CBSE Test Paper-02

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

1. Silver ornaments turn black by atmospheric
   a. H_2S
   b. O_2
   c. Cl_2
   d. N_2
2. Ni^{2+} in traces can be tested using
   a. Dimethylglyoxime
   b. Potassium ferrocyanide
   c. Ammonium sulphocyanide
   d. Sodium nitroprusside
3. Which one of the following combines with Fe^{2+} ion to form a brown complex?
   a. N_2O_3
   b. N_2O_5
   c. N_2O
   d. NO
4. Which of the following sulphides is soluble in aqua regia?
   a. ZnS
   b. HgS
   c. CdS
   d. HgS , ZnS
5. Among the following, which bivalent ion of the first transition series shows maximum magnetic moment?
   a. Co^{2+}
   b. Ni^{2+}
   c. Mn^{2+}
   d. Fe^{2+}

6. What is the general valence shell configuration of f-block elements?
7. What is the composition of mischmetall? Give its one use.
8. Out of Al, Zn, Mg and Fe which is the maximum density element?
9. Complete the following reactions:
   $CrO_4^{2-} + \_\_\_ \rightleftharpoons \_\_\_ \rightleftharpoons \_\_\_ + H_2O$
10. Why do transition elements show similarities along the horizontal period?
11. Why is any transition series, melting points first increase and then decrease and also they show a dip in the middle?
12. Which is a stronger reducing agent Cr^{2+}or Fe^{2+} and why?
13. Compare the chemistry of actinoids with that of lanthanoids with reference to:
    i. Electronic configuration
    ii. Oxidation states
    iii. Chemical reactivity
14. Write down the electronic configuration of all 3d transition metal atoms. Also show the electronic configuration using electron box diagram.
15. A violet compound of manganese (A) decomposes on heating to liberate oxygen and compounds (B) and (C) of manganese are formed. Compound (C) reacts with KOH in the presence of oxygen to give compound (B). On heating compound (C) with concentrated H_2SO_4 and NaCl, chlorine gas is liberated and a compound (D) of manganese along with other products is formed. Identify A to D and also explain the reactions involved.

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Solutions

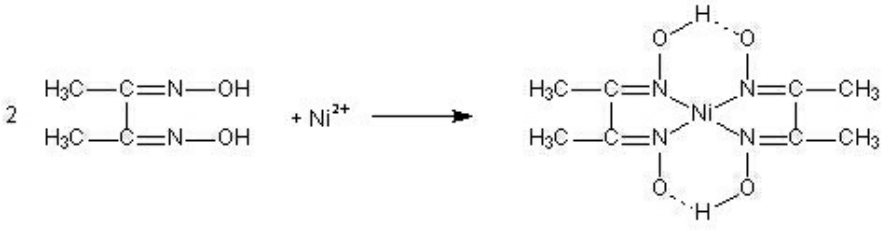
1. a. H_2S

   Explanation: Silver ornaments turns black coming in contact with H_2S due to formation of Ag_2S. The chemical equation for this change can be represented as given below:

   $2Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$

2. a. Dimethylglyoxime

   Explanation: Ni^{2+} forms complex with DMG which is red in colour.



3. d. NO

   Explanation: The brown ring test is usually carried out by adding dilute ferrous sulphate solution to an aqueous solution containing nitrate ion, and then carefully adding concentrated sulphuric acid along the sides of the test tube. A brown ring at the interface between the solution and sulphuric acid layers indicates the presence of nitrate ion in solution. $[Fe(H_2O)_5NO]^{2+}$ is brown colour complex formed?

   $NO_3 + 3Fe^{2+} + 4H^+ \rightarrow NO + Fe^{3+} + 2H_2O$

   $[Fe(H_2O)]^{2+} + NO \rightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$

4. b. HgS

   Explanation: HgS is only soluble in aqua regia. Aqua regia is a mixture of concentrated HCl and concentrated HNO_3 in ratio 3:1. The solubilization turns Hg in $HgCl_4^{2-}$, a complex called chloromercurate which is stable in water.

   $3HgS + 2NO_3^- + 12Cl^- + 8H_3O^+ \Leftrightarrow 3HgCl_4^{2-} + 2NO + 12H_2O + 3S$

5. c. Mn^{2+}

Explanation: Mn^{2+} has d^5 configuration so maximum number of unpaired electrons and hence maxium magnetic moment. This magnetic moment can be calculated by using the spin only formula: $\mu_{so} = \angle n(n+2)$, where n= number of unpaired electrons.

6. F-block elements are those in which the last electron enters the f orbital. F- orbital can accommodate maximum of 14 electrons.
   The general electronic configuration of f-block elements is
   $(n-2)\ f^{1-14}(n-1)\ d^{0-1}ns^2$
7. Mischmetall is an alloy which consists of a Lanthanoid metal (95%) and iron(5%) and traces of S, C, Ca & Al. A good amount of this alloy is used in magnesium based alloy to produce bullets, shell and lighter Flint.
8. Fe
9. $2CrO_4^{2-} + 2H^+ \rightleftharpoons 2HCrO_4^- \rightleftharpoons Cr_2O_7^{2-} + H_2O$
10. There are greater horizontal similarities in the properties of then transition elements in contrast to the main group elements.This is because all of them contain incompletely filled d-subshell in ground state or in stable oxidation state.
11. Melting points first increase because the number of unpaired electrons increases. Due to increase in the number of unpaired electron, strength of metallic bonding increases and hence melting point increases. After reaching the maximum, the melting points decrease because the pairing of electrons starts in the d-subshell and number of unpaired electrons decreases and so the strength of metallic bond decreases. The dip in the middle is due to exactly half filled configuration of d-subshell (d^5)which has higher stability. Hence, electrons are held tightly by the nucleus. As a result, metallic bond is weaker. And thus melting point graph shows dip at this point.
12. Reducing agents are those which itself get oxidised and make the other substance get reduced. The following reactions are involved when $Cr^{2+}$and Fe^{2+}act as reducing agents.
    $Cr^{2+} \rightarrow Cr^{3+} + e^-$ and $Fe^{2+} \rightarrow Fe^{3+} + e^-$. The $E^{\circ}_{Cr^{3+}/Cr^{2+}}$ value is - 0.41 V and $E^{\circ}_{Fe^{3+}/Fe^{2+}}$ is +0.77 V. This means that Cr^{2+}can be easily oxidized to $Cr^{3+}, but\ Fe^{2+}$does not get oxidized to Fe^{3+}easily. Therefore, $Cr^{2+}$is a better reducing agent than Fe^{3+}.
13. i. **Electronic configuration :** In lanthanoids 4f - orbitals are progressively filled so

their electronic configuration is $4f^{1-14}\ 5d^{0-1}\ 6s^2$ whereas in actinoids 5f-orbitals are progressively filled so their electronic configuration is $5f^{1-14}6d^{0-1}\ 7s^2$

ii. **Oxidation states:** Lanthanoid show +3 oxidation state. Some elements show +2 and +4 oxidation states also. Actinoids show +2 ,+4, +5, +6, + 7 oxidation states. Although +3 and +4 are most common.

iii. **Chemical reactivity:** Actinoids are more reactive than lanthanoids due to bigger atomic size and lower ionization energy.

14. Electronic configuration of 3d metal atoms is as follows:

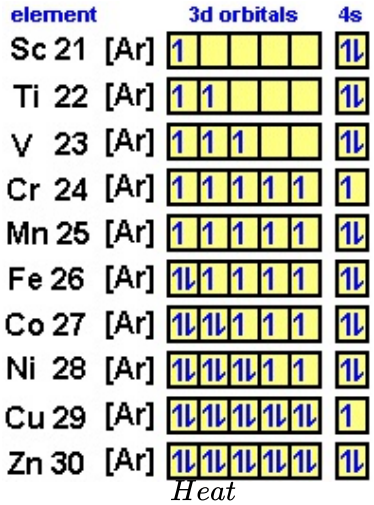
Sc(Z=21) : $[Ar]3d^14s^2$, Ti(Z=22) : $[Ar]3d^24s^2$, V(Z=23) : $[Ar]3d^34s^2$,Cr(Z=24) : $[Ar]3d^54s^1$,

Mn(Z=25) : $[Ar]3d^54s^2$

Fe(Z=26) : $[Ar]3d^64s^2$, Co(Z=27) : $[Ar]3d^74s^2$, Ni(Z=28) : $[Ar]3d^84s^2$, Cu(Z=29) : $[Ar]3d^{10}4s^1$,

Zn(Z=30) : $[Ar]3d^{10}4s^2$

Electron box diagram is shown below:



15. $\underset{(A)}{KMnO_4} \xrightarrow{Heat} \underset{(B)}{K_2MnO_4} + \underset{(C)}{MnO_2} + O_2$

$MnO_2 + KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$

$MnO_2 + 4NaCl + 4H_2SO_4 \rightarrow \underset{(D)}{MnCl_2} + 2NaHSO_4 + Cl_2 + H_2O$

From the above set of reaction we can deduce that:

(A) = $KMnO_4$

(B) = K_2MnO_4

(C) = MnO_2

(D) = $MnCl_2$