

Chemistry Worksheets Class 12 on Chapter 8: The d & f Block Elements with Answers - Set 3

Q1. The lanthanoid contraction relates to:

- a.) oxidation states
- b.) magnetic state
- c.) atomic radius
- d.) valence electrons

Correct Answer– (c.) atomic radius

Q2. The highest magnetic moment is shown by the transition metal ion with which of the following outermost electronic configuration.

- a.) $3d^2$
- b.) $3d^5$
- c.) $3d^7$
- d.) $3d^9$

Correct Answer– (b.) $3d^5$

Q3. If the seventh period is completed, the atomic number of the last element would be:

- a.) 118
- b.) 112
- c.) 107
- d.) 120

Correct Answer– (a.) 118

Q4. The element with atomic number 116 will belong to which period?

- a.) third
- b.) fifth
- c.) seventh
- d.) sixth

Correct Answer– (c.) seventh

Q5. Which compound is volatile on heating?

- a.) MgCl_2
- b.) HgCl_2
- c.) ZnCl_2
- d.) None of the above

Correct Answer– (b.) HgCl_2

Q6. Why Zn^{2+} salts are colourless while Ni^{2+} salts are coloured?

Answer. Zn^{2+} with the configuration $[\text{Ar}]^{18}3d^{10}$ has all filled orbitals. As a result, its salts are colourless. Ni^{2+} with the configuration $[\text{Ar}]^{18}3d^8$ has two half-filled orbitals. As a result, its salts are coloured.

Q7. Although +3 oxidation state is the characteristic oxidation state of lanthanoids but cerium shows +4 oxidation state also. Why?

Answer. Although +3 oxidation state is the characteristic oxidation state of lanthanoids but cerium shows +4 oxidation state also because after losing one more electron, cerium acquires stable $4f^0$ electronic configuration.

Q8. A compound has been found to have a magnetic moment of 3.9 B.M. How many unpaired electrons does it contain?

Answer. $\mu = \sqrt{n(n+2)}$, where n is the number of unpaired electrons.

3.9 can be written as $\sqrt{15}$

$$\sqrt{15} = \sqrt{n(n+2)}$$

$$15 = n(n+2)$$

$$3 \times 5 = n(n+2)$$

$$\text{Hence, } n = 3.$$

Therefore, the number of unpaired electrons is 3.

Q9. Following are the transition metal ions of the 3d series.

Ti^{4+} , V^{2+} , Mn^{3+} , Cr^{3+}

Answer the following questions:

- i.) Which ion is most stable in an aqueous solution and why?
- ii.) Which ion is a strong oxidising agent and why?
- iii.) Which ion is colourless and why?

Answer. i.) Cr^{3+} because of half-filled t_{2g} configuration.

ii.) Mn^{3+} due to stable d^5 configuration

iii.) Ti^{4+} because it has no unpaired electrons.

Q10. CrO_3 is an acid hydride. Explain.

Answer. CrO_3 readily dissolves in water to give chromic acid, which acts as a strong acid. Therefore, CrO_3 is an acid anhydride.



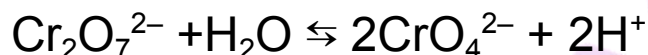
Q11. To what extent do the electronic configurations decide the ability of oxidation states in the first series of the transition element? Illustrate your answer with example.

Answer. In a transition series, the oxidation states which result in half filled and completely filled d-subshell are more stable.

For example, in the first transition series, electronic configuration of Mn ($Z=25$) is $[\text{Ar}] 3d^5 4s^2$. It shows oxidation states from +2 to +7 but Mn (II) is most stable because it has stable electronic configuration. Similarly, we can say for Zn ($Z=30$) having electronic configuration $[\text{Ar}] 3d^{10} 4s^2$ exhibits stable +2 oxidation state because of completely filled $3d^{10}$ configuration.

Q12. What is the effect of increasing pH on a solution of potassium dichromate?

Answer. The dichromate and chromate ions exist in equilibrium at $\text{pH} = 4$.



Dichromate ion
(Orange red)

Chromate ion
(Yellow)

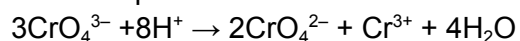
On increasing the pH (by adding alkali), the H^+ ions are used up and according to Le Chatelier's principle, the reaction proceeds towards the forward direction producing yellow chromate ions.

On decreasing the pH (by adding an acid) the reaction shifts towards the backward direction producing the orange dichromate ion.

Q13. Define disproportionation reaction. Give two examples of disproportionation reaction in aqueous solution.

Answer. The disproportionation reactions are those in which the same substance gets oxidised as well as reduced.

For example—

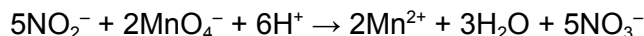


Q14. Write the chemical equations for the following reactions:

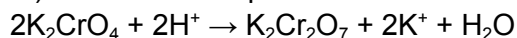
- Oxidation of nitrite ion by MnO_4^- in acidic medium.
- Acidification of potassium chromate solution.
- Disproportionation of manganese (VI) in acidic solution.

Answer.

- Oxidation of nitrite ion by MnO_4^- in acidic medium.



b.) Acidification of potassium chromate solution.



c.) Disproportionation of manganese (VI) in acidic solution.



Q15. Explain giving a suitable reason for each of the following:

i.) Transition metals and their compounds are generally found to be good catalysts.

ii.) Metal-metal bonding is more frequent for the 4d and the 5d series of transition metals than that for the 3d series.

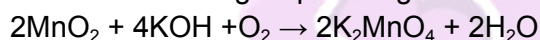
Answer.

i.) The catalytic properties of transition elements are due to the presence of unpaired electrons in their incomplete d- orbitals and variable oxidation states.

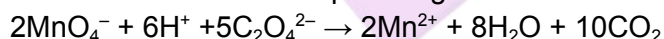
ii.) Metal-metal bonding is more common in the 4d and 5d series of transition metals than in the 3d series because the electrons in the outermost shell of these transition metals are farther away from the nucleus.

Q16. Describe the preparation of potassium permanganate. How does the acidified permanganate solution react with oxalic acid?

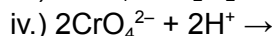
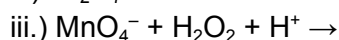
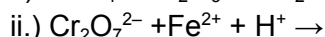
Answer. Potassium permanganate is prepared by the fusion of MnO_2 with an alkali metal hydroxide and an oxidising agent like KNO_3 . It forms dark green, K_2MnO_4 which disproportionates in a neutral or acidic solution to give permanganate.



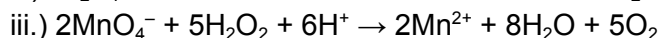
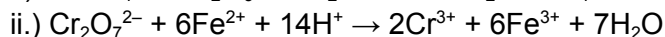
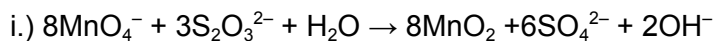
Reaction of the acidified permanganate solution with oxalic acid-

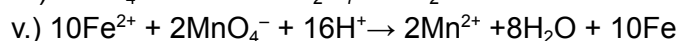
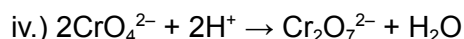


Q17. Complete the following chemical equations:



Answer.





Q18. a.) i.) How is the variability in oxidation states of transition metals different from that of the p-block elements?

ii.) Out of Cu^+ and Cu^{2+} , which ion is unstable in an aqueous solution and why?

iii.) The orange colour of $\text{Cr}_2\text{O}_7^{2-}$ ion changes to yellow when treated with an alkali. Why?

b.) The chemistry of actinoids is complicated as compared to lanthanoids. Give two reasons.

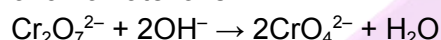
Answer.

i.) The variability in transition metal oxidation states is due to incomplete filling of d-orbitals in such a way that their oxidation states differ by unity, e.g., Fe^{2+} and Fe^{3+} , etc. The oxidation states of P-block elements differ by two units, e.g. +3 and +5. Furthermore, higher oxidation states in transition elements are more stable for heavier elements in a group, e.g., Mo^{+6} is more stable than Cr^{4+} . Due to the inert pair effect, lower oxidation states in P-block elements are more stable for heavier members, e.g., Pb^{2+} is more stable than Pb^{4+} .

ii.) In an aqueous solution, Cu^+ is more unstable than Cu^{2+} . This is due to the fact that, while the 2nd I.E. of copper is high, the hydration enthalpy for Cu^{2+} is much lower than that of Cu^+ , and compounds are unstable in an aqueous solution and undergo disproportionation.



iii.) The orange colour of the $\text{Cr}_2\text{O}_7^{2-}$ ion changes to yellow when exposed to alkali due to the formation of chromate ions.



b.) Actinoids' chemistry is more complicated than lanthanoids' because:

i.) Actinoids have a wide range of oxidation states, i.e., +3, +4, +5, +6 due to a small energy difference between their 5f, 6d, and 7s subshells.

ii.) Actinoids are radioactive, which complicates their chemistry.

Q19. How would you account for the irregular variation of ionization enthalpies (first and second) in the first series of the transition elements?

Answer. Due to the continuous filling of the inner d-orbitals, ionisation enthalpies are found to increase in the given series. The irregular variations of ionisation enthalpies can be attributed to the extra stability of configurations such as d^0 , d^5 , d^{10} . Since these states are extremely stable, their ionisation enthalpies are extremely high.

Cr has low ionisation energy in the first ionisation state. This is due to the fact that after losing one electron, it achieves the stable configuration $3d^5$. Zn, on the other hand, has an extremely high first ionisation energy due to the removal of an electron from stable and fully-filled orbitals $3d^{10}4s^2$.

Second ionisation energies are higher than the first because it is more difficult to remove an electron once one has been removed. Furthermore, elements such as Cr and Cu have extremely high second ionisation energies because they have attained a stable configuration after losing the first electron (Cr^+

: $3d^5$ and $Cu^+ : 3d^{10}$). As a result, extracting one more electron from this stable configuration will require a significant amount of energy.

Q20. Give reasons-

- i.) Transition metals have high melting points.
- ii.) Second and third transition series have similar radii.
- iii.) Second ionization is difficult for Cu and Cr whereas it is easy for Zn.
- iv.) Most of the transition elements are paramagnetic.
- v.) Transition elements form alloys.

Answer.

- i.) In transition metals, in addition to ns electrons, $(n-1)d$ electrons can participate in bonding, resulting in stronger metallic bonds. As a result, their melting points rise.
- ii.) The size of the 5d series decreases due to lanthanoid contraction. As a result, their sizes are the same as the sizes of elements in the 4d series.
- iii.) The electronic configuration of Cr is $3d^5 4s^1$ and that of Cu is $3d^{10} 4s^1$. After the first ionisation, which removes the electron from 4s, the second ionisation requires disturbance in a half-filled or fully-filled configuration, which requires a high enthalpy, whereas the Zn configuration is $3d^{10} 4s^2$. The configuration of Zn is completely filled. Second ionisation is thus easier for Zn but difficult for Cr and Cu.
- iv.) The presence of one or more unpaired electrons in atomic orbitals causes magnetism in transition elements.
- v.) Due to their similar sizes, transition metals can take each other's position in the crystal lattice. As a result, they can form alloys.