

West Bengal State University
B.A./B.Sc./B.Com. (Honours, Major, General) Examinations, 2011
Part - II

CHEMISTRY (Physical) — HONOURS
Paper - IV (A)

Duration : 2 Hours

[Maximum Marks : 50

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

The figures in the margin indicate full marks.

GROUP - A

Answer any *three* questions, taking *one* from each Unit.

UNIT - I

1. a) What do you mean by Compton effect ?
 A beam of X-rays is scattered by loosely bound electrons of a target through 45° to the direction of the beam. What is the amount of Compton shift ?
 (rest mass of electron = 9.109×10^{-31} kg, $h = 6.625 \times 10^{-34}$ Js). 4
- b) Find the eigenfunction of the linear momentum operator, $\hat{P}_x \left(= \frac{h}{i} \frac{d}{dx} \right)$, if the eigenvalue is k . 2
- c) Classify each of the following operators as linear or non-linear : 2
 $\frac{d}{dx}$, \log , $\sqrt{\quad}$, $\int dx$
- d) What do you mean by zero point energy of a particle executing simple harmonic motion ? The occurrence of zero point energy for such a particle is consistent with the Heisenberg uncertainty principle. Explain. 2 + 2

- e) i) Giving the physical meaning of Radial Distribution Function of H-atom, establish its mathematical form. 2
- ii) Explain why the p -orbitals are often labelled as p_x , p_y and p_z instead of p_0 , p_{+1} , p_{-1} . 2
2. a) Evaluate the commutator $[p_x^2, x]$. 3
- b) Calculate the probability that a particle in a one-dimensional box of length L is found to be between 0 and $L/2$. 3
- c) Apply de Broglie's hypothesis to arrive at Bohr's quantization condition. 2
- d) What is meant by degeneracy? Find the quantum numbers associated with the energy level $\frac{17 h^2}{8 ma^2}$ of a particle in cubical box and hence indicate the degree of degeneracy. 4
- e) The 1s-state of a hydrogen atom is given by
- $$\psi = \frac{1}{\sqrt{\pi}} \left(\frac{1}{a_0} \right)^{3/2} \exp(-r/a_0)$$
- Determine the most probable value of r in this state. 4

UNIT - II

3. a) What do you mean by 'fugacity' of the gas? Express fugacity in terms of measurable properties (such as P , V) of the gas and state how it can be determined. 4
- b) Chemical potential of an ideal gas is given as
- $$\mu = \mu^0 + RT \ln P \quad \therefore p = e^{\frac{\mu - \mu^0}{RT}} \quad \dots (i)$$
- Justify the dimension of both sides of equation (i). 2
- c) Determine the effect of introducing an inert gas, keeping pressure of the system constant, on the position of equilibrium of the following reaction: 3
- $$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
- d) The solubility of a sparingly soluble salt in water increases in presence of an added electrolyte without a common ion. Justify. 3

