ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Chemical & Ionic Equilibrium

Premium CSIR-NET PYQ Book

29 Previous-Year Questions · 18 with verified answers · Distractor Analysis

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

CSIR-NET · GATE · IIT-JAM — 2 Topics · 29 Real PYQs

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Course Contents

2 Topics · 29 PYQs

1	**Chemical Equilibrium** 16 Qs E 3 · M 12 · H 1	55%	
2	**Ionic Equilibrium** 13 Qs E 5 · M 8 · H 0	45%	

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

TOPIC 1

Chemical Equilibrium

16 questions · Easy 3 | Medium 12 | Hard 1 · PYQ frequency: Rare

Q1

Consider the reaction, $2C(s)+O_2(g) \rightleftharpoons 2CO(g)$ at equilibrium, The equilibrium can be shifted towards the forward direction by

A. Increasing the amount of carbon in the system

B. Decreasing the volume of the system

C. Decreasing the pressure of the system

D. Increasing the temperature of the system

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer C Decreasing the pressure of the system

CONCEPT

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Δn_gas = 2 − 1 = +1, so lowering the pressure (or increasing volume) favours the forward reaction. Adding solid carbon has no effect; the reaction is exothermic (ΔH ≈ −221 kJ), so raising T shifts it backward.
- Therefore the answer is (C).

FINAL: (C) Decreasing the pressure of the system

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: C

A **Increasing the amount of carbon in the system**

Why (C) is the key — Δn_gas = 2 − 1 = +1, so lowering the pressure (or increasing volume) favours the forward reaction. Adding solid carbon has no effect; the reaction is exothermic (ΔH ≈ −221 kJ), so raising T shifts it backward.

B **Decreasing the volume of the system**

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

D **Increasing the temperature of the system**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q2

The temperature (T) dependence of the equilibrium constant (K) of a chemical reaction is correctly described by the following statement:

A. For an endothermic reaction, the slope of ln K vs 1/T plot is positive

B. For an exothermic reaction, K is proportional to T

C. For an exothermic reaction, K at a higher temperature is lower than K at a lower temperature

D. If Δ H is independent of temperature, the change in K with T is smaller at lower temperatures

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer C For an exothermic reaction, K at a higher temperature is lower than K at a lower temperature

CONCEPT

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- van't Hoff: ln K = −ΔH°/RT + const. Exothermic (ΔH° < 0): K falls as T rises, so K(high T) < K(low T). For endothermic reactions the ln K vs 1/T slope (−ΔH°/R) is negative.
- Therefore the answer is (C).

FINAL: (C) For an exothermic reaction, K at a higher temperature is lower than K at a lower temperature

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: C

A **For an endothermic reaction, the slope of ln K vs 1/T plot is positive**

Why (C) is the key — van't Hoff: ln K = −ΔH°/RT + const. Exothermic (ΔH° < 0): K falls as T rises, so K(high T) < K(low T). For endothermic reactions the ln K vs 1/T slope (−ΔH°/R) is negative.

B **For an exothermic reaction, K is proportional to T**

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

D **If Δ H is independent of temperature, the change in K with T is smaller at lower temperatures**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q3 The reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is carried out at 300 K by mixing N_2 and H_2. The standard free energy of formation of NH_3 is -16.4 kJ/mol. After one hour of mixing, the partial pressures of N_2, H_2 and NH_3 are 50 bars, 2 bars and 200 bars, respectively. What is the reaction free energy at this stage of the reaction? IIT JAM 2008
(Numerical answer type — write the value.)

ANSWER: −21.3 kJ mol⁻¹

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$\Delta G = \Delta G^\circ + RT \ln Q$. $\Delta G^\circ = 2(-16.4) = -32.8$ kJ; $Q = p^2(NH_3)/(p(N_2)p^3(H_2)) = 200^2/(50 \times 2^3) = 100$; $RT \ln Q = 8.314 \times 300 \times 4.605 = 11.5$ kJ. $\Delta G = -32.8 + 11.5 = -21.3$ kJ mol⁻¹ (reaction still proceeds forward).

Q4

A vessel contains a mixture of H_2 and N_2 gas. The density of this gas mixture is 0.2 g L^{-1} at 300 K and 1 atm. Assuming that both the gases behave ideally, the mole fraction of N_2(g) in the vessel is ___ (final answer should be rounded off to two decimal places) [Given: R = 0.082 L atm mol^{-1} K^{-1}, atomic wt. of hydrogen = 1.0 and atomic wt. of nitrogen = 14.0]
(Numerical answer type — write the value.)

ANSWER: 0.11

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$\rho = PM/RT \rightarrow M_{avg} = 0.2 \times 0.082 \times 300/1 = 4.92$ g mol^{-1}. $28x + 2(1-x) = 4.92 \rightarrow 26x = 2.92 \rightarrow x(N_2) = 0.11$.

Q5

Consider the reaction $CO(g) + (1)/(2)O_2(g) \rightarrow CO_2(g)$. The value of ΔU for the reaction at 300 K is -281.8 kJ mol^{-1}. The value of ΔH at same temperature is _____ kJ mol^{-1} (rounded up to the first decimal place). [R = 8.3 J K^{-1} mol^{-1}]
(Numerical answer type — write the value.)

ANSWER: −283.0 kJ mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
$\Delta H = \Delta U + \Delta n_g RT$ with $\Delta n_g = 1 - 1.5 = -0.5$: $\Delta H = -281.8 + (-0.5)(8.3)(300)/1000 = -281.8 - 1.2 = -283.0$ kJ mol^{-1}.

Q6

The triple point for water is

A. unique

B. depends on p but is independent of T

C. depends on T but is independent of P

D. depends on both P and T

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Only T touches K'.

Correct Answer A unique

CONCEPT

At equilibrium $\Delta G = 0$ and $\Delta G^\circ = -RT \ln K$. $K_p = K_c(RT)^{\Delta n}$; Le Chatelier predicts the shift; van't Hoff gives $d \ln K/dT = \Delta H^\circ/RT^2$. Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- At the triple point $F = C - P + 2 = 1 - 3 + 2 = 0$: both T and p are fixed (273.16 K, 611 Pa) — a unique, invariant point.
- Therefore the answer is (A).

FINAL: (A) unique

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing $K_p = K_c$ when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: A

B **depends on p but is independent of T**

Why (A) is the key — At the triple point F = C − P + 2 = 1 − 3 + 2 = 0: both T and p are fixed (273.16 K, 611 Pa) — a unique, invariant point.

C **depends on T but is independent of P**

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

D **depends on both P and T**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q7

The number of degrees of freedom for a system consisting of NaCl(s), Na^+(aq) and Cl^-(aq) at equilibrium is

A) 2

B) 3

C) 4

D) 5

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer A 2

CONCEPT

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Components C = 2 (NaCl and H_2O; Na^+ and Cl^- are linked by electroneutrality), phases P = 2 (solid NaCl, solution): F = 2 − 2 + 2 = 2.
- Therefore the answer is (A).

FINAL: (A) 2

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: A

B **3**

Why (A) is the key — Components C = 2 (NaCl and H_2O; Na^+ and Cl^- are linked by electroneutrality), phases P = 2 (solid NaCl, solution): F = 2 − 2 + 2 = 2.

C **4**

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

D **5**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q8

For a one component system, the maximum number of phases that can coexist at equilibrium is

A) 3

B) 2

C) 1

D) 4

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer A 3

CONCEPT

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- F = C − P + 2 ≥ 0 with C = 1 gives P ≤ 3: at most three phases coexist (the triple point).
- Therefore the answer is (A).

FINAL: (A) 3

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: A

B **2**

Why (A) is the key — F = C − P + 2 ≥ 0 with C = 1 gives P ≤ 3: at most three phases coexist (the triple point).

C **1**

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

D **4**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q9

Among the following, the equilibrium which is NOT affected by an increase in pressure is

A $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

B $H_2(g) + I_2(s) \rightleftharpoons 2HI(g)$

C $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

D $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Only T touches K'.

Correct Answer D $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

CONCEPT

At equilibrium $\Delta G = 0$ and $\Delta G^\circ = -RT \ln K$. $K_p = K_c(RT)^{\Delta n}$; Le Chatelier predicts the shift; van't Hoff gives $d \ln K/dT = \Delta H^\circ/RT^2$. Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Pressure affects equilibria only through Δn_{gas}. (d): 4 mol gas → 4 mol gas, $\Delta n = 0$, unaffected. (a) +1, (b) +1, (c) +1.
- Therefore the answer is (D).

FINAL: (D) $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing $K_p = K_c$ when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: D

A $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

Why (D) is the key — Pressure affects equilibria only through Δn_gas. (d): 4 mol gas → 4 mol gas, Δn = 0, unaffected. (a) +1, (b) +1, (c) +1.

B $H_2(g) + I_2(s) \rightleftharpoons 2HI(g)$

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

C $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q10

Sulfur can exist in four phases. The possible number of triple points is

A 1

B 2

C 3

D 4

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Only T touches K'.

Correct Answer D 4

CONCEPT

At equilibrium $\Delta G = 0$ and $\Delta G^\circ = -RT \ln K$. $K_p = K_c(RT)^{\Delta n}$; Le Chatelier predicts the shift; van't Hoff gives $d \ln K/dT = \Delta H^\circ/RT^2$. Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Triple points = ways of choosing 3 phases out of 4 = ${}^4C_3 = 4$ (not all need be stable, but four are possible).
- Therefore the answer is (D).

FINAL: (D) 4

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing $K_p = K_c$ when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: D

A

1

Why (D) is the key — Triple points = ways of choosing 3 phases out of 4 = $^4C_3 = 4$ (not all need be stable, but four are possible).

B

2

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

C

3

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q11

For the pair of reactions given below (i) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (ii) $(1)/(2)N_2(g) + (3)/(2)H_2(g) \rightleftharpoons NH_3(g)$ If at a particular temperature, K_P1 and K_P2 are the equilibrium constants for reactions (i) are (ii) respectively, then

A. $K_{P1} = 2K_{P2}$

B. $K_{P1} = 2K_{P2}^2$

C. $K_{P1} = K_{P2}^2$

D. $K_{P1}^2 = K_{P2}$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer C $K_{P1} = K_{P2}^2$

CONCEPT

At equilibrium $\Delta G = 0$ and $\Delta G^\circ = -RT \ln K$. $K_p = K_c(RT)^{\Delta n}$; Le Chatelier predicts the shift; van't Hoff gives $d \ln K/dT = \Delta H^\circ/RT^2$. Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Reaction (i) is twice reaction (ii), so $K_{P1} = (K_{P2})^2$ (equilibrium constants multiply exponentially with stoichiometric scaling).
- Therefore the answer is (C).

FINAL: (C) $K_{P1} = K_{P2}^2$

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing $K_p = K_c$ when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: C

A **$K_{P1} = 2K_{P2}$**

Why (C) is the key — Reaction (i) is twice reaction (ii), so $K_{P1} = (K_{P2})^2$ (equilibrium constants multiply exponentially with stoichiometric scaling).

B **$K_{P1} = 2K_{P2}^2$**

Ruled out: Writing Kp = Kc when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

D **$K_{P1}^2 = K_{P2}$**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q12 The enthalpy of fusion of ice at 273K is 6.01 kJ mol^{-1} and the enthalpy of vaporization of water at 273K is 44.83 kJ mol^{-1}. The enthalpy of sublimation (in kJ mol^{-1}) of ice at 273K, is ___
(Numerical answer type — write the value.)

ANSWER: 50.84 kJ mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Hess: $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap} = 6.01 + 44.83 = 50.84$ kJ mol^{-1}.

Q13

m_1 and m_2 are the slopes (dP/dT) of the solid – liquid equilibrium lines in the P – T phase diagrams of H_2O and CO_2, respectively. For P < 10 atm, the values of m_1 and m_2 are

A. $m_1 > 0$ and $m_2 > 0$

B. $m_1 > 0$ and $m_2 < 0$

C. $m_1 < 0$ and $m_2 < 0$

D. $m_1 < 0$ and $m_2 > 0$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer D $m_1 < 0$ and $m_2 > 0$

CONCEPT

At equilibrium $\Delta G = 0$ and $\Delta G^\circ = -RT \ln K$. $K_p = K_c(RT)^{\Delta n}$; Le Chatelier predicts the shift; van't Hoff gives $d \ln K/dT = \Delta H^\circ/RT^2$. Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- Clapeyron $dP/dT = \Delta H_{fus}/(T\Delta V_{fus})$. Water expands on freezing ($\Delta V_{fus} < 0$) → $m_1 < 0$; CO_2 (like most substances) contracts on freezing → $m_2 > 0$.
- Therefore the answer is (D).

FINAL: (D) $m_1 < 0$ and $m_2 > 0$

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing $K_p = K_c$ when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: D

A

$m_1 > 0$ and $m_2 > 0$

Why (D) is the key — Clapeyron dP/dT = ΔH_fus/(TΔV_fus). Water expands on freezing (ΔV_fus < 0) → $m_1 < 0$; CO_2 (like most substances) contracts on freezing → $m_2 > 0$.

B

$m_1 > 0$ and $m_2 < 0$

Ruled out: Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

C

$m_1 < 0$ and $m_2 < 0$

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q14

The enthalpy of vaporization of a liquid at its boiling point (T_b = 200 K) is 15.3 kJ mol^{-1}. If the molar volumes of the liquid and the vapour at 200 K are 100 and 12000 cm^3 mol^{-1}, respectively, then the slope (dP)/(dT) of the liquid-boundary is ___ kPa K^{-1} (Upto two decimal places. Note : 1 Pa = 1 J m^{-1}) (Numerical answer type — write the value.)

ANSWER: 6.43 kPa K^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Clapeyron: $dP/dT = \Delta H_{vap}/(T_b \Delta V) = 15\,300/(200 \times (12\,000 - 100)\times 10^{-6}\ m^3) = 15\,300/2.38 = 6\,429\ Pa\ K^{-1} = 6.43\ kPa\ K^{-1}$.

Q15

Consider the following phase diagram of CO_2 (not to scale). At equilibrium, the INCORRECT statement is:

A At 200 K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid

B It is not possible to obtain liquid CO_2 from gaseous CO_2 below 5.11 atm

C Both liquid and gas phase of CO_2 coexist at 298.15 K and 67 atm

D With increasing pressure, the melting point of solid CO_2 increases

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Only T touches K'.

Correct Answer A At 200 K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid

CONCEPT

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

↓

LOGIC / WORKING

- 200 K is below the triple point (216.6 K, 5.11 atm), so compressing the gas at 200 K deposits solid CO_2, never liquid — statement (a) is incorrect. (b), (c) and (d) follow from the diagram (positive melting-line slope).
- Therefore the answer is (A).

FINAL: (A) At 200 K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid

SHORTCUT / EXAM TRICK

K changes only with temperature; pressure/inert gas change composition, not K.

COMMON MISTAKE

Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.

EXAM TIP

Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MEMORY TRICK

'Only T touches K'.

Why the Other Options Are Wrong

Correct answer: A

B **It is not possible to obtain liquid CO_2 from gaseous CO_2 below 5.11 atm**

Why (A) is the key — 200 K is below the triple point (216.6 K, 5.11 atm), so compressing the gas at 200 K deposits solid CO_2, never liquid — statement (a) is incorrect. (b), (c) and (d) follow from the diagram (positive melting-line slope).

C **Both liquid and gas phase of CO_2 coexist at 298.15 K and 67 atm**

Ruled out: Writing Kp = Kc when $\Delta n \neq 0$; using ΔG instead of ΔG° in $-RT \ln K$.

D **With increasing pressure, the melting point of solid CO_2 increases**

Ruled out: Exothermic: K falls as T rises (ln K vs 1/T slope positive).

Q16

The reaction $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ at 500°C, with initial pressures of 0.7 bar of CO and 1.0 bar of Cl_2, is allowed to reach equilibrium. The partial pressure of $COCl_2(g)$ at equilibrium is 0.15 bar. The equilibrium constant for this reaction at 500°C (rounded off to two decimal places) is ___.
(Numerical answer type — write the value.)

ANSWER: 0.32

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Equilibrium

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
At equilibrium: $p(COCl_2) = 0.15$, $p(CO) = 0.70 - 0.15 = 0.55$, $p(Cl_2) = 1.00 - 0.15 = 0.85$ bar. $K_p = 0.15/(0.55 \times 0.85) = 0.32$.

TOPIC REVISION

Chemical Equilibrium

16 PYQs · Last-minute revision

TOPIC SUMMARY

At equilibrium ΔG = 0 and ΔG° = −RT ln K. Kp = Kc(RT)^Δn; Le Chatelier predicts the shift; van't Hoff gives d ln K/dT = ΔH°/RT². Degree of dissociation links K to pressure.

IMPORTANT FORMULA SHEET

- $\Delta G^\circ = -RT \ln K$
- $Kp = Kc\,(RT)^{\Delta n}$
- $\ln(K_2/K_1) = -(\Delta H^\circ/R)(1/T_2 - 1/T_1)$
- $Kp = \alpha^2 p/(1-\alpha^2)$ for $A \rightleftharpoons 2B$

FREQUENTLY ASKED CONCEPTS

- Effect of T, p, inert gas on K and on composition
- Kp vs Kc
- van't Hoff plot slope
- Reaction quotient Q vs K

COMMON MISTAKES & QUICK NOTES

Watch out:
Writing Kp = Kc when Δn ≠ 0; using ΔG instead of ΔG° in −RT ln K.
Exothermic: K falls as T rises (ln K vs 1/T slope positive).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16

Expect 8 question(s) next session on Chemical Equilibrium.

TOPIC 2

Ionic Equilibrium

13 questions · Easy 5 | Medium 8 | Hard 0 · PYQ frequency: Rare

Q17

The pH of a solution prepared from 0.005 mole of $Ba(OH)_2$ in 100 cc water is

A. 10

B. 12

C. 11

D. 13

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer D 13

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- $Ba(OH)_2$ gives 2 OH^-: [OH^-] = 2 × 0.005/0.100 = 0.10 M → pOH = 1 → pH = 13.
- Therefore the answer is (D).

FINAL: (D) 13

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: D

A

10

Why (D) is the key — $Ba(OH)_2$ gives 2 OH^-: $[OH^-] = 2 \times 0.005/0.100 = 0.10$ M → pOH = 1 → pH = 13.

B

12

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

C

11

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q18

The solubility products (K_{sp}) for three salts MX, MY_2 and MZ_3 are 1×10^{-8}, 4×10^{-9} and 27×10^{-8}, respectively. The solubility of these salts follows the order

A. $MX > MY_2 > MZ_3$

B. $MZ_3 > MY_2 > MX$

C. $MZ_3 > MX > MY_2$

D. $MY_2 > MX > MZ_3$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer B $MZ_3 > MY_2 > MX$

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- MX: s = √(10^{-8}) = 10^{-4}; MY_2: $4s^3 = 4\times10^{-9}$ → s = 10^{-3}; MZ_3: $27s^4 = 27\times10^{-8}$ → s = 10^{-2}. Order $MZ_3 > MY_2 > MX$ — Ksp values cannot be compared directly across different stoichiometries.
- Therefore the answer is (B).

FINAL: (B) $MZ_3 > MY_2 > MX$

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: B

A **$MX > MY_2 > MZ_3$**

Why (B) is the key — MX: $s = \sqrt{(10^{-8})} = 10^{-4}$; MY_2: $4s^3 = 4\times10^{-9} \rightarrow s = 10^{-3}$; MZ_3: $27s^4 = 27\times10^{-8} \rightarrow s = 10^{-2}$. Order $MZ_3 > MY_2 > MX$ — Ksp values cannot be compared directly across different stoichiometries.

C **$MZ_3 > MX > MY_2$**

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D **$MY_2 > MX > MZ_3$**

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q19

(a) Calculate the pH of a solution obtained by mixing 50.00 mL of 0.20 M weak acid HA ($K_a = 10^{-5}$) and 50.00 mL of 0.20 M NaOH at room temperature. (b) One mole of a salt of type MX is dissolved in 1.00 kg of water. The freezing point of the solution is −2.4°C. Calculate the percent dissociation of the salt in water. (IIT JAM 2007)

ANSWER: (a) pH = 9.0; (b) 29 %

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
(a) Equal moles neutralise completely → 0.10 M NaA. pH = 7 + ½(pKa + log C) = 7 + ½(5 − 1) = 9.0. (b) ΔT_f = iK_f m: 2.4 = i × 1.86 × 1.0 → i = 1.29 = 1 + α → α = 0.29 → 29 % dissociation.

Q20

The pH of a 1.0×10^{-3} M solution of a weak acid HA is 4.0. The acid dissociation constant K_a is:

A. 1.0×10^{-3}

B. 1.0×10^{-4}

C. 1.0×10^{-5}

D. 2.0×10^{-5}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer C 1.0 × 10⁻⁵

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- $[H^+] = 10^{-4}$ M. Ka = $[H^+]^2/(C - [H^+]) = 10^{-8}/(9\times10^{-4}) = 1.1\times10^{-5} \approx 1.0\times10^{-5}$.
- Therefore the answer is (C).

FINAL: (C) 1.0 × 10⁻⁵

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: C

A **1.0×10^{-3}**

Why (C) is the key — $[H^+] = 10^{-4}$ M. $K_a = [H^+]^2/(C - [H^+]) = 10^{-8}/(9\times10^{-4}) = 1.1\times10^{-5} \approx 1.0\times10^{-5}$.

B **1.0×10^{-4}**

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D **2.0×10^{-5}**

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q21

Which one of the following species is the conjugate base of HO^-?

A. H_2O

B. O^{2-}

C. O_2^-

D. O_3^{2-}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer B O^{2-}

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- Removing a proton from HO^- leaves O^{2-} (the oxide ion), its conjugate base; H_2O is the conjugate acid.
- Therefore the answer is (B).

FINAL: (B) O^{2-}

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: B

A H_2O

Why (B) is the key — Removing a proton from HO^- leaves O^{2-} (the oxide ion), its conjugate base; H_2O is the conjugate acid.

C O_2^-

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D O_3^{2-}

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q22

If K_{sp} is the solubility product of a sparingly soluble salt A_3X_2, then its solubility is

A. $(K_{sp}/108)^{1/5}$

B. $(K_{sp})^{1/5}$

C. $(K_{sp}/72)^{1/5}$

D. $(K_{sp})^{1/2}$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer A $(K_{sp}/108)^{1}/5$

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- $A_3X_2 \rightarrow 3A^{2+} + 2X^{3-}$: Ksp = $(3s)^3(2s)^2 = 108\ s^5 \rightarrow s = (Ksp/108)^{(1/5)}$.
- Therefore the answer is (A).

FINAL: (A) $(K_{sp}/108)^{1}/5$

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: A

B $(K_{sp})^{1}/5$

Why (A) is the key — $A_3X_2 \rightarrow 3A^{2+} + 2X^{3-}$: Ksp = $(3s)^3(2s)^2 = 108\ s^5$ → s = (Ksp/108)^(1/5).

C $(K_{sp}/72)^{1}/5$

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D $(K_{sp})^{1}/2$

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q23

The pH of a 1×10^{-8} M HCl solution is close to

A. 8.0

B. 7.1

C. 6.9

D. 6.0

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer C 6.9

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- At 10^{-8} M the water autoionisation matters: [H^+] = 10^{-8} + x with x(10^{-8} + x) = 10^{-14} → [H^+] = 1.05×10^{-7} M → pH ≈ 6.98 ≈ 6.9 (must stay below 7 for an acid).
- Therefore the answer is (C).

FINAL: (C) 6.9

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: C

A **8.0**

Why (C) is the key — At 10^{-8} M the water autoionisation matters: $[H^+] = 10^{-8} + x$ with $x(10^{-8} + x) = 10^{-14}$ → $[H^+] = 1.05\times10^{-7}$ M → pH ≈ 6.98 ≈ 6.9 (must stay below 7 for an acid).

B **7.1**

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D **6.0**

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q24

At 25°C, the solubility product (K_{sp}) of CaF_2 in water is 3.2×10^{-11}. The solubility (in mole per kg of water) of the salt at the same temperature (ignore ion pairing) is

A. 4.0×10^{-6}

B. 3.2×10^{-4}

C. 2.5×10^{-4}

D. 2.0×10^{-4}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer D 2.0×10^{-4}

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- $CaF_2 \rightarrow Ca^{2+} + 2F^-$: Ksp = $4s^3 = 3.2\times10^{-11} \rightarrow s^3 = 8\times10^{-12} \rightarrow s = 2.0\times10^{-4}$ mol kg^{-1}.
- Therefore the answer is (D).

FINAL: (D) 2.0×10^{-4}

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: D

A **4.0×10^{-6}**

Why (D) is the key — $CaF_2 \rightarrow Ca^{2+} + 2F^-$: $K_{sp} = 4s^3 = 3.2\times10^{-11} \rightarrow s^3 = 8\times10^{-12} \rightarrow s = 2.0\times10^{-4}$ mol kg^{-1}.

B **3.2×10^{-4}**

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

C **2.5×10^{-4}**

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q25 The pK_a values of H_3PO_4 are 2.12, 7.21 and 12.67. The pH of a phosphate buffer containing 0.2 M NaH_2PO_4 and 0.1 M Na_2HPO_4 is ____
(Numerical answer type — write the value.)

ANSWER: 6.91

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$H_2PO_4^-/HPO_4^{2-}$ buffer uses pKa_2: pH = 7.21 + log(0.1/0.2) = 7.21 − 0.30 = 6.91.

Q26

At 298 K, 0.1 mol of ammonium acetate and 0.14 mol of acetic acid are dissolved in 1 L of water. The pH of the resulting solution is [Given: pK_a of acetic acid is 4.75]

A. 4.9

B. 4.6

C. 4.3

D. 2.3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Half way, pH = pKa'.

Correct Answer B 4.6

CONCEPT

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

↓

LOGIC / WORKING

- Ammonium acetate supplies 0.1 mol acetate (the NH_4^+ contribution is negligible beside the buffer): pH = pKa + log([CH_3COO^-]/[CH_3COOH]) = 4.75 + log(0.1/0.14) = 4.75 − 0.15 = 4.60.
- Therefore the answer is (B).

FINAL: (B) 4.6

SHORTCUT / EXAM TRICK

At the half-equivalence point pH = pKa; at equivalence of weak acid–strong base pH > 7.

COMMON MISTAKE

Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

EXAM TIP

Common ion lowers solubility; complexation or pH change can raise it.

MEMORY TRICK

'Half way, pH = pKa'.

Why the Other Options Are Wrong

Correct answer: B

A **4.9**

Why (B) is the key — Ammonium acetate supplies 0.1 mol acetate (the NH_4^+ contribution is negligible beside the buffer): pH = pKa + log([CH_3COO^-]/[CH_3COOH]) = 4.75 + log(0.1/0.14) = 4.75 − 0.15 = 4.60.

C **4.3**

Ruled out: Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.

D **2.3**

Ruled out: Common ion lowers solubility; complexation or pH change can raise it.

Q27 The solubility of PbI_2 in 0.10 M KI(aq) is ___ × 10^{-7} M (rounded up to two decimal places). [The solubility product, $K_{sp} = 7.1 \times 10^{-9}$] (Numerical answer type — write the value.)

ANSWER: 7.10×10^{-7} M

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
PbI_2: Ksp = $[Pb^{2+}][I^-]^2$ with $[I^-] \approx 0.10$ M (common ion): $s = 7.1\times10^{-9}/(0.10)^2 = 7.1\times10^{-7}$ M.

Q28 One liter of a buffer solution contains 0.004 mole of acetic acid ($pK_a = 4.76$) and 0.4 mole of sodium acetate. The pH of the solution is _____. (Round off to two decimal places)
(Numerical answer type — write the value.)

ANSWER: 6.76

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
pH = pKa + log([salt]/[acid]) = 4.76 + log(0.4/0.004) = 4.76 + 2.00 = 6.76.

Q29 A buffer solution is prepared by mixing 0.3 M NH_3 and 0.1 M NH_4NO_3. If K_b of NH_3 is 1.6×10^{-5} at 25°C, then the pH (rounded off to one decimal place) of the buffer solution at 25°C is ___.
(Numerical answer type — write the value.)

ANSWER: 9.7

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Ionic Equilibrium

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$pOH = pKb + \log([NH_4^+]/[NH_3]) = 4.80 + \log(0.1/0.3) = 4.80 - 0.48 = 4.32 \rightarrow pH = 14 - 4.32 = 9.7$.

TOPIC REVISION

Ionic Equilibrium

13 PYQs · Last-minute revision

TOPIC SUMMARY

Weak acids/bases: Ka, Kb, Kw = Ka·Kb = 10^{-14}; buffers follow Henderson–Hasselbalch pH = pKa + log([A^-]/[HA]); solubility product Ksp governs precipitation and the common-ion effect.

IMPORTANT FORMULA SHEET

- pH = ½(pKa − log C) (weak acid)
- pH = pKa + log([base]/[acid])
- Ksp = [M^+]^m[X^-]^x; s from Ksp
- β = 2.303 C Ka[H^+]/(Ka+[H^+])²

FREQUENTLY ASKED CONCEPTS

- pH of salts of weak acid/base
- Buffer capacity maximum at pH = pKa
- Solubility in presence of common ion
- Titration curve points

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting activity/complete dissociation assumptions for strong electrolytes; mixing Ksp exponents.
Common ion lowers solubility; complexation or pH change can raise it.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29

Expect 13 question(s) next session on Ionic Equilibrium.

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FOR EDUCATORS

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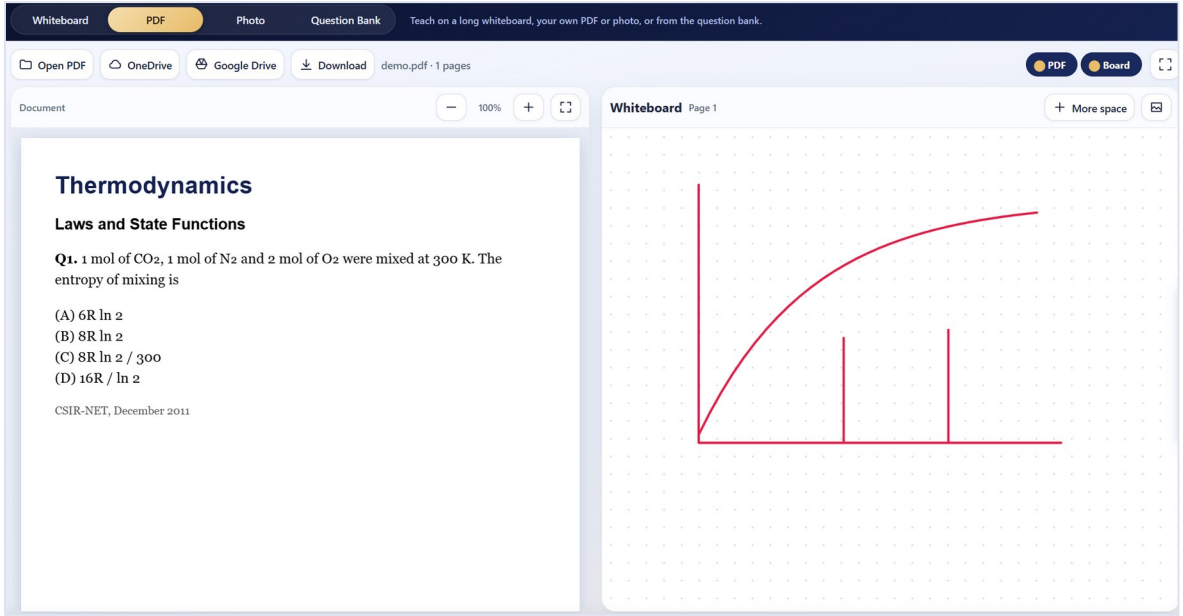
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