



Inorganic Chemistry — JEE (Advanced) Pattern Sample Test

FREE SAMPLE TEST · CHEMISTRY · PATTERN OF JEE (ADVANCED) PAPER 1

DURATION	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
60 minutes	60	17 (4 + 3 + 6 + 4)	

GENERAL INSTRUCTIONS

1. This question paper has FOUR sections. All questions are compulsory.
2. Read the marking scheme of each section carefully: wrong answers in Sections 1, 2 and 4 carry negative marks.
3. Use of a calculator, log tables or any other aid is not allowed.
4. The answer key and worked solutions are at the end of this booklet. Attempt the paper in 60 minutes before you look at them.

SECTION 1 (Q1–4) — +3 / 0 / –1

1. This section contains FOUR (04) questions.
2. Each question has FOUR options. ONLY ONE of these four options is the correct answer.
3. Full Marks: +3 if ONLY the correct option is chosen; Zero Marks: 0 if none of the options is chosen; Negative Marks: –1 in all other cases.

SECTION 2 (Q5–7) — +4 / partial / –2

1. This section contains THREE (03) questions.
2. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).
3. Full Marks: +4 ONLY if (all) the correct option(s) is(are) chosen; Partial Marks: +3 if all the four options are correct but ONLY three options are chosen; +2 if three or more options are correct but ONLY two options are chosen, both of which are correct; +1 if two or more options are correct but ONLY one option is chosen and it is a correct option; Zero Marks: 0 if unanswered; Negative Marks: –2 in all other cases.

SECTION 3 (Q8–13) — +4 / 0

1. This section contains SIX (06) questions.
2. The answer to each question is a NON-NEGATIVE INTEGER.
3. Full Marks: +4 ONLY if the correct integer is entered; Zero Marks: 0 in all other cases.

SECTION 4 (Q14–17) — +3 / 0 / –1

1. This section contains FOUR (04) Matching List Sets.
2. Each set has ONE Multiple Choice Question. Each set has TWO lists: List-I and List-II. List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).
3. FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question.
4. Full Marks: +3 ONLY if the option corresponding to the correct combination is chosen; Zero Marks: 0 if none of the options is chosen; Negative Marks: –1 in all other cases.

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Chapters covered: Classification of Elements and Periodic Properties · Chemical Bonding · Coordination Compounds · p-Block Elements · d and f-Block Elements · Metallurgy · Salt Analysis

SECTION 1 (Q1–4) · Single correct · +3 / 0 / -1

Each question has FOUR options. ONLY ONE of these four options is the correct answer.

1. Ignoring pairing energy, which of the following complexes has the most negative crystal field stabilisation energy (CFSE), in units of Δ_o ?

- (A) $[\text{Fe}(\text{CN})_6]^{3-}$
- (B) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (C) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$
- (D) $[\text{Ni}(\text{NH}_3)_6]^{2+}$

2. According to molecular orbital theory, which of the following species is diamagnetic and has a bond order of 2?

- (A) O_2
- (B) NO^-
- (C) B_2
- (D) C_2

3. In which of the following ions are the two sulphur atoms in different oxidation states?

- (A) $\text{S}_2\text{O}_3^{2-}$ (thiosulphate)
- (B) $\text{S}_2\text{O}_8^{2-}$ (peroxodisulphate)
- (C) $\text{S}_2\text{O}_7^{2-}$ (disulphate)
- (D) $\text{S}_2\text{O}_6^{2-}$ (dithionate)

4. Which of the following orders is INCORRECT?

- (A) First ionisation enthalpy: $\text{B} < \text{Be} < \text{C} < \text{O} < \text{N}$
- (B) Magnitude of electron gain enthalpy: $\text{Cl} > \text{F} > \text{Br} > \text{I}$
- (C) Atomic radius: $\text{Ga} > \text{Al}$
- (D) Thermal stability of carbonates: $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{SrCO}_3$

SECTION 2 (Q5–7) · One or more correct · +4 / partial / -2

Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

5. Which of the following statements about stereoisomerism in octahedral complexes is/are correct? (en = ethylenediamine, gly⁻ = glycinate.)

- (A) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ has three stereoisomers, of which exactly one is optically inactive.
- (B) $[\text{Co}(\text{en})(\text{NH}_3)_2\text{Cl}_2]^+$ has four stereoisomers.
- (C) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ has two geometrical isomers, and neither of them is optically active.
- (D) $[\text{Cr}(\text{gly})_3]$ has only two stereoisomers.

6. Which of the following statements is/are correct?

- (A) In B_2H_6 , all six B–H bonds have the same length.
- (B) In the borax anion $[\text{B}_4\text{O}_5(\text{OH})_4]^{2-}$, two boron atoms are sp^2 hybridised and two are sp^3 hybridised.
- (C) XeO_3 is trigonal planar.
- (D) In the tetrathionate ion $\text{S}_4\text{O}_6^{2-}$, the average oxidation state of S is +2.5, and two of the four S atoms are in the 0 state.

7. Which of the following observations is/are correct?

- (A) Aqueous CuSO_4 with excess KI gives a white precipitate of CuI_2 .
(B) When H_2O_2 is added to acidified $\text{K}_2\text{Cr}_2\text{O}_7$ and the mixture is shaken with ether, the ether layer turns blue.
(C) A solution of FeSO_4 gives a dark blue precipitate with $\text{K}_3[\text{Fe}(\text{CN})_6]$.
(D) Aqueous ZnSO_4 gives a white precipitate with NaOH that persists in excess NaOH.

SECTION 3 (Q8–13) · Non-negative integer · +4 / 0

The answer to each question is a NON-NEGATIVE INTEGER.

8. Find the total number of lone pairs of electrons on the central atoms of XeF_4 , XeO_2F_2 , ClF_3 , I_3^- , SF_4 and BrF_5 taken together.

Answer: _____

9. Find the total number of stereoisomers (geometrical and optical) of the octahedral complex ion $[\text{Co}(\text{gly})_2\text{Cl}_2]^-$, where gly^- is the glycinate ion, which binds through N and O.

Answer: _____

10. Find the total number of unpaired electrons in $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Ni}(\text{CO})_4]$, $[\text{Cu}(\text{NH}_3)_4]^{2+}$, $[\text{MnCl}_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$ taken together.

Answer: _____

11. How many of the following contain an O–O bond? H_2SO_5 , $\text{H}_2\text{S}_2\text{O}_8$, CrO_5 , $\text{K}_2\text{Cr}_2\text{O}_7$, BaO_2 , KO_2 , $\text{H}_2\text{S}_2\text{O}_7$, Na_2O_2 , N_2O_5 , H_3PO_5

Answer: _____

12. Find the sum of the oxidation states of Cr in CrO_5 , Fe in the brown-ring complex $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$ (NO bound as NO^+), Mn in K_2MnO_4 and Os in OsO_4 .

Answer: _____

13. Stable mononuclear metal carbonyls obey the 18-electron rule. Let x, y and z be the numbers of CO ligands in the neutral mononuclear carbonyls of Cr, Fe and Ni, and w the number in the mononuclear carbonyl anion of manganese with charge -1 . Find $x + y + z + w$.

Answer: _____

SECTION 4 (Q14–17) · Matching lists · +3 / 0 / –1

Each set has ONE Multiple Choice Question. Each set has TWO lists: List-I and List-II. List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).

14. Match each complex in List-I with its spin-only magnetic moment (in BM) in List-II.

List-I	List-II
(P) $[\text{Fe}(\text{CN})_6]^{3-}$	(1) 2.83
(Q) $[\text{Mn}(\text{CN})_6]^{3-}$	(2) 5.92
(R) $[\text{CoF}_6]^{3-}$	(3) 1.73
(S) $[\text{MnBr}_4]^{2-}$	(4) 4.90
	(5) 3.87

- (A) $P \rightarrow 3, Q \rightarrow 5, R \rightarrow 4, S \rightarrow 2$
(B) $P \rightarrow 1, Q \rightarrow 3, R \rightarrow 4, S \rightarrow 2$
(C) $P \rightarrow 3, Q \rightarrow 1, R \rightarrow 4, S \rightarrow 2$
(D) $P \rightarrow 3, Q \rightarrow 1, R \rightarrow 2, S \rightarrow 4$

15. Match each species in List-I with its shape in List-II.

List-I	List-II
(P) XeOF_4	(1) T-shaped
(Q) IF_7	(2) Square pyramidal
(R) ClF_3	(3) Square planar
(S) $[\text{ICl}_4]^-$	(4) Pentagonal bipyramidal
	(5) See-saw

- (A) $P \rightarrow 2, Q \rightarrow 4, R \rightarrow 1, S \rightarrow 3$
(B) $P \rightarrow 3, Q \rightarrow 4, R \rightarrow 1, S \rightarrow 2$
(C) $P \rightarrow 2, Q \rightarrow 4, R \rightarrow 5, S \rightarrow 3$
(D) $P \rightarrow 2, Q \rightarrow 1, R \rightarrow 4, S \rightarrow 3$

16. Match each process in List-I with the metal it is used for in List-II.

List-I	List-II
(P) Self-reduction (auto-reduction) of the partially roasted sulphide ore	(1) Gold
(Q) Leaching with dilute NaCN in air, then displacement with zinc	(2) Nickel
(R) Formation of a volatile carbonyl and its decomposition at higher temperature	(3) Copper
(S) Formation of a volatile iodide and its decomposition on a hot tungsten filament	(4) Zirconium
	(5) Aluminium

- (A) $P \rightarrow 3, Q \rightarrow 2, R \rightarrow 1, S \rightarrow 4$
(B) $P \rightarrow 5, Q \rightarrow 1, R \rightarrow 2, S \rightarrow 4$
(C) $P \rightarrow 3, Q \rightarrow 1, R \rightarrow 4, S \rightarrow 2$
(D) $P \rightarrow 3, Q \rightarrow 1, R \rightarrow 2, S \rightarrow 4$

17. Match each test in List-I with its observation in List-II.

List-I	List-II
(P) Pb^{2+} solution with KI solution	(1) Chocolate-brown precipitate
(Q) Ni^{2+} solution with dimethylglyoxime in ammoniacal medium	(2) Yellow precipitate, soluble in hot water, reappearing as golden spangles on cooling
(R) Fe^{3+} solution with KSCN solution	(3) Blood-red colouration, no precipitate
(S) Cu^{2+} solution with $\text{K}_4[\text{Fe}(\text{CN})_6]$ solution	(4) Rosy-red precipitate
	(5) Prussian blue precipitate

(A) $\text{P} \rightarrow 2$, $\text{Q} \rightarrow 3$, $\text{R} \rightarrow 4$, $\text{S} \rightarrow 1$

(B) $\text{P} \rightarrow 2$, $\text{Q} \rightarrow 4$, $\text{R} \rightarrow 3$, $\text{S} \rightarrow 1$

(C) $\text{P} \rightarrow 2$, $\text{Q} \rightarrow 4$, $\text{R} \rightarrow 5$, $\text{S} \rightarrow 1$

(D) $\text{P} \rightarrow 1$, $\text{Q} \rightarrow 4$, $\text{R} \rightarrow 3$, $\text{S} \rightarrow 2$

END OF THE QUESTION PAPER

ANSWER KEY

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
B	D	A	C	A, B, C	B, D	B, C	10	8

Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
15	7	21	20	C	A	D	B

WORKED SOLUTIONS

Q1. Answer B. CFSE = $(-0.4 \times \text{electrons in } t_{2g} + 0.6 \times \text{electrons in } e_g) \Delta_o$. $[\text{Fe}(\text{CN})_6]^{3-}$: Fe^{3+} , d^5 , strong field CN^- : $t_{2g}^5 \rightarrow -2.0 \Delta_o$. $[\text{Co}(\text{NH}_3)_6]^{3+}$: Co^{3+} , d^6 ; NH_3 pairs a $3+$ ion of the first series: $t_{2g}^6 \rightarrow -2.4 \Delta_o$. $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$: d^5 high spin $t_{2g}^3 e_g^2 \rightarrow 0$. $[\text{Ni}(\text{NH}_3)_6]^{2+}$: d^8 , $t_{2g}^6 e_g^2 \rightarrow -1.2 \Delta_o$ whatever the ligand. The most negative is $[\text{Co}(\text{NH}_3)_6]^{3+}$. The trap is taking the strongest ligand (CN^-) rather than counting electrons.

Q2. Answer D. Up to 14 electrons, s–p mixing puts σ_{2p} above π_{2p} . C_2 (12 electrons): $\dots \sigma_{2s}^2 \sigma_{2s}^{*2} \pi_{2p}^4$ — all paired, bond order $(8 - 4)/2 = 2$: diamagnetic. O_2 (16) and NO^- (16): $\dots \pi^* 2p^2$ with two unpaired electrons, bond order 2 but paramagnetic. B_2 (10): π_{2p}^2 , two unpaired electrons, bond order 1. Without s–p mixing C_2 would be wrongly predicted paramagnetic ($\sigma_{2p}^2 \pi_{2p}^2$ with two unpaired electrons).

Q3. Answer A. Thiosulphate is SO_3S^{2-} : a central S bonded to three O and to a terminal S, which plays the part of an O atom. The two S atoms are in different states (+5 and –1; some books write +6 and –2), averaging +2. $\text{S}_2\text{O}_8^{2-}$: two SO_3 units joined by a peroxide bridge O–O, both S +6 (the peroxide O are –1, which is why the average formula value +7 is impossible for S). $\text{S}_2\text{O}_7^{2-}$: $\text{O}_3\text{S}–\text{O}–\text{SO}_3$, both +6. $\text{S}_2\text{O}_6^{2-}$: $\text{O}_3\text{S}–\text{SO}_3$, both +5.

Q4. Answer C. (A) is correct: B (801 kJ mol^{–1}) is below Be (899) because its 2p electron is easier to remove than a 2s electron, and O (1314) is below N (1402) because of the half-filled $2p^3$ of N. (B) is correct: F (–328) is less negative than Cl (–349) because of electron repulsion in the small 2p shell; then Br (–325), I (–295). (C) is INCORRECT: Ga (135 pm) is smaller than Al (143 pm), because the ten 3d electrons of Ga shield the nucleus poorly. (D) is correct: carbonates become more stable down group 2 as the larger cations polarise CO_3^{2-} less.

Q5. Answer A, B, C. (A) trans (achiral) plus a pair of cis enantiomers: three, one inactive — true. (B) $[\text{M}(\text{AA})_2\text{b}_2]$: the two a trans, the two b trans, or both pairs cis; only the last is chiral, so 3 geometrical isomers and 4 stereoisomers — true. (C) fac and mer, each with a mirror plane — true. (D) gly^- is an unsymmetrical bidentate ligand (N and O ends), so $[\text{M}(\text{AB})_3]$ has fac and mer forms, and both are chiral: 4 stereoisomers, not 2 — false.

Q6. Answer B, D. (A) False: B_2H_6 has four terminal 2c–2e B–H bonds and two longer bridging 3c–2e B–H–B bonds. (B) True: two B are trigonal BO_3 (sp^2) and two are tetrahedral BO_4 (sp^3 , each carrying one OH). (C) False: Xe has 8 valence electrons, uses 6 in three Xe=O bonds and keeps one lone pair: four electron domains, so XeO_3 is trigonal pyramidal. (D) True: the average is $(12 - 2)/4 = 2.5$; the structure is $\text{O}_3\text{S}–\text{S}–\text{SO}_3^{2-}$ with the two bridging S at 0 and the two end S at +5.

Q7. Answer B, C. (A) False: $2\text{Cu}^{2+} + 4\text{I}^- \rightarrow 2\text{CuI} + \text{I}_2$. The white precipitate is CuI (copper(I)); CuI_2 does not exist, and the I_2 (as I_3^-) colours the solution brown. (B) True: CrO_5 (Cr(VI) with two peroxo groups) forms and dissolves in ether as a blue complex. (C) True: Fe^{2+} with ferricyanide gives Turnbull's blue (the same compound as Prussian blue). (D) False: $\text{Zn}(\text{OH})_2$ is amphoteric and dissolves in excess NaOH as $[\text{Zn}(\text{OH})_4]^{2-}$.

Q8. Answer 10. Lone pairs on the central atom = $(\text{valence electrons} - \text{electrons used in bonds} \pm \text{charge})/2$, counting 1 per bond to F and 2 per double bond to O. XeF_4 : $(8 - 4)/2 = 2$. XeO_2F_2 : $(8 - 4 - 2)/2 = 1$. ClF_3 : $(7 - 3)/2 = 2$. I_3^- : $(7 - 2 + 1)/2 = 3$. SF_4 : $(6 - 4)/2 = 1$. BrF_5 : $(7 - 5)/2 = 1$. Total 10.

Q9. Answer 8. Type $[\text{M}(\text{AB})_2\text{C}_2]$. Geometrical isomers: (i) the two Cl trans: then the N ends are either trans or cis to each other (2 isomers, both achiral); (ii) the two Cl cis: the remaining positions give three arrangements (N trans to N, O trans to O, or N trans to O), and each of these is chiral. So $2 + 3 = 5$ geometrical isomers and $2 + 3 \times 2 = 8$ stereoisomers.

Q10. Answer 15. $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$: d^3 , 3. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$: d^6 high spin, 4. $[\text{Co}(\text{NH}_3)_6]^{3+}$: d^6 low spin, 0. $[\text{Ni}(\text{CO})_4]$: Ni(0), $3d^{10}$ after CO pairs the 4s electrons, 0. $[\text{Cu}(\text{NH}_3)_4]^{2+}$: d^9 , 1. $[\text{MnCl}_4]^{2-}$: tetrahedral d^5 , 5. $[\text{NiCl}_4]^{2-}$: tetrahedral d^8 , 2. Total $3 + 4 + 0 + 0 + 1 + 5 + 2 = 15$.

Q11. Answer 7. O–O present: H_2SO_5 (Caro's acid, $\text{HO}-\text{O}-\text{SO}_3\text{H}$), $\text{H}_2\text{S}_2\text{O}_8$ ($\text{HO}_3\text{S}-\text{O}-\text{O}-\text{SO}_3\text{H}$), CrO_5 (two peroxo groups), BaO_2 and Na_2O_2 (peroxide O_2^{2-}), KO_2 (superoxide O_2^-) and H_3PO_5 (peroxomonophosphoric acid): 7. No O–O: $\text{K}_2\text{Cr}_2\text{O}_7$ (Cr–O–Cr bridge), $\text{H}_2\text{S}_2\text{O}_7$ (S–O–S bridge) and N_2O_5 (N–O–N bridge).

Q12. Answer 21. CrO_5 has one oxo O (-2) and two peroxo groups (2×-2): Cr is $+6$, not $+10$. Brown ring: H_2O neutral, NO^+ is $+1$, overall $+2$: Fe is $+1$. K_2MnO_4 : $2 + x - 8 = 0$, Mn $+6$. OsO_4 : $+8$. Sum $6 + 1 + 6 + 8 = 21$.

Q13. Answer 20. Each CO gives 2 electrons. Cr (6 valence electrons): $6 + 2x = 18$, $x = 6$. Fe (8): $y = 5$. Ni (10): $z = 4$. Mn^- ($7 + 1 = 8$): $w = 5$. Sum $6 + 5 + 4 + 5 = 20$.

Q14. Answer C. $\mu = \sqrt{n(n+2)}$ BM for n unpaired electrons. (P) Fe^{3+} d^5 , low spin with CN^- : t_2g^5 , $n = 1$, 1.73 (P $\rightarrow$ 3). (Q) Mn^{3+} d^4 , low spin with CN^- : t_2g^4 , $n = 2$, 2.83 (Q $\rightarrow$ 1); high spin would give 4.90. (R) Co^{3+} d^6 with F^- , high spin: $n = 4$, 4.90 (R $\rightarrow$ 4). (S) Mn^{2+} d^5 tetrahedral, always high spin: $n = 5$, 5.92 (S $\rightarrow$ 2).

Q15. Answer A. (P) Xe: 8 electrons, 2 in $\text{Xe}=\text{O}$ and 4 in $\text{Xe}-\text{F}$, one lone pair: 6 domains (sp^3d^2), square pyramidal (P $\rightarrow$ 2). (Q) I: 7 bonds, no lone pair: pentagonal bipyramidal (Q $\rightarrow$ 4). (R) Cl: 3 bonds and 2 lone pairs, both lone pairs equatorial: T-shaped (R $\rightarrow$ 1); see-saw needs 4 bonds and 1 lone pair, as in SF_4 . (S) I: $7 + 1 = 8$ electrons, 4 bonds and 2 lone pairs trans to each other: square planar (S $\rightarrow$ 3).

Q16. Answer D. (P) $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$ in the converter: copper (P $\rightarrow$ 3). (Q) $4\text{Au} + 8\text{CN}^- + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4[\text{Au}(\text{CN})_2]^- + 4\text{OH}^-$, then Zn displaces Au: gold (Q $\rightarrow$ 1). (R) Mond process: $\text{Ni} + 4\text{CO} \rightleftharpoons \text{Ni}(\text{CO})_4$ (formed near 330–350 K, decomposed at 450–470 K): nickel (R $\rightarrow$ 2). (S) van Arkel method: $\text{Zr} + 2\text{I}_2 \rightarrow \text{ZrI}_4$, decomposed on a hot filament: zirconium (S $\rightarrow$ 4). Aluminium is extracted by electrolysis (Hall–Héroult).

Q17. Answer B. (P) PbI_2 is yellow, dissolves in hot water and recrystallises as golden spangles (P $\rightarrow$ 2). (Q) Nickel dimethylglyoximate is a rosy-red precipitate (Q $\rightarrow$ 4). (R) $[\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]^{2+}$ gives a blood-red solution, not a precipitate (R $\rightarrow$ 3). (S) $\text{Cu}_2[\text{Fe}(\text{CN})_6]$ is a chocolate-brown precipitate (S $\rightarrow$ 1). Prussian blue is what Fe^{3+} gives with $\text{K}_4[\text{Fe}(\text{CN})_6]$.

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