(b) What are stationary states. Show that the probability current density is divergence less for such states. (8)

5. (a) How do spontaneous emission, stimulated emission, and absorption processes contribute to the overall behaviour of a laser system? (10)

(b) A crystal with lattice spacing d = 0.25 nm produces a first-order diffraction peak at an angle of 30° when illuminated with X-rays. What is the wavelength of the X-rays? (8)

6. (a) Calculate the binding energy per nucleon in C_6^{12}. Masses of proton, neutron and electron are 1.00728, 1.00867 and 0.00055 amu respectively. The mass of C_6^{12} Atom is 12.00000 amu. (10)

(b) Explain the contribution of pairing energy and asymmetry energy in the semi-empirical mass formula. (8)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4814 **J**

Unique Paper Code : 2224001203

Name of the Paper : Modern Physics

Name of the Course : **B.Sc. Hons. - (Physics)_NEP: UGCF-2022**

Semester : II / IV / VI (GE Paper)

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **All** Questions carry equal marks.
3. Q. No. **1** is compulsory.
4. Answer any **four** of the remaining five questions.
5. Use of non-programmable scientific calculators are allowed.

P.T.O.

1. Attempt any **six** questions out of **seven**.

(a) Why Compton effect cannot be observed with visible light?

(b) A neutron is moving at 1000 m/s. Calculate its de Broglie wavelength.

Given: mass of the neutron m = 1.675×10^{-27}kg. and h = 6.626×10^{-34}Joule – second.

(c) The energy of an excited hydrogen atom is -3.4 eV. Calculate the angular momentum of the electron according to Bohr theory.

(d) The speed of a bullet of mass 50gm is measured to be 300 m/s with an accuracy of 0.01%. With what accuracy can we locate the position of the bullet.

(e) Describe the fundamental properties of lasers and their significance in various applications.

(f) Find the half-life time and mean life time of a radioactive substance of which the decay constant is 4.28×10^{-4} per year.

(g) Explain the lower binding energy of heavy nuclei. (6×3=18)

2. (a) Explain the Davisson-Germer experiment in detail. Describe the experimental setup, procedure, and observations. How did this experiment confirm the wave nature of electrons and support de Broglie's hypothesis? (10)

(b) Derive the Compton shift formula :

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{m_o c}(1 - cos\theta)$$ (8)

3. (a) Find out the ground state energy and radius of the hydrogen atom. (6)

(b) Find the longest and the shortest wavelengths of the Lyman series. Given, Rydberg constant = 1.097×10^{7} m^{-1}. (6)

(c) Give the reason for nonexistence of electrons inside the nucleus by uncertainty principle. (6)

4. (a) Calculate the probability that a particle in a one-dimensional box of length L can be found between 0.4 L to 0.6 L for the

(i) Ground state

(ii) First excited state

(iii) Second excited state (10)

P.T.O.