

- (b) What is meant by the term 'Binding Energy of Nucleus' ? Explain, how the binding energy of a Helium (He) atom can be calculated. 7,5

8. (a) Why are the radioactive isotopes dangerous to the human beings ? Explain.
(b) Write short notes on the following :
(i) Radiochromatography
(ii) Radiometric Titrations.
(c) Write some applications of Neutron Absorptiometry. 4,6,2

Roll No.

Total Pages : 04

LMDE/M-24

7027

PHYSICAL CHEMISTRY-II

CHEM-202

(OBES/LOCF)

Time : Three Hours]

[Maximum Marks : 60

Note : Attempt *Five* questions in all, selecting at least *one* question from each Section. All questions carry equal marks. Use of log tables and simple calculators is allowed.

Section A

1. (a) For a simple harmonic oscillator, setup and solve a Schrödinger wave equation and solve it for the energy eigenvalues.
(b) Determine which of the following functions are eigen functions of the operator $\frac{d^2}{dx^2}$:
(i) $\exp(ikx)$
(ii) $\cos(kx)$
(iii) $\exp(-ax^2)$.

Write the eigen values wherever applicable. 9,3

2. (a) Setup and solve the time-independent Schrödinger equation for a neutral particle in a '*three-dimensional box*' and derive energy expressions.
- (b) Calculate the spacings between energy levels for :
- an electron (mass = 10^{-30} kg) in a one-dimensional box of 1.0 Å length
 - a ball bearing (mass = 1 g) in a box of 10 cm length.

Comment on the energy gaps in the two cases. 7,5

Section B

3. (a) If the normalized radial eigen function of the hydrogen-like atom is generally expressed as :

$$R_{n,l}(r) = \sqrt{\left(\frac{2Z}{na_0}\right)^3 \frac{(n-l-1)!}{2n\{(n+1)!\}^3}} \cdot \left(\frac{2Zr}{na_0}\right)^l L_{n+l}^{2l+1}\left(\frac{2Zr}{na_0}\right) \cdot \exp\left(-\frac{2Zr}{na_0}\right)$$

Obtain the radial eigen functions for :

- $n = 1, l = 0$
 - $n = 2, l = 0$
 - $n = 2, l = 1$.
- (b) How is radial probability density obtained from the hydrogen atom wavefunction :

$$\psi(r, \theta, \phi) = R(r) \cdot P(\theta) \cdot F(\phi) \quad ? \quad 7\frac{1}{2}, 4\frac{1}{2}$$

4. (a) For an electron revolving in a Hydrogen atom, write the Schrödinger equation in terms of polar coordinates. Separate the equation so obtained in three equations using the technique of separation of variables.
- (b) Discuss the classical and quantum mechanical concept of angular momentum and show that :

$$[\widehat{L}_y, \widehat{L}_z] = i\hbar \widehat{L}_x. \quad 6,6$$

Section C

5. (a) Discuss the mechanism and kinetics of coordination polymerization.
- (b) Write briefly about the following :
- Polydispersity
 - Liquid Crystal Polymers.
- (c) Write some applications of '*Flame Retardant Polymers*'. 6,4,2
6. (a) Describe the determination of molecular mass of a polymer by the '*Viscosity Method*'.
- (b) Discuss the mechanism and kinetics of '*Step-Growth*' polymerization. 6,6

Section D

7. (a) Discuss the principle, instrumentation and functioning of a '*Proportional Counter*'. Mention its applications.