ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Chemical Bonding

Premium CSIR-NET PYQ Book

71 Previous-Year Questions · 65 with verified answers · Distractor Analysis

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

CSIR-NET · GATE · IIT-JAM — 5 Topics · 71 Real PYQs

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Course Contents

5 Topics · 71 PYQs

1	Hydrogen Bonding Weak Interactions	8 Qs E 6 · M 2 · H 0	11%
2	Dipole Moment Polarity	4 Qs E 1 · M 2 · H 1	6%
3	VSEPR Geometry	4 Qs E 2 · M 2 · H 0	6%
4	MO Theory Diatomics	4 Qs E 3 · M 1 · H 0	6%
5	Chemical Bonding – General	51 Qs E 34 · M 11 · H 6	72%

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

TOPIC 1

Hydrogen Bonding Weak Interactions

8 questions · Easy 6 | Medium 2 | Hard 0 · PYQ frequency: High

Q1

Allred-Rochow electronegativity of an element is A. directly proportional to the effective nuclear charge B. directly proportional to the covalent radius C. inversely proportional to the square of the covalent radius The correct answer is

A. A and B

B. A and C

C. B and C

D. A and D

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Hydrogen Bonding Weak Interactions

Correct Answer B A and C

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^{-}), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- Allred–Rochow: $\chi = 0.359\, Z_{e}ff/r^2 + 0.744$. Electronegativity rises with $Z_{e}ff$ and falls with the square of the covalent radius. A and C (b).
- Therefore the answer is (B).

FINAL: (B) A and C

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: B

A

A and B

Why (B) is the key — Allred–Rochow: $\chi = 0.359\, Z_{eff}/r^2 + 0.744$. Electronegativity rises with Z_{eff} and falls with the square of the covalent radius. A and C (b).

C

B and C

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D

A and D

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q2

The strength of P π-d π bonding in E-O(E=Si, P, S and Cl) follows the order

A. Si-O > P-O > S-O > Cl-O

B. P-O>Si-O>S-O>Cl-O

C. S-O > Cl-O > P-O > Si-O

D. Cl-O>S-O>P-O>Si-O

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Hydrogen Bonding Weak Interactions

Correct Answer D Cl-O>S-O>P-O>Si-O

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^{-}), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- pπ–dπ bonding to oxygen strengthens as the d orbitals contract and match oxygen 2p better: Cl–O > S–O > P–O > Si–O.
- Therefore the answer is (D).

FINAL: (D) Cl-O>S-O>P-O>Si-O

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: D

A **Si-O > P-O > S-O > Cl-O**

Why (D) is the key — pπ–dπ bonding to oxygen strengthens as the d orbitals contract and match oxygen 2p better: Cl–O > S–O > P–O > Si–O.

B **P-O>Si-O>S-O>Cl-O**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

C **S-O > Cl-O > P-O > Si-O**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q3

The molecule in which the bond order increases upon addition of an electron

A O_2

B B_2

C P_2

D N_2

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Correct Answer B B_2

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- B_2 has half-filled π_u orbitals; adding an electron to a bonding orbital raises the bond order (1 → 1.5). O_2, N_2 and P_2 would add to antibonding orbitals.
- Therefore the answer is (B).

FINAL: (B) B_2

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: B

A — **O_2**

Why (B) is the key — B_2 has half-filled π_u orbitals; adding an electron to a bonding orbital raises the bond order (1 → 1.5). O_2, N_2 and P_2 would add to antibonding orbitals.

C — **P_2**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D — **N_2**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Hydrogen Bonding Weak Interactions

Q4

O_2^- is

(A) having a shorter O-O bond length than that in O_2

(B) a stronger oxidising agent than O_2

(C) IR active

(D) unable to abstract proton from weak acids

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Correct Answer B a stronger oxidising agent than O_2

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- O_2^- (bond order 1.5) has a longer O–O bond than O_2; as a homonuclear ion it is IR-inactive; it is basic enough to deprotonate weak acids (giving HO_2). $E°(O_2^-/H_2O_2)$ = +0.89 V > $E°(O_2/O_2^-)$ = −0.33 V, so superoxide is the stronger oxidant.
- Therefore the answer is (B).

FINAL: (B) a stronger oxidising agent than O_2

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: B

A **having a shorter O-O bond length than that in O_2**

Why (B) is the key — O_2^- (bond order 1.5) has a longer O–O bond than O_2; as a homonuclear ion it is IR-inactive; it is basic enough to deprotonate weak acids (giving HO_2). $E°(O_2^-/H_2O_2) = +0.89$ V > $E°(O_2/O_2^-) = -0.33$ V, so superoxide is the stronger oxidant.

C **IR active**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D **unable to abstract proton from weak acids**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q5

Among the following which set of molecular/ionic species all have a planar structure?

A BrF_3, $FClO_2$ and $[XeF_5]^-$

B XeO_3,$[ClF_4]^-$and $FClO_2$

C $[ClF_4]^-$, BrF_3 and $[XeF_5]^-$

D $FClO_2$,$[XeF_5]^-$and XeO_3

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Correct Answer C $[ClF_4]^-$, BrF_3 and $[XeF_5]^-$

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- ClF_4^- (AX_4E_2) square planar, BrF_3 (AX_3E_2) T-shaped planar, XeF^- (AXE_2) pentagonal planar. XeO_3 is pyramidal and $FClO_2$ is pyramidal, so the other sets fail.
- Therefore the answer is (C).

FINAL: (C) $[ClF_4]^-$, BrF_3 and $[XeF_5]^-$

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: C

A **BrF_3, $FClO_2$ and $[XeF_5]^-$**

Why (C) is the key — ClF_4^- (AX_4E_2) square planar, BrF_3 (AX_3E_2) T-shaped planar, XeF^- (AXE_2) pentagonal planar. XeO_3 is pyramidal and $FClO_2$ is pyramidal, so the other sets fail.

B **XeO_3,$[ClF_4]^-$and $FClO_2$**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D **$FClO_2$,$[XeF_5]^-$and XeO_3**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q6

The total number of lone pairs of electrons on all the atoms in cyanogen azide and thiocyanogen respectively, are

A. 4 and 6

B. 6 and 6

C. 3 and 4

D. 4 and 4

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Hydrogen Bonding Weak Interactions

Correct Answer A 4 and 6

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- Cyanogen azide N≡C–N_3: nitrile N 1, the N bonded to C 1, central N 0, terminal N 2 → 4. Thiocyanogen N≡C–S–S–C≡N: each N 1, each S 2 → 6.
- Therefore the answer is (A).

FINAL: (A) 4 and 6

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: A

B — **6 and 6**

Why (A) is the key — Cyanogen azide N≡C–N_3: nitrile N 1, the N bonded to C 1, central N 0, terminal N 2 → 4. Thiocyanogen N≡C–S–S–C≡N: each N 1, each S 2 → 6.

C — **3 and 4**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D — **4 and 4**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q7

The shapes of the compounds ClF_3, $XeOF_2$, N_3^- and XeO_3F_2 respectively, are:

A. trigonal planar, T-shape, V-shape and square pyramidal

B. trigonal planar, trigonal planar, V-shape and trigonal bipyramidal

C. T-shape, T-shape, linear and trigonal bipyramidal

D. T-shape, trigonal planar, linear and square pyramidal

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Correct Answer C T-shape, T-shape, linear and trigonal bipyramidal

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- ClF_3 (AX_3E_2) T-shaped; $XeOF_2$ (AX_3E_2) T-shaped; N_3^- linear (16 e^-, sp N); XeO_3F_2 (AX_5, no lone pair) trigonal bipyramidal with F axial.
- Therefore the answer is (C).

FINAL: (C) T-shape, T-shape, linear and trigonal bipyramidal

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: C

A — **trigonal planar, T-shape, V-shape and square pyramidal**

Why (C) is the key — ClF_3 (AX_3E_2) T-shaped; $XeOF_2$ (AX_3E_2) T-shaped; N_3^- linear (16 e^-, sp N); XeO_3F_2 (AX_5, no lone pair) trigonal bipyramidal with F axial.

B — **trigonal planar, trigonal planar, V-shape and trigonal bipyramidal**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D — **T-shape, trigonal planar, linear and square pyramidal**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

Q8

At room temperature, HCl is a gas while HF is a liquid because

A. Of a strong bond between H and F in HF

B. HF is less acidic as compared to HCl

C. Of strong intermolecular H-bonding in HF

D. HCl is less acidic as compared to HF

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Hydrogen Bonding Weak Interactions

PYQ FREQUENCY
High · 7 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'FON — hydrogen bonds to F, O, N'.

Hydrogen Bonding Weak Interactions

Correct Answer C Of strong intermolecular H-bonding in HF

CONCEPT

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

↓

LOGIC / WORKING

- HF molecules are linked by strong intermolecular hydrogen bonds (c).
- Therefore the answer is (C).

FINAL: (C) Of strong intermolecular H-bonding in HF

SHORTCUT / EXAM TRICK

Intramolecular H-bond → more volatile, less water-soluble (ortho isomer).

COMMON MISTAKE

Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

EXAM TIP

Among halides boiling points rise with molar mass except HF (H-bonding).

MEMORY TRICK

'FON — hydrogen bonds to F, O, N'.

Why the Other Options Are Wrong

Correct answer: C

A **Of a strong bond between H and F in HF**

Why (C) is the key — HF molecules are linked by strong intermolecular hydrogen bonds (c).

B **HF is less acidic as compared to HCl**

Ruled out: Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.

D **HCl is less acidic as compared to HF**

Ruled out: Among halides boiling points rise with molar mass except HF (H-bonding).

TOPIC REVISION

Hydrogen Bonding Weak Interactions

8 PYQs · Last-minute revision

TOPIC SUMMARY

Hydrogen bonds (X–H···Y, X,Y = N, O, F; 10–40 kJ mol^{-1}, up to 160 for F–H···F^-), intramolecular vs intermolecular effects on boiling point, acidity and solubility; van der Waals (London, Keesom, Debye) scale with polarisability; π-stacking and halogen bonding.

IMPORTANT FORMULA SHEET

- London energy $\propto -\alpha_1\alpha_2/r^6$
- Keesom $\propto -\mu_1^2\mu_2^2/(kT\ r^6)$
- H-bond strength: F–H···F^- > O–H···O > N–H···N

FREQUENTLY ASKED CONCEPTS

- Why HF, H_2O, NH_3 have high b.p.
- Intramolecular H-bond lowering b.p. (o-nitrophenol)
- Ice density anomaly
- Strength order of interactions

COMMON MISTAKES & QUICK NOTES

Watch out:
Calling C–H···O a classical hydrogen bond in basic rankings; ignoring polarisability for noble-gas boiling points.
Among halides boiling points rise with molar mass except HF (H-bonding).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8

Expect 1 question(s) next session on Hydrogen Bonding Weak Interactions.

TOPIC 2

Dipole Moment Polarity

4 questions · Easy 1 | Medium 2 | Hard 1 · PYQ frequency: Occasional

Q9

Among $SiCl_4$, $P(O)Cl_3$, NF_3, trans- $[SnCl_4(py)_2]$ (py-pyridine), those with zero dipole moment are (a) $SiCl_4$, and NF_3 (c) $SiCl_4$, and trans- $SnCl_4(py)_2$ (b) $SiCl_4$, $P(O)Cl_3$, and trans- $SnCl_4(py)_4$ (d) NF_3 and trans- $SnCl_4(py)_2$

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

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Dipole Moment Polarity

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Symmetric = silent dipole'.

Q10

The decreasing order of dipole moment of molecules is

A. $NF_3 > NH_3 > H_2O$

B. $NH_3 > NF_3 > H_3O$

C. $H_2O > NH_3 > NF_3$

D. $H_2O > NF_3 > NH_3$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Dipole Moment Polarity

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Symmetric = silent dipole'.

Correct Answer C $H_2O > NH_3 > NF_3$

CONCEPT

Molecular dipole = vector sum of bond dipoles and lone-pair contributions; symmetric geometries (linear AB_2, trigonal planar, tetrahedral, square planar) cancel; $NH_3 > NF_3$ because the lone pair reinforces N–H dipoles but opposes N–F.

↓

LOGIC / WORKING

- H_2O 1.85 D > NH_3 1.47 D > NF_3 0.23 D. In NF_3 the N–F bond dipoles oppose the lone-pair moment, almost cancelling it. (Bank key (d) was wrong — corrected.)
- Therefore the answer is (C).

FINAL: (C) $H_2O > NH_3 > NF_3$

SHORTCUT / EXAM TRICK

Any molecule with a centre of symmetry has zero dipole moment.

COMMON MISTAKE

Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

EXAM TIP

CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

MEMORY TRICK

'Symmetric = silent dipole'.

Why the Other Options Are Wrong

Correct answer: C

A **$NF_3 > NH_3 > H_2O$**

Why (C) is the key — H_2O 1.85 D > NH_3 1.47 D > NF_3 0.23 D. In NF_3 the N–F bond dipoles oppose the lone-pair moment, almost cancelling it. (Bank key (d) was wrong — corrected.)

B **$NH_3 > NF_3 > H_3O$**

Ruled out: Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

D **$H_2O > NF_3 > NH_3$**

Ruled out: CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

Q11 **Consider the following four xenon compounds: XeF_2, XeF_4, XeF_6 and XeO_3 The pair of xenon compounds expected to have non-zero dipole moment is**

A XeF_4 and XeF_6

B XeF_2 and XeF_4

C XeF_2 and XeO_3

D XeF_6 and XeO_3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Dipole Moment Polarity

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Symmetric = silent dipole'.

Correct Answer D XeF_6 and XeO_3

CONCEPT

Molecular dipole = vector sum of bond dipoles and lone-pair contributions; symmetric geometries (linear AB_2, trigonal planar, tetrahedral, square planar) cancel; $NH_3 > NF_3$ because the lone pair reinforces N–H dipoles but opposes N–F.

↓

LOGIC / WORKING

- XeF_2 (linear) and XeF_4 (square planar) are centrosymmetric, μ = 0. XeF_6 (distorted octahedron, C_3v) and XeO_3 (trigonal pyramid, C_3v) have non-zero dipole moments.
- Therefore the answer is (D).

FINAL: (D) XeF_6 and XeO_3

SHORTCUT / EXAM TRICK

Any molecule with a centre of symmetry has zero dipole moment.

COMMON MISTAKE

Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

EXAM TIP

CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

MEMORY TRICK

'Symmetric = silent dipole'.

Why the Other Options Are Wrong

Correct answer: D

A **XeF_4 and XeF_6**

Why (D) is the key — XeF_2 (linear) and XeF_4 (square planar) are centrosymmetric, $\mu = 0$. XeF_6 (distorted octahedron, C_3v) and XeO_3 (trigonal pyramid, C_3v) have non-zero dipole moments.

B **XeF_2 and XeF_4**

Ruled out: Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

C **XeF_2 and XeO_3**

Ruled out: CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

Q12

The fluoride, whose value of dipole moment is not equal to zero, is

A XeF_4

B CF_4

C SF_4

D PF_5

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Dipole Moment Polarity

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Symmetric = silent dipole'.

Correct Answer C SF_4

CONCEPT

Molecular dipole = vector sum of bond dipoles and lone-pair contributions; symmetric geometries (linear AB_2, trigonal planar, tetrahedral, square planar) cancel; $NH_3 > NF_3$ because the lone pair reinforces N–H dipoles but opposes N–F.

↓

LOGIC / WORKING

- SF_4 (see-saw) is polar; XeF_4, CF_4 and PF_5 are non-polar (c).
- Therefore the answer is (C).

FINAL: (C) SF_4

SHORTCUT / EXAM TRICK

Any molecule with a centre of symmetry has zero dipole moment.

COMMON MISTAKE

Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

EXAM TIP

CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

MEMORY TRICK

'Symmetric = silent dipole'.

Why the Other Options Are Wrong

Correct answer: C

A **XeF_4**

Why (C) is the key — SF_4 (see-saw) is polar; XeF_4, CF_4 and PF_5 are non-polar (c).

B **CF_4**

Ruled out: Forgetting the lone-pair contribution (NF_3 is nearly non-polar).

D **PF_5**

Ruled out: CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

TOPIC REVISION

Dipole Moment Polarity

4 PYQs · Last-minute revision

TOPIC SUMMARY

Molecular dipole = vector sum of bond dipoles and lone-pair contributions; symmetric geometries (linear AB_2, trigonal planar, tetrahedral, square planar) cancel; NH_3 > NF_3 because the lone pair reinforces N–H dipoles but opposes N–F.

IMPORTANT FORMULA SHEET

- $\mu = \Sigma$ bond dipoles (vector)
- $\mu(\text{resultant}) = \sqrt{(\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2\cos\theta)}$
- $1\ D = 3.336 \times 10^{-30}\ C\ m$

FREQUENTLY ASKED CONCEPTS

- Zero-dipole molecules (CO_2, BF_3, CCl_4, XeF_4, trans-1,2-dichloroethene)
- NH_3 vs NF_3, H_2O vs F_2O
- cis vs trans isomers
- Percent ionic character

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting the lone-pair contribution (NF_3 is nearly non-polar).
CO has a small dipole with the negative end on carbon (back-donation and lone-pair effects).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q9 Q10 Q11 Q12

Expect 1 question(s) next session on Dipole Moment Polarity.

TOPIC 3

VSEPR Geometry

4 questions · Easy 2 | Medium 2 | Hard 0 · PYQ frequency: Occasional

Q13

The species for which the shapes (geometry) can be predicted by VSEPR theory is/are (A) $[PtCl_4]^{2-}$ (B) $[TeCl_6]^{2-}$ (C) PF_3 and SF_6

A. A and C

B. B and C

C. C only

D. A and B

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
VSEPR Geometry

PYQ FREQUENCY
Occasional · 4 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'LP–LP > LP–BP > BP–BP'.

Correct Answer C C only

CONCEPT

Electron-domain geometry from steric number; lone pairs occupy more space (LP–LP > LP–BP > BP–BP), reducing bond angles; in trigonal bipyramids lone pairs are equatorial, in octahedra two lone pairs are trans.

↓

LOGIC / WORKING

- VSEPR works for main-group species like PF_3 and SF_6; it fails for the d^8 square-planar $[PtCl_4]^{2-}$ and for $[TeCl_6]^{2-}$, whose 'inert' lone pair leaves it regular octahedral.
- Therefore the answer is (C).

FINAL: (C) C only

SHORTCUT / EXAM TRICK

Count electron pairs on the central atom: (valence + bonds − charge)/2.

COMMON MISTAKE

Placing lone pairs axial in TBP; double bonds counted as two domains.

EXAM TIP

I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

MEMORY TRICK

'LP–LP > LP–BP > BP–BP'.

Why the Other Options Are Wrong

Correct answer: C

A

A and C

Why (C) is the key — VSEPR works for main-group species like PF_3 and SF_6; it fails for the d^8 square-planar $[PtCl_4]^{2-}$ and for $[TeCl_6]^{2-}$, whose 'inert' lone pair leaves it regular octahedral.

B

B and C

Ruled out: Placing lone pairs axial in TBP; double bonds counted as two domains.

D

A and B

Ruled out: I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

Q14

According to VSEPR theory, the geometry (with lone pair) around the central iodine in I_3^+ and I_3^- ions respectively are

A. tetrahedral and tetrahedral

B. trigonal bipyramidal and trigonal bipyramedal

C. tetrahedral and trigonal bipyramidal

D. tetrahedral and octahedral

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
VSEPR Geometry

PYQ FREQUENCY
Occasional · 4 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'LP–LP > LP–BP > BP–BP'.

Correct Answer C tetrahedral and trigonal bipyramidal

CONCEPT

Electron-domain geometry from steric number; lone pairs occupy more space (LP–LP > LP–BP > BP–BP), reducing bond angles; in trigonal bipyramids lone pairs are equatorial, in octahedra two lone pairs are trans.

↓

LOGIC / WORKING

- I_3^+: AX_2E_2, tetrahedral electron geometry (bent); I_3^-: AX_2E_3, trigonal bipyramidal electron geometry (linear).
- Therefore the answer is (C).

FINAL: (C) tetrahedral and trigonal bipyramidal

SHORTCUT / EXAM TRICK

Count electron pairs on the central atom: (valence + bonds − charge)/2.

COMMON MISTAKE

Placing lone pairs axial in TBP; double bonds counted as two domains.

EXAM TIP

I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

MEMORY TRICK

'LP–LP > LP–BP > BP–BP'.

Why the Other Options Are Wrong

Correct answer: C

A **tetrahedral and tetrahedral**

Why (C) is the key — I_3^+: AX_2E_2, tetrahedral electron geometry (bent); I_3^-: AX_2E_3, trigonal bipyramidal electron geometry (linear).

B **trigonal bipyramidal and trigonal bipyramedal**

Ruled out: Placing lone pairs axial in TBP; double bonds counted as two domains.

D **tetrahedral and octahedral**

Ruled out: I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

Q15

The INCORRECT statement about the interhalogen compound ICl_3 is

A. It exists as a dimer

B. Geometry around the iodine is tetrahedral in solid-state

C. It decomposes as ICl and Cl_2 in gas-phase

D. Liquid ICl_3 conducts electricity

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
VSEPR Geometry

PYQ FREQUENCY
Occasional · 4 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'LP–LP > LP–BP > BP–BP'.

Correct Answer B Geometry around the iodine is tetrahedral in solid-state

CONCEPT

Electron-domain geometry from steric number; lone pairs occupy more space (LP–LP > LP–BP > BP–BP), reducing bond angles; in trigonal bipyramids lone pairs are equatorial, in octahedra two lone pairs are trans.

↓

LOGIC / WORKING

- ICl_3 exists as the planar dimer I_2Cl_6 with two bridging Cl; each iodine is square planar (AX_4E_2), not tetrahedral — so (b) is incorrect. It dissociates to ICl + Cl_2 in the gas phase and the liquid self-ionises ($ICl_2^+ + ICl_4^-$) and conducts.
- Therefore the answer is (B).

FINAL: (B) Geometry around the iodine is tetrahedral in solid-state

SHORTCUT / EXAM TRICK

Count electron pairs on the central atom: (valence + bonds − charge)/2.

COMMON MISTAKE

Placing lone pairs axial in TBP; double bonds counted as two domains.

EXAM TIP

I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

MEMORY TRICK

'LP–LP > LP–BP > BP–BP'.

Why the Other Options Are Wrong

Correct answer: B

A **It exists as a dimer**

Why (B) is the key — ICl_3 exists as the planar dimer I_2Cl_6 with two bridging Cl; each iodine is square planar (AX_4E_2), not tetrahedral — so (b) is incorrect. It dissociates to ICl + Cl_2 in the gas phase and the liquid self-ionises ($ICl_2^+ + ICl_4^-$) and conducts.

C **It decomposes as ICl and Cl_2 in gas-phase**

Ruled out: Placing lone pairs axial in TBP; double bonds counted as two domains.

D **Liquid ICl_3 conducts electricity**

Ruled out: I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

Q16

Which of the following has a square planar geometry according to the VSEPR theory? Atomic number: B=5, S =16, Xe=54.

A. XeO_2F_2

B. SF_4

C. BF_4^-

D. XeF_4

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
VSEPR Geometry

PYQ FREQUENCY
Occasional · 4 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'LP–LP > LP–BP > BP–BP'.

Correct Answer D XeF_4

CONCEPT

Electron-domain geometry from steric number; lone pairs occupy more space (LP–LP > LP–BP > BP–BP), reducing bond angles; in trigonal bipyramids lone pairs are equatorial, in octahedra two lone pairs are trans.

↓

LOGIC / WORKING

- XeF_4 (AX_4E_2) is square planar (d).
- Therefore the answer is (D).

FINAL: (D) XeF_4

SHORTCUT / EXAM TRICK

Count electron pairs on the central atom: (valence + bonds − charge)/2.

COMMON MISTAKE

Placing lone pairs axial in TBP; double bonds counted as two domains.

EXAM TIP

I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

MEMORY TRICK

'LP–LP > LP–BP > BP–BP'.

Why the Other Options Are Wrong

Correct answer: D

A XeO_2F_2

Why (D) is the key — XeF_4 (AX_4E_2) is square planar (d).

B SF_4

Ruled out: Placing lone pairs axial in TBP; double bonds counted as two domains.

C BF_4^-

Ruled out: I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

TOPIC REVISION

VSEPR Geometry

4 PYQs · Last-minute revision

TOPIC SUMMARY

Electron-domain geometry from steric number; lone pairs occupy more space (LP–LP > LP–BP > BP–BP), reducing bond angles; in trigonal bipyramids lone pairs are equatorial, in octahedra two lone pairs are trans.

IMPORTANT FORMULA SHEET

- SN 2 linear; 3 trigonal planar; 4 tetrahedral; 5 TBP; 6 octahedral; 7 pentagonal bipyramid
- Angle order: CH_4 109.5° > NH_3 107° > H_2O 104.5°

FREQUENTLY ASKED CONCEPTS

- Shapes of SF_4, ClF_3, I_3^-, XeF_2, $XeOF_4$, BrF_5
- Bond angle trends down a group (NH_3 > PH_3 > AsH_3)
- Axial vs equatorial bond lengths in PCl_5

COMMON MISTAKES & QUICK NOTES

Watch out:
Placing lone pairs axial in TBP; double bonds counted as two domains.
I_3^-: 3 lone pairs equatorial, linear shape; XeF_4: square planar.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q13 Q14 Q15 Q16

Expect 1 question(s) next session on VSEPR Geometry.

TOPIC 4

MO Theory Diatomics

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

Q17

According to VSEPR theory, the molecule/ion having ideal tetrahedral shape is

A. SF_4

B. SO_4^{2-}

C. S_2Cl_2

D. SO_2Cl_2

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
MO Theory Diatomics

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Correct Answer B SO_4^{2-}

CONCEPT

LCAO MOs: bonding (lower) and antibonding (higher); bond order = (N_b − N_a)/2; s–p mixing changes the σ/π order up to N_2; paramagnetism of O_2 from two unpaired π* electrons.

↓

LOGIC / WORKING

- SO_4^{2-} has four identical substituents and no lone pair: a regular tetrahedron. SF_4 is see-saw, S_2Cl_2 is gauche, SO_2Cl_2 a distorted tetrahedron.
- Therefore the answer is (B).

FINAL: (B) SO_4^{2-}

SHORTCUT / EXAM TRICK

Removing an electron from an antibonding MO strengthens the bond (O_2^+ shorter than O_2).

COMMON MISTAKE

Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

EXAM TIP

Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

MEMORY TRICK

'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Why the Other Options Are Wrong

Correct answer: B

A — **SF_4**

Why (B) is the key — SO_4^{2-} has four identical substituents and no lone pair: a regular tetrahedron. SF_4 is see-saw, S_2Cl_2 is gauche, SO_2Cl_2 a distorted tetrahedron.

C — **$S_2\ Cl_2$**

Ruled out: Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

D — **$SO_2\ Cl_2$**

Ruled out: Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

Q18

The molecule with highest number of lone-pairs and has a linear shape based on VSEPR theory is:

A CO_2

B I_3^-

C NO_2^-

D NO_2^+

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
MO Theory Diatomics

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Correct Answer B I_3^-

CONCEPT

LCAO MOs: bonding (lower) and antibonding (higher); bond order = (N_b − N_a)/2; s–p mixing changes the σ/π order up to N_2; paramagnetism of O_2 from two unpaired π* electrons.

↓

LOGIC / WORKING

- I_3^- is linear and carries 9 lone pairs (3 on the central I, 3 on each terminal I). CO_2 has 4, NO_2^+ has 4, and NO_2^- is bent (b).
- Therefore the answer is (B).

FINAL: (B) I_3^-

SHORTCUT / EXAM TRICK

Removing an electron from an antibonding MO strengthens the bond (O_2^+ shorter than O_2).

COMMON MISTAKE

Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

EXAM TIP

Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

MEMORY TRICK

'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Why the Other Options Are Wrong

Correct answer: B

A — **CO_2**

Why (B) is the key — I_3^- is linear and carries 9 lone pairs (3 on the central I, 3 on each terminal I). CO_2 has 4, NO_2^+ has 4, and NO_2^- is bent (b).

C — **NO_2^-**

Ruled out: Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

D — **NO_2^+**

Ruled out: Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

Q19

The correct shape of $[TeF_5]^-$ ion on the basis of VSEPR theory is

A. Trigonal bipyramidal

B. Square pyramidal

C. Pentagonal planar

D. See-saw

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
MO Theory Diatomics

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Correct Answer B Square pyramidal

CONCEPT

LCAO MOs: bonding (lower) and antibonding (higher); bond order = (N_b − N_a)/2; s–p mixing changes the σ/π order up to N_2; paramagnetism of O_2 from two unpaired π* electrons.

↓

LOGIC / WORKING

- $[TeF]^-$ is AX E: octahedral electron geometry with one lone pair — square pyramidal.
- Therefore the answer is (B).

FINAL: (B) Square pyramidal

SHORTCUT / EXAM TRICK

Removing an electron from an antibonding MO strengthens the bond (O_2^+ shorter than O_2).

COMMON MISTAKE

Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

EXAM TIP

Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

MEMORY TRICK

'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Why the Other Options Are Wrong

Correct answer: B

A **Trigonal bipyramidal**

Why (B) is the key — $[TeF_]^-$ is AX E: octahedral electron geometry with one lone pair — square pyramidal.

C **Pentagonal planar**

Ruled out: Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

D **See-saw**

Ruled out: Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

Q20

Based on VSEPR theory, the predicted shapes of $[XeF_5]^-$ and BrF_5 respectively, are

A. pentagonal planar and square pyramidal

B. square pyramidal and trigonal bipyramidal

C. trigonal bipyramidal and square pyramidal

D. square pyramidal and pentagonal planar

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
MO Theory Diatomics

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Correct Answer A pentagonal planar and square pyramidal

CONCEPT

LCAO MOs: bonding (lower) and antibonding (higher); bond order = (N_b − N_a)/2; s–p mixing changes the σ/π order up to N_2; paramagnetism of O_2 from two unpaired π* electrons.

↓

LOGIC / WORKING

- $[XeF]^-$ ($AX E_2$) is pentagonal planar; BrF (AX E) is square pyramidal.
- Therefore the answer is (A).

FINAL: (A) pentagonal planar and square pyramidal

SHORTCUT / EXAM TRICK

Removing an electron from an antibonding MO strengthens the bond (O_2^+ shorter than O_2).

COMMON MISTAKE

Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

EXAM TIP

Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

MEMORY TRICK

'BCN mixes, OF fixes': π before σ for B_2–N_2; σ before π for O_2, F_2.

Why the Other Options Are Wrong

Correct answer: A

B **square pyramidal and trigonal bipyramidal**

Why (A) is the key — $[XeF]^-$ (AX_2E) is pentagonal planar; BrF (AXE) is square pyramidal.

C **trigonal bipyramidal and square pyramidal**

Ruled out: Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2).

D **square pyramidal and pentagonal planar**

Ruled out: Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

TOPIC REVISION

MO Theory Diatomics

4 PYQs · Last-minute revision

TOPIC SUMMARY

LCAO MOs: bonding (lower) and antibonding (higher); bond order = (N_b − N_a)/2; s–p mixing changes the σ/π order up to N_2; paramagnetism of O_2 from two unpaired π* electrons.

IMPORTANT FORMULA SHEET

- Bond order = (N_b − N_a)/2
- Order for Li_2–N_2: σ2s, σ*2s, π2p, σ2p, π*2p, σ*2p
- Order for O_2, F_2: σ2p below π2p

FREQUENTLY ASKED CONCEPTS

- Bond order of O_2^+, O_2^-, O_2^{2-}
- Magnetism from MO filling
- HOMO/LUMO of CO, NO
- Bond length vs bond order

COMMON MISTAKES & QUICK NOTES

Watch out:
Using the O_2 orbital order for N_2 (s–p mixing matters for B_2, C_2, N_2). Count electrons first, then fill by the correct order; paramagnetism = unpaired count.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q17 Q18 Q19 Q20

Expect 1 question(s) next session on MO Theory Diatomics.

TOPIC 5

Chemical Bonding – General

51 questions · Easy 34 | Medium 11 | Hard 6 · PYQ frequency: Very High

Q21

Which ones among CO_3^{-2}, SO_3, XeO_3, and NO_3^{-1}, have planar structure?

A. CO_3^{-2}, SO_3, and XeO_3

B. SO_3, XeO_3, and NO_3^-

C. CO_3^{-2}, XeO_3, and NO_3^-

D. CO_3^{-2}, SO_3, and NO_3^-

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D CO_3^{-2}, SO_3, and NO_3^-

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- - CO3 2 : spÂ²-hybridization (Trigonal planar) SO3 : spÂ²-hybridization (Trigonal planar) XeO3 :sp-hybridization. (Trigonal pyramidal) NO3 :spÂ²-hybridization (Trigonal planar) -- CO3 2,SO3, and NO3 2, have planar structure. Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (D).

FINAL: (D) CO_3^{-2}, SO_3, and NO_3^-

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A — **CO_3^{-2}, SO_3, and XeO_3**

Why (D) is the key — - CO3 2 : spÂ²-hybridization (Trigonal planar) SO3 : spÂ²-hybridization (Trigonal planar) XeO3 :sp-hybridization. (Trigonal pyramidal) NO3 :spÂ²-hybridization (Trigonal planar) - - CO3 2,SO3, and NO3 2, have planar structure. Explanation as extracted from the printed page; notation may be imperfect.

B — **SO_3, XeO_3, and NO_3^-**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C — **CO_3^{-2}, XeO_3, and NO_3^-**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q22

The energy of 2s and 2p orbitals is the same for

A. Li

B. Li^{+2}

C. Be^{+2}

D. H^{-}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B Li^{+2}

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Li = 1s2 2s1 2p0 +2 Li 1s1 2s0 2p0 (hydrogen like) +2 Be = 1s2 2s0 2p0 - H = 1s2 2s0 2p0 Li has one electron in 2s and no electron in 2p hence the energies of 2s and 2p orbitals will be different. Li+2 has only one electron in 1s1 hence will have no screening effect Therefore, 2s and 2p will have same energies. Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (B).

FINAL: (B) Li^{+2}

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A — **Li**

Why (B) is the key — Li = 1s2 2s1 2p0 +2 Li 1s1 2s0 2p0 (hydrogen like) +2 Be = 1s2 2s0 2p0 - H = 1s2 2s0 2p0 Li has one electron in 2s and no electron in 2p hence the energies of 2s and 2p orbitals will be different. Li+2 has only one electron in 1s1 hence will have no screening effect Therefore, 2s and 2p will have same energies. Explanation as extracted from the printed page; notation may be imperfect.

C — **Be^{+2}**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **H^-**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q23

The geometries of $[Br_3]^+$ and $[I_5]^+$ respectively, are

A. trigonal and tetrahedral

B. tetrahedral and trigonal bipyramidal

C. tetrahedral and tetrahedral

D. linear and trigonal pyramidal

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B tetrahedral and trigonal bipyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- $[Br_3]^+$ (AX_2E_2) has a tetrahedral electron-pair arrangement (bent); $[I\ ]^+$ is built on a central I with two bonds and three lone pairs — trigonal-bipyramidal electron geometry.
- Therefore the answer is (B).

FINAL: (B) tetrahedral and trigonal bipyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A — **trigonal and tetrahedral**

Why (B) is the key — $[Br_3]^+$ (AX_2E_2) has a tetrahedral electron-pair arrangement (bent); $[I\ ]^+$ is built on a central I with two bonds and three lone pairs — trigonal-bipyramidal electron geometry.

C — **tetrahedral and tetrahedral**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **linear and trigonal pyramidal**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q24

The correct statement among the following is

A N_2 has higher bond order than N_2^+ and hence has larger bond length compared to N_2^+

B N_2^+ has higher bond order than N_2 and hence has larger bond length compared to N_2

C N_2 has higher bond order than N_2^+ and hence has higher dissociation energy compared to N_2^+

D N_2 has lower bond order than N_2^+ and hence has lower dissociation energy compared to N_2^+ energy

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C N_2 has higher bond order than N_2^+ and hence has higher dissociation energy compared to N_2^+

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- + The Mo configuration of N2and N2 are 2 2 2 2 2 N2 = σ2s σ2s* π2px π2py σ2pz **8#2** B.O.= =3 **2** + 2 2 2 2 1 N2 = σ2s σ2s* π2px π2py σ2pz **7#2** B.O.= =2.5 **2** $N_2 \rightarrow N_2$ (Bond order decreases) - - Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (C).

FINAL: (C) N_2 has higher bond order than N_2^+ and hence has higher dissociation energy compared to N_2^+

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A — **N_2 has higher bond order than N_2^+ and hence has larger bond length compared to N_2^+**

Why (C) is the key — + The Mo configuration of N2and N2 are 2 2 2 2 2 N2 = σ2s σ2s* π2px π2py σ2pz **8#2** B.O.= =3 **2** + 2 2 2 2 1 N2 = σ2s σ2s* π2px π2py σ2pz **7#2** B.O.= =2.5 **2** $N_2 \rightarrow$ N_2 (Bond order decreases) - - Explanation as extracted from the printed page; notation may be imperfect.

B — **N_2^+ has higher bond order than N_2 and hence has larger bond length compared to N_2**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **N_2 has lower bond order than N_2^+ and hence has lower dissociation energy compared to N_2^+ energy**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q25

The structures of XeF_2 and XeO_2F_2 respectively are

A. bent, tetrahedral

B. linear, square planar

C. linear, see-saw

D. bent, see-saw

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C linear, see-saw

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- XeF_2 (AX_2E_3) is linear; XeO_2F_2 (AX_4E) is see-saw.
- Therefore the answer is (C).

FINAL: (C) linear, see-saw

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **bent, tetrahedral**

Why (C) is the key — XeF_2 (AX_2E_3) is linear; XeO_2F_2 (AX_4E) is see-saw.

B **linear, square planar**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **bent, see-saw**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q26

The molecule C_3O_2 has a linear structure. This compound has

A. 4 σ and 4 π bonds

B. 3 σ and 2 π bonds

C. 2 π and 3 π bonds

D. 3 σ and 4 π bonds

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A 4 σ and 4 π bonds

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- O=C=C=C=O: four bonds and four bonds (each cumulated double bond contributes one).
- Therefore the answer is (A).

FINAL: (A) 4 σ and 4 π bonds

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B — **3 σ and 2 π bonds**

Why (A) is the key — O=C=C=C=O: four Ï bonds and four Ï bonds (each cumulated double bond contributes one Ï).

C — **2 π and 3 π bonds**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **3 σ and 4 π bonds**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q27

The number of lone pair(s) of electrons on the central atom in $[BrF_4]^-$, XeF_6 and $[SbCl_6]^-$ are respectively

A. 2, 0 and 1

B. 1, 0 and 0

C. 2, 1 and 1

D. 2, 1 and 0

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D 2, 1 and 0

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Count electron pairs on the central atom: $[BrF_4]^-$ 7+4+1 = 12 e → 6 pairs, 4 bonds → 2 lone pairs (square planar). XeF_6: 8+6 = 14 e → 7 pairs → 1 lone pair (distorted octahedron). $[SbCl_6]^-$: 5+6+1 = 12 e → 6 pairs, all bonding → 0 lone pairs. So 2, 1, 0. (Bank key (c) was wrong — corrected.)
- Therefore the answer is (D).

FINAL: (D) 2, 1 and 0

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **2, 0 and 1**

Why (D) is the key — Count electron pairs on the central atom: $[BrF_4]^-$ 7+4+1 = 12 e → 6 pairs, 4 bonds → 2 lone pairs (square planar). XeF_6: 8+6 = 14 e → 7 pairs → 1 lone pair (distorted octahedron). $[SbCl_6]^-$: 5+6+1 = 12 e → 6 pairs, all bonding → 0 lone pairs. So 2, 1, 0. (Bank key (c) was wrong — corrected.)

B **1, 0 and 0**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **2, 1 and 1**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q28

The ground state electronic configuration of C_2, using all electron is

A. $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\sigma_{2p}^2\pi_{2p}^2$

B. $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\sigma_{2p}^2\pi_{2p}^*2$

C. $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\pi_{2p}^2\sigma_{2p}^1\sigma_{2p}^*1$

D. $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\pi_{2p}^4$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\pi_{2p}^4$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- C_2 has 12 electrons. Because of s–p mixing, π2p lies below σ2p, so the configuration is $\sigma1s^2\ \sigma^*1s^2\ \sigma2s^2\ \sigma^*2s^2\ \pi2p^4$ (d).
- Therefore the answer is (D).

FINAL: (D) $\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\pi_{2p}^4$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A

$\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\sigma_{2p}^2\pi_{2p}^2$

Why (D) is the key — C_2 has 12 electrons. Because of s–p mixing, π2p lies below σ2p, so the configuration is $\sigma1s^2\ \sigma^*1s^2\ \sigma2s^2\ \sigma^*2s^2\ \pi2p^4$ (d).

B

$\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\sigma_{2p}^2\pi_{2p}^*2$

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C

$\sigma_{1s}^2\sigma_{1s}^*2\sigma_{2s}^2\sigma_{2s}^*2\pi_{2p}^2\sigma_{2p}^1\sigma_{2p}^*1$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q29

The oxidation state of gold in the following complex is

A 0

B 1

C 2

D 3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C 2

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Each bridging ligand $[Me_2P(CH_2)_2]^-$ is a phosphonium bis-ylide: P^+ carries two Me groups and two CH_2^- carbanions, so the ligand is mono-anionic (−1), not dianionic. Charge balance for the neutral complex $[Au_2(CH_2)_2PMe_{22}Cl_2]$: $2x + 2(-1) + 2(-1) = 0 \Rightarrow x = +2$. The two d^9 Au(II) centres pair their odd electrons in an Au–Au bond (Schmidbaur's Au(II) ylide dimer; the structure marks each Au as II). Oxidation state = 2 — option (c).
- Therefore the answer is (C).

FINAL: (C) 2

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **0**

Why (C) is the key — Each bridging ligand $[Me_2P(CH_2)_2]^-$ is a phosphonium bis-ylide: P^+ carries two Me groups and two CH_2^- carbanions, so the ligand is mono-anionic (−1), not dianionic. Charge balance for the neutral complex $[Au_2(CH_2)_2PMe_{22}Cl_2]$: 2x + 2(−1) + 2(−1) = 0 ⇒ x = +2. The two d^9 Au(II) centres pair their odd electrons in an Au–Au bond (Schmidbaur's Au(II) ylide dimer; the structure marks each Au as II). Oxidation state = 2 — option (c).

B **1**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **3**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q30

The numbers of triangular faces in square antiprism, icosahedron and tricapped trigonal prism (capped on square faces), respectively, are

A. 8, 20 and 14

B. 8, 20 and 12

C. 10, 12 and 14

D. 10, 12 and 12

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A 8, 20 and 14

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Square antiprism: 8 triangular faces (+2 squares); icosahedron: 20; tricapped trigonal prism: 14 (a).
- Therefore the answer is (A).

FINAL: (A) 8, 20 and 14

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B **8, 20 and 12**

Why (A) is the key — Square antiprism: 8 triangular faces (+2 squares); icosahedron: 20; tricapped trigonal prism: 14 (a).

C **10, 12 and 14**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **10, 12 and 12**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q31

Among ClO_3, XeO_3 and SO_3, species with pyramidal shape is/are?

A. ClO_3^- and XeO_3

B. XeO_3 and SO_3

C. ClO_3^- and SO_3

D. SO_3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A ClO_3^- and XeO_3

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- ClO_3^- and XeO_3 have one lone pair on the centre (AX_3E, pyramidal); SO_3 is trigonal planar (a).
- Therefore the answer is (A).

FINAL: (A) ClO_3^- and XeO_3

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B — **XeO_3 and SO_3**

Why (A) is the key — ClO_3^- and XeO_3 have one lone pair on the centre (AX_3E, pyramidal); SO_3 is trigonal planar (a).

C — **ClO_3^- and SO_3**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **SO_3**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q32 **Geometries of SNF_3 and XeF_2O_2 respectively, are (a) square planar and square planar (c) square planar and trigonal bipyramidal (d) tetrahedral and trigonal bipyramidal (b) tetrahedral and tetrahedral**

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

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Q33

Arrange the following molecules in order of increasing fundamental vibrational frequencies

A $O_2^{2-} < O_2^{-} < O_2 < O_2^{+}$

B $O_2 < O_2^{+} < O_2^{-} < O_2^{2-}$

C $O_2^{2-} < O_2^{-} < O_2^{+} < O_2$

D $O_2^{+} < O_2 < O_2^{-} < O_2^{2+}$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A $O_2^{2-} < O_2^{-} < O_2 < O_2^{+}$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- The O–O stretching frequency rises with bond order: O_2^{2-} (≈800) < O_2^{-} (≈1100) < O_2 (1580) < O_2^{+} (≈1870 cm^{-1}).
- Therefore the answer is (A).

FINAL: (A) $O_2^{2-} < O_2^{-} < O_2 < O_2^{+}$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B $O_2 < O_2^+ < O_2^- < O_2^{2-}$

Why (A) is the key — The O–O stretching frequency rises with bond order: O_2^{2-} (≈800) < O_2^- (≈1100) < O_2 (1580) < O_2^+ (≈1870 cm^{-1}).

C $O_2^{2-} < O_2^- < O_2^+ < O_2$

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D $O_2^+ < O_2 < O_2^- < O_2^{2+}$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q34

The ion having the highest bond order is (1) NO^+ (2) O_2^+ (3) N_2^+ (4) C_2^+ (Numerical answer type — write the value.)

ANSWER: (A)

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
Bond orders: NO^+ (10 valence e^-, isoelectronic with N_2) = 3; O_2^+ = 2.5; N_2^+ = 2.5; C_2^+ = 1.5. Highest: NO^+.

Q35

Consider the following statements for Allred-Rochow electronegativity (chiAR): (i) chiAR is directly proportional to $Z_e$ff (ii) chiAR is inversely proportional to $Z_e$ff (iii) chiAR is inversely proportional to r(covalent). (iv) chiAR is inversely proportional to r^2(covalent). The correct statements are

A. (i) and (iv)

B. (ii) and (iv)

C. (i) and (iii)

D. (ii) and (iii)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A (i) and (iv)

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Allred-Rochow electronegativity (ĪESAR): ĪESAR = (3590 z*/r2)+ 0.744 where, r = covalent radius (in pm), z* =effective nuclear charge Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) (i) and (iv)

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B **(ii) and (iv)**

Why (A) is the key — Allred-Rochow electronegativity (ÏAR): ÏAR = (3590 z*/r2)+ 0.744 where, r = covalent radius (in pm), z* =effective nuclear charge Explanation as extracted from the printed page; notation may be imperfect.

C **(i) and (iii)**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **(ii) and (iii)**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q36

The magnitude of bond angles in gaseous NF_3, SbF_3 and $SbCl_3$ follow the order

A. $NF_3 > SbF_3 > SbCl_3$

B. $SbCl_3 > SbF_3 > NF_3$

C. $SbF_3 > SbCl_3 > NF_3$

D. $NF_3 > SbCl_3 > SbF_3$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D $NF_3 > SbCl_3 > SbF_3$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- NF_3 (N small, bond pairs close together) ≈ 102°. For Sb, Bent's rule/lone-pair dominance: more electronegative F pulls bond pairs away → smaller angle in SbF_3 (~87–95°) than in $SbCl_3$ (~97°). Order $NF_3 > SbCl_3 > SbF_3$.
- Therefore the answer is (D).

FINAL: (D) $NF_3 > SbCl_3 > SbF_3$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A $NF_3 > SbF_3 > SbCl_3$

Why (D) is the key — NF_3 (N small, bond pairs close together) ≈ 102°. For Sb, Bent's rule/lone-pair dominance: more electronegative F pulls bond pairs away → smaller angle in SbF_3 (~87–95°) than in $SbCl_3$ (~97°). Order $NF_3 > SbCl_3 > SbF_3$.

B $SbCl_3 > SbF_3 > NF_3$

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C $SbF_3 > SbCl_3 > NF_3$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q37

Choose the correct order of energy of 2 σ_g and 1 π₀ molecular orbitals for B_2, C_2 and O_2 :

A. 2 σ_g>1 π_u for all the three

B. 2 σ_g>1 π_u for B_2 and C_2 only

C. 1 π_u>2 σ_g for C_2 and O_2 only

D. 2 σ_g>1 π_u for B_2 and O_2 only

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B 2 σ_g>1 π_u for B_2 and C_2 only

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- For B_2 and C_2 strong s–p mixing pushes $2\sigma_g$ above $1\pi_u$; for O_2 (and F_2) the mixing is weak and $2\sigma_g$ lies below $1\pi_u$.
- Therefore the answer is (B).

FINAL: (B) 2 σ_g>1 π_u for B_2 and C_2 only

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A **2 $\sigma_g > 1\pi_u$ for all the three**

Why (B) is the key — For B_2 and C_2 strong s–p mixing pushes $2\sigma_g$ above $1\pi_u$; for O_2 (and F_2) the mixing is weak and $2\sigma_g$ lies below $1\pi_u$.

C **1 π_u>2 σ_g for C_2 and O_2 only**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **2 $\sigma_g > 1\pi_u$ for B_2 and O_2 only**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q38

The total bond order between adjacent carbon atoms of benzene is

A. 0.5

B. 2

C. 1.5

D. 2.5

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C 1.5

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- One □ bond plus half a □ bond (6 □ electrons over 6 bonds): total bond order 1.5.
- Therefore the answer is (C).

FINAL: (C) 1.5

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A — **0.5**

Why (C) is the key — One ï bond plus half a ï bond (6 ï electrons over 6 bonds): total bond order 1.5.

B — **2**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **2.5**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q39

The highest occupied MO in N_2 and O_2^+ respectively are (take x-axis as internuclear axis)

A. σ_2p_x, $\pi^*_2p_y$

B. π_2p_y, π_2p_z

C. $\sigma^*_2p_x$, σ_2p_x

D. $\pi^*_2p_y$, $\pi^*_2p_z$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A $\sigma_2 p_x, \pi^*_2 p_y$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Taking x-axis as internuclear axis. N2 = Ï21s Ï21s* Ï22s Ï22s* Ï22py Ï22pz Ï22px O2+ = Ï21s Ï21s* Ï22s Ï22s* Ï22px Ï22py Ï22px Ï1*2pz Ï1*2py Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) $\sigma_2 p_x, \pi^*_2 p_y$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B

π_2p_y, π_2p_z

Why (A) is the key — Taking x-axis as internuclear axis. N2 = Ï21s Ï21s* Ï22s Ï22s* Ï22py Ï22pz Ï22px O2+ = Ï21s Ï21s* Ï22s Ï22s* Ï22px Ï22py Ï22px Ï1*2pz Ï1*2py Explanation as extracted from the printed page; notation may be imperfect.

C

$\sigma^*_2p_x$, σ_2p_x

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D

$\pi^*_2p_y$, $\pi^*_2p_z$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q40

The size of the d orbitals in Si, P, S and Cl follows the order.

A. Cl > S > P > Si

B. Cl > P > S > Si

C. P > S > Si > Cl

D. Si > P > S > Cl

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D Si > P > S > Cl

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Size of d-orbitals decrease with decrease in size of element. The decreasing order of size is Si > P > S > Cl. Therefore decreasing order of size of d-orbitals is Si> P > S >Cl. - Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (D).

FINAL: (D) Si > P > S > Cl

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **Cl > S > P > Si**

Why (D) is the key — Size of d-orbitals decrease with decrease in size of element. The decreasing order of size is Si > P > S > Cl. Therefore decreasing order of size of d-orbitals is Si> P > S >Cl. - Explanation as extracted from the printed page; notation may be imperfect.

B **Cl > P > S > Si**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **P > S > Si > Cl**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q41

The number of lone-pairs are identical in the pairs

A. XeF_4, ClF_3

B. XeO_4, ICl_4^-

C. XeO_2F_2, ICl_4^-

D. XeO_4, ClF_3

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A XeF_4, ClF_3

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- CSIR DEC 2013 Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) XeF_4, ClF_3

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B **XeO_4, ICl_4^-**

Why (A) is the key — CSIR DEC 2013 Explanation as extracted from the printed page; notation may be imperfect.

C **XeO_2F_2, ICl_4^-**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **XeO_4, ClF_3**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q42 If a homonuclear diatomic molecule is oriented along the Z-axis, the molecular orbital formed by linear combination of p_x orbitals of the two atoms is

A) σ

B) σ^*

C) π

D) δ

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C π

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- With the bond along z, the two p_x orbitals overlap side-on, giving π (and π^*) MOs (c).
- Therefore the answer is (C).

FINAL: (C) π

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A σ

Why (C) is the key — With the bond along z, the two p_x orbitals overlap side-on, giving π_{pp} (and π^*_{pp}) MOs (c).

B σ^*

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D δ

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q43

The correct non-linear and iso-structural pair is

A. SCl_2 and I_3^-

B. SCl_2, and I_3^+

C. SCl_2, and ClF_2^-

D. I_3^+ and ClF_2^-

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B SCl_2, and I_3^+

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- (I) SCl2 b.p.=2 l. p. =2 Stearic number (S)=4 - (II) I3 b.p. = 2 l. p. =3 (S)=5 + (III) I3 b.p. = 2 l. p. =2 (S)=4 - (IV) ClF2 b.p. = 2 l. p. =2 (S)=4 Shapes of species are Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (B).

FINAL: (B) SCl_2, and I_3^+

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A — **SCl_2 and I_3^-**

Why (B) is the key — (I) SCl2 b.p.=2 l. p. =2 Stearic number (S)=4 - (II) I3 b.p. = 2 l. p. =3 (S)=5 + (III) I3 b.p. = 2 l. p. =2 (S)=4 - (IV) ClF2 b.p. = 2 l. p. =2 (S)=4 Shapes of species are Explanation as extracted from the printed page; notation may be imperfect.

C — **SCl_2, and ClF_2^-**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **I_3^+ and ClF_2^-**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q44

Structures of $SbPh_5$ and PPh_5 respectively are

A. trigonal bipyramidal, square pyramidal

B. square pyramidal, trigonal bipyramidal

C. trigonal bipyramidal, trigonal bipyramidal

D. square pyramidal, square pyramidal

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B square pyramidal, trigonal bipyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- SbPh is the classic exception — square pyramidal in the solid; PPh is trigonal bipyramidal.
- Therefore the answer is (B).

FINAL: (B) square pyramidal, trigonal bipyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A **trigonal bipyramidal, square pyramidal**

Why (B) is the key — SbPh is the classic exception — square pyramidal in the solid; PPh is trigonal bipyramidal.

C **trigonal bipyramidal, trigonal bipyramidal**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **square pyramidal, square pyramidal**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q45 **The maximum bond order obtained from the molecular orbitals of a transition metal dimer, formed as linear combinations of d-orbitals alone, is**

A 3

B 4

C 5

D 6

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C 5

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Five d orbitals give one σ, two π and two δ bonding combinations: a maximum bond order of 5 (e.g. Mo_2, Cr_2 quintuple bonds).
- Therefore the answer is (C).

FINAL: (C) 5

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **3**

Why (C) is the key — Five d orbitals give one σ, two π and two δ bonding combinations: a maximum bond order of 5 (e.g. Mo_2, Cr_2 quintuple bonds).

B **4**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **6**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q46

Correct combination for π and π^* orbitals in B_2 molecule is

A. π: Gerade, π^*: Ungerade

B. π: Ungerade, π^*: Gerade

C. π: Gerade, π^*: Gerade

D. π: Ungerade, π^*: Ungerade

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B π: Ungerade, π^*: Gerade

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- For a homonuclear diatomic the bonding orbital is (ungerade) and the antibonding * is _g (gerade).
- Therefore the answer is (B).

FINAL: (B) π: Ungerade, π^*: Gerade

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A

π: Gerade, π^*: Ungerade

Why (B) is the key — For a homonuclear diatomic the bonding ï orbital is ï$_u$ (ungerade) and the antibonding ï* is ï_g (gerade).

C

π: Gerade, π^*: Gerade

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp³ centres are 109.5°.

D

π: Ungerade, π^*: Ungerade

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q47

The number of 3c-2e bonds present in $Al(BH_4)_3$ is-

A four

B three

C six

D zero

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C six

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Each BH_4^- binds aluminium through two Al–H–B bridges (bidentate); three ligands give six 3c-2e bonds.
- Therefore the answer is (C).

FINAL: (C) six

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **four**

Why (C) is the key — Each BH_4^- binds aluminium through two Al–H–B bridges (bidentate); three ligands give six 3c-2e bonds.

B **three**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **zero**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q48

The expected H-H-H bond angle in $[H_3]^+$is

A 180Â°

B 120Â°

C 60Â°

D 90Â°

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C 60Â°

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- H_3^+ is an equilateral triangle held by a single 3c-2e bond: 60° angles.
- Therefore the answer is (C).

FINAL: (C) 60Â°

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **180Â°**

Why (C) is the key — H_3^+ is an equilateral triangle held by a single 3c-2e bond: 60° angles.

B **120Â°**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **90Â°**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q49 **Removal of an electron form NO molecule results in A. An increase in the (NO) in the IR spectrum B. An EPR active species C. Electrons in HOMOs being closer to the oxygen than to nitrogen 2p orbital's D. Electrons in HOMOs being closer to the nitrogen than to oxygen 2p orbital's The correct answer is**

(A) A only

(B) A and C

(C) B and D

(D) A, B, and C

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B A and C

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- NO → NO^+ removes the π* electron: bond order 2.5 → 3, so ν(NO) rises (1876 → ~2300 cm^{-1}) — A true. NO^+ is diamagnetic (B false). In the polar π orbitals the bonding (HOMO) electrons are concentrated nearer the more electronegative O (C true).
- Therefore the answer is (B).

FINAL: (B) A and C

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A

A only

Why (B) is the key — NO → NO^+ removes the π* electron: bond order 2.5 → 3, so ν(NO) rises (1876 → ~2300 cm^{-1}) — A true. NO^+ is diamagnetic (B false). In the polar π orbitals the bonding (HOMO) electrons are concentrated nearer the more electronegative O (C true).

C

B and D

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D

A, B, and C

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q50

Among the following, the correct statement about π-molecular orbitals (π-MOs) of benzene is

A. Only the lowest energy MO is doubly degenerate

B. Only LUMO is doubly degenerate

C. Only HOMO is doubly degenerate

D. Both the HOMO and LUMO are doubly degenerate

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D Both the HOMO and LUMO are doubly degenerate

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Benzene's π MOs are a_2u (lowest), e_1g (HOMO, doubly degenerate), e_2u (LUMO, doubly degenerate) and b_2g.
- Therefore the answer is (D).

FINAL: (D) Both the HOMO and LUMO are doubly degenerate

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **Only the lowest energy MO is doubly degenerate**

Why (D) is the key — Benzene's π MOs are a_2u (lowest), e_1g (HOMO, doubly degenerate), e_2u (LUMO, doubly degenerate) and b_2g.

B **Only LUMO is doubly degenerate**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **Only HOMO is doubly degenerate**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q51

Among the following, species expected to show fluxional behaviour are (A) $[NiCl_4]^{-2}$ (tetrahedral) (B) IF_7 (pentagonal bipyramidal) (C) $[CoF_6]^{-3}$ (octahedral) (D) $Fe(CO)_5$ (trigonal bipyramidal)

A. B and C

B. B and D

C. C and D

D. A and D

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B B and D

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Fluxional (stereochemically non-rigid) species: IF_7 (pentagonal bipyramid, axial/equatorial F exchange) and $Fe(CO)_5$ (Berry pseudorotation makes all CO equivalent on the NMR time scale). Tetrahedral and octahedral complexes have no such low-energy pathway.
- Therefore the answer is (B).

FINAL: (B) B and D

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A **B and C**

Why (B) is the key — Fluxional (stereochemically non-rigid) species: IF_7 (pentagonal bipyramid, axial/equatorial F exchange) and $Fe(CO)_5$ (Berry pseudorotation makes all CO equivalent on the NMR time scale). Tetrahedral and octahedral complexes have no such low-energy pathway.

C **C and D**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **A and D**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q52

The shape of the molecule XeO_2F_2 is

A. distorted tetrahedral

B. square planar

C. trigonal bipyramidal

D. tetrahedral

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A distorted tetrahedral

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- XeO_2F_2: Xe has 4 bonding pairs and 1 lone pair (AX_4E), trigonal-bipyramidal electron geometry with the lone pair equatorial: see-saw, i.e. distorted tetrahedral.
- Therefore the answer is (A).

FINAL: (A) distorted tetrahedral

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B **square planar**

Why (A) is the key — XeO_2F_2: Xe has 4 bonding pairs and 1 lone pair (AX_4E), trigonal-bipyramidal electron geometry with the lone pair equatorial: see-saw, i.e. distorted tetrahedral.

C **trigonal bipyramidal**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **tetrahedral**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q53

According to VSEPR model, the shape of $[XeOF_5]^-$ is

A. Octahedral

B. Trigonal bipyramidal

C. square pyramidal

D. pentagonal monopyramidal

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D pentagonal monopyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- $[XeOF_5]^-$: Xe 8 + 5 (F) + 1 (charge) = 14 e^- from Xe/F plus the Xe=O: 7 electron domains (5 F, 1 O, 1 lone pair) → pentagonal bipyramidal arrangement with the lone pair axial → pentagonal pyramidal shape (O axial, F_5 pentagon).
- Therefore the answer is (D).

FINAL: (D) pentagonal monopyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **Octahedral**

Why (D) is the key — $[XeOF_5]^-$: Xe 8 + 5 (F) + 1 (charge) = 14 e^- from Xe/F plus the Xe=O: 7 electron domains (5 F, 1 O, 1 lone pair) → pentagonal bipyramidal arrangement with the lone pair axial → pentagonal pyramidal shape (O axial, F_5 pentagon).

B **Trigonal bipyramidal**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **square pyramidal**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q54

The point group of IF_7 is

A D_{6h}

B D_{5h}

C C_{6v}

D C_{5v}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B D_{5h}

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- IF_7 is a pentagonal bipyramid: C_5 principal axis, 5 C_2 axes ⊥ to it, σh → D_5h.
- Therefore the answer is (B).

FINAL: (B) D_{5h}

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A — D_{6h}

Why (B) is the key — IF_7 is a pentagonal bipyramid: C_5 principal axis, 5 C_2 axes ⊥ to it, σh → D_5h.

C — C_{6v}

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — C_{5v}

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q55

Among the following species, the one that has pentagonal shape is: (Given: atomic numbers of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively)

A. $[SF_5]^-$

B. $XeOF_4$

C. $[XeF_5]^-$

D. IF_5

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C $[XeF_5]^-$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- $[XeF_5]^-$: Xe 8 + 5 + 1 = 14 e^- → 7 pairs; 5 bonding + 2 lone pairs (axial) → pentagonal planar. IF_5 and $XeOF_4$ are square pyramidal, $[SF_5]^-$ is square pyramidal. (Bank key (d) was wrong — corrected.)
- Therefore the answer is (C).

FINAL: (C) $[XeF_5]^-$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **$[SF_5]^-$**

Why (C) is the key — $[XeF_5]^-$: Xe 8 + 5 + 1 = 14 e^- → 7 pairs; 5 bonding + 2 lone pairs (axial) → pentagonal planar. IF_5 and $XeOF_4$ are square pyramidal, $[SF_5]^-$ is square pyramidal. (Bank key (d) was wrong — corrected.)

B **$XeOF_4$**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **IF_5**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q56

Hybridization of the central atoms in I_3^-, ClF_3 and SF_4, respectively, are

A. sp^3d, sp^2 and dsp^2

B. sp, sp^2 and sp^3d

C. sp, sp^3d and dsp^2

D. sp^3d, sp^3d and sp^3d

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D sp³ d, sp³ d and sp³ d

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- I_3^-, ClF_3 and SF_4 all have five electron pairs on the centre — sp^3d (d).
- Therefore the answer is (D).

FINAL: (D) sp³ d, sp³ d and sp³ d

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **$sp^3 d$, sp^2 and dsp^2**

Why (D) is the key — I_3^-, ClF_3 and SF_4 all have five electron pairs on the centre — sp^3d (d).

B **sp, sp^2 and sp^3 d**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **sp, sp^3 d and dsp^2**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q57

The geometries of the species $[Br_3]^+$,$[Br_3]^-$and $[BrF_3]$ are, respectively

A. linear, trigonal bipyramidal and trigonal bipyramidal

B. linear, linear and trigonal planar

C. tetrahedral, trigonal bipyramidal and trigonal bipyramidal

D. tetrahedral, trigonal pyramidal and trigonal planar

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C tetrahedral, trigonal bipyramidal and trigonal bipyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Electron-pair geometries: Br_3^+ (two bonds + two lone pairs) tetrahedral; Br_3^- and BrF_3 (five pairs) trigonal bipyramidal (c).
- Therefore the answer is (C).

FINAL: (C) tetrahedral, trigonal bipyramidal and trigonal bipyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **linear, trigonal bipyramidal and trigonal bipyramidal**

Why (C) is the key — Electron-pair geometries: Br_3^+ (two bonds + two lone pairs) tetrahedral; Br_3^- and BrF_3 (five pairs) trigonal bipyramidal (c).

B **linear, linear and trigonal planar**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **tetrahedral, trigonal pyramidal and trigonal planar**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q58

Correct trend in the bond order is

A $O_2^+ > O_2^{2-} > O_2^-$

B $O_2^- > O_2^+ > O_2^{2-}$

C $O_2^{2-} > O_2^- > O_2^+$

D $O_2^+ > O_2^- > O_2^{2-}$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D $O_2^+ > O_2^- > O_2^{2-}$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Bond orders: O_2^+ 2.5 > O_2^- 1.5 > O_2^{2-} 1.0 (d).
- Therefore the answer is (D).

FINAL: (D) $O_2^+ > O_2^- > O_2^{2-}$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A $O_2^+ > O_2^{2-} > O_2^-$

Why (D) is the key — Bond orders: O_2^+ 2.5 > O_2^- 1.5 > O_2^{2-} 1.0 (d).

B $O_2^- > O_2^+ > O_2^{2-}$

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C $O_2^{2-} > O_2^- > O_2^+$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q59

The bond order of N_2^+ ion is ___ (Round off to one decimal place)
(Numerical answer type — write the value.)

ANSWER: 2.5

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
N_2^+: 13 valence e^- … $(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p)^4(\sigma 2p)^1$ → bond order = (9 − 4)/2 = 2.5.

Q60

The correct order of bond angles in BF_3, NH_3, NF_3 and PH_3 is

A. $BF_3 > NH_3 > NF_3 > PH_3$

B. $PH_3 > BF_3 > NF_3 > NH_3$

C. $PF_3 > PH_3 > NH_3 > NF_3$

D. $NH_3 > NF_3 > BF_3 > PH_3$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A $BF_3>NH_3>NF_3>PH_3$

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- BF_3 120° > NH_3 107° > NF_3 102° > PH_3 93.5° (a).
- Therefore the answer is (A).

FINAL: (A) $BF_3>NH_3>NF_3>PH_3$

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B $PH_3 > BF_3 > NF_3 > NH_3$

Why (A) is the key — BF_3 120° > NH_3 107° > NF_3 102° > PH_3 93.5° (a).

C $PF_3 > PH_3 > NH_3 > NF_3$

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D $NH_3 > NF_3 > BF_3 > PH_3$

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q61

The bond order of Be_2 molecule is (Numerical answer type — write the value.)

ANSWER: 0

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
Be_2: $(\sigma 2s)^2(\sigma^* 2s)^2 \rightarrow$ bond order = (2 − 2)/2 = 0; Be_2 is not a stable molecule.

Q62 **Effective nuclear charge for 3d electron in vanadium (atomic number =23) according to Slater's rule is**
(Numerical answer type — write the value.)

ANSWER: 4.30

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
V (Z = 23): $(1s^2)(2s^2 2p^6)(3s^2 3p^6)(3d^3)(4s^2)$. For a 3d electron: other 3d electrons 2 × 0.35 = 0.70; all inner electrons (1s–3p, 18 e^-) × 1.00 = 18; 4s electrons do not shield. S = 18.70 → Z_{eff} = 23 − 18.70 = 4.30.

Q63

The intermolecular vander Waals potential is inversely proportional to r^6. The corresponding force is proportional to

A. $(1)/(r^5)$

B. $(1)/(r^6)$

C. $(1)/(r^7)$

D. $(1)/(r^{12})$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C (1)/(r⁷)

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- F = −dV/dr; for V ∝ −1/r⁶ the force ∝ 1/r⁷.
- Therefore the answer is (C).

FINAL: (C) (1)/(r⁷)

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **(1)/(r⁵)**
Why (C) is the key — F = −dV/dr; for V ∝ −1/r⁶ the force ∝ 1/r⁷.

B **(1)/(r⁶)**
Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **(1)/(r¹²)**
Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q64

The species having trigonal pyramidal shape is

A. NO_3^-

B. CO_3^{2-}

C. BrF_3

D. SO_3^{2-}

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D SO_3^{2-}

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- SO_3^{2-} (three bonds + one lone pair) is trigonal pyramidal; NO_3^- and CO_3^{2-} are planar, BrF_3 T-shaped (d).
- Therefore the answer is (D).

FINAL: (D) SO_3^{2-}

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A NO_3^-

Why (D) is the key — SO_3^{2-} (three bonds + one lone pair) is trigonal pyramidal; NO_3^- and CO_3^{2-} are planar, BrF_3 T-shaped (d).

B CO_3^{2-}

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C BrF_3

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q65

Among the following, the isoelectronic pair is

A. NO and CO

B. O_2^- (superoxide anion) and NO^-

C. NO^+ and CO

D. O_2^- (superoxide anion) and NO^+

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C NO⁺and CO

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- NO^+ and CO both have 14 electrons (bond order 3). NO has 15, O_2^- 17, NO^- 16.
- Therefore the answer is (C).

FINAL: (C) NO⁺and CO

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **NO and CO**

Why (C) is the key — NO^+ and CO both have 14 electrons (bond order 3). NO has 15, O_2^- 17, NO^- 16.

B **O_2^- (superoxide anion) and NO^-**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **O_2^- (superoxide anion) and NO^+**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q66

Among Ar, NH_4Cl, HF and HCl , the strength of interatomic / intermolecular forces follows the order:

A. $NH_4Cl > HF > HCl > Ar$

B. $HF > HCl > Ar > NH_4Cl$

C. $HCl > Ar > NH_4Cl > HF$

D. $Ar > NH_4Cl > HF > HCl$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A NH_4 Cl>HF>HCl>Ar

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Ionic NH_4Cl > H-bonded HF > dipolar HCl > van der Waals Ar (a).
- Therefore the answer is (A).

FINAL: (A) NH_4 Cl>HF>HCl>Ar

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B **HF>HCl>Ar>NH_4 Cl**

Why (A) is the key — Ionic NH_4Cl > H-bonded HF > dipolar HCl > van der Waals Ar (a).

C **HCl>Ar>NH_4 Cl>HF**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **Ar>NH_4 Cl>HF>HCl**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q67

The most polar compound among the following is:

A SF_4

B BF_3

C XeF_4

D SO_3

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer A SF_4

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- See-saw SF_4 has a net dipole; BF_3, XeF_4 and SO_3 are non-polar (a).
- Therefore the answer is (A).

FINAL: (A) SF_4

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: A

B — **BF_3**

Why (A) is the key — See-saw SF_4 has a net dipole; BF_3, XeF_4 and SO_3 are non-polar (a).

C — **XeF_4**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D — **SO_3**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q68

Molecular shape of $SOCl_2$ is

A. Square planar

B. Trigonal pyramidal

C. Triangular planar

D. T-shape

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B Trigonal pyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- $SOCl_2$: three bonds and one lone pair on S — trigonal pyramidal (b).
- Therefore the answer is (B).

FINAL: (B) Trigonal pyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A **Square planar**

Why (B) is the key — $SOCl_2$: three bonds and one lone pair on S — trigonal pyramidal (b).

C **Triangular planar**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **T-shape**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q69

The formal charges on the nitrogen atom from left to right in the azide anion, $[N=N=N]^-$ are

A. + 1, -1, -1

B. -1, +1, -1

C. -1, -1, +1

D. -2, +1, 0

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer B -1, +1, -1

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- In $[N{=}N{=}N]^-$ the terminal N carry −1 each and the central N +1 (b).
- Therefore the answer is (B).

FINAL: (B) -1, +1, -1

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: B

A **+ 1, -1, -1**

Why (B) is the key — In $[N{=}N{=}N]^-$ the terminal N carry −1 each and the central N +1 (b).

C **-1, -1, +1**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **-2, +1, 0**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q70

The shape of CH_3^- ion is:

A. trigonal planar

B. tetrahedral

C. trigonal pyramidal

D. linear

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer C trigonal pyramidal

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- CH_3^- (three bonds + lone pair) is trigonal pyramidal (c).
- Therefore the answer is (C).

FINAL: (C) trigonal pyramidal

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: C

A **trigonal planar**

Why (C) is the key — CH_3^- (three bonds + lone pair) is trigonal pyramidal (c).

B **tetrahedral**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

D **linear**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

Q71

The average value of C-C bond in graphite is:

A. 1

B. 3/2

C. 3/4

D. 4/3

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Chemical Bonding – General

PYQ FREQUENCY
Very High · 18 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Correct Answer D 4/3

CONCEPT

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

↓

LOGIC / WORKING

- Each C in graphite has one π bond shared over three C–C bonds: bond order 1 + ⅓ = 4/3 (d).
- Therefore the answer is (D).

FINAL: (D) 4/3

SHORTCUT / EXAM TRICK

Lone pairs and electronegative substituents take equatorial/axial positions by Bent's rule: lone pairs equatorial in TBP, most electronegative atoms axial.

COMMON MISTAKE

Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

EXAM TIP

Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MEMORY TRICK

'Lone pairs go equatorial (TBP), axial (octahedral trans-pair)'.

Why the Other Options Are Wrong

Correct answer: D

A **1**

Why (D) is the key — Each C in graphite has one π bond shared over three C–C bonds: bond order 1 + ⅓ = 4/3 (d).

B **3/2**

Ruled out: Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.

C **3/4**

Ruled out: Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

TOPIC REVISION

Chemical Bonding – General

51 PYQs · Last-minute revision

TOPIC SUMMARY

VSEPR geometry from electron domains; hybridisation and Bent's rule (s-character goes to the more electropositive substituent); MO theory for diatomics (bond order, magnetism, s–p mixing); bond polarity and dipole moments; hydrogen bonding and weak interactions; Walsh diagrams; back-bonding (CO, PF_3, silylamines).

IMPORTANT FORMULA SHEET

- Bond order = (N_b − N_a)/2
- $\mu = q \cdot d$; %ionic ≈ $16|\Delta\chi| + 3.5|\Delta\chi|^2$
- Steric number = σ bonds + lone pairs
- Drago: lone-pair-rich central atoms with large size → ~90° angles (PH_3, H_2S)

FREQUENTLY ASKED CONCEPTS

- Geometry and bond angles (SF_4 see-saw, ClF_3 T-shape, XeF_4 square planar)
- Bent's rule applications (PF_3 vs PH_3 angle)
- Dipole moment zero/non-zero
- Bond order and length in O_2 species
- Strongest H-bond (F–H···F^-)

COMMON MISTAKES & QUICK NOTES

Watch out:
Counting π bonds as separate domains in VSEPR; assuming all sp^3 centres are 109.5°.
Back-bonding shortens M–C in carbonyls and makes $N(SiH_3)_3$ planar.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q33 Q34 …

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

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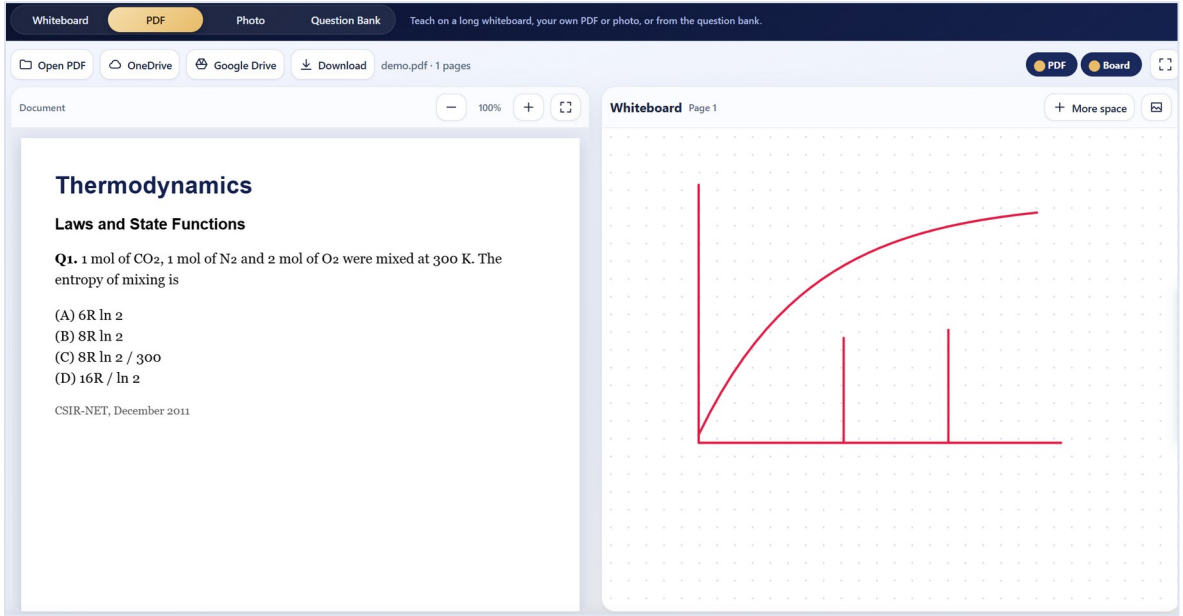
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