Chemistry Worksheets Class 12 on Chapter 8: The d & f Block Elements with Answers - Set 1

Q1. The element of the first transition series which shows the maximum number of oxidation state is-

a.) Mn
b.) Cr
c.) Fe
d.) Cu

Correct Answer– (a.) Mn

Q2. Which is colourless in H_2O?

a.) Ti^{3+}
b.) V^{3+}
c.) Cr^{3+}
d.) Sc^{3+}

Correct Answer– (d.) Sc^{3+}

Q3. Which of the following is not an actinoid?

a.) Cerium
b.) Californium
c.) Uranium
d.) Terbium

Correct Answer– (d.) Terbium

Q4. Misch metal is an alloy of-

a.) La
b.) Th
c.) Ac
d.) None of these

Correct Answer– (a.) La

Q5. During oxidation in an alkaline medium using $KMnO_4$, the oxidation number of manganese changes from-

a.) +7 to +2
b.) +2 to +7
c.) +7 to +4
d.) +7 to +5

Correct Answer– (c.) +7 to +4

Q6. Ions of Zn^{2+} and Ti^{4+} are colourless while Cu^{2+} and Ni^{2+} are coloured. Why?

Answer. Ions of Zn^{2+} ($3d^{10}$) and Ti^{4+} ($3d^{10}$) are colourless because they do not contain unpaired electrons in the d-subshell and therefore, cannot undergo dd transition, but Cu^{2+} ($3d^9$) and Ni^{2+} ($3d^8$) are coloured because they contain unpaired electrons in 3d subshell.

Q7. Why are ionisation energies of 5d elements greater than 3d elements?

Answer. In the 5d series, after lanthanum (Z=57), there is lanthanide contraction. As a result, in each group the atomic size of 5d elements is small and its nuclear charge is large. Hence, the ionisation energies of 5d elements are larger than 3d elements.

Q8. In the transition series, starting from lanthanum (Z= 57), the next element Hf has atomic number 2. Why do we observe this jump in atomic number?

Answer. In lanthanum, 5d is more stable than 4f subshell. Therefore, the 14 elements after La involve the filling of 4f- orbitals, and thus subshell gets completely filled at Lu. After Lu, the next electron enters the 5d subshell in Hf (Z=72) and is placed in the third transition series after La.

Q9. What are transition elements? Which of the d-block elements are not regarded as transition elements?

Answer. Transition elements (also known as transition metals) are elements that have partially filled d orbitals. IUPAC defines transition elements as an element having a d subshell that is partially filled with electrons, or an element that has the ability to form stable cations with an incompletely filled d orbital. The elements such as Zn, Cd, and Hg are not transition elements because of their electronic configuration. The general representation of the electronic configuration of these three elements is $(n-1)d^{10}ns^2$. The orbitals of these elements are completely filled when they are in their ground state as well as in their general oxidation state. Therefore, these elements are not transition elements.

Q10. What is lanthanoid contraction? What is the cause of it?

Answer. The gradual decrease in the atomic and ionic size of lanthanoids with an increase in atomic number is called the Lanthanide contraction
The causes for the Lanthanide Contraction are:

- The Lanthanide Contraction is caused by a poor shielding effect of the 4f electrons.
- The electrons in the 4f subshell imperfectly shield each other. Shielding in a 4f subshell is lesser than in a d subshell.
- As the atomic number of the Lanthanoids series increases, the positive charge on the nucleus also increases by +1 unit and one more electron enters into the same 4f subshell

Q11. Name the following:
(i) Divalent ion of first transition series having a maximum magnetic moment.
(ii) Coloured ions of Cu^{+} and Cu^{2+}.
(iii) Two ions of the first transition series having zero magnetic moment.

Answer.
(i) Mn^{2+}
(ii) Cu^{2+}
(iii) Sc^{3+}, Zn^{2+}

Q12. Silver is a transition metal but zinc is not. Why?

Answer. According to the definition, transition elements are those which have partially filled d- subshell in their elementary state or in their one of the oxidation states. Silver (Z=47) can exhibit +2 oxidation state in which it has an incompletely filled d-subshell ($4d^9$ configuration). Hence, silver is regarded as a transition element.
On the other hand, zinc (Z=30) has the configuration $3d^{10}$ $4s^2$. It does not have partially filled d-subshells in its elementary form or in a commonly occurring oxidation state (Zn: $3d^{10}$). Therefore, it is not regarded as a transition element.

Q13. The chemistry of all lanthanoids is so identical. Explain.

Answer. All the lanthanoids have similar outer electronic configurations and show +3 oxidation state in their compounds. Therefore, all the lanthanoids have similar chemical properties. The different lanthanoids differ mainly in the number of 4f- electrons which are buried deep in the atoms and hence, do not influence the properties. Moreover, due to lanthanoid contraction, there is very small difference in the size of all the trivalent lanthanoid ions. Thus, the size of their ions is also almost identical which results in similar chemical properties.

Q14. What happens when-
(a) A lanthanoid reacts with dilute acid.
(b) A lanthanoid reacts with water.

Answer.
(a) With dil acid they liberate hydrogen
Ln + dil acids $\rightarrow$ H_2 gas.

(b) With water lanthanoids gives hydroxides with the liberation of hydrogen.
$2Ln + 6H_2O \rightarrow 2Ln(OH)_3 + 3H_2$

Q15. Explain the following observations giving an appropriate reason for each-
(i) The enthalpies of atomisation of transition elements are quite high.
(ii) There occurs much more frequent metal-metal bonding in compounds of heavy transition metals (i.e. 3rd series).
(iii) Mn^{2+} is much more resistant than Fe^{2+} towards oxidation.

Answer.
(i) Transition metals have a higher effective nuclear charge and more valence electrons. As a result, they form strong metallic bonds, resulting in a very high enthalpy of atomization.

(ii) The presence of valence electrons and unpaired d-orbital electrons aids in the formation of metallic bonds in heavy transition metals.

(iii) Since Mn^{2+} has a half-filled ($3d^5$) d-orbital, it is stable. As a result, it does not oxidise. However, Fe^{2+} has a $3d^6$ configuration and can lose one electron to achieve a stable d^5 configuration. As a result, it is easily oxidised.

Q16. Write the chemical equation for the following-
(i) Oxidation of Fe^{2+} by $Cr_2O_7^{2-}$ in an acidic medium.
(ii) Oxidation of $S_2O_3^{2-}$ by MnO_4^- in alkaline medium.
(iii) Oxidation of I^- by MnO_4^- in alkaline medium.
(iv) Oxidation of SO_3^{2-} by $Cr_2O_7^{2-}$ in an acidic medium.
(v) Oxidation of sulphur dioxide by MnO_4^- in acidic medium.

Answer.
(i) Oxidation of Fe^{2+} by $Cr_2O_7^{2-}$ in an acidic medium.
$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$.

(ii) Oxidation of $S_2O_3^{2-}$ by MnO_4^- in alkaline medium.
$3S_2O_3^{2-} + 8MnO_4^- + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

(iii) Oxidation of I^- by MnO_4^- in alkaline medium.
$I^- + 2MnO_4^- + H_2O \rightarrow 2MnO_2 + IO_3^- + 2OH^-$

(iv) Oxidation of SO_3^{2-} by $Cr_2O_7^{2-}$ in an acidic medium.
$3SO_3^{2-} + Cr_2O_7^{2-} + 8H^+ \rightarrow 2Cr^{3+} + 3SO_4^{2-} + 4H_2O$

(v) Oxidation of sulphur dioxide by MnO_4^- in acidic medium.
$MnO_4^- + SO_2 + 2H_2O \rightarrow 5SO_4^{2-} + 2Mn^{2+} + 4H^+$

Q17. The following two reactions of HNO_3 with Zn are given:
(a) Zn + conc. $HNO_3 \rightarrow Zn(NO_3)_2 + X + H_2O$
(b) Zn + dil. $HNO_3 \rightarrow Zn(NO_3)_2 + Y + H_2O$
Identify X and Y and write balanced equations.

Answer.
$X = NO_2$
$Y = N_2O$
The balanced equations are as follows:
(a) Zn + conc. $4HNO_3 \rightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$
(b) 4Zn + dil. $10HNO_3 \rightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$

Q18. Account for the following:
(a) Transition metals and the majority of their compound acts as a good catalysts.
(b) From element to element, actinoid contraction is greater than lanthanoid contraction.

Answer. (a) Transition elements and their compounds exhibit good catalytic properties because: (i) they have variable valencies and multiple oxidation states; and transition metals occasionally form unstable intermediate compounds, providing a new path with lower activation energy for the reaction. (ii) In some cases, transition elements provide an appropriate surface for the reaction to occur.

(b) In the case of actinoids, 5f orbitals have a lower shielding effect than 4f orbitals (in lanthanoids). Thus, in the case of actinoids, the effective nuclear charge experienced by electrons in valence shells is greater than in lanthanoids.

Q19. Explain the steps of preparation of potassium dichromate?

Answer. It takes place in three steps:
(i) Conversion of chromite ore into sodium chromate- The chromate ore is fused with sodium hydroxide or sodium carbonate in the presence of air.
$4FeCrO_4 + 8Na_2CO_3 + 7O2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

(ii) Conversion of sodium chromate into sodium dichromate - The yellow solution of sodium chromate is filtered and acidified with sulphuric acid giving its dichromate.
$2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2CrO_7 + Na_2SO_4 + H_2O$
On cooling, sodium sulphate crystallizes out as $Na_2SO_4.10H_2O$ and is removed.

(iii) Conversion of sodium dichromate into potassium dichromate- Potassium dichromate is prepared by mixing a hot concentrated solution of sodium dichromate and potassium chloride in equimolar proportions
$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$
Sodium chloride being the least soluble precipitates out from the hot solution and is removed by filtration.

Q20. Compare the chemistry of actinoids with that of lanthanoids with special reference to:
(a) electronic configuration
(b) oxidation state
(c) atomic and ionic sizes
(d) chemical reactivity

Answer.

	Lanthanoids	**Actinoids**
(a) electronic configuration	It may be represented as $[Xe]_{54}$ $4f^{1-14}5d^{0-1}6s^2$	It may be represented as $[Rn]_{86}5f^{1-14}6d^{0-1}7s^2$
(b) oxidation state	Lanthanoids exhibit +2 and +4 oxidation states in addition to +3 oxidation state due to large energy gap between 4f and 5d subshells.	Due to the general small energy gap between the 5f and 6d subshells, actinoids have a large number of oxidation states.
(c) atomic and ionic sizes	Size of the atom/ion decreases across the period. In the group, the size of a lanthanoid element is smaller than the actinoid of its own group.	Size of the atom/ion decreases along the period. Actinoid has the largest size in their own group.
(d) chemical reactivity	Lanthanoids with high electropositivity have nearly identical chemical reactivity.	Actinoids (electropositive and highly reactive) are more reactive than lanthanoids (especially in finely divided form).