Exercise – I (JEE-Main Pattern)

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

1. Which of the following will increase the voltage of the cell with the following cell reaction

$Sn_{(s)} + 2Ag^{\oplus}_{(aq)} \rightarrow Sn^{2\oplus}_{(aq)} + 2Ag_{(s)}$

(1) Decrease in the concentration of $Ag^{\oplus}$ ions (2) Increase in the concentration of $Sn^{2\oplus}$ ions
(3) Increase in the concentration of $Ag^{\oplus}$ ions (4) (1) & (2) both

CEC001

2. The standard emf for the cell reaction,

$Zn_{(s)} + Cu^{2\oplus}_{(aq)} \longrightarrow Zn^{2\oplus}_{(aq)} + Cu_{(s)}$ is 1.10 volt at 25 °C. The emf for the cell reaction when 0.1 M $Cu^{2\oplus}$ and 0.1 M $Zn^{2\oplus}$ solution are used at 25°C is :

(1) 1.10 volt (2) 0.110 volt
(3) –1.10 volt (4) –0.110 volt

CEC002

3. In a cell that utilises the reaction,

$Zn(s) + 2H^{\oplus}(aq) \longrightarrow Zn^{2\oplus}(aq) + H_2(g)$ addition of H_2SO_4 to cathode compartment, will :

(1) increase the E_{cell} and shift the equilibrium to the right
(2) lower the E_{cell} and shift the equilibrium to the right
(3) lower the E_{cell} and shift the equilibrium to the left
(4) increase the E_{cell} and shift the equilibrium to the left

CEC003

4. The Gibbs energy for the decomposition of Al_2O_3 at 500°C is as follows

$\frac{2}{3}Al_2O_3(s) \longrightarrow \frac{4}{3}Al(s) + O_2(g)$, $\Delta_rG = +966$ kJ mol^{-1}

The potential difference needed for electrolytic reduction of Al_2O_3 at 500°C is at least :-

(1) 5.0 V (2) 4.5 V
(3) 3.0 V (4) 2.5 V

CEC004

5. The amount of an ion discharged during electrolysis is not directly proportional to :

(1) resistance (2) time
(3) current (4) electrochemical equivalent of the element

CEC005

6. Number of electrons involved in the electrodeposition of 63.5 g of Cu from a solution of $CuSO_4$ is :
($N_A = 6.02 \times 10^{23}$)(atomic wt. of Cu = 63.5g)
(1) 6.02×10^{23} (2) 3.01×10^{23}
(3) 12.04×10^{23} (4) 6.02×10^{22}

CEC006

7. When one coulomb of electricity is passed through an electrolytic solution the mass deposited on the electrode is equal to :
(1) equivalent weight (2) molecular weight
(3) electrochemical equivalent (4) one gram

CEC007

8. A current of 9.65 amp. passing for 16 minute 40 sec through a molten tin salt deposits 5.95 g of tin. The oxidation state of the tin in the salt is : (at. wt of Sn = 119)
(1) +4 (2) +3
(3) +2 (4) +1

CEC008

9. The time required for a current of 3 amp. to decompose electrolytically 18 g of H_2O is:
(1) 18 hour (2) 36 hour
(3) 9 hour (4) 18 seconds

CEC009

10. An ion is reduced to the element when it absorbs 6×10^{20} electrons. The number of gm equivalents of the ion is :
(1) 0.10 (2) 0.01
(3) 0.001 (4) 0.0001

CEC010

11. How many coulombs of electric charge are required for the oxidation of 1 mole of H_2O to O_2 ?
(1) 9.65×10^4 C (2) 4.825×10^5 C
(3) 1.93×10^5 C (4) 1.93×10^4 C

CEC011

12. The time required to coat a metal surface of 80 cm^2 with 5×10^{-3} cm thick layer of silver (density 1.08 g cm^{-3}) with the passage of 9.65A current through a silver nitrate solution is :
(1) 10 sec. (2) 40 sec.
(3) 30 sec. (4) 20 sec.

CEC012

13. Which of the following solution has highest resistance?
(1) 1N NaCl (2) 0.05N NaCl
(3) 2N NaCl (4) 0.1N NaCl

CEC013

14. Variation of molar conductance of an electrolytic solution with temperature is that it
(1) Increases with increase of temperature (2) Decreases with increase of temperature
(3) First increases then decreases (4) Is not affected by temperature

CEC014

15. Which pure substance will not conduct electricity?

(1) Molten NaCl (2) Molten KOH

(3) Liquefied HCl (4) Liquid Hg

CEC015

16. The equivalent conductivity (in Ω^{-1} cm^2 eq^{-1}) of 1.0 M – H_2SO_4 solution of specific conductance 2.6×10^{-1} Ω^{-1} cm^{-1}, is

(1) 1.3×10^2 (2) 6.5×10^1

(3) 1.3×10^{-1} (4) 2.6×10^2

CEC016

17. The molar conductance of a 0.01 M solution of acetic acid was found to be 16.30 Ω^{-1} cm^2 mol^{-1} at 25°C. The ionic conductance of hydrogen and acetate ions at infinite dilution are 349.8 and 40.9 Ω^{-1} cm^2 mol^{-1}, respectively, at the same temperature. What percentage of acetic acid is dissociated at this concentration ?

(1) 0.04172% (2) 4.172%

(3) 41.72% (4) 0.4172%

CEC017

18. The distance between two electrodes of a cell 2.5 cm and area of each electrode is 5 cm^2. The cell constant is

(1) 0.5 m^{-1} (2) 12.5 cm^3

(3) 2.0 cm (4) 50 m^{-1}

CEC018

19. Calculate the ionic product of water at 25° C from the following data :

Conductivity of water = 5.5×10^{-6} mho m^{-1}

$\lambda^\circ_{H^\oplus}$ = 0.035 mho m^2 mol^{-1}

$\lambda^\circ_{OH^\ominus}$ = 0.020 mho m^2 mol^{-1}

(1) 2×10^{-14} M^2 (2) 1×10^{-7} M^2

(3) 1×10^{-8} M^2 (4) 1×10^{-14} M^2

CEC019

20. Calculate K_a of acetic acid if its 0.05 M solution has molar conductivity of 7.814×10^{-4} Ω^{-1} m^2 mol^{-1} at 25°C. Given: Λ°_m for CH_3COOH = 3.907×10^{-2} Ω^{-1} m^2 mol^{-1}.

(1) 2×10^{-5} (2) 1.8×10^{-5}

(3) 4×10^{-4} (4) 0.02

CEC020

SECTION-B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +4, if only correct answer is given.
  Zero Marks : 0, if no answer is given.
  Negative Marks : -1 for incorrect answer

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1. For the cell reaction $2Ce^{4\oplus} + Co \longrightarrow 2Ce^{3\oplus} + Co^{2\oplus}$

E^{o}_{cell} is 1.89 V. If $E^{o}_{Co^{2\oplus}|Co}$ is – 0.28 V, what is the value of $E^{o}_{Ce^{4\oplus}|Ce^{3\oplus}}$?

CEC021

2. Determine the standard reduction potential for the half reaction :

$Cl_2\,(g) + 2e^{\ominus} \longrightarrow 2Cl^{\ominus}\,(aq)$

Given $Pt^{2\oplus}(aq) + 2Cl^{\ominus}\,(aq) \longrightarrow Pt\,(s) + Cl_2$, $E^{o}_{Cell} = -0.15$ V

$Pt^{2\oplus}(aq) + 2e^{\ominus} \rightarrow Pt\,(s)$ $E^{\circ} = 1.20$ V

CEC022

3. If $E^{o}_{Fe^{2\oplus}|Fe} = -0.44$ V, $E^{o}_{Fe^{3\oplus}|Fe^{2\oplus}} = 0.77$ V. Calculate $E^{o}_{Fe^{3\oplus}|Fe} \times (-3)$.

CEC023

4. The reduction potential of hydrogen electrode when placed in a buffer solution is found to be – 0.413V. The pH of the buffer is –

CEC024

5. Calculate the EMF of the following cell

$Zn \mid Zn^{2\oplus}\,(0.01M) \,||\, Zn^{2\oplus}\,(0.1\ M) \mid Zn$

at 298 K.

CEC025

6. Calculate pH using the following cell :

$\underset{1\ atm}{Pt\,(H_2)} \mid H^{\oplus}(xM) \,||\, H^{\oplus}(1M) \mid \underset{1\ atm}{Pt(H_2)}$ if $E_{cell} = 0.2364$ V.

CEC026

7. If 0.224 litre of H_2 gas is formed at the cathode, how much O_2 gas is formed at the anode under identical conditions?

CEC027

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

CEC028

9. The conductivity of pure water in a conductivity cell with electrodes of cross-sectional area 4 cm^2 and 2 cm apart is 8×10^{-7} S cm^{-1}.
The value of current that would flow through the cell under an applied potential difference of 1 volt is 1.6×10^{-X} amp. The correct value of X is :

CEC029

10. The value of Λ_m^∞ for HCl, NaCl and CH_3CO_2Na are 425, 125 and 100 S cm^2 mol^{-1} respectively. If the equivalent conductivity of the given acetic acid is 48 at 25° C, calculate its percentage of dissociation.

CEC030

Exercise – II (JEE-Main PYQs)

1. Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S m^{-1}. The resistance of 0.5 M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5 M solution of the electrolyte in S m^2 mol^{-1} is : **[JEE (Main) 2014]**

(1) 5×10^3 (2) 5×10^2 (3) 5×10^{-4} (4) 5×10^{-3}

CEC031

2. At 298 K, the standard reduction potentials are 1.51 V for $MnO_4^{\ominus}|Mn^{2\oplus}$, 1.36 V for $Cl_2|Cl^{\ominus}$, 1.07 V for $Br_2 | Br^{\ominus}$, and 0.54 V for $I_2|I^{\ominus}$. At pH = 3, permanganate is expected to oxidize $\left(\frac{RT}{F} = 0.059\,V\right)$:– **[JEE (Main) 2015]**

(1) $Cl^{\ominus}$ and $Br^{\ominus}$ (2) $Cl^{\ominus}$, $Br^{\ominus}$ and $I^{\ominus}$ (3) $Br^{\ominus}$ and $I^{\ominus}$ (4) $I^{\ominus}$ only

CEC032

3. What will occur if a block of copper metal is dropped into a beaker containing a solution of 1M $ZnSO_4$ **[JEE (Main) 2016]**

(1) The copper metal will dissolve and zinc metal will be deposited
(2) No reaction will occur
(3) The copper metal will dissolve with evolution of oxygen gas
(4) The copper metal will dissolve with evolution of hydrogen gas

CEC033

4. Oxidation of succinate ion produces ethylene and carbon dioxide gases. On passing 0.2 Faraday electricity through the aqueous solution of potassium succinate, the total volume of gases (at both cathode and anode) at 1 atm and 273 K is : **[JEE (Main) 2016]**

(1) 8.96 L (2) 2.24 L (3) 4.48 L (4) 6.72 L

CEC034

5. What is the standard reduction potential (E°) for $Fe^{3\oplus} \rightarrow Fe$?
Given that :

$Fe^{2\oplus}(aq) + 2e^{\ominus} \rightarrow Fe(s)$; $E^{o}_{Fe^{2\oplus}/Fe} = -0.47$ V

$Fe^{3\oplus}(aq) + e^{\ominus} \rightarrow Fe^{2\oplus}(aq)$; $E^{o}_{Fe^{3\oplus}/Fe^{2\oplus}} = +0.77$ V **[JEE (Main) 2017]**

(1) +0.30 V (2) +0.057 V (3) –0.057 V (4) –0.30 V

CEC035

6. To find the standard potential of $M^{3\oplus}|M$ electrode, the following cell is constituted: $Pt|M|M^{3\oplus}(0.001\ mol\ L^{-1})//Ag^{\oplus}(0.01\ mol\ L^{-1})|Ag$.
The emf of the cell is found to be 0.421 volt at 298 K. The standard potential of half reaction $M^{3\oplus}(aq) + 3e^{\ominus} \rightarrow M(s)$ at 298 K will be : **(Given $E^{\ominus}_{Ag^{\oplus}/Ag}$ at 298 K = 0.80 Volt)** **[JEE (Main) 2017]**

(1) +0.32 V (2) +0.057 V (3) –0.057 V (4) –0.32 V

CEC036

7. How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn 27.6 g of diborane ?
(Atomic weight of B = 10.8 u) **[JEE (Main) 2017]**

(1) 0.8 hours (2) 3.2 hours (3) 1.6 hours (4) 6.4 hours

CEC037

8. When 9.65 ampere current was passed for 1.0 hour into nitrobenzene in acidic medium, the amount of p-aminophenol produced is :- **[JEE (Main) 2018]**

(1) 10.9 g (2) 98.1 g

(3) 109.0 g (4) 9.81 g

CEC038

9. For the cell Zn(s) | $Zn^{2\oplus}$(aq) || $M^{x\oplus}$ (aq) | M(s), different half cells and their standard electrode potentials are given below :

$M^{x\oplus}(aq)/M(s)$	$Au^{3\oplus}(aq)/Au(s)$	$Ag^{\oplus}(aq)/Ag(s)$	$Fe^{3\oplus}(aq)/Fe^{2\oplus}(aq)$	$Fe^{2\oplus}(aq)/Fe(s)$
$E^{o}_{M^{x\oplus}/M^{(v)}}$	1.40	0.80	0.77	–0.44

If $E^{o}_{Zn^{2\oplus}/Zn} = -0.76\,V$, which cathode will give a maximum value of E^{0}_{cell} per electron transferred ?

[JEE (Main) 2019]

(1) $Fe^{3\oplus}$ / $Fe^{2\oplus}$ (2) $Ag^{\oplus}$ / Ag

(3) $Au^{3\oplus}$ / Au (4) $Fe^{2\oplus}$ / Fe

CEC039

10. If the standard electrode potential for a cell is 2 V at 300 K, the equilibrium constant (K) for the reaction

$Zn(s) + Cu^{2\oplus}(aq) \rightleftharpoons Zn^{2\oplus}(aq) + Cu(s)$

at 300 K is approximately. **(R = 8 JK^{-1} mol^{-1}, F = 96000 C mol^{-1})** **[JEE (Main) 2019]**

(1) e^{160} (2) e^{320}

(3) e^{-160} (4) e^{-80}

CEC040

11. The standard electrode potential E^0 and its temperature coefficient $\left(\frac{dE^0}{dT}\right)$ for a cell are 2V and -5×10^{-4} VK^{-1} at 300 K respectively. The cell reaction is

$Zn(s) + Cu^{2\oplus}(aq) \rightarrow Zn^{2\oplus}(aq) + Cu(s)$

The standard reaction enthalpy $\left(\Delta_r H^0\right)$ at 300 K in kJ mol^{-1} is,

[Use : R = 8 JK^{-1} mol^{-1} and F = 96,000 $Cmol^{-1}$] **[JEE (Main) 2019]**

(1) –412.8 (2) –384.0

(3) 206.4 (4) 192.0

CEC041

12. Λ°_m for NaCl, HCl and NaA are 126.4, 425.9 and 100.5 S cm^2mol^{-1}, respectively. If the conductivity of 0.001 M HA is 5×10^{-5} S cm^{-1}, degree of dissociation of HA is : **[JEE (Main) 2019]**

(1) 0.75 (2) 0.125

(3) 0.25 (4) 0.50

CEC042

13. In the cell :

$Pt(s) \mid H_2(g, 1\ bar) \mid HCl\ (aq) \mid AgCl(s) \mid Ag(s) \mid Pt(s)$

the cell potential is 0.92V when a 10^{-6} molal HCl solution is used. The standard electrode potential of $(AgCl/Ag, Cl^{\ominus})$ electrode is :

$\left\{given, \frac{2.303RT}{F} = 0.06V \text{ at } 298K\right\}$ **[JEE (Main) 2019]**

(1) 0.20 V
(2) 0.76 V
(3) 0.40 V
(4) 0.94 V

CEC043

14. The anodic half-cell of lead-acid battery is recharged using electricity of 0.05 Faraday. The amount of $PbSO_4$ electrolyzed (in g) during the process is : **(Molar mass of $PbSO_4$ = 303 g mol^{-1})**

[JEE (Main) 2019]

(1) 22.8
(2) 15.2
(3) 7.6
(4) 11.4

CEC044

15. Given that the standard potentials (E°) of $Cu^{2\oplus}/Cu$ and $Cu^{\oplus}/Cu$ are 0.34 V and 0.522 V respectively, the E° of $Cu^{2\oplus}/Cu^{\oplus}$ is : **[JEE (Main) 2020]**

(1) +0.158 V
(2) 0.182 V
(3) –0.182 V
(4) –0.158 V

CEC045

16. For an electrochemical cell

$Sn(s) \mid Sn^{2\oplus}(aq,1M) || Pb^{2\oplus}(aq,1M) \mid Pb(s)$

the ratio $\frac{[Sn^{2\oplus}]}{[Pb^{2\oplus}]}$ when this cell attains equilibrium is _____.

(Given $E^0_{Sn^{2\oplus}|Sn} = -0.14V$, $E^0_{Pb^{2\oplus}|Pb} = -0.13V$, $\frac{2.303RT}{F} = 0.06\ V$) **[JEE (Main) 2020]**

CEC046

17. The magnitude of the change in oxidising power of the $MnO_4^{\ominus} / Mn^{2\oplus}$ couple is x × 10^{-4} V, if the $H^{\oplus}$ concentration is decreased from 1 M to 10^{-4} M at 25°C. (Assume concentration of $MnO_4^{\ominus}$ and $Mn^{2\oplus}$ to be same on change in $H^{\oplus}$ concentration). The value of x is _____.
(Rounded off to the nearest integer) **[JEE (Main) 2021]**

$\left[Given: \frac{2.303\ RT}{F} = 0.059\right]$

CEC047

18. The resistance of conductivity cell containing 0.01 M KCl solution at 298 K is 1750 Ω. If the conductively of 0.01 M KCl solution at 298 K is 0.152 × 10^{-3} S cm^{-1}, then the cell constant of the conductivity cell is_____× 10^{-3} cm^{-1}. **[JEE (Main) 2022]**

CEC048

19. At 298 K, a 1 litre solution containing 10 mmol of $Cr_2O_7^{2\ominus}$ and 100 mmol of $Cr^{3\oplus}$ shows a pH of 3.0.

Given : $Cr_2O_7^{2\ominus} \rightarrow Cr^{3\oplus}$; $E^0 = 1.330$ V and

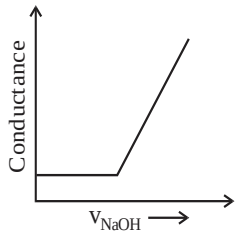
$\frac{2.303\ RT}{F} = 0.059$ V

The potential for the half cell reaction is $x \times 10^{-3}$ V. The value of x is _____. **[JEE (Main) 2023]**

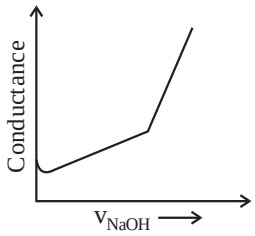
CEC049

20. Choose the correct representation of conductometric titration of benzoic acid vs sodium hydroxide. **[JEE (Main) 2023]**

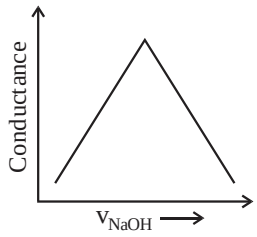
(1)



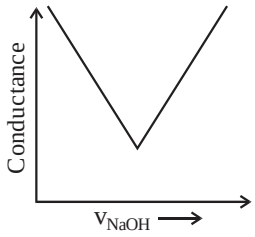
(2)



(3)



(4)



CEC050

Exercise - III (JEE Advanced Pattern)

SECTION–I

- This section contains **FIVE** questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

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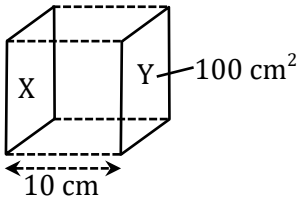
1. The conductance of a salt solution AB measured by two parallel electrodes of area 100 cm^2 separated by 10 cm was found to be 0.0001 Ω^{-1}. If volume enclosed between two electrodes contain 0.5 mole of salt, what is the molar conductivity ($Scm^2\ mol^{-1}$) of salt at same concentration ?



(A) 0.01 (B) 0.02 (C) 2×10^{-5} (D) none of these

CEC051

2. The conductivity of a saturated solution of Ag_3PO_4 is 9×10^{-6} S m^{-1} and its equivalent conductivity is 1.50×10^{-4} S m^2 $equivalent^{-1}$. The K_{sp} of Ag_3PO_4 is

(A) 4.32×10^{-18} (B) 1.8×10^{-9} (C) 8.64×10^{-13} (D) None of these

CEC052

3. 1 mole of Al is deposited by X coulomb of electricity passing through aluminium nitrate solution. The number of moles of silver deposited by X coulomb of electricity from silver nitrate solution is :

(A) 3 (B) 4 (C) 2 (D) 1

CEC053

4. The time required to coat a surface of 80 cm^2 with 5×10^{-3} cm thick layer of silver (density 1.05 g cm^{-3}) with the passage of 3A current through a silver nitrate solution is : (atomic wt. of Ag = 108)

(A) 115 sec. (B) 122 sec. (C) 135 sec. (D) 145 sec.

CEC054

5. For a spontaneous reaction, the values of ΔG, equilibrium constant (K) and E^0_{Cell} will be respectively

(A) –ve, < 1, –ve (B) –ve, >1, –ve (C) –ve, >1, +ve (D) +ve, >1, –ve

CEC055

SECTION-II

- This section contains **FIVE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4, if only (all) the correct option(s) is (are) chosen.
Partial Marks	:	+3, if all the four options are correct but ONLY three options are chosen.
Partial Marks	:	+2, if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks	:	+1, if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	:	0, if none of the options is chosen (i.e. the question is unanswered).
Negative Marks	:	–2 in all other cases.

6. During discharging of lead storage battery, which of the following is/are true ?

(A) H_2SO_4 is produced (B) H_2O is consumed

(C) $PbSO_4$ is formed at both electrodes (D) Density of electrolytic solution decreases

CEC056

7. Which of the following arrangement will produce oxygen at anode during electrolysis ?

(A) Dilute H_2SO_4 solution with Cu electrodes.

(B) Dilute H_2SO_4 solution with inert electrodes.

(C) Fused NaOH with inert electrodes.

(D) Dilute NaCl solution with inert electrodes.

CEC057

8. If 270.0 g of water is electrolysed during an experiment performed by miss Abhilasha with 75% current efficiency then

(A) 168 L of O_2 (g) will be evolved at anode at 1 atm & 273 K

(B) Total 504 L gases will be produced at 1 atm & 273 K.

(C) 336 L of H_2 (g) will be evolved at anode at 1 atm & 273 K

(D) 45 F electricity will be consumed

CEC058

9. Pick out the correct statements among the following from inspection of standard reduction potentials (Assume standard state conditions).

$Cl_2 + 2e^{\ominus} \rightleftharpoons 2Cl^{\ominus}$ $E^0_{Cl_2/Cl^{\ominus}} = +1.36$ volt

$Br_2 + 2e^{\ominus} \rightleftharpoons 2Br^{\ominus}$ $E^0_{Br_2/Br^{\ominus}} = +1.09$ volt

$I_2 + 2e^{\ominus} \rightleftharpoons 2I^{\ominus}$ $E^0_{I_2/I^{\ominus}} = +0.54$ volt

$S_2O_8^{2\ominus} + 2e^{\ominus} \rightleftharpoons 2SO_4^{2\ominus}$ $E^0_{S_2O_8^{2\ominus}/SO_4^{2\ominus}} = +2.00$ volt

(A) Cl_2 can oxidise $2SO_4^{2\ominus}$ from Solution:

(B) Cl_2 can oxidise $Br^{\ominus}$ and $I^{\ominus}$ from aqueous Solution:

(C) $S_2O_8^{2\ominus}$ can oxidise $Cl^{\ominus}$, $Br^{\ominus}$ and $I^{\ominus}$ from aqueous Solution:

(D) $S_2O_8^{2\ominus}$ is added slowly, $Br^{\ominus}$ can be reduce in presence of $Cl^{\ominus}$ **CEC059**

10. The EMF of the following cell is 0.22 volt.

$Ag(s) \mid AgCl(s) \mid KCl\ (1M) \mid H^{\oplus}(1M) \mid H_2(g)\ (1atm) \mid Pt(s)$.

Which of the following will decrease the EMF of cell.

(A) increasing pressure of $H_2(g)$ from 1 atm to 2 atm

(B) increasing $Cl^{\ominus}$ concentration in Anodic compartment

(C) increasing $H^{\oplus}$ concentration in cathodic compartment

(D) decreasing KCl concentration in Anodic compartment.

CEC060

SECTION–III

- This section contains **THREE** questions of matching type.
- This section contains **One** table (having 3 columns and 4 rows)
- Based on table, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : –1 in all other cases.

Column-I	Column-II	Column-III
(P) $Zn(s)\|ZnSO_4(0.1M)\|\|Zn(NO_3)_2(0.01M)Zn(s)$	(A) Has metal -insoluble salt - anion electrode.	(I) $E_{cell} < 0$
(Q) $Pt,Cl_2(0.1bar)\|KCl(1M)\|\|NaCl(1M)\|Cl_2(1bar),Pt$	(B) Electrolytic concentration cell	(II) $E^0_{cell} = 0$
(R) $Ag(s)\|AgCl(s)\|KCl\ (0.1M)\|\|Ag^{\oplus}(0.1M)\|Ag(s)$ $Ksp[AgCl] = 10^{-10}$.	(C) Electrode concentration cell	(III) $E_{cell} > 0$
(S) $Pt,H_2(1bar)\|H_2SO_4(0.05M)\|\|HNO_3(0.1M)\|H_2\ (1bar), Pt$	(D) Has gas-ion electrode	(IV) $E_{cell} = 0$

(1) Use : $\frac{2.303RT}{F} = 0.06$

(2) Assume constant P, T condition of operation.

11. Which option is incorrectly matched ?

(A) P - B - II (B) Q - C - II (C) R - A - I (D) S - D – IV

CEC061

12. For galvanic cell in option 'Q' on increasing concentration of KCl, cell potential will -

(A) Increase (B) decrease

(C) remains constant (D) cannot predict

CEC062

13. On increasing $Ag^{\oplus}$ concentration in anodic compartment in option (R) cell potential will

(A) Remain same (B) increase (C) decrease (D) can't predict

CEC063

SECTION–IV

- This section contains **TWO** questions.
- Each question contains two columns, **Column-I** and **Column-II.**
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **four** entries (P), (Q), (R), (S).
- Match the entries in **Column-I** with the entries in **column-II.**
- One or more entries in **Column-I** may match with one or more entries in **Column-II.**
- The ORS contains a 4 × 4 matrix whose layout will be similar to the one shown below:

(A) (P) (Q) (R) (S)
(B) (P) (Q) (R) (S)
(C) (P) (Q) (R) (S)
(D) (P) (Q) (R) (S)

- For each entry in **column-I,** darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q) and (R), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in one of the following categories :

For each entry in **Column-I**

Full Marks : +2, if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

14.

Column I	**Column II (Electrolysis product using inert electrode)**
(A) Dilute solution of HCl	(P) O_2 evolved at anode
(B) Dilute solution of NaCl	(Q) H_2 evolved at cathode
(C) Concentrated solution of NaCl	(R) Cl_2 evolved at anode
(D) $AgNO_3$ solution	(S) Ag deposition at cathode

(A) A – Q, R; B – P, Q; C – Q, R; D – P, S
(B) A – Q, R; B – P, Q; C – R, S; D – P, S
(C) A – R, S; B – P, S; C – Q, R; D – P, S
(D) A – P, Q; B – Q, R; C – P, Q; D – R, S

CEC064

15.

Column-I Cell notation :	**Column-II E_{cell}**
(A) $Mn\left\|{}^{Mn^{2\oplus}}_{(0.1M)}\right\|{}^{Cu^{2\oplus}}_{(0.01M)}\left\|Cu\right.$	(P) 0.33
(B) $Ag\left\|AgBr\right\|{}^{Br^{\ominus}}_{(0.1M)}\left\|{}^{Ag^{\oplus}}_{(0.01M)}\right\|Ag$	(Q) 0.6
(C) $Pt,H_2(4atm)\left\|{}^{H^{\oplus}}_{(0.01M)}\right\|{}^{Cl^{\ominus}}_{(0.2M)}\left\|{}^{Cl_2}_{(1atm)}\right\|Pt$	(R) 1.49
(D) $Pt,\left\|{}^{Fe^{2\oplus}}_{(0.2M)}\ {}^{Fe^{3\oplus}}_{(0.02M)}\right\|{}^{MnO_4^{\ominus}}_{(0.1M)}\ {}^{Mn^{2\oplus}}_{(0.1M)}\ {}^{H^{\oplus}}_{pH=5}\left\|Pt\right.$	(S) 1.54

Given :

$E^0_{Cu^{2\oplus}/Cu} = 0.34V$ $\quad K_{sp}(AgBr) = 10^{-13}$

$E^0_{Mn^{2\oplus}/Mn} = -1.18V$ $\quad \frac{2.303RT}{F} = 0.06$

$E^0_{Ag^{\oplus}/Ag} = 0.8V$

$E^0_{Fe^{3\oplus}/Fe^{2\oplus}} = 0.77V$

$E^0_{MnO_4^{\ominus}/Mn^{2\oplus}} = 1.52V$

$E^0_{Cl_2/Cl^{\ominus}} = 1.36V$

(A) A – S; B - R; C - S; D – S
(B) A - Q; B - R; C - P; D - S
(C) A - R; B - Q; C - S; D – P
(D) A - S; B - R; C - Q; D – P

CEC065

SECTION–V

- This section contains **FIVE** questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +3, if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0, in all other cases.

16. The resistance of a 1N solution of salt is 50 Ω . Calculate the equivalent conductance of the solution, if the two platinum electrodes in solution are 2.1 cm apart and each having an area of 4.2 cm^2.

CEC066

17. Calculate Λ_m^{∞} of oxalic acid, given that

$\Lambda_{eq}^{\infty}\ Na_2C_2O_4 = 400\Omega^{-1}\ cm^2\ eq^{-1}$

$\Lambda_m^{\infty}\ H_2SO_4 = 700\Omega^{-1}\ cm^2\ mol^{-1}$

$\Lambda_{eq}^{\infty}\ Na_2SO_4 = 450\Omega^{-1}\ cm^2\ eq^{-1}$

CEC067

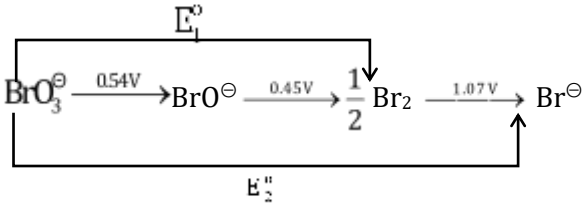
18. The equilibrium constant for the reaction $Fe^{2\oplus} + Ce^{4\oplus} \rightleftharpoons Fe^{3\oplus} + Ce^{3\oplus}$ is 4.64×10^x, the value of x is :

[**Given :** $E^0_{Ce^{4\oplus}/Ce^{3\oplus}} = 1.44$ V; $E^0_{Fe^{3\oplus}/Fe^{2\oplus}} = 0.68$ V]

Take $\frac{2.303\ RT}{F} = 0.06$ at 25°C, log 4.68 = 0.67

CEC068

19. From the standard potentials shown in the following diagram, calculate the potentials E_1° and E_2° in volts.



CEC069

20. How long a current of 2 A has to be passed through a solution of $AgNO_3$ to coat a metal surface of 80 cm^2 with 5 μm thick layer? Density of silver = 10.8 g/cm^{-3}.

CEC070

Exercise - IV (JEE Advanced PYQs)

1. The standard reduction potential data at 25°C is given below

$E^\circ (Fe^{3\oplus}, Fe^{2\oplus}) = +0.77$ V ;

$E^\circ (Fe^{2\oplus}, Fe) = -0.44$ V ;

$E^\circ (Cu^{2\oplus}, Cu) = +0.34$ V ;

$E^\circ (Cu^{\oplus}, Cu) = +0.52$ V ;

$E^\circ [O_2(g) + 4H^{\oplus} + 4e^{\ominus} \rightarrow 2H_2O] = +1.23$ V ;

$E^\circ [O_2(g) + 2H_2O + 4e^{\ominus} \rightarrow 4OH^{\ominus}] = +0.40$ V ;

$E^\circ (Cr^{3\oplus}, Cr) = -0.74$ V ;

$E^\circ (Cr^{2\oplus}, Cr) = -0.91$ V ;

Match E° of the redox pair in List-I with the values given in List-II and select the correct answer using the code given below the lists : **[JEE (Advanced) 2013]**

List-I	List-II
(P) $E^\circ(Fe^{3\oplus}, Fe)$	(1) –0.18 V
(Q) $E^\circ(4H_2O \rightleftharpoons 4H^{\oplus} + 4OH^{\oplus})$	(2) –0.4 V
(R) $E^\circ(Cu^{2\oplus} + Cu \rightarrow 2Cu^{\oplus})$	(3) –0.04 V
(S) $E^\circ(Cr^{3\oplus}, Cr^{2\oplus})$	(4) –0.83 V

(A) P-4, Q-1, R-2, S-3 (B) P-2, Q-3, R-4, S-1

(C) P-1, Q-2, R-3, S-4 (D) P-3, Q-4, R-1, S-2

CEC071

2. An aqueous solution of X is added slowly to an aqueous solution of Y as shown in List-I. The variation in conductivity of these reactions is given in List-II. Match List-I with List-II and select the correct answer using the code given below the lists : **[JEE (Advanced) 2013]**

List-I	List-II
(P) $(C_2H_5)_3N + CH_3COOH$ X Y	(1) Conductivity decreases and then increases
(Q) $KI(0.1M) + AgNO_3(0.01M)$ X Y	(2) Conductivity decreases and then does not change much
(R) $CH_3COOH + KOH$ X Y	(3) Conductivity increases and then does not change much
(S) NaOH + HI X Y	(4) Conductivity does not change much and then increases

(A) P-3, Q-4, R-2, S-1 (B) P-4, Q-3, R-2, S-1

(C) P-2, Q-3, R-4, S-1 (D) P-1, Q-4, R-3, S-2

CEC072

3. In a galvanic cell, the salt bridge - **[JEE (Advanced) 2014]**

(A) Does not participate chemically in the cell reaction

(B) Stops the diffusion of ions from one electrode to another

(C) Is necessary for the occurrence of the cell reaction

(D) Ensures mixing of the two electrolytic solutions

CEC073

4. The molar conductivity of a solution of a weak acid HX (0.01 M) is 10 times smaller than the molar conductivity of a solution of a weak acid HY (0.1 M). If $\lambda^0_{X^\ominus} \approx \lambda^0_{Y^\ominus}$, the difference in their pK_a values, $pK_a(HX) - pK_a(HY)$, is (consider degree of ionization of both acids to be <<1).

[JEE (Advanced) 2015]

CEC074

5. All the energy released from the reaction $X \rightarrow Y$, $\Delta_rG^\circ = -193$ kJ mol^{-1} is used for the oxidizing $M^\oplus$ and $M^\oplus \rightarrow M^{3\oplus} + 2e^\ominus$, $E^\circ = -0.25$ V.

Under standard conditions, the number of moles of $M^\oplus$ oxidized when one mole of X is converted to Y is : [F = 96500 C mol^{-1}] **[JEE (Advanced) 2015]**

CEC075

6. For the following electrochemical cell at 298K,

$Pt(s) \mid H_2(g, 1bar) \mid H^\oplus(aq, 1M) \parallel M^{4\oplus}(aq), M^{2\oplus}(aq) \mid Pt(s)$

$E_{cell} = 0.092$ V when $\frac{[M^{2\oplus}(aq.)]}{[M^{4\oplus}(aq.)]} = 10^x$

Given : $E^0_{M^{4\oplus}/M^{2\oplus}} = 0.151V$; $2.303\ \frac{RT}{F} = 0.059V$

The value of x is - **[JEE (Advanced) 2016]**

(A) –2 (B) –1 (C) 1 (D) 2

CEC076

7. The conductance of a 0.0015 M aqueous solution of a weak monobasic acid was determined by using a conductivity cell consisting of platinized Pt electrodes. The distance between the electrodes is 120 cm with an area of cross section of 1 cm^2. The conductance of this solution was found to be 5×10^{-7} S. The pH of the solution is 4. The value of limiting molar conductivity $\left(\Lambda^0_m\right)$ of this weak monobasic acid in aqueous solution is $Z \times 10^2$ S cm^2 mol^{-1}. The value of Z is.

[JEE (Advanced) 2017]

CEC077

8. For the following cell :

$Zn(s) \mid ZnSO_4(aq.) \parallel CuSO_4(aq.) \mid Cu(s)$

when the concentration of $Zn^{2\oplus}$ is 10 times the concentration of $Cu^{2\oplus}$, the expression for ΔG (in J mol^{-1}) is

[F is Faraday constant, R is gas constant, T is temperature, E°(cell) = 1.1V] **[JEE (Advanced) 2017]**

(A) 2.303 RT + 1.1F (B) 2.303 RT – 2.2F (C) 1.1 F (D) –2.2 F

CEC078

9. Consider an electrochemical cell: A(s) | $A^{n\oplus}$ (aq, 2M) || $B^{2n\oplus}$ (aq, 1M) | B(s). The value of ΔH^0 for the cell reaction is twice that of ΔG^0 at 300 K. If the emf of the cell is zero, the ΔS^0 (in JK^{-1} mol^{-1}) of the cell reaction per mole of B formed at 300 K is___.

(Given : ln (2) = 0.7, R (universal gas constant) = 8.3 J K^{-1} mol^{-1}. H, S and G are enthalpy, entropy and Gibbs energy, respectively.) **[JEE (Advanced) 2018]**

CEC079

10. For the electrochemical cell,

$Mg(s) \mid Mg^{2\oplus}(aq, 1\ M) \mid\mid Cu^{2\oplus}(aq, 1M) \mid Cu(s)$

the standard emf of the cell is 2.70 V at 300 K. When the concentration of $Mg^{2\oplus}$ is changed to x M, the cell potential changes to 2.67 V at 300 K. The value of x is___.

(Given, $\frac{F}{R}$ = 11500 KV^{-1}, where F is the Faraday constant and R is the gas constant, ln(10) = 2.30)

[JEE (Advanced) 2018]

CEC080

11. Consider a 70% efficient hydrogen-oxygen fuel cell working under standard conditions at 1 bar and 298 K. Its cell reaction is

$H_2(g) + O_2(g) \rightarrow H_2O(\ell)$.

The work derived from the cell on the consumption of 1.0×10^{-3} mol of $H_2(g)$ is used to compress 1.00 mol of a monoatomic ideal gas in a thermally insulted container. What is the change in the temperature (in K) of the ideal gas ?

The standard reduction potentials for the two half-cells are given below.

$O_2(g) + 4\ H^{\oplus}(aq.) + 4e^{\ominus} \rightarrow 2H_2O(\ell)$, E° = 1.23 V,

$2H^{\oplus}(aq.) + 2e^{\ominus} \rightarrow H_2(g)$, E° = 0.00V.

Use F = 96500 C mol^{-1}, R = 8.314 J $mol^{-1}K^{-1}$ **[JEE (Advanced) 2020]**

CEC081

Paragraph for Q.12 and Q.13

At 298 K, the limiting molar conductivity of a weak monobasic acid is 4×10^2 S cm^2 mol^{-1}. At 298 K, for an aqueous solution of the acid the degree of dissociation of α and the molar conductivity is $y \times 10^2$ Scm^2 mol^{-1}. At 298 K, upon 20 times dilution with water, the molar conductivity of the solution becomes $3y \times 10^2$ S cm^2 mol^{-1}.

12. The value of y is _____. **[JEE (Advanced) 2021]**

CEC082

13. The value of α is _____. **[JEE (Advanced) 2021]**

CEC083

14. Some standard electrode potentials at 298 K are given below:

$Pb^{2\oplus}/Pb$	-0.13 V
$Ni^{2\oplus}/Ni$	-0.24 V
$Cd^{2\oplus}/Cd$	-0.40 V
$Fe^{2\oplus}/Fe$	-0.44 V

To a solution containing 0.001 M of $X^{2\oplus}$ and 0.1 M of $Y^{2\oplus}$, the metal rods X and Y are inserted (at 298 K) and connected by a conducting wire. This resulted in dissolution of X. The correct combination(s) of X and Y, respectively, is (are)

(Given: Gas constant, R = 8.314 J K^{-1} mol^{-1}, Faraday constant, F = 96500 C mol^{-1})

[JEE (Advanced) 2022]

(A) Cd and Ni (B) Cd and Fe

(C) Ni and Pb (D) Ni and Fe

CEC084

15. The reduction potential (E^0, in V) of $MnO_4^{\ominus}$ (aq)/Mn(s) is _____. **[JEE (Advanced) 2022]**

[Given : $E^0_{(MnO_4^{\ominus}(aq)/MnO_2(s))} = 1.68V$; $E^0_{(MnO_2(s)/Mn^{2\oplus}(aq))} = 1.21V$; $E^0_{(Mn^{2\oplus}(aq)/Mn(s))} = -1.03V$]

CEC085

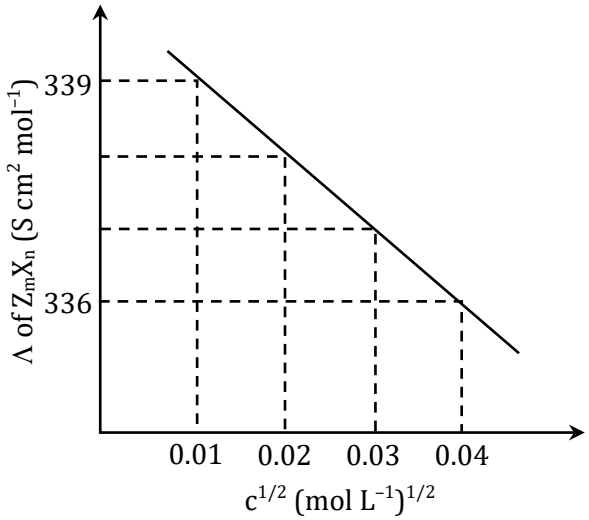
16. Consider the strong electrolytes Z_mX_n, U_mY_p and V_mX_n. Limiting molar conductivity (Λ^0) of U_mY_p and V_mX_n are 250 and 440 S cm^2 mol^{-1}, respectively. The value of (m + n + p) is _____.

Given :

Ion	$Z^{n\oplus}$	$U^{p\oplus}$	$V^{n\oplus}$	$X^{m\ominus}$	$Y^{m\ominus}$
λ^0(S cm^2 mol^{-1})	50.0	25.0	100.0	80.0	100.0

λ^0 is the limiting molar conductivity of ions

The plot of molar conductivity (Λ) of Z_mX_n *vs* $c^{1/2}$ is given below. **[JEE (Advanced) 2022]**



CEC086

17. Plotting $1/\Lambda_m$ against $c\Lambda_m$ for aqueous solutions of a monobasic weak acid (HX) resulted in a straight line with y-axis intercept of P and slope of S. The ratio P / S is

[Λ_m = molar conductivity

Λ_m° = limiting molar conductivity

c = molar concentration

K_a = dissociation constant of HX] **[JEE (Advanced) 2023]**

(A) $K_a\ \Lambda_m^\circ$ (B) $K_a\ \Lambda_m^\circ\ /\ 2$ (C) $2\ K_a \Lambda_m^\circ$ (D) $1\ /\ (K_a \Lambda_m^\circ)$

CEC215

Answer Key

Exercise - I (JEE-Main Pattern)

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	1	1	4	1	3	3	3	1	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	3	2	3	1	3	1	2	4	4	1
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	2	1	0	7	0	4	0	2	6	12

Exercise - II (JEE-Main PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	3	3	2	1	3	1	2	4	3	1
Question	11	12	13	14	15	16	17	18	19	20
Answer	1	2	1	3	1	2.15	3776	266	917	2

Exercise - III (JEE-Advanced Pattern)

Section-I	Q.	1	2	3	4	5
	A.	B	A	A	B	C
Section-II	Q.	6	7	8	9	10
	A.	CD	BCD	ABC	BC	AD
Section-III	Q.	11	12	13		
	A.	C	A	C		
Section-IV	Q.	14	15			
	A.	A	C			
Section-V	Q.	16	17	18	19	20
	A.	10.00	600.00	12.00	0.55, 0.61	193.00

Exercise - IV (JEE Advanced PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	D	A	AB	3	4	D	6	B	–11.62	10
Question	11	12	13	14	15	16	17			
Answer	13.32	0.86	0.21, 0.22	ABC	0.77	7	A			