The d- and f-Block Elements

- 1. The colour of KMnO₄ solution is decolourised by Fe²⁺ solution, one mole of Fe²⁺ reacts with x moles of KMnO₄.
- 2. Use riund s rule to derive the electronic configuration of Ce³⁺ ion, and calculate its magnetic moment on the basis of 'spin-only' formula.
- 3. A compound of a metal ion $M^{x+}(Z = 24)$ has a spin only magnetic moment of $\sqrt{15}$ Bohr Magnetons. Find the number of unpaired electrons in the compound.
- 4. What are the number of ions formed on dissolving one molecule of FeSO₄(NH₄)₂ SO₄.6H₂O (Mohr's salt)?
- 5. In an alkaline condition $KMnO_4$ reacts as follows: $2KMnO_4 + 2KOH \rightarrow 2K_2MnO_4 + H_2O + O$ Calculate its equivalent weight.
- **6.** Titanium shows magnetic moment of 1.73 B.M. in its compound. What is the oxidation number of Ti in the compound?
- 7. Four successive members of the first series of the transition metals are listed below. How many of them have the standard potential (E_{M²⁺/M}) value with positive sign?
 (I) Co(Z=27) (II) Ni(Z=28) (IV) Fe(Z=26)
- 8. What is the approximate percentage of iron in mischmetal?
- 9. The standard redox potentials for the reactions $Mn^{2+} + 2e^- \rightarrow Mn$ and $Mn^{3+} + e^- \rightarrow Mn^{2+}$ are -1.18 V and 1.51 V respectively. What is the redox potential for the reaction $Mn^{3+} + 3e^- \rightarrow Mn$?
- 10. $\operatorname{CrO}_4^{2-} \xrightarrow{\operatorname{pH} = x} \operatorname{CrO}_7^{2-} \xrightarrow{\operatorname{pH} = y} \operatorname{CrO}_4^{2-}$. Find the sum of x and y
- 11. 12 grams of silver was extracted from a sample of an ore from which the only source of silver was Ag₂S. How many grams of Ag₂S were in the original sample?
- 12. What is the oxidation number of Mn in the product of alkaline oxidative fusion of MnO₂.
- 13. Out of the following, how many oxides are acidic. MnO, Mn₂O₃, MnO₂, MnO₃, Mn₂O₇
- **14.** How many of the transition elements are called platinum metals?
- 15. A light blue coloured compound (A) on heating gives a black compound (B) which reacts with glucose to give a red compound (C). After the completion of reaction, how many metal oxides are formed?



SOLUTIONS

1. (0.2) $MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ In the above reaction 1 mole of MnO_4^- reacts with 5 mole of Fe^{2+} .

or 1 mole of Fe²⁺ reacts with 0.2 mole of MnO₄.

2. (1.73) The electronic configuration of Ce^{3+} (atomic no. of Ce = 58) is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1$ There is only one unpaired electron in Ce^{3+} ion. The spin-only formula for calculating the magnetic moment is

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

where n is the number of unpaired electrons in the species. Here, n = 1,

So, $\mu = \sqrt{1 \times 3} \, BM = 1.73 \, BM$

- 3. (3) Magetic moment $\mu = \sqrt{n(n+2)}$ where n = number of unpaired electrons $\sqrt{15} = \sqrt{n(n+2)}$ $\therefore n = 3$
- 4. (5) FeSO₄.(NH₄)₂SO₄.6H₂O in solution will give Fe²⁺, 2(SO₄²⁻), 2(NH₄⁺) hence total number of ions is 5.
- 5. (158) Change in O.S. is by 1.

Hence eq. wt. is
$$\frac{158}{1} = 158 \text{ g}$$

- 6. (3) Magnetic moment $\mu = \sqrt{n(n+2)}BM$ $1.73 = \sqrt{n(n+2)} : n=1$, it has one unpaired electron hence electronic configuration is $[Ar]3d^1$ and electronic configuration for Z=22 is $[Ar]3d^24s^2$. Hence charge on Ti is +3.
- 7. (1) $E_{Cu^{2+}/Cu}^{\circ} = 0.34 \text{ volt},$ other has – ve $E_{R.P.}^{\circ}$ $E_{Co^{2+}/Co}^{\circ} = -0.28$

$$E_{Ni^{2+}/Ni}^{\circ} = -0.25$$

$$E_{Fe^{2+}/Fe}^{\circ} = -0.44$$

8. (5) Mischmetal is an alloy which contains rare earth elements (94-95%), iron (5%) and traces of sulphur, carbon, silicon, calcium and aluminium. It is used in gas lighters, tracer bullets and shells.

9. (-0.28)

$$Mn^{2+} + 2e^{-} \longrightarrow Mn, \Delta G_1 = -nFE_1 = -2 \times F \times (-1.18)$$

$$Mn^{3+} + e^{-} \longrightarrow Mn^{2+}, \Delta G_2 = -nFE_2 = -1 \times F \times (1.51)$$

Adding,
$$Mn^{3+} + 3e^{-} \longrightarrow Mn$$
, $\Delta G_3 = -3FE_3$

$$\Delta G_3 = \Delta G_1 + \Delta G_2$$

$$-3FE_3 = -2 \times F \times (-1.18) - (1) \times F \times (1.51)$$

$$E_3 = -0.28 \,\mathrm{V}$$

10. (11) $\operatorname{CrO_4^{2-}} \xrightarrow{\operatorname{pH}=3} \operatorname{CrO_7^{2-}} \xrightarrow{\operatorname{pH}=8} \operatorname{CrO_4^{2-}}$ \therefore Sum of x and y is 11.

11. (13.8) $(2Ag^{+} + S^{2-} \longrightarrow Ag_{2}S)$

(13.8)
$$(2Ag + S \longrightarrow Ag_2S)$$

Mass of Ag_2S required

$$= \frac{\text{Molar mass of } Ag_2S \times 12}{2 \times 108} = 13.8g$$

12. (+6) $2MnO_2 + 4KOH + O_2 \longrightarrow$

$$2K_{2}MnO_{4} + 2H_{2}O$$

Pd

Oxidation number of Mn in K2MnO4 is 6

$$K_2MnO_4$$
; $2+x-8=0$

$$x = +6$$

(3) Lower O.S. compounds are basic and higher O.S. compounds are acidic.

14. (6) Second and third triad of 4d and 5d series of group VIII or group, 8, 9 and 10 are collectively called platinum metals. These are:

4d series: Ru Rh

15. (2) $Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$;

$$2\text{CuO} + \text{glucose} \longrightarrow \text{Cu}_2\text{O}$$

