

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 $\text{\AA}^0$.
 $h = 6.626 \times 10^{-27} \text{ erg.sec}$, $m = 9.11 \times 10^{-28} \text{ gm}$.

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 electro negativity 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: 1×1=1
 - a) Define Helmholtz free energy (A).
 - b) State the zeroth law of Thermodynamics.
2. Answer any two questions: 2×2=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: 5×1=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?

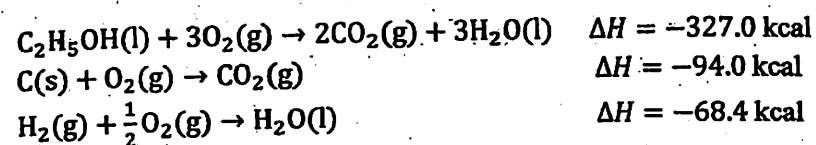
- ii) Calculate the total kinetic energy of all molecules of one mole of an ideal gas present in a 3 litre vessel under 2 atmospheres of pressure at a certain temperature. 3+2

4. Answer any one question: 10×1=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 reduce 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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