

2025

2nd Semester Examination (CCFUP : NEP)

CHEMISTRY

Paper : MJ 2-T (Single Core Major)

(Inorganic Chemistry - I)

Full Marks : 40

Time : Two Hours

The figures in the margin indicate full marks.

*Candidates are required to give their answers
in their own words as far as practicable.*

Group - A

Answer any *five* questions.

2×5=10

1. What is the quantum defect? Explain it with an example using Sommerfeld's atomic model.
2. Show that Lyman series occurs in between 912Å and 1216Å for the hydrogen atom.
3. Write the conjugate acids and bases corresponding to each of the following : CH_3COOH , HS^- .
4. During the formation of Ni^{2+} from Ni, electrons are lost from the 4s orbital rather than the 3d orbital — Explain.

P.T.O.

(2)

5. Arrange the following ions in order of increasing stability in aqueous medium, with justification : $[\text{Fe}(\text{H}_2\text{O})_6]^{+3}$, $[\text{Al}(\text{H}_2\text{O})_6]^{+3}$, $[\text{Mn}(\text{H}_2\text{O})_6]^{+2}$.
6. Write the IUPAC names of the elements with atomic numbers 103 and 111. What are their chemical properties?
7. Calculate the equivalent mass of the oxidizing agent in the following reaction :
- $$\text{SO}_2 + 2\text{H}_2\text{S} \rightarrow 3\text{S} + 2\text{H}_2\text{O}$$
8. Derive the expression for the solubility product (K_{sp}) of aluminium phosphate, assuming 'S' as its molar solubility at 25°C. If the temperature is increased from 25°C to 50°C, will the value of K_{sp} change?

Group - B

Answer any **four** questions.

5×4=20

9. (a) Explain the basis of electronegativity as described by the Allred-Rochow scale, and correlate it with Pauling's scale.
- (b) HBrO_4 is less stable than HClO_4 and HIO_4 , yet it is a better oxidizing agent than both — Explain.
10. (a) Define the formal potential of a redox couple. Using the Nernst equation, prove that the chloride ion is oxidized by permanganate solution only at low pH (below 1.5), and not in neutral solution.

3+2

(3)

[Given : $E^\circ_{\text{MnO}_4^-/\text{Mn}^{+2}} = +1.51\text{V}$, $E^\circ_{1/2\text{Cl}_2/\text{Cl}^-} = +1.36\text{V}$].

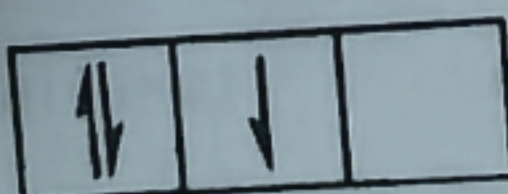
- (b) What is Zimmermann-Reinhardt (ZR) solution? Mention one of its uses in the laboratory. (1+2)+2

- (a) "The Aufbau configuration and the actual configuration of elemental copper differ." Write the electronic configurations in each case and explain the reason for this difference.

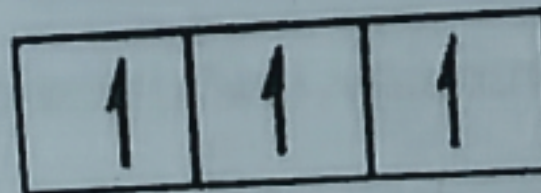
- (b) Show that the de Broglie wavelength of the electron in the first Bohr orbit of the hydrogen atom is $2\pi a_0$, where $a_0 = 1^{\text{st}}$ Bohr orbit radius.

- (c) Check the applicability of Heisenberg's Uncertainty Principle to a moving cricket ball of mass 160 g, given that the uncertainty in its position is 10^{-8}cm . 2+1+2

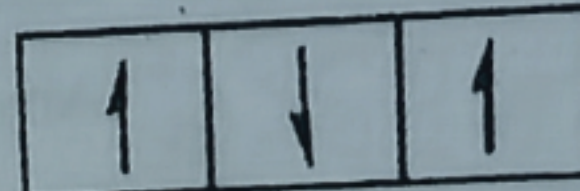
12. (a) Which of the following electronic arrangements for a p^3 configuration is acceptable? Justify your choice using an appropriate fundamental rule of electron distribution and afterwards correlate your result with exchange energy calculation.



(a)



(b)



(c)

P.T.O.

(4)

- (b) 'The maximum electron capacity of any two.' How can this be proven?
- (c) Many salts of lithium and magnesium are in organic solvents. Explain why.
13. (a) By constructing Frost diagrams, compare the thermodynamic stability of Cu^+ and Ag^+ in aq. Given :
- $$\text{Ag}^{2+} \xrightarrow{+1.99\text{V}} \text{Ag}^+ \xrightarrow{+0.80\text{V}} \text{Ag}$$
- $$\text{Cu}^{2+} \xrightarrow{+0.15\text{V}} \text{Cu}^+ \xrightarrow{+0.50\text{V}} \text{Cu}$$
- (b) Cite an example of a superacid and mention one of its potential applications.
14. (a) The acid strength of HF, HCl, HBr, and CH_3COOH differs in aqueous solution, but all are equally strong in liquid ammonia — Explain.
- (b) Why is H^+ generally considered a typical hard acid?
- (c) Define the buffer capacity of a buffer solution containing 0.1(M) acetic acid and 0.2(M) sodium acetate.

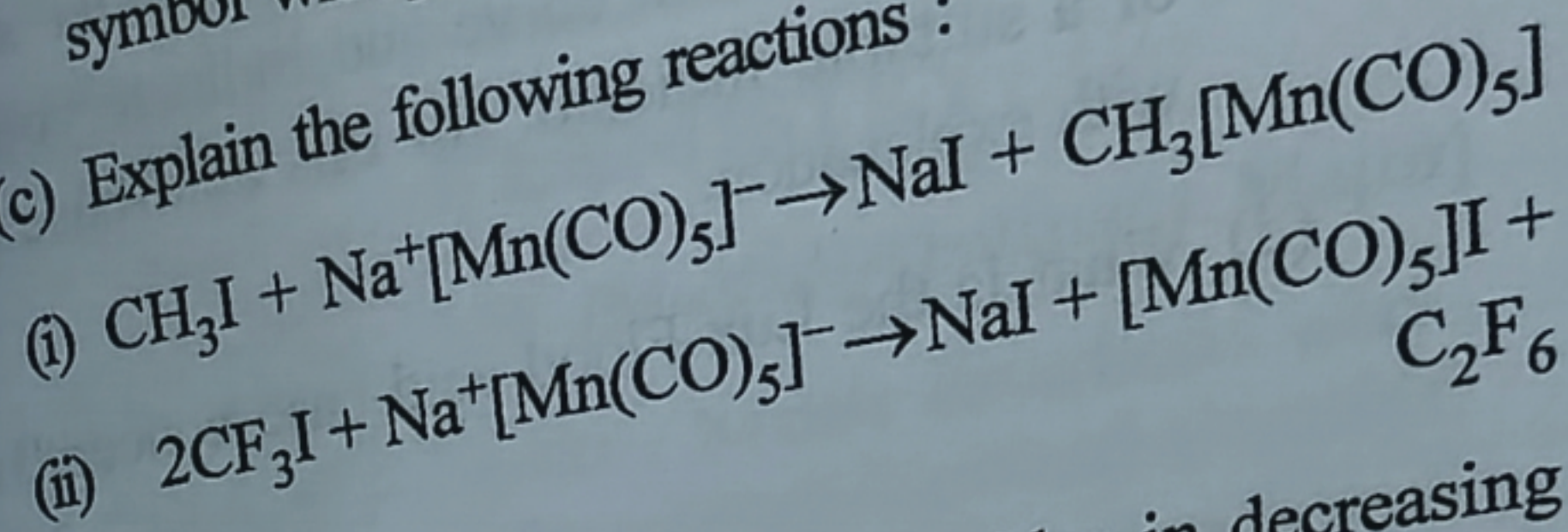
Group - C

15. (a) What do you mean by redox indicator? Give two examples.
- Answer any one question : $10 \times 1 = 10$

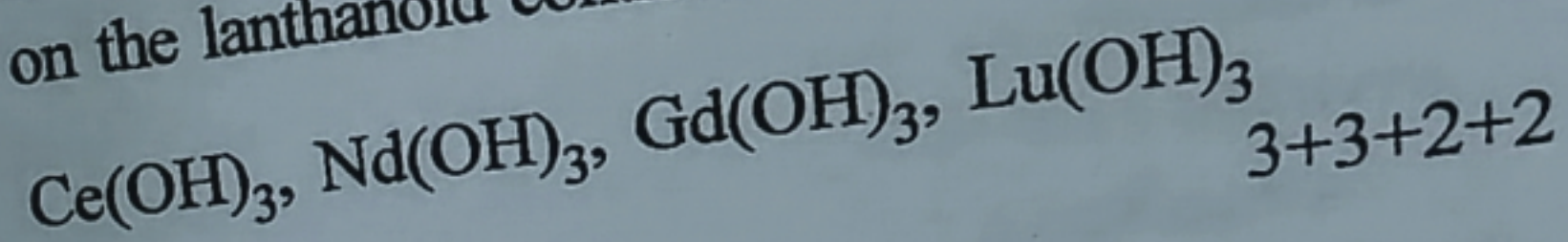
(5)

Determine the different possible energy states of the V^{3+} ion and hence deduce the ground state term symbol with proper justification.

(c) Explain the following reactions :



(d) Arrange the following hydroxides in decreasing order of basicity and explain your answer based on the lanthanoid contraction :



16. (a) In the titration of $\text{Fe}(\text{II})$ with $\text{K}_2\text{Cr}_2\text{O}_7$ in the presence of the indicator Ba-diphenylamine sulfonate, the addition of H_3PO_4 is essential. However, when ferroin is used as the indicator, $\text{Fe}(\text{II})$ can be titrated with $\text{K}_2\text{Cr}_2\text{O}_7$ without adding H_3PO_4 . Explain this observation.
- (b) What is the solubility product principle? In Group IIIA analysis, for the precipitation of Fe^{3+} , Al^{3+} , and Cr^{3+} ions, a mixture of NH_4Cl and NH_4OH is used instead of NaOH . Explain why.

P.T.O.

(6)

(c) Calculate the pH values during the titration of 50 mL of 0.1 (M) HCl solutions by adding 50, and 50.1 mL of 0.1 (M) NaOH. Draw the titration curve and indicate your choice of a suitable indicator for this acid-base titration with explanation.

(d) What is the Lux-Flood acid-base concept?

3+3+3+