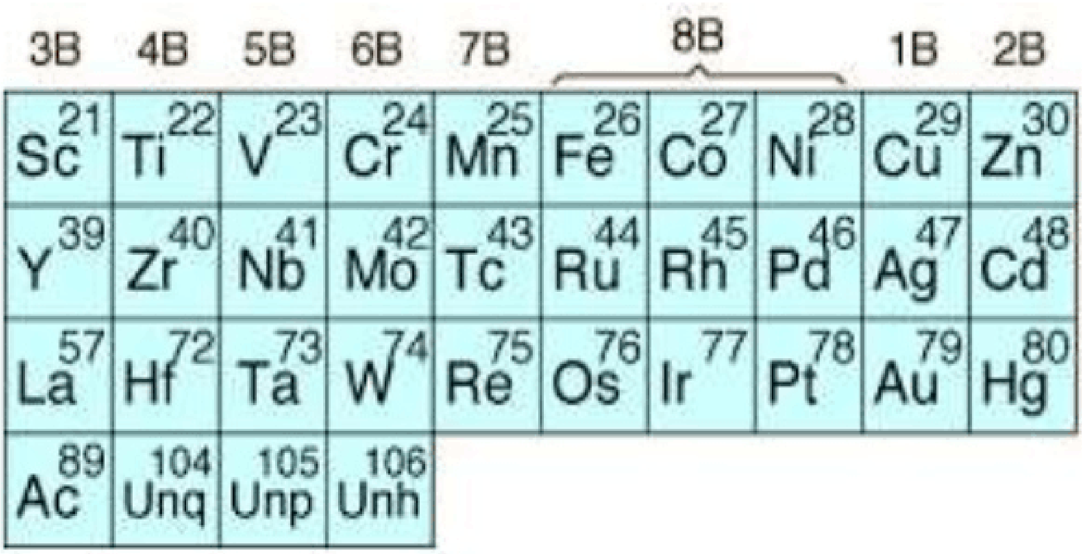
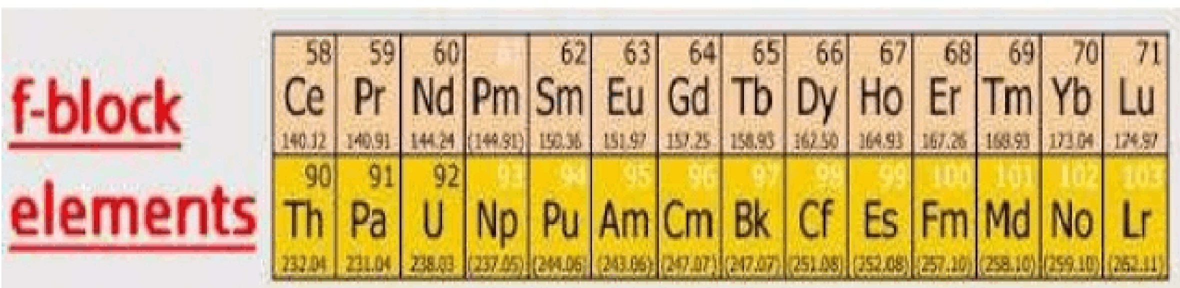
Chemistry Class 12 NCERT Solutions: Chapter 8 the D and F Block Elements Part 1





Q: 1. Write down the electronic configuration of:

(i) $Cr^{3+}+$

(ii) Pm^{3+}

(iii) Cu^{+}

(iv) Ce^{4+}

(v) Co^2+

(vi) Lu^{2+}

(vii) Mn^{2+}

(viii) Th^{4+}

Answer:

(i) Cr^{3+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

Or, $[Ar]^{18} 3d^3$

(ii) Pm^{3+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 4f^4$

Or, $[Xe]^{54} 3d^3$

(iii) Cu^+ : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

Or, $[Ar]^{18} 3d^{10}$

(iv) Ce^{4+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6$

Or, $[Xe]^{54}$

(v) Co^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

Or, $[Ar]^{18} 3d^7$

(vi) Lu^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 4f^{14} 5d^1$

Or, $[Xe]^{54} 2f^{14} 3d^3$

(vii) Mn^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

Or, [Ar]^{18} 3d^5

(viii) Th^{4+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 6s^2 6s^6$

Or, $[Rn]^{86}$

Q: 2. Why are Mn^{2+} compounds more stable than Fe^{2+} towards oxidation to their $+3$ state?

Answer:

Electronic configuration of $Mn^{2+} \text{is} [Ar]^{18} 3d^5$

Electronic configuration of $Fe^{2+} \text{is} [Ar]^{18} 3d^6$.

It is known that half-filled and fully7filled orbitals are more stable. Therefore, $\text{Mn in} (+2)$ state has a stable d^5 configuration. This is the reason Mn^{2+} shows resistance to oxidation to $Mn^{3+}. Also, Fe^{2+} \text{has} 3d^6$ configuration and by losing one electron, its configuration changes to a more stable $3d^5$ configuration. Therefore, Fe^{2+} easily gets oxidized to Fe^{+3} oxidation state.

Q: 3. Explain briefly how $+2$ state becomes more and more stable in the first half of the first row transition elements with increasing atomic number?

Answer:

The oxidation states displayed by the first half of the first row of transition metals are given in the table below.

	Sc	Ti	V	Cr	Mn
		+ 2	+ 2	+ 2	+ 2
	+ 3	+ 3	+ 3	+ 3	+ 3
Oxidation state		+ 4	+ 4	+ 4	+ 4
			+ 5	+ 5	+ 6
				+ 6	+ 7

Q_3_Oxidation Sate

It can be easily observed that except Sc , all others metals display $+2$ oxidation state. Also, on moving from Sc to Mn , the atomic number increases from $21 \text{to} 25$. This means the number of electrons in the $3d - \text{orbital}$ also increases from $1 \text{to} 5$.

$Sc\,(+2) = d^1$

$Ti\,(+2) = d^2$

$V\,(+2) = d^3$

$Cr\,(+2) = d^4$

$Mn\,(+2) = d^5$

$+2$ oxidation state is attained by the loss of the two $4s$ electrons by these metals. Since the number of electrons in $(+2)$ state also increases from $Ti\,(+2)$ to $Mn\,(+2)$, the stability of $+2$ state increases (as $d-$ orbital is becoming more and more half-filled) . $Mn\,(+2)\,\text{has} d^5$ electrons (that is half7filled shell, which is highly stable) .

Q: 4. To what extent do the electronic configurations decide the stability of oxidation states in the first series of the transition elements? Illustrate your answer with examples.

Answer:

The elements in the first half of the transition series exhibit many oxidation states with Mn exhibiting maximum number of oxidation states $(+2 \text{to} + 7)$. The stability of $+2$ oxidation state increases with the increase in atomic number. This happens as more electrons are getting filled in the orbital. However, Sc does not show $+2$ oxidation state. Its electronic configuration is $4s^2 3d^1$. It loses all the three electrons to form Sc^{3+}. $+3$ oxidation state of Sc is very stable as by losing all three electrons, it attains stable noble gas configuration, $[Ar]$. $Ti\,(+4)\,\text{and} V\,(+5)$ are very stable for the same reason. For $Mn, +2$ oxidation state is very stable as after losing two electrons, its $d - \text{orbital}$ is exactly half7filled, $[Ar]\,3d^5$.

Q: 5. What may be the stable oxidation state of the transition element with the following electron configurations in the ground state of their atoms : $3d^3, 3d^5, 3d^8$ and $3d^4$?

Answer:

	Electronic configuration in ground state	Stable Oxidation states
(i)	$3d^3$ (Vanadium)	+ 2, + 3, + 4 and + 5
(ii)	$3d^5$ (Chromium)	+ 3, + 4, + 6
(iii)	$3d^5$ (Manganese)	+ 2, + 4, + 6, + 7
(iv)	$3d^8$ (Cobalt)	$+2, +3$
(v)	$3d^4$	There is no $3d^4$ configuration in ground state

Q_5_The Stable Oxidation State of the Transition Element