

d and f Block Elements

Question1

In the following pairs, the one in which both transition metal ions are colourless is

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Options:

- A. Sc^{3+} , Zn^{2+}
- B. V^{2+} , Ti^{3+}
- C. Zn^{2+} , Mn^{2+}
- D. Ti^{4+} , Cu^{2+}

Answer: A

Solution:

In transition metal ions, the coloration typically depends on the presence of unpaired electrons in the d-orbitals. Ions with either completely empty d-orbitals (d^0) or fully filled d-orbitals (d^{10}) do not exhibit d-d transitions, which are responsible for colored compounds. As a result, these ions tend to be colorless.

The Sc^{3+} ion has the electron configuration $[\text{Ar}]3d^0$, meaning its d-orbitals are empty.

The Zn^{2+} ion has the electron configuration $[\text{Ar}]3d^{10}$, indicating fully filled d-orbitals.

Since both Sc^{3+} and Zn^{2+} lack the d-d electron transitions necessary for color, they are colorless.

Question2

A member of the Lanthanoid series which is well known to exhibit +4 oxidation state is



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Options:

- A. Samarium
- B. Europium
- C. Erbium
- D. Cerium

Answer: D

Solution:

The Lanthanoid series element known for exhibiting a +4 oxidation state is Cerium.

The electronic configuration of Cerium (Ce) is:



When Cerium is in the +4 oxidation state (Ce^{+4}), it has the electronic configuration:



In this state, Cerium has a stable noble gas configuration, which is why it is well-known to exhibit a +4 oxidation state.

Question3

In which of the following pairs, both the elements do not have $(n - 1)d^{10}ns^2$ configuration?

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Options:

- A. Cu, Zn
- B. Zn, Cd



C. Cd, Hg

D. Ag, Cu

Answer: D

Solution:

To determine which pairs of elements do not both have the configuration $(n - 1)d^{10}ns^2$, let's examine the electronic configurations provided:

Cu (Copper): $[\text{Ar}]3d^{10}4s^1$

Zn (Zinc): $[\text{Ar}]3d^{10}4s^2$

Cd (Cadmium): $[\text{Kr}]4d^{10}5s^2$

Hg (Mercury): $[\text{Xe}]4f^{14}5d^{10}6s^2$

Ag (Silver): $[\text{Kr}]4d^{10}5s^1$

From the configurations:

Copper (Cu) does not have an ns^2 configuration (as it is $4s^1$).

Silver (Ag) also lacks an ns^2 configuration (as it is $5s^1$).

Thus, in the pair consisting of **Ag** and **Cu**, neither element has the $(n - 1)d^{10}ns^2$ configuration.

Question4

MnO exhibits

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Options:

A. ferrimagnetism

B. antiferromagnetism

C. ferromagnetism

D. paramagnetism

Answer: B

Solution:

MnO exhibit antiferromagnetism. They have domain structure similar to ferromagnetic substance, but their domains are oppositely oriented and cancel out each other's magnetic moment.

Question5

The transition element ($\approx 5\%$) present with lanthanoid metal in misch metal is

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Options:

A. Mg

B. Fe

C. Zn

D. Co

Answer: B

Solution:

The alloy "misch metal" consists of a lanthanoid metal (95%) and iron (5%) and traces of S, C, Ca and Al.

Question6

Match the following.

I. Zn^{2+} (i) d^8 configuration

II. Cu^{2+} (ii) Colourless

III. Ni^{2+} (iii) $\mu = 1.73\text{BM}$



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Options:

A.

I	II	II
(i)	(ii)	(iii)

B.

I	II	II
(ii)	(iii)	(i)

C.

I	II	II
(ii)	(i)	(iii)

D.

I	II	II
(i)	(iii)	(ii)

Answer: B

Solution:

The correct match is I-(ii), II-(iii), III-(i)

• Zn^{2+} ($Z = 30$) The outer electronic configuration of Zn^{2+} is $3d^{10}$. Thus, it has no unpaired electrons. Hence, it is colourless.

• Cu^{2+} ($Z = 29$) The outer electronic configuration of Cu^{2+} is $3d^9$. Hence, it contains one unpaired electron. So, $\mu = \sqrt{1(1+2)} = 1.73BM$

• Ni^{2+} ($Z = 28$) The outer electronic configuration of $4d^8Ni^{2+}$ is $3d^8$. Hence, its configuration is d^8 .



Question7

Which of the following statements related to lanthanoids is incorrect?

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Options:

- A. Lanthanoids are silvery white soft metals.
- B. Samarium shows +2 oxidation state.
- C. Ce^{+4} solutions are widely used as oxidising agents in titrimetric analysis.
- D. Colour of lanthanoid ion in solution is due to $d - d$ transition.

Answer: D

Solution:

The incorrect statement regarding lanthanoids is given in option (d). Its correct form is colour of Lanthanoid ion in solution is due to $f f$ transition.

Question8

Which of the following is correct with respect to melting point of a transition element?

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Options:

- A. $\text{V} > \text{Cr}$
- B. $\text{Cr} > \text{Mn}$
- C. $\text{Mn} > \text{Fe}$
- D. $\text{Ti} > \text{V}$



Answer: B

Solution:

In general, the melting points of transition elements increases across a period from left to right due to increasing atomic number and the corresponding increase in effective nuclear charge.

Among the elements mentioned in the options, chromium (Cr) has a higher melting point compared to manganese (Mn). It is because chromium has a larger atomic number and a higher effective nuclear charge. Which leads to stronger metallic bonding and higher melting temperatures.

Question9

A transition metal exists in its highest oxidation state. It is expected to behave as

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Options:

- A. a central metal in a coordination compound
- B. an oxidising agent
- C. a reducing agent
- D. a chelating agent

Answer: B

Solution:

In highest oxidation state of transition metals can undergo reduction and thus act as the oxidising agent.

Question10

What will be the value of x in Fe^{x+} , if the magnetic moment, $\mu = \sqrt{24}$ BM ?



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Options:

A. +3

B. 0

C. +1

D. +2

Answer: D

Solution:

Given that, magnetic moment, $\mu = \sqrt{24}$

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

where, n = unpaired electrons

$$\sqrt{24} = \sqrt{n(n+2)}$$

$$24 = n(n+2) = n^2 + 2n$$

$$n^2 + 2n - 24 = 0 \Rightarrow n^2 + 6n - 4n - 24 = 0$$

$$n(n+6) - 4(n+6) = 0 \Rightarrow (n-4)(n+6) = 0$$

$$n = 4, -6$$

\therefore Number of unpaired electrons = 4

If oxidation of F is +2 then it has 4 unpaired electrons.

Question11

The only lanthanoid which is radioactive

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Options:

A. cerium



- B. promethium
- C. praseodymium
- D. lanthanum

Answer: B

Solution:

Promethium is a radioactive lanthanoid.

Question12

Which of the following does not represent property stated against it?

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Options:

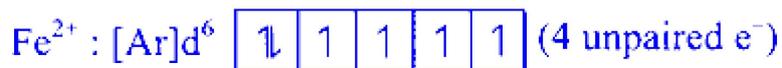
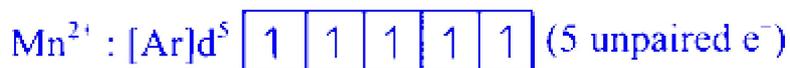
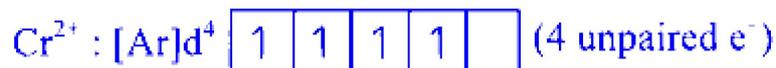
- A. $\text{CO}^{2+} < \text{Fe}^{2+} < \text{Mn}^{2+}$ - Ionic size
- B. $\text{Ti} < \text{V} < \text{Mn}$ - Number of oxidation states
- C. $\text{Cr}^{2+} < \text{Mn}^{2+} < \text{Fe}^{2+}$ - Paramagnetic behaviour
- D. $\text{Sc} > \text{Cr} > \text{Fe}$ - Density

Answer: C

Solution:

The property stated against option (c) is incorrect.

The electronic configuration of given elements (ions) are



It is clear from above electronic configuration that Mn^{2+} has maximum number of unpaired electrons (5).

\therefore It shown maximum paramagnetic behaviours among the given ions.

Question13

Which one of the following is correct for all elements from Sc to Cu?

KCET 2021

Options:

- A. The lowest oxidation state shown by them is +2
- B. 4s orbital is completely filled in the ground state
- C. 3d orbital is not completely filled in the ground state
- D. The ions in +2 oxidation states are paramagnetic

Answer: D

Solution:

From Sc^{2+} to Cu^{2+} all the ions are paramagnetic in nature as they all contain unpaired electrons as shown below.

Elements	Electronic configuration	Number of unpaired electron(s)
Sc^{2+}	$[\text{Ar}]3d^1$	1
Ti^{2+}	$[\text{Ar}]3d^2$	2
V^{2+}	$[\text{Ar}]3d^3$	3



Elements	Electronic configuration	Number of unpaired electron(s)
Cr^{2+}	$[\text{Ar}]3d^4$	4
Mn^{2+}	$[\text{Ar}]3d^5$	5
Fe^{2+}	$[\text{Ar}]3d^6$	4
Co^{2+}	$[\text{Ar}]3d^7$	3
Ni^{2+}	$[\text{Ar}]3d^8$	2
Cu^{2+}	$[\text{Ar}]3d^9$	1

Question 14

Which of the following pairs has both the ions coloured in aqueous solution? [Atomic numbers of

$\text{Sc} = 21, \text{Ti} = 22, \text{Ni} = 28, \text{Cu} = 29, \text{Mn} = 25]$

KCET 2021

Options:

A. $\text{Sc}^{3+}, \text{Mn}^{2+}$

B. $\text{Ni}^{2+}, \text{Ti}^{4+}$

C. $\text{Ti}^{3+}, \text{Cu}^+$

D. $\text{Mn}^{2+}, \text{Ti}^{3+}$

Answer: D

Solution:

Elements	Electronic configuration	Colour
Sc^{3+}	$[\text{Ar}]3d^0$	Colourless

Elements	Electronic configuration	Colour
Ti ³⁺	[Ar]3d ¹	Violet
Mn ²⁺	[Ar]3d ⁵	Pink
Ni ²⁺	[Ar]3d ⁸	Green
Cu ⁺	[Ar]3d ¹⁰	Colourless
Ti ⁴⁺	[Ar]3d ⁰	Colourless

∴ Only option (d) (i.e. Mn²⁺, Ti³⁺ pair) is coloured in aqueous solution.

Question15

Identify the set of paramagnetic ions among the following.

KCET 2020

Options:

- A. V²⁺, Co²⁺, Ti⁴⁺
- B. Ni²⁺, Cu²⁺, Zn²⁺
- C. Ti²⁺, Cu²⁺, Mn³⁺
- D. Sc³⁺, Ti³⁺, V³⁺

Answer: C

Solution:

Out of the given four options, the following set of ions is paramagnetic : Ti²⁺, Cu²⁺, Mn³⁺

Ti → 4s², 3d² (ground state) Ti²⁺ → 3d² → 2 unpaired electrons.

Cu → 4s¹, 3d¹⁰ (ground state) Cu²⁺ → 3d⁹ → 1 unpaired electrons.

Mn → 4s², 3d⁵ (ground state) Mn³⁺ → 3d⁴ → 4 unpaired electrons.

A substance is called paramagnetic if it contains at least one unpaired electron.



Question16

For Cu_2Cl_2 and CuCl_2 in aqueous medium, which of the following statement is correct?

KCET 2020

Options:

- A. CuCl_2 is more stable than Cu_2Cl_2
- B. Stability of Cu_2Cl_2 is equal to stability of CuCl_2
- C. Both are unstable
- D. Cu_2Cl_2 is more stable than CuCl_2

Answer: A

Solution:

Out of Cu_2Cl_2 and CuCl_2 in aqueous medium, CuCl_2 is more stable than Cu_2Cl_2 as $\text{Cu}^{2+}(\text{aq})$ is more stable than $\text{Cu}^+(\text{aq})$ due to more negative enthalpy of hydration which compensates for the second ionisation enthalpy of Cu.

In CuCl_2 , Cu is in Cu^{2+} state and in Cu_2Cl_2 , Cu is in Cu^+ state

Question17

The elements in which electrons are progressively filled in $4f$ -orbital are called

KCET 2019

Options:

- A. actinoids



B. transition elements

C. lanthanoids

D. halogens

Answer: C

Solution:

The elements in which electrons are progressively filled in $4f$ -orbital are called lanthanoids. These are fourteen elements from cerium (Ce) to lutetium (Lu). These resemble one another more closely than to the members of ordinary elements in any series. In actinoids, electrons are progressively filled in $5f$ -orbital.

Question18

Incorrect statement with reference to Ce($Z = 58$) is

KCET 2019

Options:

A. Ce^{4+} is a reducing agent

B. Ce in +3 oxidation state is more stable than in +4

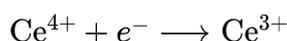
C. Atomic size of Ce is more than that of Lu

D. Ce shows common oxidation states of +3 and +4

Answer: A

Solution:

Statement (a) is incorrect as Ce^{4+} cannot be a reducing agent. In Ce^{4+} , the electronic configuration of Ce is $[\text{Xe}]4f^0$. It cannot be oxidised further as it is a highly stable state. It tends to attain a stable +3 oxidation state, so Ce^{4+} acts as a good oxidant (or oxidising agent).



The other given statements are correct.



Question19

A mixture of NaCl and $K_2Cr_2O_7$ is heated with conc. H_2SO_4 , deep red vapours are formed. Which of the following statements is false?

KCET 2019

Options:

- A. The vapours give a yellow solution with NaOH
- B. The vapours contain CrO_2Cl_2 only
- C. The vapours contain CrO_2Cl_2 and Cl_2
- D. The vapours when passed into lead acetate in acetic give a yellow precipitate

Answer: C

Solution:

Statement (C) is false as NaCl on heating with $K_2Cr_2O_7$ / conc. H_2SO_4 gives deep red fumes of chromyl chloride (CrO_2Cl_2) only.



These fumes of CrO_2Cl_2 when passed through NaOH solution forms Na_2CrO_4 turning NaOH solution yellow. This solution on acidification with CH_3COOH , followed by addition of lead acetate gives thick yellow precipitate ($PbCrO_4$)



Question20

Which of the following statements is wrong?

KCET 2019

Options:

- A. In highest oxidation states, the transition metals show acidic character
- B. Mn^{3+} and CO^{3+} are oxidising agents in aqueous solution
- C. Metals in highest oxidation states are more stable in oxide than in fluorides
- D. All elements of $3d$ series exhibit variable oxidation states

Answer: D

Solution:

Statement (d) is wrong as all elements (except Zn) of $3d$ series exhibit variable oxidation states. This is because the difference in the energy of $(n - 1)d$ -electrons and ns -electrons is low which implies that electrons from both energy levels can take part in bonding. All the other given statements are correct.

Question21

Oxidation state of copper is +1 in

KCET 2019

Options:

- A. malachite
- B. cuprite
- C. azurite
- D. chalcopyrite

Answer: B

Solution:

Oxidation state of copper is (+1) in cuprite. The molecular formula of cuprite is Cu_2O . Oxidation state of Cu_2O is as follows



$$2x - 2 = 0; x = \frac{+2}{2}; x = +1$$

Oxidation state of Cu with name of ore is given in following table.

Name	Formula	Oxidation state
Azurite	$\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$	+2
Malachite	$\text{Cu}_2\text{CO}_3(\text{OH})_2$	+2
Chalcopyrite	CuFeS_2	0

Question22

Which of the following oxides shows electrical properties like metals?

KCET 2018

Options:

- A. SiO_2
- B. MgO
- C. $\text{SO}_2(\text{ s})$
- D. CrO_2

Answer: D

Solution:

The correct answer is Option D: CrO_2 .

Here's why:

SiO_2 (silicon dioxide) has a network covalent structure, making it an electrical insulator rather than a conductor.

MgO (magnesium oxide) is an ionic compound with a large band gap. Such materials typically do not conduct electricity.

$\text{SO}_2(\text{ s})$ —if it exists in solid form—is not known for metallic conductivity; it is generally not considered to have the conduction properties of metals.

CrO_2 (chromium dioxide), on the other hand, is a well-known metallic oxide. It possesses unique properties such as half-metallicity, meaning electrons in one spin channel contribute to electrical conduction. This gives CrO_2 metallic-like electrical conductivity, which is why it is used in magnetic recording and related applications.

Thus, CrO_2 is the oxide that shows electrical properties similar to metals.



Question23

Which of the following oxidation states is common for all lanthanides?

KCET 2018

Options:

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

Answer: B

Solution:

The common oxidation state for all lanthanides is +3 .

Question24

The magnetic nature of elements depends on the presence of unpaired electrons. Identify the configuration of transition elements which shows highest magnetic moment?

KCET 2017

Options:

- A. $3d^7$
- B. $3d^8$
- C. $3d^5$
- D. $3d^2$

Answer: C

Solution:

The larger the number of unpaired electrons in an element; the greater is the paramagnetic character and larger is the magnetic moment, this can be calculated from the relation.

$$\mu = \sqrt{n(n+2)} \text{ B.M}$$

Where, n is the number of unpaired electrons and μ is magnetic moment. $3d^5$ contains the highest unpaired electron so has the highest magnetic moment.

Question 25

Which of the following statements is wrong regarding lanthanoids?

KCET 2017

Options:

- A. Ln (III) compounds are predominantly ionic in character.
- B. Ln (III) compounds are generally colourless.
- C. Ln (III) hydroxides are mainly basic in nature.
- D. The ionic size of Ln(III) ions decreases with increasing atomic number.

Answer: B

Solution:

The explanation concerns the properties of lanthanoids, specifically focusing on Ln(III) ions. Here is a more refined and professional explanation:

The Ln(III) ions, due to their relatively large size, typically form compounds where the bonding is predominantly ionic.

These Ln(III) compounds are generally colorful. This coloration is due to electronic transitions within the f-orbitals.

Hydroxides of Ln(III) are mainly basic. This basicity is a characteristic of the hydroxides formed by these large, charged ions.

As you move across the lanthanoid series (increasing atomic number), the ionic size of the Ln(III) ions decreases. This trend is known as the lanthanoid contraction, and it occurs because the addition of electrons in f-orbitals does not effectively shield the increasing nuclear charge from the outer electrons.

