Chapter 18

The *d* & *f*-Block Elements

1. In context with the transition elements, which of the following statements is incorrect? **[AIEEE-2009]**

   (1) In the highest oxidation states, the transition metals show basic character and form cationic complexes

   (2) In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4*s* and 3*d* electrons are used for bonding.

   (3) Once the d^5 configuration is exceeded, the tendency to involve all the 3*d* electrons in bonding decreases

   (4) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes

2. Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is incorrect? **[AIEEE-2009]**

   (1) The ionic sizes of Ln (III) decrease in general with increasing atomic number

   (2) Ln (III) compounds are generally colourless

   (3) Ln (III) hydroxides are mainly basic in character

   (4) Because of the large size of the Ln (III) ions the bonding in its compounds is predominently ionic in character

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

   (1) Cr > Mn > Fe > Co (2) Mn > Cr > Fe > Co

   (3) Cr > Fe > Mn > Co (4) Fe > Mn > Cr > Co

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

   (1) Ferrous compounds are relatively more ionic than the corresponding ferric compounds.

   (2) Ferrous compounds are less volatile than the coirresponding ferric compounds.

   (3) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds

   (4) Ferrous oxide is more basic innature than the ferric oxide.

5. Which of the following arrangements does not represent the correct order of the property stated against it? **[JEE (Main)-2013]**

   (1) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: paramagnetic behaviour

   (2) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size

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

   (4) Sc < Ti < Cr < Mn : number of oxidation states

6. 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 $E^{0}_{M^{3+}/M^{2+}}$ value? **[JEE (Main)-2013]**

   (1) Cr (Z = 24)

   (2) Mn (Z = 25)

   (3) Fe (Z = 26)

   (4) Co (Z = 27)

7. Which series of reactions correctly represents chemical reactions related to iron and its compound? **[JEE (Main)-2014]**

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

   (2) $Fe \xrightarrow{O_2,heat} FeO \xrightarrow{dil.H_2SO_4} FeSO_4 \xrightarrow{heat} Fe$

   (3) $Fe \xrightarrow{Cl_2,heat} FeCl_3 \xrightarrow{heat,air} FeCl_2 \xrightarrow{Zn} Fe$

   (4) $Fe \xrightarrow{O_2,heat} Fe_3O_4 \xrightarrow{CO,600^oC} FeO \xrightarrow{CO,700^oC} Fe$

8. Match the catalysts to the correct processes :

Catalyst	Process
a. $TiCl_3$	(i) Wacker process
b. $PdCl_2$	(ii) Ziegler-Natta polymerization
c. $CuCl_2$	(iii) Contact process
d. V_2O_5	(iv) Deacon's process

[JEE (Main)-2015]

(1) a(iii), b(ii), c(iv), d(i) (2) a(ii), b(i), c(iv), d(iii)

(3) a(ii), b(iii), c(iv), d(i) (4) a(iii), b(i), c(ii), d(iv)

9. The color of $KMnO_4$ is due to **[JEE (Main)-2015]**

(1) M $\rightarrow$ L charge transfer transition

(2) d - d transition

(3) L $\rightarrow$ M charge transfer transition

(4) σ - σ^* transition

10. Which of the following compounds is metallic and ferromagnetic? **[JEE (Main)-2016]**

(1) CrO_2 (2) VO_2

(3) MnO_2 (4) TiO_2

11. The pair having the same magnetic moment is

[At. No.: Cr = 24, Mn = 25, Fe = 26, Co = 27]

[JEE (Main)-2016]

(1) $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

(2) $[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)_6]^{2+}$

(3) $[CoCl_4]^{2-}$ and $[Fe(H_2O)_6]^{2+}$

(4) $[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$

12. In the following reactions, ZnO is respectively acting as a/an **[JEE (Main)-2017]**

(a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$

(b) $ZnO + CO_2 \rightarrow ZnCO_3$

(1) Acid and acid (2) Acid and base

(3) Base and acid (4) Base and base

13. The effect of lanthanoid contraction in the lanthanoid series of elements by and large means **[JEE (Main)-2019]**

(1) Increase in atomic radii and decrease in ionic radii

(2) Decrease in atomic radii and increase in ionic radii

(3) Decrease in both atomic and ionic radii

(4) Increase in both atomic and ionic radii

14. The element that usually does NOT show variable oxidation states is **[JEE (Main)-2019]**

(1) Cu (2) Ti

(3) V (4) Sc

15. $\underline{A} \xrightarrow{4\,KOH,O_2} \underset{(Green)}{2\underline{B}} + 2H_2O$

$3\underline{B} \xrightarrow{4\,HCl} \underset{(Purple)}{2\underline{C}} + MnO_2 + 2H_2O$

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

In the above sequence of reactions, $\underline{A}$ and $\underline{D}$, respectively, are **[JEE (Main)-2019]**

(1) KI and K_2MnO_4

(2) KIO_3 and MnO_2

(3) MnO_2 and KIO_3

(4) KI and $KMnO_4$

16. The lanthanide ion that would show colour is **[JEE (Main)-2019]**

(1) Gd^{3+} (2) Lu^{3+}

(3) La^{3+} (4) Sm^{3+}

17. The statement that is INCORRECT about the interstitial compounds is **[JEE (Main)-2019]**

(1) They are chemically reactive.

(2) They are very hard.

(3) They have high melting points.

(4) They have metallic conductivity.

18. The maximum number of possible oxidation states of actinoides are shown by **[JEE (Main)-2019]**

(1) Berkelium (Bk) and californium (Cf)

(2) Neptunium (Np) and plutonium (Pu)

(3) Actinium (Ac) and thorium (Th)

(4) Nobelium (No) and lawrencium (Lr)

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

(1) $Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$

(2) $Ti^{3+} < Ti^{2+} < Sc^{3+} < V^{2+}$

(3) $Sc^{3+} < Ti^{3+} < V^{2+} < Ti^{2+}$

(4) $V^{2+} < Ti^{2+} < Ti^{3+} < Sc^{3+}$

20. The highest possible oxidation states of uranium and plutonium, respectively, are : **[JEE (Main)-2019]**

(1) 6 and 7 (2) 7 and 6

(3) 6 and 4 (4) 4 and 6

21. The metal that gives hydrogen gas upon treatment with both acid as well as base is : **[JEE (Main)-2019]**

(1) Zinc (2) Magnesium

(3) Iron (4) Mercury

22. The pair that has similar atomic radii is : **[JEE (Main)-2019]**

(1) Mo and W (2) Ti and Hf

(3) Sc and Ni (4) Mn and Re

23. The highest value of the calculated spin only magnetic moment (in BM) among all the transition metal complexes is **[JEE (Main)-2019]**

(1) 5.92 (2) 6.93

(3) 4.90 (4) 3.87

24. The transition element that has lowest enthalpy of atomisation, is **[JEE (Main)-2019]**

(1) V (2) Cu

(3) Fe (4) Zn

25. The correct order of atomic radii is **[JEE (Main)-2019]**

(1) Ce > Eu > Ho > N (2) N > Ce > Eu > Ho

(3) Eu > Ce > Ho > N (4) Ho > N > Eu > Ce

26. 5 g of zinc is treated separately with an excess of

(a) Dilute hydrochloric acid and

(b) Aqueous sodium hydroxide.

The ratio of the volumes of H_2 evolved in these two reactions is **[JEE (Main)-2020]**

(1) 1 : 4 (2) 2 : 1

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

27. The incorrect statement is **[JEE (Main)-2020]**

(1) Manganate and permanganate ions are paramagnetic

(2) Manganate and permanganate ions are tetrahedral

(3) Manganate ion is green in colour and permanganate ion is purple in colour

(4) In manganate and permanganate ions, the π-bonding takes place by overlap of p-orbitals of oxygen and d-orbitals of manganese

28. The incorrect statement(s) among (a) - (c) is (are)

(a) W(VI) is more stable than Cr(VI).

(b) In the presence of HCl, permanganate titrations provide satisfactory results.

(c) Some lanthanoid oxides can be used as phosphors. **[JEE (Main)-2020]**

(1) (a) and (b) only

(2) (a) only

(3) (b) and (c) only

(4) (b) only

29. The lanthanoid that does NOT show +4 oxidation state is **[JEE (Main)-2020]**

(1) Tb (2) Dy

(3) Ce (4) Eu

30. Consider the following reactions:

$NaCl + K_2Cr_2O_7 + H_2SO_4 \rightarrow$ (A) + side products
(Conc.)

(A) + NaOH $\rightarrow$ (B) + Side products

(B) + H_2SO_4 + $H_2O_2 \rightarrow$ (C) + Side products
(dilute)

The sum of the total number of atoms in one molecule each of (A), (B) and (C) is _____.

[JEE (Main)-2020]

31. The sum of the total number of σ bonds between chromium and oxygen atoms in chromate and dichromate ions is _____ .

[JEE (Main)-2020]

32. The correct electronic configuration and spin-only magnetic moment (BM) of Gd^{3+} (Z = 64), respectively, are **[JEE (Main)-2020]**

(1) [Xe] $5f^7$ and 8.9 (2) [Xe] $4f^7$ and 7.9

(3) [Xe] $5f^7$ and 7.9 (4) [Xe] $4f^7$ and 8.9

33. The atomic radius of Ag is closest to **[JEE (Main)-2020]**

(1) Cu (2) Au

(3) Hg (4) Ni

34. The third ionization enthalpy is minimum for **[JEE (Main)-2020]**

(1) Mn (2) Fe

(3) Co (4) Ni

35. The electronic configurations of bivalent europium and trivalent cerium are **[JEE (Main)-2020]**

(atomic number : Xe = 54, Ce = 58, Eu = 63)

(1) [Xe] $4f^7$ and [Xe] $4f^1$

(2) [Xe] $4f^7$ $6s^2$ and [Xe] $4f^2$ $6s^2$

(3) [Xe] $4f^2$ and [Xe] $4f^7$

(4) [Xe] $4f^4$ and [Xe] $4f^9$

36. Mischmetal is an alloy consisting mainly of **[JEE (Main)-2020]**

(1) Lanthanoid and actinoid metals

(2) Actinoid and transition metals

(3) Lanthanoid metals

(4) Actinoid metals

37. The electrode potential of M^{2+} / M of 3d-series elements shows positive value for : **[JEE (Main)-2021]**

(1) Cu (2) Zn

(3) Co (4) Fe

38. The incorrect statement among the following is: **[JEE (Main)-2021]**

(1) $VOSO_4$ is a reducing agent

(2) RuO_4 is an oxidizing agent

(3) Red colour of ruby is due to the presence of Co^{3+}

(4) Cr_2O_3 is an amphoteric oxide

39. What is the correct order of the following elements with respect to their density? **[JEE (Main)-2021]**

(1) Cr < Zn < Co < Cu < Fe

(2) Cr < Fe < Co < Cu < Zn

(3) Zn < Cu < Co < Fe < Cr

(4) Zn < Cr < Fe < Co < Cu

40. Given below are two statements:

Statement-I: CeO_2 can be used for oxidation of aldehyde 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: **[JEE (Main)-2021]**

(1) Both Statement I and Statement II are false

(2) Both Statement I and Statement II are true

(3) Statement I is true but Statement II is false

(4) Statement I is false but Statement II is true

41. In which of the following pairs, the outer most electronic configuration will be the same? **[JEE (Main)-2021]**

(1) Ni^{2+} and Cu^+ (2) Fe^{2+} and Co^+

(3) Cr^+ and Mn^{2+} (4) V^{2+} and Cr^+

42. The spin only magnetic moment of a divalent ion in aqueous solution (atomic number 29) is **[JEE (Main)-2021]**

43. Which one of the following lanthanoids does not form MO_2? **[JEE (Main)-2021]**

[M is lanthanoid metal]

(1) Nd (2) Pr

(3) Dy (4) Yb

44. Dichromate ion is treated with base, the oxidation number of Cr in the product formed is _____. **[JEE (Main)-2021]**

45. In mildly alkaline medium, thiosulphate ion is oxidized by MnO_4^- to "A". The oxidation state of sulphur in "A" is _____. **[JEE (Main)-2021]**

46. Given below are two statement : 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. **[JEE (Main)-2021]**

(1) A is false but R is true

(2) A is true but R is false

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

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

47. Given below are two statements :

Statement I : The E° value for Ce^{4+}/Ce^{3+} is +1.74 V.

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. **[JEE (Main)-2021]**

(1) Both **statement I** and **statement II** are correct

(2) **Statement I** is correct but **statement II** is incorrect

(3) Both **statement I** and **statement II** are incorrect

(4) **Statement I** is incorrect but **statement II** is correct

48. Fex_2 and Fey_3 are known when x and y are **[JEE (Main)-2021]**

(1) x = F, Cl, Br, I and y = F, Cl, Br

(2) x = Cl, Br, I and y = F, Cl, Br, I

(3) x = F, Cl, Br and y = F, Cl, Br, I

(4) x = F, Cl, Br, I and y = F, Cl, Br, I

49. What is the spin-only magnetic moment value (BM) of a divalent metal ion with atomic number 25, in it's aqueous solution? **[JEE (Main)-2021]**

(1) 5.92 (2) 5.26

(3) Zero (4) 5.0

50. Given below are two statements :

Statements I : Potassium permanganate on heating at 573 K forms potassium manganate.

Statements II : Both potassium permanganate and potassium manganate are tetrahedral and paramagnetic in nature.

In the light of the above statements, choose the **most appropriate** answer from the options given below : **[JEE (Main)-2021]**

(1) Statement I is false but statement II is true

(2) Both statement I and statement II are false

(3) Both statement I and statement II are true

(4) Statement I is true but statement II is false

51. The common positive oxidation states for an element with atomic number 24, are **[JEE (Main)-2021]**

(1) +1 and +3 to +6 (2) +1 to +6

(3) +2 to +6 (4) +1 and +3

52. Cu^{2+} salt reacts with potassium iodide to give: **[JEE (Main)-2021]**

(1) Cu_2I_2 (2) Cu_2I_3

(3) $Cu(I_3)_2$ (4) CuI

53. The set having ions which are coloured and paramagnetic both is **[JEE (Main)-2021]**

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

(3) Sc^{3+}, V^{5+}, Ti^{4+} (4) Ni^{2+}, Mn^{7+}, Hg^{2+}

54. The correct order of following 3d metal oxides, according to their oxidation number is **[JEE (Main)-2021]**

(a) CrO_3

(b) Fe_2O_3

(c) MnO_2

(d) V_2O_5

(e) Cu_2O

(1) (a) > (d) > (c) > (b) > (e)

(2) (d) > (a) > (b) > (c) > (e)

(3) (a) > (c) > (d) > (b) > (e)

(4) (c) > (a) > (d) > (e) > (b)

55. 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) **[JEE (Main)-2021]**

(1) 1.73, 3.87, 0 (2) 0, 3.87, 1.73

(3) 3.87, 1.73, 0 (4) 1.73, 0, 3.87

56. Which one of the following when dissolved in water gives coloured solution in nitrogen atmosphere? **[JEE (Main)-2021]**

(1) AgCl (2) Cu_2Cl_2

(3) $ZnCl_2$ (4) $CuCl_2$

57. The number of 4*f* electrons in the ground state electronic configuration of Gd^{2+} is _____. [Atomic number of Gd = 64] **[JEE (Main)-2021]**

58. 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 : **[JEE (Main)-2021]**

(1) X = amphoteric Y = basic

(2) X = basic Y = basic

(3) X = basic Y = amphoteric

(4) X = acidic Y = acidic

59. The number of *f* electrons in the ground state electronic configuration of Np (Z = 93) is _____. (Integer answer) **[JEE (Main)-2021]**

60. The addition of dilute NaOH to Cr^{3+} salt solution will give : **[JEE (Main)-2021]**

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

(2) Precipitate of $[Cr(OH)_6]^{3-}$

(3) Precipitate of $Cr_2O_3(H_2O)_n$

(4) Precipitate of $Cr(OH)_3$

61. Potassium permaganate on heating at 513 K gives a non-gaseous product which is

[JEE (Main)-2021]

(1) Paramagnetic and green

(2) Paramagnetic and colourless

(3) Diamagnetic and colourless

(4) Diamagnetic and green

62. Which one of the following lanthanides exhibits +2 oxidation state with diamagnetic nature? (Given Z for Nd = 60, Yb = 70, La = 57, Ce = 58)

[JEE (Main)-2021]

(1) Nd (2) Yb

(3) La (4) Ce

63. In the structure of the dichromate ion, there is a :

[JEE (Main)-2021]

(1) Linear symmetrical Cr – O – Cr bond

(2) Non-linear symmetrical Cr – O – Cr bond

(3) Linear unsymmetrical Cr – O – Cr bond

(4) Non-linear unsymmetrical Cr – O – Cr bond

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

[JEE (Main)-2021]

(1) $4f^6$ (2) $4f^7$

(3) $4f^6 6s^2$ (4) $4f^7 6s^2$

65. The value of magnetic quantum number of the outermost electron of Zn^+ ion is _____. (Integer answer) **[JEE (Main)-2021]**

66. Identify the element for which electronic configuration in +3 oxidation state is $[Ar]3d^5$:

[JEE (Main)-2021]

(1) Mn (2) Ru

(3) Co (4) Fe

67. In the given chemical reaction colors of the Fe^{2+} and Fe^{3+} ions, are respectively: **[JEE (Main)-2021]**

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$$

(1) Yellow, Green (2) Green, Orange

(3) Green, Yellow (4) Yellow, Orange

68. Number of electrons present in 4f orbital of Ho^{3+} ion is _____. (Given Atomic No. of Ho = 67)

[JEE (Main)-2021]

69. The oxide that shows magnetic property is :

[JEE (Main)-2021]

(1) MgO (2) Na_2O

(3) SiO_2 (4) Mn_3O_4

70. The difference in oxidation state of chromium in *chromate* and *dichromate* salts is _____,

[JEE (Main)-2022]

71. Metals generally melt at very high temperature. Amongst the following, the metal with the highest melting point will be **[JEE (Main)-2022]**

(1) Hg (2) Ag

(3) Ga (4) Cs

72. Manganese (VI) has ability to disproportionate in acidic solution. The difference in oxidation states of two ions it forms in acidic solution is _____.

[JEE (Main)-2022]

73. Cerium (IV) has a noble gas configuration. Which of the following is correct statement about it?

[JEE (Main)-2022]

(1) It will not prefer to undergo redox reactions.

(2) It will prefer to gain electron and act as an oxidizing agent

(3) It will prefer to give away an electron and behave as reducing agent

(4) It acts as both, oxidizing and reducing agent.

74. Among the following which is the strongest oxidizing agent? **[JEE (Main)-2022]**

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

(3) Ti^{3+} (4) Cr^{3+}

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

[JEE (Main)-2022]

(1) V^{2+} (2) Ni^{2+}

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

76. 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)

[JEE (Main)-2022]

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

[JEE (Main)-2022]

(1) Ce (At. No. 58) (2) La (At. No. 57)

(3) Lu (At. No. 71) (4) Gd (At. No. 64)

78. 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) **[JEE (Main)-2022]**

79. In 3d series, the metal having the highest M^{2+}/M standard electrode potential is

[JEE (Main)-2022]

(1) Cr (2) Fe

(3) Cu (4) Zn

80. 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] **[JEE (Main)-2022]**

(1) Eu^{2+} and Tm^{2+} (2) Sm^{2+} and Tm^{3+}

(3) Tb^{4+} and Yb^{2+} (4) Dy^{3+} and Yb^{3+}

81. Which one of the lanthanoids given below is the most stable in divalent form? **[JEE (Main)-2022]**

(1) Ce (Atomic Number 58)

(2) Sm (Atomic Number 62)

(3) Eu (Atomic Number 63)

(4) Yb (Atomic Number 70)

82. The electronic configuration of Pt(atomic number 78) is: **[JEE (Main)-2022]**

(1) [Xe] $4f^{14}\ 5d^9\ 6s^1$ (2) [Kr] $4f^{14}\ 5d^{10}$

(3) [Xe] $4f^{14}\ 5d^{10}$ (4) [Xe] $4f^{14}\ 5d^8\ 6s^2$

83. 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) **[JEE (Main)-2022]**

84. 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)

[JEE (Main)-2022]

85. The spin-only magnetic moment value of M^{3+} ion (in gaseous state) from the pairs Cr^{3+}/Cr^{2+}, Mn^{3+}/Mn^{2+}, Fe^{3+}/Fe^{2+} and Co^{3+}/Co^{2+} that has negative standard electrode potential, is_____ B.M. [Nearest integer]

[JEE (Main)-2022]

86. 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]

[JEE (Main)-2022]

87. 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.

[JEE (Main)-2022]

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

(3) Statement I is true but Statement II is false

(4) Statement I is false but Statement II is true

88. The total number of Mn=O bonds in Mn_2O_7 is ___.

[JEE (Main)-2022]

(1) 4 (2) 5

(3) 6 (4) 3

89. In neutral or alkaline solution, MnO_4^- oxidises thiosulphate to : **[JEE (Main)-2022]**

(1) $S_2O_7^{2-}$ (2) $S_2O_8^{2-}$

(3) SO_3^{2-} (4) SO_4^{2-}

90. Match **List-I** with **List-II**, match the gas evolved during each reaction.

List-I	**List-II**
(A) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta}$	(I) H_2
(B) $KMnO_4 + HCl \rightarrow$	(II) N_2
(C) $Al + NaOH + H_2O \rightarrow$	(III) O_2
(D) $NaNO_3 \xrightarrow{\Delta}$	(IV) Cl_2

Choose the **correct** answer from the options given below: **[JEE (Main)-2022]**

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

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

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

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

91. 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 Mn in B is smaller than that of A, then the spin-only magnetic moment (μ) value of B in BM is _____. (Nearest integer) **[JEE (Main)-2022]**

92. In following pairs, the one in which both transition metal ions are colourless is : **[JEE (Main)-2022]**

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

(4) V^{2+}, Ti^{3+} (4) Zn^{2+}, Mn^{2+}

[JEE (Main)-2022]

93. Which of the following 3d-metal ion will give the lowest enthalpy of hydration ($\Delta_{hyd}H$) when dissolved in water? **[JEE (Main)-2022]**

(1) Cr^{2+} (2) Mn^{2+}

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

94. 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) **[JEE (Main)-2022]**

(1) Sm^{2+} and Er^{3+} (2) Yb^{2+} and Lu^{3+}

(3) Eu^{2+} and Tb^{4+} (4) Tb^{2+} and Tm^{4+}

95. The number of terminal oxygen atoms present in the product B obtained from the following reaction is _____.

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

$A + H^+ \rightarrow B + H_2O + Na^+$

[JEE (Main)-2022]

96. Given below are two statements.

Statement I: O_2, Cu^{2+}, and Fe^{3+} are weakly attracted by magnetic field and are magnetized in the same direction as magnetic field.

Statement II: NaCl and H_2O are weakly magnetized in opposite direction to magnetic field.

In the light of the above statements, choose the ***most appropriate*** answer from the options given below.

[JEE (Main)-2022]

(1) Both **Statement I** and **Statement II** are correct.

(2) Both **Statement I** and **Statement II** are incorrect.

(3) **Statement I** is correct but **Statement II** is incorrect.

(4) **Statement I** is incorrect but **Statement II** is correct.

97. Match **List-I** with **List-II**.

List-I	**List-II**
(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(I) Cu
(B) $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$	(II) $Cu/ZnO - Cr_2O_3$
(C) $CO(g) + H_2(g) \rightarrow HCHO(g)$	(III) $Fe_xO_y + K_2O + Al_2O_3$
(D) $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$	(IV) Ni

Choose the **correct** answer from the options given below :

[JEE (Main)-2022]

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

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

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

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

98. Match **List-I** with **List-II.**

List-I (Processes/ Reactions)	**List-II (Catalyst)**
(A) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$	(I) Fe(s)
(B) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$	(II) Pt(s) – Rh(s)
(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(III) V_2O_5
(D) Vegetable oil(l) + H_2 $\rightarrow$ Vegetable ghee(s)	(IV) Ni(s)

Choose the **correct** answer from the options given below :

[JEE (Main)-2022]

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

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

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

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

99. Match **List-I** with **List-II**.

List-I **Reaction**		**List-II** **Catalyst**
(A) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$	(I)	NO(g)
(B) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(II)	$H_2SO_4(l)$
(C) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow C_6H_{12}O_6 (\underset{\text{Glucose}}{}) + C_6H_{12}O_6 (\underset{\text{Fructose}}{})$	(III)	Pt(s)
(D) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$	(IV)	Fe(s)

Choose the **correct** answer from the options given below:

[JEE (Main)-2022]

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

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

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

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

❑ ❑ ❑

Chapter 18

The *d* & *f*-Block Elements

1. Answer (1)

   In the highest oxidation states, the transition metals show acidic character.

2. Answer (2)

   Ln (III) compounds are generally coloured.

3. Answer (2)

   Mn > Cr > Fe > Co

   $E^{o}_{Mn^{2+}/Mn} = -1.18$

   $E^{o}_{Cr^{2+}/Cr} = -0.91$

   $E^{o}_{Fe^{2+}/Fe} = -0.44$

   $E^{o}_{CO^{2+}/CO} = -0.28$

4. Answer (3)

5. Answer (1)

   Number of unpaired electrons of V^{2+}, Cr^{2+}, Mn^{2+} and Fe^{2+} are 3, 4, 5 and 4 respectively. Hence the given order of paramagnetic behaviour is incorrect.

6. Answer (4)

   Cobalt has the highest value of $E^{\circ}_{Co^{3+}/Co^{2+}} = +1.97\ V$.

   Other values of standard reduction potential are $E^{\circ}_{Mn^{3+}/Mn^{2+}} = +1.57\,V$, $E^{\circ}_{Fe^{3+}/Fe^{2+}} = 0 + 0.77\,V$ and $E^{\circ}_{Cr^{3+}/Cr^{2+}} = -0.41V$.

7. Answer (4)

   $$Fe \xrightarrow[Heat]{O_2} Fe_3O_4$$

   This reaction is corresponding to the combustion of Fe.

   $$Fe_3O_4 \xrightarrow[600^{\circ}C]{CO} FeO \xrightarrow[700^{\circ}C]{CO} Fe$$

   These reactions correspond to the production of Fe by reduction of Fe_3O_4 in blast furnace.

8. Answer (2)

   $TiCl_3$ - Ziegler-Natta polymerisation

   V_2O_5 - Contact process

   $PdCl_2$ - Wacker process

   $CuCl_2$ - Deacon's process

9. Answer (3)

   Charge transfer spectra from ligand (L) to metal (M) is responsible for color of $KMnO_4$.

10. Answer (1)

    CrO_2 is strongly attracted towards magnetic field so it is ferromagnetic.

11. Answer (1)

    Identical the number of unpaired electrons higher the magnetic moment

	Metal ion	Unpaired electrons
$[Cr(H_2O)_6]^{2+}$	Cr^{2+}	4
$[Fe(H_2O)_6]^{2+}$	Fe^{2+}	4

    $\therefore$ $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$ have identical magnetic moment.

12. Answer (2)

    In (a), ZnO acts as acidic oxide as Na_2O is basic oxide.

    In (b), ZnO acts as basic oxide as CO_2 is acidic oxide.

13. Answer (3)

    Due to lanthanoid contraction, size of atom as well as ion of lanthanoid decrease.

14. Answer (4)

    Sc shows fixed oxidation state of +3

15. Answer (3)

    $$\underset{(A)}{2MnO_2} + 4KOH + O_2 \longrightarrow \underset{\substack{(Green)\\(B)}}{2K_2MnO_4} + 2H_2O$$

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

    $$2KMnO_4 + H_2O + KI \longrightarrow 2MnO_2 + 2KOH + \underset{(D)}{KIO_3}$$

    A – MnO_2

    D – KIO_3

16. Answer (4)

Sm^{+3} = Partially filled f orbital = $4f^5$

Sm = $4f^6 6s^2$

Sm^{+3} = Yellow.

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

17. Answer (1)

Interstitial compounds are inert.

18. Answer (2)

Actinoids	Oxidation state shown
Th	+4
Ac	+3
Pu	+3, +4, +5, +6, +7
Np	+3, +4, +5, +6, +7
Bk	+3, +4
Cm	+3, +4
Lr	+3

$\therefore$ Maximum oxidation state is shown by (Np and Pu).

19. Answer (1)

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) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

Magnetic moment is directly proportional to the number of unpaired electrons. So the correct increasing order of magnetic moment is

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

0 1 2 3 unpaired electrons

20. Answer (1)

Maximum oxidation state shown by

Uranium = + 6

Plutonium = + 7

21. Answer (1)

$Zn + NaOH \longrightarrow Na_2ZnO_2 + H_2$

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

Zn is amphoteric.

22. Answer (1)

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.

23. Answer (1)

The 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. Magnetic moment is given as

$\mu = \sqrt{n(n+2)}$ BM [no. of unpaired electrons = n)

Maximum value of magnetic moment

$= \sqrt{5(5+2)} = \sqrt{35} = 5.92$ BM

24. Answer (4)

Zinc has least enthalpy of atomisation in 3d-transition series.

25. Answer (3)

Atomic radii follows the order

Eu	>	Ce	>	Ho	>	N
199 pm		183 pm		176 pm		70 pm

26. Answer (4)

$$\mathbf{Zn + 2NaOH \rightarrow Na_2[ZnO_2] + H_2}$$

(1 mol) (1 mol)

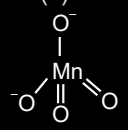
$$\mathbf{Zn + 2HCl \rightarrow ZnCl_2 + H_2}$$

(1 mol) (1 mol)

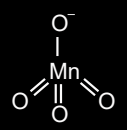
from one mole of Zn, 1 mol of H_2 is produced by both NaOH and HCl.

$\therefore$ Molar ratio = Volume ratio *ie*. 1 : 1

27. Answer (1)



Manganate ion (MnO_4^{2-})
Tetrahedral
Green colour
$p\pi$-$d\pi$ bonding between oxygen and manganese



Permanganate ion (MnO_4^-)
Purple colour
$p\pi$-$d\pi$ bonding between oxygen and manganese

28. Answer (4)

- W(VI) is more stable than Cr(VI)
- Permanganate titrations in presence of HCl are unsatisfactory as HCl is oxidised to Cl_2
- Lanthanoid oxides are used as phosphors.

29. Answer (4)

Europium (Eu)

Atomic No $\rightarrow$ 63

Electronic configuration $\rightarrow$ $[Xe]4f^7 6s^2$

Can show only + 2 and + 3 oxidation state.

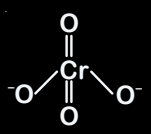
30. Answer (18)

$$NaCl \xrightarrow[conc.H_2SO_4]{K_2Cr_2O_7} \underset{(A)}{CrO_2Cl_2} \xrightarrow{NaOH} \underset{(B)}{Na_2CrO_4}$$

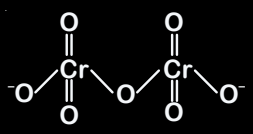
$$\underset{(B)}{Na_2CrO_4} \xrightarrow[H_2O_2]{dil\ H_2SO_4} \underset{(C)}{CrO_5}$$

Total number of atoms in A, B and C are 18.

31. Answer (12)



4 Cr – O bonds



8 Cr – O bonds

if we consider only σ bonds then the answer would be 12 but there are 6π bonds also then the total number of Cr – O bonds will be 18

32. Answer (2)

Gd^{3+} (Z = 64) = [Xe] $4f^7$

$$\mu = \sqrt{n(n+2)} = \sqrt{7(7+2)} = 7.9\ B.M.$$

33. Answer (2)

Ag and Au have similar atomic radius.

34. Answer (2)

The electronic configurations of the given metals and in their +3 state are :

Mn : $3d^5\,4s^2$ Mn^{3+} : $3d^4$

Fe : $3d^6\,4s^2$ Fe^{3+} : $3d^5$

Co : $3d^7\,4s^2$ Co^{3+} : $3d^6$

Ni : $3d^8\,4s^2$ Ni^{3+} : $3d^7$

Since Fe^{3+} has stable configuration of $3d^5$, the third ionization energy of Fe is minimum.

35. Answer (1)

$$Ce^{3+}(Z = 58) - [Xe]4f^1$$

$$Eu^{2+}(Z = 63) - [Xe]4f^7$$

36. Answer (3)

Misch metal is an alloy consisting mainly of lanthanoid metals.

37. Answer (1)

Only Cu^{2+}/Cu has positive SRP among 3d-series metals.

38. Answer (3)

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

RuO_4 is an oxidizing agent

$VOSO_4 \Rightarrow VO^{2+} \Rightarrow V^{4+}$ (it can oxidized) So it is a reducing agent.

Cr_2O_3 is amphoteric oxide

39. Answer (4)

Cu	Co	Fe	Cr	Zn	density in g/cm^3
8.9	8.7	7.8	7.19	7.1	

40. Answer (2)

Ce and Eu have stable oxidation state of +3. So $\overset{+4}{Ce}O_2$ acts as oxidizing agent to get reduced to +3 and $\overset{+2}{Eu}SO_4$ acts as reducing agent to get oxidized to +3.

41. Answer (3)

$Cr^+ - 4s^0\,3d^5$, $Mn^{2+} - 4s^0\,3d^5$ } have some electronic configuration in the outer most shell

42. Answer (2)

The element having atomic no. 29 is copper

The electronic configuration of Cu^{2+} is

Cu^{2+} : $3d^9$

It has 1 unpaired electron

$$\mu = \sqrt{3} = 1.73\ BM \simeq 2$$

43. Answer (4)

Nd (60) = $4f^4\,6s^2$

Pr (59) = $4f^3\,6s^2$

Dy (66) = $4f^{10}\,6s^2$

Yb (70) = $4f^{14}\,6s^2$

Yb^{+2} has fully-filled 4f orbital, it will require very large amount of energy to reach +4 oxidation state.

44. Answer (6)

$$Cr_2O_7^{2-} \xrightarrow{OH^-} CrO_4^{2-}$$

$\therefore$ Oxidation state of Cr in CrO_4^{2-} is +6.

45. Answer (6)

In neutral or faintly alkaline medium

$$8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow \underset{(A)}{8MnO_2} + 6SO_4^{2-} + 2OH^-$$

A is SO_4^{2-}. The oxidation state of sulphur in A is +6.

46. Answer (2)

Size of Bk^{3+} is 98 pm

Size of Np^{3+} is 101 pm

So size of Np^{3+} is more than Bk^{3+} ion.

there is a gradual decrease in the size of M^{3+} ions across the series. This may be referred to as the actinoid contraction.

47. Answer (2)

$$Ce^{4+} \xrightarrow{e^-} Ce^{3+} \qquad E^\circ = +1.74\ V$$

Positive SRP and higher SRP means greater oxidising power. So, Ce^{4+} wants to reduce to Ce^{3+}. Indicates Ce^{4+} is less stable than Ce^{3+}.

48. Answer (1)

FeI_3 does not exist as I^- reduces Fe^{3+} to Fe^{2+}.

But FeF_2, $FeCl_2$, $FeBr_2$, FeI_2 all exist.

49. Answer (1)

The element having atomic number 25 is manganese. The electronic configuration of Mn^{2+} is

$Mn^{2+} : 3d^5$

In aqueous solution it exists as $[Mn(H_2O)_6]^{2+}$. Since H_2O is a weak field ligand, it does not cause pairing of unpaired electrons. So, its spin only magnetic moment is

$$\mu = \sqrt{5 \times 7} = 5.92\ BM$$

50. Answer (4)

$KMnO_4$ on heating dissociates as

$$\underset{\text{Permanganate}}{\overset{+7}{2KMnO_4}} \xrightarrow{\Delta} \underset{\text{Manganate}}{\overset{+6}{K_2MnO_4}} + MnO_2 + O_2$$

Both permanganate and manganate are tetrahedral but only manganate is paramagnetic.

$\overset{+7}{Mn} : 3d^0 4s^0$ Diamagnetic

$\overset{+6}{Mn} : 3d^1 4s^0$ Paramagnetic

$\therefore$ Statement I is true but statement II is false.

51. Answer (3)

Z = 24 represents chromium

Common positive oxidation state of Cr are from +2 to +6

where +3 and +6 are the most common ones.

52. Answer (1) or (4)

Cu^{2+} salt reacts with potassium iodide to form Cu_2I_2 and KI_3

$$2Cu^{2+} + 5KI \longrightarrow Cu_2I_2 \downarrow + KI_3 + 4K^+$$

Cu_2I_2 is sometimes also written as CuI.

53. Answer (1)

To show colour and paramagnetic behaviour, the ion must have unpaired electron(s)

Cu^{2+} - $3d^9$ (one unpaired e^-)

Cr^{3+} - $3d^3$ (three unpaired e^-)

Sc^+ - $3d^2$ (two unpaired e^-)

54. Answer (1)

Metal oxide	Oxidation number
CrO_3	+6
Fe_2O_3	+3
MnO_2	+4
V_2O_5	+5
Cu_2O	+1

a > d > c > b > e

55. Answer (1)

The electronic configuration and magnetic moment of the given species are

$Ti^{3+} : 3d^1$ μ = 1.73 BM

$V^{2+} : 3d^3$ μ = 3.87 BM

$Sc^{3+} : 3d^0$ μ = 0

56. Answer (4)

$CuCl_2$ in water gives blue solution.

57. Answer (7)

Atomic number of Gd is 64

Electronic configuration of Gd is $[Xe]4f^7 5d^1 6s^2$

$Gd^{2+} = [Xe]4f^7 5d^1$

58. Answer (2)

V_2O_3 (X) is basic and CrO (Y) is also basic. The transition metal oxides in lower oxidation states are basic.

59. Answer (4)

The electronic configuration of neptunium in ground state is [Rn] $5f^4 6d^1 7s^2$

$\therefore$ It has 4 electrons in the f subshell of the anti penultimate shell.

60. Answer (4)

$$Cr^{3+} + OH^- \longrightarrow \underset{\text{(green ppt)}}{Cr(OH)_3}$$

If NaOH is present in excess, then

$$Cr(OH)_3 + OH^- \longrightarrow \underset{\text{(green solution)}}{\left[Cr(OH)_4\right]^-}$$

61. Answer (1)

$$2KMnO_4 \xrightarrow{513K} \underset{\substack{\text{Paramagnetic}\\\text{(Green)}}}{K_2MnO_4} + MnO_2 + \underset{\substack{\text{Paramagnetic}\\\text{(Colorless)}}}{O_2}$$

62. Answer (2)

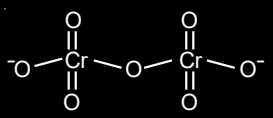
Yb (70) = $4f^{14}\ 6s^2$

$Yb^{+2} = 4f^{14}\ 6s^0$

$\because$ All the electrons are paired hence Yb^{+2} is diamagnetic

63. Answer (2)

Structure of dichromate is



Structure is non — linear with symmetrical

Cr – O – Cr bond

64. Answer (2)

Outermost electronic configuration of Eu

Eu (63) = $4f^7 6s^2$

$Eu^{2+} = 4f^7$

65. Answer (0)

Zn(30) = $[Ar]4s^2 3d^{10}$

$Zn^{+} = [Ar]4s^1 3d^{10}$

Outermost electron is present in 4s

n = 4 l = 0 $m_l = 0$

66. Answer (4)

Mn(25) = $[Ar]3d^5 4s^2$

$Mn^{+3} = [Ar]3d^4 4s^0$

Ru-belongs to 4*d* transition series

Co (27) = $[Ar]3d^7 4s^2$

$Co^{+3} = [Ar]3d^6 4s^0$

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

$Fe^{+3} = [Ar]3d^5 4s^0$

67. Answer (3)

Fe^{2+} is green in color

Fe^{3+} is yellow in color

68. Answer (10)

Electronic configurations of Ho and Ho^{3+} are

Ho : $4f^{11}\ 6s^2$

Ho^{3+} : $4f^{10}$

$\therefore$ Number of electrons present in 4f orbital of Ho^{3+} is 10.

69. Answer (4)

Mn_3O_4 is magnetic in nature.

70. Answer (0)

Chromate ion $\rightarrow CrO_4^{2-}$, oxidation state of Cr = +6

Dichromate ion $\rightarrow CrO_4^{2-}$, oxidation state of Cr = +6

$\therefore$ Difference in oxidation state = zero

71. Answer (2)

Melting points of the given metals

Hg : –38.83° C

Ag : 961.8° C

Ga : 29.76° C

Cs : 28.44° C

$\therefore$ Metal having highest melting point is Ag.

72. Answer (3)

Manganese (VI) disproportionates in acidic medium as

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

Difference in oxidation states of Mn in the products formed = 7 – 4 = 3

73. Answer (2)

E° value of $Ce^{+4}|Ce^{+3}$ is 1.74 V, which suggests that it is a very good oxidising agent.

74. Answer (1)

$E^\circ_{Fe^{3+}|Fe^{2+}} = +0.77V$

$E^\circ_{Ti^{3+}|Ti^{2+}} = -0.37\ V$

$E^\circ_{Mn^{+3}|Mn^{+2}} = +1.57\ V$ $E^\circ_{Cr^{3+}|Cr^{2+}} = -0.41\ V$

Mn^{+3} is the best oxidising agent among the given series.

75. Answer (2)

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

Since Ni^{2+} has least number of unpaired electrons.

Hence Ni^{2+} will have lowest spin only magnetic moment Value.

76. Answer (3)

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

77. Answer (1)

$Ce \rightarrow [Xe]4f^1\ 5d^1\ 6s^2$

$Ce^{+4} \rightarrow [xe]\ 4f^0\ 5d^0\ 6s^0$

Cerium in +4 oxidation state acquires inert gas configuration.

78. Answer (6)

$KMnO_4(\text{acidic medium}) + H_2C_2O_4 \rightarrow CO_2 + Mn^{+2}$

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.

79. Answer (3)

Metal	E° M^{2+}/M
Cr	–0.90 V
Fe	–0.44 V
Cu	+ 0.34 V
Zn	(–0.76 V)

The metal having highest E°(M^{2+}/M) standard reduction potential is Cu.

80. Answer (3)

	+2	+3	+4
Eu	$4f^7$	$4f^6$	
Tm	$4f^{13}$	$4f^{12}$	
Sm	$4f^6$	$4f^5$	
Tb	$4f^9$	$4f^8$	$4f^7$
Yb	$4f^{14}$	$4f^{13}$	
Dy	$4f^{10}$	$4f^9$	

Hence, the pair Tb^{+4} Yb^{+2} have half filled and completely filled f subshells respectively.

81. Answer (3)

Eu^{+2} is $4f^7$

Yb^{+2} is $4f^{14}$

but Eu^{+2} is more stable than Yb^{+2} because

$E^\circ_{Eu|Eu^{+2}} > E^\circ_{Yb|Yb^{+2}}$

82. Answer (1)

Pt = [Xe] $4f^{14}\ 5d^9\ 6s^1$

83. Answer (00.00)

$MnO_4^{-2} \xrightarrow{H^+} MnO_2 + MnO_4^- + H_2O$

$Mn^{+7} = d^0$

Hence, magnetic moment = zero

84. Answer (5)

Co^{3+} will not liberate H_2 gas an reaction with dilute acid

$E^\circ_{Co^{3+}/Co^{2+}} = +1.97$

And Co^{3+} has electronic configuration = [Ar] $3d^6$

$\therefore$ 4 unpaired e^- are present in it

$\therefore$ Spin-only magnetic moment = $\sqrt{4(4+2)}$

= 4·92

$\approx$ 5

85. Answer (4)

Among the pairs given, Cr^{3+}/Cr^{2+} has negative reduction potential which is –0.41 V.

Cr (III) $\Rightarrow d^3$

Number of unpaired electrons = 3

$\mu = \sqrt{3(3+2)} = \sqrt{15} \simeq 4$ B.M.

86. Answer (05.00)

MnF_3 has the strongest oxidising ability

$\left[\begin{matrix} E^\circ_{Mn^{+3}/Mn^{+2}} \simeq 1.57\ V \\ \& \ E^\circ_{Mn^{+4}/Mn^{+2}} \simeq 1.2\ V \end{matrix}\right]$

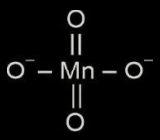
So, spin only magnetic moment

$= \sqrt{4(4+2)} = \sqrt{24}$ B.M.

$\simeq 5$

87. Answer (2)

Manganate ion MnO_4^{2-} has tetrahedral structure

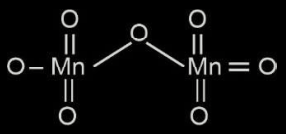


has only $d\pi$ - $p\pi$ π-bonds.

Fe^{3+} is not used as a catalyst in the conversion of I^- to I_2 by $K_2Cr_2O_7$. $K_2Cr_2O_7$ oxidise I^- in acidic medium easily

88. Answer (3)

Structure of Mn_2O_7 is as :



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

89. Answer (4)

$H_2O + 8MnO_4^- + 3S_2O_3^{2-} \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

90. Answer (3)

$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

$KMnO_4 + HCl \longrightarrow KCl + MnCl_2 + Cl_2 + H_2O$

$Al + NaOH + H_2O \longrightarrow Na(Al(OH)_4) + H_2$

$2NaNO_3(s) \xrightarrow{\Delta} 2NaNO_2(s) + O_2$

91. Answer (4)

$3\overset{+6}{M}nO_4^{-2} + 4H^+ \rightarrow \overset{+4}{M}nO_2 + \overset{+7}{M}nO_4^-$

$Mn \rightarrow 4s^2 3d^5$

$Mn^{+4} \rightarrow 3d^3$

n = 3

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

$= \sqrt{3(5)}$

$= \sqrt{15}$

$= 3.87 \approx 4$ B.M.

92. Answer (A)

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.

93. Answer (B)

	Δ_{hyd} H (M^{+2})
Cr	–1925
Mn	–1862
Fe	–1560
Co	– 1640

Mn^{+2} has lowest $\Delta_{hyd}H$

94. Answer (A, D)

Species having same number of electrons are isoelectronic

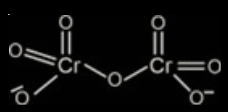
$\left.\begin{matrix} Tb \longrightarrow 65 & Tb^{+2} \longrightarrow 63 \text{ electrons} \\ Tm \longrightarrow 69 & Tm^{+4} \longrightarrow 65 \text{ electrons} \end{matrix}\right\}$ not isoelectronic

$\left.\begin{matrix} Sm^{+2} \longrightarrow 60 \text{ electrons} \\ Er^{+3} \longrightarrow 65 \text{ electrons} \end{matrix}\right\}$ not isoelectronic

95. Answer (6)

$FeCr_2O_4 + Na_2CO_3 + O_2 \longrightarrow Fe_2O_3 + CO_2 + \underset{(A)}{Na_2CrO_4}$

$Na_2CrO_4 + H^+ \longrightarrow Cr_2O_7^{-2} + H_2O + \overset{+}{N}a$



96. Answer (1)

O_2, Cu^{2+} and Fe^{3+} have 2, 1 and 5 unpaired electrons respectively, so these are the paramagnetic species. Hence, they are attracted by magnetic field.

NaCl and H_2O are the diamagnetic species so they are repelled by the magnetic field.

97. Answer (3)

Here, we have to match the reactions with their correct catalyst :

(A) $N_2(g) + 3H_2(g) \xrightarrow{Fe_xO_y + K_2O + Al_2O_3} 2NH_3(g)$

(B) $CO(g) + 3H_2(g) \xrightarrow{Ni} CH_4(g) + H_2O(g)$

(C) $CO(g) + H_2(g) \xrightarrow{Cu} HCHO(g)$

(D) $CO(g) + 2H_2(g) \xrightarrow{Cu/ZnO\text{-}Cr_2O_3} CH_3 - OH(g)$

$\therefore$ Option (3) is correct option.

98. Answer (2)

(A) $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3$

(B) $4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)\text{–}Rh(s)}$

$4NO(g) + 6H_2O(g)$

(C) $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

(D) Vegetable oil(l) + $H_2 \xrightarrow{Ni(s)}$

Vegetable ghee(s)

99. Answer (3)

(A) $4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$

(B) $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

(C) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \xrightarrow{H_2SO_4(l)}$

$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$

(D) $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3$

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