CBSE Test Paper-03

Class - 12 Chemistry (The d– & f- Block Elements)

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1. Transition metals with highest melting point is
    a. Hg
    b. Sc
    c. Cr
    d. W
2. Which of the following is not considered a transition metal?
    a. Zn
    b. Ac
    c. Y
    d. La
3. Which is the most stable oxidation state of iron?
    a. +1
    b. +3
    c. 0
    d. +2
4. In the reaction, $SnCl_2 + HgCl_2 \rightarrow A + SnCl_4$, A is
    a. $HgCl_2$
    b. Hg
    c. HgCl
    d. $HgCl_3$
5. Maximum magnetic moment is shown by
    a. d^6
    b. d^8
    c. d^7
    d. d^5
6. Write the outer electronic configuration of Lanthanoids.
7. Name the lanthanoid element which exhibit +4 oxidation state besides +3 oxidation

state.

8. Name the transition element which does not exhibit variable oxidation states.

9. Why do actinoids, in general, exhibit a greater range of oxidation states than the lanthanoids?

10. Why are Fe^{2+} compounds easily oxidises to Fe^{3+} as compared to Mn^{+2} compounds.

11. Explain why
    i. E^o for Mn^{3+}/Mn^{2+} couple is more positive than that for Fe^{3+}/Fe^{2+} (At. No. of Mn= 25, Fe = 26)
    ii. Ce^{3+} can be easily oxidized to Ce^{4+} (At. No. of Ce = 58)

12. Uses Hund's rule to derive the electronic configuration of Ce^{3+} ion, and calculate its magnetic moment on the basis of 'spin only' formula.

13. What are alloys? Name an important alloy which contains some of the Lanthanoid metals. Mention its uses.

14. The chemistry of the actinoid elements is not so smooth as that of the lanthanoids. Justify this statements by giving some examples from the oxidation state of these elements.

15. Indicate the steps in the preparation of:
    i. $K_2Cr_2O_7$ from chromite ore.
    ii. $KMnO_4$ from pyrolusite ore.

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Solutions

1. d. W

   Explanation: The high melting points of these metals are attributed to the involvement of greater number of electrons from (n-1)d in addition to the ns electrons in the interatomic metallic bonding. W belongs to 5d series and it has lot of unpaired electrons ($5d^4 6s^2$).

2. a. Zn

   Explanation: Zinc, cadmium and mercury of group 12 have full d^{10} configuration in their ground state as well as in their common oxidation states and hence, are not regarded as transition metals. However, being the end members of the three transition series, their chemistry is studied along with the chemistry of the transition metals.

3. b. +3

   Explanation: Fe has d^5 configuration in +3 oxidation state.

4. b. Hg

   Explanation: Tin(II) chloride react with mercury(II) chloride in acidic medium to produce mercury and tin(IV) chloride as given below:
   $SnCl_2 + HgCl_2 \rightarrow Hg + SnCl_4$

5. d. d^5

   Explanation: Magnetic moment is directly proportional to the total number of unpaired electrons. So it will be maximum for the element having maximum unpaired electrons i.e. d^5 system.

6. $4f^{1\text{-}14}5d^{0\text{-}1}6s^2$ is outer electronic configuration of Lanthanoids.

7. Generally, Lanthanide elements shows +3 oxidation state but cerium apart from +3 shows +4 oxidation state. The formation of Ce(IV) is favoured by its noble gas configuration, but it is a strong oxidant reverting to the common +3 state. The E^o

value for Ce^{4+}/ Ce^{3+} is + 1.74 V.

8. Scandium (Z= 21) does not exhibit variable oxidation states. It shows only +3 oxidation state.

9. They have lower ionization energy and less effective nuclear charge therefore more number of valence electrons can take part in bond formation. Also there is very less difference between the enegry of 5f ,6d,7s orbitals.

10. Mn^{2+} compounds are less readily converted to its +3 oxidation state (Mn^{3+}) as compared to Fe^{2+} because Mn^{2+} ($3d^5$) is more stable than Mn^{3+} ($3d^4$) due to stable half filled d-orbital electronic configuration. Whereas Fe^{3+} ($3d^5$) is more stable than Fe^{2+} ($3d^6$) due to half filled d-orbitals therefore Fe^{2+} gets easily converted to Fe^{3+}

11.
    1. Mn^{2+} is more stable($3d^5 4s^0$) because of half filled d-orbitals than Mn^{3+}($3d^4 4s^0$) whereas Fe^{3+}($3d^5$ $4s^0$) is more stable than Fe^{2+}($3d^6 4s^0$), therefore Mn^{3+} can be easily reduced to Mn^{2+} whereas Fe^{3+} is not easily reduced to Fe^{2+} rather Fe^{2+} is more easily oxidized to Fe^{3+}.
    2. Ce^{4+} is more stable than Ce^{3+} because of stable inert gas configuration and higher hydration energy hence Ce^{3+} is easily oxidized to Ce^{4+}.

12. $_{58}Ce$ has electronic configuration as $[Xe]^{54}$ $4f^1$ $5d^1$ $6s^2$ while Ce^{3+} will have electronic configuration as $[Xe]^{54}$ $4f^1$.

    Thus, number of unpaired electron in Ce^{3+} is 1. $\mu = \sqrt{n(n+2)}$
    $= \sqrt{1(1+2)} = \sqrt{3}BM$
    = 1.73 BM

13. Alloys are homogenous mixture of two or more metals. One of them can be non metal also. Mischmetal is an alloy which contains some of the Lanthanoid metals, it contains 45% Lanthanoid metals and iron ~ 5% and traces of S, C, Ca and Al.
    Mischmetal is used in Mg-based alloy to produce bullets, shell and lighter flint.
    Addition of 3% mischmetal to magnesium increases its strength and used in making jet engine parts.

14. Chemistry of actinoids is not as smooth as lanthanoids because actinoids are radioactive elements and they show a large number of oxidation state compared to lanthanoids. Lanthanoids shows limited number of oxidation state like + 2,+3 and +4 (out of which +3 is most common). This is because of large energy gap between 4f, 5d and 6s subshells. The dominant oxidation state of actinoids is also +3 but they show a number of other oxidation state also e.g. uranium (Z= 92) and plutonium (Z= 94) show +3, +4, +5 and +6 neptunium (Z = 94) shows +3, +4, +5 and +7 etc This is due to small energy difference between 5f, 6d and 7s subshells of the actinoids.

15. i. Potassium dichromate $(K_2Cr_2O_7)$ is prepared from chromite ore $(FeCr_2O_4)$ in the following steps.

   Step (1): Preparation of sodium chromate- 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.

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

   Step (2): Conversion of sodium chromate into sodium dichromate- The yellow solution of sodium chromate is filtered and acidified with sulphuric acid to give a solution from which orange sodium dichromate, $Na_2Cr_2O_7 \cdot 2H_2O$ can be crystallised. $2Na_2CrO_4 + conc.H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$

   Step(3): Conversion of sodium dichromate to potassium dichromate- Sodium dichromate is more soluble than potassium dichromate, therefore it is prepared by treating the solution of sodium dichromate with potassium chloride.

   $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$

   The chromates and dichromates are interconvertible in aqueous solution depending upon pH of the solution. The oxidation state of chromium in chromate and dichromate is the same.

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

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

   The combined reaction can be shown like:

$$\underset{\substack{Chromate\\(Yellow)}}{2CrO_4^{2-}} \underset{Alkali}{\overset{Acid}{\longleftrightarrow}} \underset{\substack{Hydrogen\\chromate}}{2HCrO_4^-} \underset{Alkali}{\overset{Acid}{\longleftrightarrow}} \underset{\substack{Dichromate\\(Orange)}}{Cr_2O_7^{2-}}$$

ii. Potassium permanganate $(KMnO_4)$ can be prepared from pyrolusite.(MnO_2) The ore is fused with KOH in the presence of either atmospheric oxygen or an oxidising agent, such as KNO_3 or $KClO_4$ to give K_2MnO_4

$$2MnO_2 + 4KOH + O_2 \xrightarrow{heat} \underset{(Green)}{2K_2MnO_4} + 2H_2O$$

This produces the dark green K_2MnO_4 which disproportionates in a neutral or acidic solution to give permanganate.

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

Commercially it is prepared by the alkaline oxidative fusion of MnO_2 followed by the electrolytic oxidation of manganate (Vl).

$$MnO_2 \xrightarrow{fused\ with\ KOH\ and\ oxidised\ by\ KNO_3\ or\ air} MnO_4^{2-}$$

$$MnO_4^{2-} \xrightarrow{electrolytic\ oxidation\ in\ alkaline\ solution} MnO_4^-$$

In the laboratory, a manganese (II) ion salt is oxidised by peroxodisulphate to permanganate.

$2Mn^{2+} + 5S_2O_8^{2-} + 8H_2O \rightarrow 2MnO_4^- + 10SO_4^{2-} + 16H^+$