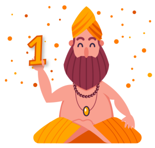

NCERT EXRECISES

8.1. 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+}.
Sol:
(i) Cr^{3+} = $[Ar]^{18}3d^{3}$
(ii) Pm^{3+} = $[Xe]^{54}\ 4f^{4}$
(iii) Cu^{+} = $[Ar]^{18}\ 3d^{10}$
(iv) Ce^{4+} = $[Xe]^{54}$
(v) Co^{2+} = $[Ar]^{18}\ 3d^{7}$
(vi) Lu^{2+} = $[Xe]^{54}\ 4f^{14}\ 5d^{1}$
(vii) Mn^{2+} = $[Ar]^{18}\ 3d^{5}$
(viii) Th^{4+}= $[Rn]^{86}$

8.2. Why are Mn^{2+} compounds more stable than Fe^{2+} towards oxidation to their +3 state?
Sol: Electronic configuration of Mn^{2+} is $3d^{5}$. This is a half-filled configuration and hence stable. Therefore, third ionization enthalpy is'very high, i. e., third electron cannot be lost easily. Electronic configuration of Fe^{2+} is $3d^{6}$. It can lose one electron easily to achieve a stable configuration $3d^{5}$.

8.3. Explain briefly how +2 state becomes more and more stable in the first half of the first row transition elements with increasing atomic number?
Sol: Here after losing 2 electrons from j-orbitals, the 3d-orbital gets gradually occupied with increase in atomic number. Since the number of unpaired electrons in 3d orbital increases, the stability of the cations (M^{2+}) increases from Sc^{2+} to Mn^{2+}.

8.4. 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.
Sol: In the first series of transition elements, the oxidation states which lead to exactly half-filled or completely filled d-orbitals are more stable. For example, Mn (Z = 25) has electronic configuration [Ar] $3d^{5}\ 4s^{2}$. It shows oxidation states + 2 to + 7 but Mn (II) is most stable because of half-filled configuration [Ar] $3d^{5}$. Similarly Sc^{3+} is more stable then Sc+ and Fe^{3+} is more stable than Fe^{2+} due to half filled it f-orbitals.

8.5. What may be the stable oxidation state of the transition element with the following delectron configurations in the ground state of their atoms: $3d^{3}$, $3d^{5}$, $3d^{8}$ and $3d^{4}$?
Sol:
(a) $3d^{3}\ 4s^{1}$ = + 5.
(b) $3d^{5}\ 4s^{2}$ = + 2, + 7,$3d^{5}\ 4s^{1}$ = +6.
(c) $3d^{8}4s^{2}$ = + 2.
(d) $3d^{4}4s^{2}$ = $3d^{5}\ 4s^{1}$ = +6 (and + 3).

8.6. Name the oxometal anions of the first series of the transition metals in which the metal exhibits the oxidation state equal to its group number.

Sol:
$Cr_2O_7^{2-}$ and CrO_4^{2-} (Group number = Oxidation state of Cr = 6).
MnO_4^- (Group number = Oxidation state of Mn = 7).

8.7. What is lanthanoid contraction? What are the consequences of lanthanoid contraction?
Sol:
Lanthanoid Contraction: In the lanthanoids, the electrons are getting filled in the 4f-subshell. On moving from left to right, the nuclear charge increases and this increase is expected to be compensated by the increase in the magnitude of shielding effect by the 4 f- electrons However, the f-electrons have very poor shielding effect. Consequently, the atomic and ionic radii decrease from left to right and this is knwon as lanthanoid contraction.
Consequences of lanthanoid Contraction
(a) Separation Lanthanoids: All the lanthanoids have quite similar properties and due to this reason they are difficult to separate.
(b) Variation in basic strength of hydroxides: Due to lanthanoid contraction, size of M^{3+} ions decreases and thus there is a corresponding increase in the covalent character in M—OH bond. Thus basic character of oxides and hydroxides decreases from $La(OH)_3$ to $Lu(OH)_3$.
(c) Similarity in the atomic sizes of the elements of second and third transition series present in the same group. The difference in the value of atomic radii of Y and La is quite, large as compared to the difference in the value of Zr and Hf. This is because of the lanthanoid contraction.
(d) Variation in standard reduciton potential: Due to lanthanoid contraction there is a small but steady increase in the standard reduction potential (E°) for the reduction process.
$M^{3+}(aq) + 3e^- \rightarrow 4\ M(aq)$
(e) Variation in physical properties like melting point, boiling point, hardness etc.

8.8. What are the characteristics of the transition . elements and why are they called transition elements? Which of the d-block elements may not be regarded as the transition elements?
Sol: General characteristics of transition elements.
(i) Electronic configuration - $(n-1)\ d^{1-10}\ ns^{1-2}$
(ii) Metallic character - With the exceptions of Zn, Cd and Hg, they have typical metallic structures.
(iii) Atomic and ionic size-ions of same charge in a given series show progressive decrease in radius with increasing atomic number.
(iv) Oxidation state-Variable; ranging from+2 to +7.
(v) Paramagnetism - The ions with unpaired electrons are paramagnetic.
(vi) Ionisation enthalpy - Increases with increase in charge.
Formation of coloured ions - Due to presence of unpaired electrons.
(viii) Formation of complex compounds - Due to small size and high charge density of metal ions.
(ix) They possess catalj^c properties - Due to their ability to adopt multiple oxidation states. .
(x) Formation of interstitial compounds.
(xi) Alloy formation.
They are called transition elements due to their incompletely filled d-orbitals in ground state or in any stable oxidation state and they are placed between s and p- block elements. Zn, Cd and Hg have fully filled d- orbitals in their ground state hence may not be regarded as the transition elements.

8.9. In what way is the electronic configuration of the transition elements different from that of the non transition elements?

Sol: Transition elements contain partially filled d-orbitals whereas non-transition elements have no d-orbitals or have completely filled d -orbitals.

8.10. What are the different oxidation states exhibited by the lanthanoids?
Sol: Lanthanides exhibits + 2, + 3 and + 4 oxidation states. The most corrtmon oxidation state of lanthanoids is +3.

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