

INORGANIC CHEMISTRY

NEET

CRASH COURSE

d & f - Block Elements

SMART ACHIEVERS
JEE | NEET | FOUNDATION

587, Nitikhand-1, Indirapuram, Gzb.

7292077839 / 7292047839 | smartachievers.online

A Unit of SMARTACHIEVERS LEARNING Pvt. Ltd., Delhi

SUMMARY

The d-block consisting of Groups 3-12 occupies the large middle section of the periodic table. In these elements the inner d orbitals are progressively filled. The f-block is placed outside at the bottom of the periodic table and in the elements of this block, 4f and 5f orbitals are progressively filled.

Corresponding to the filling of 3d, 4d and 5d orbitals, three series of transition elements are well recognised. All the transition elements exhibit typical metallic properties such as –high tensile strength, ductility, malleability, thermal and electrical conductivity and metallic character. Their melting and boiling points are high which are attributed to the involvement of $(n-1)$ d electrons resulting into strong interatomic bonding. In many of these properties, the maxima occur at about the middle of each series which indicates that one unpaired electron per d orbital is particularly a favourable configuration for strong interatomic interaction.

Successive ionisation enthalpies do not increase as steeply as in the main group elements with increasing atomic number. Hence, the loss of variable number of electrons from $(n-1)$ d orbitals is not energetically unfavourable. The involvement of $(n-1)$ d electrons in the behaviour of transition elements impart certain distinct characteristics to these elements. Thus, in addition to variable oxidation states, they exhibit paramagnetic behaviour, catalytic properties and tendency for the formation of coloured ions, interstitial compounds and complexes.

The transition elements vary widely in their chemical behaviour. Many of them are sufficiently electropositive to dissolve in mineral acids, although a few are 'noble'. Of the first series, with the exception of copper, all the metals are relatively reactive.

The transition metals react with a number of non-metals like oxygen, nitrogen, sulphur and halogens to form binary compounds. The first series transition metal oxides are generally formed from the reaction of metals with oxygen at high temperatures. These oxides dissolve in acids and bases to form oxometallic salts. Potassium dichromate and potassium permanganate are common examples. Potassium dichromate is prepared from the chromite ore by fusion with alkali in presence of air and acidifying the extract. Pyrolusite ore (MnO_2) is used for the preparation of potassium permanganate. Both the dichromate and the permanganate ions are strong oxidising agents.

The two series of inner transition elements, lanthanoids and actinoids constitute the f-block of the periodic table. With the successive filling of the inner orbitals, 4f, there is a gradual decrease in the atomic and ionic sizes of these metals along the series (lanthanoid contraction). This has far reaching consequences in the chemistry of the elements succeeding them. Lanthanum and all the lanthanoids are rather soft white metals. They react easily with water to give solutions giving $+3$ ions. The principal oxidation state is $+3$, although $+4$ and $+2$ oxidation states are also exhibited by some occasionally. The chemistry of the actinoids is more complex in view of their ability to exist in different oxidation states. Furthermore, many of the actinoid elements are radioactive which make the study of these elements rather difficult.

There are many useful applications of the d- and f-block elements and their compounds, notable among them being in varieties of steels, catalysts, complexes, organic syntheses, etc.

d & f - BLOCK ELEMENT

- Q.1 Amongst the following metals, which has highest melting point ?
 (1) Ti (2) Cr (3) Fe (4) Cu
- Q.2 The melting point of Zn is lower as compared to those of the other elements of 3d series because :
 (1) the d-orbitals are completely filled.
 (2) the d-orbitals are partially filled.
 (3) d-electrons do not participate in metallic bonding.
 (4) (1) and (3) both.
- Q.3 Which of the statements is **False** ?
 (1) In 3d series, there is a regular increase in the first ionisation enthalpy of transition elements from left to right.
 (2) In 3d series, the negative value of standard electrode potential (E/V) for M^{2+}/M decreases in the order $Ti > Mn > Cr > Fe$.
 (3) The decreases in metallic radius coupled with increase in atomic mass results in a general increase in the density of transition elements from Ti to Cu.
 (4) The higher oxidation state are favoured by the heavier elements (i.e. heavier members) in the groups of d-block.
- Q.4 The metallic bond strength in first transition series increases from -
 (1) Sc to Mn (2) Sc to Cr (3) Cr to Zn (4) Sc to Cu
- Q.5 The highest oxidation state is exhibited by the transition metals with configuration :
 (1) $(n-1)d^3ns^2$ (2) $(n-1)d^5ns^1$ (3) $(n-1)d^5ns^2$ (4) $(n-1)d^8ns^2$.
- Q.6 Transition metals ions form interstitial compounds because -
 (1) Interstices are available in their crystal lattice (2) They have empty d-orbitals
 (3) They have high value of ionic potential (4) They show variable oxidation states
- Q.7 The stability of particular oxidation state of a metal in aqueous solution is determined by :
 (1) enthalpy of sublimation of the metal (2) ionisation energy
 (3) enthalpy of hydration of the metal ion (4) all of these.
- Q.8 Formula of chromyl chloride is -
 (1) $CrOCl_2$ (2) CrO_2Cl (3) CrO_2Cl_2 (4) $(CrOCl)_2$
- Q.9 First IE of 5d series elements are higher than those of 3d and 4d series elements. This is due to :
 (1) bigger size of atoms of 5d-series elements than 3d-series elements.
 (2) greater effective nuclear charge is experienced by valence electrons because of the weak shielding of the nucleus by 4f-electrons in 5d series.
 (3) (1) and (2) both.
 (4) None of these.

- Q.10 The reaction, $2\text{Cu}^+ \rightarrow \text{Cu} + \text{Cu}^{2+}$ is called -
 (1) Reduction (2) Oxidation (3) Displacement (4) disproportionation
- Q.11 Which of the following ions give colourless aqueous solution?
 (1) Ni^{2+} (2) Fe^{2+} (3) Cu^{2+} (4) Cu^+
- Q.12 The catalytic activity of the transition metals and their compounds is ascribed to :
 (1) their chemical reactivity.
 (2) their magnetic behaviour.
 (3) their unfilled d-orbitals.
 (4) their ability to adopt multiple oxidation state and their complexing ability.
- Q.13 The general electronic configuration of transition element is -
 (1) $(n-1)d^{1-5}$ (2) $(n-1)d^{1-10}ns^1$
 (3) $(n-1)d^{1-10}ns^{1-2}$ (4) None of these
- Q.14 Manganous salt in presence of catalyst zinc sulphate or zinc oxide is oxidised by potassium permanganate in neutral or faintly alkaline medium to :
 (1) MnO_2 (2) Mn_2O_7 (3) Mn_2O_3 (4) Can not be oxidised
- Q.15 Which of the following transition metal has the highest melting point -
 (1) Cr (2) Mo (3) W (4) Hg
- Q.16 $\text{FeCr}_2\text{O}_4 + \text{Na}_2\text{CO}_3 + \text{O}_2 \xrightarrow{\text{Fusion}} [\text{X}] \xrightarrow[\text{H}_2\text{O}]{\text{H}^+} [\text{Y}] \xrightarrow[\text{H}_2\text{O}_2]{\text{H}^+} [\text{Z}]$
 Which of the following statement is true for the compounds [X], [Y] and [Z] ?
 (1) In all three compounds, the chromium is in + 6 oxidation state.
 (2) [Z] is a deep blue-violet coloured compound which decomposes rapidly in aqueous solution into Cr^{3+} and dioxygen.
 (3) Saturated solution of [Y] gives bright orange compound, chromic anhydride, with concentrated H_2SO_4 .
 (4) All of these.
- Q.17 Which of the following group of transition metals is called coinage metals -
 (1) Cu, Ag, Au (2) Ru, Rh, Pd (3) Fe, Co, Ni (4) Os, Ir, Pt
- Q.18 Which of the following statements is false ?
 (1) An acidified solution of $\text{K}_2\text{Cr}_2\text{O}_7$ liberates iodine from potassium iodide
 (2) In acidic solution, dichromate ions are converted to chromate ions.
 (3) Potassium dichromate on heating undergoes decomposition to give Cr_2O_3 and O_2 gas.
 (4) Potassium dichromate is used as a titrant of Fe^{2+} ion.

- Q.19 General electronic configuration of lanthanides is :
 (1) $(n-2)d^{0-1} (n-1)f^{0-14} ns^1$ (2) $(n-2)f^{0-14} (n-1)d^{0-1} ns^{1-2}$
 (3) $(n-2)f^{0-14} (n-1)d^{10} ns^2$ (4) $(n-2)f^{1-14} (n-1)s^2 p^6 d^{0-1} ns^2$
- Q.20 $KMnO_4$ on heating at temperature 513 K decomposes to give :
 (1) K_2MnO_4 , MnO_2 and O_2 (2) K_2O , MnO_2 and O_2
 (3) K_2MnO_4 , Mn_2O_7 and KO_2 (4) K_2MnO_4 and MnO_2
- Q.21 The starting material for the manufacture of $KMnO_4$ is -
 (1) Pyrolusite (2) Manganese (3) Magnetite (4) Haematite
- Q.22 Across the lanthanide series, the basicity of the lanthanoid hydroxides :
 (1) increases (2) decreases
 (3) first increases and then decreases (4) does not change
- Q.23 Green vitriol is -
 (1) $FeSO_4 \cdot 7H_2O$ (2) $ZnSO_4 \cdot 7H_2O$ (3) $CaSO_4 \cdot 2H_2O$ (4) $CuSO_4 \cdot 5H_2O$
- Q.24 At pH = 12, $Cr_2O_7^{2-}$ change to -
 (1) CrO_3 (2) CrO_2^{2+} (3) CrO_4^{2-} (4) no change
- Q.25 Lanthanoid and actinides resemble in :
 (1) electronic configuration (2) oxidation state
 (3) ionization energy (4) formation of complexes
- Q.26 The separation of lanthanoids by ion exchange method is based on
 (1) sizes of the ions (2) oxidation state of the ions
 (3) the solubility of their nitrates (4) basicity of hydroxides of lanthanides
- Q.27 The ionic radius of Cr is minimum in which of the following compounds ?
 (1) CrF_3 (2) $CrCl_3$ (3) Cr_2O_3 (4) K_2CrO_4
- Q.28 Which of the following compound has not d-electron but coloured in nature :
 (1) CrO_4^{2-} (2) MnO_4^- (3) CrO_2Cl_2 (4) All of these
- Q.29 The reason for the formation of complex compounds by transition metal is -
 (1) Availability of empty d-orbitals (2) Completely filled d-orbitals
 (3) Paramagnetism (4) Bigger size
- Q.30 Calomel is -
 (1) $Hg_2Cl_2 + Hg$ (2) $HgCl_2$ (3) $Hg + HgCl_2$ (4) Hg_2Cl_2
- Q.31 CrO_3 is a/an.....
 (1) Acidic oxide (2) Basic oxide (3) Neutral oxide (4) Amphoteric

- Q.32 The lanthanide contraction is responsible for the fact that -
(1) Zr and Y have about the same radius (2) Zr and Nb have similar oxidation state
(3) Zr and Hf have about the same radius (4) Zr and Zn have the same oxidation state
- Q.33 Which of the following compounds is diamagnetic -
(1) $ZnCl_2$ (2) $CrCl_3$ (3) $CuSO_4$ (4) $NiCl_4^{2-}$
- Q.34 Which of the following compounds is used as the starting material for the preparation of potassium dichromate -
(1) $K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$ (Chrome alum) (2) $PbCrO_4$ (Chrome yellow)
(3) $FeCr_2O_4$ (Chromite) (4) $PbCrO_4 \cdot PbO$ (Chrome red)
- Q.36 Which of the following is ionic in nature -
(1) CuF_2 (2) $CuCl_2$ (3) $CuBr_2$ (4) None of these
- Q.37 The correct order of magnetic moments (spin only values in BM) among is -
(1) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$
(2) $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$
(3) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$
(4) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$
- Q.38 Which of the following transition metal ions has the lowest density?
(1) Copper (2) Nickel (3) Scandium (4) Zinc
- Q.39 Amongst the following the lowest degree of paramagnetism per mole of the compound at 298K will be shown by:
(1) $MnSO_4 \cdot 4H_2O$ (2) $CuSO_4 \cdot 5H_2O$ (3) $FeSO_4 \cdot 6H_2O$ (4) $NiSO_4 \cdot 6H_2O$
- Q.40 Which one of the following characteristics of the transition metals is associated with their catalytic activity?
(1) Colour of hydrated ions. (2) Variable oxidation states.
(3) High enthalpy of atomization. (4) Paramagnetic behaviour.
- Q.41 Which of the following compounds is (are) coloured due to charge transfer spectra and not due to d-d transition?
(1) $K_2Cr_2O_7$ (2) $KMnO_4$ (3) Both (1) & (2) (4) None of these
- Q.42 The correct order of ionic radii of Y^{3+} , La^{3+} , Eu^{3+} and Lu^{3+} is :
(1) $La^{3+} < Eu^{3+} < Lu^{3+} < Y^{3+}$ (2) $Y^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$
(3) $Lu^{3+} < Y^{3+} < Eu^{3+} < La^{3+}$ (4) $Lu^{3+} < Eu^{3+} < La^{3+} < Y^{3+}$
- Q.43 Which oxide of manganese is amphoteric ?
(1) MnO (2) MnO_2 (3) Mn_2O_7 (4) Mn_2O_3
- Q.44 V_2O_5 reacts with alkalis to give :
(1) VO_4^{3-} (2) VO_4^+ (3) VO^{2+} (4) None

- Q.45 Ionic character of halides of metals (3d-transition series) decreases in the order -
 (1) $M-I > M-Br > M-Cl > M-F$ (2) $M-Cl > M-Br > M-I > M-F$
 (3) $M-Br > M-Cl > M-F > M-I$ (4) $M-F > M-Cl > M-Br > M-I$
- Q.46 Which of the following contains the maximum number of unpaired electrons -
 (1) $TiCl_3$ (2) $MnCl_2$ (3) $FeSO_4$ (4) $CuSO_4$
- Q.47 Which of the following products are formed when potassium bromide reacts with potassium permanganate in alkaline pH?
 (1) BrO_3^- , MnO_2 (2) BrO_4^- , Mn^{2+} (3) Br_2 , MnO_2 (4) BrO^- , MnO_4^{2-}
- Q.48 Which of the following is expected to have lowest magnetic moment -
 (1) Ti^{2+} (2) Mn^{2+} (3) Co^{2+} (4) Cu^{2+}
- Q.49 Titanium shows magnetic moment of 1.73 B.M. in its compounds. What is the oxidation number of Ti in the compound?
 (1) +1 (2) +4 (3) +3 (4) +2
- Q.50 Ti^{+2} and Ni^{2+} contain -
 (1) Equal number of paired electrons (2) Equal number of unpaired electrons
 (3) Different number of 2p electrons (4) Different number of 3p electrons
- Q.51 Super conductors are derived from compounds of:
 (1) p-block elements (2) lanthanoides (3) actinoides (4) transition elements
- Q.52 $N_2(g) + 3H_2(g) \xrightleftharpoons{Fe + Mo} 2NH_3(g)$; Haber's process, Mo is used as
 (1) a catalyst (2) a catalytic promoter
 (3) an oxidising agent (4) as a catalytic poison
- Q.53 The magnetic moment of a transition metal ion is found to be 3.87 B.M. The number of unpaired electrons present in it is -
 (1) 2 (2) 3 (3) 4 (4) 5

ASSERTION AND REASON

Directions : Each of these questions contains an Assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (1) If both assertion and reason are true and reason is the correct explanation of assertion.
 (2) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (3) If Assertion is true but reason is false.
 (4) If both assertion and reason are false.

- Q.54 **Assertion :** The value of enthalpy of atomisation is maximum at about the middle of each series.
Reason : There is one unpaired electron per d-orbital and this results in stronger interatomic interaction.
- Q.55 **Assertion :** Mn^{3+} and Co^{3+} ions are the strongest oxidising agents in aqueous solutions amongst 3d series elements.
Reason : E^0 values for the redox couple $\text{Mn}^{3+} | \text{Mn}^{2+}$ and $\text{Co}^{3+} | \text{Co}^{2+}$ are +1.57V and + 1.97 V respectively.
- Q.56 **Assertion :** Copper (II) compounds are unstable in aqueous solutions and undergo disproportionation.
Reason : Cu^{2+} (aq) is stable than Cu^+ (aq) due to the much more negative enthalpy of hydration of Cu^{2+} (aq.) than Cu^+ , which more than compensates for the second ionization enthalpy of Cu.
- Q.57 **Assertion :** The green manganate is paramagnetic but the purple permanganate is diamagnetic in nature.
Reason : MnO_4^{2-} contains one unpaired electron while in MnO_4^- all electrons are paired.
- Q.58 **Assertion :** Solution of Na_2CrO_4 in water is intensely coloured.
Reason : Oxidation state of Cr in Na_2CrO_4 is +VI. [AIIMS 2003]
- Q.59 **Assertion :** The spin only magnetic moment of Sc^{3+} is 1.73 BM.
Reason : The spin only magnetic moment (in BM) of an ion is equal to $\sqrt{n(n+2)}$, where n is the number of paired electrons present in the ion. [EAMCET 2005]
- Q.60 **Assertion :** Mercury vapour is shining silvery in appearance.
Reason : Mercury is a non-metal with shining silvery appearance. [AIIMS 2007]
- Q.61 **Assertion :** KMnO_4 is oxidising agent in neutral, acidic and in basic medium.
Reason : Equivalent mass of KMnO_4 in acidic medium is 31.6.
- Q.62 **Assertion :** K_2CrO_4 is yellow coloured compound.
Reason : Chromate ion has tetrahedral geometry.
- Q.63 **Assertion :** TiCl_4 is a colourless compound.
Reason : Ti^{4+} ion has no unpaired electron.

- Q.64 **Assertion :** All the members of actinide series are radioactive in nature.
Reason : The electrons are gradually accommodated in 5f-energy subshell.
- Q.65 **Assertion :** Potassium ferrocyanide is diamagnetic where as potassium ferricyanide is paramagnetic.
Reason : Crystal field splitting in ferrocyanide ion is greater than that of ferricyanide ion.
- Q.66 **Assertion :** Ionisation of transition metals involve loss of ns electrons before (n – 1)d electrons.
Reason : Filling of ns-orbitals take place before the filling of (n – 1)d-orbitals.
- Q.31 Which one of the following statements related to lanthanons is incorrect ? [NEET-II 2016]
(1) Ce (+4) solutions are widely used as oxidizing agent in volumetric analysis.
(2) Europium shows +2 oxidation state.
(3) The basicity decreases as the ionic radius decreases from Pr to Lu
(4) All the lanthanous are much more reactive than aluminium
- Q.32 Name the gas that can readily decolourise acidified KMnO_4 solution : [NEET 2017]
(1) CO_2 (2) SO_2 (3) NO_2 (4) P_2O_5

ANSWER KEY

Q.1	2	Q.2	4	Q.3	1	Q.4	2	Q.5	3	Q.6	1	Q.7	4
Q.8	3	Q.9	2	Q.10	4	Q.11	4	Q.12	4	Q.13	3	Q.14	1
Q.15	3	Q.16	4	Q.17	1	Q.18	2	Q.19	2	Q.20	1	Q.21	1
Q.22	2	Q.23	1	Q.24	3	Q.25	1	Q.26	1	Q.27	4	Q.28	4
Q.29	1	Q.30	4	Q.31	1	Q.32	3	Q.33	1	Q.34	3	Q.36	1
Q.37	1	Q.38	3	Q.39	2	Q.40	2	Q.41	3	Q.42	3	Q.43	2
Q.44	1	Q.45	4	Q.46	2	Q.47	1	Q.48	4	Q.49	3	Q.50	2
Q.51	4	Q.52	2	Q.53	2	Q.54	1	Q.55	1	Q.56	1	Q.57	1
Q.58	2	Q.59	4	Q.60	4	Q.61	2	Q.62	2	Q.63	1	Q.64	2
Q.65	3	Q.66	2										