

U.G. 1st Semester Examination - 2025**CHEMISTRY****[MAJOR]****Course Code: CHEM-MAT-01****[NEP-2020]**

Full Marks: 40

Time: $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***Write the answers of Group-A and Group-B in separate books.****GROUP-A****(Inorganic-1A)****[Marks : 20]**

1. Answer any **one** question: $1 \times 1 = 1$
 - a) What is the lowest value of principal quantum number that allows 'g' orbital to exist?
 - b) Which metal ion in its +2 oxidation state has five 3d electrons?
2. Answer any **two** questions: $2 \times 2 = 4$
 - a) The energy of an excited H-atom is -3.4 eV. Calculate the angular momentum of the electron according to Bohr Theory.

[Turn over]

- b) What is the significance of magnetic quantum number?
- c) Determine the ground state term symbol of Ni^{2+} ion.

3. Answer any **one** question: $5 \times 1 = 5$

- a) i) Explain the basis of Pauling's electronegativity scale. Using the bond energy data, given in the parenthesis in kJ/mole, determine the more ionic bond in H-O-Cl and suggest the mode of its ionization in aqueous solution.

H-H (437), Cl-Cl (239), O-O (143),
H-O (462) & Cl-O (218) $1+2$

- ii) Explain wave-particle duality. 2

- b) i) The electron affinity of Au is abnormally high and it may exist as auride—Justify the statement.

- ii) What new line results from the combination of the first two lines in the Paschen series? What will be its wave length? $2\frac{1}{2} + 2\frac{1}{2}$

4. Answer any **one** question: $10 \times 1 = 10$

- a) i) Arrange the following in order of H^{-1} , F^{-1} , Cl^{-1} & Br^{-1} ionic size.

- ii) Kinetic energy of an electron is 50 eV. Find out its de-Broglie wavelength in $\text{\AA}$.
 $h = 6.626 \times 10^{-27} \text{ erg.sec}$, $m = 9.11 \times 10^{-28} \text{ gm}$.

- iii) Compare the penetrating power of 4s and 3d orbitals by drawing qualitatively the radial probability distribution curves of the orbitals.

- iv) The F-F bond distance in F_2 is 141.3 pm. Calculate Allred Rochow's electronegativity of Fluorine using Slater's rule.

$$2+3+2+3=10$$

- b) i) Zr and Hf coexist in nature and their separation is a difficult task. Explain.

- ii) Draw the shapes of 'd' orbitals.

- iii) On the basis of exchange energy explain why $3d^5 4s^1$ electronic configuration is more stable than $3d^4 4s^2$ electronic configuration.

- iv) Write down the time independent Schrödinger wave equation and define each of the terms in it. State physical significance if ψ . $2+2+2+(3+1)=10$

GROUP-B

(Physical-1A)

[Marks: 20]

1. Answer any one question: $1 \times 1 = 1$

- a) Define Helmholtz free energy (A).
- b) State the zeroth law of Thermodynamics.

2. Answer any two questions: $2 \times 2 = 4$

- a) From the second virial coefficient how can you calculate Boyle temperature?
- b) The critical temperature and critical pressure of ethane are 32.3°C and 48.2 atm , respectively. Calculate the critical volume using the van der Waals equation.

c) What is the physical significance of enthalpy?

3. Answer any one question: $5 \times 1 = 5$

- a) Derive an expression for the binary collision frequency for identical gas molecules. Find the dimension and C.G.S unit of van der Waals' constant 'a'. $3+2$

- b) i) Draw schematically the one-dimensional velocity distribution plots for an ideal gas at two different temperatures. What specific type of distribution is it?

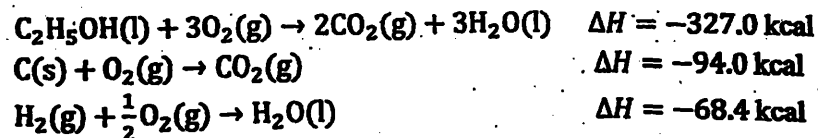
- ii) Calculate the total kinetic energy of all molecules of one mole of an ideal gas present in a 3 litre vessel under 2 atmospheres of pressure at a certain temperature. $3+2$

4. Answer any one question: $10 \times 1 = 10$

- a) i) Show that $\left(\frac{\partial U}{\partial V}\right)_T = 0$

for a gas obeying $P(V - nb) = nRT$.

- ii) Calculate the heat of formation of ethanol at 25°C from the given ΔH values:



- iii) Obtain an integrated form of Kirchhoff's relation between ΔH of a reaction and temperature. $3+4+3$

- b) i) What is Hess's law of constant heat summation?

- ii) The reduced volume and temperature of a gas are 10.2 and 0.7. What will be its pressure if its critical Pressure is 42 atm ?

- iii) Derive the relationship $TV^{\gamma-1} = \text{constant}$,
between temperature and volume in
reversible adiabatic expansion. 3+3+4
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