(This Question paper contains 2 printed page) Roll No. _____

S.No. of Question Paper : **6580** **L**

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

Semester: II- Semester (GE Paper)

Name of the Paper: **Modern Physics**

Unique Paper Code: 2224001203 **90**

Duration: **3 hours** Maximum marks:

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

1. Attempt any six questions out of seven.

(a)Calculate the mass defect of He_2^4 . Given: Mass of proton = 1.00728 u, Mass of neutron = 1.00866 u, mass of helium nucleus = 4.00150 u.

(b) An X-ray photon of wavelength 0.5 nm is scattered through an angle of 60^o. Calculate the change in wavelength.

(c) Define group velocity and phase velocity.

(d) What is the significance of Planck's constant in the uncertainty principle?

(e) What are the essential components of a laser system?

(f) For a crystal with spacing $d = 0.3\ nm$, X-rays of wavelength $0.1\ nm$ are used. Find the angle for second-order diffraction.

(g) Explain the lower binding energy of lighter nuclei.

$(6 \times 3 = 18)$

1-(a)Explain the experimental setup and working of the Davisson–Germer experiment. How did it demonstrate the wave nature of electrons?

(10)

(b)A wave is described by the dispersion relation:

$$\omega = 4k^2 + 2k$$

Find:
(i) Phase velocity
(ii) Group velocity

(8)

2(a) Explain the gamma-ray microscope thought experiment and show how it leads to the uncertainty in position and momentum.

(10)

(b) An electron is confined within a region of width $1.0 \times 10^{-8} m$. Find the minimum uncertainty in its momentum and velocity.

(8)

3(a) Compare the behavior of photons and electrons in the two-slit experiment. What conclusions can be drawn about the nature of matter and radiation?

(10)

(b) In a double-slit experiment, slit separation $d = 4\lambda$ and slit width $a = \lambda$. Find the first missing order. (8)

4(a) Explain the process of lasing action in a laser system. How does the population inversion created within the gain medium lead to the emission of coherent light?

(10)

b) For a system, $A_{21} = 2.0 \times 10^{-7} \mathrm{s}^{-1}$and energy density of radiation $u(\nu) = 10^{-5}\ \mathrm{J/m}^{-3}$. Given $B_{21} = 10^{-12} \mathrm{m}^{-3} \mathrm{J}^{-1} \mathrm{s}^{-2}$, find the ratio of stimulated to spontaneous emission rates.

(8)

5 (a) Write down the assumptions and draw backs of Liquid drop model. Derive the Semi empirical binding-energy formula.

(10)

(b) Calculate the binding energy of (Z=13, A=27). Use (in MeV): $a_v = 15.8$, $a_s = 18.3$, $a_c = 0.714$, $a_a = 23.2$ $a_p = 12$ (8)

6(a) Discuss the conservation laws involved in beta decay and explain how the neutrino ensures their validity. (10)

(b) Explain the N–Z graph and discuss its significance in understanding nuclear stability.

(8)