CHEMISTRY (CODE – 043)

Chapter-wise Test: The d- and f-Block Elements

(NCERT Class XII Chemistry, Unit 4: The d- and f-Block Elements)

PRACTICE QUESTION PAPER

CLASS XII (2026-27)

Time: 1½ hours **Max. Marks: 35**

GENERAL INSTRUCTIONS: Read the following instructions carefully.

1. There are 17 questions in this question paper with internal choice. All questions are based on Unit 4: The d- and f-Block Elements.
2. SECTION A consists of 8 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 3 very short answer questions carrying 2 marks each.
4. SECTION C consists of 4 short answer questions carrying 3 marks each.
5. SECTION D consists of 1 case-based question carrying 4 marks.
6. SECTION E consists of 1 long answer question carrying 5 marks.
7. All questions are compulsory. Internal choice is provided in Questions 9 to 15, 16(iii) and 17.
8. Questions 2, 3, 9, 12, 13, 14 and 16 are based on figures, structures or data tables given in the paper.
9. Use of log tables and calculators is not allowed.

SECTION A

Questions 1 to 8 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions. Each question carries 1 mark.

1 Which of the following is **not** regarded as a transition element? — 1

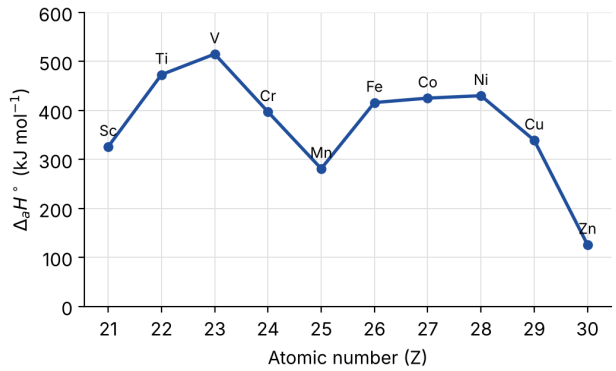
A. Fe
B. Cu
C. Zn
D. Ni

2 The table gives the standard electrode potentials, E° (M^{3+}/M^{2+}), of some 3d metals. — 1

Couple	**Ti^{3+}/Ti^{2+}**	**V^{3+}/V^{2+}**	**Cr^{3+}/Cr^{2+}**	**Mn^{3+}/Mn^{2+}**	**Fe^{3+}/Fe^{2+}**	**Co^{3+}/Co^{2+}**
E° (V)	−0.37	−0.26	−0.41	+1.57	+0.77	+1.97

Which of the following conclusions is correct?

A. Mn^{3+} is a weaker oxidising agent than Fe^{3+}.
B. Cr^{2+} is a strong reducing agent while Mn^{3+} is a strong oxidising agent.
C. Co^{2+} is a stronger oxidising agent than Co^{3+}.
D. Cr^{3+} is easily reduced to Cr^{2+}.

3	Fig. 1 shows the variation of the enthalpy of atomisation ($\Delta_a H°$) across the 3d series of transition elements.  **Fig. 1** The very low value of $\Delta_a H°$ of zinc is because: A. zinc has the highest first ionisation enthalpy in the series B. zinc has the smallest atomic radius in the series C. zinc forms very strong metallic bonds D. zinc has a completely filled 3d subshell, so no unpaired d electrons are available for metallic bonding	1
4	The spin-only magnetic moment (in BM) of Mn^{2+} (Z = 25) is (√35 = 5.92): A. 1.73 B. 2.84 C. 5.92 D. 4.90	1
5	Lanthanoid contraction is caused by: A. the poor shielding of one 4*f* electron by another with increase in nuclear charge B. the very good shielding effect of 4*f* electrons C. the decrease in nuclear charge along the series D. the increase in the number of shells along the series	1
6	In acidic medium, the product obtained by the reduction of MnO_4^- is: A. MnO_2 B. Mn^{2+} C. MnO_4^{2-} D. Mn_2O_3	1
7	When green potassium manganate (K_2MnO_4) is acidified, it disproportionates to give: A. Mn^{2+} and MnO_2 B. MnO_4^- and Mn^{2+} C. MnO_4^- and MnO_2 D. MnO_2 and Mn_2O_7	1
8	**Assertion (A):** Cu^+ ion is unstable in aqueous solution and undergoes disproportionation. **Reason (R):** The hydration enthalpy of Cu^{2+} is so much more negative than that of Cu^+ that it more than compensates the second ionisation enthalpy of copper. Select the most appropriate answer from the options given below: A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

SECTION B

Question Nos. 9 to 11 are very short answer questions carrying 2 marks each.

9 **Attempt either A or B.** 1+1

The table gives the colours of some aqueous ions of the 3d series.

Ion	Configuration	Colour in aqueous solution
Sc^{3+}	$3d^0$	Colourless
Ti^{3+}	$3d^1$	Purple
Mn^{2+}	$3d^5$	Pink
Cu^{2+}	$3d^9$	Blue
Zn^{2+}	$3d^{10}$	Colourless

(A) (i) Why are Sc^{3+} and Zn^{2+} colourless?
(ii) What is the cause of colour in Ti^{3+}, Mn^{2+} and Cu^{2+}?

OR

(B) (i) Using the table, predict whether the Cu^{+} ion would be coloured. Give a reason.
(ii) Calculate the spin-only magnetic moment of Mn^{2+} in BM. ($\sqrt{35} = 5.92$)

10 **Attempt either A or B.** 1+1

(A) Write the electronic configurations of Cr (Z = 24) and Cu (Z = 29). Why are they different from the expected configurations?

OR

(B) (i) What are interstitial compounds? (ii) Write two characteristic properties of these compounds.

11 **Attempt either A or B.** 1+1

(A) Calculate the spin-only magnetic moment of (i) Co^{2+} (Z = 27) and (ii) Ni^{2+} (Z = 28). ($\sqrt{15} = 3.87$; $\sqrt{8} = 2.83$)

OR

(B) Write the ionic equations for the oxidation of (i) Fe^{2+} and (ii) I^{-} by acidified potassium dichromate.

SECTION C

Question Nos. 12 to 15 are short answer questions carrying 3 marks each.

12 **Attempt either A or B.** 1+1+1

(A) The table lists the oxidation states shown by some elements of the first transition series.

Element	Sc	Mn	Cu	Zn
Oxidation states	+3	+2, +3, +4, +5, +6, +7	+1, +2	+2

(i) Which of these elements shows the maximum number of oxidation states? Why?
(ii) Why do Sc and Zn show only one oxidation state?
(iii) Cu^{+} is not stable in aqueous solution. Explain with the help of an equation.

OR

(B) Explain the following:
(i) Cr^{2+} is a strong reducing agent whereas Mn^{3+} is a strong oxidising agent although both have a d^4 configuration.
(ii) Transition metals and their compounds show catalytic properties.
(iii) Transition metals form a large number of complexes.

13 **Attempt either A or B.** 1+1+1

(A) The table gives the ionic radii of some lanthanoid ions (Ln^{3+}).

Ion	La^{3+}	Nd^{3+}	Gd^{3+}	Dy^{3+}	Er^{3+}	Yb^{3+}
Atomic number	57	60	64	66	68	70
Ionic radius (pm)	106	99	94	91	88	86

(i) What is the trend in the radii along the series? Name the phenomenon.
(ii) What is the cause of this trend?
(iii) State one consequence of it on the chemistry of the transition elements.

OR

(B) (i) Ce^{4+} is a good oxidising agent whereas Eu^{2+} is a good reducing agent. Explain.
(ii) What is mischmetall? Give one use.

14 **Attempt either A or B.** 1+1+1

(A) Fig. 2 shows the steps in the preparation of the dichromate of potassium from chromite ore.

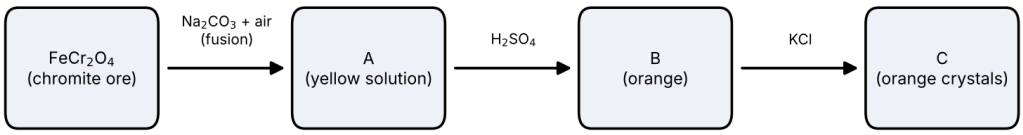


Fig. 2

(i) Identify A, B and C.
(ii) Write the ionic equation for the conversion of A into B on acidification.
(iii) What will you observe when sodium hydroxide solution is added to an aqueous solution of B? Write the equation.

OR

(B) Write the ionic equations for the reaction of acidified potassium permanganate with (i) Fe^{2+}, (ii) oxalate ions ($C_2O_4^{2-}$), (iii) iodide ions.

15	**Attempt either A or B.** **(A)** Describe the preparation of potassium permanganate from pyrolusite (MnO_2). Write the chemical equations for the two steps involved in the laboratory/industrial method, and name the process for the final step in the commercial method. **OR** **(B)** Write any three differences between the lanthanoids and the actinoids.	1+1+1

SECTION D

Question No. 16 is a case-based/data-based question carrying 4 marks.

16 **Why is the standard electrode potential of copper positive?** — 1+1+2

The standard electrode potential of the M^{2+}/M system depends on three energy terms: the enthalpy of atomisation ($\Delta_a H°$), the ionisation enthalpies ($\Delta_i H°_1 + \Delta_i H°_2$) and the hydration enthalpy of M^{2+} ($\Delta_{hyd} H°$). The following data (in kJ mol^{-1}) were collected for four 3d metals.

Element	$\Delta_a H°$	$\Delta_i H°_1$	$\Delta_i H°_2$	$\Delta_{hyd} H°$ (M^{2+})	$E°$ (M^{2+}/M) (V)
Mn	279	717	1509	−1862	−1.18
Ni	431	736	1752	−2121	−0.25
Cu	339	745	1958	−2121	+0.34
Zn	130	906	1734	−2059	−0.76

Answer the following questions:

(i) Calculate the sum $\Delta_a H° + \Delta_i H°_1 + \Delta_i H°_2 + \Delta_{hyd} H°$ for copper and zinc.
(ii) Which of the four metals is the weakest reducing agent? Can it liberate hydrogen from dilute acids?
(iii) **Attempt either A or B.**
(A) Why is the $E°$ of Mn^{2+}/Mn (−1.18 V) more negative than expected from the trend of the other elements?
OR
(B) Explain why $E°$ of Ni^{2+}/Ni is less negative than expected.

SECTION E

Question No. 17 is a long answer question carrying 5 marks.

17 **Attempt either A or B.** — 5

(A) A compound **A** is obtained as a dark green solid when MnO_2 is fused with KOH in the presence of air. On acidification, A gives a purple compound **B** and a brown precipitate **C**. When B is heated at 513 K, it gives A, C and a gas **D**.
(i) Identify A, B, C and D.
(ii) Write the ionic equation for the conversion of A into B and C on acidification.
(iii) Write the equation for the thermal decomposition of B.
(iv) The compound A is paramagnetic whereas B is diamagnetic. Explain.

OR

(B) Explain the following with reasons:
(i) Transition metals show variable oxidation states.
(ii) Most transition metal ions are coloured.
(iii) Transition metals and their compounds are good catalysts.
(iv) Transition metals form interstitial compounds.
(v) The enthalpies of atomisation of transition metals are high.

— End of Question Paper —