Chapter_08

The d-and f-Block Elements

Practice Questions

1. Which of the following element does not have $(n-1)\,d^{10}ns^2$ electronic configuration?
(a) Zn *(b)* Cd
(c) Hg *(d)* Cu

2. The ground state electronic configuration of neutral titanium atom is
(a) $[Ar]\,4s^2 4p^2$ *(b)* $[Ar]\,3d^2 4s^2$
(c) $[Ar]\,4s^2 p_x^1 p_y^1$ *(d)* $[Ar]\,3d^5$

3. The third ionisation enthalpy is minimum form
(a) Mn *(b)* Ni
(c) Co *(d)* Fe

4. Which element can have oxidation state from 4 to 6?
(a) Fe *(b)* Mg
(c) Co *(d)* Cr

5. Magnetic moment of a transition metal ion is found to be 3.87 BM. The number of unpaired electrons present in it is
(a) 2 *(b)* 3
(c) 4 *(d)* 5

6. Which of the following aqueous solutions will be coloured?
(a) $Zn(NO_3)_2$ *(b)* $LiNO_3$
(c) $CoNO_3$ *(d)* $HgCl_2$

7. Which of the following alloys contain Cu and Zn?
(a) Brass *(b)* Bronze
(c) Bell metal *(d)* All of these

8. Acidified potassium dichromate oxidises
(a) iodides to iodine *(b)* sulphides to sulphur
(c) tin (IV) to tin (II) *(d)* Both (a) and (b)

9. Which of the following can react with $K_2Cr_2O_7$?
(a) SO_3^{-2} *(b)* CO_3^{-2}
(c) SO_4^{-2} *(d)* NO_3^-

10. Dichromates are generally prepared by the fusion of chromite ore with
(a) sodium carbonate *(b)* potassium carbonate
(c) Both (a) and (b) *(d)* Neither (a) nor (b)

11. Permanganate ion (MnO_4^-) is dark purple coloured though Mn is in + 7 oxidation state with d^0 configuration. This is due to
(a) *d-d* transition
(b) charge transfer from metal to ligand
(c) charge transfer from ligand to metal
(d) All of the above

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

13. The product of following reaction is
$$K_2CrO_4 + \text{dil.}\,HNO_3\ (\text{excess}) \longrightarrow$$
(a) Cr^{3+} and $Cr_2O_7^{2-}$
(b) $Cr_2O_7^{2-}$, NO_3^- and H_2O
(c) Only Cr^{3+}
(d) Only Cr^{7+}

14. The green manganate and purple permanganate are respectively
(a) paramagnetic, diamagnetic
(b) diamagnetic, paramagnetic
(c) paramagnetic, paramagnetic
(d) diamagnetic, diamagnetic

15. The most common lanthanoid among the following is
(a) lanthanum *(b)* cerium
(c) promethium *(d)* plutonium

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

17. The correct order of ionic radii of Ce, Pm, Gd and Dy in +3 oxidation state is
(a) $Ce^{3+} < Gd^{3+} < Pm^{3+} < Dy^{3+}$
(b) $Ce^{3+} < Pm^{3+} < Gd^{3+} < Dy^{3+}$
(c) $Dy^{3+} < Gd^{3+} < Pm^{3+} < Ce^{3+}$
(d) $Pm^{3+} < Ce^{3+} < Dy^{3+} < Gd^{3+}$

18. A man made white silvery metal, radioactive in nature, has strong tendency to form oxocations and complexes. It is used as a nuclear fuel in atomic reactor. This metal is a
(a) actinide
(b) lanthanide
(c) representative element
(d) transition metal

19. All the actinoids are believed to have the electronic configuration of
(a) $6s^2$ *(b)* $7s^2$
(c) $5f^{14}$ *(d)* $6d^{10}$

20. What will be the most common oxidation state shown by the actinoids?
(a) −3 *(b)* +3
(c) −4 *(d)* +4

21. Which of the following elements shows maximum number of different oxidation states in its compounds?

(a) Eu *(b)* La

(c) Gd *(d)* Am

22. The actinoids resemble the lanthanoids in having more compounds in

(a) +3 state *(b)* +4 state

(c) +5 state *(d)* +2 state

23. Compound(s) useful in the battery industries is/are

(a) MnO_2 *(b)* Zn

(c) Ni/Cd *(d)* All of these

24. Catalyst used in the oxidation of SO_2 in the manufacture of H_2SO_4 is

(a) $CuCl_2$

(b) V_2O_5

(c) MnO_2

(d) None of thesee

25. Which of the following compounds form the basis, if Ziegler-Natta catalysts is used to manufacture of polythene?

(a) $TiCl_4$ *(b)* $Al(CH_3)_3$

(c) $TiCl_4$ with $Al(CH_3)_3$ *(d)* None of these

ANSWERS

1. (d)	**2.** (b)	**3.** (d)	**4.** (d)	**5.** (b)	**6.** (c)	**7.** (a)	**8.** (d)	**9.** (a)	**10.** (c)
11. (c)	**12.** (b)	**13.** (b)	**14.** (a)	**15.** (b)	**16.** (d)	**17.** (c)	**18.** (a)	**19.** (b)	**20.** (b)
21. (d)	**22.** (a)	**23.** (d)	**24.** (b)	**25.** (c)					

Hints & Solutions

1. (*d*) The electronic configurations of Zn, Cd and Hg are represented by the general formula $(n-1)\,d^{10}ns^2$. The orbitals in these elements are completely filled in the ground state as well as in their common oxidation states.

Cu has electronic configuration $3d^{10}4s^1$. Thus, Cu does not have $(n-1)d^{10}ns^2$ electronic configuration.

3. (*d*) Fe has minimum value of third ionisation enthalpy. Ground state electronic configuration of Fe is $[Ar]3d^64s^2$.

Fe^{2+} has $[Ar]3d^6$ configuration, whereas Fe^{3+} has $[Ar]3d^5$. The latter is a stable configuration and easier to ionise Fe^{2+} to Fe^{3+} than expected.

Hence possess least value.

Ni has highest value of third ionisation enthalpy due to its greater nuclear charge and smaller size.

Due to the same reason, Co > Fe > Mn should be the order for the remaining elements, but the anomalous order is due to greater stability of Mn^{2+} having $[Ar]3d^5$ configuration than Mn^{3+} with $[Ar]3d^4$.

Whereas for Co^+, the electronic configuration is $[Ar]3d^7$, Thus, ionisation enthalpy needed to remove third electron is less as compared to that of Mn^{2+}.

4. (*d*) Oxidation state of alkaline earth metal (i.e. Mg) is fixed and equal to (+)2.

Oxidation state of *d*-block elements can vary,

i.e. for Fe and Co it is as follows :

Oxidation state of Co = (+) 2 to (+) 4 and oxidation state of Fe = (+) 2 to (+) 6, but (+) 6 is less stable.

Oxidation state of Cr = (+) 2 to (+) 6, where (+) 6 state is more stable.

5. (*b*) Magnetic moment of a transition metal ion

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

$$\therefore \qquad 3.87 = \sqrt{n(n+2)} \qquad (\text{Given}, \mu = 3.87)$$

On solving, $n = 3$

Thus, number of unpaired electrons are 3.

6. (*c*) Only Co^+, because of the presence of unpaired electrons in *d*-orbitals show *d-d* transition and, hence it is coloured.

8. (*d*) Acidified potassium dichromate oxidises iodides to iodine, sulphides to sulphur, tin(II) to tin(IV), iron(II) salts to iron (III).

9. (*a*) Oxidation state of central atoms are as follows :

Sulphur in $SO_3^{-2} = +4$

Carbon in $CO_3^{-2} = +4$

Sulphur in $SO_4^{-2} = +6$

Nitrogen in $NO_3^- = +5$

Since, $K_2Cr_2O_7$ is a strong oxidising agent it can oxidise the species, which is not in its most possible positive oxidising state.

Thus, SO_3^{-2} can react with $K_2Cr_2O_7$ as follows :

$$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+(aq) \longrightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + 4H_2O(l)$$

10. (*c*) Dichromates are generally prepared from chromate which in turn are obtained by the fusion of chromite ore ($FeCr_2O_4$) with sodium or potassium carbonate in free access of air.

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \longrightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

$$2Na_2CrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + 2Na^+ H_2O$$

11 (*c*) In MnO_4^-,

$$x + (-2)4 = -1$$

$$\Rightarrow \quad x = +7$$

$_{25}Mn^{+7} = [Ar]$, no unpaired electrons.

Thus, it will not show *d-d* transition. It is dark purple coloured due to charge transfer from ligand to metal.

12. (*b*) SO_2 gas can readily decolourise acidified $KMnO_4$ solution because $KMnO_4$ is an oxidising agent that easily oxidises SO_2,

$$2MnO_4^- + 5SO_2 + 2H_2O \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+$$

while other options such as NO_2 (strong oxidising agent), CO_2 (neither oxidising agent nor reducing agent) cannot decolourise acidified $KMnO_4$ solution.

13. (*b*) The product of given reaction is $Cr_2O_7^{2-}$, NO_3^- and H_2O,

$$\underset{\text{Chromate (yellow)}}{2CrO_4^{2-}} + \underset{\text{(Dil.)}}{2HNO_3} \longrightarrow \underset{\text{Dichromate (orange)}}{Cr_2O_7^{2-}} + 2NO_3^- + H_2O$$

14. (*a*) The manganate and permanganate ions are tetrahedral. Here, the π-bonding takes place by overlap of *p*-orbitals of oxygen with *d*-orbitals of manganese. The green manganate is paramagnetic because of one unpaired electron but the purple permanganate is diamagnetic due to charge transfer.

15. (*b*) Lanthanum is a *d*-block element, whereas plutonium is an actinoid. Both cerium and promethium are lanthanoids. But cerium is a common lanthanoid because it occurs naturally, whereas Pm does not occur naturally and is radioactive.

16. (*d*) Zr^{4+} and HF^{4+} have same size due to lanthanoid contraction.

18. (*a*) Actinide is a man-made white silvery metal, radioactive in nature has a strong tendency to form oxocations and complexes.

19. (*b*) All the actinoids are believed to have the electronic configuration of $7s^2$ and variable occupancy of $5f$ and $6d$-subshell.

25 (*c*) $TiCl_4$ with $Al(CH_3)_3$ forms the basis of *Ziegler-Natta* catalysts that is used to manufacture polythene.