ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Acids, Bases, Periodic Properties & d-Block

Premium CSIR-NET PYQ Book

43 Previous-Year Questions · 40 with verified answers · Distractor Analysis

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

CSIR-NET · GATE · IIT-JAM — 4 Topics · 43 Real PYQs

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Course Contents

4 Topics · 43 PYQs

1	**Periodic Properties** 17 Qs E 5 · M 4 · H 8	40%	
2	**Acid and Bases** 13 Qs E 5 · M 7 · H 1	30%	
3	**d-Block Elements** 12 Qs E 6 · M 6 · H 0	28%	
4	**Acids, Bases, Periodic Properties & d-Block – General** 1 Qs E 0 · M 1 · H 0	2%	

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

TOPIC 1

Periodic Properties

17 questions · Easy 5 | Medium 4 | Hard 8 · PYQ frequency: Rare

Q1 Gas phase bond length and dipole moment of a compound (MX) is 3 Å and 10.8 D, respectively. The ionic character in gas phase MX is ___ % (Round off to one decimal place) ($1\ D = 3.336 \times 10^{-30}\ C\ m$) (Numerical answer type — write the value.)

ANSWER: 75.0 %

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Fully ionic $\mu = e \times d = 1.602\times10^{-19} \times 3\times10^{-10} = 4.806\times10^{-29}$ C m = 14.41 D. Ionic character = 10.8/14.41 = 75.0 %.

Q2

For Na^+, Mg^{2+}, Al^{3+} and F^-, the CORRECT order of ionic radii is

A. $Al^{3+} > Mg^{2+} > Na^+ > F^-$

B. $Al^{3+} > Na^+ > Mg^{2+} > F^-$

C. $Na^+ > F^- > Mg^{2+} > Al^{3+}$

D. $F^- > Na^+ > Mg^{2+} > Al^{3+}$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer D $F^{-}>Na^{+}>Mg^{2+}>Al^{3+}$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Isoelectronic ions shrink with nuclear charge: $F^{-} > Na^{+} > Mg^{2+} > Al^{3+}$ (d). Chapter list · Next in chapter →
- Therefore the answer is (D).

FINAL: (D) $F^{-}>Na^{+}>Mg^{2+}>Al^{3+}$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: D

A $Al^{3+} > Mg^{2+} > Na^{+} > F^{-}$

Why (D) is the key — Isoelectronic ions shrink with nuclear charge: $F^- > Na^+ > Mg^{2+} > Al^{3+}$ (d). Chapter list · Next in chapter →

B $Al^{3+} > Na^{+} > Mg^{2+} > F^{-}$

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

C $Na^{+} > F^{-} > Mg^{2+} > Al^{3+}$

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q3

Two sets of quantum numbers with the same number of radial nodes are

A. $n=3 ; l=2 ; m_l=0$ and $n=2 ; l=1 ; m_l=0$

B. $n=3 ; l=0 ; m_l=0$ and $n=2 ; l=0 ; m_l=0$

C. $n=3 ; l=1 ; m_l=1$ and $n=2 ; l=1 ; m_l=0$

D. $n=3 ; l=1 ; m_l=-1$ and $n=2 ; l=1 ; m_l=0$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer A n=3 ; l=2 ; m_l=0 and n=2 ; l=1 ; m_l=0

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Radial nodes = n − l − 1. 3d (3,2): 0 and 2p (2,1): 0 — equal. The other pairs give 2 vs 1 (3s/2s) or 1 vs 0 (3p/2p).
- Therefore the answer is (A).

FINAL: (A) n=3 ; l=2 ; m_l=0 and n=2 ; l=1 ; m_l=0

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: A

B **n=3 ; l=0 ; m_l=0 and n=2 ; l=0 ; m_l=0**

Why (A) is the key — Radial nodes = n − l − 1. 3d (3,2): 0 and 2p (2,1): 0 — equal. The other pairs give 2 vs 1 (3s/2s) or 1 vs 0 (3p/2p).

C **n=3 ; l=1 ; m_l=1 and n=2 ; l=1 ; m_l=0**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **n=3 ; l=1 ; m_l=-1 and n=2 ; l=1 ; m_l=0**

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

Q4

With respect to periodic properties, the CORRECT statement is

A. Electron affinity order is F>O>Cl

B. First ionisation energy order is Al>Mg>K

C. Atomic radius order is N>P> As

D. Ionic radius order is $K^{+}>Ca^{2+}>Mg^{2+}$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer D Ionic radius order is $K^+ > Ca^{2+} > Mg^{2+}$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- $K^+ > Ca^{2+} > Mg^{2+}$ is the correct ionic-radius order; EA is Cl > F > O, IE_1 is Mg > Al > K, and radius is As > P > N (d).
- Therefore the answer is (D).

FINAL: (D) Ionic radius order is $K^+ > Ca^{2+} > Mg^{2+}$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: D

A **Electron affinity order is F>O>Cl**

Why (D) is the key — $K^+ > Ca^{2+} > Mg^{2+}$ is the correct ionic-radius order; EA is Cl > F > O, IE_1 is Mg > Al > K, and radius is As > P > N (d).

B **First ionisation energy order is Al>Mg>K**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

C **Atomic radius order is N>P> As**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q5

The correct order of the boiling points of the compounds is

A $CH_4 > SiH_4 > SnH_4 > GeH_4$

B $SiH_4 > CH_4 > GeH_4 > SnH_4$

C $SnH_4 > GeH_4 > CH_4 > SiH_4$

D $SnH_4 > GeH_4 > SiH_4 > CH_4$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer D $SnH_4 > GeH_4 > SiH_4 > CH_4$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Boiling points rise with molar mass: $SnH_4 > GeH_4 > SiH_4 > CH_4$ (d).
- Therefore the answer is (D).

FINAL: (D) $SnH_4 > GeH_4 > SiH_4 > CH_4$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: D

A $CH_4 > SiH_4 > SnH_4 > GeH_4$

Why (D) is the key — Boiling points rise with molar mass: $SnH_4 > GeH_4 > SiH_4 > CH_4$ (d).

B $SiH_4 > CH_4 > GeH_4 > SnH_4$

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

C $SnH_4 > GeH_4 > CH_4 > SiH_4$

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q6

Among the following, the compound that has the lowest degree of ionic character is

(A) NaCl

(B) $MgCl_2$

(C) $AlCl_3$

(D) $CaCl_2$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer C $AlCl_3$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Small, highly charged Al^{3+} polarises Cl^- most: $AlCl_3$ is the most covalent (c).
- Therefore the answer is (C).

FINAL: (C) $AlCl_3$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: C

A **NaCl**

Why (C) is the key — Small, highly charged Al^{3+} polarises Cl^- most: $AlCl_3$ is the most covalent (c).

B **$MgCl_2$**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **$CaCl_2$**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q7

The energy of an electron in a hydrogenic atom with nuclear charge Z varies as:

A. Z

B. Z^2

C. $1 / Z$

D. $1 / Z^2$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer B Z^2

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- $E_n = -13.6\ Z^2/n^2$ eV: the energy scales as Z^2.
- Therefore the answer is (B).

FINAL: (B) Z^2

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: B

A **Z**

Why (B) is the key — $E_n = -13.6\ Z^2/n^2$ eV: the energy scales as Z^2.

C **1 / Z**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **1 / Z^2**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q8 **Among the following, the element having maximum inert pair effect is [Given: Atomic number of Ge = 30, Pb = 82, Si = 14 and Sn = 50]**

A. Ge

B. Pb

C. Si

D. Sn

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer B Pb

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- The inert-pair effect (reluctance of ns^2 to take part in bonding) increases down group 14 because of poor shielding by d/f electrons and relativistic 6s contraction: Pb ≫ Sn > Ge > Si. Pb(II) is the stable state. (Bank key (c) was wrong — corrected.)
- Therefore the answer is (B).

FINAL: (B) Pb

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: B

A **Ge**

Why (B) is the key — The inert-pair effect (reluctance of ns^2 to take part in bonding) increases down group 14 because of poor shielding by d/f electrons and relativistic 6s contraction: Pb ≫ Sn > Ge > Si. Pb(II) is the stable state. (Bank key (c) was wrong — corrected.)

C **Si**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **Sn**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q9

The correct order of acidic character is:

A. $Al_2O_3 > MgO > SiO_2 > P_4O_{10}$

B. $P_4O_{10} > Al_2O_3 > MgO > SiO_2$

C. $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$

D. $SiO_2 > P_4O_{10} > Al_2O_3 > MgO$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer C $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Oxide acidity rises across period 3: $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$ (c).
- Therefore the answer is (C).

FINAL: (C) $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: C

A $Al_2O_3 > MgO > SiO_2 > P_4O_{10}$

Why (C) is the key — Oxide acidity rises across period 3: $P_4O_{10} > SiO_2 > Al_2O_3 > MgO$ (c).

B $P_4O_{10} > Al_2O_3 > MgO > SiO_2$

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D $SiO_2 > P_4O_{10} > Al_2O_3 > MgO$

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

Q10

Among lithium, nitrogen, carbon and oxygen, which element has the highest first ionization potential?

A. Lithium

B. Nitrogen

C. Carbon

D. Oxygen

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer B Nitrogen

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- N (half-filled $2p^3$, 14.5 eV) has the highest IE_1 of Li, C, N, O (b).
- Therefore the answer is (B).

FINAL: (B) Nitrogen

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: B

A **Lithium**

Why (B) is the key — N (half-filled $2p^3$, 14.5 eV) has the highest IE_1 of Li, C, N, O (b).

C **Carbon**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **Oxygen**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q11

Identify the correct option: In the periodic table, on moving from left to right along a period,

A. The atomic size of the element increases

B. The first ionization potential of the element decreases

C. The oxide of the element becomes less basic

D. The oxide of the element becomes more basic

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer C The oxide of the element becomes less basic

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Across a period oxides become less basic (more acidic) (c).
- Therefore the answer is (C).

FINAL: (C) The oxide of the element becomes less basic

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: C

A **The atomic size of the element increases**

Why (C) is the key — Across a period oxides become less basic (more acidic) (c).

B **The first ionization potential of the element decreases**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **The oxide of the element becomes more basic**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q12

The correct order of the mean bond energies in the binary hydrides is:

A. $CH_4 > NH_3 > H_2O > HF$

B. $NH_3 > CH_4 > H_2O > HF$

C. $HF > H_2O > CH_4 > NH_3$

D. $HF > H_2O > NH_3 > CH_4$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer C HF>H_2 O>CH_4>NH_3

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Mean bond enthalpies: H–F 565, O–H 463, C–H 413, N–H 391 kJ mol^{-1}. So HF > H_2O > CH_4 > NH_3.
- Therefore the answer is (C).

FINAL: (C) HF>H_2 O>CH_4>NH_3

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: C

A $CH_4 > NH_3 > H_2O > HF$

Why (C) is the key — Mean bond enthalpies: H–F 565, O–H 463, C–H 413, N–H 391 kJ mol^{-1}. So HF > H_2O > CH_4 > NH_3.

B $NH_3 > CH_4 > H_2O > HF$

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D $HF > H_2O > NH_3 > CH_4$

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

Q13

The correct order of the ionic radii is:

A. $In^{3+} > Sn^{4+} > Sr^{2+} > Rb^{+}$

B. $Sn^{4+} > In^{3+} > Sr^{2+} > Rb^{+}$

C. $Rb^{+} > In^{3+} > Sr^{2+} > Sn^{4+}$

D. $Rb^{+} > Sr^{2+} > In^{3+} > Sn^{4+}$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer D $Rb^{+}>Sr^{2+}>In^{3+}>Sn^{4+}$

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Isoelectronic Kr-core cations shrink with increasing charge: Rb^{+} (1.52 Å) > Sr^{2+} (1.18) > In^{3+} (0.80) > Sn^{4+} (0.69).
- Therefore the answer is (D).

FINAL: (D) $Rb^{+}>Sr^{2+}>In^{3+}>Sn^{4+}$

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: D

A $In^{3+} > Sn^{4+} > Sr^{2+} > Rb^{+}$

Why (D) is the key — Isoelectronic Kr-core cations shrink with increasing charge: Rb^{+} (1.52 Å) > Sr^{2+} (1.18) > In^{3+} (0.80) > Sn^{4+} (0.69).

B $Sn^{4+} > In^{3+} > Sr^{2+} > Rb^{+}$

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

C $Rb^{+} > In^{3+} > Sr^{2+} > Sn^{4+}$

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

Q14

The decreasing order of the first ionization energy of the following element is

A. He > H > Be > B

B. Be>B>H>He

C. H>He>Be>B

D. B>Be>He>H

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer A He > H > Be > B

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- IE_1: He 24.6 > H 13.6 > Be 9.3 > B 8.3 eV (a).
- Therefore the answer is (A).

FINAL: (A) He > H > Be > B

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: A

B **Be>B>H>He**

Why (A) is the key — IE_1: He 24.6 > H 13.6 > Be 9.3 > B 8.3 eV (a).

C **H>He>Be>B**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **B>Be>He>H**

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

Q15

The decreasing order of ionic nature of the following compound is:

(A) LiI > NaBr > KCl > CsF

(B) LiI>KCl>NaBr>CsF

(C) CsF>NaBr>KCl>LiI

(D) CsF>KCl>NaBr>LiI

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer D CsF>KCl>NaBr>LiI

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- Ionic character grows with electronegativity difference: CsF > KCl > NaBr > LiI (d).
- Therefore the answer is (D).

FINAL: (D) CsF>KCl>NaBr>LiI

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: D

A **LiI > NaBr > KCl > CsF**

Why (D) is the key — Ionic character grows with electronegativity difference: CsF > KCl > NaBr > LiI (d).

B **LiI>KCl>NaBr>CsF**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

C **CsF>NaBr>KCl>LiI**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q16

The compound having the highest melting point is:

(A) LiCl

(B) LiF

(C) LiI

(D) LiBr

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer B LiF

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- LiF (smallest anion, highest lattice energy) melts highest (845 °C) (b).
- Therefore the answer is (B).

FINAL: (B) LiF

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: B

A **LiCl**

Why (B) is the key — LiF (smallest anion, highest lattice energy) melts highest (845 °C) (b).

C **LiI**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **LiBr**

Ruled out: Electronegativity depends on oxidation state and hybridisation ($sp > sp^2 > sp^3$ for C).

Q17

The decreasing order of the first ionization energy of the following elements is:

A. Xe>Be>As>Al

B. Xe>As>Al>Be

C. Xe>As>Be>Al

D. Xe>Be>Al>As

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Periodic Properties

PYQ FREQUENCY
Rare · 2 papers

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Across: smaller, harder to ionise; Down: bigger, easier'.

Correct Answer C Xe>As>Be>Al

CONCEPT

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

↓

LOGIC / WORKING

- IE_1: Xe 12.1 > As 9.8 > Be 9.3 > Al 6.0 eV (c).
- Therefore the answer is (C).

FINAL: (C) Xe>As>Be>Al

SHORTCUT / EXAM TRICK

Half-filled/filled subshells raise IE (N, Be); small size + lone-pair repulsion lowers EA (F, O).

COMMON MISTAKE

Comparing isoelectronic ions without noting that higher Z means smaller radius.

EXAM TIP

Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MEMORY TRICK

'Across: smaller, harder to ionise; Down: bigger, easier'.

Why the Other Options Are Wrong

Correct answer: C

A **Xe>Be>As>Al**

Why (C) is the key — IE_1: Xe 12.1 > As 9.8 > Be 9.3 > Al 6.0 eV (c).

B **Xe>As>Al>Be**

Ruled out: Comparing isoelectronic ions without noting that higher Z means smaller radius.

D **Xe>Be>Al>As**

Ruled out: Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

TOPIC REVISION

Periodic Properties

17 PYQs · Last-minute revision

TOPIC SUMMARY

Trends in atomic/ionic radius, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken, Allred–Rochow); effective nuclear charge (Slater); anomalies (N > O in IE, Cl > F in EA, d-block contraction, inert-pair effect); diagonal relationships.

IMPORTANT FORMULA SHEET

- $Z_{eff} = Z - S$ (Slater)
- Mulliken $\chi = (IE + EA)/2$
- Allred–Rochow $\chi = 0.359\, Z_{eff}/r^2 + 0.744$
- IE_1 order: He > Ne > F > N > O …

FREQUENTLY ASKED CONCEPTS

- Why Be, N, Ne have high IE
- Why Cl has higher EA than F
- Ga ≈ Al radius (d-block contraction)
- Inert-pair effect (Tl^+, Pb^{2+})
- Diagonal pairs Li/Mg, Be/Al, B/Si

COMMON MISTAKES & QUICK NOTES

Watch out:
Comparing isoelectronic ions without noting that higher Z means smaller radius.
Electronegativity depends on oxidation state and hybridisation (sp > sp^2 > sp^3 for C).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17

Expect 8 question(s) next session on Periodic Properties.

TOPIC 2

Acid and Bases

13 questions · Easy 5 | Medium 7 | Hard 1 · PYQ frequency: Very High

Q18

The compound that will behave as an acid in H_2SO_4 is

A. CH_3COOH

B. HNO_3

C. $HClO_4$

D. H_2O

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer C $HClO_4$

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- 306 HClO4 behave as an acid in H2SO4 ,because HClO4 contain higher dissociation constant than that of H2SO4. HClO4, pKa, value -9 H2SO4 , pKa value -3, HNO3 , pKa value -1, CH3COOH , pKa value 4.7. pKa value of HClO4 > pKa value of H2SO4 CSIR DEC 2013] Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (C).

FINAL: (C) $HClO_4$

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: C

A CH_3COOH

Why (C) is the key — 306 HClO4 behave as an acid in H2SO4 ,because HClO4 contain higher dissociation constant than that of H2SO4. HClO4, pKa, value -9 H2SO4 , pKa value -3, HNO3 , pKa value -1, CH3COOH , pKa value 4.7. pKa value of HClO4 > pKa value of H2SO4 CSIR DEC 2013] Explanation as extracted from the printed page; notation may be imperfect.

B HNO_3

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D H_2O

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q19

Among the following, the correct acid strength trend is represented by

A $[Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+2}$

B $[Fe(H_2O)_6]^{+3} < [Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+2}$

C $[Fe(H_2O)_6]^{+2} < [Fe(H_2O)_6]^{+3} < [Al(H_2O)_6]^{+3}$

D $[Fe(H_2O)_6]^{+2} < [Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3}$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer D $[Fe(H_2O)_6]^{+2} < [Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3}$

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- For aqua ion complex , acidity is more when (i) small size (ii) greater charge. CSIR JUNE 15 Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (D).

FINAL: (D) $[Fe(H_2O)_6]^{+2} < [Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3}$

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: D

A $[Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+2}$

Why (D) is the key — For aqua ion complex , acidity is more when (i) small size (ii) greater charge. CSIR JUNE 15 Explanation as extracted from the printed page; notation may be imperfect.

B $[Fe(H_2O)_6]^{+3} < [Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+2}$

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

C $[Fe(H_2O)_6]^{+2} < [Fe(H_2O)_6]^{+3} < [Al(H_2O)_6]^{+3}$

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q20

For the reaction, $HX\ (aq) + H_2O(l)\ \overset{\text{gives}}{\underset{\text{left}}{\rightleftharpoons}}\ H_3O^+ + X^-$ the highest value of $[X^-]$, when X^- is

A. OCl^-

B. F^-w

C. Cl^-

D. NO_2^-

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer C Cl^-

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- Due to more acidity of HCl it will undergo more ionization. Hence, concentration of Cl- will be maximum. Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (C).

FINAL: (C) Cl^-

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: C

A OCl^-

Why (C) is the key — Due to more acidity of HCl it will undergo more ionization. Hence, concentration of Cl- will be maximum. Explanation as extracted from the printed page; notation may be imperfect.

B F^-w

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D NO_2^-

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q21

The reactions given below, A $Cl_2 + H_2O \rightarrow HOCl + H_3O^+ + Cl^-$ B $Cl_2 + 2NH_3 \rightarrow NH_2Cl + NH_4 + Cl$ Are examples of

A. disproportionation only

B. disproportionation (A) and solvation (B)

C. solvation (A) and disproportionation (B)

D. solvalysis as well as disproportionation

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer D solvalysis as well as disproportionation

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- In both, Cl_2 (0) goes to +1 (HOCl / NH_2Cl) and −1 (Cl^-) — disproportionation — and the solvent (H_2O or NH_3) is split in the process — solvolysis (hydrolysis/ammonolysis). (Bank key (a) is incomplete — corrected.)
- Therefore the answer is (D).

FINAL: (D) solvalysis as well as disproportionation

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: D

A — **disproportionation only**

Why (D) is the key — In both, Cl_2 (0) goes to +1 (HOCl / NH_2Cl) and −1 (Cl^-) — disproportionation — and the solvent (H_2O or NH_3) is split in the process — solvolysis (hydrolysis/ammonolysis). (Bank key (a) is incomplete — corrected.)

B — **disproportionation (A) and solvation (B)**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

C — **solvation (A) and disproportionation (B)**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q22

Consider compounds PF_5, SbF_5, PH_3 and SbH_3. The strongest acid and the strongest base among these are, respectively

A. PF_5 and PH_3

B. SbF_5 and PH_3

C. SbF_5 and SbH_3

D. PF_5 and SbH_3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer B SbF_5 and PH_3

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- SbF5 is strongest acid and PH3 is strongest base. CSIR JUNE 2019 Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (B).

FINAL: (B) SbF_5 and PH_3

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: B

A **PF_5 and PH_3**

Why (B) is the key — SbF5 is strongest acid and PH3 is strongest base. CSIR JUNE 2019 Explanation as extracted from the printed page; notation may be imperfect.

C **SbF_5 and SbH_3**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D **PF_5 and SbH_3**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q23 **Among $SO_2(OH)F$, CH_3CO_2H, LiF and H_2O, the compound(s) which behave(s) as a base in liquid HF is/are (1) CH_3CO_2H and LiF only (2) LiF only (3) $SO_2(OH)F$ and LiF only (4) CH_3CO_2H, LiF and H_2O (Numerical answer type — write the value.)**

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

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Q24

The correct order of acidity among the following species is

A $[Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} > [Sc(H_2O)_6]^{3+}$

B $[Sc(H_2O)_6]^{3+} > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} > [Na(H_2O)_6]^+$

C $[Mn(H_2O)_6]^{2+} > [Ni(H_2O)_6]^{2+} > [Sc(H_2O)_6]^{3+} > [Na(H_2O)_6]^+$

D $[Sc(H_2O)_6]^{3+} > [Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+}$

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer B $[Sc(H_2O)_6]^{3+} > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} > [Na(H_2O)_6]^{+}$

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- Acidity of aqua ions rises with charge and charge density: Sc^{3+} > Ni^{2+} (smaller) > Mn^{2+} > Na^{+}.
- Therefore the answer is (B).

FINAL: (B) $[Sc(H_2O)_6]^{3+} > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} > [Na(H_2O)_6]^{+}$

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^{+}–I^{-}, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: B

A $[Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+} > [Sc(H_2O)_6]^{3+}$

Why (B) is the key — Acidity of aqua ions rises with charge and charge density: $Sc^{3+} > Ni^{2+}$ (smaller) > $Mn^{2+} > Na^+$.

C $[Mn(H_2O)_6]^{2+} > [Ni(H_2O)_6]^{2+} > [Sc(H_2O)_6]^{3+} > [Na(H_2O)_6]^+$

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D $[Sc(H_2O)_6]^{3+} > [Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{2+} > [Mn(H_2O)_6]^{2+}$

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q25

In the following reactions carried out in liquid NH_3 $Zn(NH_2)_2+2\ KNH_2 \rightarrow K_2[Zn(NH_2)_4]$ $K_2[Zn(NH_2)_4]+2\ NH_4NO_3 \rightarrow Zn(NH_2)_2+2\ KNO_3+4\ NH_3$ KNH_2 and NH_4NO_3 act respectively as

A. Solvo-acid and solvo-base

B. Solvo-base and solvo-acid

C. Conjugate acid and conjugate base

D. Conjugate base and conjugate acid

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer B Solvo-base and solvo-acid

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- In liquid ammonia NH_2^- is the solvent anion (solvo-base) and NH_4^+ the solvent cation (solvo-acid): KNH_2 dissolves the amide as an amido complex and NH_4NO_3 neutralises it back.
- Therefore the answer is (B).

FINAL: (B) Solvo-base and solvo-acid

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: B

A — **Solvo-acid and solvo-base**

Why (B) is the key — In liquid ammonia NH_2^- is the solvent anion (solvo-base) and NH_4^+ the solvent cation (solvo-acid): KNH_2 dissolves the amide as an amido complex and NH_4NO_3 neutralises it back.

C — **Conjugate acid and conjugate base**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D — **Conjugate base and conjugate acid**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q26

Which of the following react(s) with AsF_5 in liquid BrF_3 ?

A. XeF_6 only

B. XeF_6 and XeF_4

C. XeF_6 and XeF_2

D. XeF_4 and XeF_2

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer C XeF_6 and XeF_2

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- Separation of XeF4 from a mixture involves preferential complexation of XeF2 and XeF6 and XeF4 is then removed in vacuum Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (C).

FINAL: (C) XeF_6 and XeF_2

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: C

A — **XeF_6 only**

Why (C) is the key — Separation of XeF4 from a mixture involves preferential complexation of XeF2 and XeF6 and XeF4 is then removed in vacuum Explanation as extracted from the printed page; notation may be imperfect.

B — **XeF_6 and XeF_4**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D — **XeF_4 and XeF_2**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q27

The compound that gives a basic solution in HF is :

A. AsF_5

B. PF_5

C. BF_3

D. BrF_3

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer D BrF_3

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- AsF5 + 2HF → [AsF6]- + [H2F]+ PF5 + 2HF →[PF6]- + [H2F]+ BF3 + 2HF → [BF4]- + [H2F]+ BrF3+ HF →[BrF2]+ + [HF2]- BrF3 acts as base as it donate F- in HF Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (D).

FINAL: (D) BrF_3

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: D

A **AsF_5**

Why (D) is the key — AsF5 + 2HF → [AsF6]- + [H2F]+ PF5 + 2HF →[PF6]- + [H2F]+ BF3 + 2HF → [BF4]- +[H2F]+ BrF3+ HF →[BrF2]+ + [HF2]- BrF3 acts as base as it donate F- in HF Explanation as extracted from the printed page; notation may be imperfect.

B **PF_5**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

C **BF_3**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q28

The reaction of IO_3^- with I^- in aqueous acidic medium results in

A. I_2 and H_2O

B. I_2 and H_2O_2

C. IO^- and H_2O

D. IO^- and H_2O_2

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer A I_2 and H_2O

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- IO3- (aq) + 5I-(aq) + 6H+ (aq) → 3I2(aq) + 3H2O(l) Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) I_2 and H_2O

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: A

B — **I_2 and H_2O_2**

Why (A) is the key — IO3- (aq) + 5I-(aq) + 6H+ (aq) → 3I2(aq) + 3H2O(l) Explanation as extracted from the printed page; notation may be imperfect.

C — **IO^- and H_2O**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D — **IO^- and H_2O_2**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q29

The cations formed upon dissolving SnF_4 and AuF_3 in liquid BrF_3 separately, respectively are

A. SnF_3^+ and BrF_2^+

B. BrF_2^+ and AuF_2^+

C. BrF_2^+ only

D. SnF_3^+ and AuF_2^+

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer C BrF_2^+only

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- SnF_4 and AuF_3 are fluoride acceptors, so only BrF_2^+ cations form (c).
- Therefore the answer is (C).

FINAL: (C) BrF_2^+only

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: C

A SnF_3^+ **and** BrF_2^+

Why (C) is the key — SnF_4 and AuF_3 are fluoride acceptors, so only BrF_2^+ cations form (c).

B BrF_2^+ **and** AuF_2^+

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D SnF_3^+ **and** AuF_2^+

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Q30

Among the following reactions, those that are feasible in liquid NH_3 are (I) $KNO_3 + AgCl \rightarrow KCl + AgNO_3$ (II) $NH_4Br + KNH_2 \rightarrow KBr + 2NH_3$ (III) $Fe(CO)_5 + 2e^- \rightarrow [Fe(CO)_4]^{2-} + CO$

A. I, II and III

B. I and II only

C. I and III only

D. II and III only

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acid and Bases

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer A I, II and III

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- •When aqueous solution of AgNO3 is added to an aqueous solution of KCl, white ppt of AgCl is formed. KCl+AgNO3 →AgCl + KNO3 White ppt But in liquid NH3, the direction of the reaction is reversed. AgCl + KNO3 → KCl+ AgNO3 • NH4Br + KNH2 → KBr + 2NH3 This reaction is neutralization reaction in liquid NH3 Ammonia solutions of alkali metals and alkaline earth metals are strong reducing agents. Fe(CO)5 +2e- → [Fe(CO)4]-2 + CO Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) I, II and III

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: A

B **I and II only**

Why (A) is the key — •When aqueous solution of AgNO3 is added to an aqueous solution of KCl, white ppt of AgCl is formed. KCl+AgNO3 →AgCl + KNO3 White ppt But in liquid NH3, the direction of the reaction is reversed. AgCl + KNO3 → KCl+ AgNO3 • NH4Br + KNH2 → KBr + 2NH3 This reaction is neutralization reaction in liquid NH3 Ammonia solutions of alkali metals and alkaline earth metals are strong reducing agents. Fe(CO)5 +2e- → [Fe(CO)4]-2 + CO Explanation as extracted from the printed page; notation may be imperfect.

C **I and III only**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D **II and III only**

Ruled out: Soft–soft pairs (Ag^{+}–I^{-}, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

TOPIC REVISION

Acid and Bases

13 PYQs · Last-minute revision

TOPIC SUMMARY

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

IMPORTANT FORMULA SHEET

- Pauling: pKa ≈ 8 − 5m for $XO_m(OH)_n$ (m = non-hydroxyl O)
- HSAB: soft acids Ag^+, Hg^{2+}, Pt^{2+}; hard acids H^+, Al^{3+}, Ln^{3+}
- H_0 Hammett function for superacids

FREQUENTLY ASKED CONCEPTS

- Order of acidity of oxoacids
- Hard/soft classification of ions
- Why HF is weak in water
- Levelling in liquid NH_3 vs acetic acid
- Lewis acidity of BF_3 < BCl_3 < BBr_3

COMMON MISTAKES & QUICK NOTES

Watch out:
Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).
Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30

Expect 1 question(s) next session on Acid and Bases.

TOPIC 3

d-Block Elements

12 questions · Easy 6 | Medium 6 | Hard 0 · PYQ frequency: Rare

Q31

The most probable oxidation states for both Cr and Mo are

A. +2, +3, +4

B. +2, +3, +5

C. +2, +3, +6

D. +3,+4,+5

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer C +2, +3, +6

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- Both group-6 metals show +2, +3 and +6 as their common states (e.g. $CrCl_2$, Cr_2O_3/$CrCl_3$, CrO_3; $MoCl_2$ clusters, Mo_2O_3, MoO_3). Chapter list · Next in chapter →
- Therefore the answer is (C).

FINAL: (C) +2, +3, +6

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: C

A **+2, +3, +4**

Why (C) is the key — Both group-6 metals show +2, +3 and +6 as their common states (e.g. $CrCl_2$, Cr_2O_3/$CrCl_3$, CrO_3; $MoCl_2$ clusters, Mo_2O_3, MoO_3). Chapter list · Next in chapter →

B **+2, +3, +5**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **+3,+4,+5**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q32

The transition metal monoxide that shows metallic conductivity is:

A. NiO

B. MnO

C. TiO

D. CoO

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer C TiO

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- TiO (Ti^{2+} d^2, overlapping t_2g band) is metallic; NiO, MnO and CoO are insulators (c).
- Therefore the answer is (C).

FINAL: (C) TiO

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: C

A **NiO**

Why (C) is the key — TiO (Ti^{2+} d^2, overlapping t_2g band) is metallic; NiO, MnO and CoO are insulators (c).

B **MnO**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **CoO**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q33

The metal that is extracted by the reduction method is:

A. Al

B. Au

C. Hg

D. Mg

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer C Hg

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- HgS (cinnabar) is simply roasted in air: $HgS + O_2 \rightarrow Hg + SO_2$ (self-reduction, no reducing agent needed). Al and Mg need electrolysis; Au is leached with cyanide.
- Therefore the answer is (C).

FINAL: (C) Hg

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: C

A **Al**

Why (C) is the key — HgS (cinnabar) is simply roasted in air: $HgS + O_2 \rightarrow Hg + SO_2$ (self-reduction, no reducing agent needed). Al and Mg need electrolysis; Au is leached with cyanide.

B **Au**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **Mg**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q34

The compound formed by dissolving elemental gold in aqua regia is:

A. AuCl

B. $AuNO_3$

C. $H[AuCl_4]$

D. $H[Au(NO_3)_4]$

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer C H[AuCl₄]

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- $Au + HNO_3 + 4HCl \rightarrow H[AuCl_4] + NO + 2H_2O$ (c).
- Therefore the answer is (C).

FINAL: (C) H[AuCl₄]

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: C

A **AuCl**

Why (C) is the key — $Au + HNO_3 + 4HCl \rightarrow H[AuCl_4] + NO + 2H_2O$ (c).

B **$AuNO_3$**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **$H[Au(NO_3)_4]$**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q35

Number of moles of ions produced by complete dissociation of one mole of Mohr's salt in water is

A) 3

B) 4

C) 5

D) 6

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer C 5

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- Mohr's salt $(NH_4)_2Fe(SO_4)_2{\cdot}6H_2O \rightarrow 2\ NH_4^+ + Fe^{2+} + 2\ SO_4^{2-}$ = 5 mol ions per mol.
- Therefore the answer is (C).

FINAL: (C) 5

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: C

A **3**

Why (C) is the key — Mohr's salt $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O \rightarrow 2\ NH_4^+ + Fe^{2+} + 2\ SO_4^{2-}$ = 5 mol ions per mol.

B **4**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **6**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q36

A filter paper moistioned with ammonical sodium nitroprusside solution turns violet on contact with a drop of alkaline Na_2S solution. The violet colour is due to the formation of

A. $[Fe(SCN)_5(NO)]^-$

B. $[Fe(SCN)_5(NO)]^{2-}$

C. $[Fe(CN)_5(NOS)]^{3-}$

D. $[Fe(CN)_5(NOS)]^{4-}$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer D $[Fe(CN)_5(NOS)]^{4-}$

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- Sulfide adds to the nitrosyl of nitroprusside: $[Fe(CN)_5(NOS)]^{4-}$ (violet) (d).
- Therefore the answer is (D).

FINAL: (D) $[Fe(CN)_5(NOS)]^{4-}$

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: D

A $[Fe(SCN)_5(NO)]^-$

Why (D) is the key — Sulfide adds to the nitrosyl of nitroprusside: $[Fe(CN)_5(NOS)]^{4-}$ (violet) (d).

B $[Fe(SCN)_5(NO)]^{2-}$

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

C $[Fe(CN)_5(NOS)]^{3-}$

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q37

Among the following, the ligand that BEST stabilizes low oxidation state of tungsten (W) is

A H_2O

B NH_3

C CO

D F^-

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer B NH_3

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- CO is a strong π-acceptor: it removes electron density from an electron-rich low-oxidation-state metal (W(0) in $W(CO)_6$), stabilising it. H_2O, NH_3 and F^- are σ/π-donors that stabilise high oxidation states.
- Therefore the answer is (B).

FINAL: (B) NH_3

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: B

A — **H_2O**

Why (B) is the key — CO is a strong π-acceptor: it removes electron density from an electron-rich low-oxidation-state metal (W(0) in $W(CO)_6$), stabilising it. H_2O, NH_3 and F^- are σ/π-donors that stabilise high oxidation states.

C — **CO**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D — **F^-**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q38 **In the following Latimer diagram, the species the undergoes disproportionation reaction is MnO_4^- xrightarrow+0.56 MnO_4^{2-} xrightarrow0.93 MnO_2 xrightarrow+0.15 Mn_2O_3 xrightarrow-0.25 $Mn(OH)_2$ xrightarrow-1.56 Mn**

A MnO_4^{2-}

B MnO_4^{3-}

C Mn_2O_3

D $Mn(OH)_2$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
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EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer A MnO_4^{2-}

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- A species disproportionates when E°(right) > E°(left): for MnO_4^{2-}, 0.93 V > 0.56 V (a). MnO_2, Mn_2O_3 and $Mn(OH)_2$ all have E°(right) < E°(left).
- Therefore the answer is (A).

FINAL: (A) MnO_4^{2-}

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: A

B MnO_4^{3-}

Why (A) is the key — A species disproportionates when E°(right) > E°(left): for MnO_4^{2-}, 0.93 V > 0.56 V (a). MnO_2, Mn_2O_3 and $Mn(OH)_2$ all have E°(right) < E°(left).

C $Mn_2\ O_3$

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D $Mn(OH)_2$

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q39

A yellow precipitate is formed upon addition of aqueous $AgNO_3$ to a solution of

A. phosphite

B. pyrophosphate

C. metaphosphate

D. orthophosphate

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer D orthophosphate

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- Orthophosphate gives yellow Ag_3PO_4; pyrophosphate and metaphosphate give white silver salts ($Ag_4P_2O_7$, $AgPO_3$), and phosphite reduces Ag^+ (black Ag).
- Therefore the answer is (D).

FINAL: (D) orthophosphate

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: D

A **phosphite**

Why (D) is the key — Orthophosphate gives yellow Ag_3PO_4; pyrophosphate and metaphosphate give white silver salts ($Ag_4P_2O_7$, $AgPO_3$), and phosphite reduces Ag^+ (black Ag).

B **pyrophosphate**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

C **metaphosphate**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q40

In a saturated calomel electrode, the saturation is with respect to

A. KCl

B. Hg_2Cl_2

C. $HgCl_2$

D. AgCl

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer A KCl

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- The SCE is Hg | Hg_2Cl_2 | KCl(sat.): the electrolyte is saturated potassium chloride, which fixes [Cl^-] and hence the potential (0.244 V).
- Therefore the answer is (A).

FINAL: (A) KCl

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: A

B **$Hg_2 Cl_2$**

Why (A) is the key — The SCE is Hg | Hg_2Cl_2 | KCl(sat.): the electrolyte is saturated potassium chloride, which fixes [Cl^-] and hence the potential (0.244 V).

C **$HgCl_2$**

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

D **AgCl**

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q41

In qualitative inorganic analysis of metal ions, the ion which precipitates as sulfide in the presence of H_2S in warm dilute HCl is

A Cr^{3+}

B Al^{3+}

C Co^{2+}

D Bi^{3+}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3d loves low, 5d loves high oxidation states'.

Correct Answer D Bi^{3+}

CONCEPT

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

↓

LOGIC / WORKING

- Group II cations (Bi^{3+}, Cu^{2+}, Cd^{2+} …) precipitate as sulfides from acidic H_2S (d).
- Therefore the answer is (D).

FINAL: (D) Bi^{3+}

SHORTCUT / EXAM TRICK

Maximum oxidation state = group number up to Mn (+7); then falls (Fe +6, Co +4, Ni +4, Cu +3).

COMMON MISTAKE

Taking Zn as a transition element in the strict (incomplete d subshell) definition.

EXAM TIP

Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MEMORY TRICK

'3d loves low, 5d loves high oxidation states'.

Why the Other Options Are Wrong

Correct answer: D

A Cr^{3+}

Why (D) is the key — Group II cations (Bi^{3+}, Cu^{2+}, Cd^{2+} …) precipitate as sulfides from acidic H_2S (d).

B Al^{3+}

Ruled out: Taking Zn as a transition element in the strict (incomplete d subshell) definition.

C Co^{2+}

Ruled out: Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

Q42 **Titanium tetrachloride ($TiCl_4$) reacts with THF to form an octahedral complex X under inert atmosphere at 25°C. If 5.0 g of $TiCl_4$ is used and the yields is 80 \%, the amount of X (in grams) formed is ___ (Round off to one decimal place) (Use atomic weights: Ti=48, Cl=35.5 Q=16, C=12 and H=1) (Numerical answer type — write the value.)**

ANSWER: 7.0 g

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
d-Block Elements

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$TiCl_4$ + 2 THF → $TiCl_4(THF)_2$ (octahedral, X). M($TiCl_4$) = 190, M(X) = 190 + 2 × 72 = 334. n = 5.0/190 = 0.0263 mol → 0.8 × 0.0263 × 334 = 7.0 g.

TOPIC REVISION

d-Block Elements

12 PYQs · Last-minute revision

TOPIC SUMMARY

Transition metals: variable oxidation states, colour (d–d, CT), paramagnetism, catalysis, complex formation; trends in stability of oxidation states across 3d (Mn^{2+} stable, Cr^{6+}/Mn^{7+} oxidising); 4d/5d prefer higher states; Latimer/Frost diagrams; aqueous chemistry (hydrolysis, polyoxometalates).

IMPORTANT FORMULA SHEET

- Common states: Sc +3; Ti +4; V +5/+4; Cr +3/+6; Mn +2/+4/+7; Fe +2/+3; Co +2/+3; Ni +2; Cu +2/+1; Zn +2
- $\mu_{so} = \sqrt{n(n+2)}$
- Frost diagram: slope = E°

FREQUENTLY ASKED CONCEPTS

- Most stable oxidation state per element
- Why Cu^{+} disproportionates in water
- Colour of ions (Ti^{3+} purple, V^{3+} green, Cr^{3+} violet, Mn^{2+} pink, Fe^{3+} yellow, Cu^{2+} blue)
- Maximum oxidation state (Ru/Os +8)

COMMON MISTAKES & QUICK NOTES

Watch out:
Taking Zn as a transition element in the strict (incomplete d subshell) definition.
Cr(VI) and Mn(VII) are strongly oxidising; Mo(VI)/W(VI) and Tc(VII)/Re(VII) are stable.

MOST-REPEATED PYQs & EXPECTED IN EXAM

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

Expect 12 question(s) next session on d-Block Elements.

TOPIC 4

Acids, Bases, Periodic Properties & d-Block – General

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

Q43

In the reactions (A) and (B), $n(H_2O) + Cl^- \rightarrow [Cl(H_2O)_n]^-$ $(H_2O)_6 + Mg^{+2} \rightarrow [Mg(H_2O)_6]^{+2}$ (A) (B) water behaves as

A. An acid in both (A) and (B)

B. An acid in (A) and a base in (B)

C. A base in (A) an acid in (B)

D. A base in both (A) and (B)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Acids, Bases, Periodic Properties & d-Block – General

PYQ FREQUENCY
Rare · 1 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Like binds like: hard–hard, soft–soft'.

Correct Answer B An acid in (A) and a base in (B)

CONCEPT

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

↓

LOGIC / WORKING

- Solvating Cl^-, water donates H-bonds (δ^+ H to the anion) → acts as an acid. Solvating Mg^{2+}, water donates its O lone pair → acts as a (Lewis) base.
- Therefore the answer is (B).

FINAL: (B) An acid in (A) and a base in (B)

SHORTCUT / EXAM TRICK

More oxo groups (not OH) → stronger acid: $HClO_4 \gg HClO_3 \gg HClO_2 \gg HClO$.

COMMON MISTAKE

Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

EXAM TIP

Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MEMORY TRICK

'Like binds like: hard–hard, soft–soft'.

Why the Other Options Are Wrong

Correct answer: B

A — **An acid in both (A) and (B)**

Why (B) is the key — Solvating Cl^-, water donates H-bonds (δ^+ H to the anion) → acts as an acid. Solvating Mg^{2+}, water donates its O lone pair → acts as a (Lewis) base.

C — **A base in (A) an acid in (B)**

Ruled out: Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).

D — **A base in both (A) and (B)**

Ruled out: Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

Acids, Bases, Periodic Properties & d-Block – General

TOPIC SUMMARY

Arrhenius, Brønsted–Lowry, Lewis, Lux–Flood definitions; HSAB (hard–hard, soft–soft); acid strength trends (HF < HCl < HBr < HI; oxoacids by oxidation state and number of oxo groups, Pauling's rules); levelling effect; superacids; non-aqueous solvents.

IMPORTANT FORMULA SHEET

- Pauling: pKa ≈ 8 − 5m for $XO_m(OH)_n$ (m = non-hydroxyl O)
- HSAB: soft acids Ag^+, Hg^{2+}, Pt^{2+}; hard acids H^+, Al^{3+}, Ln^{3+}
- H_0 Hammett function for superacids

FREQUENTLY ASKED CONCEPTS

- Order of acidity of oxoacids
- Hard/soft classification of ions
- Why HF is weak in water
- Levelling in liquid NH_3 vs acetic acid
- Lewis acidity of BF_3 < BCl_3 < BBr_3

COMMON MISTAKES & QUICK NOTES

Watch out:
Predicting BF_3 as the strongest boron halide Lewis acid (π-back-donation from F weakens it).
Soft–soft pairs (Ag^+–I^-, Hg^{2+}–S^{2-}) explain insolubility and extraction behaviour.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q43

Expect 1 question(s) next session on Acids, Bases, Periodic Properties & d-Block – General.

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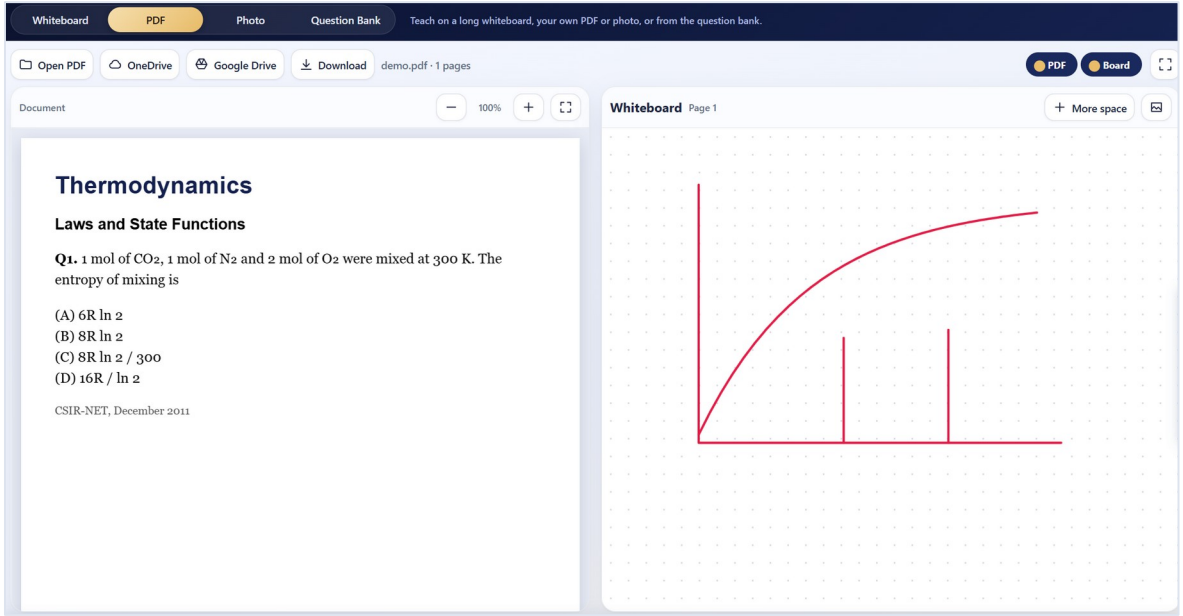
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