d and f Block Elements

Question1

Identify the ion (hydrated in solution) which is not correctly matched with its spin only magnetic moment (in BM) given in brackets

AP EAPCET 2025 - 26th May Evening Shift

Options:

A.

$Cr^{3+}(4.90)$

B.

$Cu^{2+}(1.73)$

C.

$Co^{3+}(4.90)$

D.

$Fe^{2+}(4.90)$

Answer: A

Solution:

Among the given option Cr^{3+} ion's magnetic moment does not match.

$Cr[24] = [Ar]3d^5 4s^1$
$Cr^{3+} = [Ar]3d^3$

Unpaired electron = 3

Magnetic moment

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$= \mu = \sqrt{n(n+2)}$

$= \sqrt{3(3+2)}$

$\mu = \sqrt{15}$ or 3.87 B.M.

Question2

Which one of the following statements is not correct?

AP EAPCET 2025 - 24th May Morning Shift

Options:

A.

CrO is basic but Cr_2O_3 is amphoteric.

B.

Nitrite is oxidised to nitrate in acidic medium by $KMnO_4$.

C.

$PdCl_2$ is the catalyst in Wacker process.

D.

The reactivity of the earlier members of lanthanide series is similar to that of aluminium.

Answer: D

Solution:

Option A

CrO is basic but Cr_2O_3 is amphoteric.

- Cr oxidation states:
- In CrO, Cr is in +2 oxidation state → basic oxide.
- In Cr_2O_3, Cr is in +3 oxidation state → amphoteric oxide.

✅ **This statement is correct.**

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Option B

Nitrite is oxidised to nitrate in acidic medium by $KMnO_4$.

- In acidic medium, $MnO_4^- \rightarrow Mn^{2+}$ (oxidizing agent).
- Nitrite (NO_2^-, N in +3) can be oxidized to nitrate (NO_3^-, N in +5)).

✅ **This is correct.**

Option C

$PdCl_2$ is the catalyst in Wacker process.

- The **Wacker process** (oxidation of ethylene to acetaldehyde) uses **$PdCl_2$–$CuCl_2$** as a catalyst system.

✅ **Correct.**

Option D

The reactivity of the earlier members of lanthanide series is similar to that of aluminium.

- Lanthanides are *strongly electropositive* and more reactive than aluminum.
- They readily react with water and acids even at moderate temperatures, unlike Al (which is passivated by oxide film).

❌ **This statement is not correct.**

✅ **Final Answer: Option D** is **not correct.**

Question3

The amphoteric oxide of vanadium (V) reacts with alkali and forms an oxo ion ' X ' and with acid forms an oxo ion Y. The oxidation states of ' V ' in X and Y are respectively

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Options:

A.

$+2, +5$

B.

$+3, +3$

C.

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$+5, +5$

D.

$+5, +2$

Answer: C

Solution:

Amphoteric oxide of vanadium

$= V_2O_5$

V_2O_5 with alkali

$V_2O_5 + 6NaOH \longrightarrow 2Na_3VO_4 + 3H_2O$

oxidation state $= +5$ in Na_3VO_4

V_2O_5 with acid

$V_2O_5 + 6HCl \longrightarrow 2VO_2Cl + H_2O + Cl_2$

Oxidation state $= +5$ in VO_2Cl

Question4

How many of the following lanthanide elements exhibit +4 oxidation state?

Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy

AP EAPCET 2025 - 22nd May Morning Shift

Options:

A.

5

B.

4

C.

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3

D.

6

Answer: A

Solution:

Among given lanthanides, total five elements gives +4 oxidation states, they are

Ce, Pr, Tb, Dy, Nd

Question5

Match the following

List-I (Aquated ion)		List-II (Colour)	
(A)	Ni^{2+}	(I)	Violet
(B)	Fe^{3+}	(II)	Blue
(C)	Mn^{3+}	(III)	Yellow
(D)	V^{4+}	(IV)	Red
		(V)	Green

Correct answer is

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Options:

A.

A-V, B-III, C-IV, D-II

B.

A-IV, B-V, C-I, D-III

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C.

A-I, B-III, C-IV, D-V

D.

A-V, B-III, C-I, D-II

Answer: D

Solution:

Let's determine the **color of each aquated ion**:

(A) Ni^{2+}

- In aqueous solution: $[Ni(H_2O)_6]^{2+}$
- This complex is **green** in color.

✅ **(A) → (V) Green**

(B) Fe^{3+}

- In aqueous solution: $[Fe(H_2O)_6]^{3+}$
- This complex is **yellow to brownish-yellow**.

✅ **(B) → (III) Yellow**

(C) Mn^{3+}

- In aqueous solution: $[Mn(H_2O)_6]^{3+}$
- This complex is **violet or red-purple**.

✅ **(C) → (I) Violet**

(D) V^{4+}

- In aqueous solution: $[VO]^{2+}$ (vanadyl ion)
- This species is **blue**.

✅ **(D) → (II) Blue**

✅ **Final Matching:**

$A - V, \quad B - III, \quad C - I, \quad D - II$

✅ **Correct Option: D**

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Question6

The ion with $4f^7$ configuration is

AP EAPCET 2025 - 21st May Evening Shift

Options:

A.

Pr^{3+}

B.

Lu^{3+}

C.

Eu^{2+}

D.

Ce^{4+}

Answer: C

Solution:

Step 1. Recall that $4f^7$ means half-filled 4f shell (7 electrons).

Step 2. Check each ion

(A) Pr^{3+}

Praseodymium (Pr) = atomic number 59

Neutral configuration: $[Xe]4f^3 6s^2$

When it loses 3 electrons → remove $6s^2$ and one $4f$:

Pr^{3+} : $[Xe]4f^2$

❌ Not $4f^7$.

(B) Lu^{3+}

Lutetium (Lu) = atomic number 71

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Neutral configuration: $[Xe]4f^{14}5d^{1}6s^{2}$

Removing three electrons → $6s^{2}$ and $5d^{1}$:

Lu^{3+} : $[Xe]4f^{14}$

❌ Not $4f^{7}$.

(C) Eu^{2+}

Europium (Eu) = atomic number 63

Neutral configuration: $[Xe]4f^{7}6s^{2}$

Losing two electrons → remove both $6s$ electrons:

Eu^{2+} : $[Xe]4f^{7}$

✅ Matches $4f^{7}$.

(D) Ce^{4+}

Cerium (Ce) = atomic number 58

Neutral: $[Xe]4f^{1}5d^{1}6s^{2}$

Losing 4 electrons → $4f^{1}5d^{1}6s^{2}$ → remove all →

Ce^{4+} : $[Xe]$

❌ Not $4f^{7}$.

✅ **Correct Answer: Option C** – Eu^{2+}

Question7

The correct order of oxidising power of the given ions is

AP EAPCET 2024 - 22th May Morning Shift

Options:

A. $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

B. $VO_2^+ < MnO_4^- < Cr_2O_7^{2-}$

C. $MnO_4^- < Cr_2O_7^{2-} < VO_2^+$

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D. $Cr_2O_7^{2-} < VO_2^+ < MnO_4^-$

Answer: A

Solution:

The correct order of oxidizing power for the given ions is:

$VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

Oxidizing power is directly related to the oxidation number of an element; the higher the oxidation number, the greater the oxidizing power.

For VO_2^+, if we let the oxidation number of Vanadium be x, we can write:

$x + 2(-2) = 1 \implies x = +5$

For $Cr_2O_7^{2-}$, the calculation is:

$2x + 7(-2) = -2 \implies x = +6$

For MnO_4^-, the calculation is:

$x + 4(-2) = -1 \implies x = +7$

This shows that MnO_4^- has the highest oxidation number, therefore, it is the strongest oxidizing agent among the given ions.

Question8

Which of the following lanthanoids have [Xe] $4f^x5d^16s^2$ configuration in their ground state.$(X = 1 - 14)$

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Options:

A. Pr, Tb, Yb

B. Ce, Yb, Lu

C. Ce, Gd, Lu

D. Gd, Tb, Lu

Answer: C

Solution:

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Name	Atomic Number	Electronic Configuration
Cerium (Ce)	58	$[Xe]4f^{1}5d^{1}6s^{2}$
Gadolinium (Gd)	64	$[Xe]4F^{7}5d^{1}6s^{2}$
Lutetium (Lu)	71	$[Xe]4f^{14}5d^{1}6s^{2}$

Question9

Match the following.

List I	List II
A. Technicium	I. Non-metal
B. Fluorine	II. Transition metal
C. Tellurium	III. Lanthanoid
D. Dysprosium	IV. Metalloid

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Options:

A. A-II, B-I, C-III, D-IV

B. A-III, B-I, C-IV, D-II

C. A-II, B-I, C-IV, D-III

D. A-IV, B-I, C-II, D-III

Answer: C

Solution:

Let's match each element from List I with its correct category in List II:

A. Technicium

Technicium (technetium, symbol Tc) is a transition metal.

Match: II. Transition metal

B. Fluorine

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Fluorine is a halogen, which is classified as a non-metal.

Match: I. Non-metal

C. Tellurium

Tellurium is known for its properties that are intermediate between metals and non-metals, so it is classified as a metalloid.

Match: IV. Metalloid

D. Dysprosium

Dysprosium is part of the lanthanide series (also known as lanthanoids).

Match: III. Lanthanoid

Thus, the correct matching is:

A-II, B-I, C-IV, D-III

This corresponds to Option C.

Question10

The transition metal with highest melting point is

AP EAPCET 2024 - 20th May Evening Shift

Options:

A. Re

B. Cr

C. Mo

D. W

Answer: D

Solution:

The correct answer is Option D: tungsten (W).

Here's a bit of explanation:

Tungsten (W) has a melting point of about $3422^{\circ}C$, which is the highest among the elements listed.

For comparison:

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Rhenium (Re) melts at around $3186^{\circ}C$.

Molybdenum (Mo) melts at approximately $2623^{\circ}C$.

Chromium (Cr) melts at roughly $1907^{\circ}C$.

Thus, tungsten (W) clearly stands out as the transition metal with the highest melting point.

Question11

Which transition metal does not form 'MO' type oxide? ($M =$ transition metal)

AP EAPCET 2024 - 20th May Morning Shift

Options:

A. V

B. Cr

C. Mn

D. Sc

Answer: D

Solution:

Let's analyze the formation of a simple monoxide (with formula MO) for each metal:

For a metal to form an oxide of the type MO, the metal would need to adopt a +2 oxidation state (since oxygen is -2).

Vanadium, chromium, and manganese can adopt a +2 oxidation state:

Vanadium can form VO (vanadium(II) oxide).

Chromium can form CrO (chromium(II) oxide), although it is less stable, it is known under certain conditions.

Manganese forms MnO (manganese(II) oxide) quite readily.

Scandium, on the other hand, almost exclusively forms a +3 oxidation state. Its stable oxide is Sc_2O_3 (scandium(III) oxide), and there is no stable monoxides like ScO.

Thus, the transition metal that does not form an "MO" type oxide is:

Option D: Scandium.

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Question12

Identify the isoelectronic pair of ions from the following.

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Options:

A. Pr^{3+}, Nd^{3+}

B. Tb^{3+}, Dy^{2+}

C. Eu^{2+}, Gd^{3+}

D. Pr^{3+}, Ce^{4+}

Answer: C

Solution:

Isoelectronic species have same number of electrons in them.

(a) Pr^{3+} number of electron $= 59 - 3 = 56$

Nd^{3+} number of electron $= 60 - 3 = 57$

$\therefore$ Pr^{3+} and Nd^{3+} are not isoelectronic.

(b) Tb^{3+} : Total number of electron $= 65 - 3 = 62$

Dy^{2+} : Total number of electron $= 66 - 2 = 64$

$\therefore$ Tb^{3+} and Dy^{2+} are not isoelectronic.

(c) Eu^{2+} number of electron $= 63 - 2 = 61 Gd^{3+}$ number of electron $= 64 - 3 = 61$

$\therefore$ Eu^{2+} and Gd^{3+} are isoelectronic.

(d) Pr^{3+} number of electron $= 59 - 3 = 56 Ce^{4+}$ number of electron $= 58 - 4 = 54$

$\therefore$ Pr^{3+} and Ce^{4+} are not isoelectronic.

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Question13

Assertion (A) Transition metals and their complexes show catalytic activity.

Reason (R) The activation energy of a reaction is lowered by the catalyst.

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Options:

A. Both A and R are correct and R is the correct explanation of A.

B. Both A and R are correct but R is not the correct explanation of A.

C. A is correct but R is incorrect.

D. A is incorrect but R is correct.

Answer: B

Solution:

Transition metals and their complexes show catalytic activity because of

I. presence of vacant *d*-orbitals.

II. ability to show variable oxidation valencies.

III. tendency to form complex compounds.

A catalyst is a chemical species which increases the rate of the reaction by lowering the activation energy of the reaction.

Thus, Assertion and Reason are correct but Reason is not correct explanation of Assertion.

Question14

A purple coloured compound of manganese (X) decomposes on heating to liberate oxygen and forms compounds of manganese Y and Z. Compound Z reacts with KOH in presence of potassium nitrate to give compound Y. Compounds X, Y and Z respectively are

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Options:

A. $X - \mathrm{KMnO_4}, Y - \mathrm{Mn_2O_7}, Z - \mathrm{MnO_2}$

B. $X - \mathrm{K_2MnO_4}, Y - \mathrm{KMnO_4}, Z - \mathrm{Mn_2O_7}$

C. $X - \mathrm{KMnO_4}, Y - \mathrm{K_2MnO_4}, Z - \mathrm{MnO_2}$

D. $\mathrm{X - KMnO_4, Y - MnO_2}. Z - \mathrm{MnO}$

Answer: C

Solution:

$X \xrightarrow{\Delta} O_2 + Y + Z$ and $Z \underset{KNO_3}{\overset{KOH}{\longrightarrow}} Y$

$\underset{(X)}{2KMnO_4} \longrightarrow \underset{(Y)}{K_2MnO_4} + \underset{(Z)}{MnO_2} + O_2$

$\underset{(Z)}{MnO_2} \underset{KNO_3}{\overset{KOH}{\longrightarrow}} \underset{(Y)}{K_2MnO_4}$

$\therefore X = KMnO_4, Y = K_2MnO_4$ and $Z = MnO_2$

Question15

Match the following columns and choose thecorrect code.

	Column I (Property)		Column II (Metal)
A.	Element with highest second ionisation enthalpy $(\Delta_i H_2)$	1.	CO
B.	Element with highest third ionisation enthalpy $(\Delta_i H_3)$	2.	Cr
C.	M in $[M(CO)_6]$	3.	Cu
D.	Element with highest heat of atomisation $(\Delta_a H)$	4.	Zn

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	Column I (Property)		Column II (Metal)
		5.	Ni

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Options:

A. A - 3, B - 1, C - 5, D - 4

B. A - 3, B - 4, C - 2, D - 5

C. A - 4, B - 1, C - 2, D - 3

D. A - 5, B - 4, C - 1, D - 3

Answer: B

Solution:

(A) Electronic configuration of Cu is

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

$\Delta_i H_1$ is low while $\Delta_i H_2$ is highest because of fully filled d-orbital.

(B) Electronic configuration of Zn is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

First 2 electrons are removed from s-orbital while 3rd electron released from fully filled d-orbital, which require large amount of energy.

(C) M in $[M(CO)_6]$ is Cr.

(D) Ni has highest heat of atomisation in the 3d-transition series.

Question16

Which of the following is not arranged in the correct sequence?

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Options:

A. MO, M_2O_3, MO_2, M_2O_5 (Decreasing basic nature)

B. Sc, V, Cr, Mn (Increasing number of oxidation states)

C. d^5, d^3, d^1, d^4 (Increasing magnetic moment)

D. $Mn^{2+}, Fe^{2+}, Cr^{2+}, Co^{2+}$ (Decreasing stability)

Answer: C

Solution:

(a) Basic character of metal oxides decreases with increase in oxidation number

$\overset{+2}{M}O, \overset{+3}{M}_2O_3, \overset{+4}{M}O_2, \overset{+5}{M}_2O_5$
(Decreasing basics character)

(b) Manganese (Mn) has maximum number of oxidation state.

Sc, V, Cr, Mn (Increasing number of oxidation states)

(c) Magnetic moment $= \sqrt{n(n+1)}$

($n =$ number of unpaired electron)

Magnetic moment $\propto$ unpaired electron

Configuration	Unpaired electron	Magnetic moment
d^5	5	5.90
d^3	3	3.82
d^1	1	1.92
d^4	4	4.90

So, the correct order of magnetic moment is

$d^5 > d^4 > d^3 > d^1$

(d)
$$\begin{aligned} Mn^{2+} &\rightarrow 3d^5 \\ Fe^{2+} &\rightarrow 3d^6 \\ Cr^{2+} &\rightarrow 3d^4 \\ Co^{2+} &\rightarrow 3d^7 \end{aligned}$$

Mn^{2+} is most stable as d-subshell is half filled.

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Question17

Which among the following is coloured?

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Options:

A. CuCl

B. $ScCl_3$

C. $CuCl_2$

D. $TiCl_4$

Answer: C

Solution:

The electronic configuration of Cu^{2+} is

$[Ar]3d^9$

It contains one unpaired electron,

Hence, $CuCl_2$ is coloured compound.In all other compounds,

$CuCl \rightarrow [Cu^+] \Rightarrow 3d^{10}4s^0$
$ScCl_3 \rightarrow [Sc^{3+}] \Rightarrow 3p^64s^2$
$TiCl_4 \rightarrow [Ti^{4+}] \Rightarrow 3p^64s^2$

No unpaired electrons are present.

Question18

The electronic configuration of Fe^{3+} is (atomic number of $Fe = 26$)

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Options:

A. $[\mathrm{Ar}]3d^5 4s^1$

B. $[\mathrm{Ar}]3d^6 4s^0$

C. $[\mathrm{Ar}]3d^5 4s^0$

D. $[\mathrm{Ar}]3d^6 4s^2$

Answer: C

Solution:

For general electronic configuration of metal,

$\mathrm{Fe} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6, 4s^2$

Now, for $\mathrm{Fe} = [\mathrm{Ar}]3d^6 4s^2$

$\mathrm{Fe}^{2+} = [\mathrm{Ar}]3d^6 4s^0$ [Remove $2e^-$ from s-orbital first]

$\Rightarrow \quad \mathrm{Fe}^{3+} = [\mathrm{Ar}]3d^6 4s^0$

Fe^{3+} is denoted as ferric (III) ion.

Question19

The magnetic moment of Fe^{2+} is ..... BM.

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Options:

A. 3.87

B. 0

C. 4.9

D. 1.73

Answer: C

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Solution:

Fe(Z = 26) = $[Ar]3d^6\ 4s^2$

$Fe^{2+} = [Ar]3d^6\ 4s^0$

Total number of unpaired electrons = 4

i.e., n = 4

Magnetic moment, $\mu = \sqrt{n(n+2)}$

$= \sqrt{4(4+2)} = \sqrt{4 \times 6}$

$= \sqrt{24}$

$= 4.9$ BM

Hence, magnetic moment of Fe^{2+} is 4.9 BM.

Question20

Which of the following statement is not correct?

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Options:

A. Fe^{3+}/Fe^{2+} redox couple has less positive electron potential than Mn^{3+}/Mn^{2+} couple.

B. MnO_4^{2-} is a strong oxidising agent but CrO_4^{2-} is not.

C. The second and third series of transition elements have almost similar atomic radii.

D. The $E\Upsilon$ value for Mn^{3+}/Mn^{2+} couple is much more positive than for Cr^{3+}/Cr^{2+} couple.

Answer: B

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Solution:

CrO_4^{2-} is a stronger oxidising agent as compared to MnO_4^{2-}.

$Cr^{+6} \rightarrow [Ar]3d^0 4s^0$ which is stable. So, Cr reading loses its 6 electrons to attain stable noble gas and acting as oxidising agent but in Mn^{+6} [electronic configuration is $[Ar]3d^1 4s^0$] one electron is difficult to remove and acquire stable form. Hence, MnO_4^- is not oxidising agent but $CrO_4{}^{2-}$ is good oxidising agent.

Question21

To which group of the periodic table does an element having electronic configuration [Ar] $3d^5$ $4s^2$ belong?

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Options:

A. Second

B. Fourth

C. Seventh

D. Third

Answer: C

Solution:

The given electronic configuration is [Ar] $3d^5$ $4s^2$. To determine the group of the periodic table to which this element belongs, we need to analyze its electron configuration, particularly the electrons in the outermost shells.

In this configuration:

- [Ar] represents the argon core, which is a stable, noble gas with 18 electrons.
- $3d^5$ indicates there are 5 electrons in the 3d subshell.
- $4s^2$ indicates there are 2 electrons in the 4s subshell.

Total electrons in the outer shells (valence electrons) = 5 (in 3d subshell) + 2 (in 4s subshell) = 7 valence electrons.

This pattern of electron configuration is characteristic of the elements in Group 7 of the periodic table. The 3d subshell is filling and the outer 4s subshell contains 2 electrons, typical of a transition metal in Group 7.

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Examples of such elements include manganese (Mn), which has the atomic number 25 and the electron configuration [Ar] $3d^5$ $4s^2$.

Therefore, the element with the electronic configuration [Ar] $3d^5$ $4s^2$ belongs to:

Option C: Seventh

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