The D and F Block Elements

Question1

Given below are two statements :
Statement (I) : The 4f and 5f - series of elements are placed separately in the Periodic table to preserve the principle of classification.
Statement (II) :S-block elements can be found in pure form in nature. In the light of the above statements, choose the most appropriate answer from the options given below :
[27-Jan-2024 Shift 1]

Options:

A. Statement I is false but Statement II is true

B. Both Statement I and Statement II are true

C. Statement I is true but Statement II is false

D. Both Statement I and Statement II are false

Answer: C

Solution:

Solution:
s-block elements are highly reactive and found in combined state.

Question2

NaCl reacts with conc. H_2SO_4 and $K_2Cr_2O_7$ to give reddish fumes (B), which react with NaOH to give yellow solution (C). (B) and (C) respectively are;
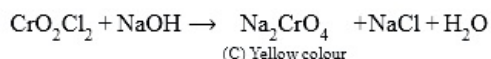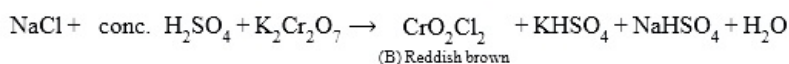[27-Jan-2024 Shift 1]

Options:

A. CrO_2Cl_2, Na_2CrO_4

B. Na_2CrO_4, CrO_2Cl_2

C. CrO_2Cl_2, $KHSO_4$

D. CrO_2Cl_2, $Na_2Cr_2O_7$

Answer: A

Solution:

$$NaCl + \text{ conc. } H_2SO_4 + K_2Cr_2O_7 \rightarrow \underset{\text{(B) Reddish brown}}{CrO_2Cl_2} + KHSO_4 + NaHSO_4 + H_2O$$

$$CrO_2Cl_2 + NaOH \rightarrow \underset{\text{(C) Yellow colour}}{Na_2CrO_4} + NaCl + H_2O$$

Question3

Given below are two statements:

Statement (I) : In the Lanthanoids, the formation of Ce^{+4} is favoured by its noble gas configuration.

Statement (II) : Ce^{+4} is a strong oxidant reverting to the common +3 state.

In the light of the above statements, choose the most appropriate answer from the options given below:
[27-Jan-2024 Shift 2]

Options:

A. Statement I is false but Statement II is true

B. Both Statement I and Statement II are true

C. Statement I is true but Statement II is false

D. Both Statement I and Statement II are false

Answer: B

Solution:

Solution:
Statement (1) is true, Ce^{+4} has noble gas electronic configuration.

Statement (2) is also true due to high reduction potential for $Ce^{4+} / Ce^{3+}(+1.74V)$, and stability of Ce^{3+}, Ce^{4+} acts as strong oxidizing agent.

Question4

Choose the correct option having all the elements with d^{10} electronic configuration from the following:
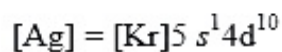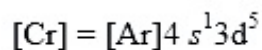**[27-Jan-2024 Shift 2]**

Options:

A. ^{27}Co, ^{28}Ni, ^{26}Fe, ^{24}Cr

B. ^{29}Cu, ^{30}Zn, ^{48}Cd, ^{47}Ag

C. ^{46}Pd, ^{28}Ni, ^{26}Fe, ^{24}Cr

D. ^{28}Ni, ^{24}Cr, ^{26}Fe, ^{29}Cu

Solution:

$[Cr] = [Ar]4s^13d^5$

$[Cd] = [Kr]5s^24d^{10}$

$[Cu] = [Ar]4s^13d^{10}$

$[Ag] = [Kr]5s^14d^{10}$

$[Zn] = [Ar]4s^23d^{10}$

Question5

In alkaline medium. MnO_4^- oxidises I^- to
[29-Jan-2024 Shift 1]

Options:

A. IO_4^-

B. IO^-

C. I_2

D. IO_3^-

Solution:

Solution:

$$2MnO_4^- + H_2O + I^- \xrightarrow{\text{alkaline medium}} 2MnO_2 + 2OH^- + IO_3^-$$
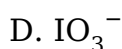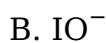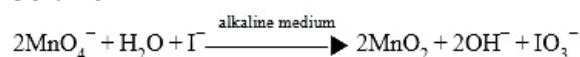
Question6

In chromyl chloride test for confirmation of Cl^- ion, a yellow solution is obtained. Acidification of the solution and addition of amyl alcohol and 10% H_2O_2 turns organic layer blue indicating formation of chromium pentoxide. The oxidation state of chromium in that is
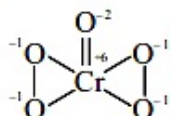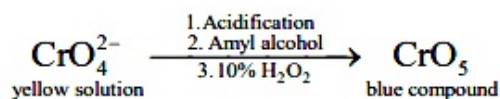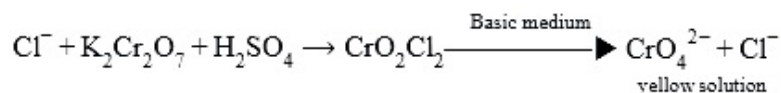**[29-Jan-2024 Shift 1]**

Options:

A. +6

B. +5

C. +10

D. +3

Solution:

$$Cl^- + K_2Cr_2O_7 + H_2SO_4 \rightarrow CrO_2Cl_2 \xrightarrow{\text{Basic medium}} CrO_4^{2-} + Cl^-$$
(yellow solution)

$$CrO_4^{2-} \xrightarrow[\text{3. 10\% } H_2O_2]{\substack{\text{1. Acidification} \\ \text{2. Amyl alcohol}}} CrO_5$$
yellow solution → blue compound

(Cr complex structure: Cr^{+6} with O^{-2} and four O^{-1})

Question7

Which of the following statements are correct about Zn, Cd and Hg ?
A. They exhibit high enthalpy of atomization as the d-subshell is full.
B. Zn and Cd do not show variable oxidation state while Hg shows +I and + II.
C. Compounds of Zn, Cd and Hg are paramagnetic in nature.
D. Zn, Cd and Hg are called soft metals.
Choose the most appropriate from the options given below:
[29-Jan-2024 Shift 2]

Options:

A. B, D only

B. B, C only

C. A, D only

D. C, D only

Solution:

Solution:
(A) Zn, Cd, Hg exhibit lowest enthalpy of atomization in respective transition series.

(C) Compounds of Zn, Cd and Hg are diamagnetic in nature.

Question8

Which of the following acts as a strong reducing agent? (Atomic number : Ce = 58, Eu = 63, Gd = 64, Lu = 71)

Options:

A. Lu^{3+}

B. Gd^{3+}

C. Eu^{2+}

D. Ce^{4+}

Answer: C

Solution:

Solution:

$Eu^{+2} \xrightarrow{\hspace{2cm}} Eu^{+3} + 1e^-$

$[Xe]4f^7 6s^0 \qquad\qquad [Xe]4f^6 6s^0$

Question9

Match List-I with List-II

List-I	List-II
Species	Electronic distribution
(A) Cr^{-2}	(I) $3d^8$
(B) Mn^+	(II) $3d^3 4s^1$
(C) Ni^{-2}	(III) $3d^4$
(D) V^-	(IV) $3d^5 4s^1$

Choose the correct answer from the options given below: [30-Jan-2024 Shift 1]

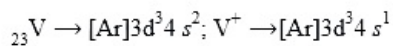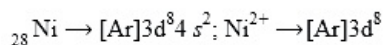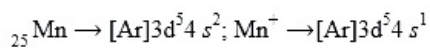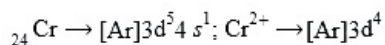**Options:**

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

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

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

D. (A)-II, (B)-I, (C)-IV, (D)-III
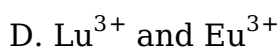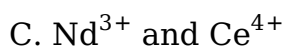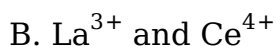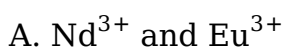
Answer: B

Solution:

$_{24}Cr \rightarrow [Ar]3d^5 4s^1; Cr^{2+} \rightarrow [Ar]3d^4$

$_{25}Mn \rightarrow [Ar]3d^5 4s^2; Mn^+ \rightarrow [Ar]3d^5 4s^1$

$_{28}Ni \rightarrow [Ar]3d^8 4s^2; Ni^{2+} \rightarrow [Ar]3d^8$

$_{23}V \rightarrow [Ar]3d^3 4s^2; V^+ \rightarrow [Ar]3d^3 4s^1$

Question10

Diamagnetic Lanthanoid ions are:
[30-Jan-2024 Shift 1]

Options:

A. Nd^{3+} and Eu^{3+}

B. La^{3+} and Ce^{4+}

C. Nd^{3+} and Ce^{4+}

D. Lu^{3+} and Eu^{3+}

Answer: B

Solution:

$Ce : [Xe]4f^1 5d^1 6s^2; Ce^{4+}$ diamagnetic

$La : [Xe]4f^0 5d^1 6s^2; La^{3+}$ diamagnetic
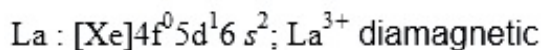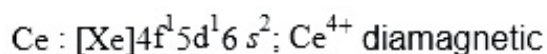
Question11

The orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to
[30-Jan-2024 Shift 2]

Options:

A. Charge transfer transition in both.

B. d → d transition in $KMnO_4$ and charge transfer transitions in $K_2Cr_2O_7$.

C. d → d transition in $K_2Cr_2O_7$ and charge transfer transitions in $KMnO_4$.
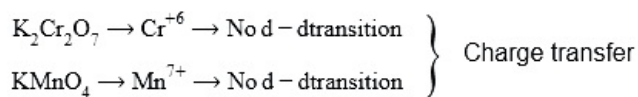
D. d → d transition in both.

Answer: A

Solution:

$$K_2Cr_2O_7 \rightarrow Cr^{+6} \rightarrow No\ d-dtransition$$
$$KMnO_4 \rightarrow Mn^{7+} \rightarrow No\ d-dtransition$$

Charge transfer

Question12

Alkaline oxidative fusion of MnO$_2$ gives " A " which on electrolytic oxidation in alkaline solution produces B. A and B respectively are:
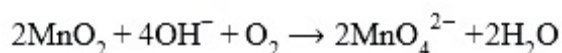**[30-Jan-2024 Shift 2]**

Options:

A. Mn_2O_7 and MnO_4^-

B. MnO_4^{2-} and MnO_4^-

C. Mn_2O_3 and MnO_4^{2-}
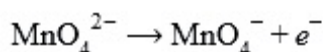
D. MnO_4^{2-} and Mn_2O_7

Answer: B

Solution:

Alkaline oxidative fusion of MnO$_2$:

$$2MnO_2 + 4OH^- + O_2 \rightarrow 2MnO_4^{2-} + 2H_2O$$

Electrolytic oxidation of MnO_4^{2-} in alkaline medium.

$$MnO_4^{2-} \rightarrow MnO_4^- + e^-$$

Question13

A and B formed in the following reactions are:
$CrO_2Cl_2 + 4\,NaOH \rightarrow A + 2\,NaCl + 2H_2O$
$A + 2\,HCl + 2H_2O_2 \rightarrow B + 3H_2O$
[30-Jan-2024 Shift 2]
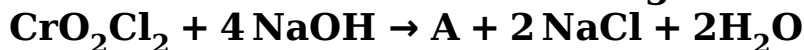
Options:

A. A = Na_2CrO_4, B = CrO_5

B. A = $Na_2Cr_2O_4$, B = CrO_4

C. A = $Na_2Cr_2O_7$, B = CrO_3

D. A = $Na_2Cr_2O_7$, B = CrO_5

Answer: A

Solution:

$$CrO_2Cl_2 + 4\,NaOH \rightarrow \underset{(A)}{Na_2CrO_4} + 2\,NaCl + 2H_2O$$

$$Na_2CrO_4 + 2H_2O_2 + 2\,HCl \rightarrow \underset{(B)}{CrO_5} + \underset{\text{Missing from balanced eqaution}}{2\,NaCl} + 3H_2O$$
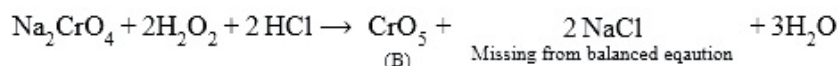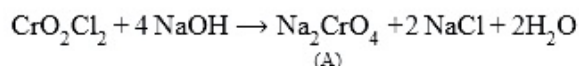
Question14

Identify correct statements from below:
A. The chromate ion is square planar.
B. Dichromates are generally prepared from chromates.
C. The green manganate ion is diamagnetic.
D. Dark green coloured K_2MnO_4 disproportionate in a neutral or acidic medium to give permanganate.
E. With increasing oxidation number of transition metal, ionic character of the oxides decreases.
Choose the correct answer from the options given below:
[31-Jan-2024 Shift 1]

Options:

A. B, C, D only

B. A, D, E only

C. A, B, C only

D. B, D, E only

Answer: D

Solution:

A. CrO_4^{2-} is tetrahedral

B. $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$

C. As per NCERT, green manganate is paramagnetic with 1 unpaired electron.

D. Statement is correct

E. Statement is correct

Question15

The 'Spin only' Magnetic moment for $[Ni(NH_3)_6]^{2+}$ is ___$\times 10^{-1}$ BM.
(given = Atomic number of Ni : 28)
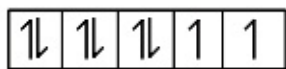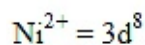**[31-Jan-2024 Shift 1]**

Answer: 28

Solution:

NH_3 act as WFL with Ni^{2+}

$Ni^{2+} = 3d^8$

No. of unpaired electron $= 2$

$\mu = \sqrt{n(n+2)} = \sqrt{8} = 2.82\,BM$

$= 28.2 \times 10^{-1}\,BM$

$x = 28$

Question16

Choose the correct statements from the following
A. Mn_2O_7 is an oil at room temperature

B. V_2O_4 reacts with acid to give VO_2^{2+}

C. CrO is a basic oxide

D. V_2O_5 does not react with acid

Choose the correct answer from the options given below :
[31-Jan-2024 Shift 2]

Options:

A. A, B and D only

B. A and C only

C. A, B and C only

D. B and C only

Answer: B

Solution:

Solution:
(A) Mn_2O_7 is green oil at room temperature.

(B) V_2O_4 dissolve in acids to give VO^{2+} salts.

(C) CrO is basic oxide

(D) V_2O_5 is amphoteric it reacts with acid as well as base.

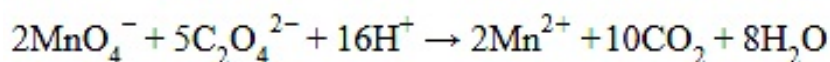
Question17

Number of moles of H$^+$ions required by 1 mole of $MnO_4^-$to oxidise oxalate ion to CO_2 is____
[31-Jan-2024 Shift 2]

Answer: 8

Solution:

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

∴ Number of moles of H$^+$ions required by 1 mole of $MnO_4^-$to oxidise oxalate ion to CO_2 is 8

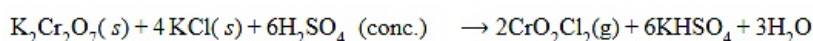
Question18

In the reaction of potassium dichromate, potassium chloride and sulfuric acid (conc.), the oxidation state of the chromium in the product is (+)___
[31-Jan-2024 Shift 2]

Answer: 6

Solution:

Solution:

$$K_2Cr_2O_7(s) + 4KCl(s) + 6H_2SO_4 \text{ (conc.)} \rightarrow 2CrO_2Cl_2(g) + 6KHSO_4 + 3H_2O$$

This reaction is called chromyl chloride test.

Here oxidation state of Cr is +6 .

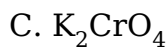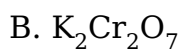---

Question19

Which of the following compounds show colour due to d-d transition?
[1-Feb-2024 Shift 2]

Options:

A. $CuSO_4 \cdot 5H_2O$

B. $K_2Cr_2O_7$

C. K_2CrO_4

D. $KMnO_4$

Answer: A

Solution:

$CuSO_4 \cdot 5H_2O$

$Cu^{2+} : 3d^9 4s^0$
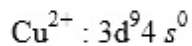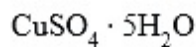
unpaired electron present so it show colour due to d-d transition.

Question20

The transition metal having highest 3rd ionisation enthalpy is :
[1-Feb-2024 Shift 2]

Options:

A. Cr

B. Mn

C. V

D. Fe

Answer: B

Solution:

Mn : $3d^5 4s^2$

Fe : $3d^6 4s^2$

Cr : $3d^5 4s^1$

V : $3d^3 4s^2$
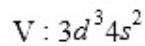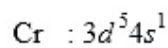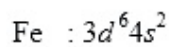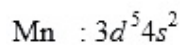
So Mn has highest 3rd IE among all the given elements due to d^5 configuration.

Question21

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : In aqueous solutions Cr^{2+} is reducing while Mn^{3+} is oxidising in nature.

Reason (R) : Extra stability to half filled electronic configuration is observed than incompletely filled electronic configuration.
In the light of the above statement, choose the most appropriate answer from the options given below:
[1-Feb-2024 Shift 2]

Options:

A. Both (A) and (R) are true and (R) is the correct explanation of (A)

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

C. (A) is false but (R) is true

D. (A) is true but (R) is false

Answer: A

Solution:

Solution:
Cr^{2+} is reducing as it configuration changes from d^4 to d^3 due to formation of Cr^{3+}, which has half filled t_{2g} level, on other hand, the change Mn^{3+} to Mn^{2+} result half filled d^5 configuration which has extra stability.

Question22

The magnetic moment of a transition metal compound has been calculated to be 3.87 B.M. The metal ion is
[24-Jan-2023 Shift 1]

Options:

A. Cr^{2+}

B. Mn^{2+}

C. V^{2+}

D. Ti^{2+}

Answer: C

Solution:

Cr^{+2} : [Ar], $3d^4$, $4\,s^0 n = 4$, $\mu = \sqrt{4(4+2)} = \sqrt{24}$
$= 4.89\,BM$
Mn^{+2} : [Ar], $3d^5$, $4\,s^0 n = 5$, $\mu = \sqrt{5(5+2)} = \sqrt{35}$
$= 5.91\,BM$
V^{+2} : [Ar], $3d^3$, $4\,s^0 n = 3$, $\mu = \sqrt{3(3+2)} = \sqrt{15}$
$= 3.87\,BM$
Ti^{+2} : [Ar], $3d^2$, $4\,s^0 n = 2$, $\mu = \sqrt{2(2+2)} = \sqrt{8}$
$= 2.82\,BM$

Question23

An ammoniacal metal salt solution gives a brilliant red precipitate on addition of dimethylglyoxime. The metal ion is :
[24-Jan-2023 Shift 1]

Options:

A. Cu^{2+}

B. Co^{2+}

C. Fe^{2+}

D. Ni^{2+}

Answer: D

Solution:

Solution:

$$Ni^{+2} + 2\,DMG \xrightarrow{NH_3(aq)} [Ni(DMG)_2]$$
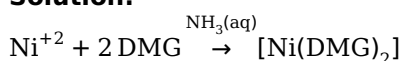
Question24

Which one amongst the following are good oxidizing agents?
A. Sm^{2+}
B. Ce^{2+}
C. Ce^{4+}
D. Tb^{4+}
Choose the most appropriate answer from the options given below:
[24-Jan-2023 Shift 2]

Options:

A. Conly

B. D only

C. A and B only

D. C and D only

Answer: D

Solution:

Solution:
Ce^{+4} and Tb^{+4} act as oxidising agent.

Question25

$K_2Cr_2O_7$ paper acidified with dilute H_2SO_4 turns green when exposed to [24-Jan-2023 Shift 2]

Options:

A. Carbon dioxide

B. Sulphur trioxide

C. Hydrogen sulphide

D. Sulphur dioxide

Answer: D

Solution:

Solution:
$3SO_2 + Cr_2O_7{}^{2-} + 2H^+ \rightarrow 3SO_4{}^{2-} + 2Cr^{+3} + H_2O$
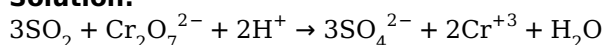
Question26

Potassium dichromate acts as a strong oxidizing agent in acidic solution. During this process, the oxidation state changes from [25-Jan-2023 Shift 2]

Options:

A. +3 to +1

B. +6 to +3

C. +2 to +1

D. +6 to +2

Answer: B

Solution:

Solution:

$14H^+ + 6e^- + \underset{+6}{Cr_2O_7{}^{-2}} \longrightarrow \underset{+3}{2Cr^{+3}} + 7H_2O$
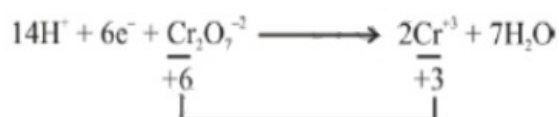
Question27

During the borax bead test with $CuSO_4$, a blue green colour of the bead

was observed in oxidising flame due to the formation of
[29-Jan-2023 Shift 1]

Options:

A. Cu_3B_2

B. Cu

C. $Cu(BO_2)_2$

D. CuO

Answer: C

Solution:

Solution:
Blue green colour is due to formation of $Cu(BO_2)_2$

$CuSO_4 \xrightarrow{\Delta} CuO + SO_3$
$CuO + B_2O_3 \rightarrow Cu(BO_2)_2$

Question28

The set of correct statements is:
(i) Manganese exhibits +7 oxidation state in its oxide.
(ii) Ruthenium and Osmium exhibit +8 oxidation in their oxides.
(iii) Sc shows +4 oxidation state which is oxidizing in nature.
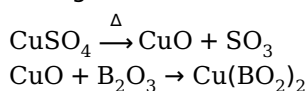**(iv) Cr shows oxidising nature in +6 oxidation state.**
[29-Jan-2023 Shift 2]

Options:

A. (ii) and (iii)

B. (i), (ii) and (iv)

C. (i) and (iii)

D. (ii), (iii) and (iv)

Answer: B

Solution:

Solution:
(i), (ii) and (iv) correct.
Manganese exhibits +7 oxidation state in its oxide. (Mn_2O_7)
Ru& Os from RuO_4 & OsO_4 oxide in +8 oxidation state
Cr in +6 oxidation act is oxidizing.
Sc does not show +4 oxidation state.

Question29

A solution of CrO_5 in amyl alcohol has a....colour
[29-Jan-2023 Shift 2]

Options:

A. Green

B. Orange-Red

C. Yellow

D. Blue

Answer: D

Solution:

Solution:
A solution of CrO_5 in amyl alcohol has a blue colour. So, option (4) is correct.

Question30

During the qualitative analysis of SO_3^{2-} using dilute H_2SO_4, SO_2 gas is evolved which turns $K_2Cr_2O_7$ solution (acidified with dilute H_2SO_4):
[30-Jan-2023 Shift 1]

Options:

A. Black

B. Red

C. Green

D. Blue

Answer: C

Solution:

Solution:
$$Cr_2O_7^{2-} + SO_3^{2-} \xrightarrow{H^+} \underset{Green}{Cr^{3+}} + SO_4^{2-}$$
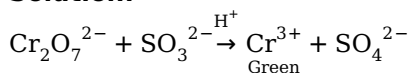
Question31

When Cu^{2+} ion is treated with KI, a white precipitate, X appears in solution. The solution is titrated with sodium thiosulphate, the compound Y is formed. X and Y respectively are

Options:

A. $X = Cu_2I_2$
$Y = Na_2S_4O_5$

B. $X = Cu_2I_2$ $Y = Na_2S_4O_6$

C. $X = CuI_2$ $Y = Na_2S_4O_3$

D. $X = CuI_2$ $Y = Na_2S_4O_6$

Answer: B
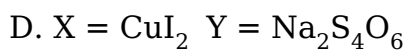
Solution:
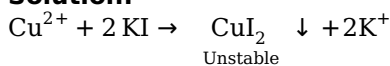
Solution:
$Cu^{2+} + 2KI \rightarrow \underset{\text{Unstable}}{CuI_2} \downarrow + 2K^+$
I^- is strong R.A it reduces Cu^{2+} to Cu^+
$2CuI_2 \rightarrow \underset{\text{(White)'X'}}{Cu_2I_2} \downarrow + I_2$
$KI + I_2 \rightarrow K^+I_3^-$ (Brown solution)
$I_3^- \rightleftharpoons I_2 + I^-$
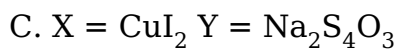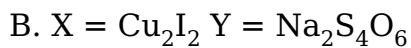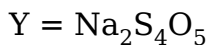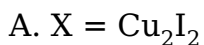$KI_3 + Na_2S_2O_3 \rightarrow KI + \underset{\text{(Y)}}{Na_2S_4O_6}$

Question32

The correct order of basicity of oxides of vanadium is [31-Jan-2023 Shift 1]

Options:

A. $V_2O_3 > V_2O_4 > V_2O_5$

B. $V_2O_3 > V_2O_5 > V_2O_4$

C. $V_2O_5 > V_2O_4 > V_2O_3$

D. $V_2O_4 > V_2O_3 > V_2O_5$
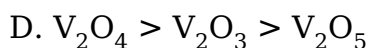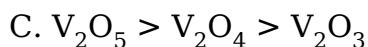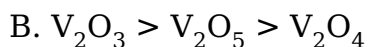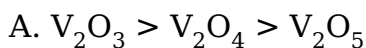
Answer: A

Solution:

Solution:
With increase in % of oxygen acidic nature of oxide of an element increase and basic nature decreases

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Question33

Highest oxidation state of Mn is exhibited in Mn$_2$O$_7$. The correct statements about Mn$_2$O$_7$ are

(A) Mn is tetrahedrally surrounded by oxygen atoms
(B) Mn is octahedrally surrounded by oxygen atoms
(C) Contains Mn-O-Mn bridge
(D) Contains Mn-Mn bond.
Choose the correct answer from the options given below
[1-Feb-2023 Shift 1]

Options:

A. A and C only

B. A and D only

C. B and D only

D. B and C only
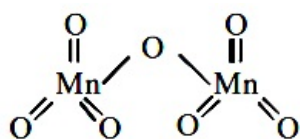
Solution:

Question34

A solution of FeCl$_3$ when treated with K$_4$[Fe(CN)$_6$] gives a prussiun blue precipitate due to the formation of
[1-Feb-2023 Shift 1]

Options:

A. K[Fe$_2$(CN)$_6$]

B. Fe[Fe(CN)$_6$]

C. Fe$_3$[Fe(CN)$_6$]$_2$

D. Fe$_4$[Fe(CN)$_6$]$_3$

Solution:

Solution:
Formation of Prussian blue complex takes place.

Question35

Which of the following are the example of double salt?
(A) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$
(B) $CuSO_4 \cdot 4NH_3 \cdot H_2O$
(C) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$
(D) $Fe(CN)_2 \cdot 4KCN$
Choose the correct answer.
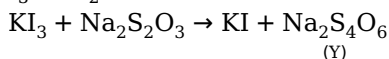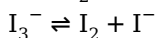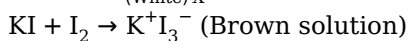[1-Feb-2023 Shift 1]
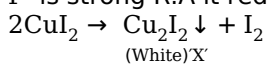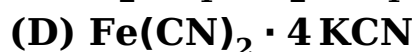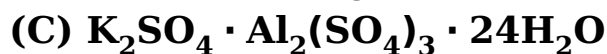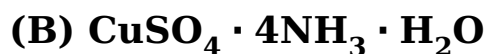
Options:

A. A and C only

B. A and B only

C. A, B and D only

D. B and D only

Answer: A

Solution:

Solution:
Double salt contain's two or more types of salts. $CuSO_4.4NH_3 \cdot H_2O$ and $Fe(CN)_2 .4KCN$ are complex compounds.

Question36

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Cu^{2+} in water is more stable than Cu^+.
Reason (R) : Enthalpy of hydration for Cu^{2+} is much less than that of Cu^+.
In the light of the above statements, choose the correct answer from the options given below :
[1-Feb-2023 Shift 2]

Options:

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

B. (A) is correct but (R) is not correct.

C. (1) is not correct but (R) is correct.

D. Both (A) and (R) are correct but (R) is not the correct explanation of (A).

Answer: A

Solution:

$2Cu^+ \rightarrow Cu^{2+} + Cu$
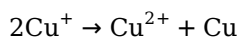
The stability of Cu^{2+} (aq) rather than Cu^+(aq), is due to the much more negative $\Delta_{hyd}H$ of Cu^{2+} (aq) than Cu^+(aq), which more than compensates for the second ionisation enthalpy of Cu.

Question37

Which element is not present in Nessler's reagent ?
[1-Feb-2023 Shift 2]

Options:

A. Mercury

B. Potassium

C. Iodine

D. Oxygen

Answer: D

Solution:

Solution:
(Nessler's Reagent $\rightarrow K_2[HgI_4]$

Question38

In ammonium-phosphomolybdate, the oxidation state of Mo is + ___
[6-Apr-2023 shift 1]

Answer: 6

Solution:
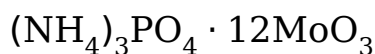
$(NH_4)_3PO_4 \cdot 12MoO_3$
Let X = oxidation state of Mo in MoO_3
$X + (-2) \times 3 = 0$
$X = +6$
Ans: 6

Question39

In chromyl chloride, the number of d-electrons present on chromium is same as in (Given at no. of Ti : 22, V: 23, Cr : 24, Mn : 25, Fe : 26)

Options:

A. Fe (III)

B. V (IV)

C. Ti (III)

D. Mn (VII)

Answer: D

Solution:

Solution:
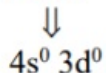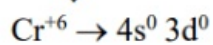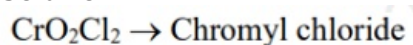
$CrO_2Cl_2 \rightarrow$ Chromyl chloride
$\Downarrow$
$Cr^{+6} \rightarrow 4s^0\ 3d^0$
$\left.\begin{array}{l} \\ Mn(vii) \rightarrow Mn^{+7} \\ \Downarrow \\ 4s^0\ 3d^0 \end{array}\right\}$ — Same

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Question40

Which halogen is known to cause the reaction given below:
$$2Cu^{2+} + 4X^- \rightarrow Cu_2X_2(\ s) + X_2$$
[8-Apr-2023 shift 1]
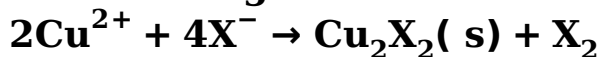
Options:

A. All halogens

B. Only chlorine

C. Only Bromine

D. Only Iodine

Answer: D

Solution:

(Only iodine)
$2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$
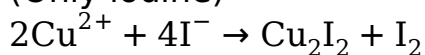
Question41

Given below are two statements :

Statement I : Aqueous solution of $K_2Cr_2O_7$ is preferred as a primary standard in volumetric analysis over $Na_2Cr_2O_7$ aqueous solution.
Statement II : $K_2Cr_2O_7$ has a higher solubility in water than $Na_2Cr_2O_7$
In the light of the above statements, choose the correct answer from the options given below:
[10-Apr-2023 shift 1]

Options:

A. Statement I is false but Statement I is true

B. Statement I is true but Statement II is false

C. Both Statement I and Statement II are true

D. Both Statement I and Statement II are false

Answer: B

Solution:

Solution:
(1) $K_2Cr_2O_7$ is used as primary standard. The concentration $Na_2Cr_2O_7$ changes in aq. solution.
(2) It is less soluble than $Na_2Cr_2O_7$

Question42

Prolonged heating is avoided during the preparation of ferrous ammonium sulphate to
[10-Apr-2023 shift 1]

Options:

A. prevent hydrolysis

B. prevent reduction

C. prevent breaking

D. prevent oxidation

Answer: C

Solution:

Solution:
It may oxidise ferrous ion to ferric ions.

Question43

Which of the following statements are correct?

(A) The M^{3+}/M^{2+} reduction potential for iron is greater than manganese
(B) The higher oxidation states of first row d-block elements get stabilized by oxide ion.
(C) Aqueous solution of Cr^{2+} can liberate hydrogen from dilute acid.
(D) Magnetic moment of V^{2+} is observed between 4.4-5.2 BM.
Choose the correct answer from the options given below:
[10-Apr-2023 shift 1]

Options:

A. (C), (D) only

B. (B), (C) only

C. (A), (B), (D) only

D. (A), (B) only

Answer: B

Solution:

Solution:
(A) The M^{3+}/M^{2+} reduction potential for manganese is greater than iron
(B) $E_{Fe^{+3}/Fe^{+2}}{}^0 = +0.77$
$E_{Mn^{+3}/Mn^{+2}}{}^0 = +1.57$
(C) $E_{Cr^{+3}/Cr^{+2}}{}^0 = -0.26$
$\therefore Cr^{2\oplus} + H^{\oplus} \rightarrow Cr^{3\oplus} + \frac{1}{2}H_2$
(D) $V^{2\oplus} = 3$ unpaired electron
Magnetic Moment $= 3.87$ B.M

Question44

When a solution of mixture having two inorganic salts was treated with freshly prepared ferrous sulphate in acidic medium, a dark brown ring was formed whereas on treatment with neutral $FeCl_3$. it gave deep red colour which disappeared on boiling and a brown red ppt was formed. The mixture contains
[11-Apr-2023 shift 1]

Options:

A. $C_2O_4{}^{2-}$ & $NO_3{}^{-}$

B. $SO_3{}^{2-}$ & $C_2O_4{}^{2-}$

C. CH_3COO^{-} & $NO_3{}^{-}$

D. $SO_3{}^{2-}$ & CH_3COO^{-}

Answer: C

Solution:

$CH_3COO^- + FeCl_3 \rightarrow Fe(CH_3COO)_3$ or $[Fe_3 (OH)_2 (CH_3COO)_6]^+$

Blood red colour

$\downarrow \Delta$

$Fe(OH)_2 (CH_3COO)\downarrow$

Red-brown precipitate

$2NO_3^- + 4H_2SO_4 + 6Fe^{2+} \rightarrow 6Fe^{3+} + 2NO\uparrow + 4SO_4^{2-} + 4H_2O$

$[Fe(H_2O)_6]^{2+} + NO \rightarrow [Fe(H_2O)_5 (NO)]^{2+} + H_2O$

Brown
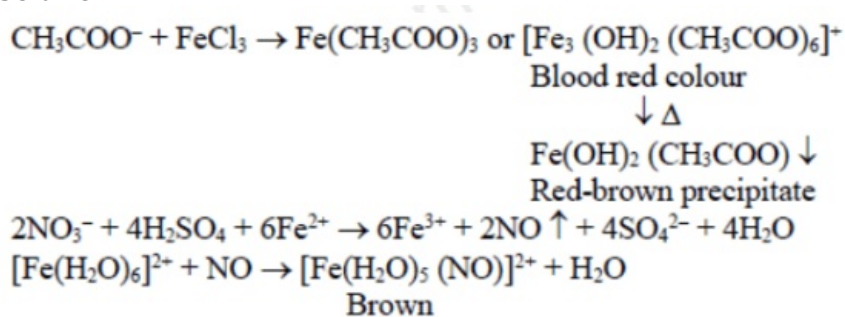
Question45

The pair of lanthanides in which both elements have high third - ionization energy is:
[13-Apr-2023 shift 1]

Options:

A. Dy, Gd

B. Eu, Gd

C. Lu, Yb

D. Eu, Yb

Answer: D

Solution:

Solution:

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

Yb^{+2} : $[Xe]4f^{14}$ High IE due to half filled & fully filled configurations

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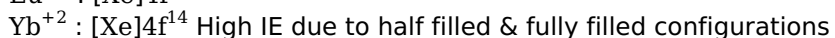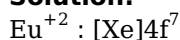
Question46

In Chromyl chloride, the oxidation state of chromium is (+) _____.
[15-Apr-2023 shift 1]

Answer: 6

Solution:

$$CrO_2 \; CO_2 \quad \text{(Chromyl chloride)}$$
$$\downarrow$$
$$x - 4 - 2 = 0$$
$$\boxed{x = +6}$$

Question47

The difference in oxidation state of chromium in chromate and dichromate salts is ___
[24-Jun-2022-Shift-1]

Answer: 0

Solution:

Solution:
Chromate ion $\rightarrow CrO_4^{2-}$, oxidation state of $Cr = +6$
Dichromate ion $\rightarrow CrO_7^{2-}$, oxidation state of $Cr = +6$
$\therefore$ Difference in oxidation state = zero

Question48

Manganese (VI) has ability to disproportionate in acidic solution. The difference in oxidation states of two ions it forms in acidic solution is___
[24-Jun-2022-Shift-2]

Answer: 3

Solution:

Solution:
Manganese (VI) disproportionates in acidic medium as
$$3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$$
The difference in oxidation states of Mn in the products formed $= 7 - 4 = 3$
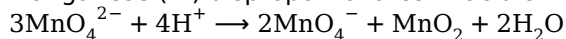
Question49

Cerium (IV) has a noble gas configuration. Which of the following is

correct statement about it?
[25-Jun-2022-Shift-1]

Options:

A. It will not prefer to undergo redox reactions.

B. It will prefer to gain electron and act as an oxidizing agent.

C. It will prefer to give away an electron and behave as reducing agent.

D. It acts as both, oxidizing and reducing agent.

Answer: B

Solution:

Solution:
Cerium exists in two different oxidation state $+3, +4$
$Ce^{+4} + e^- \rightarrow Ce^{3+}$ $E^0 = +1.61V$
$Ce^{+3} + 3e^- \rightarrow Ce$ $E^0 = -2.336V$
It shows Ce^{+4} acts as a strong oxidising agent \& accepts electron.
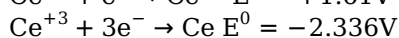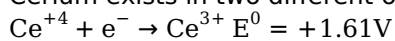
Question50

Among the following, which is the strongest oxidizing agent?
[25-Jun-2022-Shift-1]

Options:

A. Mn^{3+}

B. Fe^{3+}

C. Ti^{3+}

D. Cr^{3+}

Answer: A

Solution:

Solution:
Strongest oxidising agent have highest reduction potential value
$E^{\circ}_{Fe^{3+} \mid Fe^{2+}} = +0.77V$ $E^{\circ}_{Ti^{3+} \mid Ti^{2+}} = -0.37V$
$E^{\circ}_{Mn^{+3} \mid Mn^{+2}} = +1.57V$ $E^{\circ}_{Cr^{3+} \mid Cr^{2+}} = -0.41V$
Mn^{+3} is the best oxidising agent among the given series.
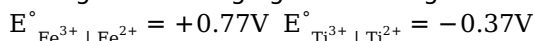
Question51

The metal ion (in gaseous state) with lowest spin-only magnetic moment value is

Options:

A. V^{2+}

B. Ni^{2+}

C. Cr^{2+}

D. Fe^{2+}

Answer: B

Solution:

Solution:

	Valence shell configuration	Unpaired electrons
V^{2+}	$3d^3 4s^0$	$n = 3$
Ni^{2+}	$3d^8 4s^0$	$n = 2$
Cr^{2+}	$3d^4 4s^0$	$n = 4$
Fe^{2+}	$3d^6 4s^0$	$n = 4$

Question52

The spin-only magnetic moment value of the most basic oxide of vanadium among V_2O_3, V_2O_4 and V_2O_5 is_____ B.M. (Nearest integer) [26-Jun-2022-Shift-1]

Answer: 3

Solution:

Solution:
The most basic oxide among V_2O_3, V_2O_4 and V_2O_5 is V_2O_3
$V_2O_3 = V^{+3}(d^2)$
Magnetic moment $= \sqrt{2(2 + 2)} = \sqrt{8}$
$= 2.83 \approx 3$
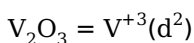
Question53

The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?

Options:

A. Ce (At. No. 58)

B. La (At. No. 57)

C. Lu (At. No. 71)

D. Gd (At. No. 64)

Answer: A

Solution:
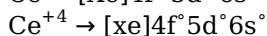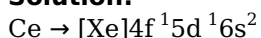
Solution:
Ce → [Xe]4f^{1}5d^{1}6s^2
Ce^{+4} → [xe]4f$^\circ$5d$^\circ$6s$^\circ$
Cerium in +4 oxidation state acquires inert gas configuration.

Question54

The number of statements correct from the following for Copper (at. no. 29) is/are____
(A) Cu(II) complexes are always paramagnetic.
(B) Cu(I) complexes are generally colourless
(C) Cu(I) is easily oxidized
(D) In Fehling solution, the active reagent has Cu(I)
[27-Jun-2022-Shift-1]

Answer: 3

Solution:

Solution:
(A) Cu (II) complexes are always paramagnetic as they have one unpaired electron due to d^9 configuration of Cu(II)
(B) Cu(I) complexes are generally colourless due to d^{10} configuration.
(C) Cu(I) is easily oxidised to Cu^{+2} in aqueous solution 2Cu$^+$ → Cu^{+2} + Cu
Cu^{+1} disproportionates to Cu^{+2} and Cu
(E$_{cell}$$^\circ$ > 0 for this cell reaction in aqueous solution)
In Fehling's solution, active reagent has Cu(II) which is reduced to Cu(I) on reaction with aldehydes.

Question55

Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is _____B.M. (Nearest integer)

Answer: 6

Solution:

$KMnO_4$ (acidic medium) $+ H_2C_2O_4 \rightarrow CO_2 + Mn^{+2}$
Mn^{+2} has 5 unpaired electrons
$\therefore$ Spin only magnetic moment $= \sqrt{5(5+2)}$
$= \sqrt{5 \times 7}$
$= \sqrt{35}$
$\simeq 5.92$ B.M.
$\simeq 6$ B.M.

Question56

The ' f ' orbitals are half and completely filled, respectively in lanthanide ions
[Given : Atomic no. Eu, 63; Sm, 62; Tm, 69; Tb, 65; Yb, 70; Dy, 66]
[27-Jun-2022-Shift-2]

Options:

A. Eu^{2+} and Tm^{2+}

B. Sm^{2+} and Tm^{3+}

C. Tb^{4+} and Yb^{2+}

D. Dy^{3+} and Yb^{3+}

Answer: C

Solution:

Solution:
$T b \rightarrow 4f^9 6s^2$
$Tb^{+4} \rightarrow 4f^7$
$Yb \rightarrow 4f^{14} 6 s^2$
$Yb^{+2} \rightarrow 4f^{14}$
Hence, the pair Tb^{+4} and Yb^{+2} have half filled and completely filled f subshells respectively.

Question57

Dihydrogen reacts with CuO to give
[28-Jun-2022-Shift-1]

Options:

A. CuH_2

B. Cu

C. Cu_2O

D. $Cu(OH)_2$

Answer: B

Solution:

Solution:
$CuO + H_2 \rightarrow Cu + H_2O$ (under hot conditions)

Question58

Which one of the lanthanoids given below is the most stable in divalent form?
[28-Jun-2022-Shift-1]

Options:

A. Ce (Atomic Number 58)

B. Sm (Atomic number 62)

C. Eu (Atomic Number 63)

D. Yb (Atomic Number 70)

Answer: C

Solution:

Solution:
Electronic configuration of Europium (Eu) is $[Kr]4f^7 6s^2$. It can loose two electron to gain the half filled stable state. Hence, +2 oxidation state is most stable.

Question59

The number of terminal oxygen atoms present in the product B obtained from the following reaction is_____
$FeCr_2O_4 + Na_2CO_3 + O_2 \rightarrow A + Fe_2O_3 + CO_2$
$A + H^+ \rightarrow B + H_2O + Na^+$
[29-Jun-2022-Shift-1]

Answer: 6

Solution:

$FeCr_2O_4 + Na_2CO_3 + O_2 \rightarrow Fe_2O_3 + CO_2 + Na_2CrO_4$

$Na_2CrO_4 + H^+ \rightarrow Cr_2O_7^{-2} + H_2O + Na^+$

Question60

An acidified manganate solution undergoes disproportionation reaction. The spin-only magnetic moment value of the product having manganese in higher oxidation state is _____B.M. (Nearest integer)
[29-Jun-2022-Shift-1]

Answer: 0

Solution:

Solution:

$3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2^{+4} + 2H_2O$

$Mn^{+7} = $ no. of unpaired electrons is ' 0 '

$\mu = 0$ B.M.

Question61

The reaction of H_2O_2 with potassium permanganate in acidic medium leads to the formation of mainly :
[25-Jul-2022-Shift-1]

Options:

A. Mn^{2+}

B. Mn^{4+}

C. Mn^{3+}

D. Mn^{6+}

Answer: A

Solution:

$H_2O_2 + MnO_4^- \rightarrow Mn^{2+} + O_2$ (unbalanced)

Question62

Among Co^{3+}, Ti^{2+}, V^{2+} and Cr^{2+} ions, one if used as a reagent cannot liberate H_2 from dilute mineral acid solution, its spin-only magnetic moment in gaseous state is B.M. (Nearest integer)
[25-Jul-2022-Shift-1]

Answer: 5

Solution:

Solution:
Co^{3+} will not liberate H_2 gas an reaction with dilute acid
$E_{Co^{3+}/Co^{2+}}^{O} = +1.97$
And Co^{3+} has electronic configuration $= [Ar]3d^6$
∴4 unpaired e^- are present in it
∴ Spin-only magnetic moment $= \sqrt{4(4+2)} = 4.92 \approx 5$

Question63

The spin-only magnetic moment value of the compound with strongest oxidizing ability among MnF_4, MnF_3 and MnF_2 is _____ B.M. [nearest integer]
[26-Jul-2022-Shift-2]

Answer: 5

Solution:

Solution:

$$\begin{array}{ccc} MnF_4 & MnF_3 & MnF_2 \\ \searrow & \searrow & \searrow \\ +4 & +3 & +2 \\ E.C = [Ar]3d^3 & [Ar]3d^4 & [Ar]3d^5 \end{array}$$

Hence $MnF_3 \Rightarrow$ strongest O.A
$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.89 = 5$

Question64

Given below are two statements.
Statement I: Iron (III) catalyst, acidified $K_2Cr_2O_7$ and neutral $KMnO_4$ have the ability to oxidise I^- to I_2 independently.
Statement II: Manganate ion is paramagnetic in nature and involves $p\pi - p\pi$ bonding.
In the light of the above statements, choose the correct answer from the options given below.
[27-Jul-2022-Shift-1]

Options:

A. Both Statement I and Statement II are true.

B. Both Statement I and Statement II are false.

C. Statement I is true but Statement II is false.

D. Statement I is false but Statement II is true.

Answer: B

Solution:

Solution:
Manganate ion MnO_4^{2-} has tetrahedral structure

has only $d\pi - p\pi$-bonds.
Fe^{3+} is not used as a catalyst in the conversion of I' to I_2 by $K_2Cr_2O_7 \cdot K_2Cr_2O_7$ oxidise I^- in acidic medium easily

----

Question65

The total number of Mn = O bonds in Mn_2O_7 is _____.
[27-Jul-2022-Shift-1]

Options:

A. 4

B. 5

C. 6

D. 3

Answer: C

Solution:

Solution:

Structure of Mn_2O_7 is as :

∴ There are total $6M = O$ bonds are present in Mn_2O_7 compound.

Question66

In the titration of $KMnO_4$ and oxalic acid in acidic medium, the change in oxidation number of carbon at the end point is _____.
[27-Jul-2022-Shift-1]

Answer: 1

Solution:

Solution:

$16H^+ + 2MnO_4^- + 5C_2O_4^{2-} \rightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$

During titration of oxalic acid by $KMnO_4$, oxalic acid converts into CO_2.

∴ Change in oxidation state of carbon $= 1$

Question67

In neutral or alkaline solution, MnO_4^- oxidises thiosulphate to :
[27-Jul-2022-Shift-2]

Options:

A. $S_2O_7^{2-}$

B. $S_2O_8^{2-}$

C. SO_3^{2-}

D. SO_4^{2-}

Answer: D

Solution:

$$8\text{MnO}_4^- + 3\text{S}_2\text{O}_3^{2-} + \text{H}_2\text{O} \xrightarrow[\text{alk. solution}]{\text{neutral or}} 8\text{MnO}_2 + 6\text{SO}_4^{2-} + 2\text{OH}^-$$

Question68

The oxidation state of manganese in the product obtained in a reaction of potassium permanganate and hydrogen peroxide in basic medium is _____.

[27-Jul-2022-Shift-2]

Answer: 4

Solution:

Solution:

$$2\text{KMnO}_4 + 3\text{H}_2\text{O}_2 \xrightarrow{\text{basic medium}} 2\text{MnO}_2 + 3\text{O}_2 + 2\text{H}_2\text{O} + 2\,\text{KOH}$$

Question69

Which of the following has least tendency to liberate H_2 from mineral acids?
[28-Jul-2022-Shift-1]

Options:

A. Cu

B. Mn

C. Ni

D. Zn

Answer: A

Solution:

The metal atom whose oxidation potential is less than that of hydrogen can release H_2 from mineral acids.
$\text{E}_{\text{Zn}/\text{Zn}^{+2}} = 0.76$
$\text{E}_{\text{Ni}/\text{Ni}^{\circ 2}} = 0.25$
$\text{E}_{\text{Mn}/\text{Mn}^{+2}} = 1.18$
$\text{E}_{\text{Cu}^\circ/\text{Cu}^{+2}} = -0.34$

Question70

The disproportionation of MnO_4^{2-} in acidic medium resulted in the formation of two manganese compounds A and B. If the oxidation state of M n in B is smaller than that of A, then the spin-only magnetic moment (μ) value of B in BM is _____.(Nearest integer)
[28-Jul-2022-Shift-1]

Answer: 4

Solution:

Solution:
$3MnO_4^{-2} + 4H^+ \rightarrow MnO_2 + MnO_4^-$
$Mn \rightarrow 4s^2 3d^5$
$Mn^{+4} \rightarrow 3d^3$
$n = 3$
$\mu = \sqrt{n(n+2)}$
$\quad = \sqrt{3(5)}$
$\; = \sqrt{15}$
$\; = 3.87 \approx 4$ B.M.

Question71

Which of the following pair is not isoelectronic species?
(At. no. Sm, 62; Er, 68; Yb, 70; Lu, 71; Eu, 63; Tb, 65; Tm, 69)
[28-Jul-2022-Shift-2]

Options:

A. Sm^{2+} and Er^{3+}

B. Yb^{2+} and Lu^{3+}

C. Eu^{2+} and Tb^{4+}

D. Tb^{2+} and Tm^{4+}

Answer: 0

Solution:

Solution:
Species having same number of electrons are isoelectronic

$Tb \longrightarrow 65Tb^{+2} \longrightarrow 63$ electrons
$Tm \longrightarrow 69Tm^{+4} \longrightarrow 65$ electrons $\Big\}$ not isoelectronic

$Sm^{+2} \longrightarrow 60$ electrons
$Er^{+3} \longrightarrow 65$ electrons $\Big\}$ not isoelectronic

Question72

The reaction of zinc with excess of aqueous alkali, evolves hydrogen gas and gives :
[29-Jul-2022-Shift-1]

Options:

A. $Zn(OH)_2$

B. ZnO

C. $[Zn(OH)_4]^{2-}$

D. $[ZnO_2]^{2-}$

Answer: C

Solution:

Solution:
Zinc dissolves in excess of aqueous alkali.
$Zn + 2OH^- + 2H_2O \longrightarrow [Zn(OH)_4]^{2-} + H_2 \uparrow$ (Tetrahydroxozincate(II) ion)
However, this reaction in NCERT is given as
$Zn + 2\,NaOH \longrightarrow Na_2ZnO_2 + H_2 \uparrow$
$ZnO_2{}^{2-}$ is anhydrous form of $[Zn(OH)_4]^{2-}$.
$ZnO_2{}^{2-} + 2H_2O \rightleftharpoons [Zn(OH)_4]^{2-}$
So in aqueous medium best answer of this question is $[Zn(OH)_4]^{2-}$.

Question73

In following pairs, the one in which both transition metal ions are colourless is :
[29-Jul-2022-Shift-1]

Options:

A. Sc^{3+}, Zn^{2+}

B. Ti^{4+}, Cu^{2+}

C. V^{2+}, Ti^{3+}

D. Zn^{2+}, Mn^{2+}

Answer: A

Solution:

Solution:
Sc^{+3} and Zn^{+2} are colourless as they contain no unpaired electron. Whereas the transition metal ions Cu^{+2}, Ti^{+3}, V^{+2} and Mn^{+2} are coloured as they contain unpaired electrons.

The unpaired electron from lower energy d orbital gets excited to a higher energy d orbital on absorbing light of frequency which lies in visible region. The colour complementary to light absorbed is observed.

Question74

In neutral or faintly alkaline medium, KMnO$_4$ being a powerful oxidant can oxidize, thiosulphate almost quantitatively, to sulphate. In this reaction overall change in oxidation state of manganese will be :
[29-Jul-2022-Shift-1]

Options:

A. 5

B. 1

C. 0

D. 3

Answer: D

Solution:

Solution:
In neutral or Faintly alkaline medium, thiosulphate is oxidised almost quantitatively to sulphate ion according to reaction given below,
$8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$
Here the Mn changes from Mn^{+7} to Mn^{+4}
Thus overall change in its oxidation number would be of 3 .

Question75

Which of the following 3d-metal ion will give the lowest enthalpy of hydration (Δ_{hyd} H) when dissolved in water?
[29-Jul-2022-Shift-2]

Options:

A. Cr^{2+}

B. Mn^{2+}

C. Fe^{2+}

D. Co^{2+}

Answer: B

Solution:

Ion	ΔH_{Hyd}^{O} (kJ/mole)
Cr^{2+}	−1925
Mn^{2+}	−1862
Fe^{2+}	−1998
Co^{2+}	−2079

Question76

The major components of German silver are
[25 Feb 2021 Shift 2]

Options:

A. Cu, Z n and Ag

B. Cu, Z n and N i

C. Ge, Cu and Ag

D. Z n, N i and Ag

Answer: B

Solution:

Solution:
The major components of German silver are
Cu : 25 − 30%, Z n : 25 − 30% and N i : 40 − 30%.

Question77

In which of the following pairs, the outer most electronic configuration will be the same?
[25 Feb 2021 Shift 1]

Options:

A. V^{2+} and Cr^{+}

B. Cr^{+} and $M n^{2+}$

C. $N i^{2+}$ and Cu^{+}

D. $F e^{2+}$ and Co^{+}

Answer: B

Solution:

(a) $V^{2+} - [Ar]3d^3$; $Cr^+ - [Ar]3d^5$
(b) $Cr^+ - [Ar]3d^5$; $Mn^{2+} - [Ar]3d^5$
(c) $Ni^{2+} - [Ar]3d^8$; $Cu^+ - [Ar]3d^{10}$
(d) $Fe^{2+} - [Ar]3d^6$; $Co^+ - [Ar]3d^74s^1$
Thus, in option (b), both ions have same outer most electronic configuration.

Question78

What is the correct order of the following elements with respect to their density ?
[24 Feb 2021 Shift 2]

Options:

A. $Cr < Zn < Co < Cu < Fe$

B. $Zn < Cu < Co < Fe < Cr$

C. $Zn < Cr < Fe < Co < Cu$

D. $Cr < Fe < Co < Cu < Zn$

Answer: C

Solution:

Solution:
Generally, due to decrease in metallic radius and increase in atomic mass density increase across the period from left to right.

Metal	Density (g/cm^3)
Zn	7.13
Cr	7.19
Fe	7.8
Co	8.7
Cu	8.9

Correct order is $Cu > Co > Fe > Cr > Zn$.

Question79

In mild alkaline medium, thiosulphate ion is oxidised by MnO_4^- to " $A^{''}$.

The oxidation state of sulphur in " $A^{''}$ is ....
[26 Feb 2021 Shift 2]

Answer: 6

Solution:

$$S_2O_3{}^{2-} + MnO_4{}^- \xrightarrow[\text{Alkaline medium}]{\text{Mild}} SO_4{}^{2-} + MnO_4{}^{2-}$$

Thiosulphate ion [Reducing agent]   Permanganate ion [Oxidising agent]   Sulphate ion(A)   Manganate ion

Oxidation number of sulphur in $SO_4{}^{2-}$(A) is $+6$

$$\left[\begin{array}{c} \because x + 4(-2) = -2 \\ \Rightarrow x = +6 \end{array} \right]$$

Question80

On treating a compound with warm dil. H_2SO_4, gas X is evolved, which turns $K_2Cr_2O_7$ paper acidified with dil. H_2SO_4 to a green compound Y. X and Y respectively are
[26 Feb 2021 Shift 1]

Options:

A. $X = SO_2$, $Y = Cr_2O_3$

B. $X = SO_3$, $Y = Cr_2O_3$

C. $X = SO_2$, $Y = Cr_2(SO_4)_3$

D. $X = SO_3$, $Y = Cr_2(SO_4)_3$

Answer: C

Solution:

Solution:
Gas, X turns acidified dichromate ($K_2Cr_2O_7$) green that means it is a reducing agent.
Cr (VI) from compound $K_{22}Cr_2O_7$ on reduction changes its colour from orange to green which is the colour of Cr (III) compound Y.
SO_2 can show both reducing and oxidising properties whereas SO_3 cannot show reducing property because of highest group number 16, oxidation state ($+6$) of sulphur in SO_3.
So, X is SO_2.
As, X reacts with $K_2Cr_2O_7$ in dil. H_2SO_4 medium, the green coloured Cr (III) compound, Y must be Cr (III) sulphate or $Cr_2(SO_4)_3$.
So, Y is $Cr_2(SO_4)_3$.
The overall reactions can be shown as :

(Compound) $\xrightarrow[\text{H}_2\text{SO}_4]{\text{Dil.}}$ $SO_2(g)$ $\xrightarrow[\text{dil . H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7}$ $Cr_2(SO_4)_3$
Water soluble $SO_3{}^-$ salt   (X)   (Y) Green

(i) $SO_3{}^{2-} + H_2SO_4 \longrightarrow SO_2 \uparrow + H_2O + SO_4{}^{2-}$
                        (X)

(ii) $\overset{+6}{K_2Cr_2O_7} + \overset{+4}{SO_2} + H_2SO_4 \longrightarrow \overset{+3}{Cr_2(SO_4)_3} + \overset{+6}{K_2SO_4} + H_2O$
    (Orange)   (Y) (Green)

Question81

On treating a compound with warm dil. H_2SO_4, gas X is evolved, which turns $K_2Cr_2O_7$ paper acidified with dil. H_2SO_4 to a green compound Y . X and Y respectively are
[26 Feb 2021 Shift 1]

Options:

A. $X = SO_2, Y = Cr_2O_3$

B. $X = SO_3, Y = Cr_2O_3$

C. $X = SO_2, Y = Cr_2(SO_4)_3$

D. $X = SO_3, Y = Cr_2(SO_4)_3$

Answer: C

Solution:

Gas, X tums acidified dichromate ($K_2Cr_2O_7$) green that means it is a reducing agent.
Cr (VI) from compound $K_{22}Cr_2O_7$ on reduction changes its colour from orange to green which is the colour of Cr (III) compound Y .
SO_2 can show both reducing and oxidising properties whereas SO_3 cannot show reducing property because of highest group number 16, oxidation state (+6) of sulphur in SO_3.
So, X is SO_2.
As, X reacts with $K_2Cr_2O_7$ in dil. H_2SO_4 medium, the green coloured Cr (III) compound, Y must be Cr (III) sulphate or $Cr_2(SO_4)_3$.
So, Y is $Cr_2(SO_4)_3$.
The overall reactions can be shown as :

$$\underset{\text{Water soluble } SO_3^- \text{ salt}}{\text{(Compound)}} \xrightarrow[H_2SO_4]{\text{Dil.}} \underset{(X)}{SO_2(g)} \xrightarrow[\text{dil . } H_2SO_4]{K_2Cr_2O_7} \underset{\underset{\text{Green}}{(Y)}}{Cr_2(SO_4)_3}$$

(i) $SO_3^{2-} + H_2SO_4 \longrightarrow \underset{(X)}{SO_2} \uparrow + H_2O + SO_4^{2-}$

(ii) $\underset{\text{(Orange)}}{\overset{+6}{K_2Cr_2O_7}} + \overset{+4}{SO_2} + H_2SO_4 \longrightarrow \underset{\underset{\text{(Green)}}{(Y)}}{\overset{+3}{Cr_2(SO_4)_3}} + \overset{+6}{K_2SO_4} + H_2O$

Question82

Which one of the following lanthanoids does not form MO_2 ? [M is lanthanoid metal]
[26 Feb 2021 Shift 1]

Options:

A. Pr

B. Dy

C. Nd

D. Yb

Answer: D

Solution:

In oxides, MO_2 (M is lanthanoid metal) only four lanthanoids exhibit $+4$ oxidation state. These lanthanoids are praseodymium (Pr, Z $= 59$), neodymium (Nd , Z $= 60$) terbium (Tb, Z $= 65$) dysprosium (Dy, Z $= 66$)
So, Yb (ytterbium) option (d) does not form MO_2 type of oxide.

Note The common and predominant oxidation state of lanthanoids is $+3$. Consequently M^{4+} compounds are strong oxidising agents which changes to the common $+3$ state. Similarly, lanthanoid compounds of $+2$ state have a tendency to show reducing property as they get changed to $+3$ state easily.

Question83

Given below are two statements:
Statement I CeO_2 can be used for oxidation of aldehydes and ketones.

Statement II Aqueous solution of $EuSO_4$ is a strong reducing agent.

In the light of the above statements, choose the correct answer from the options given below.
[25 Feb 2021 Shift 1]

Options:

A. Both statement I and statement II are true.

B. Both statement I and statement II are false.

C. Statement I is true but statement II is false.

D. Statement I is false but statement II is true.

Answer: A

Solution:

Solution:
Both statement I and statement II are true. The $+3$ oxidation state of lanthanide is most stable and therefore lanthanide in $+4$ oxidation state has strong tendency to gain electrons and converted into $+3$ and therefore act as strong oxidising agent, e.g. Ce^{4+}.
$\therefore CeO_2$ is used to oxidised alcohol, aldehyde and ketones. Lanthanides in $+2$ oxidation state has strong tendency to loss electron and converted into $+3$ oxidation state e.g. Eu^{+2}.
$\therefore EuSO_4$ acts as strong reducing agent.

Question84

The major components in "Gun Metal" are :
[24 Feb 2021 Shift 1]

Options:

A. Cu, Zn and Ni

B. Cu, Sn and Zn

C. Al , Cu, M g and M n

D. Cu, N i and F e

Answer: B

Solution:

Solution:
The major components in "Gun Metal" are Cu : 87%; Z n : 3%; Sn : 10%.

Question85

The electrode potential of M^{2+}/M of 3d -series elements shows positive value of
[24 Feb 2021 Shift 1]

Options:

A. Z n

B. F e

C. Co

D. Cu

Answer: D

Solution:

Solution:
Only copper shows positive value for electrode potential of M^{2+}/M of 3d -series elements.

Question86

The incorrect statement among the following is
[24 Feb 2021 Shift 2]

Options:

A. VOSO$_4$ is a reducing agent.

B. Cr_2O_3 is an amphoteric oxid

C. RuO$_4$ is an oxidising agent.

D. Red colour of ruby is due to the presence of Co^{3+}.

Answer: B

Solution:

Red colour of ruby is due to presence of Cr^{3+} ions in Al_2O_3.

Chromium is the trace element that causes ruby's red colour, which ranges from an orange red to a publish red. The strength of ruby's red depends on how much chromium is present.

Question87

The common positive oxidation states for an element with atomic number 24 , are
[17 Mar 2021 Shift 2]

Options:

A. $+2$ to $+6$

B. $+1$ and $+3$ to $+6$

C. $+1$ and $+3$

D. $+1$ to $+6$

Answer: A

Solution:

Solution:
Common positive oxidation states for an element with atomic number 24 , are $+2$ to $+6$
Chromium ($Z = 24$)
Electronic configuration: [Ar] $4s^1 3d^5$ It has five electrons in 3d -subshell and one electron in 4s-subshell. Thus, chromium metal has six valence electrons.
Chromium can lose some or all of its valence electrons to form ions with different oxidation states. Thus, chromium shows the oxidation states of $+1$, $+2$, $+3$, $+4$, $+5$ and $+6$ respectively.
The most common oxidation states of chromium are $+2$, $+3$ and $+6$.

Question88

The oxide that shows magnetic property is
[18 Mar 2021 Shift 2]

Options:

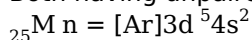A. SiO_2

B. Mn_3O_4

C. Na_2O

D. MgO

Answer: B

Solution:

Generally, d-block elements shows magnetic property due to presence of unpaired electrons in its d -block. Mn i.e. manganese shows $+2$ and $+3$ oxidation state.
Both having unpaired electrons as shown below
$_{25}Mn = [Ar]3d^54s^2$
$Mn^{2+}(3d^54s^0)$ having 5 unpaired electrons in 3d orbital.
$Mn^{+3}, (3d^44s^0)$ having 4 unpaired electrons in 3d orbital.
SiO_2, p-block element compound is commonly believed to be a typical diamagnetic as no unpaired electrons are present.
MgO and Na_2O also have unpaired electrons and hence are diamagnetic.
Hence, Mn_3O_4 show magnetic property.

Question89

Fex $_2$ and $_{Lt_3}$ are known when x and y are
[16 Mar 2021 Shift 2]

Options:

A. x = F , Cl , Br, I and y = F , Cl and Br
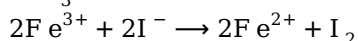
B. x = F , Cl , Br and y = F , Cl , Br and I

C. x = Cl , Br, I and y = F , Cl , Br and I
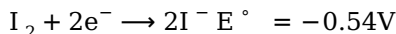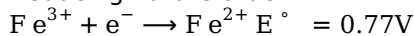
D. x = F , Cl , Br, I and y = F , Cl , Br and I

Answer: A

Solution:

Fel_3 does not exist because of I^-. Being a very good reducing agent, I^- reduces Fe^{3+} to Fe^{2+}.
$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$
Reducing nature order $I > Br > Cl > F$
$Fe^{3+} + e^- \longrightarrow Fe^{2+} E° = 0.77V$
$I_2 + 2e^- \longrightarrow 2I^- E° = -0.54V$
As standard reduction potential value of Fe^{3+} is more than I_2, so it is reduced to Fe^{2+}. Hence, except Fel_3, all other halogens can form iron halide compounds.

Question90

Given below are two statements.
Statement I The E ° value of CC^{4+}/Ce^{3+} is $+1.74V$.
Statement II Ce is more stable in Ce^{4+} state than Ce^{3+} state.
In the light of the above statements, choose the most appropriate answer from the options given below.
[16 Mar 2021 Shift 1]

Options:

A. Both statement I and statement II are correct.

B. Statement I is incorrect but statement II is correct.

C. Both statement I and statement II are incorrect.

D. Statement I is correct but statement II is incorrect.

Answer: D

Solution:

Solution:
$E^\circ_{Ce^{4+}/Ce^{+3}}$ = 1.74 (data given)
Ce^{4+} can be reduced to Ce^{3+} and can oxidise water.
$Ce^{4+} + e^- \longrightarrow Ce^{3+}$
Ce^{4+} is having noble gas configuration [Xe] $4f^0$ but it is strong oxidant and gets converted to Ce^{3+}.
Statement I is correct but statement II is incorrect.

Question91

Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) Size of Bk^{3+} ion is less than Np^{3+} ion.
Reason (R) The above is a consequence of the lanthanoid contraction.
In the light of the above statements, choose the correct answer from the options given below
[16 Mar 2021 Shift 1]

Options:

A. A is false but R is true

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

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

D. A is true but R is false.

Answer: D

Solution:

Solution:
$_{97}Bk$ (Berkelium) and $_{93}Np$ (Neptunium) are present in actinide series. Due to actinoid contraction, there is gradual decrease in size of M^{3+} ions across the period due to poor shielding of 5f -electrons. So, Bk^{3+} is smaller than that of Np^{3+} due to actinoid contraction. So, A is true and R is false.

Question92

The spin only magnetic moments (in BM) for free Ti^{3+}, V^{2+} and Sc^{3+} ions respectively are
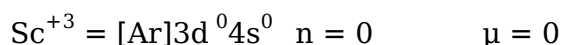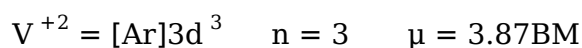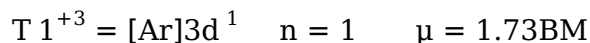**(At.No. Sc : 21, Ti : 22, V: 23)**
[25 Jul 2021 Shift 2]

Options:

A. 3.87, 1.73, 0

B. 1.73, 3.87, 0

C. 1.73, 0, 3.87

D. 0, 3.87, 1.73

Solution:

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

$T1^{+3} = [Ar]3d^1$ $n = 1$ $\mu = 1.73\ BM$

$V^{+2} = [Ar]3d^3$ $n = 3$ $\mu = 3.87\ BM$

$Sc^{+3} = [Ar]3d^04s^0$ $n = 0$ $\mu = 0$

Question93

The correct order of following 3d metal oxides, according to their oxidation numbers is :
(a) CrO_3
(b) Fe_2O_3
(c) MnO_2
(d) V_2O_5
(e) Cu_2O
[25 Jul 2021 Shift 1]

Options:

A. (d) > (a) > (b) > (c) > (e)

B. (a) > (c) > (d) > (b) > (e)

C. (a) > (d) > (c) > (b) > (e)

D. (c) > (a) > (d) > (e) > (b)

Solution:

Solution:
(a) $\overset{+6}{Cr}O_3$
(b) $\overset{+3}{Fe}_2O_3$
(c) $\overset{+4}{Mn}O_2$
(d) $\overset{+5}{V}_2O_5$

(e) $\overset{+1}{Cu_2}O$

So order of oxidation state

a > d > c > b > e

Question94

The set having ions which are coloured and paramagnetic both is -
[22 Jul 2021 Shift 2]

Options:

A. Cu^{2+}, Cr^{3+}, Sc^+

B. Cu^{2+}, Zn^{2+}, Mn^{4+}

C. Sc^{3+}, V^{5+}, Ti^{4+}

D. Ni^{2+}, Mn^{7+}, Hg^{2+}

Answer: A

Solution:

Solution:

Cu^{2+} : $[Ar]3d^9 4s^0$

Cr^{3+} : $[Ar]3d^3 4s^0$ All are coloured and paramagnetic due to presence of unpaired electrons

Sc^+ : $[Ar]3d^1 4s^1$

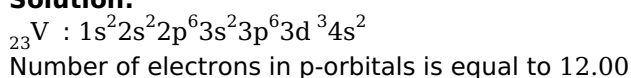--

Question95

Number of electrons that Vanadium (Z = 23) has in p-orbitals is equal to _____
[22 Jul 2021 Shift 2]

Answer: 12

Solution:

Solution:
$_{23}V$: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$
Number of electrons in p-orbitals is equal to 12.00

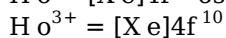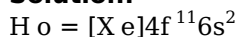
Question96

Number of electrons present in 4f orbital of Ho^{3+} ion is _____ .
(Given Atomic No. of Ho = 67)
[25 Jul 2021 Shift 2]

Answer: 10

Solution:

Solution:
$Ho = [Xe]4f^{11}6s^2$
$Ho^{3+} = [Xe]4f^{10}$
so number of e^- present in 4f is 10 .

Question97

The nature of oxides V_2O_3 and CrO is indexed as 'X' and 'Y' type respectively. The correct set of X and Y is
[27 Aug 2021 Shift 1]

Options:

A. X = basic Y = amphoteric

B. X = amphoteric, Y = basic

C. X = acidic, Y = acidic

D. X = basic, Y = basic

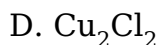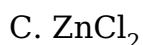**Answer: D**

Solution:

Solution:
V_2O_3 is a basic oxide as on dissolving in acids, give solution of vanadium (III) complexes. In case of transition metal oxide, the metal with lower oxidation states are basic. So, CrO is also basic as oxidation state of Cr is +2.

Question98

Which one of the following when dissolved in water gives coloured solution in nitrogen atmosphere?
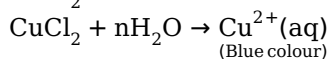[26 Aug 2021 Shift 1]

Options:

A. $CuCl_2$

B. AgCl

C. $ZnCl_2$

D. Cu_2Cl_2

Answer: A

Solution:

Solution:

$CuCl_2$ will dissolve in water to give blue colour Cu^{2+} ions. The colour is due to the presence of unpaired e^- in Cu^{2+} ions.

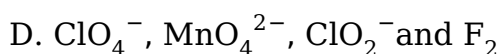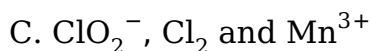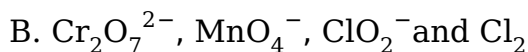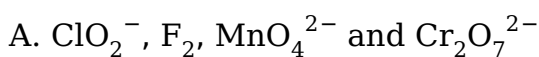$CuCl_2 + nH_2O \rightarrow \underset{\text{(Blue colour)}}{Cu^{2+}(aq)}$

AgCl and Cu_2Cl_2 are insoluble in water while $ZnCl_2$ on dissolving in water forms colourless solution due to formation of Zn^{2+} ions, which has no unpaired e^-.

Question99

In which one of the following sets all species show disproportionation reaction
[31 Aug 2021 Shift 2]

Options:

A. ClO_2^-, F_2, MnO_4^{2-} and $Cr_2O_7^{2-}$

B. $Cr_2O_7^{2-}$, MnO_4^-, ClO_2^- and Cl_2

C. ClO_2^-, Cl_2 and Mn^{3+}

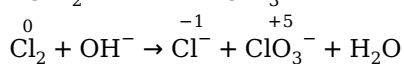D. ClO_4^-, MnO_4^{2-}, ClO_2^- and F_2

Answer: B

Solution:

Solution:

Disproportionation reactions are redox reaction in which a compound undergoes oxidation as well as reduction. The element of reacting species is in an intermediate oxidation state and simultaneously gets oxidised and reduced.

$3\overset{+3}{Cl}O_2^- \rightarrow \overset{-1}{Cl^-} + 2\overset{+5}{Cl}O_3^-$

$\overset{0}{Cl_2} + OH^- \rightarrow \overset{-1}{Cl^-} + \overset{+5}{Cl}O_3^- + H_2O$

$2Mn^{3+} + 2H_2O \rightarrow Mn^{2+} + \overset{+4}{Mn}O_2 + 4H^+$

But MnO_4^- does not get disproportonated.
Hence, option (c) is the correct answer.

Question100

Potassium permanganate on heating at 513K gives a product which is
[27 Aug 2021 Shift 2]

Options:

A. paramagnetic and colourless

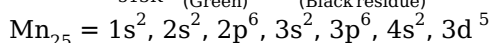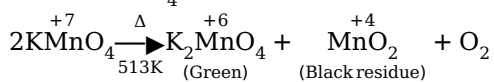B. diamagnetic and green

C. diamagnetic and colourless

D. paramagnetic and green

Answer: A

Solution:

Solution:
When $KMnO_4$ is heated at 513K, it forms K_2MnO_4 and MnO_2 and O_2.

$2\overset{+7}{KMnO_4} \xrightarrow[513K]{\Delta} \underset{\text{(Green)}}{\overset{+6}{K_2MnO_4}} + \underset{\text{(Black residue)}}{\overset{+4}{MnO_2}} + O_2$

$Mn_{25} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^5$
$Mn^{+6} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$; 1 unpaired electron, so paramagnetic.
So, option (d) is correct.

Question101

The addition of dilute NaOH to Cr^{3+} salt solution will give [27 Aug 2021 Shift 2]

Options:

A. a solution of $[Cr(OH)_4]^-$

B. precipitate of $Cr_2O_3(H_2O)_n$

C. precipitate of $[Cr(OH)_6]^{3-}$

D. precipitate of $Cr(OH)_3$

Answer: B

Solution:

Solution:
The addition of dil. NaOH to Cr^{3+} solution will produce ppt. of $Cr_2O_3(H_2O)_n$.

$Cr^{3+} + NaOH \rightarrow \underset{\text{(Precipitate)}}{Cr_2O_3(H_2O)_n}$

Therefore, the option (b) is correct.

Question102

The Eu^{2+} ion is a strong reducing agent in spite of its ground state electronic configuration (outermost): [Atomic number of Eu = 63] [31 Aug 2021 Shift 2]
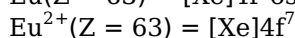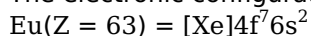
Options:

A. $4f^7 6s^2$

B. $4f^6$

C. $4f^7$

D. $4f^6 6s^2$

Answer: C

Solution:

Solution:
The electronic configuration of Eu and Eu^{2+} ion is as follows :
$Eu(Z = 63) = [Xe]4f^7 6s^2$
$Eu^{2+}(Z = 63) = [Xe]4f^7$

Question103

Which one of the following lanthanides exhibits +2 oxidation state with diamagnetic nature ?
(Given, Z for Nd = 60, Yb = 70, La = 57, Ce = 58)
[31 Aug 2021 Shift 1]

Options:

A. Nd

B. Yb

C. La

D. Ce

Answer: B

Solution:

Solution:
Ytterbium shows +2 oxidation state and it is diamagnetic in nature.
$Yb = [Xe], 4f^{14}, 6s^2$
$Yb^{2+} = [Xe], 4f^{14}$

Since, there is no unpaired electron, it is diamagnetic in nature.

Question104

The number of f - electrons in the ground state electronic configuration of Np(Z = 93) is ....

(Nearest integer)

Answer: 18

Solution:

Solution:
The electronic configuration of Np = 93 is
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 4f^{14} 5d^{10} 6s^2 6p^6 5f^4 6d^1 7s^2$
In ground state, total number of f electrons = 14 + 4 = 18

Question105

The number of 4f electrons in the ground state electronic configuration of Gd^{2+} is [Atomic number of Gd is 64.]

Answer: 7

Solution:

Solution:
The electronic configuration of Gd is as follows
Gd = [Xe] $4f^7$, $5d^1$, $6s^2$
So, electronic configuration of Gd^{2+} will be
Gd^{2+} = [Xe], $4f^7$, $5d^1$, $6s^0$
∴ The number of 4 f electrons in ground state configuration of Gd^{2+} is 7.

Question106

In the given chemical reaction, colours of the Fe^{2+} and Fe^{3+} ions, are respectively
$$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$$

Options:

A. yellow, orange

B. yellow, green

C. green, orange

D. green, yellow

Answer: D

Solution:

The Fe^{2+} ion has green colour while Fe^{3+} is yellow in colour.

Question107

The third ionization enthalpy is minimum for:
[Jan. 08,2020 (I)]

Options:

A. Co

B. F e

C. N

D. M n

Answer: B

Solution:

Solution:
$_{26}F e = [Ar]3d^6 4s^2$. Third ionisation results into stable d^5 configuration.

Question108

For the following Assertion and Reason, the correct option is:
Assertion: For hydrogenation reactions, the catalytic activity increases from Group 5 to Group 11 metals with maximum activity shown by Group 7 − 9 elements.
Reason: The reactants are most strongly adsorbed on group 7 − 9 elements.
[Jan. 08,2020 (II)]

Options:

A. The assertion is true, but the reason is false.

B. Both assertion and reason are false.

C. Both assertion and reason are true and the reason is the correct explanation for the assertion.

D. Both assertion and reason are true but the reason is not the correct explanation for the assertion.

Solution:

Solution:
Reactant should not be adsorbed strongly which might result into immobilisation that inhibit further adsorption on the catalyst's surface.

Question109

The atomic radius of Ag is closest to:
[Jan. 07,2020 (I)]

Options:

A. Au

B. N i

C. Cu

D. H g

Answer: A

Solution:

Solution:
Atomic size of elements of 4d and 5d transition series are nearly same due to lanthanide contraction.

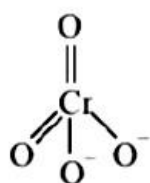
Question110

The sum of the total number of bonds between chromium and oxygen atoms in chromate and dichromate ions is _____.
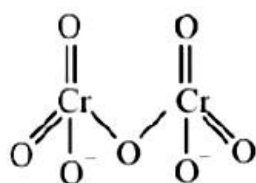## [NV, Jan. 09, 2020 (II)]

Answer: 12

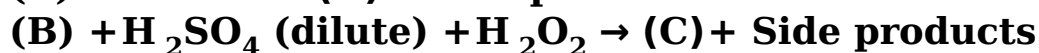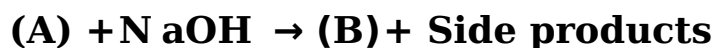**Solution:**

Chromate ion   Dichromate ion

⇒ Total number of Cr and O bonds is 12 .

Question111

Consider the following reactions:
$$NaCl + K_2Cr_2O_7 + H_2SO_4(\text{ Conc. }) \rightarrow (A) + \text{ Side products}$$
$$(A) + NaOH \rightarrow (B) + \text{ Side products}$$
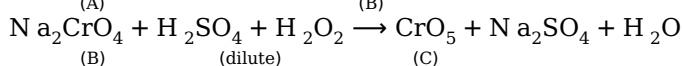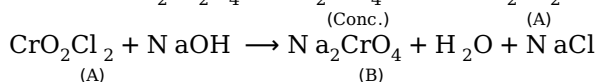$$(B) + H_2SO_4 \text{ (dilute) } + H_2O_2 \rightarrow (C) + \text{ Side products}$$
The sum of the total number of atoms in one molecule each of (A), (B) and (C) is _____.
[NV, Jan. 07, 2020 (II)]

Answer: 18

Solution:

Solution:
$$4NaCl + K_2Cr_2O_4 + 3H_2SO_4 \longrightarrow 2\underset{(A)}{CrO_2Cl_2} + K_2SO_4 + 2NaSO_4 + 3H_2O$$
(Conc.)
$$\underset{(A)}{CrO_2Cl_2} + NaOH \longrightarrow \underset{(B)}{Na_2CrO_4} + H_2O + NaCl$$
$$\underset{(B)}{Na_2CrO_4} + \underset{(\text{dilute})}{H_2SO_4} + H_2O_2 \longrightarrow \underset{(C)}{CrO_5} + Na_2SO_4 + H_2O$$
The sum of total no. of atoms in one molecules each of A,
B & C = 5 + 7 + 6 = 18.0

Question112

The electronic configurations of bivalent europium and trivalent cerium are:
(atomic number : $Xe = 54$, $Ce = 58$, $Eu = 63$
[Jan. 09,2020 (I)]

Options:

A. $[Xe]4f^2$ and $[Xe]4f^7$

B. $[Xe]4f^7$ and $[Xe]4f^1$

C. $[Xe]4f^76s^2$ and $[Xe]4f^26s^2$

D. $[Xe]4f^4$ and $[Xe]4f^9$

Answer: B

Solution:

Solution:
$Eu^{2+} : [Xe]4f^7$; $Ce^{3+} : [Xe]4f^1$

Question113

The highest possible oxidation states of uranium and plutonium, respectively, are:
[Jan. 09,2020 (I)]
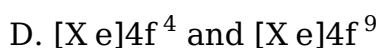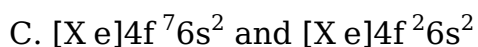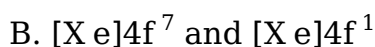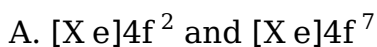
Options:

A. 6 and 7

B. 6 and 4

C. 7 and 6

D. 4 and 6

Answer: A

Solution:

Solution:
Maximum oxidation state shown by uranium is +6 and plutonium is 7 .

Question114

The incorrect statement(s) among (1) – (3) is (are):
(1) W(VI) is more stable than Cr(VI).
(2) in the presence of HCl , permanganate titrations provide satisfactory results.
(3) some lanthanoid oxides can be used as phosophorus.
[Sep. 4,2020 (II)]

Options:

A. (2) and (3) only

B. (l) and (2) only

C. (2) only

D. (1) only

Answer: C

Solution:

Solution:
(i) W(VI) is more stable than Cr(VI) due to smaller size of atoms and also due to lanthanide contraction.
(ii) Permanganate titrations in presence of HCl are unsatisfactory as HCl is oxidised to Cl_2
(iii) Lanthanoid oxides are used as phosphors.

Question115

The incorrect statement is:
[Sep. 03,2020(II)]

Options:

A. Manganate and permanganate ions are tetrahedral

B. In manganate and permanganate ions, the π -bonding takes place by overlap of p -orbitals of oxygen and d − orbitals of manganese

C. Manganate and permanganate ions are paramagnetic

D. Manganate ion is green in colour and permanganate ion is purple in colour

Answer: C

Solution:

Solution:

Maganate	Permanganate
MnO_4^{2-}	MnO_4^-
Mn^{+6} structure with O double bond, O=, O$^-$, O$^-$	Mn^{+7} structure with O double bond, O=, O$^-$, O$^-$
Paramagnetic, green in colour, Tetrahedral & contains $p\pi - d\pi$ bond	Diamagnetic, purple in colour, Tetrahedral & contains $p\pi - d\pi$ bond

Manganate ion is paramagnetic while permanganate ion is diamagnetic.

Question116

The lanthanoid that does NOT show+ 4 oxidation state is:
[Sep. 06,2020(I)]

Options:

A. Dy

B. Ce

C. Eu

D. T b

Answer: C

Solution:

Europium(Eu)
Atomic No. - 63
Electronic configuration - $[Xe]4f^{7}6s^{2}$
It shows only +2 and +3 oxidation state.

Question117

Mischmetal is an alloy consisting mainly of:
[Sep. 06,2020(II)]

Options:

A. lanthanoid metals

B. actinoid and transition metals

C. lanthanoid and actinoid metals

D. actinoid metals

Answer: A

Solution:

Solution:
Mischmetal is an alloy consisting mainly of lanthanoid metals.
Alloy ⇒
Lan. metal ⇒ ≈ 95%
Iron ⇒ ≈ 5%
S, C, Ca, Al ⇒ traces

Question118

The correct electronic configuration and spin-only magnetic moment (BM) of Gd $^{3+}$(Z = 64), respectively, are:
[Sep. 05,2020(I)]

Options:

A. [Xe] $4f^{7}$ and 8.9

B. [Xe] $4f^{7}$ and 7.9

C. $[Xe]5f^{7}$ and 8.9

D. [Xe] 5f and 7.9

Answer: B

Solution:

Solution:
Electronic configuration of 64
Gd = $[Xe]4f^{7}5d^{1}6s^{2}$

$_{64}Gd^{3+} = [Xc]4f^7$
No. of unpaired electron $= 7$
$\mu = \sqrt{n(n+2)}BM = \sqrt{63} = 7.93BM$

Question119

The pair of metal ions that can give a spin only magnetic moment of 3.9BM for the complex [M (H$_2$O)$_6$]Cl$_2$, is:
[Jan. 12,2019(I)]

Options:

A. V^{2+} and Co^{2+}

B. V^{2+} and Fe^{2+}

C. Co^{2+} and Fe^{2+}

D. Cr^{2+} and Mn^{2+}

Answer: A

Solution:

Solution:
Given $\mu = 3.9BM$
$\mu = \sqrt{n(n+2)}B \cdot M$.; $3.9 = \sqrt{n(n+2)}$; $n = 3$
So, the central metal ion has 3 unpaired electrons.
$\therefore$ Configuration is either d^3 or d^7
As H_2O is a weak field ligand. V^{2+} and Co^{2+} will have 3 unpaired electrons. V^{2+} has d^3 configuration; Co^{2+} has d^7 configuration.

Question120

The element that usually does NOT show variable oxidation states is:
[Jan. 11, 2019(I)]

Options:

A. Cu

B. Ti

C. Sc

D. V

Answer: C

Solution:

Solution:
Sc shows oxidation state of +3 only.

Question121

The highest value of the calculated spin only magnetic moment (in BM) among all the transition metal complexes is:
[Jan. 9,2019(I)]

Options:

A. 5.92

B. 6.93

C. 3.87

D. 4.90

Answer: A

Solution:

Solution:
Magnetic moment, $\mu = \sqrt{n(n+2)}$ BM (where, n = no. of unpaired electrons)
As transition metal atom/ion in a complex may have unpaired electrons ranging from zero to 5 . So, maximum number of unpaired electrons that may be present in a complex is 5.
∴ Maximum value of magneticmoment among all the transition metal complexes is $\sqrt{5(5+2)} = \sqrt{35} = 5.92$BM

Question122

The transition element that has lowest enthalpy of atomisation is:
[Jan. 9,2019(II)]

Options:

A. F e

B. Cu

C. V

D. Z n

Answer: D

Solution:

Solution:
As zinc has no unpaired of electrons to take part in the bond, it has least enthalpy of atomisation amongst the given transition elements.

Question123

The correct order of atomic radii is :
[Jan. 12, 2019 (II)]

Options:

A. N > Ce > E u > H o

B. H o > N > E u > Ce

C. Ce > E u > H o > N

D. E u > Ce > H o > N

Answer: D

Solution:

Solution:
Atomic radii follows the order
E u > Ce > H o > N
185pm 182pm 177pm 71pm

Question124

The effect of lanthanoid contraction in the lanthanoid series of elements by and large means:
[Jan. 10,2019 (I)]

Options:

A. increase in both atomic and ionic radii

B. decrease in atomic radii and increase in ionic radii

C. decrease in both atomic and ionic radii
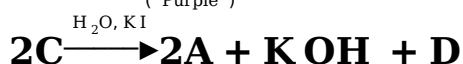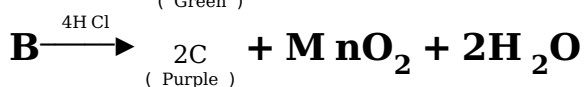
D. increase in atomic radii and decrease in ionic radii

Answer: C

Solution:

Solution:
Due to lanthanoid contraction, size of atoms as well as ions of lanthanoid decreases.

Question125

$A \xrightarrow{4KOH, O_2} 2B + 2H_2O$
$\quad\quad\quad\quad\;\;(Green)$

$B \xrightarrow{4HCl} 2C + MnO_2 + 2H_2O$
$\quad\quad\quad\;\;(Purple)$

$2C \xrightarrow{H_2O, KI} 2A + KOH + D$

In the above sequence of reactions, A and D, respectively, are:
[Jan. 11,2019(II)]

Options:

A. KI and $KMnO_4$

B. MnO_2 and KIO_3

C. KIO_3 and MnO_2

D. KI and K_2MnO_4

Answer: B

Solution:

Solution:

$$2MnO_2 \xrightarrow{KOH,\ O_2} 2K_2MnO_4 + 2H_2O$$
(A)   (Green) (B)

$$K_2MnO_4 \xrightarrow{4HCl} 2KMnO_4 + MnO_2 + 2H_2O$$
(Purple) (C)

$$2KMnO_4 \xrightarrow{H_2O,\ KI} 2MnO_2 + 2KOH + KIO_3$$
(A)   (D)

Question126

The pair that has similar atomic radii is :
[April 12,2019 (II)]

Options:

A. Mn and Re

B. Ti and Hf

C. Sc and Ni

D. Mo and W

Answer: D

Solution:

Solution:
Mo and W belong to group-6 and period 5 (4d series) and 6(5d series) respectively. Due to lanthanoid contraction, radius of Mo and W are almost same i.e. 0.140nm and 0.141nm respectively.

Question127

Consider the hydrated ions of Ti^{2+}, V^{2+}, Ti^{3+}, and Sc^{3+}. The correct order of their spin-only magnetic moments is:
[April 12,2019 (II)]

Options:
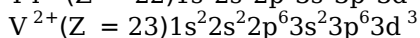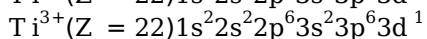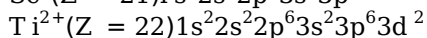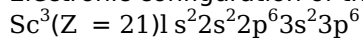
A. $V^{2+} < Ti^{2+} < Ti^{3+} < Sc^{3+}$

B. $Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$

C. $Ti^{3+} < Ti^{2+} < Sc^{3+} < V^{2+}$

D. $Sc^{3+} < Ti^{3+} < V^{2+} < Ti^{2+}$

Answer: B

Solution:

Solution:
Electronic configuration of the given transition metal ions are :
$Sc^{3}(Z = 21)1s^{2}2s^{2}2p^{6}3s^{2}3p^{6}$
$Ti^{2+}(Z = 22)1s^{2}2s^{2}2p^{6}3s^{2}3p^{6}3d^{2}$
$Ti^{3+}(Z = 22)1s^{2}2s^{2}2p^{6}3s^{2}3p^{6}3d^{1}$
$V^{2+}(Z = 23)1s^{2}2s^{2}2p^{6}3s^{2}3p^{6}3d^{3}$
Since, magnetic moment is directly proportional to the number of unpaired electrons. The correct increasing order of magnetic moment is
$Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$ because they have 0,1,2 and 3 unpaired electrons respectively.

Question128

The correct order of the first ionization enthalpies is:
[April 10,2019 (II)]

Options:

A. $Ti < Mn < Zn < Ni$

B. $Ti < Mn < Ni < Zn$

C. $Mn < Ti < Zn < Ni$

D. $Zn < Ni < Mn < Ti$

Answer: B

Solution:

Solution:
I.E. increases on moving left to right in a period. $\therefore$ $Ti < Mn < Ni < Zn$

Question129

The INCORRECT statement is:

Options:

A. the gemstone, ruby, has Cr^{3+} ions occupying the octahedral sites of beryl.

B. the spin-only magnetic moment of $[Ni(NH_3)_4(H_2O)_2]^{2+}$ is 2.83BM

C. the color of $[CoCl(NH_3)_5]^{2+}$ is violet as it absorbs the yellow light.

D. the spin-only magnetic moments of $[Fe(H_2O)_6]^{2+}$ and $[Cr(H_2O)_6]^{2+}$ are nearly similar.

Answer: A

Solution:

Solution:
Ruby is aluminium oxide (Al_2O_3) containing about $0.5 - 1\%Cr^{3+}$ ions, which are randomly distributed in place of Al^{3+} ions.

Question130

Match the catalysts (Column I) with products (Column II).

Column I	Column II
Catalyst	Product
V_2O_5	Polyethylene
$TiCl_4/Al(Me)_3$	ethanol
$PdCl_2$	H_2SO_4
Iron Oxide	NH_3

Options:

A. (A) − (iii); (B) − (iv); (C) − (i); (D) − (ii)

B. (A) − (ii); (B) − (iii); (C) − (i); (D) − (iv)

C. (A) − (iii); (B) − (i); (C) − (ii); (D) − (iv)

D. (A) − (iv); (B) − (iii); (C) − (ii); (D) − (i)

Answer: C

Solution:

Solution:
(A) $V_2O_5 \rightarrow$ Preparation of H_2SO_4 in contact process
(B) $TiCl_4 + Al(Me)_3 \rightarrow$ Polyethylene (Ziegler-Natta catalyst)
(C) $PdCl_2 \rightarrow$ Ethanol (Wacker's process)

(D) Iron oxide $\rightarrow NH_3$ in (Haber's process)

Question131

The statement that is INCORRECT about the interstitial compounds is: [April 8,2019 (II)]

Options:

A. they are chemically reactive.

B. they are very hard.

C. they have metallic conductivity.

D. they have high melting points.

Answer: A

Solution:

Solution:
Interstitial compounds are inert, i.e., they are chemically non-reactive.

Question132

Thermal decomposition of a Mn compound (X) at $513K$ results in compound Y, MnO_2 and a gaseous product. MnO_2 reacts with $NaCl$ and concentrated H_2SO_4 to give a pungent gas Z. X, Y, and Z, respectively, are : [April 12, 2019 (II)]
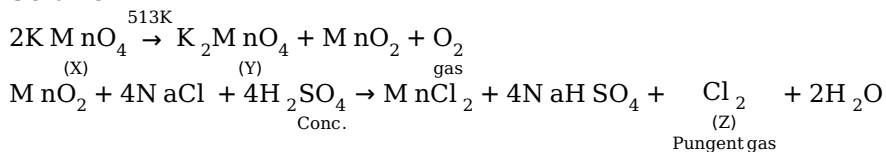
Options:

A. $KMnO_4$, K_2MnO_4 and Cl_2

B. K_2MnO_4, $KMnO_4$ and SO_2

C. K_3MnO_4, K_2MnO_4 and Cl_2

D. K_2MnO_4, $KMnO_4$ and Cl_2

Answer: A

Solution:

Solution:

$$2\underset{(X)}{KMnO_4} \xrightarrow{513K} \underset{(Y)}{K_2MnO_4} + MnO_2 + \underset{gas}{O_2}$$

$$MnO_2 + 4NaCl + 4\underset{Conc.}{H_2SO_4} \rightarrow MnCl_2 + 4NaHSO_4 + \underset{\substack{(Z) \\ Pungent\ gas}}{Cl_2} + 2H_2O$$

Question133

The maximum number of possible oxidation states of actinoides are shown by:
[April 9, 2019 (II)]

Options:

A. Nobelium (No) and lawrencium (Lr)

B. Actinium (Ac) and thorium (Th)

C. Berkelium (Bk) and californium (Cf)

D. Neptunium (Np) and plutonium (Pu)

Answer: D

Solution:

Solution:
Actinoids Oxidation state shown
$Th + 3, +4$
$Ac + 3$
$Pu + 3, +4, +5, +6, +7$
$Np + 3, +4, +5, +6, +7$
$Bk + 3, +4$
$Cm + 3, +4, +5$
$Ir + 3$
∴ Maximum oxidation state is shown by Np and Pu.

Question134

The lanthanide ion that would show colour is:
[April 8, 2019 (II)]

Options:

A. Gd^3

B. Sm^3

C. La^{3+}

D. Lu^3

Answer: B

Solution:

Solution:
$Sm = 4f^6 6s^2$
$Sm^{3+} = 4f^5 = $ Partially filled f orbital
∴Sm^{3+} will be coloured

$Lu^{3+} = 4f^{14} =$ colourless.

Question135

When XO_2 is fused with an alkali metal hydroxide in presence of an oxidizing agent such as KNO_3, a dark green product is formed which disproportionate in acidic solution to afford a dark purple solution. X is:
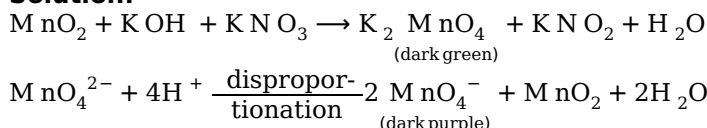[Online April 16, 2018]

Options:

A. Mn

B. Cr

C. V

D. Ti

Answer: A

Solution:

Solution:

$$MnO_2 + KOH + KNO_3 \longrightarrow \underset{\text{(dark green)}}{K_2MnO_4} + KNO_2 + H_2O$$

$$MnO_4^{2-} + 4H^+ \xrightarrow[\text{tionation}]{\text{dispropor-}} \underset{\text{(dark purple)}}{2 MnO_4^-} + MnO_2 + 2H_2O$$

Question136

Which of the following ions does not liberate hydrogen gas on reaction with dilute acids?
[Online April 9, 2017]

Options:

A. Ti^{2+}

B. V^{2+}

C. Cr^{2+}

D. Mn^{2+}

Answer: D

Solution:

Solution:
Ions $E^0(V)$

T i^{2+} − 0.37
V $^{2+}$ − 0.26
Cr^{2+} − 0.41
M n^{2+} + 1.57
Negative value of E ^{0} means these metals librate hydrogen from dilute acid.
$(M^{2+} + 2H^+ − e^- \longrightarrow M^{3+} + H_2)$

Question137

In the following reactions, Z nO is respectively acting as a/an:
(i) $ZnO + Na_2O \rightarrow Na_2ZnO_2$
(ii) $ZnO + CO_2 \rightarrow ZnCO_3$
[2017]

Options:

A. base and acid

B. base and base

C. acid and acid

D. acid and base

Answer: D

Solution:

Solution:
(i) $\underset{\text{acid}}{ZnO} + \underset{\text{base}}{Na_2O} \rightarrow \underset{\text{salt}}{Na_2ZnO_2}$
(ii) $\underset{\text{base}}{ZnO} + \underset{\text{acid}}{CO_2} \rightarrow \underset{\text{salt}}{ZnCO_3}$

Question138

The reaction of zinc with dilute and concentrated nitric acid, respectively, produces:
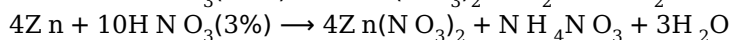**[2016]**

Options:

A. N O and N $_2$O

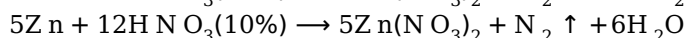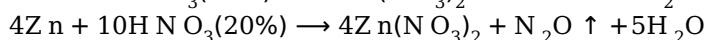B. N O$_2$ and N $_2$O

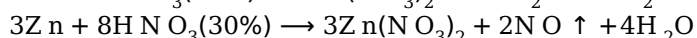C. N $_2$O and N O$_2$

D. N O$_2$ and N O

Answer: C

Solution:

Reaction of Zn with different concentration of HNO_3 are as follows:

$Zn + 4HNO_3(60\%) \longrightarrow Zn(NO_3)_2 + 2NO_2 \uparrow + 2H_2O$

$3Zn + 8HNO_3(30\%) \longrightarrow 3Zn(NO_3)_2 + 2NO \uparrow + 4H_2O$

$4Zn + 10HNO_3(20\%) \longrightarrow 4Zn(NO_3)_2 + N_2O \uparrow + 5H_2O$

$5Zn + 12HNO_3(10\%) \longrightarrow 5Zn(NO_3)_2 + N_2 \uparrow + 6H_2O$

$4Zn + 10HNO_3(3\%) \longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$

Hence option (c) is correct.

Question139

Which one of the following species is stable in aqueous solution? [Online April 9,2016]

Options:

A. Cr^{2+}

B. MnO_4^{2-}

C. MnO_4^{3-}
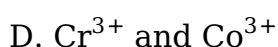
D. Cu^+

Answer: B

Solution:

Solution:
In MnO_4^{2-} manganese is in +6 oxidation state which is having highest stability.

Question140

The transition metal ions responsible for colour in ruby and emerald are, respectively: [Online April 10,2016]

Options:

A. Co^{3+} and Cr^{3+}

B. Co^{3+} and Co^{3+}

C. Cr^{3+} and Cr^{3+}

D. Cr^{3+} and Co^{3+}

Answer: C

Solution:

A ruby is a crystal of alumina, aluminum oxide (Al_2O_3) containing a trace of chromium (III) ions replacing some of the aluminum ions. In ruby, each Al't ion and Cr^{3+} ion is surrounded by six oxide ions in an octahedral arrangement. The origin of the color of emeralds is similar to that of the color of rubies. However, the bulk of an emerald crystal is composed of beryl, beryllium aluminum silicate ($Be_3Al_2(SiO_3)_6$) instead of the alumina which forms rubies. The color is produced by chromium (III) ions, which replace some of the aluminum ions in the crystal. In emeralds, the Cr^{3+} is surrounded by six silicate ions, rather than the six oxide ions in ruby. Therefore, the color (green) of emeralds is different from that of ruby.

Question141

Which of the following compounds is metallic and ferromagnetic? [2016]

Options:

A. $V O_2$

B. $M nO_2$

C. $T iO_2$

D. CrO_2

Answer: D

Solution:

Solution:
Out of all the four given metallic oxides, CrO_2 is attracted by magnetic field very strongly. The effect persists even when the magnetic field is removed. Thus CrO_2 is metallic and ferromagnetic in nature.

Question142

When concentrated $H Cl$ is added to an aqueous solution of $CoCl_2$, its colour changes from reddish pink to deep blue. Which complex ion gives blue colour in this reaction? [Online April 11, 2015]

Options:

A. $[CoCl_4]^{2-}$

B. $[CoCl_6]^{3-}$

C. $[CoCl_6]^4$

D. $[Co(H_2O)_6]^{2+}$

Answer: A

Solution:

Aqueous solution of $CoCl_2$ contains $[Co(H_2O)_6]^{2+}$ which is pinkish in colour so option (d) is incorrect. Reduction potential of $Co^{3+} \longrightarrow Co^{2+}$ is high so option(b) is incorrect. Co^{2+} does not oxidises easily to Co^{3+}.

It is general case that symmetrical substituted octahedral complexes are less deeper in colour than tetrahedral complexes. So $[CoCl_4]^{2-}$ is deep blue in colour.

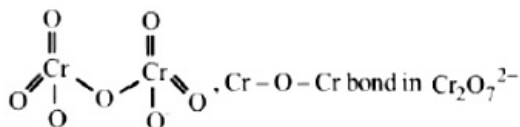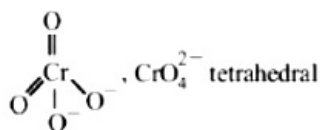---

Question143

Which of the following statements is false?
[Online April 11, 2015]

Options:

A. $Na_2Cr_2O_7$ is less soluble than $K_2Cr_2O_7$

B. $Na_2Cr_2O_7$ is primary standard in volumetry

C. CrO_4^{2-} is tetrahedral in shape

D. CrO_7^{2-} has a $Cr - O - Cr$ bond

Answer: A

Solution:

$Na_2Cr_2O_7$ is used as a primary standard in volumetry.

Hydration energy of $Na^{\oplus}$ is greater than $K^{\oplus}$. Because of smaller size of $Na^{\oplus}$, $Na_2Cr_2O_7$ is more soluble than $K_2Cr_2O_7$

Question144

Chloro compound of Vanadium has only spin magnetic moment of 1.73BM . This Vanadium chloride has the formula:
[Online April 9,2014]

Options:

A. VCl_2

B. VCl_4

C. VCl_3

D. VCl_5

Solution:

Solution:
Magnetic moment $= \sqrt{n(n+2)}$
where n = number of unpaired electrons $\sqrt{n(n+2)} = 1.73$
$\therefore$ n = 1
Electronic configuration of V is $[Ar]4s^2 3d^3$.
For only one unpaired electron it has to be V^{4+}.
Hence, the formula of vanadium chloride is VCl_4.

Question145

Which one of the following exhibits the large number of oxidation states?
[Online April 12,2014]

Options:

A. $Ti(22)$

B. $V(23)$

C. $Cr(24)$

D. $Mn(25)$

Solution:

Solution:
Maganese exhibits the large number of oxidation states. The most common oxidation states of Mn are $+2,+3,+4,+6$ and $+7$

Question146

The equation which is balanced and represents the correct product(s) is:
[2014]

Options:

A. $Li_2O + 2KCl \longrightarrow 2LiCl + K_2O$

B. $[CoCl(NH_3)_5]^+ + 5H^+ \longrightarrow Co^{2+} + 5NH_4^+ + Cl^-$

C. $[Mg(H_2O)_6]^{2+} + (EDTA)^{4-} \xrightarrow{\text{excess NaOH}} [Mg(EDTA)]^{2+} + 6H_2O$

D. $CuSO_4 + 4KCN \longrightarrow K_2[Cu(CN)_4] + K_2SO_4$

Solution:

Solution:
The equation in option (b) is correct since both charges as well as atoms are balanced. For the rest,
(a) Given reaction in unfavourable in the forward direction (K_2O is unstable, while Li_2O is stable)
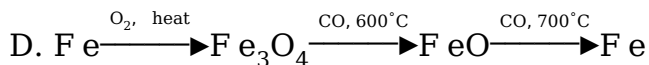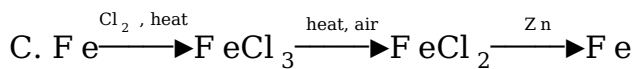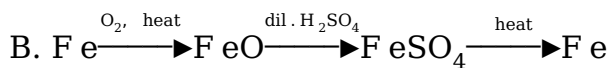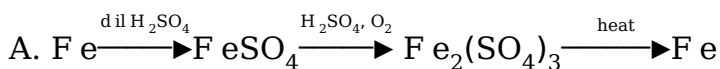(c) Given reaction is not balanced w.r.t. charge.
(d) Given reaction will give $K_3[Cu(CN)_4]$ as product instead of $K_2[Cu(CN)_4]$

Question147

Which series of reactions correctly represents chemical reactions related to iron and its compound?
[2014]

Options:

A. $Fe \xrightarrow{dil\, H_2SO_4} FeSO_4 \xrightarrow{H_2SO_4,\, O_2} Fe_2(SO_4)_3 \xrightarrow{heat} Fe$

B. $Fe \xrightarrow{O_2,\ heat} FeO \xrightarrow{dil.\, H_2SO_4} FeSO_4 \xrightarrow{heat} Fe$

C. $Fe \xrightarrow{Cl_2,\, heat} FeCl_3 \xrightarrow{heat,\, air} FeCl_2 \xrightarrow{Zn} Fe$

D. $Fe \xrightarrow{O_2,\ heat} Fe_3O_4 \xrightarrow{CO,\, 600°C} FeO \xrightarrow{CO,\, 700°C} Fe$

Answer: D

Solution:

Solution:
In equation (a) $Fe_2(SO_4)_3$, and in equation (b) $FeSO_4$ on decomposition will form oxide instead of Fe. In equation (c) $FeCl_3$ cannot be reduced when heated in air. Hence equation (d) is correct.

Question148

Which of the following is not formed when H_2S reacts with acidic $K_2Cr_2O_7$ solution?
[Online April 9, 2014]

Options:

A. $CrSO_4$

B. $Cr_2(SO_4)_3$

C. K_2SO_4

D. S

Solution:

Solution:
$K_2Cr_2O_7 + 4H_2SO_4 + 3H_2S \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3S$

Question149

Which of the following arrangements does not represent the correct order of the property stated against it?
[2013]

Options:

A. $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: paramagnetic behaviour
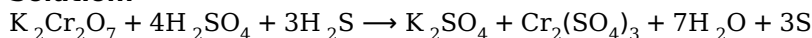
B. $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size

C. $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: stability in aqueous solution

D. $Sc < Ti < Cr < Mn$: number of oxidation states

Answer: A

Solution:

Solution:
$V = 3d^3 4s^2$; $V^{2+} = 3d^3 = 3$ unpaired electrons
$Cr = 3d^5 4s^1$; $Cr^{2+} = 3d^4 = 4$ unpaired electrons
$Mn = 3d^5 4s^2$; $Mn^{2+} = 3d^5 = 5$ unpaired electrons
$Fe = 3d^6 4s^2$; $Fe^{2+} = 3d^6 = 4$ unpaired electrons
Hence the correct order of paramagnetic behaviour
$V^{2+} < Cr^{2+} = Fe^{2+} < Mn^{2+}$
(b) For the same oxidation state, the ionic radii generally decreases as the atomic number increases in a particular transition series, hence the order is
$Mn^{2+} > Fe^{2+} > Co^{2+} > Ni^{2+}$
(c) Larger size, least hydrated more stable in aqueous solution. As we move across the period ($Sc^{3+} \to Cr^{3+} \to Fe^{3+} \to Co^{3+}$), the ionic size usually decreases. Sc^{3+} with the large size as least hydrated and hence more stable.
(d) $Sc - (+2), (+3)$
$Ti - (+2), (+3), (+4)$
$Cr - (+2), (+3), (+4), (+5), (+6)$
$Mn - (+2), (+3), (+4), (+5), (+6), (+7)$
i.e. $Sc < Ti < Cr < Mn$

Question150

Four successive members of the first row transition elements are listed below with atomic numbers. Which one of them is expected to have the highest $E_{M^{3+}/M^{2+}}$ value?
[2013]

Answer: D

Solution:

Solution:
$E°Cr^{3+}/Cr^{2+} = -0.41V$
$E_{Fe^{3+}/Fe^{2+}} = +0.77V$
$E°Mn^{3+}/Mn^{2+} = +1.57V$, $E°Co^{3+}/Co^{2+} = +1.97V$

Question151

The element with which of the following outer electron configuration may exhibit the largest number of oxidation states in its compounds:
[Online April 9,2013]

Options:

A. $3d^5 4s^2$

B. $3d^8 4s^2$

C. $3d^7 4s^2$

D. $3d^6 4s^2$

Answer: A

Solution:

Solution:
The element with outer electron configuration $3d^5 4s^2$ is Mn which exhibits oxidation states from +2 to +7 .

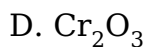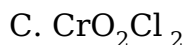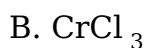
Question152

Potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride, gives brown-red vapours of :
[Online April 9, 2013]

Options:

A. CrO_3

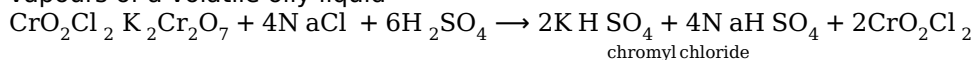B. CrCl $_3$

C. CrO$_2$Cl$_2$

D. Cr$_2$O$_3$

Answer: C

Solution:

Solution:
Solid potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride gives orange red vapours of a volatile oily liquid
CrO_2Cl_2 $K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \longrightarrow 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2$
<div align="center"><small>chromyl chloride</small></div>

Question153

When a small amount of K M nO$_4$ is added to concentrated H $_2$SO$_4$, a green oily compound is obtained which is highly explosive in nature. Compound may be:
[Online April 23, 2013]

Options:

A. M nSO$_4$

B. M n$_2$O$_7$

C. M nO$_2$

D. M n$_2$O$_3$

Answer: B

Solution:

Solution:
K M nO$_4$ reacts with H $_2$SO$_4$ to form M n$_2$O$_7$ which is highly explosive substance.
$2KMnO_4 + H_2SO_4 \longrightarrow K_2SO_4 + Mn_2O_7 + H_2O$

Question154

Identify incorrect statement:
[Online April 23, 2013]

Options:

A. Cu$_2$O is colourless.

B. Copper (I) compounds are colourless except when colour results from charge transfer.

C. Copper (I) compounds are diamagnetic.

D. Cu_2S is black.

Answer: A

Solution:

Solution:
Cu_2O is yellow in colour.

Question155

Iron exhibits +2 and +3 oxidation states. Which of the following statements about iron is incorrect?
[2012]

Options:

A. Ferrous oxide is more basic in nature than the ferric oxide.

B. Ferrous compounds are relatively more ionic than the corresponding ferric compounds.

C. Ferrous compounds are less volatile than the corresponding ferric compounds.

D. Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.

Answer: D

Solution:

Solution:
Fe^{3+} is easily hydrolysed than Fe^{2+} due to more positive charge.

Question156

Which pair of elements with the given atomic numbers is expected to have similar properties?
[Online May 19,2012]

Options:

A. 40,72

B. 20,36

C. 10,28

D. 11,12

Answer: A

Solution:

Z r(40), Hf (72) have similar properties as they belong to same group and have same valence shell electronic configuration.

Question157

Which is not the correct statement?
(At. nos. Ce = 58, Lu = 71, La = 57, Y b = 70)
[Online May 7,2012]

Options:

A. Colour of Yb^{3+} ion is pink.

B. La^{3+} is diamagnetic.

C. Ce^{4+} has f^0 configuration.

D. Lu^{3+} had f^{14} configuration.

Answer: A

Solution:

Solution:
Option (a) is incorrect as Yb^{3+} is colorless.

Question158

Magnetic moment of Gd $^{3+}$ ion (Z = 64) is
[Online May 12,2012]

Options:

A. 3.62BM

B. 9.72BM

C. 7.9BM

D. 10.60BM

Answer: C

Solution:

$Gd(64) = [Xe]4f^7 5d^1 6s^2$
$Gd^{3+} = [Xe]4f^7 5d^0$ as ^{0}
i.e. no. of unpaired electrons $= 7$
$\mu = \sqrt{n(n + 2)} = \sqrt{7(7 + 2)}$
$= \sqrt{63} = 7.93BM$

Question159

Which of the following forms stable +4 oxidation state?
[Online May 26,2012]

Options:

A. $La(Z = 57)$

B. $Eu(Z = 63)$

C. $Ce(Z = 58)$

D. $Gd (Z = 64)$

Answer: C

Solution:

Solution:
Only $Ce(Z = 58)$ shows stable (+4) oxidation state.

Question160

The number of unpaired electrons in Gadolinium [Z = 64] is
[Online May 26,2012]

Options:

A. 3

B. 8

C. 6

D. 2

Answer: B

Solution:

Solution:
$Gd (64) = [Xe]4f^7 5d^1 6s^2$
∴ No. of unpaired electrons $= 8$

Question161

The correct order of $E^\circ M^{2+} / M^{2+}$ values with negative sign for the four successive elements Cr, Mn, Fe and Co is
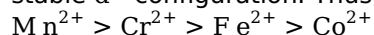**[2010]**

Options:

A. M n > Cr > F e > Co

B. Cr < F e > M n > Co

C. F e > M n > Cr > Co

D. Cr > M n > F e > Co

Answer: A

Solution:

Solution:
Across the first transition series, the negative values for standard electrode potential decrease except for M n due to the stable d^5 configuration. Thus, correct order is
$Mn^{2+} > Cr^{2+} > Fe^{2+} > Co^{2+}$

Question162

Knowing that the chemistry of lanthanoids(Ln) is dominated byits +3 oxidation state, which of the following statements is incorrect? [2009]

Options:

A. The ionic size of Ln (III) decreases in general with increasing atomic number

B. Ln (III) compounds are generally colourless.

C. Ln (III) hydroxides are mainly basic in character.

D. Because of the large size of the Ln(III) ions the bonding in its compounds is predominantly ionic in character.

Answer: B

Solution:

Solution:
Most of the Ln^{3+} compounds except La^{3+} and Lu^{3+} are coloured due to the presence of unpaired f -electrons.

Question163

Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration gives unsatisfactory result when carried out in the presence of H Cl , because H Cl [2008]

Options:

A. gets oxidised by oxalic acid to chlorine

B. furnishes H^+ ions in addition to those from oxalic acid

C. reduces permanganate to Mn^{2+}

D. oxidises oxalic acid to carbon doxide and water

Answer: C

Solution:

Solution:
The titration of oxalicacid with $KMnO_4$ in presence of HCl gives unsatisfactory result because of the fact that $KMnO_4$ can also oxidise HCl along with oxalic acid. HCl on oxidation gives Cl_2 and HCl reduces $KMnO_4$ to Mn^{2+}, thus the correct answer is (c).

Question164

Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being
[2008]

Options:

A. 4f orbitals more diffused than the 5 forbitals

B. leasser energy difference between 5f and 6d than between 4f and 5d orbitals

C. more energy difference between 5f and 6d than between 4f and 5d orbitals

D. more reactive nature of the actionids than the lanthanoids

Answer: B

Solution:

Solution:
Note : The main reason for exhibiting larger number of oxidation states by actinoids as compared to lanthanoids is lesser energy difference between 5f and 6d orbitals as compared to that between 4f and 5d orbitals.
In case of actinoids we can remove electrons from 5f as well as from 6d and due to this actinoids exhibit larger number of oxidation state than lanthanoids.

Question165

Identify the incorrect statement among the following:
[2007]

Options:

A. 4f and 5 forbitals are equally shielded.

B. d -Block elements show irregular and erratic chemical properties among themselves.

C. La and Lu havepartially filled d -orbitals and no other partially filled orbitals.

D. The chemistry of various lanthanoids is very similar.

Answer: A

Solution:

Solution:
4f Orbital is nearer to nucleus as compared to 5f orbital therefore, shielding of 4f is more than 5f .

Question166

The actinoids exhibit more number of oxidation states in general than the lanthanoids. This is because
[2007]

Options:

A. the 5f orbitals extend further from the nucleus than the 4f orbitals

B. the 5f orbitals are more buried than the 4f orbitals

C. there is a similarity between 4f and 5 forbitals in their angular part of the wave function

D. the actinoids are more reactive than the lanthanoids.

Answer: A

Solution:

Solution:
Note: More the distance between nucleus and outer orbitals, lesser will be force of attraction on them. Distance between nucleus and 5f orbitals is more as compared to distance between 4f orbital and nucleus. So actinoids exhibit more number of oxidation states in general than the lanthanoids.

Question167

The "spin-only" magnetic moment [in units of Bohr magneton, (μ_B)] of Ni^2 in aqueous solution would be (At. No. $Ni = 28$)
[2006]

Options:

A. 6

B. 1.73

C. 2.82

D. 4.90

Answer: C

Solution:

The number of unpaired electrons in $Ni^{2+}(aq) = 2$. Water is a weak ligand, hence no pairing will take place $\therefore$ spin magnetic moment $= \sqrt{n(n + 2)} = \sqrt{2(2 + 2)} = \sqrt{8} = 2.82$

Question168

Lanthanoid contraction is caused due to
[2006]

Options:

A. the same effective nuclear charge from Ce to Lu

B. the imperfect shielding on outer electrons by 4f electrons from the nuclear charge

C. the appreciable shielding on outer electrons by 4f electrons from the nuclear charge

D. the appreciable shielding on outer electrons by 5d electrons from the nuclear charge

Answer: B

Solution:

Solution:
The configuration of lanthanides shows that the additional electron enters the 4f subshell. The shielding of one 4f electron by another is very little or imperfect. The imperfect shielding of f electrons is due to the shape of f orbitals which is very much diffused. Thus as the atomic number increases, the nuclear charge increases by unity at each step, while no comparable increase in the mutual shielding effect of 4 foccurs. This causes a contraction in the size of the 4f subshell as a result of which atomic and ionic radii decrease gradually from La to Lu.

Question169

The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is:
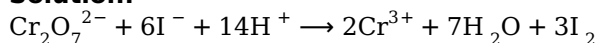## [2005]

Options:

A. +3

B. +2

C. +6

D. +4

Answer: A

Solution:

Solution:
$Cr_2O_7^{2-} + 6I^- + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O + 3I_2$

Question170

The value of the 'spin only' magnetic moment for one of the following configurations is 2.84BM . The correct one is
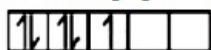[2005]

Options:

A. d^5 (in strong ligand field)

B. d^3 (in weak as well as in strong fields)

C. d^4 (in weak ligand fields)

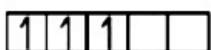D. d^4 (in strong ligand fields)

Answer: D

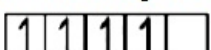## Solution:

Solution:

$d^5 \rightarrow$ strong ligand field

$$\mu = \sqrt{n(n+2)} = \sqrt{1(1+2)} = \sqrt{3} = 1.73BM$$
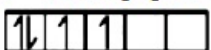
$d^3 -$ in weak as well as in strong field

$$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87B.M$$

$d^4 -$ in weak ligand field

$$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.89$$

$d^4 -$ in strong ligand field

$$\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.82$$

Question171

Which of the following factors may be regarded as the main cause of lanthanide contraction?
[2005]

Options:

A. Greater shielding of 5d electrons by 4f electrons

B. Poorer shiel ding of 5d electrons by 4f electrons

C. Effective shielding of one of the 4f electrons by another in the subshell

D. Poor shielding of one of the 4f electrons by another in the subshell

Answer: D

Solution:

Solution:
Lanthanide contraction is associated with the intervention of the 4f orbitals which must be filled before the 5d series of elements begin. The filling of 7f before 5d orbitals results in a regular decrease in atomic radii called lanthanoid contraction which essentially compensates for the expected increase in atomic size with increasing atomic number. The factor responsible for the lanthanoid contraction is the imperfect shelding of one electron by another in the same set of orbitals.

Question172

The lanthanide contraction is responsible for the fact that
[2005]

Options:

A. Z r and Z n have the same oxidation state

B. Z r and Hf have about the same radius

C. Z r and N b have similar oxidation state

D. Z r and Y have about the same radius

Answer: B

Solution:

Solution:
Note : In vertical columns of transition elements, there is an increase in size from first member to second member as expected but from second member to third member, there is very small chang in size and some times sizes are same. This is due to lanthanide contraction this is the reason for Z r and H f to have same radius.

Question173

Heating mixture of Cu_2O and Cu_2S will give
[2005]

Options:

A. Cu_2SO_3

B. $CuO + CuS$

C. $Cu + SO_3$

D. $Cu + SO_2$

Answer: D

Solution:

$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2 .$$
self reduction

Question174

Calomel (Hg_2Cl_2) on reaction with ammonium hydroxide gives [2005]

Options:

A. HgO

B. Hg_2O

C. $NH_2 - Hg - Hg - Cl$

D. $HgNH_2Cl$

Answer: D

Solution:

Solution:
$Hg_2Cl_2 + 2NH_4OH \longrightarrow Hg + HgNH_2Cl + NH_4Cl + 2H_2O$

Question175

Of the following outer electronic configurations of atoms, the highest oxidation state is achieved by which one of them ? [2004]

Options:

A. $(n-1)d^3 ns^2$

B. $(n-1)d^5 ns^1$

C. $(n-1)d^8 ns^2$

D. $(n-1)d^5 ns^2$

Answer: D

Solution:

Solution:
$(n-1)d^5 ns^2$ attains the maximum O.S. of +7

Question176

The correct order of magnetic moments (spin only values in B.M.) among the following is
[2004]

Options:

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

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

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

D. $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$ (Atomic nos. : $Mn = 25$, $Fe = 26$, $Co = 27$)
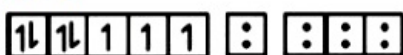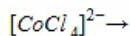
Answer: C

Solution:

Solution:

$[Fe(CN)_6]^{4} \rightarrow$

No of unpaired electron $= 0$

$[MnCl_4]^{2-} \rightarrow$

No of unpaired electrons $= 5$

$[CoCl_4]^{2-} \rightarrow$

No of unpaired electrons $= 3$

Note : The greater the number of unpaired electrons, greater the magnitude of magnetic moment. Hence the correct order will be $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4}$

Question177

Cerium (Z = 58) is an important member of the lanthanoids. Which of the following statements about cerium is incorrect?
[2004]

Options:

A. The +4 oxidation state of cerium is not known in solutions

B. The +3 oxidation state of cerium is more stable than the +4 oxidation state

C. The common oxidation states of cerium are +3 and +4

D. Cerium (IV) acts as an oxidizing agent

Answer: A

Solution:

The +4 oxidation state of cerium is also known in solution.

Question178

Ammonia forms the complex ion $[Cu(NH_3)_4]^{2+}$ with copper ions in alkaline solutions but not in acidic solutions. What is the reason for it? [2003]
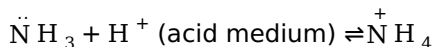
Options:

A. In acidic solutions, protons coordinate with ammonia molecules forming NH_4^+ ions and thus NH_3 molecules are not available

B. In alkaline solutions insoluble $Cu(OH)_2$ is precipitated which is soluble in excess of any alkali

C. Copper hydroxide is an amphoteric substance

D. In acidic solutions hydration protects copper ions

Answer: A

Solution:

Solution:

$\overset{..}{N}H_3 + H^+$ (acid medium) $\rightleftharpoons \overset{+}{N}H_4$

Question179

A red solid is insoluble in water. However it becomes soluble if some KI is added to water. Heating the red solid in a test tube results in liberation of some violet coloured fumes and droplets of a metal appear on the cooler parts of the test tube. The red solid is [2003]
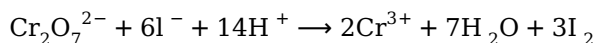
Options:

A. HgL_2

B. HgO

C. Pb_3O_4

D. $(NH_4)_2Cr_2O_7$

Answer: A

Solution:

$$Cr_2O_7{}^{2-} + 6I^- + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O + 3I_2$$

Question180

What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?
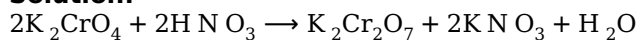**[2003]**

Options:

A. $Cr_2O_7{}^{2-}$ and H_2O are formed

B. $CrO_4{}^{2-}$ is reduced to +3 state of Cr

C. $CrO_4{}^{2-}$ is oxidized to +7 state of Cr

D. Cr^{3+} and $Cr_2O_7{}^{2-}$ are formed

Answer: A

Solution:

Solution:
$2K_2CrO_4 + 2HNO_3 \longrightarrow K_2Cr_2O_7 + 2KNO_3 + H_2O$

Question181

Which one of the following nitrates will leave behind a metal on strong heating?
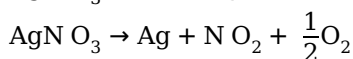**[2003]**

Options:

A. Copper nitrate

B. Manganese nitrate

C. Silver nitrate

D. Ferric nitrate

Answer: C

Solution:

Solution:
$AgNO_3$ on heating till red hot decomposes as follows:
$AgNO_3 \rightarrow Ag + NO_2 + \frac{1}{2}O_2$

Question182

The radius of La^{3+} (Atomic number of La = 57) is 1.06Å. Which one of the following given values will be closest to the radius of Lu^{3+} (Atomic number of Lu = 71) ?
[2003]

Options:

A. 1.40Å

B. 1.06Å

C. 0.85Å

D. 1.60Å

Answer: C

Solution:

Solution:
Ionic radii $\propto \dfrac{1}{z}$

Thus, $\dfrac{z_2}{z_1} = \dfrac{71}{57} = \dfrac{1.06}{(\text{Ionic radii of } Lu^{3+})}$

$\therefore$ Ionic radii of Lu^{3+} = 0.85Å

Question183

A reduction in atomic size with increase in atomic number is a characteristic of elements of
[2003]

Options:

A. d -block

B. f -block

C. radioactive series

D. high atomic masses

Answer: B

Solution:

Solution:
f -Block elements show a regular decrease in atomic size due to lanthanide\/actinide contraction.

Question184

Which of the following ions has the maximum magnetic moment?
[2002]

Options:

A. Mn^{+2}

B. Fe^{+2}

C. Ti^{+2}

D. Cr^{+2}

Answer: A

Solution:

Solution:
Mn^{2+} – 5 unpaired electrons
Fe^{2+} – 4 unpaired electrons
Ti^{2+} – 2 unpaired electrons
Cr^{2+} – 4 unpaired electrons
Note : Magnetic moment ∝ Number of unpaired electrons

Question185

The most stable ion is
[2002]

Options:

A. $[Fe(OH)_5]^3$

B. $[Fe(Cl)_6]^3$

C. $[Fe(CN)_6]^{3-}$

D. $[Fe(H_2O)_6]^{3+}$

Answer: C

Solution:

Solution:
The cyano and hydroxo complexes are far more stable than those formed by halide ion. This is due to the fact that CN^- and OH^- are strong Lewis bases (nucleophiles). Further $[Fe(OH)_5]^{3-}$ is not formed. hence most stable ion is $[Fe(CN)_6]^{3-}$

Question186

When $KMnO_4$ acts as an oxidising agent and ultimately forms

$[MnO_4]^{-2}$, MnO_2, Mn_2O_3, Mn^{+2} then the number of electrons transferred in each case respectively is
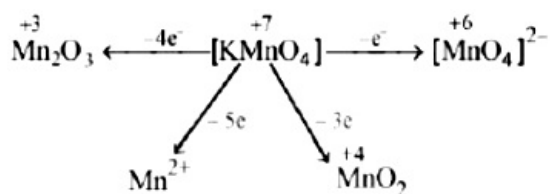[2002]

Options:

A. 4,3,1,5

B. 1,5,3,7

C. 1,3,4,5

D. 3,5,7,1 .

Answer: C

Solution:

Solution:

Question187

Most common oxidation states of Ce (cerium) are
[2002]

Options:

A. +2,+3

B. +2,+4

C. +3,+4

D. +3,+5 .

Answer: C

Solution:

Solution:
Common oxidation states of Ce(cerium) are +3 and +4

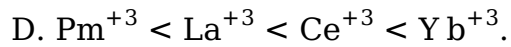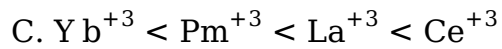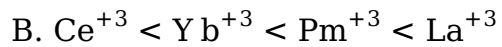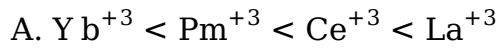---

Question188

Arrange Ce^{+3}, La^{+3}, Pm^{+3} and Yb^{+3} in increasing order of their ionic radii.

[2002]

Options:

A. $Yb^{+3} < Pm^{+3} < Ce^{+3} < La^{+3}$

B. $Ce^{+3} < Yb^{+3} < Pm^{+3} < La^{+3}$

C. $Yb^{+3} < Pm^{+3} < La^{+3} < Ce^{+3}$
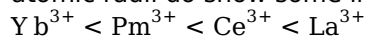
D. $Pm^{+3} < La^{+3} < Ce^{+3} < Yb^{+3}$.

Answer: A

Solution:

In lanthanides there is a regular decrease in the atomic radii as well as ionic radii of trivalent ions as the atomic number increases from Ce to Lu. This decrease in size of atoms and ions is known as **lanthanide contraction**. Although the atomic radii do show some irregularities but ionic radii decrease from La to Lu. Thus the correct order is.
$Yb^{3+} < Pm^{3+} < Ce^{3+} < La^{3+}$
86.8pm 97pm 102pm 103pm