Chapter 22. d- and f-Block Elements

1. Name the gas that can readily decolourise acidified $KMnO_4$ solution.
(a) SO_2 (b) NO_2
(c) P_2O_5 (d) CO_2
(NEET 2017)

2. $HgCl_2$ and I_2 both when dissolved in water containing I^- ions, the pair of species formed is
(a) HgI_2, I^- (b) HgI_4^{2-}, I_3^-
(c) Hg_2I_2, I^- (d) HgI_2, I_3^-
(NEET 2017)

3. The reason for greater range of oxidation states in actinoids is attributed to
(a) actinoid contraction
(b) 5*f*, 6*d* and 7*s* levels having comparable energies
(c) 4*f* and 5*d* levels being close in energies
(d) the radioactive nature of actinoids.
(NEET 2017)

4. Which one of the following statements related to lanthanons is incorrect?
(a) Europium shows +2 oxidation state.
(b) The basicity decreases as the ionic radius decreases from Pr to Lu.
(c) All the lanthanons are much more reactive than aluminium.
(d) Ce(+4) solutions are widely used as oxidizing agent in volumetric analysis.
(NEET-II 2016)

5. Which one of the following statements is correct when SO_2 is passed through acidified $K_2Cr_2O_7$ solution?
(a) SO_2 is reduced.
(b) Green $Cr_2(SO_4)_3$ is formed.
(c) The solution turns blue.
(d) The solution is decolourised.
(NEET-I 2016)

6. The electronic configurations of Eu (Atomic No. 63), Gd (Atomic No. 64) and Tb (Atomic No. 65) are
(a) $[Xe]4f^6 5d^1 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^8 5d^1 6s^2$
(b) $[Xe]4f^7 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^9 6s^2$
(c) $[Xe]4f^7 6s^2$, $[Xe]4f^8 6s^2$ and $[Xe]4f^8 5d^1 6s^2$
(d) $[Xe]4f^6 5d^1 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^9 6s^2$
(NEET-I 2016)

7. Gadolinium belongs to 4*f* series. Its atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?
(a) $[Xe]\ 4f^9 5s^1$ (b) $[Xe]\ 4f^7 5d^1 6s^2$
(c) $[Xe]\ 4f^6 5d^2 6s^2$ (d) $[Xe]\ 4f^8 6d^2$
(2015)

8. Assuming complete ionisation, same moles of which of the following compounds will require the least amount of acidified $KMnO_4$ for complete oxidation?
(a) $FeSO_3$ (b) FeC_2O_4
(c) $Fe(NO_2)_2$ (d) $FeSO_4$ *(2015)*

9. Magnetic moment 2.84 B.M. is given by
(At. nos. Ni = 28, Ti = 22, Cr = 24, Co = 27)
(a) Cr^{2+} (b) Co^{2+}
(c) Ni^{2+} (d) Ti^{3+}
(2015, Cancelled)

10. Which of the following processes does not involve oxidation of iron?
(a) Formation of $Fe(CO)_5$ from Fe.
(b) Liberation of H_2 from steam by iron at high temperature.
(c) Rusting of iron sheets.
(d) Decolourisation of blue $CuSO_4$ solution by iron.
(2015, Cancelled)

11. Because of lanthanoid contraction, which of the following pairs of elements have nearly same atomic radii? (Numbers in the parenthesis are atomic numbers)
(a) Zr(40) and Hf(72) (b) Zr(40) and Ta(73)
(c) Ti(22) and Zr(40) (d) Zr(40) and Nb(41)
(2015, Cancelled)

12. The reaction of aqueous $KMnO_4$ with H_2O_2 in acidic conditions gives
(a) Mn^{4+} and O_2 (b) Mn^{2+} and O_2
(c) Mn^{2+} and O_3 (d) Mn^{4+} and MnO_2.
(2014)

13. Magnetic moment 2.83 BM is given by which of the following ions?
(At. nos. Ti = 22, Cr = 24, Mn = 25, Ni = 28)
(a) Ti^{3+} (b) Ni^{2+}
(c) Cr^{3+} (d) Mn^{2+} *(2014)*

14. Reason of lanthanoid contraction is
(a) negligible screening effect of '*f*'-orbitals
(b) increasing nuclear charge
(c) decreasing nuclear charge
(d) decreasing screening effect. *(2014)*

15. Which of the following statements about the interstitial compounds is incorrect?
(a) They are much harder than the pure metal.
(b) They have higher melting points than the pure metal.
(c) They retain metallic conductivity.
(d) They are chemically reactive.
(NEET 2013)

16. Which of the following lanthanoid ions is diamagnetic?
(At. nos. Ce = 58, Sm = 62, Eu = 63, Yb = 70)
(a) Eu^{2+} (b) Yb^{2+}
(c) Ce^{2+} (d) Sm^{2+}
(NEET 2013)

17. Identify the correct order of solubility in aqueous medium.
(a) $Na_2S > CuS > ZnS$
(b) $Na_2S > ZnS > CuS$
(c) $CuS > ZnS > Na_2S$
(d) $ZnS > Na_2S > CuS$ *(NEET 2013)*

18. Sc (Z = 21) is a transition element but Zn (Z = 30) is not because
(a) both Sc^{3+} and Zn^{2+} ions are colourless and form white compounds.
(b) in case of Sc, 3*d* orbitals are partially filled but in Zn these are filled.
(c) last electron is assumed to be added to 4*s* level in case of Zn.
(d) both Sc and Zn do not exhibit variable oxidation states.
(Karnataka NEET 2013)

19. Identify the alloy containing a non-metal as a constituent in it.
(a) Invar (b) Steel
(c) Bell metal (d) Bronze *(2012)*

20. Which of the statements is not true?
(a) On passing H_2S through acidified $K_2Cr_2O_7$ solution, a milky colour is observed.
(b) $Na_2Cr_2O_7$ is preferred over $K_2Cr_2O_7$ in volumetric analysis.
(c) $K_2Cr_2O_7$ solution in acidic medium is orange.
(d) $K_2Cr_2O_7$ solution becomes yellow on increasing the pH beyond 7. *(2012)*

21. The catalytic activity of transition metals and their compounds is ascribed mainly to
(a) their magnetic behaviour
(b) their unfilled *d*-orbitals
(c) their ability to adopt variable oxidation states
(d) their chemical reactivity *(Mains 2012)*

22. Which of the following exhibits only + 3 oxidation state?
(a) U (b) Th
(c) Ac (d) Pa *(Mains 2012)*

23. Which one of the following does not correctly represent the correct order of the property indicated against it?
(a) Ti < V < Cr < Mn; increasing number of oxidation states
(b) $Ti^{3+} < V^{3+} < Cr^{3+} < Mn^{3+}$: increasing magnetic moment
(c) Ti < V < Cr < Mn : increasing melting points
(d) Ti < V < Mn < Cr : increasing 2nd ionization enthalpy *(Mains 2012)*

24. Four successive members of the first series of the transition metals are listed below. For which one of them the standard potential ($E^{\circ}_{M^{2+}/M}$) value has a positive sign?
(a) Co (Z = 27) (b) Ni (Z = 28)
(c) Cu (Z = 29) (d) Fe (Z = 26)
(Mains 2012)

25. For the four successive transition elements (Cr, Mn, Fe and Co), the stability of +2 oxidation state will be there in which of the following order?
(a) Mn > Fe > Cr > Co
(b) Fe > Mn > Co > Cr
(c) Co > Mn > Fe > Cr
(d) Cr > Mn > Co > Fe
(At. nos. Cr = 24, Mn = 25, Fe = 26, Co = 27)
(2011)

26. Acidified $K_2Cr_2O_7$ solution turns green when Na_2SO_3 is added to it. This is due to the formation of
(a) $Cr_2(SO_4)_3$ (b) CrO_4^{2-}
(c) $Cr_2(SO_3)_3$ (d) $CrSO_4$ *(2011)*

27. Which of the following ions will exhibit colour in aqueous solutions?
(a) La^{3+} (*Z* = 57) (b) Ti^{3+} (*Z* = 22)
(c) Lu^{3+} (*Z* = 71) (d) Sc^{3+} (*Z* = 21)
(2010)

28. Which of the following ions has electronic configuration [Ar]$3d^6$?
(a) Ni^{3+} (b) Mn^{3+}
(c) Fe^{3+} (d) Co^{3+}
(At. nos. Mn = 25, Fe = 26, Co = 27, Ni = 28)
(2010)

29. Which of the following pairs has the same size?
(a) Fe^{2+}, Ni^{2+} (b) Zr^{4+}, Ti^{4+}
(c) Zr^{4+}, Hf^{4+} (d) Zn^{2+}, Hf^{4+}
(2010)

30. Match List I (substances) with List II (processes) employed in the manufacture of the substances and select the correct option.

List I (Substances)	List II (Processes)
(A) Sulphuric acid	(i) Haber's process
(B) Steel	(ii) Bessemer's process
(C) Sodium hydroxide	(iii) Leblanc process
(D) Ammonia	(iv) Contact process

(a) A - (i), B - (iv), C - (ii), D - (iii)
(b) A - (i), B - (ii), C - (iii), D - (iv)
(c) A - (iv), B - (iii), C - (ii), D - (i)
(d) A - (iv), B - (ii), C - (iii), D - (i)
(Mains 2010)

31. Which of the following oxidation states is the most common among the lanthanoids?
(a) 4 (b) 2
(c) 5 (d) 3 *(Mains 2010)*

32. Which one of the elements with the following outer orbital configurations may exhibit the largest number of oxidation states?
(a) $3d^5 4s^1$ (b) $3d^5 4s^2$
(c) $3d^2 4s^2$ (d) $3d^3 4s^2$ *(2009)*

33. The correct order of decreasing second ionisation enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is
(a) Mn > Cr > Ti > V (b) Ti > V > Cr > Mn
(c) Cr > Mn > V > Ti (d) V > Mn > Cr > Ti
(2008)

34. Which one of the following ions is the most stable in aqueous solution?
(At. No. Ti = 22, V = 23, Cr = 24, Mn = 25)
(a) V^{3+} (b) Ti^{3+}
(c) Mn^{3+} (d) Cr^{3+} *(2007)*

35. Identify the incorrect statement among the following:
(a) Lanthanoid contraction is the accumulation of successive shrinkages.
(b) As a result of lanthanoid contraction, the properties of 4*d* series of the transition elements have no similarities with the 5*d* series of elements.
(c) Shielding power of 4*f* electrons is quite weak.
(d) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.
(2007)

36. In which of the following pairs are both the ions coloured in aqueous solution?
(At. no. : Sc = 21, Ti = 22, Ni = 28, Cu = 29, Co = 27)
(a) Ni^{2+}, Cu^{+} (b) Ni^{2+}, Ti^{3+}
(c) Sc^{3+}, Ti^{3+} (d) Sc^{3+}, Co^{2+}.
(2006)

37. Copper sulphate dissolves in excess of KCN to give
(a) $Cu(CN)_2$ (b) CuCN
(c) $[Cu(CN)_4]^{3-}$ (d) $[Cu(CN)_4]^{2-}$
(2006)

38. More number of oxidation states are exhibited by the actinoids than by the lanthanoids. The main reason for this is
(a) more active nature of the actinoids
(b) more energy difference between 5*f* and 6*d* orbitals than that between 4*f* and 5*d* orbitals
(c) lesser energy difference between 5*f* and 6*d* orbitals than that between 4*f* and 5*d* orbitals
(d) greater metallic character of the lanthanoids than that of the corresponding actinoids. *(2006, 2005)*

39. The number of moles of $KMnO_4$ reduced by one mole of KI in alkaline medium is
(a) one (b) two
(c) five (d) one fifth. *(2005)*

40. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionisation enthalpy?
(a) Vanadium (*Z* = 23)
(b) Chromium (*Z* = 24)
(c) Manganese (*Z* = 25)
(d) Iron (*Z* = 26) *(2005)*

41. The aqueous solution containing which one of the following ions will be colourless?
(Atomic number : Sc = 21, Fe = 26, Ti = 22, Mn = 25)
(a) Sc^{3+} (b) Fe^{2+}
(c) Ti^{3+} (d) Mn^{2+} *(2005)*

42. Among the following series of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is
[At. nos. Ti = 22, V = 23, Cr = 24, Mn = 25]
(a) Ti^{3+}, V^{2+}, Cr^{3+}, Mn^{4+}
(b) Ti^{+}, V^{4+}, Cr^{6+}, Mn^{7+}
(c) Ti^{4+}, V^{3+}, Cr^{2+}, Mn^{3+}
(d) Ti^{2+}, V^{3+}, Cr^{4+}, Mn^{5+} *(2004)*

43. Lanthanoids are
(a) 14 elements in the sixth period (atomic no. 90 to 103) that are filling 4*f* sublevel
(b) 14 elements in the seventh period (atomic number = 90 to 103) that are filling 5*f* sublevel
(c) 14 elements in the sixth period (atomic number = 58 to 71) that are filling the 4*f* sublevel
(d) 14 elements in the seventh period (atomic number = 50 to 71) that are filling 4*f* sublevel. *(2004)*

44. Which one of the following characteristics of the transition metals is associated with their catalytic activity?
(a) High enthalpy of atomization
(b) Paramagnetic behaviour
(c) Colour of hydrated ions
(d) Variable oxidation states *(2003)*

45. The basic character of the transition metal monoxides follows the order
(Atomic no's. Ti = 22, V = 23, Cr = 24, Fe = 26)
(a) VO > CrO > TiO > FeO
(b) CrO > VO > FeO > TiO
(c) TiO > FeO > VO > CrO
(d) TiO > VO > CrO > FeO *(2003)*

46. The correct order of ionic radii of Y^{3+}, La^{3+}, Eu^{3+} and Lu^{3+} is
(Atomic nos. Y = 39, La = 57, Eu = 63, Lu = 71)
(a) $Y^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$
(b) $Y^{3+} < Lu^{3+} < Eu^{3+} < La^{3+}$
(c) $Lu^{3+} < Eu^{3+} < La^{3+} < Y^{3+}$
(d) $La^{3+} < Eu^{3+} < Lu^{3+} < Y^{3+}$ *(2003)*

47. General electronic configuration of lanthanides is
(a) $(n-2)\,f^{1-14}\,(n-1)\,s^2p^6d^{0-1}\,ns^2$
(b) $(n-2)\,f^{10-14}\,(n-1)\,d^{0-1}\,ns^2$
(c) $(n-2)\,f^{0-14}\,(n-1)\,d^{10}\,ns^2$
(d) $(n-2)\,d^{0-1}\,(n-1)\,f^{1-14}\,ns^2$ *(2002)*

48. An atom has electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$, you will place it in
(a) fifth (b) fifteenth
(c) second (d) third. *(2002)*

49. Which of the following shows maximum number of oxidation states?
(a) Cr (b) Fe
(c) Mn (d) V *(2002, 2000, 1994)*

50. Zn gives H_2 gas with H_2SO_4 and HCl but not with HNO_3 because
(a) Zn act as oxidising agent when react with HNO_3
(b) HNO_3 is weaker acid than H_2SO_4 and HCl
(c) In electrochemical series Zn is above hydrogen
(d) $NO_3^{\ominus}$ is reduced in preference to hydronium ion. *(2002)*

51. Which of the following statement is not correct?
(a) $La(OH)_3$ is less basic than $Lu(OH)_3$.
(b) In lanthanide series ionic radius of Lu^{+3} ion decreases.
(c) La is actually an element of transition series rather lanthanides.
(d) Atomic radius of Zn and Hf are same because of lanthanide contraction. *(2001)*

52. The most convenient method to protect the bottom of ship made of iron is
(a) coating it with red lead oxide
(b) white tin plating
(c) connecting it with Mg block
(d) connecting it with Pb block. *(2001)*

53. Which ion is colourless?
(a) Cr^{4+} (b) Sc^{3+}
(c) Ti^{3+} (d) V^{3+} *(2000)*

54. Which of the following configuration is correct for iron?
(a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$
(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ *(1999)*

55. Which of the following has more unpaired *d*-electrons?
(a) N^{3+} (b) Fe^{2+}
(c) Zn^{+} (d) Cu^{+} *(1999)*

56. Bell metal is an alloy of
(a) Cu + Zn (b) Cu + Sn
(c) Cu + Pb (d) Cu + Ni *(1999)*

57. In which of the following compounds transition metal has zero oxidation state?
(a) $NOClO_4$ (b) $NH_2.NH_2$
(c) CrO_5 (d) $[Fe(CO)_5]$ *(1999)*

58. Which one of the following elements constitutes a major impurity in pig iron?
(a) Sulphur (b) Oxygen
(c) Silicon (d) Carbon *(1998)*

59. Which one of the following ionic species will impart colour to an aqueous solution?
(a) Zn^{2+} (b) Cu^{+}
(c) Ti^{4+} (d) Cr^{3+} *(1998)*

60. Which one of the following elements shows maximum number of different oxidation states in its compounds?
(a) Gd (b) La
(c) Eu (d) Am *(1998)*

61. Without losing its concentration, $ZnCl_2$ solution cannot be kept in contact with
(a) Pb (b) Al
(c) Au (d) Ag *(1998)*

62. Which of the following does not represent the correct order of the property indicated?
(a) $Mn^{2+} > Ni^{2+} < Co^{2+} < Fe^{2+}$
(b) $Fe^{2+} > Co^{2+} > Ni^{2+} > Cu^{2+}$
(c) $Ni^{2+} > Cr^{2+} > Fe^{2+} > Mn^{2+}$
(d) Se > Ti > Cr > Mn *(1997)*

63. The lanthanide contraction is responsible for the fact that
(a) Zr and Hf have about the same radius
(b) Zr and Zn have the same oxidation state
(c) Zr and Y have about the same radius
(d) Zr and Nb have similar oxidation state. *(1997)*

64. Which of the following element is responsible for oxidation of water to O_2 in biological processes?
(a) Cu (b) Mo
(c) Fe (d) Mn *(1997)*

65. The electronic configuration of gadolinium (Atomic No = 64) is
(a) [Xe] $4f^3\ 5d^5\ 6s^2$ (b) [Xe] $4f^6\ 5d^2\ 6d^2$
(c) [Xe $4f^8\ 5d^9\ 6s^2$ (d) [Xe] $4f^7\ 5d^1\ 6s^2$. *(1997)*

66. $K_2Cr_2O_7$ on heating with aqueous NaOH gives
(a) $Cr_2O_7^{2-}$ (b) $Cr(OH)_2$
(c) CrO_4^{2-} (d) $Cr(OH)_3$ *(1997)*

67. A transition element *X* has a configuration [Ar]$3d^4$ in its +3 oxidation state. Its atomic number is
(a) 22 (b) 19
(c) 25 (d) 26 *(1996)*

68. When calomel reacts with NH_4OH, we get
(a) Hg_2O (b) HgO
(c) $HgNH_2Cl$ (d) NH_2–Hg–Hg–Cl *(1996)*

69. The electronic configuration of transition elements is exhibited by
(a) ns^1 (b) ns^2np^5
(c) $ns^2\ (n-1)d^{1-10}$ (d) $ns^2\ (n-1)d^{10}$ *(1996)*

70. $KMnO_4$ reacts with oxalic acid according to the equation
$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
Here 20 mL of 0.1 M $KMnO_4$ is equivalent to
(a) 50 mL of 0.5 M $C_2H_2O_4$
(b) 20 mL of 0.1 M $C_2H_2O_4$
(c) 20 mL of 0.5 M $C_2H_2O_4$
(d) 50 mL of 0.1 M $C_2H_2O_4$ *(1996)*

71. Amongst TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$, which are the colourless species? (atomic number of Ti = 22, Co = 27, Cu = 29, Ni = 28)
(a) CoF_6^{3-} and $NiCl_4^{2-}$ (b) TiF_6^{2-} and Cu_2Cl_2
(c) Cu_2Cl_2 and $NiCl_4^{2-}$ (d) TiF_6^{2-} and CoF_6^{3-} *(1995)*

72. The mercury is the only metal which is liquid at 0°C. This is due to its
(a) high vapour pressure
(b) weak metallic bond
(c) high ionization energy
(d) both (b) and (c). *(1995)*

73. Which of the following statement concerning lanthanide elements is false?
(a) All lanthanides are highly dense metals.
(b) More characteristic oxidation state of lanthanide elements is +3.
(c) Lanthanides are separated from one another by ion exchange method.
(d) Ionic radii of trivalent lanthanides steadily increases with increase in the atomic number. *(1994)*

74. To protect iron against corrosion, the most durable metal plating on it, is
(a) copper plating (b) zinc plating
(c) nickel plating (d) tin plating. *(1994)*

75. When $CuSO_4$ is electrolysed using platinum electrodes,
(a) copper is liberated at cathode, sulphur at anode
(b) copper is liberated at cathode, oxygen at anode
(c) sulphur is liberated at cathode, oxygen at anode
(d) oxygen is liberated at cathode, copper at anode. *(1993)*

76. The transition elements have a general electronic configuration

(a) $ns^2np^6nd^{1-10}$
(b) $(n-1)d^{1-10}$, ns^{0-2}, np^{0-6}
(c) $(n-1)d^{1-10}$, ns^{1-2} (d) nd^{1-10} ns^{-2}

(1991)

77. Photographic films and plates have an essential ingredient of
(a) silver nitrate (b) silver bromide
(c) sodium chloride (d) oleic acid.

(1989)

78. Nitriding is the process of surface hardening of steel by treating it is an atmosphere of
(a) NH_3 (b) O_3
(c) N_2 (d) H_2S. *(1989)*

79. While extracting an element from its ore, the ore is ground and leached with dil. potassium cyanide solution to form the soluble product potassium argentocyanide. The element is
(a) lead (b) chromium
(c) manganese (d) silver. *(1989)*

80. A blue colouration is not obtained when
(a) ammonium hydroxide dissolves in copper sulphate
(b) copper sulphate solution reacts with $K_4[Fe(CN)_6]$
(c) ferric chloride reacts with sod. ferrocyanide
(d) anhydrous $CuSO_4$ is dissolved in water.

(1989)

81. The electronic configurations of four elements are given below. Which element does not belong to the same family as others?
(a) $[Xe]4f^{14}5d^{10}6s^2$ (b) $[Kr]4d^{10}5s^2$
(c) $[Ne]3s^23p^5$ (d) $[Ar]3d^{10}4s^2$

(1989)

82. The oxidation state of Cr in $K_2Cr_2O_7$ is
(a) +5 (b) +3
(c) +6 (d) +7

(1988)

83. Hypo is used in photography to
(a) reduce AgBr grains to metallic silver
(b) convert metallic silver to silver salt
(c) remove undecomposed silver bromide as a soluble complex
(d) remove reduced silver.

(1988)

Answer Key

1.	(a)	**2.**	(b)	**3.**	(b)	**4.**	(c)	**5.**	(b)	**6.**	(b)	**7.**	(b)	**8.**	(d)	**9.**	(c)	**10.**	(a)
11.	(a)	**12.**	(b)	**13.**	(b)	**14.**	(a)	**15.**	(d)	**16.**	(b)	**17.**	(b)	**18.**	(b)	**19.**	(b)	**20.**	(b)
21.	(c)	**22.**	(c)	**23.**	(c)	**24.**	(c)	**25.**	(a)	**26.**	(a)	**27.**	(b)	**28.**	(d)	**29.**	(c)	**30.**	(d)
31.	(d)	**32.**	(b)	**33.**	(c)	**34.**	(d)	**35.**	(b)	**36.**	(b)	**37.**	(c)	**38.**	(c)	**39.**	(b)	**40.**	(c)
41.	(a)	**42.**	(d)	**43.**	(c)	**44.**	(d)	**45.**	(d)	**46.**	(b)	**47.**	(a)	**48.**	(a)	**49.**	(c)	**50.**	(d)
51.	(a)	**52.**	(b)	**53.**	(b)	**54.**	(d)	**55.**	(b)	**56.**	(b)	**57.**	(d)	**58.**	(d)	**59.**	(d)	**60.**	(d)
61.	(b)	**62.**	(c)	**63.**	(a)	**64.**	(c)	**65.**	(d)	**66.**	(c)	**67.**	(c)	**68.**	(c)	**69.**	(c)	**70.**	(d)
71.	(b)	**72.**	(d)	**73.**	(d)	**74.**	(c)	**75.**	(b)	**76.**	(c)	**77.**	(b)	**78.**	(a)	**79.**	(d)	**80.**	(b)
81.	(c)	**82.**	(c)	**83.**	(c)														

EXPLANATIONS

1. (a) : SO_2 readily decolourises pink violet colour of acidified $KMnO_4$ solution.

$$2KMnO_4 + 5SO_2 + 2H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$$

(Pink violet) (Colourless)

2. (b) : $HgCl_2 + 4I^-_{(aq)} \rightarrow HgI^{2-}_{4(aq)} + 2Cl^-_{(aq)}$

$I_{2(s)} + I^-_{(aq)} \rightarrow I^-_{3(aq)}$

3. (b) : Actinoids have a greater range of oxidation states due to comparable energies of 5*f*, 6*d* and 7*s* orbitals. Hence, all their electrons can take part in bond formation.

4. (c) : The first few members of the lanthanoid series are quite reactive, almost like calcium. However, with increasing atomic number, their behaviour becomes similar to that of aluminium.

5. (b) : $K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

(Green)

6. (b) **7. (b)**

8. (d) : $KMnO_4$ (Mn^{7+}) changes to Mn^{2+} *i.e.*, number of electrons involved per mole of $KMnO_4$ is 5.

(a) For $FeSO_3$,

$Fe^{2+} \longrightarrow Fe^{3+}$ (No. of e^-s involved = 1)

$SO_3^{2-} \longrightarrow SO_4^{2-}$ (No. of e^-s involved = 2)

Total number of e^-s involved = 1 + 2 = 3

(b) For FeC_2O_4,

$Fe^{2+} \longrightarrow Fe^{3+}$ (No. of e^-s involved = 1)

$C_2O_4^{2-} \longrightarrow 2CO_2$ (No. of e^-s involved = 2)

Total number of e^-s involved = 1 + 2 = 3

(c) For $Fe(NO_2)_2$,

$Fe^{2+} \longrightarrow Fe^{3+}$ (No. of e^-s involved = 1)

$2NO_2^- \longrightarrow 2NO_3^-$ (No. of e^-s involved = 4)

Total number of e^-s involved = 1 + 4 = 5

(d) For $FeSO_4$,

$Fe^{2+} \longrightarrow Fe^{3+}$ (No. of e^-s involved = 1)

Total number of e^-s involved = 1

As $FeSO_4$ requires least number of electrons thus, it will require least amount of $KMnO_4$.

9. (c) : Magnetic moment (μ) = $\sqrt{n(n+2)}$

2.84 B.M. corresponds to 2 unpaired electrons.

Cr^{2+} – $3d^4$, 4 unpaired electrons

Co^{2+} – $3d^7$, 3 unpaired electrons

Ni^{2+} – $3d^8$, 2 unpaired electrons

Ti^{3+} – $3d^1$, 1 unpaired electron

10. (a) : Oxidation number of Fe in $Fe(CO)_5$ is zero.

11. (a) : Zr and Hf have nearly same radii due to lanthanoid contraction.

12. (b) : Hydrogen peroxide is oxidised to H_2O and O_2.

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$

or, $2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$

13. (b) : Magnetic moment is given by

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

[where n = no. of unpaired electrons]

When $n = 2$, then μ = 2.83 B.M.

For Ti^{3+} ($3d^1$), $n = 1$; Cr^{3+} ($3d^3$), $n = 3$

Ni^{2+} ($3d^8$), $n = 2$; Mn^{2+} ($3d^5$), $n = 5$

Hence, Ni^{2+} has two unpaired electrons, with magnetic moment 2.83 B.M.

14. (a) : Due to poor shielding effect of 4*f*-orbitals, nucleus will exert a strong attraction and size of atom or ion goes on decreasing as move in the series with increase in atomic number.

15. (d) : Interstitial compounds are generally chemically inert.

16. (b) : Sm^{2+} ($Z = 62$) : $[Xe]4f^6$

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

Yb^{2+} ($Z = 70$) : $[Xe]4f^{14}$

Ce^{2+} ($Z = 58$) : $[Xe]4f^15d^1$

Only Yb^{2+} is diamagnetic.

17. (b) : Sodium sulphide is soluble in water. The solubility product (and hence solubility) of ZnS is larger than that of CuS.

18. (b) : Sc (Z = 21) has incompletely filled 3*d*-orbitals in its ground state ($3d^1$), it is considered as a transition element but Zn (Z = 30) has completely filled *d*-orbitals ($3d^{10}$) in its ground state and its common oxidation state of (+2), it is not considered as a transition element.

19. (b) : Invar $\Rightarrow$ Ni(metal) + Fe(metal)

Steel $\Rightarrow$ C(non-metal) + Fe(metal)

Bell metal $\Rightarrow$ Cu(metal) + Sn(metal) + Fe(metal)

Bronze $\Rightarrow$ Cu(metal) + Sn(metal)

20. (b) **21. (c)**

22. (c) : U exhibits + 3, + 4, + 5, + 6

Th exhibits + 3, + 4 ; Ac exhibits + 3 only

Pa exhibits + 3, + 4, + 5

23. (c) :

Element	Ti	V	Cr	Mn
No. of oxidation states	3	4	5	6

Given order is correct

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

For Ti^{3+} $n = 1$, $\mu = \sqrt{1(1+2)} = \sqrt{3}$ B.M.

For V^{3+} $n = 2$, $\mu = \sqrt{2(2+2)} = \sqrt{8}$ B.M.

For Cr^{3+} $n = 3$, $\mu = \sqrt{3(3+2)} = \sqrt{15}$ B.M.

For Mn^{3+} $n = 4$, $\mu = \sqrt{4(4+2)} = \sqrt{24}$ B.M.

Thus magnetic moment : $Ti^{3+} < V^{3+} < Cr^{3+} < Mn^{3+}$

Melting point order :	Mn	<	Ti	<	Cr	<	V
	1245°C		1668°C		1875°C		1900°C

2^{nd} ionisation enthalpy order

	Ti	<	V	<	Mn	<	Cr
kJ/Mol	1320		1376		1513		1635

24. (c) :

Element	Co	Ni	Cu	Fe
$E°_{M^{2+}/M}$(V)	−0.28	−0.25	+0.34	−0.44

25. (a) : The order can be explained using the idea of spin correlation. Spin correlation refers to lowering of energy for like (parallel) spins. Spin correlation leading to decrease in repulsion for electrons of like spins than for electrons of different spins is called exchange energy.

Spin correlation and its exchange energy gives an electronic configuration a special stability which is greatest for half-filled electronic configurations.

Mn^{2+} (d^5) gets stabilisation due to half-filled configuration.

In Fe^{2+} (d^6) the placing of one extra electron in a subshell destabilises. Placing of 2 electrons in Co^{2+} (d^7) destabilises it more. Cr^{2+} (d^4) has one vacant subshell. Fe^{2+} gets more stabilisation compared to Cr^{2+} through exchange energy. So the order is as follows:

Mn > Fe > Cr > Co

26. (a) : $K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$

$[Na_2SO_3 + [O] \rightarrow Na_2SO_4] \times 3$

$K_2Cr_2O_7 + 3Na_2SO_3 + 4H_2SO_4 \rightarrow 3Na_2SO_4 + K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O$

or $Cr_2O_7^{2-} + 3SO_3^{2-} + 8H^+ \rightarrow 3SO_4^{2-} + 2Cr^{3+} + 4H_2O$

27. (b) : Ti^{3+} (Z = 22)

Ions which have unpaired electrons exhibit colour in solution. Ti^{3+} has an outer electronic configuration of $4s^0\ 3d^1$, *i.e.*, 1 unpaired electron.

Thus its solution will be coloured.

$Sc^{3+} \rightarrow d^0$

In case of La^{3+}, $4f^0$ configuration is present and in Lu^{3+}, $4f^{14}$ is present. So, there is no possibility of *f-f* transition, hence these ions do not appear coloured.

28. (d) : The electronic configuration of the given ions is :

Ni^{3+} : $[Ar]3d^7 4s^0$, Mn^{3+} : $[Ar]3d^4 4s^0$

Fe^{3+} : $[Ar]3d^5 4s^0$, Co^{3+} : $[Ar]3d^6 4s^0$

Thus, Co^{3+} is the ion with the desired configuration.

29. (c) : Hf^{4+} and Zr^{4+} belong to group IVB. But, Hf^{4+} has same size as Zr^{4+} due to the addition of 14 lanthanide elements before it in which electrons are added into the *f*-subshell which poorly shield the outer electrons and contraction in size occurs.

30. (d)

31. (d) : The common stable oxidation state of all the lanthanoids is +3. The oxidation state of +2 and +4 are also exhibited by some of the elements. These oxidation states are only stable in those cases where stable $4f^0$, $4f^7$ or $4f^{14}$ configurations are achieved.

32. (b) : Greater the number of valence electrons, more will be the number of oxidation states exhibited by the element.

Option (a) : $3d^5 4s^1$, can show a maximum of 6 oxidation states.

Option (b) : $3d^5 4s^2$, can show a maximum of 7 oxidation states.

Option (c) : $3d^2 4s^2$ can show a maximum of 4 oxidation states.

Option (d) : $3d^3 4s^2$ can show a maximum of 5 oxidation states.

33. (c) : Electronic configuration of the given elements are

Mn $\rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$

Cr $\rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Ti $\rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$

V $\rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$

In general, ionization potential (both 1^{st} and 2^{nd}) increases from left to right across the period due to increase in effective nuclear charge. On this basis, the second IP values should exhibit the trend:

Mn > Cr > V > Ti

But the actual observed order is:

Cr > Mn > V > Ti

Practically, only chromium is exceptional and rest others show the normal trend. This exceptional behaviour of chromium is due to the stable configuration ($3d^5$) that it achieves after the loss of first electron.

34. (d) : +4 is the most stable oxidation state of vanadium and titanium. Mn^{3+} is not stable. Mn^{2+}, rather than Mn^{3+} is much more stable in aqueous solution. For chromium, +3 oxidation state is most stable in aqueous solution.

35. (b) : In each vertical column of transition elements, the elements of second and third transition series resemble each other more closely than the elements of first and second transition series on account of lanthanide contraction. Hence

the properties of elements of 4*d* series of the transition elements resemble with the properties of the elements of 5*d* series of the transition elements.

36. (b) : Sc → [Ar] $3d^1\ 4s^2$, Sc^{3+} → [Ar]
Ti → [Ar] $3d^2\ 4s^2$, Ti^{3+} → [Ar] $3d^1$
Ni → [Ar] $3d^8\ 4s^2$, Ni^{2+} → [Ar] $3d^8$
Cu → [Ar] $3d^{10}\ 4s^1$, Cu^+ → [Ar] $3d^{10}$
Co → [Ar] $3d^7\ 4s^2$, Co^{2+} → [Ar] $3d^7$
Ti^{3+}, Ni^{2+} and Co^{2+} are coloured due to presence of unpaired electrons.

37. (c) : First cupric cyanide is formed which decomposes to give cuprous cyanide and cyanogen gas. Cuprous cyanide dissolves in excess of potassium cyanide to form a complex, potassium cyanide $[K_3Cu(CN)_4]$.

$[CuSO_4 + 2KCN \rightarrow Cu(CN)_2 + K_2SO_4] \times 2$
$2Cu(CN)_2 \rightarrow Cu_2(CN)_2 + (CN)_2$
$Cu_2(CN)_2 + 6KCN \rightarrow 2K_3Cu(CN)_4$
$2CuSO_4 + 10KCN \rightarrow 2K_3Cu(CN)_4 + 2K_2SO_4 + (CN)_2$

38. (c) : The 5*f*-orbitals extend into space beyond the 6*s* and 6*p*-orbitals and participate in bonding. This is in direct contrast to the lanthanides where the 4*f*-orbitals are buried deep inside in the atom, totally shielded by outer orbitals and thus unable to take part in bonding.

39. (b) : In alkaline medium :

$2KMnO_4 + H_2O \longrightarrow 2KOH + 2MnO_2$
$KI + 3[O] \longrightarrow KIO_3$
$2KMnO_4 + KI + H_2O \longrightarrow 2KOH + 2MnO_2 + KIO_3$.

40. (c) : V^{2+} (21) $[Ar]^{18}\ 3d^3\ 4s^0$
Cr^{2+} (22) $[Ar]^{18}\ 3d^4\ 4s^0$
Mn^{2+} (23) $[Ar]^{18}\ 3d^5\ 4s^0$
Fe^{2+} (24) $[Ar]^{18}\ 3d^5\ 4s^1$

- To find ionization enthalpy we first see electronic configuration.
- Then we see shell
- If shell are same then see charge
- Then see extra stability (Half filled and fully filled)

⇒ $I.E_3$ (Mn) > $I.E_3$ (Fe) > $I.E_3$ (Cr) > $I.E_3$ (V)

41. (a) : If the transition metal ion has unpaired electron then it shows colour.
Sc^{3+} $[Ar]^{18}\ 3d^0\ 4s^0$
Fe^{2+} $[Ar]^{18}\ 3d^5\ 4s^1$
Ti^{3+} $[Ar]^{18}\ 3d^1\ 4s^0$
Mn^{2+} $[Ar]^{18}\ 3d^5\ 4s^0$
Hence Sc^{3+} do not contain unpaired electron and hence it will not undergo *d* – *d* transition and do not show colour.

42. (d) : $Ti_{22} = 3d^2\ 4s^2$; $Ti^{2+} = 3d^2$
$V_{23} = 3d^3\ 4s^2$; $V^{3+} = 3d^2$
$Cr_{24} = 3d^4\ 4s^2$; $Cr^{4+} = 3d^2$
$Mn_{25} = 3d^5\ 4s^2$; $Mn^{5+} = 3d^2$

43. (c) : As sixth period can accommodate only 18 elements in the table, 14 members of 4*f* series (atomic number 58 to 71) are separately accommodated in a horizontal row below the periodic table. These are called as lanthanides.

44. (d) : The transition elements, on account of their variable valency, are able to form unstable intermediate compounds very readily.

45. (d) : Oxides of transition metals in low oxidation states +2 and +3 (MO, M_3O_4 and M_2O_3) are generally basic except Cr_2O_3 which is amphoteric in character. Basic character generally decreases with increase in atomic number.

46. (b) : On going from La^{3+} to Lu^{3+}, the ionic radius shrinks from 1.15 Å to 0.93 Å (lanthanide contraction). The radius of La^{3+} is also larger than that of Y^{3+} ion which lies immediately above it in periodic table.

47. (a) : The general electronic structure of lanthanides is
$(n-2)f^{1-14}\ (n-1)s^2p^6d^{0-1}ns^2$

48. (a) : The electronic configuration of an atom
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$
In the configuration, the last electron of the atom is filled in *d* sub-shell as $3d^3$. Thus this element belongs to *d*-block of the periodic table with group no. V.

49. (c) : Each of the element in group III B to VII B can show the maximum oxidation state equal to its group number.
Mn is in group seven shows a maximum oxidation state of +7 in $KMnO_4$.

50. (d) : Zinc is on the top position of hydrogen in electrochemical series. So Zn displaces H_2 from dilute H_2SO_4 and HCl with liberation of H_2.
$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
On the other hand HNO_3 is an oxidising agent. Hydrogen obtained in this reaction is converted into H_2O.
$Zn + 2HNO_3 \rightarrow Zn(NO_3)_2 + 2H$
$2HNO_3 \rightarrow H_2O + 2NO_2 + O$
$2H + O \rightarrow H_2O$.

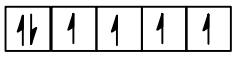
51. (a) : $La(OH)_3$ is more basic than $Lu(OH)_3$. In lanthanides the basic character of hydroxides decreases as the ionic radius decreases.

52. (b) : The most convenient method to protect the bottom of the ship made of iron is white tin plating preventing the build up of barnacles.

53. (b) : $_{21}Sc \rightarrow 3d^1,\ 4s^2$ (valence shell)
In Sc^{3+} there is no unpaired '*d*' electrons, therefore it is colourless ion in its solution.

54. (d) : $_{26}Fe \rightarrow 1s^2,\ 2s^2,\ 2p^6,\ 3s^2,\ 3p^6,\ 4s^2,\ 3d^6$
According to '$n + l$' rule electron first enters to '4*s*' and then to 3*d* subshell.

55. (b) : In Fe^{2+} there are 24 electrons and 2-electrons are removed from 4*s*-subshell.
There are 4-unpaired electrons in the 3*d*-subshell.



3*d*

56. (b) : Bell metal $\Rightarrow$ Cu = 80%, Sn = 20%
It is used for making bells, utensils, etc.

57. (d) : In Iron carbonyl the oxidation number of 'Fe' is zero.

$[Fe(CO)_5] \rightarrow x + 5 \times 0 = 0 \Rightarrow x = 0$

58. (d) : Pig iron is the impure form of iron, which contains carbon as the major impurity, *i.e.* 2.5 to 5%.

59. (d) : $Cr^{3+}(21) \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^3$.
As Cr^{3+} ion has three unpaired electrons in its valence shell, so it imparts green colour to an aqueous solution.

60. (d) : 'La' forms compounds in which its oxidation no. is +3.
'Eu' and 'Gd' exhibit +2 as well as +3 oxidation state and not higher than that, due to stable (f^7) configuration. whereas 'Am' exhibits the oxidation states +2, +3, +4, +5, +6, etc. due to extremely large size and low ionisation energy.

61. (b) : Only 'Al' lies above 'Zn' in electrochemical series, which can displace the latter from $ZnCl_2$ solution. Therefore conc. of $ZnCl_2$ will decrease when kept in 'Al' container.

$2Al + 3ZnCl_2 \rightarrow 2AlCl_3 + 3Zn$

62. (c) : The correct order is
$Cr^{2+} > Mn^{2+} > Fe^{2+} > Ni^{2+}$.

63. (a) : Due to lanthanide contraction, the elements of second and third *i.e.* Zr and Hf transition series resemble more with each other than the elements of first and second transition series.

64. (c)

65. (d) : Half-filled and fully filled orbitals are more stable.

66. (c) : $K_2Cr_2O_7 + 2NaOH \rightarrow K_2CrO_4 + Na_2CrO_4 + H_2O$

or $Cr_2O_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$

67. (c) : It is the configuration of metal ion. The metal atom will have three more electrons. Therefore the atomic number of the metal = (18) + 4 + 3 = 25.

68. (c) : When calomel reacts with NH_4OH, it turns black due to the formation of a mixture of mercury and ammonium basic mercury (II) chloride.

$Hg_2Cl_2 + 2\ NH_4OH \rightarrow NH_4Cl + 2H_2O + Hg + HgNH_2Cl$
(calomel)

69. (c) : General electronic configuration of transition elements is $ns^2\ (n-1)d^{1-10}$.

70. (d) : $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

$\therefore$ 2 moles of $MnO_4^- \equiv$ 5 moles of $C_2O_4^{2-}$
20 mL of 0.1 M $KMnO_4$ = 2 mmol of $KMnO_4$
Also, 50 mL of 0.1 M $C_2H_2O_4 \equiv$ 5 mmol of $C_2O_4^{2-}$
Therefore, these are equivalent.

71. (b) : In TiF_6^{2-} titanium is in +4 state. In Cu_2Cl_2, the copper is in +1 state. Thus in both cases, transition from one *d*-orbital to other is not possible.
Ti - $3d^2, 4s^2 \rightarrow Ti^{4+}$ - $3d^0\ 4s^0$
Cu - $3d^{10}, 4s^1 \rightarrow Cu^+$ - $3d^{10}\ 4s^0$

72. (d) : Very high ionisation energy of Hg makes it difficult for electrons to participate in metallic bonding.

73. (d) : Ionic radii of trivalent lanthanides decreases with increase in atomic number.

74. (c) : A layer of oxide is formed on the surface of nickel, which protects nickel, below it and thus the iron underneath it.

75. (b) : $CuSO_4 \rightleftharpoons Cu^{2+} + SO_4^{2-}$
$H_2O \rightleftharpoons H^+ + OH^-$
At cathode : $Cu^{2+} + 2e^- \rightarrow Cu$
At anode : $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

76. (c) : The general electronic configuration of transition elements is $(n-1)d^{1-10}ns^{1-2}$

77. (b) : AgBr is highly photosensitive and is used as an ingredient for photographic films and plates.

78. (a) : When steel is heated in presence of NH_3, iron nitride on the surface of steel is formed which imparts a hard coating. This process is called nitriding.

79. (d) : Cyanide process is used in the metallurgy of Ag.

$2Ag_2S + 8NaCN + O_2 + 2H_2O \rightarrow 4Na[Ag(CN)_2] + 4NaOH + 2S$
$2Na[Ag(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2Ag\downarrow$

80. (b) : $2CuSO_4 + K_4[Fe(CN)_6] \rightarrow Cu_2[Fe(CN)_6] + 2K_2SO_4$
chocolate ppt.

81. (c) : $[Ne]3s^23p^5$ is the electronic configuration of a *p*-block element whereas other configurations are those of *d*-block elements.

82. (c) : Oxidation state of Cr in $K_2Cr_2O_7$ is
$2 + 2x - 14 = 0 \quad \therefore\ 2x = 14 - 2$
$2x = 12 \quad \therefore\ x = +6$.

83. (c) : Undecomposed AgBr forms a soluble complex with hypo and the reaction is given as:

$AgBr + 2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2] + NaBr$
soluble complex