U.G. 1st Semester Examination - 2024

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: 1×1=1

   a) What do you mean by *Eigen function*?

   b) The first Bohr radius of H-atom is 0.529Å, find the same for He^+ ion.

2. Answer any **two** questions: 2×2=4

   a) Calculate the Allred-Rochow electronegativity of F. (Given: F-F bond distance = 141.3 pm).

b) Explain why second electron affinity of oxygen is negative?

c) Write two limitations of Aufbau principle.

3. Answer any **one** question: 5×1=5

a) Calculate the wavelength of β line in Lyman series of He^+. (Given: R=109677 cm^{-1}). From Heisenberg's uncertainty principle prove that $\Delta E.\ \Delta t \approx h/2\pi$. What is the lowest value of 'n' that allows 'g' orbital to exist. 2+2+1

b) i) Compare van der Walls radii and covalent radii.

ii) Comment on the relative ionic radii of O^{2-}, F^- and Na^+. 3+2

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

a) i) What do you mean by quantum numbers? The intrinsic spin angular momentum of an electron is defined by two quantum numbers – explain. 1+2

ii) State Pauli's exclusion principle. Apply this to predict the maximum capacity of 3rd quantum shell for accommodating electrons? 1+2

iii) Calculate the exchange energy of p^4 electronic configuration with maximum pairing and maximum unpairing. 1+1

iv) Draw the radial probability distribution curve for 3s atomic orbital. 2

b) i) During ionization of vanadium, the 4s electron comes out first-explain it using the concept of Slater's rule. 2

ii) Is electronegativity an intrinsic property? Calculate the electronegativity of carbon atom in C-H bond, if E_{C-H}, E_{H-H} and E_{C-C} are 98.8, 104 and 83 KCal/mole respectively. E = bond energy. 1+2

iii) Electron affinity of SF_5 is very high while that of SF_6 is only modest – Explain. 2

iv) In hydrogenic ion the energy required to excite the electron from its ground state to first excited state is 40.8 ev. Find the energy required to release the electron from the ion. 2

v) What is meant by microstate? 1

GROUP-B

(Physical-1A)

[Marks: 20]

1. Answer any **one** question: $1\times1=1$

   a) Define Boyle temperature.

   b) Define most probable velocity.

2. Answer any **two** questions: $2\times2=4$

   a) Write down the Virial equation of state in terms of 1/V for real gases explaining the meaning of the symbols used.

   b) The diameter of Argon atom is 2.87Å. Calculate the mean free path of this gas at 27°C and 1 atm.

   c) Define the first law of thermodynamics, write the mathematical form of the law explaining the terms involved.

3. Answer any **one** question: $5\times1=5$

   a) i) Van der Waal's constants for Carbon Dioxide are $a=0.364\ Nm^4mol^{-2}$ $b=4.28\times10^{-5}m^3mol^{-1}$ and $R=8.314JK^{-1}mol^{+1}$. Calculate its critical constants V_C, T_C, P_C.

   ii) The heat of neutralization of HCN (aq.) is 3 Kcal per eq at 25°C by a strong alkali. Calculate the heat of dissociation of HCN (aq.). [Given heat of nutralization of HCN by strong alkali is –13.7Kcal per eq] 3+2

   b) i) Convert Maxwell's distribution of molecular velocities into Maxwell's distribution of kinetic energy.

   ii) Under what conditions is the heat evolved or absorbed equal to the internal energy change? 4+1

4. Answer any **one** question: $10\times1=10$

   a) i) For one mole of an ideal gas, show that $C_P-C_V=R$, where symbols have their usual meanings.

   ii) Show that at low pressures, the Dieterici equation of state and the van der Waal's equation of state would respond to the same extent.

iii) A man is running along a beach and he perform 4.3×10^5J of work giving off 3.8×10^5J of heat. What is his internal energy change? If he later walks on another day, he gives off 1.2×10^5J of heat, then his internal energy decreases by 2.6×10^5J. How much workd does he do then? 3+2+5

b) i) Show that in adiabatic expansion of an ideal gas PV^{γ}=Constant (The symbols have their usual meanings.).

ii) Calculate the temperature at which the r.m.s velocity of SO_2 will be equal to that of O_2 at 27°C.

iii) 10 liters of Helium gas expanded reversibly and adiabatically from 10 atm to 1 atm. Final volume is 25 liters. Calculate the adiabatic work. $3\frac{1}{2}+3\frac{1}{2}+3$

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