WEIRD CHEMIST

d-Block Elements

Melting Point and Atomic Size – SOLUTIONS

DPP – 02

Topic: Melting point and Atomic size | **Questions:** 32 Questions | **Exam:** NEET / JEE

Quick Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	4	9	4	17	4	25	1
2	1	10	3	18	4*	26	2
3	2	11	2	19	2	27	2
4	4	12	1	20	2	28	1
5	4	13	3	21	2	29	1*
6	1	14	1	22	4	30	3
7	1	15	1	23	2	31	3
8	1*	16	4	24	3	32	3

**Q.8 repeats Q.2, Q.18 repeats Q.13, Q.29 repeats Q.26 – same stem/options in your source file, solved once and cross-referenced.*

▶ TYPE 1 : Melting Point & Enthalpy of Atomisation

[F] Master Formulae

The one idea that answers almost every question in this section:

- Metallic bonding in the d-block isn't just from ns electrons – unpaired $(n-1)d$ electrons join in too, adding covalent-type M–M bonds on top. **More unpaired d-electrons = stronger bonding = higher melting point / enthalpy of atomisation.**
- This is why the melting-point curve across a series rises to a peak near the middle (max unpaired d-electrons, e.g. Cr, Mo, W) and crashes at the end: **Zn/Cd/Hg are d^{10} – fully paired, so those d-electrons sit out of bonding entirely**, leaving only weak ns-electron metallic bonding.
- Down a group (3d $\rightarrow$ 4d $\rightarrow$ 5d), atomisation enthalpy generally **increases** – bigger, more diffuse d-orbitals overlap better, so M–M bonding gets stronger, not weaker.

Q1. From Sc (Z = 21) to Zn (Z = 30) in 3d series, the lowest value of enthalpy of atomisation is for

[NCERT Pg. 218]

(1) Cu (2) V (3) Ni (4) Zn

[E] Explanation

Zn ($3d^{10}4s^2$) has a fully-paired d-subshell – no unpaired d-electrons are available to reinforce the metallic bond. Only its two $4s$ electrons hold the lattice together, giving Zn by far the weakest metallic bonding, and hence the lowest enthalpy of atomisation, in the entire 3d series (roughly a third of its neighbours' values).

[Ans] Answer

Option (4) Zn.

Q2. The melting point of Zn is lower as compared to those of the other elements of 3d series elements because

(1) The d-orbitals are completely filled
(2) The d-orbitals are partially filled
(3) Zn is a transition element
(4) All of these

[E] Explanation

Root cause: Zn's d-subshell is completely filled (d^{10}), so those electrons are core-like and don't contribute extra bonding – weak metallic bond, low melting point follows as a consequence. (Also note: Zn is *not* actually a transition element by definition, Q3 style from DPP-01 – so option 3 is doubly wrong.)

[Ans] Answer

Option (1) The d-orbitals are completely filled.

Q3. In general melting point of transition elements in a series can be explained by following relation

(1) Melting point $\propto$ atomic weight
(2) Melting point $\propto$ no. of unpaired valence electrons
(3) Melting point $\propto$ Internuclear distance
(4) Melting point $\propto \dfrac{1}{\text{atomic weight}}$

[E] Explanation

This is the Master Formula above, restated as a direct proportionality: melting point tracks the number of unpaired valence (mostly d) electrons available for M–M bonding – peaking mid-series (Cr, Mo, W) and collapsing at d^{10} (Zn, Cd, Hg).

[Ans] Answer

Option (2)

Q4. In the series Sc to Zn the enthalpy of atomisation of 'Zn' is the lowest because

(1) Zn exists in molecular state
(2) In the crystal of Zn interatomic distance is small

(3) IP of Zn is minimum in the series

(4) No 3d orbital involved in metallic bonding.

[E] Explanation

Same fact as Q1/Q2, phrased as a direct mechanism: Zn's $3d^{10}$ electrons are too stable/core-like to participate in delocalised metallic bonding at all – only $4s$ electrons are involved, so the metallic bond is unusually weak.

[Ans] Answer

Option (4) No 3d orbital involved in metallic bonding.

Q5. Assertion: In first transition series Zn has highest melting point.
Reason: In Zn there are 5 unpaired electrons.

(1) Both Assertion and Reason are true, Reason gives correct explanation

(2) Both Assertion and Reason are true, Reason doesn't give correct explanation

(3) Assertion is correct but Reason is false

(4) Both Assertion and Reason are false

[E] Explanation

Both halves are wrong. Zn actually has the **lowest** melting point in the 3d series (Q1), not the highest. And Zn ($3d^{10}4s^2$) has **zero** unpaired electrons – both d and s subshells are fully paired – not 5. (5 unpaired electrons is Mn's signature, not Zn's.)

[!] Common Mistake

Easy to skim "Zn ... unpaired electrons" and default to the famous "5 unpaired" fact – but that fact belongs to Mn ($3d^5$, half-filled), a completely different element. Always re-derive per element, don't pattern-match to a memorised number.

[Ans] Answer

Option (4) Both Assertion and Reason are false.

Q6. The melting point of Zn is lower as compared to those of the other elements of 3d series because

(1) the d-orbitals are completely filled

(2) the d-orbitals are partially filled

(3) d-electrons do not participate in metallic bonding

(4) very weak metallic bond

[E] Explanation

Same question as Q2/Q4, now with the causal chain broken into finer options. The **root** cause is that the d-orbitals are completely filled (d^{10}) – everything else (d-electrons not bonding, weak metallic bond, low MP) *follows from* that one fact. When a root cause is available among the

choices, that's the one to pick over its own downstream consequences.

[A] Approach

Socho ek zanjeer (chain) ki tarah: d-orbitals full → d-electrons bonding mein part nahi lete → bond weak ho jaata hai → melting point kam. Jab MCQ mein poori chain ke options diye ho, hamesha *sabse pehli link* (root cause) choose karo.

[Ans] Answer

Option (1) The d-orbitals are completely filled.

Q7. Assertion: The metal of 4d and 5d series have greater enthalpies of atomisation than the corresponding elements of the series.
Reason: More frequent metal-metal bonding in compound of the heavy transition metals.

(1) If both Assertion & Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are False.

[E] Explanation

True and true, and genuinely linked: 4d/5d orbitals are larger and more diffuse than 3d, so they overlap far more effectively – this shows up as a stronger, more frequent tendency toward metal–metal bonding (visible even inside their compounds, e.g. metal clusters), and that same strong M–M bonding is exactly what drives up their enthalpies of atomisation as pure metals.

[Ans] Answer

Option (1)

Q8. The melting point of Zn is lower as compared to those of the other element of 3d series because

(1) The d-orbitals are completely filled

(2) The d-orbitals are partially filled

(3) Zn is a transition element

(4) All of these

[E] Explanation

This is an exact repeat of Q.2 – identical stem (one-word plural variation only) and identical four options. Flagging it rather than silently re-deriving as if new. Working and answer are unchanged from Q.2.

[Ans] Answer

Option (1) The d-orbitals are completely filled – see full working at Q.2.

Q9. The elements with maximum and minimum melting points in the second transition series respectively are

(1) Cr and Zn
(2) Ti and Cu
(3) Ru and Hg
(4) Mo and Cd

[E] Explanation

"Second transition series" = the **4d series** (Y, Z=39 to Cd, Z=48) – so Cr and Zn (both 3d) and Hg (not even 4d, it's 5d/Period 6) are automatically out of scope, regardless of their melting points. Within the actual 4d series: **Mo** sits mid-series with the most unpaired d-electrons available for bonding → highest m.p. (∼2623°C); **Cd** sits at the $4d^{10}5s^2$ end, same weak-bonding story as Zn → lowest m.p. (∼321°C).

[!] Common Mistake

Options (1) and (3) both smuggle in an element from the wrong series (Zn or Hg is 3d/5d respectively, not 4d) – always check which *row* an element actually belongs to before comparing it within a "series" question.

[Ans] Answer

Option (4) Mo and Cd.

Q10. Which metal has the highest melting point?

(1) Platinum (2) Gold (3) Tungsten (4) Iridium

[E] Explanation

Tungsten (W) has the highest melting point of *any* metal on the periodic table (∼3422°C) – it's a mid-5d-series element with a huge number of unpaired d-electrons available for bonding, and this exact property is why W is used as light-bulb filament wire.

[Ans] Answer

Option (3) Tungsten.

Q11. Volatile metals are

(1) Cu, Ag, Au
(2) Zn, Cd, Hg
(3) C, Pb
(4) Fe, Co, Ni

[E] Explanation

Zn, Cd, Hg – the d^{10} family with the weakest metallic bonding in the d-block (Q1–Q8 logic) – have unusually low boiling points for metals, making them "volatile" (Hg is even liquid at room temperature). This is the same root cause as their low melting points, just showing up at the boiling-point end too.

[Ans] Answer

Option (2) Zn, Cd, Hg.

Q12. Assertion: Transition metal have high melting point.
Reason: Transition metal are attributed to the involvement of greater number of electrons from $(n-1)d$ in addition to the ns electron in the interatomic metallic bonding.

(1) If both Assertion & Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are False.

[E] Explanation

Both true, and directly linked: unlike s-block metals (only ns electrons bond), transition metals bring $(n-1)d$ electrons into the bonding too – exactly the mechanism behind this entire TYPE section. More bonding electrons involved → stronger lattice → higher melting point.

[Ans] Answer

Option (1)

▶ TYPE 2 : Atomic & Ionic Size

[F] Master Formulae

The rules that solve this section:

- **Across a period (3d row):** size generally shrinks left to right – rising nuclear charge, poorly shielded by other d-electrons in the same subshell.
- **Down a group, normally:** size should increase (new principal shell) – but going 4d → 5d, the intervening **lanthanide contraction** (poor shielding by the filled 4f subshell) adds enough extra effective nuclear charge to almost exactly cancel that increase. Result: **4d and 5d congeners are near-twins in size** – Zr≈Hf, Nb≈Ta, Mo≈W. This single fact solves most of this section.
- **For ions of the same element:** higher oxidation state → smaller radius (more positive charge pulls the remaining electron cloud in tighter); low-spin also shrinks a d-ion further than high-spin.

Q13. Which of the following pairs has the same size?

[AIPMT (Prelims)-2010]

(1) Fe^{2+}, Ni^{2+}

(2) Zr^{4+}, Ti^{4+}

(3) Zr^{4+}, Hf^{4+}

(4) Zn^{2+}, Hf^{4+}

[E] Explanation

Zr^{4+} and Hf^{4+} are the textbook lanthanide-contraction pair – Hf sits directly below Zr, but the filled $4f^{14}$ shell in between compresses Hf just enough to match Zr's size almost exactly (both ∼72 pm). Ti^{4+} (first-row 3d) is noticeably smaller than either.

[Ans] Answer

Option (3) Zr^{4+}, Hf^{4+}.

Q14. Which of the following atomic radii is incorrect.

(A) Fe < Co < Ni

(B) Sc > Ti > V > Cr > Mn

(C) Fe = Co = Ni

(D) Ti > Zr > Hf

(E) Ti < Zr = Hf

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

[E] Explanation

Check each statement against the two rules above:

- (A) Fe<Co<Ni – **wrong**. Near the end of the 3d series these three are essentially the same size (roughly 126, 125, 124 pm) – not a clean increasing trend.
- (C) Fe=Co=Ni – **correct**, matches the real near-equality just described.
- (B) Sc>Ti>V>Cr>Mn – **correct**, standard decreasing-across-period trend for the early 3d elements.
- (D) Ti>Zr>Hf – **wrong**. Going down Group 4, size should *increase* Ti→Zr (new shell), then lanthanide contraction holds Zr≈Hf – so this statement has the direction backwards *and* the Zr/Hf relationship wrong.
- (E) Ti<Zr=Hf – **correct**, exactly the lanthanide-contraction pattern from the Master Formulae box.

So the genuinely **incorrect** statements are only (A) and (D).

[!] Common Mistake

This question is a trap for anyone who assumes atomic radius always increases smoothly down a group – Group 4 (Ti/Zr/Hf) is the single most-tested counter-example to that assumption in this whole chapter.

[Ans] Answer

Option (1) A, D.

Q15. Match the column

Metal	Similar size metal
A. Zr	i. Co
B. Fe	ii. Hf
C. Nb	iii. W
D. Mo	iv. Ta

(1) A–ii; B–i; C–iv; D–iii
(2) A–ii; B–i; C–iii; D–iv
(3) A–i; B–ii; C–iv; D–iii
(4) A–i; B–ii; C–iii; D–iv

[E] Explanation

Four lanthanide-contraction "twin" pairs, all Group-matched (4d element ↔ its 5d congener), plus one 3d-neighbour pair:

- Zr (Group 4, 4d) ↔ Hf (Group 4, 5d): **ii**
- Nb (Group 5, 4d) ↔ Ta (Group 5, 5d): **iv**
- Mo (Group 6, 4d) ↔ W (Group 6, 5d): **iii**
- Fe ↔ Co (adjacent 3d neighbours, near-equal size per Q14): **i**

So: A–ii, B–i, C–iv, D–iii.

[A] Approach

Group 4, 5, 6 teeno mein hi yehi pattern chalta hai – 4d wala apne seedhe niche wale 5d congener jaisa size rakhta hai (lanthanide contraction ki wajah se). Ek baar yeh pattern samajh jao, poora match-the-column table 30 second mein solve ho jaata hai.

[Ans] Answer

Option (1) A–ii; B–i; C–iv; D–iii.

Q16. In which of the following the ionic radius of Fe is minimum?

(1) $Fe(CO)_5$
(2) $K_4[Fe(CN)_6]$
(3) Mohr Salt
(4) $K_3[Fe(CN)_6]$

[E] Explanation

Work out Fe's oxidation state in each (CO is neutral; CN^- and SO_4^{2-} are anionic):

- $Fe(CO)_5$: neutral ligands → Fe is in the **0** oxidation state.
- $K_4[Fe(CN)_6]$: $4(+1) + Fe + 6(-1) = 0 \Rightarrow Fe = +2$ (low-spin, ferrocyanide).
- Mohr salt ($FeSO_4 \cdot (NH_4)_2SO_4 \cdot {}_6H_2O$): classic ferrous salt → Fe $= +2$ (high-spin).
- $K_3[Fe(CN)_6]$: $3(+1) + Fe + 6(-1) = 0 \Rightarrow Fe = +3$ (low-spin, ferricyanide).

Higher oxidation state shrinks the ion, and CN^- (strong field) gives a more compact low-spin arrangement on top of that. $K_3[Fe(CN)_6]$ stacks *both* effects – highest charge (+3) **and** low-spin – making it the smallest Fe species here.

[!] Common Mistake

Don't stop at "highest oxidation state = smallest" alone – spin state matters too. Between two ions of the *same* charge, the low-spin one is always smaller (compact t_{2g}-only filling vs. high-spin electrons spilling into the larger e_g set).

[Ans] Answer

Option (4) $K_3[Fe(CN)_6]$.

Q17. Which elements have minimum difference in size?

(1) Na, K
(2) Sc, La
(3) Ti, Zr
(4) Mo, W

[E] Explanation

Mo (4d) and W (5d) are a lanthanide-contraction twin pair (Group 6, same logic as Q15) – their sizes are almost identical. By contrast: Na/K (s-block, normal ∼0.4 Å group increase), Sc/La (Group 3, but La sits *before* the lanthanide contraction kicks in, so the gap is large, not compressed), and Ti/Zr (first → second row jump with no contraction yet applied) all show a normal, sizeable increase.

[Ans] Answer

Option (4) Mo, W.

Q18. Which of the following pairs has the same size?

(1) Zn^{2+}, Hf^{4+}
(2) Fe^{2+}, Ni^{2+}
(3) Zr^{4+}, Ti^{4+}
(4) Zr^{4+}, Hf^{4+}

[E] Explanation

This is Q.13 again – identical four ion-pairs, just shuffled into a different option order (the correct pair is option (3) there, option (4) here). Same lanthanide-contraction answer: $Zr^{4+} \approx Hf^{4+}$.

[Ans] Answer

Option (4) Zr^{4+}, Hf^{4+} – see full working at Q.13.

Q19. Zr and Hf have almost equal atomic and ionic radii because

(1) of diagonal relationship
(2) of lanthanide contraction
(3) of actinide contraction
(4) both belong to same transition series

[E] Explanation

The direct statement of the Master Formula: the 14 elements of the lanthanide series (La to Lu) sit *between* Zr's row and Hf's row, and their poorly-shielding $4f$ electrons raise Hf's effective nuclear charge just enough to cancel the size increase a new principal shell would normally bring.

[Ans] Answer

Option (2) Lanthanide contraction.

Q20. Which of the following ions has smallest radius?

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

[E] Explanation

All four are $+2$, so it comes down to where each sits on the $3d$ series' ionic-radius curve. Approximate high-spin M^{2+} radii: Ti^{2+} ≈86, V^{2+} ≈79, Mn^{2+} ≈83, Ni^{2+} ≈69 pm. Ni^{2+} (d^8) sits near the minimum of this (double-humped) curve – maximum crystal-field stabilisation with no electrons forced into the larger e_g set – making it the smallest of the four.

[Ans] Answer

Option (2) Ni^{2+}.

▶ TYPE 5: Ionisation Enthalpy

[F] Master Formulae

The two rules that unlock this whole section:

- **Universal law, no exceptions:** $IP_1 < IP_2 < IP_3 < \ldots$ always. Removing an electron from a *more positive* ion always costs *more* energy – full stop.
- **Anomalous spikes/dips come from crossing d^5 or d^{10} stability:** if an ionisation step **breaks** a stable half-filled (d^5) or fully-filled (d^{10}) configuration, that step needs unusually **high** energy (e.g. Cr's IP_2, Mn's IP_3, Cu's IP_2). If a step **achieves** d^5/d^{10}, that step is relatively **favourable** (e.g. Mn's IP_2, Fe's IP_3). Track exactly which electron leaves and what configuration is left behind – every question in this TYPE reduces to this.
- First IE rising down a group (3d→4d→5d, especially the 5d jump) is **not** about size – it's poor shielding by the intervening (4f, for 5d) subshell raising effective nuclear charge.

Q21. The correct order of decreasing second ionisation enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is

[AIPMT (Prelims)-2008]

(1) Ti > V > Cr > Mn
(2) Cr > Mn > V > Ti
(3) V > Mn > Cr > Ti
(4) Mn > Cr > Ti > V

[E] Explanation

Track each $M^+ \rightarrow M^{2+}$ step:

- $Ti^+(3d^2 4s^1) \rightarrow Ti^{2+}(3d^2)$: plain removal, no anomaly.
- $V^+(3d^3 4s^1) \rightarrow V^{2+}(3d^3)$: plain removal, no anomaly.
- Cr^+: Cr's neutral atom is $3d^5 4s^1$, so Cr^+ is *already* $3d^5$ (stable!) after just one ionisation. The **second** ionisation must break that stable half-filled shell → **anomalous spike**.
- $Mn^+(3d^5 4s^1) \rightarrow Mn^{2+}(3d^5)$: this step *achieves* the stable half-filled shell → relatively favourable, a mild dip below the naive trend.

Cr's spike puts it on top; Mn's is still elevated (relative to V, Ti) simply from higher baseline nuclear charge, but lower than Cr's anomaly. Net order: **Cr > Mn > V > Ti**.

[Ans] Answer

Option (2) Cr > Mn > V > Ti.

Q22. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy?

[AIPMT (Prelims)-2005]

(1) Vanadium (Z = 23)
(2) Chromium (Z = 24)
(3) Iron (Z = 26)
(4) Manganese (Z = 25)

[E] Explanation

This time look at the **third** ionisation ($M^{2+} \rightarrow M^{3+}$):

- $V^{2+}(3d^3) \rightarrow V^{3+}(3d^2)$: plain.
- $Cr^{2+}(3d^4) \rightarrow Cr^{3+}(3d^3)$: plain (Cr already used up its anomaly at IP_2).
- $Mn^{2+}(3d^5$, stable!$) \rightarrow Mn^{3+}(3d^4)$: **breaks** the stable half-filled shell $\rightarrow$ anomalous spike.
- $Fe^{2+}(3d^6) \rightarrow Fe^{3+}(3d^5$, stable!): *achieves* stability $\rightarrow$ relatively favourable, a dip.

Manganese's third ionisation is the one paying the "breaking stability" tax – it's the highest of the four.

[A] Approach

Yeh section mein sabse important skill: har ion ka config likho, aur dekho ki electron nikaalne se *stability toot rahi hai ya ban rahi hai*. Todna (breaking) = spike. Banana (achieving) = dip. Bas isi se puri category solve ho jaati hai.

[Ans] Answer

Option (4) Manganese (Z = 25).

Q23. First IE of 5d series elements are higher than those of 3d and 4d series elements. This is due to

(1) Bigger size of atoms of 5d-series elements than the size of 3d-series elements
(2) Greater effective nuclear charge is experienced by valence electrons because of the weak shielding of the nucleus by 4f-electrons in 5d series
(3) d-d transition
(4) All of these

[E] Explanation

Option (1) actually argues *backwards* – a bigger atom should have a *lower* IE (valence electron farther from nucleus, easier to remove), not higher, so it can't be a correct explanation for the observed *increase*. The real reason is the intervening, poorly-shielding $4f^{14}$ subshell (lanthanide contraction's electronic cause) pulling the effective nuclear charge up sharply for 5d valence electrons – overpowering the "bigger atom" effect entirely.

[!] Common Mistake

Because "size" and "ionisation energy" often move together in easier questions, it's tempting to pick option (1) or "All of these" by habit. Here size and IE are pulling in *opposite* directions, and shielding wins – always check whether the listed factors actually point the same direction as the trend being explained.

[Ans] Answer

Option (2)

Q24. Which among the following orders of second IP is correct?

(1) Mn $>$ Cr
(2) Zn $>$ Cu
(3) Na $>$ Cu
(4) Cr $>$ K

[E] Explanation

Check each using the "breaking vs. achieving stability" rule plus one extra idea – breaking a *true noble-gas core* costs far more than breaking a merely-stable sub-shell:

- Mn $>$ Cr: **false** – Q21 established Cr's IP_2 (breaks $3d^5$) is higher than Mn's (achieves $3d^5$).
- Zn $>$ Cu: **false** – Cu^+ is already the very stable, fully-filled $3d^{10}$ after just one ionisation; Cu^{2+} must break that filled shell ($3d^{10} \rightarrow 3d^9$), an anomalous spike. Zn's IP_2 is just a plain removal of its last "normal" $4s$ electron. Cu's $IP_2 \gg$ Zn's.
- Na $>$ Cu: **true** – Na^+ is a genuine noble-gas core ([Ne]); ripping a second electron out of a complete octet costs enormously more than breaking Cu's merely-stable d^{10} sub-shell. Na's IP_2 ($\sim$4562 kJ/mol) dwarfs Cu's ($\sim$1958 kJ/mol).
- Cr $>$ K: **false** – K^+ is also a true noble-gas core ([Ar]), so K's IP_2 ($\sim$3052) is much bigger than Cr's anomalous-but-still-just-a-subshell IP_2 ($\sim$1592).

[!] Common Mistake

Don't treat every "stable configuration" as equally hard to break. A complete noble-gas octet (Na^+, K^+) is a much deeper energy well than a merely half-filled or fully-filled *d-subshell* (Cr^+, Cu^+) – the gap between these two "kinds" of stability is exactly what this question is testing.

[Ans] Answer

Option (3) Na $>$ Cu.

Q25. Which among the following statements regarding IP is incorrect?

(1) IP_1 of Mn is greater than its IP_2
(2) IP of Mn^{2+} is greater than IP of Fe^{2+}
(3) IP_3 of Mn is greater than IP_3 of Cr
(4) IP of 3d series element increases from Sc to Zn in irregular manner.

[E] Explanation

(1) is the odd one out – and it doesn't even need any transition-metal-specific reasoning. **Successive ionisation energies always increase** ($IP_1 < IP_2 < IP_3 \ldots$) for *every* element, with zero exceptions – you're always removing an electron from an increasingly positive, increasingly electron-hungry ion. So "$IP_1 >$ its IP_2" is simply impossible.
The other three are all genuinely correct: (2) "IP of Mn^{2+}" means removing Mn's 3rd electron – which breaks $3d^5$ stability (Q22), so it's indeed higher than Fe's ($3d^6 \rightarrow 3d^5$, achieving stability). (3) restates Q22/Q28's result directly. (4) is simply the general statement that the whole series rises with atomic number but with anomalies (Cr, Cu dips in IP_1; various IP_2/IP_3 spikes) – true.

[Ans] Answer

Option (1) "IP_1 of Mn is greater than its IP_2" – this is the incorrect statement.

Q26. The atomic no. of V, Cr, Mn and Fe are 23, 24, 25 & 26 respectively. Which of the following has highest value of their second ionization enthalpy?

(1) V (2) Cr (3) Mn (4) Fe

[E] Explanation

Same four elements' IP_2 story as Q21, now with Fe substituted for Ti. Fe's second ionisation ($Fe^+3d^64s^1 \rightarrow Fe^{2+}3d^6$) is a plain step, no anomaly – same category as V. Cr's remains the only anomalous spike (breaking its already-achieved $3d^5$ from the first ionisation). Cr stays on top.

[Ans] Answer

Option (2) Cr.

Q27. For the process Cu(g) $\longrightarrow$ Cu≡(g) + e^- the electron is to be removed from

(1) 3d subshell
(2) 4s subshell
(3) 3p subshell
(4) any of the above

[E] Explanation

Cu's exceptional ground state is $[Ar]3d^{10}4s^1$ – only *one* electron sits in $4s$, and ionisation always removes the outermost/highest-energy electron first. That lone $4s^1$ electron is exactly the one removed, leaving the very stable $Cu^+ = [Ar]3d^{10}$.

[Ans] Answer

Option (2) 4s subshell.

Q28. The correct order of decreasing third ionisation enthalpy of Ti, V, Cr, Mn is

(1) Mn > Cr > V > Ti
(2) Ti > V > Cr > Mn
(3) Cr > Mn > V > Ti
(4) V > Mn > Cr > Ti

[E] Explanation

Third-ionisation ($M^{2+} \rightarrow M^{3+}$) configs: $Ti^{2+}(3d^2) \rightarrow 3d^1$; $V^{2+}(3d^3) \rightarrow 3d^2$; $Cr^{2+}(3d^4) \rightarrow 3d^3$ – all three plain removals. $Mn^{2+}(3d^5$, stable$) \rightarrow 3d^4$ – **breaks** stability, anomalous spike, same fact as Q22. With Mn on top by anomaly, and Ti/V/Cr following the normal increasing-with-Z baseline: **Mn > Cr > V > Ti**.

[Ans] Answer

Option (1) Mn > Cr > V > Ti.

Q29. The atomic numbers of V, Cr, Mn, and Fe are respectively 23, 24, 25 and 26. Which one of these may be expected to have the highest second ionization enthalpy?

(1) Cr (2) Mn (3) Fe (4) V

[E] Explanation

This is Q.26 again – identical four elements and identical question (highest IP_2 among V, Cr, Mn, Fe), just with the options reshuffled (Cr is option 2 there, option 1 here). Same anomaly, same answer: Cr's IP_2 spikes from breaking its self-achieved $3d^5$ stability.

[Ans] Answer

Option (1) Cr – see full working at Q.26.

Q30. The correct order of ionisation energy is

(1) Cu > Ag > Au
(2) Cu > Au > Ag
(3) Au > Cu > Ag
(4) Ag > Au > Cu

[E] Explanation

This is IP_1 of the coinage metals. Actual values: Au ≈ 890, Cu ≈ 745, Ag ≈ 731 kJ/mol. Au's is anomalously high due to strong **relativistic contraction** of its $6s$ orbital (a heavy-element effect that pulls the valence electron unusually close to the nucleus); Ag, despite sitting "in between" by row, actually has the *lowest* IP_1 of the three.

[A] Approach

Coinage metals ka IP trend seedha group-wise nahi chalta – Au relativistic effects ki wajah se sabse zyada tight electron pakadta hai, upar se anomaly hai, neeche se nahi.

[Ans] Answer

Option (3) Au > Cu > Ag.

Q31. Which of the following does not correctly represent the order of the property indicated against it?

(1) Ti < V < Cr < Mn : Increasing number of oxidation states
(2) $Cr_2O_7^{2-} < MnO_4^-$: Increasing oxidising power

(3) $Ti < V < Cr < Mn$: Increasing melting point

(4) $Lu^{3+} < Eu^{3+} < La^{3+}$: Increasing order of ionic radii

[E] Explanation

Check each: (1) number of accessible oxidation states genuinely rises Ti→Mn (Mn reaches all the way to +7) – correct. (2) MnO_4^- is indeed a stronger oxidiser than $Cr_2O_7^{2-}$ – correct. (4) lanthanide contraction shrinks ionic radius steadily across La→Lu, so increasing order $Lu^{3+} < Eu^{3+} < La^{3+}$ (Eu roughly mid-series) is correct.
(3) is the false one: actual melting points are Ti ≈1668, V≈1910, Cr≈1907, **Mn≈1246°C** – Mn is a sharp *dip*, not the peak this statement implies. Mn's complex crystal structure and comparatively poor d-electron participation in metallic bonding make it the melting-point anomaly of the whole 3d series.

[Ans] Answer

Option (3) $Ti < V < Cr < Mn$: Increasing melting point – this does **not** correctly represent the trend.

Q32. Which one of the following does not correctly represent the correct order of the property indicated against it?

[AIPMT (Mains)-2012]

(1) $Ti < V < Cr < Mn$: increasing number of oxidation states

(2) $Ti^{3+} < V^{3+} < Cr^{3+} < Mn^{3+}$: increasing magnetic moment

(3) $Ti < V < Cr < Mn$: increasing melting points

(4) $Ti < V < Mn < Cr$: increasing 2nd ionization enthalpy

[E] Explanation

(1) correct, same fact as Q31. (2) M^{3+} unpaired-electron counts: $Ti^{3+}(3d^1$, 1 unpaired), $V^{3+}(3d^2$, 2), $Cr^{3+}(3d^3$, 3), $Mn^{3+}(3d^4$, 4) – magnetic moment climbs smoothly with unpaired count, correct.
(4) matches Q21's established order exactly (increasing IP_2: Ti<V<Mn<Cr) – correct.
(3) is again the false statement – **identical trap to Q31** – Mn's real melting point is anomalously low, not the series maximum this option implies.

[!] Common Mistake

Notice this is the *same* wrong fact (Mn melting-point anomaly) dressed up in two different AIPMT papers (Q31 and this one) – once you know Mn is the melting-point outlier of the 3d series, both questions fall in seconds.

[Ans] Answer

Option (3) $Ti < V < Cr < Mn$: increasing melting points – this does **not** correctly represent the trend.

Melting point and size both come down to the same question:

how many d-electrons are actually free to bond, and how stable is the config left behind.

– Your Weird Chemist