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Bachelor of Science (B.Sc.) Semester—V
(C.B.S.) Examination
QUANTUM MECHANICS, NANOMATERIALS AND NANOTECHNOLOGY
Paper—II
(Physics)

Time—Three Hours] [Maximum Marks—50

N.B. :— (1) All questions are compulsory.
(2) Draw neat diagrams, wherever necessary.

EITHER

1. (A) (i) What is Planck's quantum hypothesis ? 3

(ii) Explain how classical physics failed to explain black body spectra. 2

(B) (i) Derive Planck's radiation law in terms of wavelength. 3

(ii) Calculate the Planck's constant of a photon having energy 12.4×10^{4} eV of wavelength 1Å and speed is 3×10^{8} m/s. 2

OR

(C) What is Compton effect ? Give its experimental arrangement. 2½

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(F) Derive Schrodinger's time independent equation for the matter waves. 2½

EITHER

3. (A) What are the nanomaterials ? How nanomaterials are different from bulk materials ? Explain any two size dependent properties of nanomaterials. 5

(B) (i) Explain top down approach for the synthesis of nanomaterials with neat diagram. 3

(ii) The block has a surface area of 6 m^2 and volume of 1 m^3. Calculate the surface to volume ratio of the block system. 2

OR

(C) Define nanoclusters. What are properties of nanoclusters ? 2½

(D) What are quantum dots ? Explain the properties of quantum dots. 2½

(E) State the properties and applications of carbon nanotube. 2½

(F) The surface to volume ratio of a quantum dot is $2\times10^{+9}$ m^{-1}, calculate the radius of the quantum dot. 2½

EITHER

4. (A) What is scanning electron microscope ? Explain its construction and working with necessary diagram. 5

(B) (i) Explain with suitable diagrams the sol-gel method for synthesis of nano particles. 3

(ii) Calculate the crystallite size of nanocrystallite copper oxide (CuO) material diffracting at an angle 38.2° with FWHM of 0.4° with an x-ray of wavelength 1.54 Å. 2

OR

(C) Explain the HCR technique for the synthesis of nanomaterials. 2½

(D) Explain the Debye Scherrer formula for the determination of the size of nanomaterials. 2½

(E) Calculate inter planar distance of a nanomaterial. Give λ = 1.54 Å, θ = 60°, the order of diffraction n = 1. 2½

(F) How nanotechnology is useful in home appliances ? 2½

5. Attempt any **TEN** questions (1 mark each) :

(i) Define perfectly black body.

(ii) Find the de-Broglie wavelength of an electron moving at the speed of 5×10^{6} m/s (mass of electrons = 9.1×10^{-31} kg).

(iii) Define group velocity and phase velocity.

(iv) What is normalization of wave function ?

(v) Define expectation value of a dynamical quantity.

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(D) State and prove Heisenberg's uncertainty principle by Gamma ray microscope (thought experiment). 2½

(E) A microscope using photons is employed to locate on electron in an atom within a distance of 0.2 Å. What is the uncertainty in the momentum of electron located in this way ? 2½

(F) Obtain a relation between group velocity (Vg) and phase velocity (Vp). 2½

EITHER

2. (A) (i) Obtain an expression for energy of free particle in one dimensional potential well. 3

(ii) Find the ground state energy of particle of mass 9.1×10^{-31} kg confined to one dimensional box of size 10^{-10} m. (Given h = 6.63×10^{-34} Js). 2

(B) State and prove Ehrenfest's theorem. 5

OR

(C) Give physical significance of wave function, ψ. 2½

(D) Define eigen value and eigen function. 2½

(E) The wave function is given by $\psi(x) = e^{ax}$, where a is constant. Find the eigen value for the operator $\frac{d}{dx}$ and $\frac{d^2}{dx^2}$. 2½

(vi) Write a normalized wave function $\psi_{(x)}$ for a particle moving in one dimensional box of width π Å in its least energy state.

(vii) What is magic number in nano-cluster ?

(viii) What are Fullerenes ?

(ix) Define nanoscience and nanotechnology.

(x) What are limitations of SEM ?

(xi) State two application nanotechnology in medicine.

(xii) Full width at half maximum (FWHM) of the diffraction peak is 0.234°, convert it into radian. 10×1=10

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