Chemistry Worksheets Class 12 on Chapter 8: The d & f Block Elements with Answers - Set 2

Q1. The number of unpaired electrons in Fe^{3+} ion is-

a.) 4
b.) 5
c.) 3
d.) 2

Correct Answer– (b.) 5

Q2. Maximum oxidation number of manganese is in-

a.) K_2MnO_4
b.) MnO_2
c.) $KMnO_4$
d.) Mn_2O_4

Correct Answer– (c.) KMnO

Q3. Which of the following ions do not give coloured solution?

a.) Fe^{2+}
b.) Zn^{2+}
c.) Cr^{3+}
d.) Mn^{2+}

Correct Answer– (b.) Zn^{2+}

Q4. The number of unpaired electrons in Ni^{2+} is-

a.) 0
b.) 2
c.) 4
d.) 8

Correct Answer– (b.) 2

Q5. The hybridisation of Cr in $Cr_2O_7^{2+}$ ion is-

a.) sp^3d
b.) sp^3d^2
c.) sp^3
d.) sp^2

Correct Answer– (c.) sp^3

Q6. Calculate the magnetic moment of a divalent and a trivalent ion in an aqueous solution if its atomic number is 25.

Answer. Divalent ion having atomic number 25 will have an electronic configuration of d^5. It is made up of five unpaired electrons.
n=5
Its only magnetic moment is spin-

$$\mu = \sqrt{n\,(n+2)}$$
$$\mu = \sqrt{5\,(5+2)} = 5.92B.M$$

The electronic configuration of a trivalent ion with atomic number 25 is d^4. It is made up of four unpaired electrons.
n = 4
Its only magnetic moment is spin-

$$\mu = \sqrt{n\,(n+2)}$$
$$\mu = \sqrt{4\,(4+2)} = 4.90B.M$$

Q7. Which is a stronger reducing agent Cr^{+2} or Fe^{2+} and why?

Answer. Cr^{2+} is a better reducing agent than Fe^{2+}. This can be explained based on their electronic configuration.
When Cr^{+2} is reduced, it obtains the d^3 configuration, whereas Fe^{2+} obtains the d^5 configuration. The d^3 is more stable than d^5.

Q8. Write down the electronic configuration of:
i.) $Cr^{3+.}$
ii.) Pm^{3+}

Answer.
i.) $Cr^{3+.}$ = $[Ar]3d^34s^0$
ii.) Pm^{3+}= $[Xe]4f^4$

Q9. Complete and balance the following chemical equations:

a.) $Cr_2O_7^{2-} + I^- + H^+ \rightarrow$
b.) $MnO_4^- + SO_3^{2-} + H^+ \rightarrow$

Answer. a.) $Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$
b.) $2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

Q10. How would you account for the following:
a.) The oxidizing power of oxoanions are in order
$VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$
b.) The third ionization enthalpy of manganese (Z=25) is exceptionally high.

Answer.
a.) VO_2^+ : Oxidation state of V is +5
$Cr_2O_7^{2-}$: Oxidation state of Cr is +6
MnO_4^-: Oxidation state of Mn is +7
With the increasing oxidation states, the ease with which the oxoanions accepts electrons also increases.
Thus, Oxidation state $\propto$ Oxidizing power
Therefore, the oxidizing power are in order $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$.

b.) Mn (Z = 25) has an electronic configuration $[Ar]3d^54s^2$ and the electronic configuration of Mn^{+2} is $[Ar]3d^54s^0$.
Since the 3d subshell is half-filled, Mn^{+2} is highly stable and thus energy required to remove one more electron from Mn^{+2} is very high. Therefore, the third ionization enthalpy of Manganese is exceptionally high.

Q11. Why is the highest oxidation state of a metal exhibited in its oxide or fluoride only?

Answer. Both oxygen and fluorine are strong oxidising agents, and their oxides and fluorides are highly electronegative and small in size. They can oxidise the metal to its highest oxidation states due to these properties.

Q12. Explain the following observations:
a.) Transition metals generally form coloured compounds.
b.) Zinc is not regarded as a transition metal.
c.) Transition elements and their compounds are generally found to be good catalysts in chemical reactions.

Answer.
a.) In general, transition metal ions have one or more unpaired electrons. When visible light strikes a transition metal compound or ion, the unpaired electrons in the lower energy d-orbital are promoted to higher energy d-orbitals, a process is known as the d-d transition. Since, the energy involved in the d-d transition is quantized, only a specific wavelength is absorbed, while the remaining wavelengths in the

visible region are transmitted. As a result, transmitted light contains some complementary colour to the absorbed colour.
b.) The electronic configuration of Zinc is [Ar]$3d^{10}4s^2$. Transition elements are characterised by (n-1) d subshells that are partially filled.
Zinc is not a transition element because its 3d subshell is completely filled.
c.) Transition metals and their compounds are effective catalysts due to their ability to exhibit variable oxidation states and form complexes. They provide a suitable surface for a reaction to occur.
For example, vanadium oxide in the contact process and finely divided iron in the Haber's Process.

Q13. Account for the following:
a.) The enthalpy of atomization of the transition metals is high.
b.) The lowest oxide of a transition metal is basic while the highest is amphoteric or acidic.
c.) Cobalt (II) is stable in an aqueous solution but in the presence of complexing agents, it is easily oxidized.

Answer.
a.) Since transition metals have a large number of unpaired electrons and thus strong metallic bonding. Therefore, their enthalpies of atomization are high.
b.) The lower oxide of a transition metal is basic because the metal atom has a low oxidation state and still has electrons to donate, whereas the highest oxide is acidic because the metal atom has a high oxidation state and no free electrons. As an example, MnO is a basic element, whereas Mn_2O_7 is an acidic element.
c.) In an aqueous solution, cobalt (II) is stable, but in the presence of a complexing agent, it changes its oxidation state from +2 to +3 and is easily oxidised. Although the third ionisation energy for Co is high, the greater the amount of crystal field stabilisation field ligands, the higher the ionisation energy.

Q14. Describe the preparation of-
a.) Potassium dichromate from sodium chromate.
b.) $KMnO_4$ from K_2MnO_4.

Answer.
a.) Potassium dichromate from sodium chromate.
i.) $2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$
ii.) $Na_2CrO_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$

b.) $KMnO_4$ from K_2MnO_4
$2K_2MnO_4 + Cl_2 \rightarrow 2KMnO_4 + 2KCl$

Q15. When MnO_2 is fused with KOH in the presence of KNO_3 as an oxidising agent, it gives a dark green compound (A). Compound (A) disproportionates in an acidic solution to give purple compound (B). An alkaline solution of compound (B) oxidises KI to compound (C) whereas the acidified solution of compound (B) oxidises KI to (D). Identify A, B, C and D.

Answer. MnO_2 is fused with KOH in the presence of KNO_3 as an oxidising agent, it gives a dark green compound (A)
$MnO_2 + 2KOH + KNO_3 \rightarrow K_2MnO_4 + KNO_2 + H_2O$
The dark green compound (A) is K_2MnO_4.

Compound (A) K_2MnO_4 disproportionates in an acidic solution to give purple compound (B)
$3K_2MnO_4 + 4H^+ \rightarrow 2KMnO_4 + MnO_2 + 2H_2O + 4K^+$
The purple compound (B) is $KMnO_4$.

An alkaline solution of compound (B) $KMnO_4$ oxidises KI to compound (C).
$2KMnO_4 + KI + H_2O \rightarrow 2MnO_2 + 2KOH + KIO_3$
The compound(C) is KIO_3

Acidified solution of compound (B) $KMnO_4$ oxidises KI to (D)
$2KMnO_4 + 10KI + 8H_2SO_4 \rightarrow 6K_2SO_4 + 2MnSO_4 + 8H_2O + 5I_2$
The compound (D) is I_2.

Q16. Differentiate between lanthanoids and actinoids.

Answer. The difference between Lanthanoids and Actinoids are as follows:

Property	Lanthanoids	Actinoids
Oxidation states	Lanthanoids show mainly +3 oxidation state except in a few cases where it is +2 and +4.	In addition to +3 oxidation state, they also show higher oxidation states such as +4, +5, +6 and +7.
Binding energies	Binding energies of 4f are higher.	Binding energies of 5f are lower.
Shielding effect	4f electrons have a greater shielding effect. Therefore,	5f electrons have a poor shielding effect. Therefore, the contraction in their sizes is more.
Tendency to form complexes	The tendency to form complexes is less.	They have a greater tendency to form complexes.
Basic character	Lanthanoid compounds are less basic.	Actinoid compounds are more basic.
Tendency to form oxo ions	They do not form oxo ions.	They form oxo ions such as UO_2^+, NpO_2^+, PuO_2^+, UO_2^{2+}.
Radioactivity	Except promethium, these are	All the actinoids are radioactive.

	on-radioactive.	
Colours	Most of their ions are colourless.	Most of the actinoid ions are coloured. For example, U^{3+} (red), U^{4+} (green), UO_2^{2+} (yellow)
Paramagnetic character	They are paramagnetic and their magnetic properties can be easily explained.	They are also paramagnetic but their magnetic properties cannot be easily explained.

Q17. Answer the following:
a.) Name the element of 3d transition series which shows maxium number of oxidation states. Why does it show so?
b.) Which transition metal of 3d series has positive $E°(M^+|M)$ vale and why?
c.) Out of Cr^{3+} and Mn^{3+}, which is a stronger oxidizing agent and why?
d.) Name a member of the lanthanoid series which is well known to exhibit +2 oxidation state.
e.) Complete the following equation:
$MnO_4^- + 8H^+ + 5e^- \rightarrow$

Answer.
a.) Mn, due to the presence of 5 unpaired electrons in the 3d-subshell.
b.) Cu because it has high enthalpy of atomization and low enthalpy of hydration.
c.) Mn^{+3} because it is more stable due to its half-filled (3d) configuration. It has 4 electrons in its valence shell and where it gains one electron to form Mn^{+2} ($3d^5$)
d.) Eu^{2+} (Eu)
e.) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

Q18. The elements of 3d transition series are given as:
Sc Ti V Cr Mn Fe Co Ni Cu Zn
Answer the following:
a.) Write the element which is not regarded as a transition element. Give reason.
b.) Which element has the highest melting point?
c.) Write the element which can show an oxidation of +1.
d.) Which element is a strong oxidising agent in +3 oxidation state and why?

Answer.
a.) Zinc (Zn) is not considered a transition element because it lacks a partially filled d-orbital in either the ground state or the stable +2 oxidation state.
b.) Vanadium (V) (Atomic number = 23)
c.) The oxidation state of copper (Cu) (Atomic number = 29) is +1.
d.) Due to its extra stable half-filled configuration ($3d^5$), Fe^{3+} is a strong oxidising agent because it readily accepts an electron to form Fe^{2+}. As a result, iron is a powerful oxidising agent in the +3 oxidation state.

Q19. a.) Give the general electronic configuration of d-block elements.
b.) Silver has completely filled d-orbitals ($4d^{10}$) in its ground state. Yet, it is considered as a transition element. Why?
c.) Cu^{+} ion is not stable in an aqueous solution. Explain.
d.) Actinoid contraction is greater from element to element than lanthanoid contraction. Why?

Answer.
a.) The general electronic configuration of d-block elements is $(n - 1)d^{1-10}\ ns^{1\ or\ 2}$.
b.) Transition elements are those with a partially filled d or f subshell in any common oxidation state. Silver in its ground state has completely filled d-orbitals ($4d^{10}$). It can be found in two oxidation states: +1 and +2. An electron is removed from the s-orbitals in the +1 oxidation state. However, an electron is removed from the d-orbitals in the +2 oxidation state. As a result, the d-orbital becomes incomplete ($4d^{9}$). As a result, it is a transition element.
c.) Cu^{2+} is more stable in aqueous medium than Cu^{+}. This is because, while removing one electron from Cu^{+} to Cu^{2+} requires energy, the high hydration energy of Cu^{2+} compensates for it. As a result, the Cu^{+} ion in an aqueous solution is unstable.
d.) Actinoid contraction is greater than lanthanoid contraction from element to element due to poor shielding by 5f-electrons in actinoids than that of 4f-electrons in lanthanoids.

Q20. a.) Which of the first row transition metal exhibits +7 oxidation state?
b.) How would you account for the irregular variation of 1st and 2nd ionisation enthalpies in the 1st series of transition elements?
c.) What are interstitial compounds?
d.) Give two uses of potassium permanganate.

Answer.
a.) Manganese shows the largest oxidation states in the 3d series of transition metals because it has the most unpaired electrons in its -orbitals. As a result, by removing all of its electrons, we obtain different oxidation states.
b.) Ionization enthalpies are found to increase in the given series due to a continuous filling of the inner d-orbitals. The irregular variation of ionization enthalpies can be attributed to the extra stability of configurations such as d^{0}, d^{5}, d^{10}. Since these states are exceptionally stable, their ionization enthalpies are very high.
c.) Interstitial compounds are those formed when small atoms such as H, N, or C are trapped inside metal crystal lattices. They are typically non-stoichiometric and neither ionic nor covalent.
Due to their closed crystalline structure with voids, interstitial compounds are well known for transition compounds. Since transition metals have very large atomic sizes, they have large voids to occupy these small atoms.
d.) Some of the uses of potassium permanganate are as follows:

- $KMnO_4$ is known to be used in tanning leathers, printing fabrics
- This compound can even be used as a bleaching agent, as a pesticide, and as an antiseptic

- One of the most important industrial applications of potassium permanganate is as an oxidizing agent in the chemical synthesis of many important compounds.