

# Chemistry

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(Chapter 4) (The d and f block Elements) (Exercise)  
(Class 12)

## Question 4.23:

Which metal in the first series of transition metals exhibits +1 oxidation state most frequently and why?

### Answer 4.23:

In the first transition series, Cu exhibits +1 oxidation state very frequently. It is because Cu (+1) has an electronic configuration of  $[\text{Ar}]3d^{10}$ . The completely filled  $d$ -orbital makes it highly stable.

## Question 4.24:

Calculate the number of unpaired electrons in the following gaseous ions:  $\text{Mn}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{V}^{3+}$  and  $\text{Ti}^{3+}$ . Which one of these is the more stable in aqueous solution?

### Answer 4.24:

|       | Gaseous ions                         | Number of unpaired electrons |
|-------|--------------------------------------|------------------------------|
| (i)   | $\text{Mn}^{3+}$ , $[\text{Ar}]3d^4$ | 4                            |
| (ii)  | $\text{Cr}^{3+}$ , $[\text{Ar}]3d^3$ | 3                            |
| (iii) | $\text{V}^{3+}$ , $[\text{Ar}]3d^2$  | 2                            |
| (iv)  | $\text{Ti}^{3+}$ , $[\text{Ar}]3d^1$ | 1                            |

$\text{Cr}^{3+}$  is the most stable in aqueous solutions owing to a  $t_{2g}^3$  configuration.

## Question 4.25:

Give examples and suggest reasons for the following features of the transition metal chemistry:

(i) The lowest oxide of transition metal is basic, the highest is amphoteric/acidic.

(ii) A transition metal exhibits highest oxidation state in oxides and fluorides.

(iii) The highest oxidation state is exhibited in oxoanions of a metal.

### Answer 4.25:

(i) In the case of a lower oxide of a transition metal, the metal atom has a low oxidation state. This means that some of the valence electrons of the metal atom are not involved in bonding. As a result, it can donate electrons and behave as a base.

On the other hand, in the case of a higher oxide of a transition metal, the metal atom has a high oxidation state. This means that the valence electrons are involved in bonding and so, they are unavailable. There is also a high effective nuclear charge. As a result, it can accept electrons and behave as an acid.

For example,  $\text{Mn}^{II}\text{O}$  is basic and  $\text{Mn}^{VII}\text{O}_7$  is acidic.

(ii) Oxygen and fluorine act as strong oxidising agents because of their high electro negativities and small sizes. Hence, they bring out the highest oxidation states from the transition metals. In other words, a transition metal exhibits higher oxidation states in oxides and fluorides. For example, in  $\text{OsF}_6$  and  $\text{V}_2\text{O}_5$ , the oxidation states of Os and V are +6 and +5 respectively.

(iii) Oxygen is a strong oxidising agent due to its high electronegativity and small size. So, oxo-anions of a metal have the highest oxidation state. For example, in  $\text{MnO}_4^-$ , the oxidation state of Mn is +7.

## Question 4.26:

Indicate the steps in the preparation of:

(i)  $\text{K}_2\text{Cr}_2\text{O}_7$  from chromite ore.

(ii)  $\text{KMnO}_4$  from pyrolusite ore.

### Answer 4.26:

(i) Potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) is prepared from chromite ore ( $\text{FeCr}_2\text{O}_4$ ) in the following steps:

Step (i): Preparation of sodium chromate



Step (ii): Conversion of sodium chromate into sodium dichromate



Step (iii): Conversion of sodium dichromate to potassium dichromate



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**Princeton Review**



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