NRT/KS/19/2138

Bachelor of Science (B.Sc.) Semester–V Examination

QUANTUM MECHANICS, NANOMATERIALS AND NANOTECHNOLOGY

Optional Paper–2

(Physics)

Time : Three Hours] [Maximum Marks : 50

N.B. :— (1) All questions are compulsory.

(2) Draw neat diagrams wherever necessary.

EITHER

1. (A) What is Compton Effect ? Discuss experimental arrangement of Compton Effect. Obtain an expression for Compton shift with results. 5

(B) (i) What are the significance of Compton effect ? 3

(ii) A monochromatic beam of X-ray having wavelength 5.5×10^{-11}m is scattered through an angle 45º. Find the wavelength of scattered beam.

(Given : $M_0 = 9.1\times10^{-31}$kg, h = 6.63×10^{-34}JS, C = 3×10^{8} m/sec) 2

OR

(C) State and prove de-Broglie's hypothesis. 2½

(D) Show that the electron has a wave like nature by Davisson and Germer's experiment. 2½

(E) Why electron can not exist inside the nucleus ? Explain. 2½

(F) The life time of an excited state of an atom is about 10^{-8} sec. Calculate the minimum uncertainty in the determination of energy of an excited state.

(Given : h = 6.63×10^{-34} JS) 2½

EITHER

2. (A) What do you mean by free particle ? Obtain an expression for the energy of particle confined in a rectangular one dimensional box. 5

(B) (i) Explain degeneracy and non-degeneracy. 3

(ii) Find the minimum energy of an electron constrained to move linearly in infinitely high potential box of length 10^{-11} m.

(Give : h = 6.63×10^{-34} JS, M = 9.1×10^{-31}kg) 2

OR

(C) Derive Schrodinger's time independent wave equation for a free particle. 2½

(D) What is normalization of a wave function ? How it is mathematically expressed ? 2½

(E) Explain the physical significance of wave function ψ. 2½

(F) Find the lowest energy of an electron confined in a cubical box of each side 1 AV in ev.

(Given : h = 6.63×10^{-34} JS, m = 9.1×10^{-31}kg) 2½

EITHER

3. (A) Explain Top-down and Bottom-up approaches for the synthesis of nanomaterials. 5

(B) (i) Explain 3D, 2D, 1D and 0D materials. 3

(ii) What would be the surface to volume ratio of a quantum dot of radius 2 nm ? 2

OR

(C) Discuss the physical properties of nanomaterials. 2½

(D) Differentiate between nanomaterials and bulk materials. 2½

(E) Why surface to volume ratio is very high for nanoparticles as compared to bulk materials ? Explain with an example. 2½

(F) The block of nanomaterials has a surface area $36m^2$ and volume of $1m^3$. Calculate the surface to volume ratio of the block system. 2½

EITHER

4. (A) Discuss how Debye-Scherrer's technique is used for the determination of size of nano-materials. 5

(B) (i) State the different techniques to determine particle size of nanomaterials and distinguish between them in short. 3

(ii) Calculate the crystallite size using Debye-Scherrer's formula from the following data :

Source wavelength = 0.154 nm; Peak FWHM = 0.5 degrees; Peak position = 27º; Scherrer's constant = 0.94. 2

OR

(C) What is Sol-Gel method ? Explain the synthesis of nanomaterials by this method. 2½

(D) What is BET ? How BET technique is used for the determination of specific surface ? 2½

(E) Distinguish between SEM and TEM. 2½

(F) Calculate wavelength of X-ray diffracted from nano material having interplanar distance of 0.89 AU and an angle of diffraction of 30º in first order. 2½

5. Attempt any **ten** (1 mark each) :

(i) Write Planck's Law in terms of wavelength.

(ii) State Heisenberg's uncertainty principle.

(iii) Find the de-Broglie wavelength for an electron moving at the speed of 5×10^6 m/s.

(Given : $h = 6.63\times10^{-34}$ JS)

(iv) Define Expectation value.

(v) State momentum and energy operator.

(vi) What is well behaved wave function ? State the conditions for it.

(vii) State, why one nanometer is a magical point on the dimensional scale.

(viii) Write any two applications of nanomaterials in medical science.

(ix) What are the fundamental issues in nanomaterials ? State any two.

(x) Why wet chemical synthesis is easy as compared to other synthesis methods ?

(xi) What are the disadvantages of SEM ?

(xii) What are the applications of nanotechnology ? 10