CBSE Test Paper-01

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

1. Oxidation state of Mn in MnO_4^- is +7 indicating all electrons paired in Mn but MnO_4^- is coloured. This is due to:
   a. none of these
   b. both presence of unpaired electron in d-orbital in oxygen and charge transfer
   c. presence of unpaired electron in d-orbital in oxygen
   d. charge transfer
2. In dilute alkaline solution, MnO_4^- changes to
   a. MnO_4^{2-}
   b. MnO_2
   c. Mn_2O_3
   d. MnO
3. Zr and Hf have almost equal atomic and ionic radii because
   a. Both belong to same transition series
   b. Of lanthanoid contraction
   c. Of diagonal relationship
   d. Of actinoid contraction
4. Silver is refined by cupellation process. The process removes the impurity of
   a. Au
   b. Pb
   c. Cu
   d. Pt
5. The compound which is widely used as a white pigment is
   a. ZnO
   b. Al_2O_3
   c. $PbCO_3$
   d. $CaCO_3$
6. Write the outer electronic configuration of Cr atom(Z= 24).

7. Name the lanthanoid element which exhibits a + 4 oxidation state besides +3 oxidation state?
8. Why is $KMnO_4$ kept in dark bottles?
9. Calculate the 'spin only' magnetic moment of M^{2+} (aq) ion (Z= 27).
10. Give some of the uses of $KMnO_4$.
11. In what way is the electronic configuration of the transition elements different from that of the non-transition elements?
12. What is the lanthanoid contraction? What are its causes and consequences?
13. Calculate the 'spin only' magnetic moment of $M^{2+}_{(aq)}$ ion (Z = 27).
14. Explain the following facts:
    a. Transition metals act as catalysts.
    b. Chromium group elements have the higher melting points in their respective series.
    c. Transition metals form coloured complexes.
15. a. Give balanced chemical equations of two reactions in which $KMnO_4$ acts as an oxidizing agent in acidic medium.
    b. Give reason:
        i. Cr^{2+} is a strong reducing agent whereas Mn^{2+} is not (Cr = 24, Mn = 25)
        ii. The transition metal ions such as Cu^+, Ag^+ and Sc^{3+} are colourless
        iii. Chemistry of the actinoids is much more complicated than that of the lanthanoids.

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Solutions

1. d. charge transfer

   Explanation: The oxidation state of Mn in MnO_4^- is +7. Which means that Mn does not have any unpaired d-electrons left. However, MnO_4^- is deep purple in colour because of charge transfer from the ligand (O_2^-) to the metal center. This is called a ligand-to-metal charge transfer.

2. b. MnO_2

   Explanation: In alkaline medium, reduction of MnO_4^- take place to form MnO_2. The chemical equation for this change is given below as:

   $MnO_4^-(aq) + 2H_2O(l) + 3e^- \rightarrow MnO_2(s) + 4OH^-(aq)$

3. b. Of lanthanoid contraction

   Explanation: As after lanthanum, electron filling take place in f-subshell. Electrons present in f-subshell didn't do good shielding due to which with the increasing atomic number or increasing effective nuclear charge size gets constricted and size of Hf and Zr becomes almost equal.

4. b. Pb

   Explanation: Cupellation is a refining process in metallurgy, where ores or alloyed metals are treated under very high temperatures and have controlled operations to separate noble metals, like gold and silver, from base metals like lead, copper, zinc or bismuth, present in the ore. Cupellation removes the impurity of Pb from silver. The reaction is given as below:

   $Ag(s) + 2Pb(s) + O_2(g) \rightarrow 2PbO(absorbed) + Ag(l)$

5. a. ZnO

   Explanation: ZnO is white in color. This is because Zn is in +2 oxidation state with d^{10} system having no unpaired electrons and hence absence of d-d transition.

6. Cr (Z=24) : $[Ar]3d^5 4s^1$
7. Cerium shows +3 as well as +4 oxidation states.
8. $KMnO_4$ is kept in dark bottles because $KMnO_4$ gets decomposed to K_2MnO_4 in presence of sun light.
9. M^{2+} (aq) (Z= 27) will have electronic configuration as $[Ar]3d^7 4s^0$. It has 3 unpaired electron i.e.(n=3).
   Magnetic moment is calculated using spin only formula.
   $\mu = \sqrt{n(n+2)}$
   $\mu = \sqrt{3 \times 5} = \sqrt{15}$
   = 3.87 B.M
10. Potassium permanganate is used –
    a. As an oxidizing agent in analytical chemistry and organic chemistry.
    b. For bleaching of wool, cotton, silk and other textile fibres.
    c. For decolourisation of oils.
11. Transition metals have a partially filled d-orbital of pen-ultimate shell in their ground state or most stable oxidation state. Therefore, the electronic configuration of transition elements is $(n - 1)d^{1-10}ns^{1-2}$ The non-transition elements either do not have a d-orbital in pen ultimate shell or have a fully filled d-orbital. Therefore, the electronic configuration of non-transition elements is ns^{1-2}or ns^2np^{1-6}
12. Lanthanoid contractions is the cumulative effect of the regular decrease in size or radii of Lanthanoid with increase in atomic number is called Lanthanoid contraction. The main causes of Lanthanoid contraction is the diffused shape of f -orbitals. They have poor shielding effect due to which the effective nuclear charge increase with increase in atomic number. This causes a decrease in atomic radii.
    Due to Lanthanoid contraction-
    i. Radii of the members of the third transition series is similar to those of second transition series.
    ii. It becomes difficult to separate Lanthanoids.
13. Element M having atomic number(Z) = 27 will have electronic configuration as

[Ar]$3d^7 4s^2$. Therefore, the dipositive ion of M will have electronic configuration as [Ar]$3d^7$.

$3d^7$ can be represented as follows:

↑↓	↑↓	↑	↑	↑

It has 3 unpaired electrons

Therefore, n = 3

Magnetic moment can be calculated as

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

$= \sqrt{3\,(3+2)} = \mu$

$= \sqrt{15} = \mu$

$\mu \approx 4BM$

14. a. Transition metals act as a catalyst due to their abilities to show multiple oxidation state and form unstable complexes with the substrates which decomposes to product.
    b. Chromium group elements have high melting point in their respective series due to the presence of maximum number of unpaired electrons in d-orbitals because of which they form strong metallic bonding. Because of strong metallic bonding, they have high melting point.
    c. Transition metal ions have incompletely filled d orbitals. When an electron from a lower energy d orbital is excited to a higher energy d orbital, the energy of excitation corresponds to the frequency of light absorbed. This frequency generally lies in the visible region. The colour observed corresponds to the complementary colour of the light absorbed.
15. a. Acidified permanganate solution act as a strong oxidising agent. $KMnO_4$ oxidises oxalates to carbon dioxide, sulphides to sulphur etc and itself get reduced to Mn^{+2}.

    $5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

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

    b. i. Cr^{2+} is less stable than Cr^{3+} therefore it is good reducing agent. Cr^{3+} is stable because outer most electronic configuration of Cr^{3+} is $3d^3$, which makes a stable half filled t_{2g} configuration. Whereas Mn^{2+} has outermost electronic

configuration as $3d^5$ which is stable due to half filled d-orbitals therefore it is not reducing agent.

ii. Cu^+, Ag^+, Sc^{3+} are colourless because they do not have unpaired electrons. Due to absence of unpaired electrons in them, no d-d transition occurs.

iii. Actinoids show large number of oxidation states, that is why their chemistry is more complicated. Secondly all of them are radioactive and the earlier members have relatively long half-lives, the latter ones have half-life values ranging from a day to some minutes. The latter members could be prepared only in nanogram quantities. These facts render their study more difficult.