	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**Department: SCIENCE 2025 – 26** **SUBJECT: CHEMISTRY**	**Date: 04/11/2025**
Worksheet No: 9 **WITH ANSWERS**	**CHAPTER: The d- and f- Block Elements**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT	**CLASS & SEC:**	**ROLL NO.**

1. Which property of transition metals enables them to behave as catalysts?
(a) High melting point
(b) High ionisation enthalpy
(c) Alloy formation
(d) Variable oxidation states
2. Which of the following is a strong oxidising agent?
(At. No. Mn = 25, Zn = 30, Cr = 24, Sc = 21)
(a) Mn^{3+} (b) Zn^{2+} (c) Cr^{3+} (d) Sc^{3+}
3. The incorrect statement about interstitial compounds is
(a) they are chemically reactive.
(b) They are very hard.
(c) They retain metallic conductivity.
(d) They have a high melting point.

4. Out of the following transition elements, the maximum number of oxidation states is shown by
(a) Sc (Z = 21) (b) Cr (Z = 24) (c) Mn (Z = 25) (d) Fe (Z = 26)
5. Lanthanoid contraction is due to an increase in
(a) atomic number
(b) shielding by 4*f* electrons
(c) effective nuclear charge
(d) atomic radius.

6. The most common and stable oxidation state of a Lanthanoid is
(a) +2 (b) +3 (c) +4 (d) +6
7. All the lanthanoids show + 3 as the common oxidation state, yet Ce shows + 4 state because
(a) it tends to attain a noble gas configuration.
(b) It has a variable ionisation enthalpy.
(c) It tends to gain 1 more electron.
(d) It has an unpaired electron in 6s.
8. Which of the following is the reason for zinc not exhibiting variable oxidation states?
(a) Inert pair effect
(b) Completely filled 3*d* subshell
(c) Completely filled 4*s* subshell
(d) Common ion effect

9. Which set of ions exhibit specific colours? (Atomic number of Sc = 21, Ti = 22, V=23, Mn = 25, Fe = 26,
Ni = 28, Cu = 29 and Zn =30)
(a) Sc^{3+}, Ti^{4+}, Mn^{3+} (b) Sc^{3+}, Zn^{2+}, Ni^{2+} (c) V^{3+}, V^{2+}, Fe^{3+} (d) Ti^{3+}, Ti^{4+}, Sc^{3+}

10. Which of the following is a diamagnetic ion? (Atomic numbers of Sc, V, Mn, and Cu are 21, 23, 25, and 29, respectively.)
(a) V^{2+} (b) Sc^{3+} (c) Cu^{2+} (d) Mn^{3+}

Assertion Reasoning Questions

DIRECTIONS: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true, and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true, but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true, but reason (R) is false.
(d) Assertion (A) is false, but reason (R) is true.
(e) Both Assertion and Reason are false.

11. **Assertion (A):** Transition metals have a high melting point.
Reason (R): Transition metals have completely filled *d*-orbitals.

12. **Assertion (A):** Transition metals have low melting points.
Reason (R): The involvement of a greater number of (n – 1)d and ns electrons in the interatomic metallic bonding.

13. **Assertion (A):** Cu cannot liberate H_2 on reaction with dilute mineral acids.
Reason (R): Cu has a positive electrode potential.

14. Within the 3d series, Manganese exhibits oxidation states in aqueous solutions from +2 to +7, from Mn^{2+} to MnO_4^-. Likewise, iron forms both Fe^{2+} and Fe^{3+}. Cr and Mn form oxyions CrO_4^{2-}, MnO_4^- owing to their willingness to form multiple bonds. The pattern with the early transition metals in the 3d series up to Mn and for the 4d,5d metals up to Ru and Os is that the maximum oxidation state corresponds to the number of outer shell electrons. The highest oxidation states of the 3d metals may depend upon the complex formation or upon the pH. Within the 3d series, there is considerable variation in the relative stability of oxidation states, sometimes on moving from metal to the neighbour, thus for Iron, Fe^{3+} is more stable than Fe^{2+}, especially in alkaline conditions, while the reverse is for Cobalt. The ability of transition metals to exhibit a wide range of oxidation states is marked with metals such as Vanadium, where the standard potential can be rather small, making a switch between states relatively easy.

(Source: Cotton S. A. (2011) Lanthanides: Comparison to 3d metals. Encyclopaedia of Inorganic and Bioinorganic Chemistry)

A. What is the oxidation state of Iron in Ferric?
B. Which is more stable, Fe^{2+} or Fe^{3+}?
C. Why is the maximum oxidation state of Chromium in its compounds +6?

2 Mark questions

15. The electronic configuration of actinoids is irregular. Why?

16. What happens when KMnO4 is heated?

17. Discuss the consequences of lanthanoid contraction.

18. How would you account for?
(a) The $E°$ value for the Mn^{3+}/Mn^{2+} couple is much more positive than that for the Cr^{3+}/Cr^{2+} couple or Fe^{3+}/Fe^{2+} couple.
(b) Complete the following equation:
$2MnO_4^{-} + 16H^{+} + 5C_2O_4^{2-}$

3 mark questions

19. What is the effect of pH on the solution of $K_2Cr_2O_7$? Also, give the structure of chromate and dichromate
ions along with the colour of the species.

20. (a) Explain the method of preparation of sodium dichromate from chromite ore.
(b) Give the equation representing the oxidation of ferrous salts by dichromate ion.

21. When $FeCr_2O_4$ is fused with Na_2CO_3 in the presence of air it gives a yellow solution of compound (*A*). Compound (*A*) on acidification gives compound (*B*). Compound (*B*), on reaction with KCl, forms an orange coloured compound (*C*). An acidified solution of compound (*C*) oxidises Na_2SO_3 to (*D*). Identify (*A*),(*B*), (*C*) and (*D*).

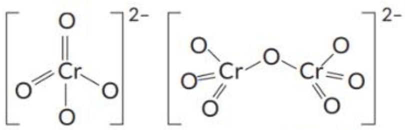
22. Complete the following reactions.
(i) $MnO_2 + KOH + O_2$
(ii) $I^{-} + MnO_4^{-} + H^{+}$
(iii) $Cr_2O_7^{2-} + Sn^{2+} + H^{+}$

23. The following are the transition metal ions of the 3*d* series:
Ti^{4+}, V^{2+}, Mn^{3+}, Cr^{3+}
(Atomic numbers: Ti = 22, V = 23, Mn = 25, Cr = 24)
Answer the following:
(i) Which ion is most stable in aqueous solution and why?
(ii) Which ion is a strong oxidising agent and why?
(iii) Which ion is colourless and why?

5-mark questions

24. Assign a reason for each of the following:
(i) Manganese exhibits the highest oxidation state of +7 among the 3*d* series of transition elements.
(ii) Transition metals and their compounds are generally found to be good catalysts in chemical reactions.
(iii) Cr^{2+} is reducing in nature, while with the same *d*-orbital configuration (*d*4) Mn^{3+} is an oxidising agent.
(iv) Zn has the lowest enthalpy of atomization.
(v) Cu+ is unstable in an aqueous solution.

25. a) The elements of the 3*d* transition series are given as
Sc Ti V Cr Mn Fe Co Ni Cu Zn
Answer the following:
(i) Write the element that shows the maximum number of oxidation states. Given reason.
(ii) Which element has the highest melting point?
(iii) Which element shows only the +3 oxidation state?
(iv) Which element is a strong oxidising agent in the +3oxidation state and why?
(v) Ti^{4+} is colourless, whereas V^{4+} is coloured in an aqueous solution.

Q No	Answers
1	(d) Variable oxidation states
2	(a) Mn^{3+}
3	(a) they are chemically reactive.
4	(c) Mn (Z = 25)
5	(c) effective nuclear charge
6	(b) +3
7	(a) it has a tendency to attain noble gas configuration.
8	(b) Completely filled 3*d* subshell
9	(c) V^{3+}, V^{2+}, Fe^{3+}
10	(b) Sc^{3+}
11	c) Assertion (A) is true, but reason (R) is false
12	(d) Assertion (A) is false, but reason (R) is true.
13	(a) Both A and R are true, and R is the correct explanation of A
14	A. Fe^{3+} B. Fe^{3+} because of its d^5 configuration C. The maximum oxidation state of Chromium in its compounds is +6 because it has only 6 electrons in its ns and n-1 d orbitals.
15	The electronic configurations of actinoids are irregular because the energy difference between the 5f, 6d, and 7s subshells is minimal. This allows electrons to occupy either the 5f or 6dorbitals, leading to variations in electron filling patterns and making the configurations difficult to predict with certainty
16	$2KMnO_{4(s)} \rightarrow K_2MnO_{4(s)} + MnO_{2(s)} + O_{2(g)}$
17	• The similarity in atomic sizes of second and third-row transition metals • The difficulty in separating lanthanoid elements due to their similar chemical properties. • Decrease in the basic strength of lanthanide hydroxides,
18	(a) The E^0 value for Mn^{3+}/Mn^{2+} is more positive because the Mn^{2+} ion, with its half-filled d^5configuration, is significantly more stable than the Mn^{3+} (d^4)ion (b) $2MnO^{-}_4 + 5C_2O^{2-}_4 + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
19	In acidic solutions (pH<7), the solution is orange due to the dichromate ion, while in alkaline solutions (pH>7), the colour shifts to yellow because of the formation of the chromate ion. 
20	(a) Sodium dichromate is prepared from chromite ore by first roasting it with sodium carbonate and air to form sodium chromate. The sodium chromate is then acidified with sulfuric acid to convert it to sodium dichromate. $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$ $2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$ (b) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$
21	A = Na_2CrO_4 B = $Na_2Cr_2O_7$ C = $K_2Cr_2O_7$ D Na_2SO_4

	$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$ $2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$ $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$ $K_2Cr_2O_7 + 3Na_2SO_3 + 4H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3Na_2SO_4 + K_2SO_4 + 4H_2O$
22	(i) $2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$ (ii) $5I^- + MnO_4^- + 8H^+ \rightarrow 5I_2 + Mn^{2+} + 4H_2O$ (iii) $Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 3Sn^{4+} + 7H_2O$
23	(i) Cr^{3+} ; Chromium has atomic number 24, so its electron configuration is $3d^5 4s^1$. When it forms the Cr^{3+} ion, its electron configuration becomes $[Ar]3d^3$. This half-filled t_{2g} orbital is very stable, making the ion less likely to react in solution. (ii) Mn^{3+}; Manganese has atomic number 25, with an electron configuration of $3d^5 4s^2$. The Mn^{3+} ion has an electron configuration of $[Ar]3d^4$. This ion readily accepts an electron to become Mn^{2+}, which has a very stable, half-filled $3d^5$ configuration. This tendency to gain an electron makes Mn^{3+} a strong oxidizing agent. (iii) Ti^{4+}; Titanium has atomic number 22, with an electron configuration of $3d^2 4s^2$. The Ti^{4+} ion has lost all its valence electrons, resulting in an empty 3d orbital. Since there are no d electrons, no d-d electron transitions can occur, and the ion appears colourless.
24.	(i) Manganese exhibits the highest oxidation state of +7 among the 3d series of transition elements because it can utilize all of its 3d and 4s electrons for bonding with oxygen (ii) Transition metals and their compounds are generally good catalysts because they can easily change their oxidation states, allowing them to participate in various redox reactions by accepting or donating electrons. (iii) Cr^{2+} is reducing in nature because it has a d^4 configuration and can readily donate one electron to achieve a more stable d^5 configuration, while Mn^{3+}, with the same d^4 configuration, is an oxidizing agent because it can readily accept an electron to reach a more stable d^5 configuration. (iv) Zinc has the lowest enthalpy of atomization because its d-orbitals are completely filled $3d^{10}$ with no unpaired electrons, which results in the weakest metallic bonding among the 3d series of transition metals. (v) $Cu^+$is unstable in aqueous solution because it undergoes a disproportionation reaction to form the more stable Cu^{2+} ions and metallic copper (Cu). This happens because the higher charge of the Cu^{2+}ion leads to a significantly larger hydration energy.
25	(i) Manganese (Mn) shows the maximum number of oxidation states +2 to +7because it has a partially filled 3d subshell with 5 unpaired electrons, plus the two electrons in the 4s orbital, which can all be involved in bonding. (ii) Chromium (Cr) has the highest melting point due to strong metallic bonds formed by its unpaired electrons. (iii) Scandium (Sc) shows only the +3 oxidation state because it loses its two 4s and one 3d electrons to achieve a stable noble gas configuration [Ar].

	(iv) Manganese (Mn) is a strong oxidizing agent in the +3 state because Mn^{3+} can easily gain an electron to become the more stable, half-filled $3d^5$ configuration of Mn^{2+} (v) Ti^{4+} is colourless because it has no d-electrons, preventing d-d electronic transitions which are responsible for colour. In contrast, V^{4+} is coloured because its d-electron configuration $3d^1$ allows for d-d transitions, where an electron can absorb visible light and move to a higher energy level, making the solution appear coloured.

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