation:

Explanation:
Since hydrocarbon 'B' decolourise $_2$ water as well as alkaline $_4$ solution, so it is an unsaturated hydrocarbon.Since 'B' takes only one mole of $_2$, it contains only one double bond. Hence, compound 'B' is ethene. $_{2\ (\ )}{}_4 + {}_2\frac{}{\text{high}}{}_2{}_6\ \frac{\text{1 bromo 2 methyl propane}}{\text{2 bromo 2 methyl propane}} = \frac{\text{no. of 1 H}}{\text{no. of 2 H}} \times \frac{\text{reactivity of 1}}{\text{reactivity of 2}}$
$= \frac{9}{1} \times \frac{1}{3.8} = 9:3.8$(Because relative ratio of abstraction per -atom is 5: 3.8: 1 for 3 , 2 and 1 − respectively.)Compound 'B' decolourise bromine water as well as alkaline $_4$ solution as

follows $_{(\ )}^{2}{}_{4}$ + 4 $_{2}$ + [ ] ^{Alk} $_{4}$ $_{|2}^{2}$ Ethyl alcohol on heating with conc sulphuric acid gives ethene, thus the organic liquid 'A' is ethyl alcohol. $_{(ethyl\ alcohol)}^{2,5,}$ ^{2} $_{(\ )}^{4}$ $_{,4}^{2,}$ + $_{2}$ Hence, the correct option is (A).

---

18. Answer: b

Explanation:

Explanation:
Given:Wavelength absorbed, λabsorbed = 355 nmλ1 (emitted) = 680 nmWe have to find the wavelength of the second emission.Let it be λ2.We know that;According to Planck's quantum theory of radiation :E = hν ..... (i)where, h = Planck's constantν = FrequencyFrequency is given by: = – ..... (ii)where, c = Speed of lightλ = Wavelength of lightSubstituting the value of frequency in equation (i), we getE = — ..... (iii) Energy of absorbed photon will be equal to sum of the energies of the emitted photons. i.e.——— = $\frac{}{1}$ + $\frac{}{2}$ $\frac{1}{(\ \ \ \ \ )}$ = $\frac{1}{1}$ + $\frac{1}{2}$ ..... (iv)Substituting all the values in equation (iv), we get$\frac{1}{355}$ = $\frac{1}{680}$ + $\frac{1}{2}$ $\frac{1}{2}$ = $\frac{1}{355}$ − $\frac{1}{680}$ = $\frac{680-355}{241400}$ $\frac{1}{2}$ = $\frac{325}{241400}$ $_{2}$ = $\frac{241400}{325}$ = 742.769nm 743nmHence, the correct option is (B).

---

19. Answer: c

Explanation:

Statement A: "During charging of the battery, $PbSO_4$ on the anode is converted into PbO_2.
Analysis: This statement is incorrect. During the charging process, lead sulfate ($PbSO_4$) at the anode is converted into lead (Pb) and not lead dioxide (PbO_2). Therefore, this statement is false.

Statement B: "During charging of the battery, $PbSO_4$ on the cathode is converted into PbO_2.
Analysis: This statement is also incorrect. During charging, the lead sulfate ($PbSO_4$) at the cathode is converted into lead dioxide (PbO_2). Therefore, this statement is true.

Statement C: "Lead storage battery consists of a grid of lead packed with PbO_2 as anode.
Analysis: This statement is incorrect. In a lead storage battery, the anode is made of lead (Pb), while the cathode is made of lead dioxide (PbO_2). Therefore, this statement is false.

Statement D: "Lead storage battery has a 38% solution of sulfuric acid as an electrolyte.
Analysis: This statement is correct. A lead storage battery uses a 35-38% solution of sulfuric acid (H_2SO_4) as the electrolyte. Therefore, this statement is true.

Conclusion:
The correct statements are **B** and **D**.

Final Answer:
- Correct statements: **B and D**

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

20. **Answer: 917 - 917**

Explanation:

The Nernst equation for the reaction $\mathrm{Cr_2O_7^{2-}} + 14\mathrm{H^+} + 6e^- \rightarrow 2\mathrm{Cr^{3+}} + 7\mathrm{H_2O}$ is given by:

$$E = E^\circ - \frac{0.059}{n} \log\left(\frac{[\text{Products}]}{[\text{Reactants}]}\right)$$

Given data: - $E^\circ = 1.330\,\text{V}$, $n = 6$, $\text{pH} = 3$, - $[\mathrm{H^+}] = 10^{-\text{pH}} = 10^{-3}$, - $[\mathrm{Cr_2O_7^{2-}}] = \frac{10}{1000} = 0.01\,\text{M}$, - $[\mathrm{Cr^{3+}}] = \frac{100}{1000} = 0.1\,\text{M}$. Substitute into the Nernst equation:

$$E = 1.330 - \frac{0.059}{6} \log\left(\frac{(0.1)^2}{(0.01)(10^{-3})^{14}}\right)$$

$$E = 1.330 - \frac{0.059}{6} \log\left(\frac{0.01}{0.01 \times 10^{-42}}\right)$$

$$E = 1.330 - \frac{0.059}{6} \log(10^{42})$$

$$E = 1.330 - \frac{0.059}{6} \times 42$$

$$E = 1.330 - 0.413 = 0.917\,\text{V}$$

Since $E = x \times 10^{-3}$, we have $x = 917$.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here

- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

21. **Answer: 25 - 25**

Explanation:

$\Lambda_m = \frac{\kappa \times 1000}{M}$
$\Lambda_m = \frac{1}{\rho} \times \frac{1000}{M}$
$\frac{1}{5 \times 10^{-3}} \times \frac{1000}{0.8}$
So , correct answer is $25 \times 10^4\, \Omega^{-1}\, cm^{-2}\, mol^{-1}$

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell

- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

22. Answer: 14 - 14

Explanation:

The dissociation of AgBr is:

$$\mathrm{AgBr}(s) \rightleftharpoons \mathrm{Ag}^{+}(\mathrm{aq}) + \mathrm{Br}^{-}(\mathrm{aq}),$$

$$K_{\mathrm{sp}} = [\mathrm{Ag}^{+}][\mathrm{Br}^{-}] = 4.9 \times 10^{-13}.$$

Let the solubility of AgBr be s mol/L. Then, $[\mathrm{Ag}^{+}] = s$ and $[\mathrm{Br}^{-}] = s$.

$$s^2 = 4.9 \times 10^{-13}, \quad s = \sqrt{4.9 \times 10^{-13}} = 7 \times 10^{-7}\,\mathrm{M}.$$

Since $1\,\mathrm{L}$ of saturated AgBr solution is taken, the concentration of Ag^{+} and Br^{-} from AgBr are both $7 \times 10^{-7}\,\mathrm{M}$. We are adding $1 \times 10^{-5}\,\mathrm{M}$ $AgNO_3$.
The Ag^{+} from $AgNO_3$ will be significantly greater than the Ag^{+} from AgBr, so we can

approximate the total $[Ag^+]$ as $1 \times 10^{-5}\,M$.
The common ion effect will suppress the solubility of AgBr, so the $[Br^-]$ remains approximately $7 \times 10^{-7}\,M$. The $[NO_3^-]$ will be $1 \times 10^{-5}\,M$.
Conductivity (κ)
The formula for conductivity is:

$$\kappa = \sum \lambda_i c_i.$$

Substitute the values:

$$\kappa = \lambda_{Ag^+}[Ag^+] + \lambda_{Br^-}[Br^-] + \lambda_{NO_3^-}[NO_3^-].$$

$$\kappa = (6 \times 10^{-3})(1 \times 10^{-5}) + (8 \times 10^{-3})(7 \times 10^{-7}) + (7 \times 10^{-3})(1 \times 10^{-5}).$$

$$\kappa = 6 \times 10^{-8} + 5.6 \times 10^{-9} + 7 \times 10^{-8}.$$

$$\kappa \approx 13.56 \times 10^{-8} = 14 \times 10^{-8}\,S\,m^{-1}.$$

Final Answer:
The conductivity is $14 \times 10^{-8}\,S\,m^{-1}$.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

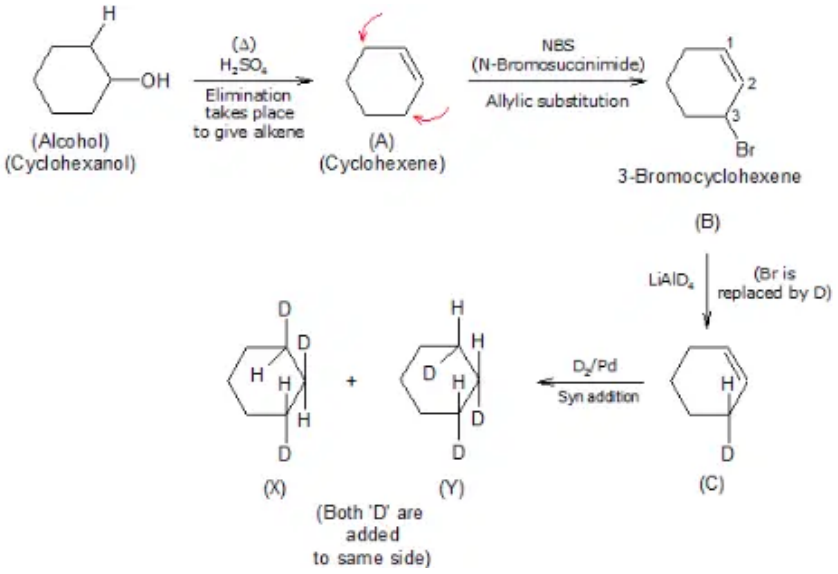
- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

23. Answer: d

Explanation:

Explanation:
When cyclohexanol is treated with conc. sulphuric acid , H_2SO_4, and heated, dehydration of the alcohols take place and cyclohexene is formed.Further, cyclohexene on reaction with N-bromosuccinimide (NBS) undergoes allylic substitution, 3-bromo cyclohexene (B) is formed.Lithium aluminium deuteride, $LiAlD_4$ reduces (B) into (C) [only 'Br' is replaced by 'D' atom]. (C) on reduction with D_2/Pd undergoes syn addition to give two stereoisomers (X) and (Y).The set of reactions involved are:



Hence, the correct option is (D).

---

24. Answer: a

Explanation:

Explanation:

Average Rate $= \frac{1}{2}\{-\frac{\Delta[N_2O_5]}{\Delta}\} = -\frac{1}{2}[\frac{(2.08-2.33)molL^{-1}}{184\ min}] = 6.79\times10^{-4}\ mol\ L^{-1}\ /\ min$

$= (6.79\times10^{-4}\ mol\ L^{-1}\ min^{-1})\times(60\ min\ /\ 1\ h) = 4.07\times10^{-2}\ mol\ L^{-1}\ /\ h$

$= 6.79\times10^{-4}\ mol\ L^{-1}\times1\ min\ /\ 60\ s = 1.13\times10^{-5}\ mol\ L^{-1}\ s^{-1}$ It may be remembered that,Rate $= \frac{1}{4}\{\frac{\Delta[NO_2]}{\Delta}\}\frac{\Delta[NO_2]}{\Delta} = 6.79\times10^{-4}\times4\ mol\ L^{-1}\ min^{-1} = 2.72\times10^{-3}\ mol\ L^{-1}\ min^{-1}$ Hence, the correct option is (A).

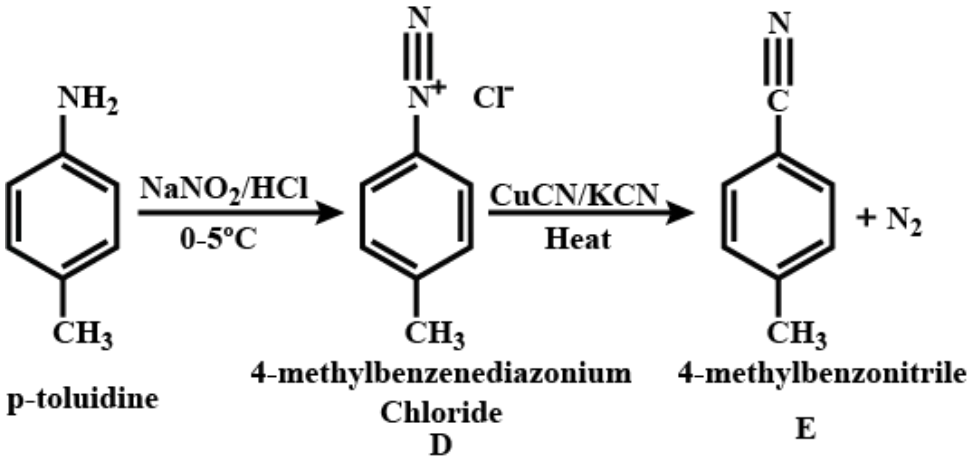
---

25. Answer: c

Explanation:

Explanation:

Diazotization of p-toluidine with a cold solution of sodium nitrite and HCl gives 4-methyl benzene diazonium chloride (compound D). On heating with CuCN and KCN, the diazonium group is replaced with the cyano group to obtain 4-methyl benzonitrile (compound E).



Hence, the correct option is (C).

---

26. Answer: d

Explanation:

Explanation:
As $_3$ is added to the solution, KCl will be displaced according to the following reaction.
$AgNO_3$ ( ) + KCl( ) AgCl(s) + KNO_3 (aq)For every mole of KCl displaced from solution, one mole of $_3$ comes in solution resulting in almost constant conductivity. As the endpoint is reached, added $_3$ remain in solution increasing ionic concentration, thus conductivity increases.Hence, the correct option is (D).

---

27. Answer: 0.52 - 0.52

Explanation:

Explanation:
We know that, Δ = −
So for the reaction, $^{2+}$ + 2 $^{-}$ Δ = 2 × × 0.337 ... (1)
For the reaction, $^{+}$ $^{2+}$ + $^{-}$Δ = 1 × × 0.153 ... (2)
So adding both the equations, we get
$^{+}$ + $^{-}$;
ΔG∘=−0.521 F
Δ = −
Δ = 0.52
Hence, the correct answer is 0.52 .

Concepts:

1. Galvanic Cells:

Galvanic cells, also known as voltaic cells, are electrochemical cells in which spontaneous oxidation-reduction reactions produce electrical energy. It converts chemical energy to electrical energy.

It consists of two half cells and in each half cell, a suitable electrode is immersed. The two half cells are connected through a salt bridge. The need for the salt bridge is to keep the oxidation and reduction processes running simultaneously. Without it, the electrons liberated at the anode would get attracted to the cathode thereby stopping the reaction on the whole.

Working Principle Of Galvanic Cell:

1. Take two beakers containing electrolytic solutions of copper sulphate and zinc sulphate are taken. It is connected via a salt bridge containing an aqueous solution of potassium chloride.
2. Zinc and copper electrodes are immersed in the respective electrodes and connected through a voltmeter to measure the electrical potential.
3. Zinc which acts as the anode readily undergoes an oxidation process and acquires a negative charge.
4. The electrons travel through the salt bridge and undergo a reduction process at the copper cathode.
5. Thus the cathode would acquire a positive charge.
6. This flow of electrons from the anode to the cathode induces a flow of electric current in the opposite direction which shall be measured by the voltmeter.

Types of Voltaic Cell:

- **Primary Cell**
  - Dry Cell
  - Mercury Cell
  - Alkaline Cell
- **Secondary Cell**
  - Nickel-Cadmium Cell
  - Lead-Acid Cell
  - Lithium-Ion Cell

---

28. Answer: c

Explanation:

PLAN A CH ° (Standard heat of combustion) is the standard enthalpy change when one mole of the substance is completely oxidised. Also standard heat of formation (A fH°) can be taken as the standard of that substance $H^{\circ}_{CO_2} = \Delta_f H^{\circ}(CO_2) = -400kJmoI^{-1}$ $H^{\circ}_{H_2O} = \Delta_f H^{\circ}(H_2O) = -300kJmoI^{-1}$ $H^{\circ}_{glucose} = \Delta_f H^{\circ}(glucose) = -1300kJmoI^{-1}$ $H^{\circ}_{O_2} = \Delta_f H^{\circ}(O_2) = 0.00$ $C_6H_12O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$ $\Delta_c H^{\circ}(glucose) = 6[\Delta_f H^{\circ}(CO_2) + \Delta_f H^{\circ}(H_2O)]$ $-[\Delta_f H^{\circ}(C_6H_12O_6) + 6\Delta_f H^{\circ}(O_2)]$ $= 6[-400 - 300] - [-1300 + 6 \times 0]$ $= -2900kJ\,moI^{-1}$ Molar mass of $C_6H_{12}O_6 = 180gmol^{-1}$ Thus, standard heat of combustion of glucose per gram $= \frac{-2900}{180} = -16.11kJg^{-1}$ To solve such problem, students are advised to keep much importance in unit conversion. As here, value of R $(8.314JK^{-1}mol^{-1})$ in $JK^{-1}mol^{-1})$ must be converted into kJ by dividing the unit by 1000.

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

29. **Answer: a**

Explanation:

At cathode: $2H^+(aq) + 2e^- \rightarrow H_2(g)$

At NTP, $22.4\,L$ or $22400\,mL$ of $H_2 = 1\,mol$ of H_2
$112\,mL$ of $H_2 = \frac{1}{22400} \times 112 = 0.005\,mol$ of H_2

We know $n = \frac{I \times t}{F}$
$0.005 = \frac{I \times 965}{2 \times 96500} \Rightarrow I = 1\,A$

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here
- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.

---

30. Answer: d

Explanation:

Galvanization is applying a coating of zinc.

$E^0_{Pb^{+2}/Pb} = -0.13\,V$
$E^0_{Cr^{+3}/Cr} = -0.74\,V$
$E^0_{Cu^{+2}/Cu} = 0.34\,V$
$E^0_{Zn^{+2}/Zn} = -0.76\,V$

Concepts:

1. Electrochemical Cells:

An electrochemical cell is a device that is used to create electrical energy through the chemical reactions which are involved in it. The electrical energy supplied to electrochemical cells is used to smooth the chemical reactions. In the electrochemical cell, the involved devices have the ability to convert the chemical energy to electrical energy or vice-versa.

Classification of Electrochemical Cell:

Cathode

- Denoted by a positive sign since electrons are consumed here
- A reduction reaction occurs in the cathode of an electrochemical cell
- Electrons move into the cathode

Anode

- Denoted by a negative sign since electrons are liberated here

- An oxidation reaction occurs here
- Electrons move out of the anode

Types of Electrochemical Cells:

Galvanic cells (also known as Voltaic cells)

- Chemical energy is transformed into electrical energy.
- The redox reactions are spontaneous in nature.
- The anode is negatively charged and the cathode is positively charged.
- The electrons originate from the species that undergo oxidation.

Electrolytic cells

- Electrical energy is transformed into chemical energy.
- The redox reactions are non-spontaneous.
- These cells are positively charged anode and negatively charged cathode.
- Electrons originate from an external source.