Total number of printed pages–4

3 (Sem–4/CBCS) PHY HC 2

2024

PHYSICS

(Honours Core)

Paper : PHY–HC–4026

(Elements of Modern Physics)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×7=7

   (a) Write down *any one* limitation of classical mechanics in explaining photoelectric effect.

   (b) Write down the dimension of Planck's constant.

   (c) Name an experiment that confirms particle nature of radiation.

   (d) Give one practical application of particle in a box.

Contd.

(e) What are canonical conjugate pairs?

(f) Give one example of magic nuclei.

(g) Name the method used to achieve population inversion in Ruby laser.

2. Answer the following questions: 2×4=8

(a) Write the basic assumptions of quantum theory of light.

(b) State the conditions for a well-behaved wave function.

(c) What is tunnelling? Mention any two applications of tunnelling.

(d) 99% of a radioactive element disintegrates in 36 hours. Calculate its half-life. (ln 2=0·693 and ln 100=4·605)

3. Answer ***any three*** questions from the following: 5×3=15

(a) What are phase velocity and group velocity? Write down the relation between phase velocity and group velocity. Show that, if the phase velocity is constant then group velocity is equal to the phase velocity. 2+1+2=5

(b) What are operators? Derive an expression for linear momentum operator. 2+3=5

(c) Draw the graph showing the variation of binding energy per nucleon with mass number. Illustrate the main features of the graph. 2+3=5

(d) Write down the semi-empirical mass formula explaining briefly each term involved. Write *any two* properties of nuclear force. 3+2=5

(e) State the law of radioactive decay. Derive the relation $N = N_0 e^{-\lambda t}$ (symbols have their usual meaning) for a radioactive substance. 2+3=5

4. Answer ***any three*** questions from the following: 10×3=30

(a) Explain Davisson and Germer experiment. What is the significance of the experiment? 8+2=10

Or

(b) State Heisenberg's uncertainty principle. Describe gamma ray microscope experiment. Calculate the uncertainty in momentum of an electron if the uncertainty in its position is 0·4 *nm*. (h= 6·62×10^{-34} m^2kg/sec) 2+6+2=10

(c) Solve Schrödinger equation for a particle in a one-dimensional rigid box and obtain its eigenvalues. Find out an expression for zero point energy. Interpret the result. 7+2+1=10

(d) Distinguish between nuclear fission and fusion. What are the basic requirements for fusion reaction? Explain *any one* thermonuclear reaction which leads to the stellar energy. 2+2+6=10

(e) Discuss in detail the methods of energy loss by gamma photons in a medium.

(f) Distinguish between spontaneous and stimulated emission. Explain the working of He-Ne laser.
