WEIRD CHEMIST

WC

d-Block Elements

Magnetism, Complexes, Colour, Interstitials – SOLUTIONS

DPP – 06

Topic: Properties of TM **Questions:** 61 Questions **Exam:** NEET / JEE

Quick Answer Key

Q	A	Q	A	Q	A	Q	A	Q	A	Q	A
1	3	11	2	21	2	31	1	41	4	51	2*
2	3	12	3	22	3	32	3	42	2	52	1*
3	3	13	1	23	4	33	1	43	2	53	4
4	3*	14	4	24	2	34	2	44	2	54	2
5	2	15	1	25	2	35	1	45	1	55	1
6	4	16	2	26	4	36	1	46	4	56	4
7	4	17	3	27	3	37	2	47	1	57	2
8	2	18	1	28	3	38	2	48	2	58	2
9	2	19	3	29	1	39	3	49	1	59	2
10	2*	20	1	30	3	40	3	50	3	60	4*
										61	4

**Q.4 repeats Q.3 (source note wrongly says "Same as Q.49" – Q.49 is unrelated); Q.10 repeats Q.8; Q.51 repeats Q.44; Q.52 repeats Q.36; Q.60 repeats Q.56 (source note wrongly says "Same as Q.103," which doesn't exist in this 61-question paper). All flagged inline.*

▶ TYPE 1 : Magnetic Nature

[F] Master Formulae

One formula runs this entire TYPE: spin-only magnetic moment $\mu = \sqrt{n(n+2)}$ BM, where n = number of unpaired electrons. **Memorise this ladder:** n=1 $\rightarrow$ 1.73; n=2 $\rightarrow$ 2.83; n=3 $\rightarrow$ 3.87; n=4 $\rightarrow$ 4.90; n=5 $\rightarrow$ 5.92. To find n for any ion: write the neutral atom's configuration, remove ns electrons *before* $(n-1)d$ electrons for however many the charge demands, then apply Hund's rule to what's left in the d-subshell.

Q1. The value of magnetic moment in Bohr magneton for a transition metal of $3d$ series is $\sqrt{48}$. Its electronic configuration is **[NCERT Pg. 228]**

Ar $3d^5 4s^2$

Ar $3d^6 4s^2$

Ar $3d^5 4s^1$

Ar $3d^1 4s^2$

[E] Explanation

$\sqrt{48} = \sqrt{n(n+2)} \Rightarrow n = 6$ unpaired electrons needed. Check each: $3d^5 4s^2$ = 5 unpaired (d^5) + 0 (s^2, paired) = 5. $3d^6 4s^2$ = 4+0 = 4. $3d^5 4s^1$ = 5 (d^5) + 1 (s^1) = **6** ✓. $3d^1 4s^2$ = 1+0 = 1. Only Cr's exceptional ground state ($3d^5 4s^1$) gives 6.

[Ans] Answer

Option (3) [Ar]$3d^5 4s^1$.

Q2. The correct match of the order of the ions/elements for the given properties is/are **[NCERT Pg. 235, 220, 228]**

(i) $Mn^{2+} < Fe^{2+} < Co^{2+} < Ni^{2+}$ – Magnitude of hydration enthalpy

(ii) Co > Ni > Fe > Mn – Atomic radii

(iii) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$ – Number of unpaired electrons

(1) Only (iii)

(2) Both (i) and (ii)

(3) Both (i) and (iii)

(4) (i), (ii) and (iii)

[E] Explanation

(i) is correct – hydration enthalpy magnitude genuinely rises $Mn^{2+} \rightarrow Ni^{2+}$ as ionic radius shrinks and CFSE increases. (iii) is correct – unpaired count: $Ni^{2+}(d^8, 2)$ <$Co^{2+}(d^7, 3)$ <$Fe^{2+}(d^6, 4)$ <$Mn^{2+}(d^5, 5)$, a clean trend. (ii) is the flawed one: Fe, Co, Ni are established (DPP-02) to have essentially *equal* atomic radii, not a clean Co>Ni>Fe order – so this specific strict inequality isn't a well-supported fact.

[Ans] Answer

Option (3) Both (i) and (iii).

Q3. The highest magnetic moment will be shown by

(1) Zn (2) Co (3) Mn (4) Fe

[E] Explanation

Neutral-atom unpaired electrons: Zn($3d^{10} 4s^2$, 0), Co($3d^7 4s^2$, 3), Mn($3d^5 4s^2$, 5 – half-filled), Fe($3d^6 4s^2$, 4). Mn wins.

[Ans] Answer

Option (3) Mn.

Q4. The highest magnetic moment will be shown by

Flagging: your source labels this "Same as Q.49," but Q.49 (about colourless ions) is unrelated. This question is word-for-word identical to Q.3 immediately above it – that's the actual duplicate.

(1) Zn (2) Co (3) Mn (4) Fe

[Ans] Answer

Option (3) Mn – see Q.3.

Q5. Magnetic moment 2.83 BM is given by which of the following ions? (At. nos. Ti $= 22$, Cr $= 24$, Mn $= 25$, Ni $= 28$) [AIPMT-2014]

(1) Ti^{3+} (2) Ni^{2+} (3) Cr^{3+} (4) Mn^{2+}

[E] Explanation

2.83 BM $\Rightarrow n = 2$. Ti^{3+}(d^1,1.73), Ni^{2+}(d^8, 2 unpaired, **2.83** ✓), Cr^{3+}(d^3,3.87), Mn^{2+}(d^5,5.92).

[Ans] Answer

Option (2) Ni^{2+}.

Q6. Magnetic moment of Cr^{2+}, Mn^{2+} and Fe^{2+} are x, y, z. They are in order

(1) $x < y < z$ (2) $x > y > z$ (3) $z < x = y$ (4) $x = z < y$

[E] Explanation

Cr^{2+}(d^4): 4 unpaired, $x = 4.90$. Mn^{2+}(d^5): 5 unpaired, $y = 5.92$. Fe^{2+}(d^6): 4 unpaired, $z = 4.90$. So $x = z < y$.

[Ans] Answer

Option (4) $x = z < y$.

Q7. The spin only magnetic moment of Fe^{3+} ion in (BM) is approximately.

(1) 4 (2) 7 (3) 5 (4) 6

[E] Explanation

$Fe^{3+} = d^5$ (5 unpaired), $\mu = \sqrt{35} \approx 5.92$ – rounds to **6** among the given whole-number choices.

[Ans] Answer

Option (4) 6.

Q8. Which of the following pair of ions has same value of "spin-only" magnetic moment

(1) Cu^{+}, Cu^{2+} (2) Co^{3+}, Fe^{2+} (3) Ti^{2+}, V^{2+} (4) Sc^{2+}, Zn^{2+}

[E] Explanation

Co^{3+} and Fe^{2+} are both d^6 (4 unpaired each) – a genuine match. (Cu^{+}=d^{10}/0 vs Cu^{2+}=d^9/1 – different; Ti^{2+}=d^2/2 vs V^{2+}=d^3/3 – different; Sc^{2+}=d^1/1 vs Zn^{2+}=d^{10}/0 – different.)

[Ans] Answer

Option (2) Co^{3+}, Fe^{2+}.

Q9. Value of magnetic moment of a divalent metal ion is 5.92 BM. Total number of electrons in its atom would be

(1) 24 (2) 25 (3) 26 (4) 27

[E] Explanation

5.92 BM $\Rightarrow n = 5 \Rightarrow$ $M^{2+} = 3d^5$. Adding back the 2 removed $4s$ electrons, the neutral atom is $3d^5 4s^2$ = Mn, $Z = 25$ total electrons.

[Ans] Answer

Option (2) 25.

Q10. Which of the following pair of ions have same value of "spin-only" magnetic moment?

This question is identical to Q.8 above – retained as it appears twice in the original source.

(1) Cu^{+}, Cu^{2+} (2) Co^{3+}, Fe^{2+} (3) Ti^{2+}, V^{2+} (4) Sc^{2+}, Zn^{2+}

[Ans] Answer

Option (2) Co^{3+}, Fe^{2+} – see Q.8.

Q11. The magnetic moment of a divalent ion in aqueous solution if its atomic number is 25 is–

(1) 4.9 B.M (2) 5.92 BM (3) 3.8 B.M (4) 2.8 B.M

[E] Explanation

$Z = 25$ is Mn. $Mn^{2+} = 3d^5$, 5 unpaired, $\mu = 5.92$ BM.

[Ans] Answer

Option (2) 5.92 BM.

Q12. Match the column

Ions	Magnetic moment (BM)
A. Ti^{2+}	i. 3.87 BM
B. Ni^{3+}	ii. 0 BM
C. Zn^{2+}	iii. 2.83 BM
D. Sc^{2+}	iv. 1.73 BM

(1) A–i; B–ii; C–iii; D–iv

(2) A–iv; B–iii; C–ii; D–i

(3) A–iii; B–i; C–ii; D–iv

(4) A–i; B–iii; C–iv; D–ii

[E] Explanation

$Ti^{2+}(d^2)$: 2 unpaired, 2.83 $\rightarrow$ iii. $Ni^{3+}(d^7)$: 3 unpaired, 3.87 $\rightarrow$ i. $Zn^{2+}(d^{10})$: 0 unpaired, 0 $\rightarrow$ ii. $Sc^{2+}(d^1$, an unusual but computable state$)$: 1 unpaired, 1.73 $\rightarrow$ iv.

[Ans] Answer

Option (3) A–iii; B–i; C–ii; D–iv.

Q13. Which of the following transition metal ion has magnetic moment 3.87 BM?

(1) Co^{2+} (2) Co^{3+} (3) Fe^{2+} (4) Fe^{3+}

[E] Explanation

3.87 BM $\Rightarrow n = 3$. $Co^{2+} = d^7$ (3 unpaired ✓); $Co^{3+} = d^6(4)$; $Fe^{2+} = d^6(4)$; $Fe^{3+} = d^5(5)$.

[Ans] Answer

Option (1) Co^{2+}.

Q14. In which of the following compounds does the transition metal ion have 4.90 BM magnetic moment?

(1) $KMnO_4$ (2) $NiCl_2$ (3) $CoCl_2$ (4) $FeSO_4$

[E] Explanation

4.90 BM $\Rightarrow n = 4$. $KMnO_4$: $Mn^{7+} = d^0(0)$. $NiCl_2$: $Ni^{2+} = d^8(2)$. $CoCl_2$: $Co^{2+} = d^7(3)$. $FeSO_4$: $Fe^{2+} = d^6(4$ ✓$)$.

[Ans] Answer

Option (4) $FeSO_4$.

Q15. Correct order of theoretical value of magnetic moment

$MnCl_4\ ^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

$MnCl_4{}^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$
$Fe(CN)_6{}^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$
$Fe(CN)_6{}^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$

[E] Explanation

Cl^- is weak-field (high-spin); CN^- is strong-field (low-spin, especially in octahedral geometry). $[MnCl_4]^{2-}$: $Mn^{2+} = d^5$ high-spin, 5 unpaired, 5.92. $[CoCl_4]^{2-}$: $Co^{2+} = d^7$, 3 unpaired, 3.87. $[Fe(CN)_6]^{4-}$: $Fe^{2+} = d^6$, but CN^- forces **low-spin** $t_{2g}^6 e_g^0$ – **all paired**, $\mu = 0$.

[!] Common Mistake

Don't just count d-electrons and stop – the *ligand* decides whether the ion is high-spin or low-spin, and that decision changes the unpaired count completely. CN^- turning Fe^{2+}'s usual 4-unpaired count into 0 is the whole point of this question.

[Ans] Answer

Option (1) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$.

Q16. What is the value of magnetic moment of the central metal ion in K_2MnO_4?

(1) 0.0 BM (2) 1.73 BM (3) 2.83 BM (4) 3.87 BM

[E] Explanation

$2(+1) + Mn + 4(-2) = 0 \Rightarrow Mn = +6$. Mn neutral is $3d^5 4s^2$; Mn^{6+} removes 6 electrons ($4s^2$+4 from $3d^5$) $\to 3d^1$, 1 unpaired, $\mu = 1.73$.

[Ans] Answer

Option (2) 1.73 BM.

Q17. Which of the following is the correct order of magnetic moment (in BM) of Mn^{2+}, Cr^{2+} and V^{2+}

(1) $Mn^{2+} > V^{2+} > Cr^{2+}$
(2) $V^{2+} > Cr^{2+} > Mn^{2+}$
(3) $Mn^{2+} > Cr^{2+} > V^{2+}$
(4) $Cr^{2+} > V^{2+} > Mn^{2+}$

[E] Explanation

$Mn^{2+}(d^5, 5.92) > Cr^{2+}(d^4, 4.90) > V^{2+}(d^3, 3.87)$.

[Ans] Answer

Option (3) $Mn^{2+} > Cr^{2+} > V^{2+}$.

Q18. The highest magnetic moment is shown by the transition metal ion with the outermost electronic configuration:

(1) $3d^5$ (2) $3d^2$ (3) $3d^7$ (4) $3d^9$

[E] Explanation

Unpaired counts: d^5(5, half-filled maximum), d^2(2), d^7(3), d^9(1). d^5 wins outright.

[Ans] Answer

Option (1) $3d^5$.

Q19. Match the columns

Column-I (Ion)	Column-II ($M_{calculated}$)
(A) Ti^{2+}	(p) 2.84
(B) Zn^{2+}	(q) 5.92
(C) Mn^{2+}	(r) 0
(D) Sc^{3+}	(s) 4.90

(1) A – s; B – p; C – q; D – r
(2) A – r; B – p; C – q; D – s
(3) A – p; B – r; C – q; D – r
(4) A – p; B – s; C – q; D – r

[E] Explanation

$Ti^{2+}(d^2)$: 2 unpaired, ≈2.84 → p. $Zn^{2+}(d^{10})$: 0 → r. $Mn^{2+}(d^5)$: 5.92 → q. $Sc^{3+}(d^0)$: 0 → r *(same value as Zn^{2+} – perfectly fine for a matching question, one entry can repeat).*

[Ans] Answer

Option (3) A–p; B–r; C–q; D–r.

Q20. The chloro compound of vanadium has only spin magnetic moment of 1.73 BM. This vanadium chloride has the formula:– (at. no. of V $= 23$)

(1) VCl_4 (2) VCl_3 (3) VCl_2 (4) VCl_5

[E] Explanation

1.73 BM $\Rightarrow n = 1$. V neutral is $3d^34s^2$. VCl_2($V^{2+} = d^3$,3 unpaired); VCl_3($V^{3+} = d^2$,2); VCl_4($V^{4+} = d^1$,**1** ✓); VCl_5($V^{5+} = d^0$,0).

[Ans] Answer

Option (1) VCl_4.

Q21. Arrange the following ions in order of their magnetic moment:–

(i) V^{4+} (ii) Mn^{4+} (iii) Fe^{3+} (iv) Ni^{2+}

(Atomic number of V = 23, Mn = 25, Fe = 26, Ni = 28)

(1) (ii) > (iii) > (i) > (iv)

(2) (iii) > (ii) > (iv) > (i)

(3) (i) > (iv) > (iii) > (ii)

(4) (iv) > (iii) > (i) > (ii)

[E] Explanation

V^{4+} = d^1(1 unpaired,1.73). Mn^{4+}: Mn neutral $3d^5 4s^2$ → remove 4 ($4s^2$+2 from $3d^5$) → d^3(3 unpaired,3.87). Fe^{3+} = d^5(5 unpaired,5.92). Ni^{2+} = d^8(2 unpaired,2.83). Order: $Fe^{3+}(5.92)$ >$Mn^{4+}(3.87)$ >$Ni^{2+}(2.83)$ >$V^{4+}(1.73)$, i.e. (iii)>(ii)>(iv)>(i).

[Ans] Answer

Option (2) (iii) > (ii) > (iv) > (i).

Q22. A metal ion from the first transition series has a magnetic moment (calculated) of 3.87 B.M. How many unpaired electrons are expected to be present in the ion?

(1) 1 (2) 2 (3) 3 (4) 4

[Ans] Answer

Option (3) 3.

Q23. Transition metals show paramagnetism:

(1) Due to characteristic configuration

(2) High lattice energy

(3) Due to variable oxidation states

(4) Due to unpaired electrons

[E] Explanation

Paramagnetism is, at its core, simply the presence of unpaired electron spins creating a net magnetic moment – a direct physical fact, not something contingent on lattice energy or oxidation-state variability.

[Ans] Answer

Option (4) Due to unpaired electrons.

Q24. The maximum number of unpaired electrons are in

(1) Fe^{2+} (2) Fe^{3+} (3) Fe^{4+} (4) Fe

[E] Explanation

Fe($3d^6 4s^2$, 4 unpaired), Fe^{2+}($3d^6$, 4), Fe^{3+}($3d^5$, **5** – half-filled, maximum), Fe^{4+}($3d^4$, 4).

[Ans] Answer

Option (2) Fe^{3+}.

Q25. Which of the following has the maximum number of unpaired d electrons?

(1) Zn (2) Fe^{2+} (3) Ni^{3+} (4) Cu^{+}

[E] Explanation

Zn($3d^{10}$,0), Fe^{2+}($3d^6$,**4**), Ni^{3+}($3d^7$,3), Cu^+($3d^{10}$,0). Fe^{2+} wins.

[Ans] Answer

Option (2) Fe^{2+}.

▶ TYPE 2 : Complex Formation

[F] Master Formulae

NCERT gives exactly three reasons transition metals form so many complexes: **(1)** comparatively **small size** of the metal ions, **(2)** their **high ionic charges**, and **(3)** the **availability of d-orbitals** to accept lone pairs from ligands. Every question in this TYPE is testing recall of one of these three, or spotting a distractor that quietly flips one of them (e.g. "large size" instead of small, "f-orbitals" instead of d).

Q26. The transition metals form a large number of complex compounds due to [NCERT Pg. 229]

(1) Their lower ionic charges

(2) Availability of f-orbitals for bond formation

(3) Their inability to adopt multiple oxidation states

(4) Smaller size of metal ions

[E] Explanation

(1) is backwards (should be *high*, not lower, ionic charges). (2) is wrong for d-block specifically – it's d-orbitals, not f-orbitals, that are available here. (3) is backwards (TM's *ability*, not inability, to show multiple oxidation states). Only (4) directly matches one of NCERT's three genuine reasons.

[Ans] Answer

Option (4) Smaller size of metal ions.

Q27. The tendency to form complexes is maximum for

(1) Inner-transition elements

(2) Representative elements

(3) Transition elements

(4) Metals containing fully filled d-orbitals

[E] Explanation

d-block orbitals are geometrically and energetically well suited for ligand bonding – far more so than main-group (representative) elements, and more effectively than the more diffuse, shielded f-orbitals of inner-transition elements. Metals with *fully filled* d-orbitals (like Zn, d^{10}) lose the CFSE-driven versatility that makes complexation so favourable.

[Ans] Answer

Option (3) Transition elements.

Q28. How many statements are true for transition metals.

(a) They form complex compounds
(b) They show variable oxidation state
(c) Their ions are colourless
(d) Their ions contain partially filled d-orbitals

(1) 1 (2) 2 (3) 3 (4) 4

[E] Explanation

(a), (b), (d) are all textbook-defining TM properties. (c) is false as a general statement – TM ions are characteristically **coloured** (via d-d transitions), not colourless; colourless ions (Sc^{3+}, Ti^{4+}, Zn^{2+}) are the exceptions, not the rule. So 3 of the 4 statements are true.

[Ans] Answer

Option (3) 3.

Q29. Statement-A: Transition metals are highly reactive.
Statement-B: Transition metals show variable oxidation state.
Statement-C: Transition metals have low m.p.
Statement-D: Transition metals are highly electropositive.
Which of the following statements are incorrect?

(1) A, C, D
(2) A, B
(3) B, C, D
(4) A, B, C

[E] Explanation

A is false – many TM are famously *unreactive*/noble (Au, Pt, Ag); "highly reactive" describes s-block metals, not TM as a class. B is true (established throughout this DPP series). C is false – TM are known for **high**, not low, melting points (DPP-02). D is false, or at least overstated – s-block metals are the ones properly called "highly" electropositive; d-block sits in the transitional middle ground (DPP-01), not the "highly" electropositive extreme.

[Ans] Answer

Option (1) A, C, D.

Q30. Which of the following sentences is not suitable for the capacity of transition metals to form complex compounds?

(1) Transition metal ions are small in size.
(2) Nuclear charge of transition metal ion is comparatively more.
(3) Co-ordination covalent bond is not directional.
(4) Transition metal ions possess different oxidation states.

[E] Explanation

(1), (2), (4) all genuinely support complex formation. (3) is simply wrong chemistry – coordinate covalent bonds, like other covalent bonds, **are** directional; that directionality is exactly why complexes adopt specific geometries (octahedral, tetrahedral, square planar). This is the "not suitable"/incorrect statement.

[Ans] Answer

Option (3) Co-ordination covalent bond is not directional.

Q31. Transition elements make complex compounds due to–

(1) Presence of empty d-orbital
(2) Large size
(3) Variable valency
(4) Presence of $2e^-$

[E] Explanation

Directly matches NCERT's third reason: vacant d-orbitals let the metal act as a Lewis acid, accepting lone pairs donated by ligands. ("Large size," option 2, is simply backwards – TM ions are notably *small*.)

[Ans] Answer

Option (1) Presence of empty d-orbital.

▶ TYPE 3 : Colour

[F] Master Formulae

The rule that answers almost every question here: an ion is **colourless** if it's d^0 (no d-electrons at all, e.g. Sc^{3+}, Ti^{4+}) or d^{10} (fully paired, e.g. Zn^{2+}, Cu^+) – there's no partially-filled d-subshell to support a d-d electronic transition. Anything from d^1 to d^9 is expected to be **coloured**. **The one exception to memorise:** MnO_4^- and $Cr_2O_7^{2-}$ are both d^0 yet intensely coloured – their colour comes from **charge transfer** (ligand-to-metal electron jump), a completely different mechanism from d-d transitions, and it doesn't require the metal to have any d-electrons of its own.

Q32. Which of the following ions can show d-d transition?

(1) CrO_4^{2-} (2) $Cr_2O_7^{2-}$ (3) MnO_4^{2-} (4) MnO_4^-

[E] Explanation

CrO_4^{2-} and $Cr_2O_7^{2-}$: Cr is $+6$, i.e. d^0 – no d-electrons, can't do d-d transition (their colour is charge-transfer). MnO_4^-: Mn is $+7$, also d^0 – same story, charge-transfer colour. MnO_4^{2-} (manganate): Mn is $+6$, i.e. d^1 – it actually **has** a d-electron, so it's the only one of the four that can genuinely undergo a d-d transition.

[!] Common Mistake

It's tempting to assume permanganate's famous purple colour comes from a d-d transition – but Mn^{7+} is d^0, so that colour is entirely charge-transfer. This question specifically rewards knowing that distinction.

[Ans] Answer

Option (3) MnO_4^{2-}.

Q33. Which of the following pairs of ions are coloured in aqueous solution?

(1) Ni^{2+} & Ti^{3+} (2) Sc^{3+} & Ti^{3+} (3) Ni^{2+} & Sc^{3+} (4) Sc^{3+} & Cu^+

[E] Explanation

$Ni^{2+}(d^8)$ and $Ti^{3+}(d^1)$ are both coloured. Every other option pairs a coloured ion with a d^0/d^{10} colourless one (Sc^{3+} or Cu^+).

[Ans] Answer

Option (1) Ni^{2+} & Ti^{3+}.

Q34. Which of the following ions will exhibit colour in aqueous solutions? [AIPMT (Prelims)-2010]

(1) La^{3+} $(Z = 57)$ (2) Ti^{3+} $(Z = 22)$ (3) Lu^{3+} $(Z = 71)$ (4) Sc^{3+} $(Z = 21)$

[E] Explanation

$La^{3+} = [Xe]$ (d^0), $Lu^{3+} = [Xe]4f^{14}$ (full f-subshell, no unpaired f or d electrons), $Sc^{3+} = [Ar]$ (d^0) – all colourless. $Ti^{3+} = [Ar]3d^1$ is the only one with an unpaired d-electron.

[Ans] Answer

Option (2) Ti^{3+}.

Q35. In which of the following pairs are both the ions coloured in aqueous solution? (At. no.: Sc $= 21$, Ti $= 22$, Ni $= 28$, Cu $= 29$, Co $= 27$) [AIPMT (Prelims)-2006]

(1) Ni^{2+}, Ti^{3+} (2) Sc^{3+}, Ti^{3+} (3) Sc^{3+}, Co^{2+} (4) Ni^{2+}, Cu^{+}

[E] Explanation

Same logic as Q.33: $Ni^{2+}(d^8)$ and $Ti^{3+}(d^1)$ are both coloured; the other three options each include a d^0 (Sc^{3+}) or d^{10} (Cu^{+}) colourless ion.

[Ans] Answer

Option (1) Ni^{2+}, Ti^{3+}.

Q36. The aqueous solution containing which one of the following ions will be colourless? (Atomic no. Sc $= 21$, Fe $= 26$, Ti $= 22$, Mn $= 25$) [AIPMT (Prelims)-2005]

(1) Sc^{3+} (2) Fe^{2+} (3) Ti^{3+} (4) Mn^{2+}

[E] Explanation

$Sc^{3+} = d^0$, the only colourless one here. ($Fe^{2+} = d^6$, $Ti^{3+} = d^1$, $Mn^{2+} = d^5$ are all coloured, though Mn^{2+}'s is famously very pale due to spin-forbidden transitions.)

[Ans] Answer

Option (1) Sc^{3+}.

Q37. Which ion is colourless?

(1) Cr^{4+} (2) Sc^{3+} (3) Ti^{3+} (4) V^{3+}

[Ans] Answer

Option (2) Sc^{3+} (the only d^0 ion here).

Q38. Which of the following is expected to be coloured in solutions?

(1) Cu^{+} (2) Cu^{2+} (3) Ti^{4+} (4) Sc^{3+}

[Ans] Answer

Option (2) Cu^{2+} (d^9 – the only one that isn't d^0/d^{10}).

Q39. Among the following, the coloured compound is

(1) CuCl (2) $K_3[Cu(CN)_4]$ (3) $CuF_2 \cdot xH_2$Cu$(CH_3CN)_4$ BF_4

[E] Explanation

Work out Cu's oxidation state in each: CuCl (Cl^- balances, Cu$= +1$, d^{10}). $K_3[Cu(CN)_4]$ ($3K^+$ balances -3 complex charge; $4CN^- = -4$; Cu$= +1$, d^{10}). $[Cu(CH_3CN)_4]BF_4$ (neutral acetonitrile ligands, $BF_4^- = -1$; Cu$= +1$, d^{10}) – all three are colourless Cu(I). $CuF_2 \cdot xH_2O$: F^- balances Cu$= +2$, d^9 – the one genuinely coloured (blue) compound.

[Ans] Answer

Option (3) $CuF_2 \cdot xH_2O$.

Q40. Which of the following is not coloured?

(1) Mn^{2+} (2) Cr^{3+} (3) Zn^{2+} (4) Cu^{2+}

[Ans] Answer

Option (3) Zn^{2+} (d^{10}).

Q41. In which of the following metal ions does the frequency of light absorbed lie in the visible region?

(1) Sc^{3+} (2) Cu^{+} (3) Cd^{2+} (4) Cr^{3+}

[E] Explanation

"Absorbs in the visible region" = coloured. $Sc^{3+}(d^0)$, $Cu^+(d^{10})$, $Cd^{2+}(d^{10}$, Zn-family$)$ are all colourless. $Cr^{3+}(d^3)$ is the coloured one.

[Ans] Answer

Option (4) Cr^{3+}.

Q42. Which of the following metal ions is colourless?

(1) Ti^{4+}, Cu^{2+}
(2) Ti^{4+}, Cu^{+1}
(3) Cr^{2+}, Cu^{+}
(4) Ti^{4+}, Mn^{3+}

[E] Explanation

Need *both* ions colourless. $Ti^{4+}(d^0)$ and $Cu^+(d^{10})$ both qualify. Every other option pairs a colourless ion with a coloured one (Cu^{2+} is d^9; Cr^{2+} is d^4; Mn^{3+} is d^4).

[Ans] Answer

Option (2) Ti^{4+}, Cu^{+1}.

Q43. Match column-A and B

Column-A	Column-B
1. V^{4+}	a. Colourless
2. Ti^{3+}	b. Pink
3. Ti^{4+}	c. Purple
4. Mn^{2+}	d. Blue
	e. Violet

(1) 1–d; 2–c; 3–a; 4–e

(2) 1–d; 2–c; 3–a; 4–b

(3) 1–d; 2–c; 3–e; 4–b

(4) 1–e; 2–c; 3–b; 4–a

[E] Explanation

V^{4+} (as the vanadyl ion) is the classic **blue** species $\rightarrow$ d. Ti^{3+} complexes (e.g. $[Ti(H_2O)_6]^{3+}$) are the textbook **purple** example $\rightarrow$ c. Ti^{4+} is d^0, **colourless** $\rightarrow$ a. Mn^{2+} is the famous very pale **pink** ion $\rightarrow$ b.

[Ans] Answer

Option (2) 1–d; 2–c; 3–a; 4–b.

Q44. Which group of ions has coloured ions?

1. Cu^+ 2. Ti^{4+} 3. Co^{2+} 4. Fe^{2+}

(1) 1, 2, 3, 4 (2) 3, 4 (3) 2, 3 (4) 1, 2

[E] Explanation

$Cu^+(d^{10})$ and $Ti^{4+}(d^0)$ are colourless; $Co^{2+}(d^7)$ and $Fe^{2+}(d^6)$ are coloured.

[Ans] Answer

Option (2) 3, 4.

Q45. Mention the colourless pair from $[TiF_6]^{2-}$, $[CoF_6]^{3-}$, Cu_2Cl_2 and $[NiCl_4]^{2-}$

Formulas standardised from the scanned copy: "Ca_2Cl_2" read as Cu_2Cl_2 (matches the species named in the question stem), and the garbled "$[TiFe]^{2-}$"/"$[COF_6]^{3-}$" in option (3) read as $[TiF_6]^{2-}$/$[CoF_6]^{3-}$.

TiF_6 $^{2-}$ and Cu_2Cl_2

TiF_6 $^{2-}$ and $[CoF_6]^{3-}$

CoF_6 $^{3-}$ and $[NiCl_4]^{2-}$

(1) Cu_2Cl_2 and $[NiCl_4]^{2-}$

[E] Explanation

$[TiF_6]^{2-}$: Ti$= +4$, d^0 – colourless. Cu_2Cl_2 (i.e. $2\times$CuCl): Cu$= +1$, d^{10} – colourless. $[CoF_6]^{3-}$: Co$= +3$, d^6 – has d-electrons, coloured. $[NiCl_4]^{2-}$: Ni$= +2$, d^8 – coloured (well-known blue complex). So the genuinely colourless pair is $[TiF_6]^{2-}$ and Cu_2Cl_2.

[Ans] Answer

Option (1) $[TiF_6]^{2-}$ and Cu_2Cl_2.

Q46. Which of the following compounds is coloured?

(1) $TiCl_3$ (2) $FeCl_3$ (3) $CoCl_3$ (4) All above

[E] Explanation

$TiCl_3(Ti^{3+}, d^1)$, $FeCl_3(Fe^{3+}, d^5)$, $CoCl_3(Co^{3+}, d^6)$ – none is d^0 or d^{10}, so all three are expected to be (and are) coloured.

[Ans] Answer

Option (4) All above.

Q47. Which of the following ions cannot show d-d transition?

(1) Ti^{4+} (2) Cr^{3+} (3) Mn^{2+} (4) Cu^{2+}

[Ans] Answer

Option (1) Ti^{4+} (d^0 – no d-electrons at all to transition between).

Q48. Which of the following compounds is expected to be coloured?

(1) Ag_2SO_4 (2) CuF_2 (3) MgF_2 (4) CuCl

[E] Explanation

$Ag_2SO_4(Ag^+, d^{10})$, MgF_2(s-block, no d-electrons at all), $CuCl(Cu^+, d^{10})$ are all colourless. $CuF_2(Cu^{2+}, d^9)$ is coloured.

[Ans] Answer

Option (2) CuF_2.

Q49. The ions from among the following which are colourless are.

(a) Ti^{4+} (b) Cu^{+1} (c) Co^{+3} (d) Fe^{2+}

(1) a and b only (2) a, b and c (3) c and d only (4) b and c only

[E] Explanation

$Ti^{4+}(d^0)$ and $Cu^+(d^{10})$ are colourless. $Co^{3+}(d^6)$ and $Fe^{2+}(d^6)$ both have d-electrons and are coloured.

[Ans] Answer

Option (1) a and b only.

Q50. Which pair of ions is colourless:–

(1) Mn^{+3}, Co^{+3} (2) Fe^{3+}, Cr^{3+} (3) Zn^{+2}, Sc^{+3} (4) Ti^{+2}, Cu^{+2}

[E] Explanation

$Zn^{2+}(d^{10})$ and $Sc^{3+}(d^0)$ are both genuinely colourless. Every other pair has two coloured ions (Mn^{3+}/Co^{3+} are both d^4/d^6; Fe^{3+}/Cr^{3+} are d^5/d^3; Ti^{2+}/Cu^{2+} are d^2/d^9).

[Ans] Answer

Option (3) Zn^{+2}, Sc^{+3}.

Q51. Which group contains coloured ions out of:

1. Cu^+ 2. Ti^{4+} 3. Co^{2+} 4. Fe^{2+}

(1) 1, 2, 3, 4 (2) 3, 4 (3) 2, 3 (4) 1, 2

This question is identical to Q.44 above – retained as it appears twice in the original source.

[Ans] Answer

Option (2) 3, 4 – see Q.44.

Q52. The following ion in its aqueous solution is colourless:

(1) Sc^{+3} (2) Fe^{2+} (3) Ti^{3+} (4) Mn^{2+}

This question is essentially identical to Q.36 above (same four ions, same underlying fact), just reworded.

[Ans] Answer

Option (1) Sc^{+3} – see Q.36.

Q53. Which of the ions will give a colourless aqueous solution?

(1) Ni^{2+} (2) Fe^{2+} (3) Cu^{2+} (4) Cu^+

[E] Explanation

$Ni^{2+}(d^8)$, $Fe^{2+}(d^6)$, $Cu^{2+}(d^9)$ are all coloured. $Cu^+(d^{10})$ is the colourless one.

[Ans] Answer

Option (4) Cu^+.

Q54. Which of the following metal ions is expected to be coloured:–

(1) Zn^{+2} (2) Ti^{+3} (3) Sc^{+3} (4) Ti^{+4}

[E] Explanation

$Zn^{2+}(d^{10})$, $Sc^{3+}(d^0)$, $Ti^{4+}(d^0)$ are colourless. $Ti^{3+}(d^1)$ is coloured.

[Ans] Answer

Option (2) Ti^{+3}.

▶ TYPE 4 : Interstitial Compounds

[F] Master Formulae

Interstitial compounds form when small atoms (H, C, B, N) squeeze into the gaps (interstices) of a metal's crystal lattice, *without* displacing the metal atoms themselves. This makes them: **hard**, **high melting**, and still **metallically conductive** – but critically, chemically **inert/unreactive** (the small guest atoms are locked in place, not available for reaction). The classic example is steel (Fe + interstitial C).

Q55. Which of the following statements about the interstitial compounds is incorrect? [NEET-2013]

(1) They are chemically reactive
(2) They are much harder than the pure metal
(3) They have higher melting points than the pure metal
(4) They retain metallic conductivity

[E] Explanation

Interstitial compounds are chemically **inert**, not reactive – (1) is the false statement. (2), (3), (4) are all genuine, defining characteristics.

[Ans] Answer

Option (1) They are chemically reactive – this is incorrect.

Q56. Which of the following forms interstitial compounds?

(1) Fe (2) Co (3) Ni (4) All of these

[E] Explanation

Fe, Co, and Ni (and most transition metals generally) all form interstitial hydrides, carbides, nitrides, or borides.

[Ans] Answer

Option (4) All of these.

Q57. Which among the following pairs is of interstitial compounds?

(1) SiH_4, LiH
(2) Fe_3H, Mn_4N
(3) Al_4C_3, SiC
(4) $TiCl_4$, MnO_2

[E] Explanation

Fe_3H and Mn_4N are genuine interstitial compounds – small H and N atoms sitting in the interstices of the Fe/Mn metal lattice, retaining metallic character. SiH_4/LiH are a molecular covalent hydride and an ionic salt-like hydride respectively (not interstitial); Al_4C_3/SiC are covalent/ionic carbides, not metal-lattice interstitials; $TiCl_4$/MnO_2 are ordinary compounds, not interstitial at all.

[Ans] Answer

Option (2) Fe_3H, Mn_4N.

Q58. Which of the following statements regarding interstitial compounds is incorrect?

(1) They are chemically inert

(2) They are soft and nonconductive

(3) They retain metallic conductivity

(4) They have high melting point.

[E] Explanation

Interstitial compounds are actually **hard** and **conductive** (matching option 3, which is true and directly contradicts option 2's claim) – "soft and nonconductive" is backwards on both counts.

[Ans] Answer

Option (2) They are soft and nonconductive – this is incorrect.

Q59. Statement-A: Interstitial compounds make the metal more soft.
Statement-B: They make the metal more ductile.
Statement-C: They make the metal more metallic.
Statement-D: They make the metal more hard.
Which of the following statements are wrong?

(1) A, B

(2) A, B, C

(3) B, C, D

(4) A, C

[E] Explanation

Interstitial atoms wedged into the lattice actually make the metal **harder** and **less** ductile (this is precisely why steel is harder and less ductile than pure iron) – so A ("more soft") and B ("more ductile") are both wrong. D ("more hard") is correct, matching reality. C ("more metallic") overstates it – the established fact is that they *retain* metallic conductivity, not that they become *more* metallic than the pure metal; there's no basis for that stronger claim, so C is also wrong.

[Ans] Answer

Option (2) A, B, C.

Q60. Which forms interstitial compounds?

Flagging: your source labels this "Same as Q.103," but this paper only has 61 questions – no Q.103 exists here (likely a leftover reference from a larger master file this DPP was trimmed from). This question is actually identical to Q.56 above.

(1) Fe (2) Co (3) Ni (4) All

[Ans] Answer

Option (4) All – see Q.56.

Q61. Interstitial compounds are formed when small atoms are trapped inside the crystal lattice of metals. Which of the following is not a characteristic property of interstitial compounds?

(1) They have high melting points in comparison to pure metals.
(2) They are very hard
(3) They retain metallic conductivity
(4) They are chemically very reactive

[E] Explanation

Same fact as Q.55/Q.58 in a final wrap-up form – chemical reactivity is the one property that does *not* belong; interstitial compounds are chemically inert.

[Ans] Answer

Option (4) They are chemically very reactive – this is not a characteristic property.

Magnetism, colour, and complex formation are really one story –
how many d-electrons are unpaired, and whether there's a d-orbital gap left for a ligand to fill.

– Your Weird Chemist