One Two academy | Transition and Inner Transition Elements

Maximum Mark: 25 **Chemistry** **Time: 50 minutes**

Choose the correct answer: **3 x 1 = 3**

1. Which of the following oxidation states is most common among the lanthanoids?
   a) +4 c) +5 b) +2 d) +3
2. Transition element which has only +3 oxidation state is:
   a) Ni b) Mn c) Cr d) Sc
3. Chromyl chloride when dissolved in NaOH solution gives yellow solution. The yellow solution contains.
   a) $Cr_2O_7^{2-}$ b) CrO_4^{2-} c) CrO_5 d) Cr_2O_3

Answer Any four of the following: **4 x 2 = 8**

4. Explain the oxidation states of 4d series elements.
5. Mention the uses of potassium permanganate.
6. Why do transition elements show variable oxidation state?
7. What is chromyl chloride test?
8. Explain why Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing.

Answer any three of the following: **3 x 3 = 9**

9. Calculate the number of unpaired electrons in Ti^{3+}, Mn^{2+} and calculate the spin only magnetic moment.
10. Compare the ionization enthalpies of first series of transition elements.
11. Why is the first ionization enthalpy of chromium lower than that of zinc?
12. What is Hume Rothery rule to form a substitute alloy?

Answer the following: **1 x 5 = 5**

4. a) i) Actinoid contraction is greater from element to element than the lanthanoid contraction, why?
   ii) Compare lanthanoids and actinoids.

   (Or)

   b) i) What is lanthanoid contraction and what are the effects of lanthanoid contraction?
   ii) Explain the variation in $E^0_{(M3+)/(M2+)}$ 3d series.

All the Best

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Answer Key attached in the next page !!!

This page is to prevent seeing answer key

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Answer Key

Choose the Correct answer:

1. - d) 2. - d) 3. - b)

Answer any four of the following:

4. **Oxidation states of 4d series elements:**
   - At the beginning of the series, +3 oxidation state is stable but towards the end +2 oxidation state becomes stable.
   - Hence, the first and last elements show less number of oxidation states and the middle elements with more number of oxidation states

5. **Uses of potassium permanganate:**
   - It is used as a strong oxidizing agent.
   - It is used for the treatment of various skin infections and fungal infections of the foot.
   - It is used as Bayer's reagent for detecting unsaturation in an organic compound.

6. All transition elements exhibit variety of oxidation states because:
   i) These elements have several (n-1) d and ns electrons.
   ii) The energies of (n-1) d and ns orbitals are fairly close to each other.

7. **Chromyl chloride test:**
   When potassium dichromate is heated with any chloride salt in the presence of Conc H_2SO_4, orange red vapors of chromyl chloride (CrO_2Cl_2) evolved. This reaction is used to confirm the presence of chloride ion in inorganic qualitative analysis.

$$K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \longrightarrow 2KHSO_4 + 4NaHSO_4 + \underset{\text{Chromyl chloride}}{2CrO_2Cl_2}\uparrow + 3H_2O$$

8. Cr^{2+} is reducing as its configuration changes from d^4 to d^3, the latter having a half filled t_{2g} level. On the other hand, the change from Mn^{2+} to Mn^{3+} results in the half filled (d^5) configuration which has extra stability.

Answer any three of the following:

9. **Ans:** Ti^{3+} - 1.73 BM Mn^{2+} - 5.92 BM
10. Ionization energy of transition element is intermediate between those of s and p block elements. As we move from left to right in a transition metal series, the ionization increases as expected. This is due to increase in nuclear charge corresponding to the filling of d electrons.
11.

Element	Electronic Configuration	Reason for Ionization Enthalpy Trend
Chromium (Z = 24)	[Ar] $3d^5\ 4s^1$	Loses $4s^1$ easily to attain stable half-filled $3d^5$ → **lower ionization enthalpy**
Zinc (Z = 30)	[Ar] $3d^{10}\ 4s^2$	Fully filled $3d^{10}$ and $4s^2$ are very stable, harder to remove → **higher ionization enthalpy**

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12. **Hume-Rothery rule:**

According to Hume-Rothery rule to form a substitute alloy the difference between the atomic radii of solvent and solute is less than 15%. Both the solvent and solute must have the same crystal structure and valence, and their electro negativity difference must be close to zero.

Answer the following:

13. a)

i) This is because 5f orbitals have a poor shielding effect than 4f orbitals. Thus, the effective nuclear charge experience by electron in valence shell in case of actinoid is more than that of lanthanides.

ii) **Comparison of lanthanoids and actinoids:**

s.no	Lanthanoids	Actinoids
1	Differentiating electron enters in 4f orbital	Differentiating electron enters in 5f orbital
2	Binding energy of 4f orbitals are higher	Binding energy of 5f orbitals are lower
3	They show less tendency to form complexes	They show greater tendency to form complexes
4	Most of the lanthanoids are colorless	Most of the actinoids are colored. For example. U^{3+} (red), U^{4+} (green), UO_2^{2+} (yellow)
5	They do not form oxo cations	They do form oxo cations such as UO_2^{2+} NpO_2^{2+}, etc.
6	Besides +3 oxidation states lanthanoids show +2 and +4 oxidation states in few cases.	Besides +3 oxidation states actinoids show higher oxidation states such as +4, +5, +6 and +7.

(Or)

b)

i) **Lanthanoid Contraction:** As we move across 4f series, the atomic and ionic radii of lanthanoids show gradual decrease with increase in atomic number. This decrease in ionic size is called lanthanoid contraction.

ii)

- The standard electrode potential for the $^{M3+}/_{M2+}$ half-cell gives the relative stability between M^{3+} and M^{2+}.
- The negative values for titanium, vanadium and chromium indicate that the higher oxidation state is preferred. If we want to reduce such a stable Cr^{3+} ion, strong reducing agent which has high negative value for reduction potential like metallic zinc (E^0 = -0.76 V) is required.
- The high reduction potential of $Mn3+/Mn2+$ indicates Mn^{2+} is more stable than Mn^{3+}. For $Fe3+/Fe2+$ the reduction potential is 0.77V, and this low value indicates that both Fe^{3+} and Fe^{2+} can exist under normal conditions.

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