ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Analytical Chemistry & Data Analysis

Premium CSIR-NET PYQ Book

16 Previous-Year Questions · 16 with verified answers · Distractor Analysis

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

CSIR-NET · GATE · IIT-JAM — 3 Topics · 16 Real PYQs

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Course Contents

3 Topics · 16 PYQs

1	**Data Analysis** 7 Qs E 0 · M 7 · H 0	44%	
2	**Analytical Chemistry** 5 Qs E 1 · M 3 · H 1	31%	
3	**Analytical Chemistry & Data Analysis – General** 4 Qs E 3 · M 1 · H 0	25%	

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

TOPIC 1

Data Analysis

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

Q1

In least square fitting of a data set \XᵢYᵢ\ to the equation Y = A.X, the regression coefficient (A) is estimated by

A. $\Sigma Y_i^2 / \Sigma X_i^2$

B. $\Sigma X_i Y_i / \Sigma X_i^2$

C. $\Sigma X_i Y_i / \Sigma Y_i^2$

D. $\Sigma X_i^2 / \Sigma Y_i^2$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer B $\Sigma X_i Y_i / \Sigma X_i^2$

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- Minimise $\Sigma(Y_i - AX_i)^2$: $d/dA = -2\Sigma X_i(Y_i - AX_i) = 0 \rightarrow A = \Sigma X_i Y_i / \Sigma X_i^2$.
- Therefore the answer is (B).

FINAL: (B) $\Sigma X_i Y_i / \Sigma X_i^2$

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: B

A $\Sigma Y_i^2 / \Sigma X_i^2$

Why (B) is the key — Minimise $\Sigma(Y_i - AX_i)^2$: $d/dA = -2\Sigma X_i(Y_i - AX_i) = 0 \rightarrow A = \Sigma X_iY_i/\Sigma X_i^2$.

C $\Sigma X_iY_i / \Sigma Y_i^2$

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D $\Sigma X_i^2 / \Sigma Y_i^2$

Ruled out: Report a result with the same decimal place as its uncertainty.

Q2

The masses recorded when a substance is weighed 4 times are 15.8, 15.4, 15.6 and 16.0 mg. The variance (square of the standard deviation) is closest to

A. 0.02

B. 0.05

C. 0.10

D. 0.20

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer B 0.05

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- Mean = 15.7; deviations +0.1, −0.3, −0.1, +0.3; $\Sigma d^2 = 0.20$. Variance = 0.20/(n−1) = 0.067 (or 0.05 with n) — closest to 0.05.
- Therefore the answer is (B).

FINAL: (B) 0.05

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: B

A **0.02**

Why (B) is the key — Mean = 15.7; deviations +0.1, −0.3, −0.1, +0.3; $\Sigma d^2 = 0.20$. Variance = 0.20/(n−1) = 0.067 (or 0.05 with n) — closest to 0.05.

C **0.10**

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D **0.20**

Ruled out: Report a result with the same decimal place as its uncertainty.

Q3 **Repeated measurement of Pb in a lake water sample gave 3.2, 5.2 and 7.2 ppb of Pb. Standard deviation in the measurement of Pb is**

A. 2 ppb

B. 4 ppb

C. 0 ppb

D. √(2) ppb

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer A 2 ppb

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- Mean 5.2; deviations −2, 0, +2; $s = \sqrt{(\Sigma d^2/(n-1))} = \sqrt{(8/2)} = 2$ ppb.
- Therefore the answer is (A).

FINAL: (A) 2 ppb

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: A

B **4 ppb**
Why (A) is the key — Mean 5.2; deviations −2, 0, +2; $s = \sqrt{(\Sigma d^2/(n-1))} = \sqrt{(8/2)} = 2$ ppb.

C **0 ppb**
Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D **√(2) ppb**
Ruled out: Report a result with the same decimal place as its uncertainty.

Q4

The correlation coefficient of two parameters is found to be –0.99. It may be concluded that the two parameters are

A. strongly correlated

B. almost uncorrelated

C. connected by a cause-effect relationship

D. not connected by a cause-effect relationship

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer A strongly correlated

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- $|r| = 0.99$ means a very strong (negative) linear correlation; correlation never proves causation, so only (a) can be concluded.
- Therefore the answer is (A).

FINAL: (A) strongly correlated

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: A

B **almost uncorrelated**

Why (A) is the key — |r| = 0.99 means a very strong (negative) linear correlation; correlation never proves causation, so only (a) can be concluded.

C **connected by a cause-effect relationship**

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D **not connected by a cause-effect relationship**

Ruled out: Report a result with the same decimal place as its uncertainty.

Q5

For a set of 10 observed data points, the mean is 8 and the variance is 0.04. The 'standard deviation' and the 'coefficient of variation' of the data are, respectively

A. 0.005, 0.1%

B. 0.02, 0.2%

C. 0.20, 2.5%

D. 0.32, 1.0%

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer C 0.20, 2.5%

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- $s = \sqrt{0.04} = 0.20$; coefficient of variation = s/mean × 100 = 0.20/8 × 100 = 2.5 %.
- Therefore the answer is (C).

FINAL: (C) 0.20, 2.5%

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: C

A **0.005, 0.1%**

Why (C) is the key — s = √0.04 = 0.20; coefficient of variation = s/mean × 100 = 0.20/8 × 100 = 2.5 %.

B **0.02, 0.2%**

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D **0.32, 1.0%**

Ruled out: Report a result with the same decimal place as its uncertainty.

Q6

In a conductometric experiment for estimation of acid dissociation constant of acetic acid, the following values were obtained in four sets of measurements. 1.71×10^{-5}, 1.77×10^{-5}, 1.79×10^{-5} and 1.73×10^{-5}. The standard deviation of the data would be in the range of

A. 0.01×10^{-5} - 0.019×10^{-5}

B. 0.02×10^{-5} - 0.029×10^{-5}

C. 0.03×10^{-5} - 0.039×10^{-5}

D. 0.04×10^{-5} - 0.049×10^{-5}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer C $0.03 \times 10^{-5} - 0.039 \times 10^{-5}$

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- Mean 1.75×10^{-5}; deviations ±0.04, ±0.02 ($\times10^{-5}$); $\Sigma d^2 = (0.0016+0.0004+0.0016+0.0004)\times10^{-10} = 0.0040\times10^{-10}$; $s = \sqrt{(0.0040/3)}\times10^{-5} = 0.037\times10^{-5}$ — in range (c).
- Therefore the answer is (C).

FINAL: (C) $0.03 \times 10^{-5} - 0.039 \times 10^{-5}$

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: C

A **0.01×10^{-5} - 0.019×10^{-5}**

Why (C) is the key — Mean 1.75×10^{-5}; deviations $\pm0.04, \pm0.02$ ($\times10^{-5}$); $\Sigma d^2 = (0.0016+0.0004+0.0016+0.0004)\times10^{-10} = 0.0040\times10^{-10}$; $s = \sqrt{(0.0040/3)}\times10^{-5} = 0.037\times10^{-5}$ — in range (c).

B **0.02×10^{-5} - 0.029×10^{-5}**

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D **0.04×10^{-5} - 0.049×10^{-5}**

Ruled out: Report a result with the same decimal place as its uncertainty.

Q7

A physical observable, 'x', appears with the probability distribution e^(-|2x-12|) the average of x would be

A. 0

B. 3

C. 6

D. 12

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Data Analysis

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Random = Precision, Systematic = Accuracy'.

Correct Answer C 6

CONCEPT

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

↓

LOGIC / WORKING

- e^(−|2x−12|) is symmetric about 2x = 12, i.e. x = 6, so the mean is 6.
- Therefore the answer is (C).

FINAL: (C) 6

SHORTCUT / EXAM TRICK

For a product or quotient add relative uncertainties; for a sum or difference add absolute ones (in quadrature).

COMMON MISTAKE

Dividing by n instead of n−1 for a sample standard deviation.

EXAM TIP

Report a result with the same decimal place as its uncertainty.

MEMORY TRICK

'Random = Precision, Systematic = Accuracy'.

Why the Other Options Are Wrong

Correct answer: C

A — **0**

Why (C) is the key — e^(−|2x−12|) is symmetric about 2x = 12, i.e. x = 6, so the mean is 6.

B — **3**

Ruled out: Dividing by n instead of n−1 for a sample standard deviation.

D — **12**

Ruled out: Report a result with the same decimal place as its uncertainty.

TOPIC REVISION

Data Analysis

7 PYQs · Last-minute revision

TOPIC SUMMARY

Precision (random error) vs accuracy (systematic error); mean, standard deviation s, RSD, confidence interval $\bar{x} \pm ts/\sqrt{n}$; Q-test for outliers; significant figures and error propagation.

IMPORTANT FORMULA SHEET

- $s = \sqrt{(\Sigma(x_i - \bar{x})^2/(n-1)}$
- $CI = \bar{x} \pm t\ s/\sqrt{n}$
- Q = gap/range (reject if $Q > Q_{table}$)
- Addition: $\sigma = \sqrt{(\Sigma\sigma_i^2)}$; multiplication: relative errors add in quadrature

FREQUENTLY ASKED CONCEPTS

- Q-test
- t-test and F-test use
- Significant figures in results
- Linear regression / calibration

COMMON MISTAKES & QUICK NOTES

Watch out:
Dividing by n instead of n−1 for a sample standard deviation.
Report a result with the same decimal place as its uncertainty.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7

Expect 1 question(s) next session on Data Analysis.

TOPIC 2

Analytical Chemistry

5 questions · Easy 1 | Medium 3 | Hard 1 · PYQ frequency: Rare

Q8

One of the following is not related to polarography

A. limiting current

B. diffusion current constant

C. Ilkovic equation

D. current efficiency

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Analytical Chemistry

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer D current efficiency

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- Limiting/diffusion current, the diffusion-current constant and the Ilkovic equation are all polarographic terms; current efficiency belongs to electrolysis/electrogravimetry.
- Therefore the answer is (D).

FINAL: (D) current efficiency

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: D

A **limiting current**

Why (D) is the key — Limiting/diffusion current, the diffusion-current constant and the Ilkovic equation are all polarographic terms; current efficiency belongs to electrolysis/electrogravimetry.

B **diffusion current constant**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

C **Ilkovic equation**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q9

A substance undergoes a two electron reversible reduction at dropping mercury electrode, and gives a diffusion current of 7.5 µA. When the potential at the dropping mercury electrode is –0.615 V, the current is 1.5 µA. The $E_{1/2}$ (in volt) will be

A. –0.683

B. –0.674

C. –0.652

D. –0.633

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Analytical Chemistry

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer D –0.633

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- Reversible wave: E = E½ − (0.0591/n) log[i/(i_d − i)]. −0.615 = E½ − (0.0591/2) log(1.5/6.0) = E½ + 0.0178 → E½ = −0.633 V.
- Therefore the answer is (D).

FINAL: (D) –0.633

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: D

A **–0.683**

Why (D) is the key — Reversible wave: E = E½ − (0.0591/n) log[i/(i_d − i)]. −0.615 = E½ − (0.0591/2) log(1.5/6.0) = E½ + 0.0178 → E½ = −0.633 V.

B **–0.674**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

C **–0.652**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q10

The activity of water at 11 bar and 298 K is:

A. 1.101

B. 1.007

C. 0.998

D. 0.898

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Analytical Chemistry

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer B 1.007

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- ln a = $V_m(p - p^\circ)/RT = 18\times10^{-6} \times 10\times10^{5}/(8.314 \times 298) = 0.0073$ → a = 1.007 (option b). The printed key (a, 1.101) is too large.
- Therefore the answer is (B).

FINAL: (B) 1.007

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: B

A **1.101**

Why (B) is the key — ln a = V_m(p − p°)/RT = 18×10⁻⁶ × 10×10⁵/(8.314 × 298) = 0.0073 → a = 1.007 (option b). The printed key (a, 1.101) is too large.

C **0.998**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D **0.898**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q11

A student recorded a polarogram of 2.0 mM Cd^{2+} solution and forgot to add KCl solution. What type of error do you expect in his results?

A. Only migration current will be observed

B. Only diffusion current will be observed

C. Both migration current as well as diffusion current will be observed

D. Both catalytic current as well as diffusion current will be observed

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Analytical Chemistry

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer C Both migration current as well as diffusion current will be observed

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- KCl is the supporting electrolyte that suppresses migration of the electroactive ion in the field. Without it the measured current is diffusion + migration current (option c); no catalytic current arises.
- Therefore the answer is (C).

FINAL: (C) Both migration current as well as diffusion current will be observed

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: C

A **Only migration current will be observed**

Why (C) is the key — KCl is the supporting electrolyte that suppresses migration of the electroactive ion in the field. Without it the measured current is diffusion + migration current (option c); no catalytic current arises.

B **Only diffusion current will be observed**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D **Both catalytic current as well as diffusion current will be observed**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q12

For the titration of a 10 mL (aq) solution of $CaCO_3$, 2 mL of 0.001 M Na_2EDTA is required to reach the end point. The concentration of $CaCO_3$ (assume molecular weight of $CaCO_3$ = 100) is

A. 5×10^{-4} g/mL

B. 2×10^{-4} g/mL

C. 5×10^{-5} g/mL

D. 2×10^{-5} g/mL

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Analytical Chemistry

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer D 2×10^{-5} g/mL

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- EDTA:Ca = 1:1 → 2×10^{-3} L × 0.001 M = 2×10^{-6} mol $CaCO_3$ = 2×10^{-4} g in 10 mL → 2×10^{-5} g mL^{-1}.
- Therefore the answer is (D).

FINAL: (D) 2×10^{-5} g/mL

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: D

A **5×10^{-4} g/mL**

Why (D) is the key — EDTA:Ca = 1:1 → 2×10^{-3} L × 0.001 M = 2×10^{-6} mol $CaCO_3$ = 2×10^{-4} g in 10 mL → 2×10^{-5} g mL^{-1}.

B **2×10^{-4} g/mL**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

C **5×10^{-5} g/mL**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

TOPIC REVISION

Analytical Chemistry

5 PYQs · Last-minute revision

TOPIC SUMMARY

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

IMPORTANT FORMULA SHEET

- $A = \varepsilon cl = -\log T$
- Resolution $Rs = 2(t_2 - t_1)/(w_1 + w_2)$
- $N = 16(t_R/w)^2$; $H = L/N$
- Standard addition for matrix effects

FREQUENTLY ASKED CONCEPTS

- Beer's law limits
- Chromatographic resolution and plate number
- Choice of indicator
- Detection limit (3σ)

COMMON MISTAKES & QUICK NOTES

Watch out:
Using %T in place of absorbance; confusing equivalence point with end point.
Isocratic elution = constant mobile phase; gradient = composition changes with time.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q8 Q9 Q10 Q11 Q12

Expect 5 question(s) next session on Analytical Chemistry.

TOPIC 3

Analytical Chemistry & Data Analysis – General

4 questions · Easy 3 | Medium 1 | Hard 0 · PYQ frequency: Rare

Q13

The units of absorbance (A) and molar absorptivity are, respectively :

A. no unit and $dm^3\ mol^{-1}\ cm^{-1}$

B. $dm^3\ mol^{-1}\ cm^{-1}$ and no unit

C. mol. cm^{-1} and $dm^3\ mol^{-1}\ cm^{-1}$

D. both have no unit

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Analytical Chemistry & Data Analysis – General

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer A no unit and $dm^3\ mol^{-1}\ cm^{-1}$

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- A = −log T is dimensionless; from A = εcl, ε = A/(cl) has units $dm^3\ mol^{-1}\ cm^{-1}$ (L $mol^{-1}\ cm^{-1}$).
- Therefore the answer is (A).

FINAL: (A) no unit and $dm^3\ mol^{-1}\ cm^{-1}$

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: A

B **dm³ mol⁻¹ cm⁻¹ and no unit**

Why (A) is the key — A = −log T is dimensionless; from A = εcl, ε = A/(cl) has units dm³ mol⁻¹ cm⁻¹ (L mol⁻¹ cm⁻¹).

C **mol. cm⁻¹ and dm³ mol⁻¹ cm⁻¹**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D **both have no unit**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q14

The Van Deemter equation in terms of coefficient of multiple-path effect (A), coefficient of longitudinal diffusion (B), coefficient of mass-transfer (C), and linear velocity of mobile phase (u) can be represented as:

A. $H = A + B/u + Cu$

B. $H = B + A/u + Cu$

C. $H = A + B/u + C/u$

D. $H = A/u + B/u + Cu^2$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Analytical Chemistry & Data Analysis – General

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer A H = A + B/u + Cu

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- van Deemter: H = A + B/u + Cu — eddy diffusion (A), longitudinal diffusion (B/u, dominant at low flow), mass-transfer resistance (Cu, dominant at high flow).
- Therefore the answer is (A).

FINAL: (A) H = A + B/u + Cu

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: A

B **H = B + A/u + Cu**

Why (A) is the key — van Deemter: H = A + B/u + Cu — eddy diffusion (A), longitudinal diffusion (B/u, dominant at low flow), mass-transfer resistance (Cu, dominant at high flow).

C **H = A + B/u + C/u**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D **H = A/u + B/u + Cu²**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q15

A solution containing n independently absorbing species, the total absorbance is represented in terms of molar absorptivity (ε), analyte concentration (c) and path length (b) as:

A $A = [\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n]b$

B $A = [\varepsilon_1 c_1^2 + \varepsilon_2 c_2^2 + \ldots + \varepsilon_n c_n^2]b$

C $A = [\varepsilon_1 c_1^n + \varepsilon_2 c_2^n + \ldots + \varepsilon_n c_n^n]b$

D $A = [\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n]b/n$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Analytical Chemistry & Data Analysis – General

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer A $A = [\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n]b$

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- Absorbances of independent absorbers are additive: $A = (\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n)b$.
- Therefore the answer is (A).

FINAL: (A) $A = [\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n]b$

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: A

B

$A = [\varepsilon_1 c_1^2 + \varepsilon_2 c_2^2 + \ldots + \varepsilon_n c_n^2]b$

Why (A) is the key — Absorbances of independent absorbers are additive: $A = (\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n)b$.

C

$A = [\varepsilon_1 c_1^n + \varepsilon_2 c_2^n + \ldots + \varepsilon_n c_n^n]b$

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D

$A = [\varepsilon_1 c_1 + \varepsilon_2 c_2 + \ldots + \varepsilon_n c_n]b/n$

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

Q16

The isocratic elution in chromatography can be defined as

A. elution under conditions of constant temperature and pressure

B. elution under conditions of variable temperature and pressure

C. elution under conditions of constant mobile-phase composition

D. elution under conditions of varying mobile-phase compositions

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Analytical Chemistry & Data Analysis – General

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'A = εcl — Absorbance Equals ε·c·l'.

Correct Answer C elution under conditions of constant mobile-phase composition

CONCEPT

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

↓

LOGIC / WORKING

- Isocratic = single, constant mobile-phase composition throughout the run; gradient elution changes the composition with time.
- Therefore the answer is (C).

FINAL: (C) elution under conditions of constant mobile-phase composition

SHORTCUT / EXAM TRICK

Mixtures: measure A at two wavelengths and solve two Beer's-law equations.

COMMON MISTAKE

Using %T in place of absorbance; confusing equivalence point with end point.

EXAM TIP

Isocratic elution = constant mobile phase; gradient = composition changes with time.

MEMORY TRICK

'A = εcl — Absorbance Equals ε·c·l'.

Why the Other Options Are Wrong

Correct answer: C

A **elution under conditions of constant temperature and pressure**

Why (C) is the key — Isocratic = single, constant mobile-phase composition throughout the run; gradient elution changes the composition with time.

B **elution under conditions of variable temperature and pressure**

Ruled out: Using %T in place of absorbance; confusing equivalence point with end point.

D **elution under conditions of varying mobile-phase compositions**

Ruled out: Isocratic elution = constant mobile phase; gradient = composition changes with time.

TOPIC REVISION

Analytical Chemistry & Data Analysis – General

4 PYQs · Last-minute revision

TOPIC SUMMARY

Quantitative methods: titrimetry (equivalence vs end point, indicators), gravimetry, Beer–Lambert spectrophotometry (A = εcl), chromatography (retention, resolution), electrochemical sensors.

IMPORTANT FORMULA SHEET

- $A = \varepsilon cl = -\log T$
- Resolution $Rs = 2(t_2 - t_1)/(w_1 + w_2)$
- $N = 16(t_R/w)^2$; $H = L/N$
- Standard addition for matrix effects

FREQUENTLY ASKED CONCEPTS

- Beer's law limits
- Chromatographic resolution and plate number
- Choice of indicator
- Detection limit (3σ)

COMMON MISTAKES & QUICK NOTES

Watch out:
Using %T in place of absorbance; confusing equivalence point with end point.
Isocratic elution = constant mobile phase; gradient = composition changes with time.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q13 Q14 Q15 Q16

Expect 4 question(s) next session on Analytical Chemistry & Data Analysis – General.

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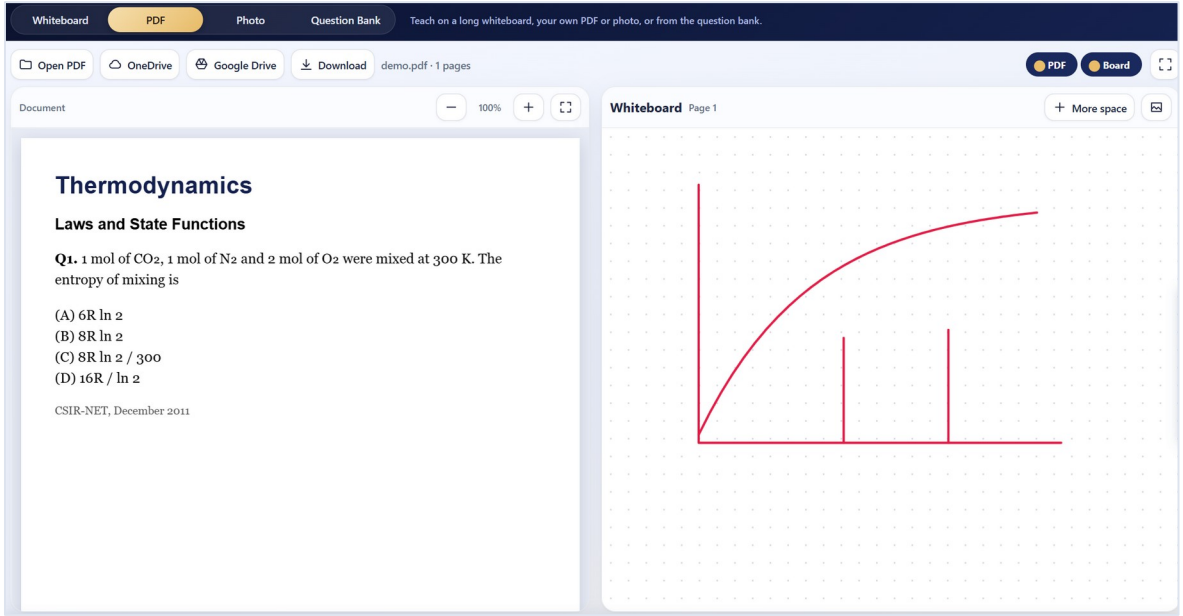
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