

d - and f - BLOCK ELEMENTS

REVIEW EXERCISES

- 8.1** What are transition metals? Which *d*-block metals are not normally considered as transition metals? Why?
- 8.2** Explain the following about transition metals :
 (i) Magnetic behaviour (ii) Metallic character
 (iii) Oxidation states.
- 8.3** How is magnetic moment of a magnetic species related to the number of unpaired electrons?
- 8.4** Why do the transition elements exhibit complex formation? Explain with suitable examples.
- 8.5** Cu(II) is paramagnetic but Cu(I) is diamagnetic. Give reason (At. no. of Cu = 29).
- 8.6** Give reasons :
 (i) First ionisation energy of 5*d*-series elements are higher than those of 3*d*- and 4*d*-transition elements.
 (ii) Transition metals show paramagnetism.
- 8.7** Why are Zn, Cd and Hg normally not considered as transition elements?
- 8.8** What are transition elements? In what way are the electronic configuration of transition elements different from those of representative elements?
- 8.9** K₂PtCl₆ is a well known compound, whereas the corresponding Ni compound is not known. State a reason for it.
- 8.10** Why do most transition metal ions exhibit paramagnetism?
- 8.11** Explain giving reasons :
 (i) Transition elements have higher melting and boiling points.
 (ii) Transition elements exhibit variable oxidation states.
 * (iii) A transition metal forms alloys with other transition elements.
 * (iv) Zn, Cd and Hg are not regarded as transition elements.
 * (v) Transition elements usually form coloured ions.
- 8.12** Give plausible reason for the fact that the first ionisation energies of 5*d*-transition metals are higher than those of 3*d*- and 4*d*-transition metals.
- 8.13** Give plausible reason for the fact that transition metals have high enthalpy of atomization.
- 8.14** What are interstitial compounds? Explain them with reference to transition metals and mention their two important properties.
- 8.15** Write the highest oxidation state of the element with atomic number 23. [Ans. +5]
- 8.16** Explain why transition metals are (a) paramagnetic (b) good catalysts. *
- 8.17** The *d*-electron configuration of Mn²⁺ and Ti²⁺ are *d*⁵ and *d*² respectively. Which one of these ions will be more paramagnetic?
- 8.18** Consider the given standard potential (in volts) in 1M acidic solution :
 Fe²⁺/Fe : - 0.4 V, Fe³⁺/Fe²⁺ : + 0.8V,
 Mn²⁺/Mn : - 1.2 V, Mn³⁺/Mn²⁺ : + 1.5V [Ans. Mn²⁺]
 (i) Comment on the relative stabilities of +2 and +3 oxidation states of iron and manganese.
 * (ii) Which of the two metals may be more easily oxidised to +2 state?
- 8.19** Name the tripositive metal ion represented by the configuration 1s² 2s² 2p⁶ 3s² 3p⁶ 3d³. [Ans. Cr³⁺ ion]
- 8.20** Giving reason indicate which one of the following would be coloured :
 Cu⁺, VO²⁺, Sc³⁺, Ni²⁺ (Atomic numbers : Cu = 29, V = 23, Sc = 21, N = 28) [Ans. Ni²⁺]
- 8.21** Decide giving reason which one of the following pairs has the property indicated :
 (i) Fe or Cu has higher melting point (ii) Co²⁺ or Ni²⁺ has lower magnetic moment. [Ans. (i) Fe (ii) Co²⁺]
- 8.22** Write the general formula by which the electronic configuration of the transition elements is represented.
- 8.23** Of the ions Co²⁺, Sc³⁺ and Cr³⁺, which ones will give coloured aqueous solutions and how will each of them respond to a magnetic field and why? [Atomic number : Co = 27, Sc = 21, Cr = 24]
- 8.24** (a) Why do the *d*-block elements exhibit a larger number of oxidation states than the *i*-block elements?
 (b) How do the transition elements form interstitial compounds? State an industrial advantage of such occurrence.
- 8.25** Name a transition metal which does not exhibit variation in oxidation states in the compounds.
- 8.26** In the transition series, with an increase in atomic number, the atomic radius does not change very much. Why is it so?
- 8.27** How do the oxides of the transition elements in lower oxidation states differ from those in higher oxidation states in the nature of metal-oxygen bonding and why?

8.28 Mention the direct consequence of the following factors on the chemical behaviour of the transition elements:

- They have incompletely filled d -orbitals in the ground state or in one of the oxidised states of their atoms.
- They contribute more valence electrons per atom in the formation of metallic bonds.

8.29 Assign reason for each of the following :

- Ce^{3+} can be easily oxidised to Ce^{4+}
- E° for Mn^{3+}/Mn^{2+} couple is more positive than for Fe^{3+}/Fe^{2+}
- Transition metals exhibit higher enthalpies of atomization.

(iv) The transition elements form interstitial compounds.

8.30 Variable oxidation states are shown both by representative elements and transition elements. How is the behaviour different for the two groups? Illustrate with one example in each case.

8.31 Account for the following :

* Zinc salts are white while Cu^{2+} salts are coloured.

8.32 Discuss the general trends in the following properties of the $3d$ transition elements (21 – 29) :

(i) Atomic size (ii) Oxidation states (iii) Formation of coloured ions.

8.33 How would you account for the following?

- The transition elements exhibit high enthalpies of atomization.
- The $4d$ and $5d$ series of the transition metals have more frequent metal-metal bonding in their compounds than do the $3d$ metals.

8.34 Describe the variability of oxidation states in the first row of the transition elements (Sc-Cu) and indicate the general trend.

8.35 Explain the following :

- Transition elements tend to be unreactive with increasing atomic number in the series.
- d -block elements exhibit more oxidation states than f -block elements.

8.36 Give reasons :

- Cr^{2+} is a strong reducing agent whereas Mn^{2+} is not ($Cr = 24$, $Mn = 25$).
- The transition metal ions such as Cu^+ , Ag^+ and Sc^{3+} are colourless.
- The enthalpies of atomization of transition metals of $3d$ series do not follow a regular trend throughout the series.
- The radius of Fe^{2+} ($Z = 26$) is less than that of Mn^{2+} ($Z = 25$).

8.37 Given below are the electrode potential values, E° for some of the first row transition elements :

Element	$E^\circ_{M^{n+}/M}$ (V)
V (23)	- 1.18
Cr (24)	- 0.91
Mn (25)	- 1.18
Fe (26)	- 0.44
Co (27)	- 0.28
Ni (28)	- 0.25
Cu (29)	+ 0.34

Explain the irregularities in these values on the basis of electronic structures of atoms.

* **8.38** Why Cd^{2+} salts are white?

8.39 How would you account for the following :

- The transition elements have high enthalpies of atomization?
- The transition metals and their compounds are found to be good catalysts in many processes?

8.40 Which is more paramagnetic, Fe^{2+} or Fe^{3+} ? Give reasons.

8.41 Give the relationship between the equivalent mass and molar mass of $KMnO_4$ (molar mass = 158 g mol^{-1}) in (a) acidic medium (b) alkaline medium (c) neutral medium.

8.42 Describe the preparation of potassium permanganate from pyrolusite ore.

8.43 Why is $K_2Cr_2O_7$ generally preferred over $Na_2Cr_2O_7$ in volumetric analysis although both are oxidising agents?

8.44 Describe with chemical equations, what happens when

(i) $K_2Cr_2O_7$ reacts with sodium chloride in the presence of conc. H_2SO_4 ;

* (ii) $K_2Cr_2O_7$ reacts with an acidified solution of KI?

8.45 (a) Describe with the help of chemical equations the preparation of potassium dichromate from chromite ore.

* (b) Give balanced chemical equations for what happens when acidified potassium dichromate solution reacts with

(i) ferrous sulphate solution (ii) hydrogen sulphide gas.

* (c) Draw the structure of $Cr_2O_7^{2-}$ ion.

8.46 Describe how potassium dichromate is made from chromite ore and give the equations for the chemical reactions involved. Write balanced ionic equations for reacting ions to represent the action of acidified potassium dichromate solution on

(i) potassium iodide solution

(ii) acidified ferrous sulphate solution.

Write the uses of potassium dichromate.

* **8.47** Describe how potassium permanganate is made from pyrolusite. Write the chemical equations for the involved reactions. Describe with an example each the oxidising actions of permanganate ion in

- alkaline and acidic media. What acid and alkali are actually used?
- 8.48** Mention two uses of potassium permanganate in laboratory .
- 8.49** (a) Starting from a sample of chromite ore, how is potassium dichromate prepared ? Describe all the steps involved with chemical equations.
 (b) Write balanced chemical equation for the reaction between an acidified solution of potassium dichromate and potassium iodide.
- 8.50** Give balanced chemical equations for the following reactions :
- * (i) Between acidified potassium dichromate and potassium iodide.
 - * (ii) Between potassium permanganate and oxalic acid in the presence of dilute sulphuric acid.
 - * (iii) Chromite ore is fused with NaOH in air.
- 51** Write the complete chemical equation for each of the following :
- (i) An alkaline solution of KMnO_4 reacts with an iodide.
 - * (ii) An excess of SnCl_2 solution is added to a solution of mercury (II) chloride.
- 8.52** A green chromium compound (A) on fusion with alkali gives a yellow compound (B) which on acidification gives an orange coloured compound (C). 'C' on treatment with NH_4Cl gives an orange coloured product (D), which on heating decomposes to give back (A). Identify A, B, C and D. Write equations for reactions.
 [Ans. Cr_2O_3 , Na_2CrO_4 , $\text{Na}_2\text{Cr}_2\text{O}_7$, $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$]
- 8.53** Describe the steps involved in the preparation of either potassium dichromate from sodium chromate or potassium permanganate from manganese dioxide.
- 8.54** What are actinoids? Discuss briefly the physical and chemical properties of actinoids.
- 8.55** Give two examples of lanthanoid elements. What are the common oxidation states exhibited by lanthanoids?
- 8.56** What are actinoids? Give two examples of actinoids.
- 8.57** What do you understand by lanthanoid contraction?
 * * What are its consequences?
- 8.58** Why do Zr and Hf exhibit similar properties? (Atomic numbers : Zr = 40, Hf = 72).
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- 8.59** What are the oxidation states exhibited by lanthanoid elements?
- 8.60** One among the lanthanoids, Ce (III) can be easily oxidised to Ce (IV). Explain.
- 8.61** Zirconium (atomic number 40) and hafnium (atomic number 72) occur together in minerals and they exhibit similar properties. Give reasons.
- * **8.62** Why is the separation of lanthanoid elements difficult?
- 8.63** What is lanthanoid contraction? How would you account for it? What are its important consequences?
- 8.64** Why do Zr and Hf exhibit similar properties ?
- * **8.65** Name the lanthanoid element which exhibits a +4 oxidation state besides the +3 oxidation state.
- 8.66** Account for the following :
 (i) Zirconium and hafnium exhibit almost similar physical properties.
 (ii) All scandium salts are white.
- 8.67** What is the basic difference between the electronic configuration of transition and inner transition elements?
- 8.68** How would you account for the following?
 * There is a greater range of oxidation states among the actinoids than that in the lanthanoids.
- 8.69** Give reason :
 Chemistry of the actinoids is much more complicated than that of the lanthanoids.
- * **8.70** The outer electronic configuration of two members of the lanthanoid series are as follows :
 $4f^1 5d^1 6s^2$ and $4f^7 5d^0 6s^2$.
 What are their atomic numbers? Predict the oxidation states exhibited by these elements in their compounds.
- 8.71** Compare the chemistry of actinoids with that of the lanthanoids in reference to (i) atomic and ionic sizes (ii) oxidation states.
- 8.72** What is meant by lanthanoid contraction? What effect does it have on the chemistry of the elements which follow lanthanoids?