ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Term Symbols & Spectroscopic States

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 — 2 Topics · 16 Real PYQs

(Mr. Aniket Bhardwaj By ABC Chemistry) · www.abcchemistry.com · 9212142427

Mr. Aniket Bhardwaj

@abcchemistry24

Instagram · YouTube · Facebook

Course Contents

2 Topics · 16 PYQs

1	**Term Symbols Atoms** 6 Qs E 3 · M 3 · H 0	38%	
2	**Term Symbols & Spectroscopic States – General** 10 Qs E 6 · M 4 · H 0	62%	

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

TOPIC 1

Term Symbols Atoms

6 questions · Easy 3 | Medium 3 | Hard 0 · PYQ frequency: High

Q1

The term symbol for the ground state of nitrogen atoms is

A. $^{3}P_{0}$

B. $^{4}P_{3}/2$

C. $^{1}P_{1}$

D. $^{4}S_{3}/2$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Correct Answer D $^4S_{3}/2$

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- N: $2p^3$ half-filled. Hund: maximum S = 3/2 (multiplicity 4), L = 0 (S term), J = 3/2 → $^4S_{3/2}$.
- Therefore the answer is (D).

FINAL: (D) $^4S_{3}/2$

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: D

A $^{3}P_{0}$

Why (D) is the key — N: $2p^3$ half-filled. Hund: maximum S = 3/2 (multiplicity 4), L = 0 (S term), J = 3/2 → $^{4}S_{3}/_{2}$.

B $^{4}P_{3}/2$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

C $^{1}P_{1}$

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

Q2

The term symbol of a molecule with electronic configuration $(1\sigma_g)^2(1\sigma_u)^2(2\sigma_g)^2(2\sigma_u)^2(2\pi_u)^1(2\pi_u)^1$ is:

A $^1\Sigma_g^+$

B $^3\Sigma_g^-$

C $^1\Sigma_g^-$

D $^3\Sigma_g^+$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Term Symbols Atoms

Correct Answer B $^3\Sigma_g^-$

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- $(2\pi_u)^1(2\pi_u)^1$ two electrons in a degenerate π set (like O_2's π_g^2): terms $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$; parity u × u = g; Hund → ground $^3\Sigma_g^-$ (option b).
- Therefore the answer is (B).

FINAL: (B) $^3\Sigma_g^-$

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: B

A $^1\Sigma_g^+$

Why (B) is the key — $(2\pi_u)^1(2\pi_u)^1$ two electrons in a degenerate π set (like O_2's π_g^2): terms $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$; parity u × u = g; Hund → ground $^3\Sigma_g^-$ (option b).

C $^1\Sigma_g^-$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

D $^3\Sigma_g^+$

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

Q3

What is the atomic term symbol for helium atom with electronic configuration $1s^2$?

A. $^2S_1/2$

B. $^1P_0$

C. $^1S_0$

D. $^1S_1$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Correct Answer C $^1S_0$

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- $1s^2$: closed shell, S = 0, L = 0, J = 0 → $^1S_0$.
- Therefore the answer is (C).

FINAL: (C) $^1S_0$

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: C

A $^2S_1/2$

Why (C) is the key — $1s^2$: closed shell, S = 0, L = 0, J = 0 → $^1S_0$.

B $^1P_0$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

D $^1S_1$

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

Q4

The lowest energy-state of an atom with electronic configuration ns^1np^1 has the term symbol

A $^3P_1$

B $^1P_1$

C $^3P_2$

D $^3P_0$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Correct Answer D ^3P_o

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- ns^1np^1 gives ^3P and ^1P; Hund: triplet lower; less than half-filled → J = |L − S| = 0 → $^3P_0$.
- Therefore the answer is (D).

FINAL: (D) ^3P_o

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: D

A $^3P_1$

Why (D) is the key — ns^1np^1 gives ^3P and ^1P; Hund: triplet lower; less than half-filled → J = |L − S| = 0 → $^3P_0$.

B $^1P_1$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

C $^3P_2$

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

Q5

The term symbol for the first excited state of Be with the electronic configuration $1s^2\ 2s^1\ 3s^1$ is

A. $^3S_1$

B. $^3S_0$

C. $^1S_0$

D. $^2S_1/2$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Correct Answer A $^3S_1$

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- $2s^1 3s^1$: two s electrons (L = 0) in different shells can be parallel: S = 1, J = 1 → $^3S_1$ (the lowest of the excited states by Hund's rule).
- Therefore the answer is (A).

FINAL: (A) $^3S_1$

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: A

B $^3S_0$

Why (A) is the key — $2s^1 3s^1$: two s electrons (L = 0) in different shells can be parallel: S = 1, J = 1 → $^3S_1$ (the lowest of the excited states by Hund's rule).

C $^1S_0$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

D $^2S_1/2$

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

Q6

the term symbol for ground state dinitrogen cation radical (N_2^+) is

A. ^2Pi_u

B. $^2\Sigma_u^-$

C. ^2Pi_g

D. $^2\Sigma_g^+$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols Atoms

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Spin first, then L, then J: Hund 1-2-3'.

Correct Answer D $^2\Sigma_g^+$

CONCEPT

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

↓

LOGIC / WORKING

- N_2 is …$(\pi_u 2p)^4(\sigma_g 2p)^2$; removing one electron from the σ_g HOMO leaves $(\sigma_g 2p)^1$: Λ = 0, g, doublet → $^2\Sigma_g^+$.
- Therefore the answer is (D).

FINAL: (D) $^2\Sigma_g^+$

SHORTCUT / EXAM TRICK

p^2 → $^3P_0$ ground; d^2 → $^3F_2$; d^8 → $^3F_4$ (hole formalism: d^n and d^{10-n} share terms, J flips).

COMMON MISTAKE

Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

EXAM TIP

Closed shells contribute S = L = 0 — only open-shell electrons matter.

MEMORY TRICK

'Spin first, then L, then J: Hund 1-2-3'.

Why the Other Options Are Wrong

Correct answer: D

A ^2Pi_u

Why (D) is the key — N_2 is …$(\pi_u 2p)^4(\sigma_g2p)^2$; removing one electron from the σ_g HOMO leaves $(\sigma_g2p)^1$: Λ = 0, g, doublet → $^2\Sigma_g^+$.

B $^2\Sigma_u^-$

Ruled out: Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.

C ^2Pi_g

Ruled out: Closed shells contribute S = L = 0 — only open-shell electrons matter.

TOPIC REVISION

Term Symbols Atoms

6 PYQs · Last-minute revision

TOPIC SUMMARY

A term symbol $^{2S+1}L_J$ summarises total spin S, total orbital angular momentum L and total J of an atom. Hund's rules pick the ground term: maximum S, then maximum L, then J = |L−S| (less than half-filled) or L+S (more than half-filled).

IMPORTANT FORMULA SHEET

- Multiplicity = 2S+1
- J = L+S … |L−S|
- Degeneracy of a term = (2S+1)(2L+1); of a level = 2J+1
- Landé g = 1 + [J(J+1)+S(S+1)−L(L+1)]/2J(J+1)

FREQUENTLY ASKED CONCEPTS

- Ground term of p^2, d^3, f^7 configurations
- Number of microstates = n!/(e!(n−e)!)
- J levels and their degeneracy
- Equivalent vs non-equivalent electrons

COMMON MISTAKES & QUICK NOTES

Watch out:
Taking J = L+S for a less-than-half-filled shell; counting Pauli-forbidden microstates for equivalent electrons.
Closed shells contribute S = L = 0 — only open-shell electrons matter.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6

Expect 1 question(s) next session on Term Symbols Atoms.

TOPIC 2

Term Symbols & Spectroscopic States – General

10 questions · Easy 6 | Medium 4 | Hard 0 · PYQ frequency: High

Q7

Observe the following electronic transition of a diatomic molecule. (A) $^1\Sigma_g^+ \rightarrow {}^3\Sigma_g^+$ (B) $^1\Sigma_u^+ \rightarrow {}^1\Sigma_g^+$ (C) $^1\Delta_u \rightarrow {}^1\Sigma_g^+$ (D) ^{1}Pi_g $\rightarrow {}^1\Sigma_u^+$ The allowed transitions are

A. (A) and (C) only

B. (B) and (D) only

C. (A), (B) and (C) only

D. (A), (C) and (D) only

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$^2\Pi \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer B (B) and (D) only

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Rules: $\Delta S = 0$, g ↔ u, $\Sigma^+ \leftrightarrow \Sigma^+$, $\Delta\Lambda = 0, \pm 1$. (A) singlet → triplet ×; (B) $^1\Sigma_u^+ \rightarrow {}^1\Sigma_g^+$ ✓; (C) $\Delta \rightarrow \Sigma$ has $\Delta\Lambda = 2$ ×; (D) $^1\Pi_g \rightarrow {}^1\Sigma_u^+$ ✓. Hence (B) and (D).
- Therefore the answer is (B).

FINAL: (B) (B) and (D) only

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: B

A **(A) and (C) only**

Why (B) is the key — Rules: $\Delta S = 0$, $g \leftrightarrow u$, $\Sigma^+ \leftrightarrow \Sigma^+$, $\Delta\Lambda = 0, \pm 1$. (A) singlet→triplet ×; (B) $^1\Sigma_u^+ \rightarrow {}^1\Sigma_g^+$ ✓; (C) $\Delta \rightarrow \Sigma$ has $\Delta\Lambda = 2$ ×; (D) $^1\Pi_g \rightarrow {}^1\Sigma_u^+$ ✓. Hence (B) and (D).

C **(A), (B) and (C) only**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **(A), (C) and (D) only**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q8

Two α particles having speeds S_1 and S_2 have kinetic energies 1 and 2 MeV respectively; the relationship between S_1 and S_2 is :

A. $S_1 = 2S_2$

B. $S_2 = 2S_1$

C. $S_2 = \sqrt{(2)}\, S_1$

D. $S_1 = \sqrt{(2S_2)}$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'$^{1}\Pi^{2} \rightarrow {}^{3}\Sigma^{-}$ at the bottom, like O_2 — a triplet ground state'.

Term Symbols & Spectroscopic States – General

Correct Answer C $S_2 = \sqrt{(2)}\, S_1$

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Kinetic energy ∝ speed²: $E_2/E_1 = 2 = (S_2/S_1)^2 \rightarrow S_2 = \sqrt{2}\, S_1$ (option c). The printed key (b) would need a four-fold energy ratio.
- Therefore the answer is (C).

FINAL: (C) $S_2 = \sqrt{(2)}\, S_1$

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: C

A $S_1 = 2S_2$

Why (C) is the key — Kinetic energy ∝ speed²: $E_2/E_1 = 2 = (S_2/S_1)^2 \rightarrow S_2 = \sqrt{2}\, S_1$ (option c). The printed key (b) would need a four-fold energy ratio.

B $S_2 = 2S_1$

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D $S_1 = \sqrt{(2S_2)}$

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q9

The standard deviation of speed (σ_c) for Maxwell's distribution satisfies the relation

A. σ_c ∝ T

B. σ_c ∝ √(T)

C. σ_c ∝ 1/T

D. σ_c ∝ 1/√(T)

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer B $\sigma_c \propto \sqrt{(T)}$

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- All characteristic speeds of the Maxwell distribution scale as $\sqrt{(T/m)}$; $\sigma_c = \sqrt{(\langle c^2\rangle - \langle c\rangle^2)} = \sqrt{(3 - 8/\pi)}\sqrt{(kT/m)} \propto \sqrt{T}$. Correct option is (b); the printed key (c) is wrong.
- Therefore the answer is (B).

FINAL: (B) $\sigma_c \propto \sqrt{(T)}$

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: B

A **$\sigma_c \propto T$**

Why (B) is the key — All characteristic speeds of the Maxwell distribution scale as $\sqrt{(T/m)}$; $\sigma_c = \sqrt{(\langle c^2 \rangle - \langle c \rangle^2)} = \sqrt{(3 - 8/\pi)}\sqrt{(kT/m)} \propto \sqrt{T}$. Correct option is (b); the printed key (c) is wrong.

C **$\sigma_c \propto 1/T$**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **$\sigma_c \propto 1/\sqrt{(T)}$**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q10

The highest molecular orbitals for an excited electronic configuration of the oxygen molecule are $[1\pi_g]^1[3\sigma_u]^1$. A possible molecular term symbol for oxygen with this electronic configuration is

A ^1Pi

B $^3\Sigma$

C $^1\Delta$

D $^1\Sigma$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer A ^{1}Pi

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- $(1\pi_g)^1(3\sigma_u)^1$: Λ = 1 + 0 = 1 → Π; parity g × u = u; two unpaired electrons can couple to singlet or triplet. ^{1}Π (option a) is a valid term (^{3}Π also exists but is not offered).
- Therefore the answer is (A).

FINAL: (A) ^{1}Pi

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: A

B — **$^3\Sigma$**

Why (A) is the key — $(1\pi_g)^1(3\sigma_u)^1$: $\Lambda = 1 + 0 = 1 \rightarrow \Pi$; parity g × u = u; two unpaired electrons can couple to singlet or triplet. $^1\Pi$ (option a) is a valid term ($^3\Pi$ also exists but is not offered).

C — **$^1\Delta$**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D — **$^1\Sigma$**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q11

Entropy of a perfect gas is

A. independent of V

B. proportional to V

C. proportional to ln V

D. proportional to V^2

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$^2\Pi \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer C proportional to ln V

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Sackur–Tetrode / ideal-gas entropy: $S = nR \ln V + f(T)$ — entropy rises logarithmically with volume ($\Delta S = nR \ln(V_2/V_1)$).
- Therefore the answer is (C).

FINAL: (C) proportional to ln V

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: C

A **independent of V**

Why (C) is the key — Sackur–Tetrode / ideal-gas entropy: $S = nR \ln V + f(T)$ — entropy rises logarithmically with volume ($\Delta S = nR \ln(V_2/V_1)$).

B **proportional to V**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **proportional to V^2**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q12

Root mean square speed of the molecules of a perfect gas is proportional to

A. $1/T_1/2$

B. T

C. $T_1/2$

D. 1/T

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$^2\Pi \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer C $T_1/2$

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- v_rms = √(3RT/M) ∝ T^½ — option (c). The printed key (d) is wrong.
- Therefore the answer is (C).

FINAL: (C) $T_1/2$

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: C

A **1/T₁/2**

Why (C) is the key — v_rms = √(3RT/M) ∝ T^½ — option (c). The printed key (d) is wrong.

B **T**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **1/T**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q13

A monoatomic perfect gas undergoes expansion from (p_1, V_1) to (p_2, V_2) under isothermal or adiabatic conditions. The pressure of the gas will fall more rapidly under adiabatic conditions because

A. $p \propto (1)/(V)$

B. $p \propto (1)/(V^{7}/5)$

C. $p \propto (1)/(V^{3}/2)$

D. $p \propto (1)/(V^{5}/3)$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'$^{2}\Pi \rightarrow {}^{3}\Sigma^{-}$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer D $p \propto (1)/(V^{5}/3)$

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Isothermal: p ∝ 1/V. Reversible adiabatic: pV^γ = const with γ = 5/3 for a monatomic gas, so p ∝ 1/V^(5/3) — steeper fall (option d). The printed key (a) describes the isothermal curve, not the reason.
- Therefore the answer is (D).

FINAL: (D) $p \propto (1)/(V^{5}/3)$

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: D

A **p ∝ (1)/(V)**

Why (D) is the key — Isothermal: p ∝ 1/V. Reversible adiabatic: pV^γ = const with γ = 5/3 for a monatomic gas, so p ∝ 1/V^(5/3) — steeper fall (option d). The printed key (a) describes the isothermal curve, not the reason.

B **p ∝ (1)/(V⁷/5)**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

C **p ∝ (1)/(V³/2)**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q14

The molar residual entropy (in J/K) for solid OCS is close to

A. 0

B. 2.9

C. 5.8

D. 8.7

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$^2\Pi \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer C 5.8

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Linear OCS can freeze in two orientations (OCS/SCO) → residual entropy S = R ln 2 = 8.314 × 0.693 = 5.8 J K^{-1} mol^{-1}.
- Therefore the answer is (C).

FINAL: (C) 5.8

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: C

A **0**

Why (C) is the key — Linear OCS can freeze in two orientations (OCS/SCO) → residual entropy $S = R \ln 2 = 8.314 \times 0.693 = 5.8$ J K^{-1} mol^{-1}.

B **2.9**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **8.7**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q15

For an assembly of molecules (molar mass = M) at temperature T, the standard deviation of Maxweller's speed is approximately

A. 0.7√((RT)/(M))

B. 1.4√((RT)/(M))

C. 0.7√((M)/(RT))

D. 1.4√((M)/(RT))

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'$^{2}\Pi \rightarrow {}^{3}\Sigma^{-}$ at the bottom, like O_2 — a triplet ground state'.

Correct Answer A 0.7√((RT)/(M))

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- $\sigma_c = \sqrt{(\langle c^2\rangle - \langle c\rangle^2)} = \sqrt{(3RT/M - 8RT/\pi M)} = \sqrt{(RT/M)}\sqrt{(3 - 2.546)} = 0.67\sqrt{(RT/M)} \approx 0.7\sqrt{(RT/M)}$ (option a). The printed key (b, 1.4) is wrong.
- Therefore the answer is (A).

FINAL: (A) 0.7√((RT)/(M))

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: A

B **1.4√((RT)/(M))**

Why (A) is the key — $\sigma_c = \sqrt{(\langle c^2\rangle - \langle c\rangle^2)} = \sqrt{(3RT/M - 8RT/\pi M)} = \sqrt{(RT/M)}\sqrt{(3 - 2.546)} = 0.67\sqrt{(RT/M)} \approx 0.7\sqrt{(RT/M)}$ (option a). The printed key (b, 1.4) is wrong.

C **0.7√((M)/(RT))**

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D **1.4√((M)/(RT))**

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

Q16

The electric-dipole allowed transition among the following is

A. $^3S \rightarrow {}^3D$

B. $^3S \rightarrow {}^3P$

C. $^3S \rightarrow {}^1D$

D. $^3S \rightarrow {}^1F$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Term Symbols & Spectroscopic States – General

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'$^3\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Term Symbols & Spectroscopic States – General

Correct Answer B $^3S \rightarrow {}^3P$

CONCEPT

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

↓

LOGIC / WORKING

- Electric-dipole rules: ΔS = 0 and ΔL = ±1 (Laporte). $^3S \rightarrow {}^3P$ satisfies both; $^3S \rightarrow {}^3D$ has ΔL = 2; the singlet targets break ΔS = 0.
- Therefore the answer is (B).

FINAL: (B) $^3S \rightarrow {}^3P$

SHORTCUT / EXAM TRICK

Fill the MO diagram, look only at partly filled degenerate π orbitals: π^2 gives $^3\Sigma^-$, $^1\Delta$, $^1\Sigma^+$ (ground $^3\Sigma^-$).

COMMON MISTAKE

Forgetting that g×g = g, u×u = g, g×u = u for parity.

EXAM TIP

Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MEMORY TRICK

'$\Pi^2 \rightarrow {}^3\Sigma^-$ at the bottom, like O_2 — a triplet ground state'.

Why the Other Options Are Wrong

Correct answer: B

A $^3S \rightarrow {}^3D$

Why (B) is the key — Electric-dipole rules: ΔS = 0 and ΔL = ±1 (Laporte). $^3S \rightarrow {}^3P$ satisfies both; $^3S \rightarrow {}^3D$ has ΔL = 2; the singlet targets break ΔS = 0.

C $^3S \rightarrow {}^1D$

Ruled out: Forgetting that g×g = g, u×u = g, g×u = u for parity.

D $^3S \rightarrow {}^1F$

Ruled out: Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

TOPIC REVISION

Term Symbols & Spectroscopic States – General

10 PYQs · Last-minute revision

TOPIC SUMMARY

Atomic terms use L = S, P, D, F…; molecular (diatomic) terms use Λ = Σ, Π, Δ with g/u parity and ± symmetry for Σ states. Spin–orbit coupling splits a term into J levels (Russell–Saunders for light atoms, jj for heavy).

IMPORTANT FORMULA SHEET

- $^{2s+1}\Lambda_{(g/u)}^{(\pm)}$
- $\Lambda = |\Sigma m_l|$; $S = \Sigma m_s$
- O_2 ground: $^3\Sigma_g^-$; N_2: $^1\Sigma_g^+$; NO: $^2\Pi$

FREQUENTLY ASKED CONCEPTS

- Term symbol of O_2, N_2, NO, CN
- g/u from the MO configuration
- +/− for Σ states
- Microstate counting

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting that g×g = g, u×u = g, g×u = u for parity.
Same-shell equivalent π^2 electrons cannot give $^3\Delta$ or $^3\Sigma^+$ (Pauli).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16

Expect 1 question(s) next session on Term Symbols & Spectroscopic States – General.

FOR STUDENTS AND EDUCATORS

Government Jobs and Examination News

Keep track of every notification in one place.

Government Jobs

- Latest vacancies
- By category
- By state
- Exams
- Chemistry jobs
- Government Jobs Blog

Scan to Explore

4ab.in/government-jobs

Examination News

- Latest updates
- Exam calendar
- Admit cards
- Results
- UG entrance exams
- PG entrance exams
- NET, SET & PhD exams
- School board exams
- Examination News Blog

Scan to Explore

4ab.in/examination-news

Vacancies, admit cards, results and exam dates: all in one place

FOR EDUCATORS

Teach from the Question Bank, one question at a time

Find the right questions, teach them in class, then take them with you.

1 Find questions

- Browse
- Question search
- Topic packs

2 Teach one by one

Question Bank

Show each question to students on the board, in your own order.

3 Export

PPTX, DOCX, PNG (zip), HTML, Markdown

Take the paper home after class.

Scan to open Question Bank

4ab.in/educators/?m=qb

Many more coming soon

My papers

Social groups

Question Paper Analyser

AI question paper generator

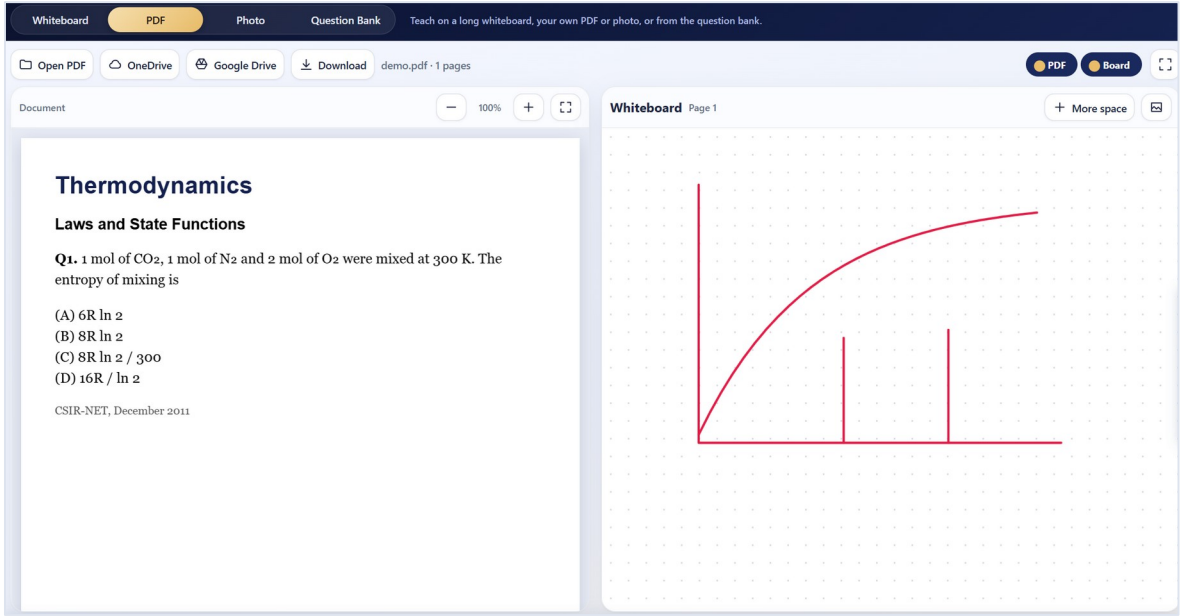
Paid

Lifetime free for educators, except AI tools

TUTOR-BRANDED TEACHING TOOLS

Free whiteboard for educators

Teach on a long whiteboard, your own PDF or photo, or from the question bank.



Start teaching

4ab.in/educators

Need more room? Add more space to the board as you teach.

Tutor pages show a small "Powered by 4AB" line. Premium removes it.

Whiteboard | **PDF** | **Photo** | **Question Bank**

EXPLORE AND USE

Chemistry Labs: symmetry and crystals

Scan a code or click a card to open the tool.

Molecular Symmetry

Explore molecular symmetry

4ab.in/molecular-symmetry/

Molecular Point Groups

Learn molecular point groups

4ab.in/molecular-point-groups/

Crystal Structure

Explore crystal structures

4ab.in/crystal-structure/

Crystal Space Groups

Browse crystal space groups

4ab.in/crystal-space-groups/

EXPLORE AND USE

Chemistry Labs: elements, calculation and drawing

Scan a code or click a card to open the tool.

Periodic Table

Explore the elements

4ab.in/periodic-table/

Chemistry Calculator

Solve chemistry calculations

4ab.in/chemistry-calculator/

Chemistry Typing

Type chemistry text

4ab.in/chemistry-typing/

Structure Editor

Draw structures

4ab.in/educators/draw/

Explore free educator tools

Mr. Aniket Bhardwaj

ABC Chemistry

9212142427

4ab.in/educators

@abcchemistry24 · Instagram · YouTube · Facebook

Scan to explore