ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Electrochemistry

Premium CSIR-NET PYQ Book

72 Previous-Year Questions · 58 with verified answers · Distractor Analysis

3-Slide Solutions | Distractor Analysis | Exam Tricks | Revision Sheets

CSIR-NET · GATE · IIT-JAM — 4 Topics · 72 Real PYQs

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Course Contents

4 Topics · 72 PYQs

1	**Debye Huckel** 12 Qs E 5 · M 6 · H 1	17%	
2	**Nernst Cells** 10 Qs E 1 · M 9 · H 0	14%	
3	**Conductance** 8 Qs E 1 · M 7 · H 0	11%	
4	**Electrochemistry – General** 42 Qs E 9 · M 30 · H 3	58%	

Legend: **E** Easy **M** Medium **H** Hard · **%** = exam weightage (share of the chapter)

TOPIC 1

Debye Huckel

12 questions · Easy 5 | Medium 6 | Hard 1 · PYQ frequency: Very High

Q1

The potential in Debye-Hückel theory is proportional to

A. 1/κ r

B. exp[-κ r]

C. exp[-κ r]/r

D. κ r

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer C exp[-κ r]/r

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|z₊z₋|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- Debye–Hückel: the screened (Yukawa) potential around a central ion is φ ∝ e^{−κr}/r — the bare Coulomb 1/r multiplied by the screening factor e^{−κr}; 1/κ is the Debye length.
- Therefore the answer is (C).

FINAL: (C) exp[-κ r]/r

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \tfrac{1}{2} c (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in |z₊z₋|.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z²'.

Why the Other Options Are Wrong

Correct answer: C

A **1/κ r**

Why (C) is the key — Debye–Hückel: the screened (Yukawa) potential around a central ion is φ ∝ e^{−κr}/r — the bare Coulomb 1/r multiplied by the screening factor e^{−κr}; 1/κ is the Debye length.

B **exp[-κ r]**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

D **κ r**

Ruled out: Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

Q2

The concentration of a $MgSO_4$ solution having the same ionic strength as that of a 0.1 M Na_2SO_4 solution is

A. 0.05 M

B. 0.067 M

C. 0.075 M

D. 0.133 M

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer C 0.075 M

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log $\gamma_\pm = -A|z_+ z_-|\sqrt{I}$ ($A = 0.509$ at 25 °C in water) holds for $I < 0.01$ M; the extended law adds $(1 + Ba\sqrt{I})$ in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- $I = \tfrac{1}{2}\Sigma c_i z_i^2$. 0.1 M Na_2SO_4: $\tfrac{1}{2}(0.2 \times 1 + 0.1 \times 4) = 0.3$. $MgSO_4$ (c): $\tfrac{1}{2}(4c + 4c) = 4c = 0.3 \rightarrow c = 0.075$ M.
- Therefore the answer is (C).

FINAL: (C) 0.075 M

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \tfrac{1}{2}\, c\, (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: C

A **0.05 M**

Why (C) is the key — $I = \frac{1}{2}\Sigma c_i z_i^2$. 0.1 M Na_2SO_4: $\frac{1}{2}(0.2 \times 1 + 0.1 \times 4) = 0.3$. $MgSO_4$ (c): $\frac{1}{2}(4c + 4c) = 4c = 0.3 \rightarrow c = 0.075$ M.

B **0.067 M**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

D **0.133 M**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q3

The ionic strength of a solution containing 0.008 M $AlCl_3$ and 0.005 M KCl is

A. 0.134 M

B. 0.053 M

C. 0.106 M

D. 0.086 M

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Ionic strength: half the sum of c z^2'.

Correct Answer B 0.053 M

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log $\gamma_\pm = -A|z_+ z_-|\sqrt{I}$ ($A = 0.509$ at 25 °C in water) holds for $I < 0.01$ M; the extended law adds $(1 + Ba\sqrt{I})$ in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- $I = \frac{1}{2}\Sigma c_i z_i^2 = \frac{1}{2}[0.008 \times 9\ (Al^{3+}) + 0.024 \times 1\ (Cl^-) + 0.005 \times 1\ (K^+) + 0.005 \times 1\ (Cl^-)] = \frac{1}{2} \times 0.106 = 0.053$ M.
- Therefore the answer is (B).

FINAL: (B) 0.053 M

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \frac{1}{2}\, c\, (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: B

A **0.134 M**

Why (B) is the key — $I = \frac{1}{2}\Sigma c_i z_i^2 = \frac{1}{2}[0.008 \times 9\ (Al^{3+}) + 0.024 \times 1\ (Cl^-) + 0.005 \times 1\ (K^+) + 0.005 \times 1\ (Cl^-)] = \frac{1}{2} \times 0.106 = 0.053$ M.

C **0.106 M**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

D **0.086 M**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q4

The electrolyte solution that has the smallest Debye-length at 298 K is

A. 0.01 M NaCl

B. 0.01 M Na_2SO_4

C. 0.01 M $CuCl_2$

D. 0.01 M $LaCl_3$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer D 0.01 M $LaCl_3$

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|$z_+ z_-$|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- Debye length $1/\kappa \propto 1/\sqrt{I}$. I: NaCl 0.01; Na_2SO_4 0.03; $CuCl_2$ 0.03; $LaCl_3$ ½(0.01 × 9 + 0.03 × 1) = 0.06 — largest I → shortest Debye length.
- Therefore the answer is (D).

FINAL: (D) 0.01 M $LaCl_3$

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: I = ½ c ($\nu_+ z_+^2 + \nu_- z_-^2$): 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in |$z_+ z_-$|.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: D

A **0.01 M NaCl**

Why (D) is the key — Debye length $1/\kappa \propto 1/\sqrt{I}$. I: NaCl 0.01; Na_2SO_4 0.03; $CuCl_2$ 0.03; $LaCl_3$ ½(0.01 × 9 + 0.03 × 1) = 0.06 — largest I → shortest Debye length.

B **0.01 M Na_2SO_4**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

C **0.01 M $CuCl_2$**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q5

1.0 ohm^{-1} dm^{2} mol^{-1}, respectively, the solubility (in g L^{-1}) of the salt in water at 25Â°C is

A. 1×10^{-6}

B. 1×10^{-3}

C. 2×10^{-1}

D. 2×10^{-4}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer C 2×10^{-1}

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law $\log \gamma_{\pm} = -A|z_+ z_-|\sqrt{I}$ ($A = 0.509$ at 25 °C in water) holds for $I < 0.01$ M; the extended law adds $(1 + Ba\sqrt{I})$ in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- Solubility from conductance: S (mol L^{-1}) = $\kappa_{salt}/\Lambda°$ ($\kappa_{salt} = \kappa_{solution} - \kappa_{water}$), then multiply by the molar mass to get g L^{-1} → 2×10^{-1} g L^{-1}. (Question text is truncated in the bank — verify numbers.)
- Therefore the answer is (C).

FINAL: (C) 2×10^{-1}

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \tfrac{1}{2} c (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers $\gamma_{\pm}$, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: C

A 1×10^{-6}

Why (C) is the key — Solubility from conductance: S (mol L^{-1}) = $\kappa_{salt}/\Lambda^{\circ}$ ($\kappa_{salt} = \kappa_{solution} - \kappa_{water}$), then multiply by the molar mass to get g L^{-1} → 2×10^{-1} g L^{-1}. (Question text is truncated in the bank — verify numbers.)

B 1×10^{-3}

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

D 2×10^{-4}

Ruled out: Adding an inert salt raises I, lowers $\gamma_{\pm}$, and increases the solubility of a sparingly soluble salt.

Q6

For an aqueous solution at 25Â°C, the Debye-Huckel limiting law is given by

A. $\log \gamma_{\pm} = 0.509 |Z_+Z_-|\sqrt{(\mu)}$

B. $\log \gamma_{\pm} = 0.509 |Z_+Z_-| \mu$

C. $\log \gamma_{\pm} = -0.509 |Z_+Z_-|\sqrt{(\mu)}$

D. $\log \gamma_{\pm} = -0.509 |Z_+Z_-| \mu^2$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer C log γ_± = -0.509 |Z₊Z₋|√(μ)

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|z₊z₋|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- Debye–Hückel limiting law in water at 25 °C: log γ± = −0.509 |z₊z₋| √I (I = ionic strength, A = 0.509 kg^{1/2} mol^{−1/2}). The sign is negative: γ± < 1.
- Therefore the answer is (C).

FINAL: (C) log γ_± = -0.509 |Z₊Z₋|√(μ)

SHORTCUT / EXAM TRICK

For a single salt M_νX_ν: I = ½ c (ν₊z₊² + ν₋z₋²): 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in |z₊z₋|.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z²'.

Why the Other Options Are Wrong

Correct answer: C

A **log y_± = 0.509 |Z₊Z₋|√(μ)**

Why (C) is the key — Debye–Hückel limiting law in water at 25 °C: log γ± = −0.509 |z₊z₋| √I (I = ionic strength, A = 0.509 kg^{1/2} mol^{−1/2}). The sign is negative: γ± < 1.

B **log y_± = 0.509 |Z₊Z₋| μ**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in |z₊z₋|.

D **log y_± = -0.509 |Z₊Z₋| μ²**

Ruled out: Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

Q7

Solutions of three electrolytes have the same ionic strength and different dielectric constants as 4, 25 and 81. The corresponding relative magnitude of Debye-Huckel screening, lengths of the three solutions are

A. 4, 25 and 81

B. 2, 5 and 9

C. 1/2, 1/5 and 1/9

D. 1, 1 and 1

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Correct Answer B 2, 5 and 9

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|z₊z₋|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- Debye length $1/\kappa \propto \sqrt{(\varepsilon T/I)}$. Same I and T → $1/\kappa \propto \sqrt{\varepsilon}$: √4 : √25 : √81 = 2 : 5 : 9.
- Therefore the answer is (B).

FINAL: (B) 2, 5 and 9

SHORTCUT / EXAM TRICK

For a single salt $M_{\nu}X_{\nu}$: $I = \frac{1}{2} c (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: B

A **4, 25 and 81**

Why (B) is the key — Debye length $1/\kappa \propto \sqrt{(\varepsilon T/I)}$. Same I and T → $1/\kappa \propto \sqrt{\varepsilon}$: $\sqrt{4} : \sqrt{25} : \sqrt{81} = 2 : 5 : 9$.

C **1/2, 1/5 and 1/9**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

D **1, 1 and 1**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q8

Two aqueous 1 : 1 electrolyte systems A and B are at different temperatures T_A and T_B and C_A and C_B concentrations, respectively. Their Debye lengths will be equal if (c) T_A = √(2) T_B and C_A = 2C_B (a) T_A = 2T_B and C_A = 2C_B (b) T_A = 2T_B and C_A = C_B/2 (d) T_A = 2T_B and C_A = √(2) C_B

SELF-PRACTICE answer on record: (A) — options were not printed in the source.

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z².'

Q9

The amount of $Ba(NO_3)_2$ (molecular weight 261.32 amu) required to be added to 500 g of a 0.11 mol kg^{-1} solution of KNO_3 in order to raise its ionic strength to 1.00 is approximately

A. 38.8 g

B. 19.4 g

C. 76.2 g

D. 126.5 g

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z^2'.

Correct Answer A 38.8 g

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log $\gamma_\pm = -A|z_+ z_-|\sqrt{I}$ ($A = 0.509$ at 25 °C in water) holds for $I < 0.01$ M; the extended law adds $(1 + Ba\sqrt{I})$ in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- $I(KNO_3, 0.11\ m) = 0.11$. $Ba(NO_3)_2$ contributes $I = \frac{1}{2}(m \times 4 + 2m \times 1) = 3m$. Need $3m = 1.00 - 0.11 = 0.89 \rightarrow m = 0.297$ mol kg^{-1}; for 0.5 kg solvent: 0.148 mol × 261.32 = 38.8 g.
- Therefore the answer is (A).

FINAL: (A) 38.8 g

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \frac{1}{2}\, c\, (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z^2'.

Why the Other Options Are Wrong

Correct answer: A

B **19.4 g**

Why (A) is the key — I(KNO_3, 0.11 m) = 0.11. $Ba(NO_3)_2$ contributes I = ½(m × 4 + 2m × 1) = 3m. Need 3m = 1.00 − 0.11 = 0.89 → m = 0.297 mol kg^{-1}; for 0.5 kg solvent: 0.148 mol × 261.32 = 38.8 g.

C **76.2 g**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

D **126.5 g**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q10

According to the Debye – Huckel limiting law, the mean activity coefficient of 5×10^{-4} mol kg^{-1} aqueous solution of $CaCl_2$ at 25°C is (the Debye – Huckel constant 'A' can be takento be 0.509)

A. 0.63

B. 0.72

C. 0.80

D. 0.91

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z^2'.

Correct Answer D 0.91

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|z₊z₋|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

↓

LOGIC / WORKING

- $I = \frac{1}{2}[5\times10^{-4} \times 4 + 1\times10^{-3} \times 1] = 1.5\times10^{-3}$. log γ± = −0.509 × |2 × 1| × √(1.5×10⁻³) = −1.018 × 0.0387 = −0.0394 → γ± = 0.913 ≈ 0.91.
- Therefore the answer is (D).

FINAL: (D) 0.91

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: $I = \frac{1}{2} c (\nu_+ z_+^2 + \nu_- z_-^2)$: 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in |z₊z₋|.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z²'.

Why the Other Options Are Wrong

Correct answer: D

A **0.63**

Why (D) is the key — $I = \frac{1}{2}[5\times10^{-4} \times 4 + 1\times10^{-3} \times 1] = 1.5\times10^{-3}$. $\log \gamma_{\pm} = -0.509 \times |2 \times 1| \times \sqrt{(1.5\times10^{-3})} = -1.018 \times 0.0387 = -0.0394 \rightarrow \gamma_{\pm} = 0.913 \approx 0.91$.

B **0.72**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

C **0.80**

Ruled out: Adding an inert salt raises I, lowers $\gamma_{\pm}$, and increases the solubility of a sparingly soluble salt.

Q11

The molality of $(NH_4)_2SO_4$ solution that has the same ionic strength as 1 mol kg^{-1} solution of KCl is

A. (1)/(3) mol kg^{-1}

B. (1)/(2) mol kg^{-1}

C. (2)/(5) mol kg^{-1}

D. (3)/(5) mol kg^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Ionic strength: half the sum of c z^2'.

Correct Answer A (1)/(3) mol kg⁻¹

CONCEPT

Ions in solution are screened by an ionic atmosphere; the limiting law log γ± = −A|z₊z₋|√I (A = 0.509 at 25 °C in water) holds for I < 0.01 M; the extended law adds (1 + Ba√I) in the denominator; Debye length κ⁻¹ ∝ 1/√I.

↓

LOGIC / WORKING

- I(KCl, 1 m) = 1. $(NH_4)_2SO_4$ at molality m: I = ½(2m × 1 + m × 4) = 3m → m = 1/3 mol kg⁻¹.
- Therefore the answer is (A).

FINAL: (A) (1)/(3) mol kg⁻¹

SHORTCUT / EXAM TRICK

For a single salt $M_\nu X_\nu$: I = ½ c ($\nu_+ z_+^2 + \nu_- z_-^2$): 1:1 → c, 2:1 → 3c, 2:2 → 4c, 3:1 → 6c.

COMMON MISTAKE

Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.

EXAM TIP

Adding an inert salt raises I, lowers γ±, and increases the solubility of a sparingly soluble salt.

MEMORY TRICK

'Ionic strength: half the sum of c z²'.

Why the Other Options Are Wrong

Correct answer: A

B **(1)/(2) mol kg^{-1}**

Why (A) is the key — I(KCl, 1 m) = 1. $(NH_4)_2SO_4$ at molality m: I = ½(2m × 1 + m × 4) = 3m → m = 1/3 mol kg^{-1}.

C **(2)/(5) mol kg^{-1}**

Ruled out: Using concentration instead of ionic strength, or forgetting the charge product in $|z_+z_-|$.

D **(3)/(5) mol kg^{-1}**

Ruled out: Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

Q12 The mean ionic activity coefficient of 0.004 molal $CaCl_2$ in water at 298 K (rounded off to thre decimal places) is _____. (Given: Debye-Huckel constant for an aqueous solution at 298 K is 0.509 $kg^{1/2}\ mol^{-1/2}$) (Numerical answer type — write the value.)

ANSWER: 0.773

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Debye Huckel

PYQ FREQUENCY
Very High · 10 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
I = ½(0.004 × 4 + 0.008 × 1) = 0.012. log γ± = −0.509 × 2 × √0.012 = −0.1115 → γ± = 10^{−0.1115} = 0.773.

TOPIC REVISION

Debye Huckel

12 PYQs · Last-minute revision

TOPIC SUMMARY

Ions in solution are screened by an ionic atmosphere; the limiting law $\log \gamma_\pm = -A|z_+ z_-|\sqrt{I}$ ($A = 0.509$ at 25 °C in water) holds for $I < 0.01$ M; the extended law adds $(1 + Ba\sqrt{I})$ in the denominator; Debye length $\kappa^{-1} \propto 1/\sqrt{I}$.

IMPORTANT FORMULA SHEET

- $I = \frac{1}{2} \Sigma c_i z_i^2$
- $\log \gamma_\pm = -A |z_+ z_-| \sqrt{I}$
- $\log \gamma_\pm = -A|z_+ z_-|\sqrt{I}/(1 + Ba\sqrt{I})$ (extended)
- $\kappa^{-1} \propto (\varepsilon T/I)^{1/2}$
- $\gamma_\pm = (\gamma_+^{\nu_+} \gamma_-^{\nu_-})^{(1/\nu)}$

FREQUENTLY ASKED CONCEPTS

- Ionic strength of mixed electrolytes
- Mean activity coefficient of $CaCl_2$, Na_2SO_4
- Salt effect on solubility (Ksp vs activities)
- Debye length dependence

COMMON MISTAKES & QUICK NOTES

Watch out:
Using concentration instead of ionic strength, or forgetting the charge product in $|z_+ z_-|$.
Adding an inert salt raises I, lowers $\gamma_\pm$, and increases the solubility of a sparingly soluble salt.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12

Expect 1 question(s) next session on Debye Huckel.

TOPIC 2

Nernst Cells

10 questions · Easy 1 | Medium 9 | Hard 0 · PYQ frequency: High

Q13

The standard EMF of the cell Pt, $H_2(g)$ | HCl(soln.) | AgCl(s), Ag(s)

A. increases with T

B. decreases with T

C. remains unchanged with T

D. decreases with [HCl]

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer B decreases with T

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- Cell reaction $\frac{1}{2}H_2(g) + AgCl(s) \rightarrow Ag(s) + HCl(aq)$: a gas is consumed, so $\Delta S^\circ < 0$; $(\partial E^\circ/\partial T) = \Delta S^\circ/nF < 0 \rightarrow E^\circ$ decreases with temperature.
- Therefore the answer is (B).

FINAL: (B) decreases with T

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: E_cell = E_R − E_L (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: B

A **increases with T**

Why (B) is the key — Cell reaction $\frac{1}{2}H_2(g) + AgCl(s) \rightarrow Ag(s) + HCl(aq)$: a gas is consumed, so $\Delta S° < 0$; $(\partial E°/\partial T) = \Delta S°/nF < 0 \rightarrow E°$ decreases with temperature.

C **remains unchanged with T**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **decreases with [HCl]**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q14

The standard electrode potential E_0 at a fixed temperature and in a given medium is dependent on

A. only the electrode composition

B. the electrode composition and the extent of the reaction

C. the extent of the electrode reaction only

D. the electrode reaction and the electrode composition

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer D the electrode reaction and the electrode composition

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- E° is an intensive property fixed by the identity of the half-reaction and the electrode materials/phases (composition); it does not depend on how far the reaction has proceeded or on the amount of material.
- Therefore the answer is (D).

FINAL: (D) the electrode reaction and the electrode composition

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: $E_{cell} = E_R - E_L$ (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: D

A — **only the electrode composition**

Why (D) is the key — E° is an intensive property fixed by the identity of the half-reaction and the electrode materials/phases (composition); it does not depend on how far the reaction has proceeded or on the amount of material.

B — **the electrode composition and the extent of the reaction**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

C — **the extent of the electrode reaction only**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q15

A solution of Fe^{3+} is titrated potentiometrically using Ce^{3+} solution at 25 ^circC. The emf (in V) of the redox system thus formed when, (i) 50\% of Fe^{3+} and (ii) 80\% of Fe^{3+} are titrated, would respectively be (Given $E^{\circ}_{Fe^{3+}/Fe^{2+}}$=0.77 V, log 2=0.301)

A. 0.734 and 0.77

B. 0.77 and 0.385

C. 0.77 and 0.734

D. 0.385 and 0.367

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer C 0.77 and 0.734

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- At 50 % titration $[Fe^{3+}] = [Fe^{2+}] \rightarrow E = E^\circ = 0.77$ V. At 80 %: $E = 0.77 + 0.059 \log([Fe^{3+}]/[Fe^{2+}]) = 0.77 + 0.059 \log(0.2/0.8) = 0.77 - 0.0355 = 0.734$ V.
- Therefore the answer is (C).

FINAL: (C) 0.77 and 0.734

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: $E_{cell} = E_R - E_L$ (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: C

A **0.734 and 0.77**

Why (C) is the key — At 50 % titration $[Fe^{3+}] = [Fe^{2+}]$ → $E = E° = 0.77$ V. At 80 %: $E = 0.77 + 0.059 \log([Fe^{3+}]/[Fe^{2+}]) = 0.77 + 0.059 \log(0.2/0.8) = 0.77 - 0.0355 = 0.734$ V.

B **0.77 and 0.385**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **0.385 and 0.367**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q16

If standard emf of the cell, Cu | Cu^{2+}(aq) \| $[Cu(NH_3)_4]^{2+}$, aq.NH_3 | Cu is 0.35, then stability constant of the formation cupric amine complex is

A. 1.0×10^{27}

B. 8.4×10^{5}

C. 7.0×10^{11}

D. 4.3×10^{13}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer C 7.0 × 10^{11}

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- $Cu \mid Cu^{2+} \parallel [Cu(NH_3)_4]^{2+} \mid Cu$: the net cell reaction is complex formation, $E^\circ = (0.0592/2) \log K_f \rightarrow \log K_f = 2 \times 0.35/0.0592 = 11.8 \rightarrow K_f \approx 7\times10^{11}$.
- Therefore the answer is (C).

FINAL: (C) 7.0 × 10^{11}

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: $E_{cell} = E_R - E_L$ (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: C

A **1.0×10^{27}**

Why (C) is the key — Cu | Cu^{2+} || $[Cu(NH_3)_4]^{2+}$ | Cu: the net cell reaction is complex formation, $E^\circ = (0.0592/2) \log K_f \rightarrow \log K_f = 2 \times 0.35/0.0592 = 11.8 \rightarrow K_f \approx 7\times10^{11}$.

B **8.4×10^{5}**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **4.3×10^{13}**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q17

For the concentration cell M | M^+(aq, 0.01 mol dm^{-3}) || M^+(aq, 0.1 mol dm^{-3}) | M the EMF (E) of the cell at a temperature (T) equals

A. 2.303(RT)/(F)

B. -2.303(RT)/(F)

C. $E^o_m{}^+/M$ + 2.303(RT)/(F)

D. $E^o_m{}^+/M$ - 2.303(RT)/(F)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Nernst Cells

Correct Answer A 2.303(RT)/(F)

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- Concentration cell (no E° term): $E = (RT/F)\ln(c_2/c_1) = (RT/F)\ln(0.1/0.01) = (RT/F)\ln 10 = 2.303\ RT/F$ (≈ 59 mV at 298 K).
- Therefore the answer is (A).

FINAL: (A) 2.303(RT)/(F)

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: E_cell = E_R − E_L (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: A

B **-2.303(RT)/(F)**

Why (A) is the key — Concentration cell (no E° term): E = (RT/F) ln(c_2/c_1) = (RT/F) ln(0.1/0.01) = (RT/F) ln 10 = 2.303 RT/F (≈ 59 mV at 298 K).

C **$E^{o}_{m^+}/M$ + 2.303(RT)/(F)**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **$E^{o}_{m^+}/M$ - 2.303(RT)/(F)**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q18 At 298 K, the EMF of the cell pt | H_2 (1 bar) | H^+(solution) || Cl^- | Hg_2Cl_2 Hg is 0.7530 V. The standard potential of the calomel electrode is 0.2802 V. If the liquid junction potential is zero, the pH of the solution is:

A. 4.7

B. 7.4

C. 8.0

D. 12.7

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Nernst Cells

Correct Answer C 8.0

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- $E_{cell} = E(\text{calomel}) - E(H^+/H_2) = 0.2802 - (-0.0591\ pH) = 0.2802 + 0.0591\ pH$. $0.7530 = 0.2802 + 0.0591\ pH \rightarrow pH = 0.4728/0.0591 = 8.0$.
- Therefore the answer is (C).

FINAL: (C) 8.0

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: $E_{cell} = E_R - E_L$ (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: C

A **4.7**

Why (C) is the key — $E_{cell} = E(\text{calomel}) - E(H^+/H_2) = 0.2802 - (-0.0591\ pH) = 0.2802 + 0.0591\ pH$. $0.7530 = 0.2802 + 0.0591\ pH$ → $pH = 0.4728/0.0591 = 8.0$.

B **7.4**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **12.7**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q19 At 25°C, the emf (in volts, rounded off to three decimal places) of the cell, $Ag|AgBr(s)|Br^-(a=0.20), Cu^{2+}(a=0.48), Cu^+(a=0.24)|Pt$ is ___ (Given: The standard emf of the cell is 0.082 V; R = 8.314 J K^{-1} mol^{-1}; F = 96500 C mol^{-1})
(Numerical answer type — write the value.)

ANSWER: ≈ 0.058 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Cell reaction: $Ag + Br^- + Cu^{2+} \rightarrow AgBr + Cu^+$ (n = 1). $Q = a(Cu^+)/[a(Br^-)a(Cu^{2+})] = 0.24/(0.20 \times 0.48) = 2.5$. $E = 0.082 - (0.02569) \ln 2.5 = 0.082 - 0.0235 = 0.058$ V.

Q20

The statement that is correct for both electrochemical (galvanic) cells and electrolytic cell is :

A. $\Delta G = -nFE$

B. Free energy decreases in both cells

C. The cell potential are temperature independent

D. Chemical energy is converted into electrical energy in both cells

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer A Δ G = -nFE

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- ΔG = −nFE holds for any electrochemical cell. In a galvanic cell E > 0 and G decreases spontaneously; in an electrolytic cell E < 0 and electrical energy drives a non-spontaneous reaction (G increases). Potentials do depend on T.
- Therefore the answer is (A).

FINAL: (A) Δ G = -nFE

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: E_cell = E_R − E_L (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: A

B **Free energy decreases in both cells**

Why (A) is the key — ΔG = −nFE holds for any electrochemical cell. In a galvanic cell E > 0 and G decreases spontaneously; in an electrolytic cell E < 0 and electrical energy drives a non-spontaneous reaction (G increases). Potentials do depend on T.

C **The cell potential are temperature independent**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

D **Chemical energy is converted into electrical energy in both cells**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q21

An electrochemical cell consists of two half-cell reactions $AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$; $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ The mass of copper (in grams) dissolved on passing 0.5 A current for 1 hour is [Given: atomic mass of Cu is 63.6; F = 96500 C mol^{-1}]

A. 0.88

B. 1.18

C. 0.29

D. 0.59

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Right minus Left, Reduction potentials'.

Correct Answer D 0.59

CONCEPT

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

↓

LOGIC / WORKING

- Q = 0.5 × 3600 = 1800 C = 1800/96500 = 0.01865 mol e^-. Cu → Cu^{2+} needs 2 e^-: 0.01865/2 × 63.6 = 0.593 ≈ 0.59 g.
- Therefore the answer is (D).

FINAL: (D) 0.59

SHORTCUT / EXAM TRICK

Right-hand electrode is the cathode: $E_{cell} = E_R - E_L$ (both as reduction potentials).

COMMON MISTAKE

Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

EXAM TIP

Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MEMORY TRICK

'Right minus Left, Reduction potentials'.

Why the Other Options Are Wrong

Correct answer: D

A **0.88**

Why (D) is the key — Q = 0.5 × 3600 = 1800 C = 1800/96500 = 0.01865 mol e^-. Cu → Cu^{2+} needs 2 e^-: 0.01865/2 × 63.6 = 0.593 ≈ 0.59 g.

B **1.18**

Ruled out: Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.

C **0.29**

Ruled out: Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

Q22

For a cell reaction, $Pb(s) + Hg_2Cl_2(s) \rightarrow PbCl_2(s) + 2Hg(l)$, $((\partial E^\circ)/(\partial T))_P$ is 1.45×10^{-4} V K^{-1}. The entropy change (in J mol^{-1} K^{-1}) for the reaction is ____
[Given: 1F = 96500 C mol^{-1}]
(Numerical answer type — write the value.)

ANSWER: ≈ 28.0 J K^{-1} mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Nernst Cells

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$\Delta S = nF(\partial E^\circ/\partial T)_P = 2 \times 96500 \times 1.45\times10^{-4} = 27.99 \approx 28.0$ J K^{-1} mol^{-1} (n = 2 for $Pb \rightarrow Pb^{2+}$).

TOPIC REVISION

Nernst Cells

10 PYQs · Last-minute revision

TOPIC SUMMARY

Nernst equation relates E to activities; standard electrodes (SHE, calomel, Ag/AgCl); concentration cells with and without transference; liquid-junction potential; E from ΔG and K; pH and glass electrodes.

IMPORTANT FORMULA SHEET

- $E = E^\circ - (0.0592/n) \log Q$ (25 °C)
- Concentration cell: $E = (0.0592/n) \log(a_2/a_1)$
- With transference: $E = t_- \times E(\text{without})$
- $\Delta S = nF(\partial E/\partial T)_p$; $\Delta H = -nF[E - T(\partial E/\partial T)]$

FREQUENTLY ASKED CONCEPTS

- Half-cell and cell reactions from notation
- E of a concentration cell
- Solubility product from E°
- Transport number from cells with/without transference

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting the activity of water/solids = 1 and putting pressures in atm but concentrations in mol L^{-1} consistently.
Glass electrode: E changes 59.2 mV per pH unit at 25 °C.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22

Expect 2 question(s) next session on Nernst Cells.

TOPIC 3

Conductance

8 questions · Easy 1 | Medium 7 | Hard 0 · PYQ frequency: Very High

Q23

The overall reaction for the passage of 1.0 faraday of charge in the following cell Ag(s)-AgCl(s) | KCl(a_1) | KCl(a_2) | AgCl(s)-Ag(s) is given by (t denotes the transport numbers)

A. t_+ KCl(a_1) → t_+ KCl(a_2)

B. t_+ KCl(a_2) → t_+ KCl(a_1)

C. t_- KCl(a_1) → t_- KCl(a_2)

D. t_- KCl(a_2) → t_- KCl(a_1)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer A $t_+\ KCl(a_1) \rightarrow t_+\ KCl(a_2)$

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance $\Lambda_m = 1000\kappa/c$ (S $cm^2\ mol^{-1}$); strong electrolytes follow Kohlrausch $\Lambda_m = \Lambda° - K\sqrt{c}$; weak electrolytes via Ostwald's dilution law $\alpha = \Lambda_m/\Lambda°$, $K = c\alpha^2/(1-\alpha)$; transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Concentration cell with transference, electrodes reversible to Cl^-. Per faraday: at the left electrode 1 mol Cl^- is consumed (Ag + Cl^- → AgCl + e), t_- mol Cl^- migrate in and t_+ mol K^+ migrate out; net loss of t_+ KCl from a_1 and gain of t_+ KCl at a_2: $t_+KCl(a_1) \rightarrow t_+KCl(a_2)$.
- Therefore the answer is (A).

FINAL: (A) $t_+\ KCl(a_1) \rightarrow t_+\ KCl(a_2)$

SHORTCUT / EXAM TRICK

$\Lambda°(CH_3COOH) = \Lambda°(CH_3COONa) + \Lambda°(HCl) - \Lambda°(NaCl)$.

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: A

B

t_+ KCl(a_2) → t_+ KCl(a_1)

Why (A) is the key — Concentration cell with transference, electrodes reversible to Cl^-. Per faraday: at the left electrode 1 mol Cl^- is consumed (Ag + Cl^- → AgCl + e), t_- mol Cl^- migrate in and t_+ mol K^+ migrate out; net loss of t_+ KCl from a_1 and gain of t_+ KCl at a_2: t_+KCl(a_1) → t_+KCl(a_2).

C

t_- KCl(a_1) → t_- KCl(a_2)

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D

t_- KCl(a_2) → t_- KCl(a_1)

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q24

Kohlrausch's law is applicable to a dilute solution of

A. Potassium chloride in hexane

B. Acetic acid in water

C. Hydrochloric acid in water

D. Benzoic acid in benzene

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer C Hydrochloric acid in water

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance $\Lambda_m = 1000\kappa/c$ (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch $\Lambda_m = \Lambda^\circ - K\sqrt{c}$; weak electrolytes via Ostwald's dilution law $\alpha = \Lambda_m/\Lambda^\circ$, $K = c\alpha^2/(1-\alpha)$; transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Kohlrausch's square-root law $\Lambda = \Lambda^\circ - b\sqrt{c}$ holds for strong electrolytes in a high-dielectric solvent (ionic atmosphere effects). HCl in water is a strong electrolyte; acetic acid is weak (Ostwald law), and KCl/benzoic acid in non-polar solvents do not ionise.
- Therefore the answer is (C).

FINAL: (C) Hydrochloric acid in water

SHORTCUT / EXAM TRICK

$\Lambda^\circ(CH_3COOH) = \Lambda^\circ(CH_3COONa) + \Lambda^\circ(HCl) - \Lambda^\circ(NaCl)$.

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: C

A **Potassium chloride in hexane**

Why (C) is the key — Kohlrausch's square-root law $\Lambda = \Lambda^\circ - b\sqrt{c}$ holds for strong electrolytes in a high-dielectric solvent (ionic atmosphere effects). HCl in water is a strong electrolyte; acetic acid is weak (Ostwald law), and KCl/benzoic acid in non-polar solvents do not ionise.

B **Acetic acid in water**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D **Benzoic acid in benzene**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q25

The limiting molar conductivities of NaCl, NaI and RbI are 12.7, 10.8 and 9.1 mS m² mol⁻¹, respectively. The limiting molar conductivity of RbCl would be

A. 32.6 mS m² mol⁻¹

B. 7.2 mS m² mol⁻¹

C. 14.4 mS m² mol⁻¹

D. 11.0 mS m² mol⁻¹

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer D 11.0 mS m² mol⁻¹

CONCEPT

Specific conductance κ (S cm⁻¹), molar conductance Λ_m = 1000κ/c (S cm² mol⁻¹); strong electrolytes follow Kohlrausch Λ_m = Λ° − K√c; weak electrolytes via Ostwald's dilution law α = Λ_m/Λ°, K = cα²/(1−α); transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Λ°(RbCl) = Λ°(NaCl) − Λ°(NaI) + Λ°(RbI) = 12.7 − 10.8 + 9.1 = 11.0 mS m² mol⁻¹ (d).
- Therefore the answer is (D).

FINAL: (D) 11.0 mS m² mol⁻¹

SHORTCUT / EXAM TRICK

Λ°(CH_3COOH) = Λ°(CH_3COONa) + Λ°(HCl) − Λ°(NaCl).

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L⁻¹, κ in S cm⁻¹); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: D

A **32.6 mS m² mol⁻¹**

Why (D) is the key — $\Lambda°(RbCl) = \Lambda°(NaCl) - \Lambda°(NaI) + \Lambda°(RbI) = 12.7 - 10.8 + 9.1 = 11.0$ mS m² mol⁻¹ (d).

B **7.2 mS m² mol⁻¹**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

C **14.4 mS m² mol⁻¹**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q26

If the concentration (c) is increased to 4 times its original value (c), the change in molar conductivity for strong electrolytes is (where b is Kohlrausch constant)

A. 0

B. b√(c)

C. 2b√(c)

D. 4b√(c)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer B b√(c)

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance Λ_m = 1000κ/c (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch Λ_m = Λ° − K√c; weak electrolytes via Ostwald's dilution law α = Λ_m/Λ°, K = cα^2/(1−α); transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Kohlrausch: Λ = Λ° − b√c. Going from c to 4c: ΔΛ = b(√(4c) − √c) = b(2√c − √c) = b√c (decrease).
- Therefore the answer is (B).

FINAL: (B) b√(c)

SHORTCUT / EXAM TRICK

Λ°(CH$_3$COOH) = Λ°(CH$_3$COONa) + Λ°(HCl) − Λ°(NaCl).

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: B

A **0**

Why (B) is the key — Kohlrausch: $\Lambda = \Lambda^\circ - b\sqrt{c}$. Going from c to 4c: $\Delta\Lambda = b(\sqrt{(4c)} - \sqrt{c}) = b(2\sqrt{c} - \sqrt{c}) = b\sqrt{c}$ (decrease).

C **2b√(c)**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D **4b√(c)**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q27

Conductometric titration of a strong acid with a strong alkali (MOH) shows linear fall of conductance up to neutralization point because of

A. formation of water

B. increase in alkali concentration

C. faster moving H^+ being replaced by slower moving M^+

D. neutralization of acid

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer C faster moving H^+ being replaced by slower moving M^+

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance $\Lambda_m = 1000\kappa/c$ (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch $\Lambda_m = \Lambda^\circ - K\sqrt{c}$; weak electrolytes via Ostwald's dilution law $\alpha = \Lambda_m/\Lambda^\circ$, $K = c\alpha^2/(1-\alpha)$; transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Before the end point every H^+ ($\lambda^\circ \approx 350$) neutralised is replaced by the much slower M^+ ($\lambda^\circ \approx 50–74$), so conductance falls linearly; after the end point excess OH^- ($\lambda^\circ \approx 198$) makes it rise.
- Therefore the answer is (C).

FINAL: (C) faster moving H^+ being replaced by slower moving M^+

SHORTCUT / EXAM TRICK

$\Lambda^\circ(CH_3COOH) = \Lambda^\circ(CH_3COONa) + \Lambda^\circ(HCl) - \Lambda^\circ(NaCl)$.

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: C

A **formation of water**

Why (C) is the key — Before the end point every H^+ ($\lambda^\circ \approx 350$) neutralised is replaced by the much slower M^+ ($\lambda^\circ \approx 50–74$), so conductance falls linearly; after the end point excess OH^- ($\lambda^\circ \approx 198$) makes it rise.

B **increase in alkali concentration**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D **neutralization of acid**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q28

The specific conductance of a solution is 0.176 Ω^{-1} cm^{-1}. If the cell constant is 0.255 cm^{-1}, the conductance (Ω^{-1}) of that solution is

A. 1.449

B. 0.690

C. 0.045

D. 0.431

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer B 0.690

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance $\Lambda_m = 1000\kappa/c$ (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch $\Lambda_m = \Lambda^\circ - K\sqrt{c}$; weak electrolytes via Ostwald's dilution law $\alpha = \Lambda_m/\Lambda^\circ$, $K = c\alpha^2/(1-\alpha)$; transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- $\kappa = G \times$ (cell constant) $\rightarrow G = \kappa/(l/A) = 0.176/0.255 = 0.690\ \Omega^{-1}$.
- Therefore the answer is (B).

FINAL: (B) 0.690

SHORTCUT / EXAM TRICK

$\Lambda^\circ(CH_3COOH) = \Lambda^\circ(CH_3COONa) + \Lambda^\circ(HCl) - \Lambda^\circ(NaCl)$.

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: B

A **1.449**

Why (B) is the key — $\kappa = G \times$ (cell constant) $\rightarrow G = \kappa/(l/A) = 0.176/0.255 = 0.690\ \Omega^{-1}$.

C **0.045**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D **0.431**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q29

For weak electrolyte like acetic acid, the relation among conductance (λ), equilibrium constant (K) and concentration (C) can be expressed as: (λ₀ is conductance at infinite dilution)

A. (1)/(λ) = (1)/(λ^o) - (Cλ)/(kλ^o)

B. (1)/(λ) = (1)/(λ^o) + (Cλ)/(Kλ^o)

C. (1)/(λ) = (1)/(λ^o) + (Cλ)/(Kλ^o2)

D. (1)/(λ) = (Cλ)/(Kλ^o2)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Kohlrausch: Λ drops with root c'.

Correct Answer C (1)/(λ) = (1)/(λ^o) + (Cλ)/(Kλ^o2)

CONCEPT

Specific conductance κ (S cm^{-1}), molar conductance Λ_m = 1000κ/c (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch Λ_m = Λ° − K√c; weak electrolytes via Ostwald's dilution law α = Λ_m/Λ°, K = cα^2/(1−α); transport numbers (Hittorf, moving boundary); conductometric titrations.

↓

LOGIC / WORKING

- Ostwald dilution law: K = Cα^2/(1 − α) with α = λ/λ°. Rearranging: 1/λ = 1/λ° + Cλ/(Kλ°^{2}) — the λ° in the second term is squared. (Bank key (b) omits the square — corrected.)
- Therefore the answer is (C).

FINAL: (C) (1)/(λ) = (1)/(λ^o) + (Cλ)/(Kλ^o2)

SHORTCUT / EXAM TRICK

Λ°(CH$_3$COOH) = Λ°(CH$_3$COONa) + Λ°(HCl) − Λ°(NaCl).

COMMON MISTAKE

Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

EXAM TIP

Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MEMORY TRICK

'Kohlrausch: Λ drops with root c'.

Why the Other Options Are Wrong

Correct answer: C

A **(1)/(λ) = (1)/(λ^o) - (Cλ)/(kλ^o)**

Why (C) is the key — Ostwald dilution law: K = Cα²/(1 − α) with α = λ/λ°. Rearranging: 1/λ = 1/λ° + Cλ/(Kλ°²) — the λ° in the second term is squared. (Bank key (b) omits the square — corrected.)

B **(1)/(λ) = (1)/(λ^o) + (Cλ)/(Kλ^o)**

Ruled out: Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.

D **(1)/(λ) = (Cλ)/(Kλ^o2)**

Ruled out: Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

Q30

The limiting molar conductivity of La^{3+} and Cl^- ions in aqueous medium at 298 K are 209.10×10^{-4} and 76.35×10^{-4} S m² mol⁻¹, respectively. The transport number of Cl^- in an infinitely dilute aqueous solution of $LaCl_3$ at 298 K is ___. (Round off to two decimal places).
(Numerical answer type — write the value.)

ANSWER: 0.52

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Conductance

PYQ FREQUENCY
Very High · 8 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$\Lambda°(LaCl_3) = \lambda°(La^{3+}) + 3\lambda°(Cl^-) = 209.10 + 229.05 = 438.15$ ($\times 10^{-4}$ S m² mol⁻¹). $t(Cl^-) = 3\lambda°(Cl^-)/\Lambda° = 229.05/438.15 = 0.52$.

TOPIC REVISION

Conductance

8 PYQs · Last-minute revision

TOPIC SUMMARY

Specific conductance κ (S cm^{-1}), molar conductance $\Lambda_m = 1000\kappa/c$ (S cm^2 mol^{-1}); strong electrolytes follow Kohlrausch $\Lambda_m = \Lambda^\circ - K\sqrt{c}$; weak electrolytes via Ostwald's dilution law $\alpha = \Lambda_m/\Lambda^\circ$, $K = c\alpha^2/(1-\alpha)$; transport numbers (Hittorf, moving boundary); conductometric titrations.

IMPORTANT FORMULA SHEET

- $\Lambda_m = 1000\kappa/c$
- $\Lambda^\circ = \lambda^\circ_+ + \lambda^\circ_-$ (law of independent migration)
- $K_a = c\Lambda^2/(\Lambda^\circ(\Lambda^\circ - \Lambda))$
- $t_+ = \lambda_+/(\lambda_+ + \lambda_-)$; $u = \lambda/F$
- Cell constant = κ_{KCl}/G

FREQUENTLY ASKED CONCEPTS

- Λ° of a weak acid from strong-electrolyte data
- Titration curve shapes
- Ionic mobility and transport number
- Abnormal mobility of H^+ and OH^- (Grotthuss)

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting the factor 1000 (c in mol L^{-1}, κ in S cm^{-1}); dividing conductance by cell constant instead of multiplying.
Strong acid–strong base titration: conductance falls, then rises (V shape); weak acid–strong base: slight rise, then steep rise.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30

Expect 1 question(s) next session on Conductance.

TOPIC 4

Electrochemistry – General

42 questions · Easy 9 | Medium 30 | Hard 3 · PYQ frequency: Very High

Q31

The Daniel cell is

A. $Pt_I(s) \mid Zn(s) \mid Zn^{2+}(aq) \vert\vert Cu^{2+}(aq) \mid Cu(s) \mid Pt_II$

B. $Pt_I(s) \mid Zn(s) \mid Zn^{2+}(aq) \vert\vert Ag^{2+}(aq) \mid Ag(s) \mid Pt_II$

C. $Pt_I(s) \mid Fe(s) \mid Fe^{2+}(aq) \vert\vert Cu^{2+}(aq) \mid Cu(s) \mid Pt_II$

D. $Pt_I(s) \mid H_2(s) \mid H_2SO_4(aq) \vert\vert Cu^{2+}(aq) \mid Cu(s) \mid Pt_II$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A $Pt_I(s) \mid Zn(s) \mid Zn^{2+}(aq) \mid\mid Cu^{2+}(aq) \mid Cu(s) \mid Pt_II$

CONCEPT

Galvanic cells convert ΔG into electrical work: $\Delta G = -nFE$; $E = E^\circ - (RT/nF) \ln Q$ (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Daniell cell: Zn anode in $ZnSO_4$ and Cu cathode in $CuSO_4$, $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$, $E^\circ = 1.10$ V.
- Therefore the answer is (A).

FINAL: (A) $Pt_I(s) \mid Zn(s) \mid Zn^{2+}(aq) \mid\mid Cu^{2+}(aq) \mid Cu(s) \mid Pt_II$

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **Pt_I(s) | Zn(s) | Zn^{2+}(aq) \|\| Ag^{2+}(aq) | Ag(s) | Pt_II**

Why (A) is the key — Daniell cell: Zn anode in $ZnSO_4$ and Cu cathode in $CuSO_4$, $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$, $E° = 1.10$ V.

C **Pt_I(s) | Fe(s) | Fe^{2+}(aq) \|\| Cu^{2+}(aq) | Cu(s) | Pt_II**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **Pt_I(s) | H_2(s) | H_2SO_4(aq) \|\| Cu^{2+}(aq) | Cu(s) | Pt_II**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q32

In a potentiometric titration, the end point is obtained by observing

A. change in colour

B. jump in potential

C. increase in current

D. increase in turbidity

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B jump in potential

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- In a potentiometric titration the emf changes sharply (a 'jump' in E vs V, maximum dE/dV) at the equivalence point; no indicator or current measurement is involved.
- Therefore the answer is (B).

FINAL: (B) jump in potential

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A — **change in colour**

Why (B) is the key — In a potentiometric titration the emf changes sharply (a 'jump' in E vs V, maximum dE/dV) at the equivalence point; no indicator or current measurement is involved.

C — **increase in current**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D — **increase in turbidity**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q33

Electrolysis of an aqueous solution of 1.0 M NaOH results in

A. Na at the cathode and O_2 at the anode

B. H_2 at the cathode and O_2 at the anode

C. Na and H_2 at the cathode, and O_2 at the anode

D. O_2 at the cathode and H_2 at the anode

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B H_2 at the cathode and O_2 at the anode

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Na^+ cannot be reduced in water (E° = −2.71 V); water/H^+ is reduced to H_2 at the cathode and OH^- is oxidised to O_2 at the anode — net electrolysis of water.
- Therefore the answer is (B).

FINAL: (B) H_2 at the cathode and O_2 at the anode

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A — **Na at the cathode and O_2 at the anode**

Why (B) is the key — Na^+ cannot be reduced in water ($E° = -2.71$ V); water/H^+ is reduced to H_2 at the cathode and OH^- is oxidised to O_2 at the anode — net electrolysis of water.

C — **Na and H_2 at the cathode, and O_2 at the anode**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D — **O_2 at the cathode and H_2 at the anode**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q34

Given that E^o(Cl₂/Cl⁻) = 1.35 V and K_{sp}(AgCl) = 10^{-10} at 25Â°C, E_o corresponding to the electrode reaction (1)/(2)Cl₂(g) + Ag^+(Soln.) + e^- → AgCl(s) is [(2.303RT)/(F) = 0.06 V]

A. 0.75 V

B. 1.05 V

C. 1.65 V

D. 1.95 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D 1.95 V

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Add ½Cl_2 + e → Cl^- (1.35 V) and $Ag^+ + Cl^- \rightarrow AgCl$ (ΔG = RT ln K_sp, i.e. contributes −0.06 log K_sp = +0.60 V for a 1-electron process): E° = 1.35 + 0.60 = 1.95 V.
- Therefore the answer is (D).

FINAL: (D) 1.95 V

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **0.75 V**

Why (D) is the key — Add ½Cl_2 + e → Cl^- (1.35 V) and Ag^+ + Cl^- → AgCl (ΔG = RT ln K_sp, i.e. contributes −0.06 log K_sp = +0.60 V for a 1-electron process): E° = 1.35 + 0.60 = 1.95 V.

B **1.05 V**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **1.65 V**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q35

Given (i) $Zn + 4NH_3 \rightarrow Zn(NH_3)_4^{2+} + 2e$, $E^\circ = 1.03$ V (ii) $Zn \rightarrow Zn^{+2} + 2e$, $E^0 = 0.763$ V the formation constant of the complex $Zn(NH_3)_4^{2+}$ is approximately

A 1×10^5

B 1×10^7

C 1×10^9

D 1×10^{12}

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 1×10^9

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- $Zn^{2+} + 4NH_3 \rightarrow Zn(NH_3)_4^{2+}$: E° = 1.03 − 0.763 = 0.267 V with n = 2. log K_f = nE°/0.0592 = 2 × 0.267/0.0592 = 9.0 → K_f ≈ 10^9.
- Therefore the answer is (C).

FINAL: (C) 1×10^9

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **1×10^{5}**

Why (C) is the key — $Zn^{2+} + 4NH_3 \rightarrow Zn(NH_3)_4^{2+}$: $E^\circ = 1.03 - 0.763 = 0.267$ V with n = 2. $\log K_f = nE^\circ/0.0592 = 2 \times 0.267/0.0592 = 9.0 \rightarrow K_f \approx 10^9$.

B **1×10^{7}**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **1×10^{12}**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q36

The correct statement among the following is

A. Salt bridge is required for the mixing of the solutions in the two half cells

B. Salt bridge allows current to flow between the half cells without mixing the solutions

C. Salt bridge enhances the rate of the reaction

D. Salt bridge consists of a non-electrolyte in a gel

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B Salt bridge allows current to flow between the half cells without mixing the solutions

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- A salt bridge (KCl/KNO_3 in agar gel) completes the circuit by ionic conduction and prevents mixing of the two half-cell solutions; it does not take part in the reaction and minimises the junction potential.
- Therefore the answer is (B).

FINAL: (B) Salt bridge allows current to flow between the half cells without mixing the solutions

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **Salt bridge is required for the mixing of the solutions in the two half cells**

Why (B) is the key — A salt bridge (KCl/KNO_3 in agar gel) completes the circuit by ionic conduction and prevents mixing of the two half-cell solutions; it does not take part in the reaction and minimises the junction potential.

C **Salt bridge enhances the rate of the reaction**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **Salt bridge consists of a non-electrolyte in a gel**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q37

The standard free energy of the reaction $AgBr(s) \rightarrow Ag^{+}(aq) + Br^{-}(aq)$ Is closest to. [$E^{\circ}(AgBr/Ag,Br^{-}) = 0.07$ V ; $E^{\circ}(Ag/Ag^{+}) = 0.80$ V; F = 96500 C mol^{-1}]

A. 7 kJ mol^{-1}

B. 70 J mol^{-1}

C. 70 kJ mol^{-1}

D. 7 J mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 70 kJ mol⁻¹

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Cell for AgBr(s) → $Ag^+ + Br^-$: $E° = E°(AgBr/Ag,Br^-) − E°(Ag^+/Ag) = 0.07 − 0.80 = −0.73$ V. $ΔG° = −nFE° = −1 × 96500 × (−0.73) = +70.4$ kJ mol⁻¹ ≈ 70 kJ mol⁻¹ (unfavourable, as expected for a sparingly soluble salt).
- Therefore the answer is (C).

FINAL: (C) 70 kJ mol⁻¹

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow ΔG < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **7 kJ mol^{-1}**

Why (C) is the key — Cell for AgBr(s) → $Ag^+ + Br^-$: $E° = E°(AgBr/Ag,Br^-) - E°(Ag^+/Ag) = 0.07 - 0.80 = -0.73$ V. $\Delta G° = -nFE° = -1 \times 96500 \times (-0.73) = +70.4$ kJ mol^{-1} ≈ 70 kJ mol^{-1} (unfavourable, as expected for a sparingly soluble salt).

B **70 J mol^{-1}**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **7 J mol^{-1}**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q38 **Conductivities of water and a saturated solution of a sparingly soluble salt AB_2 are 7 and 21 muS m^{-1}, respectively. Given, $\lambda^{\circ}_{A^{2+}} = 12.72$ mS m^2 mol^{-1} and $\lambda^{\circ}_{B^{2-}} = 7.64$ mS m^2 mol^{-1}, the solubility of AB_2, in mol m^{-3}, is**

A 5.0×10^{-4}

B 5.0×10^{-3}

C 5.0×10^{-5}

D 5.0×10^{-6}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A 5.0×10^{-4}

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- κ(salt) = 21 − 7 = 14 μS m^{-1}. $\Lambda°(AB_2) = \lambda°(A^{2+}) + 2\lambda°(B^-) = 12.72 + 2 \times 7.64 = 28.0$ mS m^2 mol^{-1}. $S = \kappa/\Lambda° = 14\times10^{-6}/28\times10^{-3} = 5.0\times10^{-4}$ mol m^{-3}.
- Therefore the answer is (A).

FINAL: (A) 5.0×10^{-4}

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **5.0×10^{-3}**

Why (A) is the key — κ(salt) = 21 − 7 = 14 μS m^{-1}. $\Lambda°(AB_2) = \lambda°(A^{2+}) + 2\lambda°(B^-) = 12.72 + 2 \times 7.64 = 28.0$ mS m^2 mol^{-1}. $S = \kappa/\Lambda° = 14\times10^{-6}/28\times10^{-3} = 5.0\times10^{-4}$ mol m^{-3}.

C **5.0×10^{-5}**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **5.0×10^{-6}**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q39

The equilibrium constant of the following reaction: $Sn(s) + Sn^{4+}(aq) \rightleftharpoons 2Sn^{2+}(aq)$ At 300 K is closest to, (Given, $E^{\circ}_{Sn^{4+}/Sn^{2+}} = 0.15$ V and, $E^{\circ}_{Sn^{2+}/Sn} = -0.15$ V, R = 8.314 J K^{-1} mol^{-1})

A $10^{6}.08$

B $10^{8}.08$

C $10^{1}0.08$

D $10^{1}2.08$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 10¹0.08

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- E°_cell = E°(Sn^{4+}/Sn^{2+}) − E°(Sn^{2+}/Sn) = 0.15 − (−0.15) = 0.30 V, n = 2. log K = nFE°/(2.303RT) = 2 × 0.30/0.0595 (300 K) = 10.08 → K = 10^{10.08}.
- Therefore the answer is (C).

FINAL: (C) 10¹0.08

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **10^{6}.08**

Why (C) is the key — E°_cell = E°(Sn^{4+}/Sn^{2+}) − E°(Sn^{2+}/Sn) = 0.15 − (−0.15) = 0.30 V, n = 2. log K = nFE°/(2.303RT) = 2 × 0.30/0.0595 (300 K) = 10.08 → K = 10^{10.08}.

B **10^{8}.08**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **10^{1}2.08**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q40

For the electrochemical cell Ag | AgCl | MCl (0.01 M) | MCl (0.02 M) | AgCl | Ag, the junction potential is the highest when M^+ is

A. H^+

B. Li^+

C. Na^+

D. K^+

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A H^+

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- E_junction ∝ $(t_+ - t_-)$ $\ln(a_2/a_1)$. H^+ has by far the highest mobility (Grotthuss mechanism, $t_+ \approx 0.82$), so the transport-number difference and the junction potential are greatest for HCl.
- Therefore the answer is (A).

FINAL: (A) H^+

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) $\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B Li^+

Why (A) is the key — $E_{junction} \propto (t_+ - t_-) \ln(a_2/a_1)$. H^+ has by far the highest mobility (Grotthuss mechanism, $t_+ \approx 0.82$), so the transport-number difference and the junction potential are greatest for HCl.

C Na^+

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D K^+

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q41

The $E_o(M^+/M)$ of the cell, SHE \| MX \| M can be obtained from the plot of (E_cell is the cell potential and m is molality of ideal dilute solution of MX)

A. E_cell vs (Tlog m)

B. E_cell vs ((1)/(T)log m)

C. E_cell vs T√(m)

D. E_cell vs (frac√(m)T)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A E_cell vs (Tlog m)

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- For SHE || MX(m) | M (ideal dilute, γ± = 1): E_cell = E°(M^+/M) + (RT/F) ln m = E° + 2.303(R/F)(T log m). A plot of E_cell against T log m is linear with intercept E°.
- Therefore the answer is (A).

FINAL: (A) E_cell vs (Tlog m)

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **E_cell vs ((1)/(T)log m)**

Why (A) is the key — For SHE || MX(m) | M (ideal dilute, γ± = 1): E_cell = E°(M⁺/M) + (RT/F) ln m = E° + 2.303(R/F)(T log m). A plot of E_cell against T log m is linear with intercept E°.

C **E_cell vs T√(m)**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **E_cell vs (frac√(m)T)**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q42

The temperature-dependence of an electrochemical cell potential is

A (Δ G)/(nFT)

B (Δ H)/(nF)

C (Δ S)/(nF)

D (Δ S)/(nFT)

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C (Δ S)/(nF)

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- ΔG = −nFE and $(\partial \Delta G/\partial T)_P = -\Delta S \rightarrow (\partial E/\partial T)_P = \Delta S/nF$ (the temperature coefficient of the emf gives the reaction entropy).
- Therefore the answer is (C).

FINAL: (C) (Δ S)/(nF)

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **(Δ G)/(nFT)**

Why (C) is the key — $\Delta G = -nFE$ and $(\partial \Delta G/\partial T)_P = -\Delta S \rightarrow (\partial E/\partial T)_P = \Delta S/nF$ (the temperature coefficient of the emf gives the reaction entropy).

B **(Δ H)/(nF)**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **(Δ S)/(nFT)**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q43

In a potentiometric titration, the end point is characterised by

A. $(dE)/(dV) = 0$; $(d^2E)/(d^2V) = 0$

B. $(dE)/(dV) \neq 0$; $(d^2E)/(d^2V) = 0$

C. $(dE)/(dV) = 0$; $(d^2E)/(d^2V) \neq 0$

D. $(dE)/(dV) \neq 0$; $(d^2E)/(d^2V) \neq 0$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B (dE)/(dV) ≠ 0; (d²E)/(d²V) = 0

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- At the equivalence point the titration curve E vs V is steepest: dE/dV is a maximum (≠ 0) and therefore its derivative $d^2E/dV^2 = 0$ (inflection point).
- Therefore the answer is (B).

FINAL: (B) (dE)/(dV) ≠ 0; (d²E)/(d²V) = 0

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **$(dE)/(dV) = 0; (d^2E)/(d^2V) = 0$**

Why (B) is the key — At the equivalence point the titration curve E vs V is steepest: dE/dV is a maximum (≠ 0) and therefore its derivative $d^2E/dV^2 = 0$ (inflection point).

C **$(dE)/(dV) = 0; (d^2E)/(d^2V) \neq 0$**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **$(dE)/(dV) \neq 0; (d^2E)/(d^2V) \neq 0$**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q44

The standard cell potential of cell, Pt | $H_2(g)$ | HBr(aq) | AgBr(s) | Ag(s), was measured over a range of temperatures, and the data was fitted as $E^0(Volt) = 0.01 - 1\times10^{-4}(T-298) - 2\times10^{-6}(T-298)^2$ The standard reaction entropy (J K^{-1} mol^{-1}) and enthalpy (kJ mol^{-1}) at 298 K are

A. -9.65 and -3.84

B. -3.84 and -9.65

C. -18.3 and -7.68

D. -7.68 and -18.3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A -9.65 and -3.84

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- $(\partial E^\circ/\partial T)$ at 298 K = -1×10^{-4} V K^{-1} → $\Delta S^\circ = nF(\partial E^\circ/\partial T) = 96500 \times (-1\times10^{-4}) = -9.65$ J K^{-1} mol^{-1}. $\Delta G^\circ = -nFE^\circ = -96500 \times 0.01 = -965$ J; $\Delta H^\circ = \Delta G^\circ + T\Delta S^\circ = -965 - 298 \times 9.65 = -3841$ J = −3.84 kJ mol^{-1}.
- Therefore the answer is (A).

FINAL: (A) -9.65 and -3.84

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **-3.84 and -9.65**

Why (A) is the key — $(\partial E^\circ/\partial T)$ at 298 K = -1×10^{-4} V K^{-1} → $\Delta S^\circ = nF(\partial E^\circ/\partial T) = 96500 \times (-1\times10^{-4}) = -9.65$ J K^{-1} mol^{-1}. $\Delta G^\circ = -nFE^\circ = -96500 \times 0.01 = -965$ J; $\Delta H^\circ = \Delta G^\circ + T\Delta S^\circ = -965 - 298 \times 9.65 = -3841$ J = −3.84 kJ mol^{-1}.

C **-18.3 and -7.68**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **-7.68 and -18.3**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q45

The electrochemical cell potential (E), after the reactants and products reach equilibrium, is (E^0 is the standard cell potential and n is the number of electrons involved)

A. E = E^° + (nF)/(RT)

B. E = E^° - (nF)/(RT)

C. E = E^°

D. E = 0

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D E = 0

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- At equilibrium ΔG = 0, and since ΔG = −nFE, the cell potential E = 0 (a 'dead' battery); E° itself is unchanged and relates to K by E° = (RT/nF) ln K.
- Therefore the answer is (D).

FINAL: (D) E = 0

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **E = E^° + (nF)/(RT)**

Why (D) is the key — At equilibrium ΔG = 0, and since ΔG = −nFE, the cell potential E = 0 (a 'dead' battery); E° itself is unchanged and relates to K by E° = (RT/nF) ln K.

B **E = E^° - (nF)/(RT)**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **E = E^°**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q46

The standard cell potential for the reaction Zn(s) + Cu^{2+}(aq) Leftrightarrow Zn^{2+}(aq) + Cu(s) is +1.10 V. The Gibbs free energy change during the reaction is (F = 96500 coulomb mol^{-1})

A. -21.2 kJ mol^{-1}

B. +212 kJ mol^{-1}

C. -212 kJ mol^{-1}

D. -212 J mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C -212 kJ mol⁻¹

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- ΔG° = −nFE° = −2 × 96500 × 1.10 = −212 300 J = −212 kJ mol⁻¹.
- Therefore the answer is (C).

FINAL: (C) -212 kJ mol⁻¹

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **-21.2 kJ mol⁻¹**

Why (C) is the key — $\Delta G^\circ = -nFE^\circ = -2 \times 96500 \times 1.10 = -212\,300$ J = −212 kJ mol⁻¹.

B **+212 kJ mol⁻¹**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **-212 J mol⁻¹**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q47 If the overpotential of an electrolysis process is increased from 0.5 V to 0.6 V, then the ratio of current densities (ln (J_o.6)/(J_o.5)) of the electrolysis will be equal to (given transfer coefficient = 0.5)

A. 0.5(F)/(RT)

B. 0.05(F)/(RT)

C. 0.1(F)/(RT)

D. 0.01(F)/(RT)

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B 0.05(F)/(RT)

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Tafel/Butler–Volmer (anodic branch): ln j = ln j_0 + αFη/RT. ln($j_{0.6}/j_{0.5}$) = αF(0.6 − 0.5)/RT = 0.5 × 0.1 F/RT = 0.05 F/RT.
- Therefore the answer is (B).

FINAL: (B) 0.05(F)/(RT)

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **0.5(F)/(RT)**

Why (B) is the key — Tafel/Butler–Volmer (anodic branch): ln j = ln j_0 + αFη/RT. ln($j_{0.6}$/$j_{0.5}$) = αF(0.6 − 0.5)/RT = 0.5 × 0.1 F/RT = 0.05 F/RT.

C **0.1(F)/(RT)**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **0.01(F)/(RT)**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q48

The mobility of a divalent cation in water is $8\times10^{-8}m^2V^{-1}s^{-1}$. The effective radius of the ion is (viscosity of water =1cP; e=1.6×10^{-19}C)

A. 106 pm

B. 212 pm

C. 424 pm

D. 318 pm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B 212 pm

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Stokes: $u = ze/(6\pi\eta r) \rightarrow r = ze/(6\pi\eta u) = 2 \times 1.6\times10^{-19}/(6\pi \times 1\times10^{-3} \times 8\times10^{-8}) = 3.2\times10^{-19}/1.51\times10^{-9} = 2.12\times10^{-10}$ m = 212 pm.
- Therefore the answer is (B).

FINAL: (B) 212 pm

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **106 pm**

Why (B) is the key — Stokes: $u = ze/(6\pi\eta r) \rightarrow r = ze/(6\pi\eta u) = 2 \times 1.6\times10^{-19}/(6\pi \times 1\times10^{-3} \times 8\times10^{-8}) = 3.2\times10^{-19}/1.51\times10^{-9} = 2.12\times10^{-10}$ m = 212 pm.

C **424 pm**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **318 pm**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q49

For the cell Cd | $CdCl_2$ || AgCl | Ag; $E^\circ_{cell} = 0.675$ V and $dE^\circ_{cell}/dT = -6.5 \times 10^{-4}$ V K^{-1} at 27Â°C. The Δ H (kJ mol^{-1}) value for the reaction Cd + 2AgCl → 2Ag + $CdCl_2$ is closest to

A. -168

B. -123

C. -95

D. -234

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A -168

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- ΔH = −nF[E° − T(dE°/dT)] = −2 × 96500 × [0.675 − 300 × (−6.5×10⁻⁴)] = −193 000 × 0.870 = −167.9 kJ mol⁻¹ ≈ −168.
- Therefore the answer is (A).

FINAL: (A) -168

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **-123**

Why (A) is the key — $\Delta H = -nF[E^\circ - T(dE^\circ/dT)] = -2 \times 96500 \times [0.675 - 300 \times (-6.5\times10^{-4})] = -193\,000 \times 0.870 = -167.9$ kJ mol$^{-1} \approx -168$.

C **-95**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **-234**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q50

Aqueous solution of sodium chloride (χ_NaCl = 0.015) at 298 K is in equilibrium with a water vapour pressure (in torr) of

A. 23.64q

B. 748.60

C. 24.36

D. negligible

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A 23.64q

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Raoult: p = x_water p° = (1 − 0.015) × 23.76 torr ≈ 23.4 torr — closest to 23.64 torr (option (a); the bank's p° is ≈ 24 torr). Vapour pressure is lowered only slightly by the non-volatile solute.
- Therefore the answer is (A).

FINAL: (A) 23.64q

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **748.60**

Why (A) is the key — Raoult: p = x_water p° = (1 − 0.015) × 23.76 torr ≈ 23.4 torr — closest to 23.64 torr (option (a); the bank's p° is ≈ 24 torr). Vapour pressure is lowered only slightly by the non-volatile solute.

C **24.36**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **negligible**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q51

Average value of enthalpy of vaporisation (in kJ/mol) of water between 363 and 373 K is

A. 42.50

B. 40.80

C. -40.65

D. -40.80

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B 40.80

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Clausius–Clapeyron over 363–373 K with the vapour pressures of water (529 and 760 torr) gives ln(760/529) = (ΔH/R)(1/363 − 1/373) → ΔH ≈ 40.8 kJ mol⁻¹, positive (vaporisation is endothermic).
- Therefore the answer is (B).

FINAL: (B) 40.80

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **42.50**

Why (B) is the key — Clausius–Clapeyron over 363–373 K with the vapour pressures of water (529 and 760 torr) gives ln(760/529) = (ΔH/R)(1/363 − 1/373) → ΔH ≈ 40.8 kJ mol^{-1}, positive (vaporisation is endothermic).

C **-40.65**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **-40.80**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q52

For a redox reaction, $Cd^{2+} + 2e^- \rightleftharpoons Cd$, the $(E_p)_a$nodic observed in cyclic voltametry at hanging mercury drop electrode is -650 mV vs. SCE. The expected value for (E_p)_cathodic is

A. –708 mV

B. –679 mV

C. –650 mV

D. –621 mV

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B –679 mV

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- For a reversible n-electron couple the CV peak separation ΔE_p = 59/n mV = 29.5 mV for n = 2. E_p,c = E_p,a − 29 ≈ −679 mV vs SCE.
- Therefore the answer is (B).

FINAL: (B) –679 mV

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **–708 mV**

Why (B) is the key — For a reversible n-electron couple the CV peak separation ΔE_p = 59/n mV = 29.5 mV for n = 2. E_p,c = E_p,a − 29 ≈ −679 mV vs SCE.

C **–650 mV**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **–621 mV**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q53

Given that $E_0(Fe^{3+}, Fe) = -0.04$ V and $E_0(Fe^{2+}, Fe) = -0.44$ V, the value of $E_0(Fe^{3+}, Fe^{2+})$ is:

A. 0.76 V

B. −0.40 V

C. −0.76 V

D. 0.40 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer A 0.76 V

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Latimer: ΔG values add. $E°(Fe^{3+}/Fe^{2+}) = [3E°(Fe^{3+}/Fe) − 2E°(Fe^{2+}/Fe)]/1 = [3(−0.04) − 2(−0.44)] = −0.12 + 0.88 = +0.76$ V (literature 0.77 V).
- Therefore the answer is (A).

FINAL: (A) 0.76 V

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: A

B **−0.40 V**

Why (A) is the key — Latimer: ΔG values add. $E°(Fe^{3+}/Fe^{2+}) = [3E°(Fe^{3+}/Fe) − 2E°(Fe^{2+}/Fe)]/1 = [3(−0.04) − 2(−0.44)] = −0.12 + 0.88 = +0.76$ V (literature 0.77 V).

C **−0.76 V**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **0.40 V**

Ruled out: $\Delta H = −nF[E − T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q54

In the mixture obtained by mixing 25.0 mL 1.2×10^{-3} M $MnCl_2$ and 35.0 mL of 6.0×10^{-4} M KCl solution, the concentrations (M) of Mn^{2+}, K^+ and Cl^- ions respectively are

A. 6.0×10^{-4}, 3.0×10^{-4}, 1.5×10^{-3}

B. 6.0×10^{-4}, 3.0×10^{-4}, 9.0×10^{-4}

C. 5.0×10^{-4}, 3.5×10^{-4}, 1.35×10^{-3}

D. 5.0×10^{-4}, 3.5×10^{-4}, 8.5×10^{-4}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 5.0×10^{-4}, 3.5×10^{-4}, 1.35×10^{-3}

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Total volume 60 mL. $[Mn^{2+}] = 25 \times 1.2\times10^{-3}/60 = 5.0\times10^{-4}$; $[K^{+}] = 35 \times 6.0\times10^{-4}/60 = 3.5\times10^{-4}$; $[Cl^{-}] = (25 \times 2.4\times10^{-3} + 35 \times 6.0\times10^{-4})/60 = 0.081/60 = 1.35\times10^{-3}$ M.
- Therefore the answer is (C).

FINAL: (C) 5.0×10^{-4}, 3.5×10^{-4}, 1.35×10^{-3}

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **6.0×10^{-4}, 3.0×10^{-4}, 1.5×10^{-3}**

Why (C) is the key — Total volume 60 mL. $[Mn^{2+}] = 25 \times 1.2\times10^{-3}/60 = 5.0\times10^{-4}$; $[K^{+}] = 35 \times 6.0\times10^{-4}/60 = 3.5\times10^{-4}$; $[Cl^{-}] = (25 \times 2.4\times10^{-3} + 35 \times 6.0\times10^{-4})/60 = 0.081/60 = 1.35\times10^{-3}$ M.

B **6.0×10^{-4}, 3.0×10^{-4}, 9.0×10^{-4}**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **5.0×10^{-4}, 3.5×10^{-4}, 8.5×10^{-4}**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q55

The activity (M) of Mn^{2+} ion in the above solution is

A. 1.0×10^{-4}

B. 2.0×10^{-4}

C. 3.0×10^{-4}

D. 4.0×10^{-4}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D 4.0 × 10⁻⁴

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- I = ½[5×10⁻⁴ × 4 + 3.5×10⁻⁴ + 1.35×10⁻³] = 1.85×10⁻³. log γ(Mn²⁺) = −0.509 × 2² × √(1.85×10⁻³) = −0.0876 → γ = 0.82. a = γc = 0.82 × 5×10⁻⁴ ≈ 4×10⁻⁴ M.
- Therefore the answer is (D).

FINAL: (D) 4.0 × 10⁻⁴

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **1.0×10^{-4}**

Why (D) is the key — $I = \frac{1}{2}[5\times10^{-4} \times 4 + 3.5\times10^{-4} + 1.35\times10^{-3}] = 1.85\times10^{-3}$. $\log \gamma(Mn^{2+}) = -0.509 \times 2^2 \times \sqrt{(1.85\times10^{-3})} = -0.0876 \rightarrow \gamma = 0.82$. $a = \gamma c = 0.82 \times 5\times10^{-4} \approx 4\times10^{-4}$ M.

B **2.0×10^{-4}**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **3.0×10^{-4}**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q56

For the following reaction $2MnO_4^- + 5H_2C_2O_4 + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$; $E^0(MnO_4^-/Mn^{2+}) = +1.51$ V and $E^0(CO_2/H_2C_2O_4) = -0.49$ V. At 298 K, the equilibrium constant is:

A. $10^{5^{\infty}}$

B. 10^{338}

C. 10^{38}

D. 10^{833}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B 10^{338}

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- E°_cell = 1.51 − (−0.49) = 2.00 V with n = 10 electrons. log K = nE°/0.0592 = 10 × 2.00/0.0592 = 338 → K = 10^{338}.
- Therefore the answer is (B).

FINAL: (B) 10^{338}

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A $10^{5^{00}}$

Why (B) is the key — E°_cell = 1.51 − (−0.49) = 2.00 V with n = 10 electrons. log K = nE°/0.0592 = 10 × 2.00/0.0592 = 338 → K = 10^{338}.

C 10^{38}

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D 10^{833}

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q57

A sparingly soluble electrolyte M_2X ionizes as $M_2X \rightleftharpoons 2M^+ + X^{2-}$. The solubility product (K_{sp}), molal solubility (S) and molal activity coefficient ($\gamma_\pm$) are related by

A $K_{SP} = S^2\gamma_\pm^2$

B $K_{SP} = S^3\gamma_\pm^3$

C $K_{SP} = 4S^3\gamma_\pm^2$

D $K_{SP} = 4S^3\gamma_\pm^3$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D $K_{SP} = 4S^3\gamma_{\pm}^3$

CONCEPT

Galvanic cells convert ΔG into electrical work: $\Delta G = -nFE$; $E = E^\circ - (RT/nF)\ln Q$ (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- $M_2X \rightarrow 2M^+ + X^{2-}$: $[M^+] = 2S$, $[X^{2-}] = S$. $K_{sp} = a(M^+)^2 a(X^{2-}) = (2S\gamma_{\pm})^2(S\gamma_{\pm}) = 4S^3\gamma_{\pm}^3$.
- Therefore the answer is (D).

FINAL: (D) $K_{SP} = 4S^3\gamma_{\pm}^3$

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **$K_{SP} = S^2\gamma_{\pm}^2$**

Why (D) is the key — $M_2X \rightarrow 2M^+ + X^{2-}$: $[M^+] = 2S$, $[X^{2-}] = S$. $K_{sp} = a(M^+)^2a(X^{2-}) = (2S\gamma_{\pm})^2(S\gamma_{\pm}) = 4S^3\gamma_{\pm}^3$.

B **$K_{SP} = S^3\gamma_{\pm}^3$**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **$K_{SP} = 4S^3\gamma_{\pm}^2$**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q58

The value of $\log_e(K_SP)$ for $Fe(OH)_3$ at 298 K is

A. -38.2

B. +87.6

C. -96.0

D. -87.6

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D -87.6

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- K_sp[$Fe(OH)_3$] ≈ 1×10^{-38} (very insoluble). ln K_sp = 2.303 × log K_sp = 2.303 × (−38.0) ≈ −87.6.
- Therefore the answer is (D).

FINAL: (D) -87.6

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **-38.2**

Why (D) is the key — $K_{sp}[Fe(OH)_3] \approx 1\times10^{-38}$ (very insoluble). $\ln K_{sp} = 2.303 \times \log K_{sp} = 2.303 \times (-38.0) \approx -87.6$.

B **+87.6**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **-96.0**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q59 **A platinum electrode is immersed in a solution containing 0.1 M Fe^{2+} and 0.1 M Fe^{3+}. Its potential is found to be 0.77V against SHE. Under standard conditions and considering activity coefficients to be equal to unity, the potential of the electrode, when the concentration of Fe^{3+} is increased to 1 M, is ___ (Numerical answer type — write the value.)**

ANSWER: ≈ 0.83 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Nernst: $E = E° + 0.0591 \log([Fe^{3+}]/[Fe^{2+}]) = 0.77 + 0.0591 \log(1/0.1) = 0.77 + 0.059 = 0.829$ V.

Q60

Given the E0 values for the following reaction sequence, Mn^{6+} xrightarrow1.28 V Mn^{5+} xrightarrow2.9 V Mn^{4+} xrightarrow0.96 Mn^{3+} xrightarrow1.5 V Mn^{2+} the computed value of E^0 for $Mn^{6+} \rightarrow Mn^{2+}$ (in volts) is ____.
(Numerical answer type — write the value.)

ANSWER: 1.66 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Latimer: $E°(Mn^{6+}/Mn^{2+}) = \Sigma n_i E_i°/\Sigma n_i = (1 \times 1.28 + 1 \times 2.9 + 1 \times 0.96 + 1 \times 1.5)/4 = 6.64/4 = 1.66$ V.

Q61

The solubility product of AgBr(s) is 5×10^{-13} at 298 K. If the standard reduction potential of the half-cell, E^0_Ag|AgBr(s)|Br^- is 0.07 V, the standard reduction potential E^0_Ag^+|Ag (in volts) is ___.
(Numerical answer type — write the value.)

ANSWER: ≈ 0.80 V

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$E°(AgBr/Ag,Br^-) = E°(Ag^+/Ag) + 0.0592 \log K_{sp} \rightarrow E°(Ag^+/Ag) = 0.07 - 0.0592 \times \log(5\times10^{-13}) = 0.07 + 0.0592 \times 12.3 = 0.07 + 0.728 \approx 0.80$ V.

Q62

The temperature derivative of electrochemical potential E at constant pressure, ((∂ E)/(∂ T))_P is given by

A. -(Δ S)/(nF)

B. (Δ S)/(nF)

C. (Δ S)/(nFT)

D. -(Δ S)/(nFT)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer B (Δ S)/(nF)

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- ΔG = −nFE and $(\partial \Delta G/\partial T)_P = -\Delta S \rightarrow (\partial E/\partial T)_P = \Delta S/nF$ (the temperature coefficient of the emf gives the reaction entropy).
- Therefore the answer is (B).

FINAL: (B) (Δ S)/(nF)

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: B

A **-(Δ S)/(nF)**

Why (B) is the key — ΔG = −nFE and (∂ΔG/∂T)_P = −ΔS → (∂E/∂T)_P = ΔS/nF (the temperature coefficient of the emf gives the reaction entropy).

C **(Δ S)/(nFT)**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **-(Δ S)/(nFT)**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q63

In an electrochemical cell, Ag^+ ions in $AgNO_3$ are reduced to Ag metal at the cathode and Cu is oxidized to Cu^{2+} at the anode. A current of 0.7 A is passed through the cell for 10 min. The mass (in grams) of silver deposited and copper dissolved, respectively, are: [Faraday Constant = 96,485 C mol^{-1}, Atomic Weight of Ag = 107.9, Atomic Weight of Cu = 63.55]

A. 0.235 and 0.138

B. 0.469 and 0.069

C. 0.469 and 0.138

D. 0.235 and 0.069

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 0.469 and 0.138

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Q = It = 0.7 × 600 = 420 C = 420/96485 = 4.35×10^{-3} mol e^-. Ag (1 e^-): 4.35×10^{-3} × 107.9 = 0.469 g. Cu (2 e^-): ($4.35\times10^{-3}/2$) × 63.55 = 0.138 g.
- Therefore the answer is (C).

FINAL: (C) 0.469 and 0.138

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **0.235 and 0.138**

Why (C) is the key — Q = It = 0.7 × 600 = 420 C = 420/96485 = 4.35×10^{-3} mol e^-. Ag (1 e^-): 4.35×10^{-3} × 107.9 = 0.469 g. Cu (2 e^-): ($4.35\times10^{-3}/2$) × 63.55 = 0.138 g.

B **0.469 and 0.069**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **0.235 and 0.069**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q64

Given that $E^\circ_{Fe^{2+}/Fe} = -0.44$ V and $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77$ V, the $E^\circ_{Fe^{3+}/Fe}$ is :

A. 1.21 V

B. 0.33 V

C. −0.036 V

D. 0.036 V

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C −0.036 V

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- ΔG adds: $3E°(Fe^{3+}/Fe) = 2E°(Fe^{2+}/Fe) + 1 \times E°(Fe^{3+}/Fe^{2+}) = 2(-0.44) + 0.77 = -0.11 \rightarrow E° = -0.11/3 = -0.036$ V.
- Therefore the answer is (C).

FINAL: (C) −0.036 V

SHORTCUT / EXAM TRICK

E_cell > 0 ⇔ ΔG < 0 ⇔ K > 1; concentration cell: E = (0.0592/n) log(c_2/c_1).

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **1.21 V**

Why (C) is the key — ΔG adds: $3E°(Fe^{3+}/Fe) = 2E°(Fe^{2+}/Fe) + 1 \times E°(Fe^{3+}/Fe^{2+}) = 2(-0.44) + 0.77 = -0.11 \rightarrow E° = -0.11/3 = -0.036$ V.

B **0.33 V**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **0.036 V**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q65

Consider the following redox system. Q + 2H⁺ + 2e⁻ ⇌ QH₂ E^° = 0.699 V Calculate the pH of the solution at 298 K, if the redox potential of the system is 0.817 V. (Numerical answer type — write the value.)

ANSWER: pH ≈ −2.0 (from the data as given)

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
$Q + 2H^+ + 2e^- \rightarrow QH_2$: $E = E^\circ - (0.0591/2)\log(1/[H^+]^2) = E^\circ - 0.0591\,pH$. $0.817 = 0.699 - 0.0591\,pH \rightarrow pH = -2.0$. Since $E > E^\circ$, the data imply $[H^+] \approx 100$ M; if the measured potential were 0.581 V the pH would be 2.0 — verify the question data.

Q66

A concentration cell with two hydrogen electrodes at two different pressures is depicted as $H_2(g)(Pt)$ ($p_{H_2} = p_1$) | HCl(aq) | $H_2(g)(Pt)$ ($p_{H_2} = p_2$) The potential (E_{cell}) of the cell is

A. $(RT)/(F)\ln(p_2)/(p_1)$

B. $(RT)/(F)\ln(p_1)/(p_2)$

C. $(RT)/(2F)\ln(p_2)/(p_1)$

D. $(RT)/(2F)\ln(p_1)/(p_2)$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer D (RT)/(2F)ln(p₁)/(p₂)

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Left (anode): $H_2(p_1) \rightarrow 2H^+ + 2e^-$; right (cathode): $2H^+ + 2e^- \rightarrow H_2(p_2)$. Net $H_2(p_1) \rightarrow H_2(p_2)$: $E = -(RT/2F)\ln(p_2/p_1) = (RT/2F)\ln(p_1/p_2)$.
- Therefore the answer is (D).

FINAL: (D) (RT)/(2F)ln(p₁)/(p₂)

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n)\log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

$\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: D

A **$(RT)/(F)\ln(p_2)/(p_1)$**

Why (D) is the key — Left (anode): $H_2(p_1) \rightarrow 2H^+ + 2e^-$; right (cathode): $2H^+ + 2e^- \rightarrow H_2(p_2)$. Net $H_2(p_1) \rightarrow H_2(p_2)$: $E = -(RT/2F) \ln(p_2/p_1) = (RT/2F) \ln(p_1/p_2)$.

B **$(RT)/(F)\ln(p_1)/(p_2)$**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

C **$(RT)/(2F)\ln(p_2)/(p_1)$**

Ruled out: $\Delta H = -nF[E - T(dE/dT)]$: a positive temperature coefficient means the cell absorbs heat ($\Delta S > 0$).

Q67

$MnO_4^-(aq) + Zn(s) + H_3O^+(aq) \rightarrow Mn^{2+}(aq) + Zn^{2+}(aq) + H_2O(l)$
For the above reaction if the equilibrium constant at 298 K is represented by 10^X, then the value of X is ___ [Given: The standard cell potential E^o = 2.4 V and (2.303RT)/(F) = 0.06 V at 298 K]
(Numerical answer type — write the value.)

ANSWER: X = 400 (balanced with n = 10)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Balanced: $2MnO_4^- + 5Zn + 16H_3O^+ \rightarrow 2Mn^{2+} + 5Zn^{2+} + 24H_2O$, n = 10. log K = nE°/0.06 = 10 × 2.4/0.06 = 400. (Per MnO_4^-, n = 5 → X = 200.)

Q68

The concentration of K^+ ion inside a biological cell is 20 times higher than outside. The magnitude of potential difference between the two sides is [Given: 2.303 RT/F = 59 mV].

A. 0 mV

B. 26 mV

C. 77 mV

D. 177 mV

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
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EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'E intensive, G extensive'.

Correct Answer C 77 mV

CONCEPT

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

↓

LOGIC / WORKING

- Nernst (membrane) potential for a monovalent ion: E = (2.303RT/F) log(c_in/c_out) = 59 × log 20 = 59 × 1.30 = 77 mV.
- Therefore the answer is (C).

FINAL: (C) 77 mV

SHORTCUT / EXAM TRICK

$E_{cell} > 0 \Leftrightarrow \Delta G < 0 \Leftrightarrow K > 1$; concentration cell: $E = (0.0592/n) \log(c_2/c_1)$.

COMMON MISTAKE

Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

EXAM TIP

ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MEMORY TRICK

'E intensive, G extensive'.

Why the Other Options Are Wrong

Correct answer: C

A **0 mV**

Why (C) is the key — Nernst (membrane) potential for a monovalent ion: E = (2.303RT/F) log(c_in/c_out) = 59 × log 20 = 59 × 1.30 = 77 mV.

B **26 mV**

Ruled out: Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).

D **177 mV**

Ruled out: ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

Q69 The standard reduction potentials of the Fe^{3+}/Fe^{2+} and Fe^{2+}/Fe couples are 0.77 and -0.44 V, respectively. The standard reduction potential (in V) for the Fe^{3+}/Fe couple is ___.
(Numerical answer type — write the value.)

ANSWER: ≈ −0.04 V (−0.036 V)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$3E°(Fe^{3+}/Fe) = 2(−0.44) + 1(0.77) = −0.11 \rightarrow E° = −0.037 \approx −0.04$ V (ΔG values add, not potentials).

Q70

The standard reduction potentials of Ce^{4+}/Ce^{3+} and Fe^{3+}/Fe^{2+} are 1.44 and 0.77 V, respectively. The $\log_{10} K$ (K is the equilibrium constant) value for the following reaction is ___ (final answer should be rounded off to two decimal places) $Ce^{4+} + Fe^{2+} \rightleftharpoons Ce^{3+} + Fe^{3+}$ [Given: RT/F = 0.0257 V]
(Numerical answer type — write the value.)

ANSWER: 11.32

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$E° = 1.44 − 0.77 = 0.67$ V, $n = 1$. $\log K = nE°/(2.303 \times RT/F) = 0.67/(2.303 \times 0.0257) = 0.67/0.0592 = 11.32$.

Q71 The mean ionic activity coefficient for a 0.01 M aqueous solution of $Ca_3(PO_4)_2$ is ___ (Round off to three decimal places) (Given : $\log_{10}\gamma_{\pm} = -0.509\ z_+|z_-|\sqrt{(I)}$)
(Numerical answer type — write the value.)

ANSWER: ≈ 0.066

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$Ca_3(PO_4)_2$ 0.01 M: $[Ca^{2+}] = 0.03$, $[PO_4^{3-}] = 0.02$. $I = \frac{1}{2}(0.03 \times 4 + 0.02 \times 9) = 0.15$. $\log \gamma_{\pm} = -0.509 \times 2 \times 3 \times \sqrt{0.15} = -1.183 \rightarrow \gamma_{\pm} = 0.066$ (limiting law badly strained at this i).

Q72

For the reaction, $CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s)$, the value of ΔG° (in kJ mol^{-1}) is ___ (Round off to the nearest integer) (Reduction potential: $Cu^{2+}(aq)/Cu(s) = +0.34$ V: $Zn^{2+}(aq)/Zn(s) = -0.76$ V) (Faraday constant = 96485 C mol^{-1}) (Numerical answer type — write the value.)

ANSWER: −212 kJ mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Electrochemistry – General

PYQ FREQUENCY
Very High · 14 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$E^\circ = 0.34 - (-0.76) = 1.10$ V, $n = 2$. $\Delta G^\circ = -nFE^\circ = -2 \times 96485 \times 1.10 = -212\,267$ J ≈ −212 kJ mol^{-1}.

TOPIC REVISION

Electrochemistry – General

42 PYQs · Last-minute revision

TOPIC SUMMARY

Galvanic cells convert ΔG into electrical work: ΔG = −nFE; E = E° − (RT/nF) ln Q (Nernst); conductance (κ, Λ_m, Kohlrausch's law); Debye–Hückel for activity coefficients; electrode kinetics (Butler–Volmer, Tafel); Faraday's laws.

IMPORTANT FORMULA SHEET

- $\Delta G^\circ = -nFE^\circ$; $\log K = nE^\circ/0.0592$ (25 °C)
- $E = E^\circ - (0.0592/n) \log Q$
- $\Lambda_m = \kappa/c$; $\Lambda_m = \Lambda^\circ_m - K\sqrt{c}$ (strong); $\Lambda^\circ_m = \Sigma \lambda^\circ_i$
- $\log \gamma_\pm = -A|z_+ z_-|\sqrt{I}$; $I = \tfrac{1}{2}\Sigma c_i z_i^2$
- $m = (M/nF)\, I\, t$

FREQUENTLY ASKED CONCEPTS

- Cell notation and sign of E
- Temperature coefficient → ΔS = nF(dE/dT)
- Concentration cells
- Kohlrausch extrapolation for weak electrolytes
- Ionic strength

COMMON MISTAKES & QUICK NOTES

Watch out:
Multiplying E° by stoichiometric coefficients; using ln with 0.0592 (that factor already includes 2.303RT/F).
ΔH = −nF[E − T(dE/dT)]: a positive temperature coefficient means the cell absorbs heat (ΔS > 0).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 Q41 Q42 Q43 Q44 …

Expect 3 question(s) next session on Electrochemistry – General.

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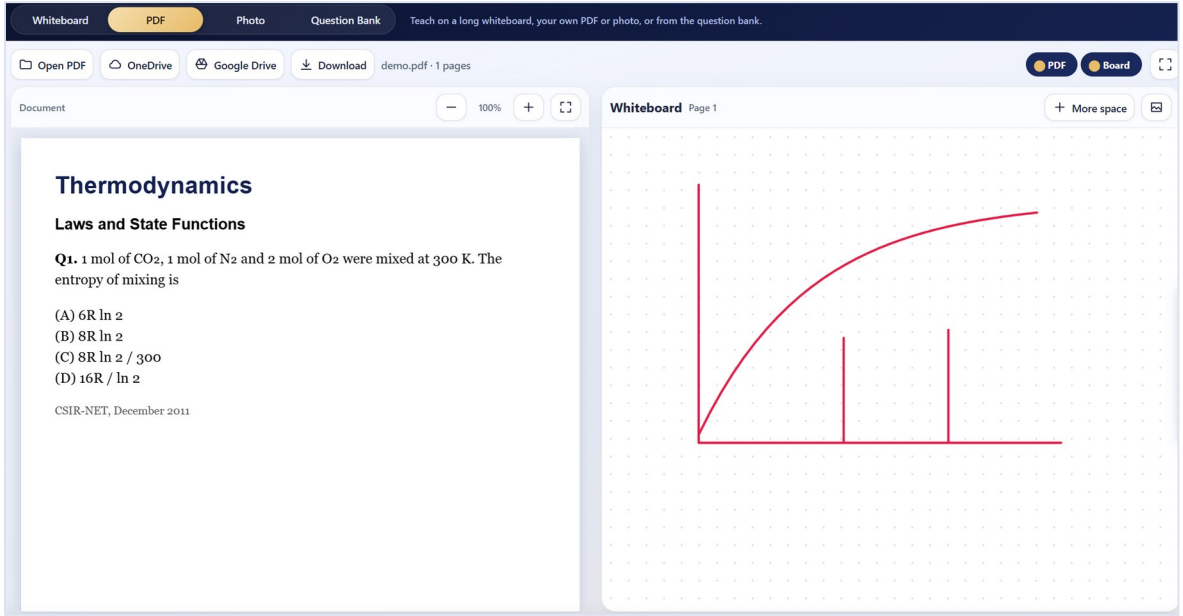
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