5. (a) How are decay constant, half life and mean life of a radioactive nuclide related with one another? Derive the equations connecting them. Give units for each quantity. How do you calculate the activity of a source?

   (b) Why is population inversion necessary for a lasing operation? Explain one method to achieve it. What is the difference between spontaneous emission and stimulated emission? Apart form these two processes, is there any other process that takes place in a laser?

   (c) Derive Bragg's law of diffraction. The wavelength of the X-ray is 0.071 nm which is diffracted by a plane of salt with 0.28 nm as the lattice constant. Find the glancing angle for the second order diffraction. Assume the value of the salt plain to be 110 and given salt is rock salt. (8,5,5)

6. (a) Explain in detail all the terms present in the semi-empirical mass formula for a nucleus of mass number 'A', containing 'Z' protons and 'N' neutrons.

   (b) Give the reason for the introduction of the concept of neutrino by Pauli. How N-Z plot can be used to predict the various types of Beta Decay?

   (c) The most probable energy of a thermal neutrons is 0.025 eV at room temperature. In what distance will half a beam of neutron have decayed. Given the half-life of the neutron is 10.3 minutes. (8,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6093 **H**

Unique Paper Code : 2224001203

Name of the Paper : Modern Physics

Name of the Course : **B.Sc. Hons. – GE**

Semester : II

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. Answer **five** questions in all.
3. **Q.1** is compulsory.
4. **All** questions carry equal marks.
5. Use of Non-Scientific calculator is allowed.

1. Attempt **all** the questions :

   (a) The half-life of a nucleus is 20 days. What is its decay constant and mean life time?

   (b) Can one measure the difference between various energy levels of a ball of mass 10 gram moving in a ID box of length 10 cm and why?

(c) What do you understand by metastable states? Why are they important?

(d) The speed of an electron is measured to be 5.3×10^3 m/s to an accuracy of 0.005%. Find the minimum uncertainty in determining the position of this electron.

(e) The energy of an excited hydrogen atom is –3.4 eV, calculate the angular momentum of the electron according to Bohr theory.

(f) An electron is accelerated by 100 V. What is its de Broglie wavelength? (3×6=18)

2. (a) Discuss how classical approaches failed to account for the spectral distribution of energy density in the black body radiation. How Planck overcame these difficulties? Derive Planck's Radiation Law.

(b) What are outcomes of the Davisson and Germer experiment? Explain how these results directly confirm the de Broglie hypothesis of the matter waves.

(c) In Davisson Germer diffraction experiment electrons of kinetic energy 100 eV are scattered from a crystal. The first maximum in intensity occurs at $\Phi = 10$ degree. What is the spacing between the crystal planes? How many peaks will there be in the interference pattern. (8,5,5)

3. (a) Explain the hydrogen spectrum on the basis of the Bohr model. Express Rydberg constant in terms of fundamental constants. Draw the energy level diagram of Hydrogen, indicating the energy of the first few states in eV and its possible transitions along with their names.

(b) How does the uncertainty principle rule out the possibility of the existence of electrons inside the nucleus.

(c) The position and momentum of a 2 KeV electron are simultaneously determined. If its position is located within 0.2 nm, what is the percentage of uncertainty in its momentum? (8,5,5)

4. (a) Define probability density and hence explain the meaning of normalization. Using time independent Schrodinger equation, derive the momentum eigen values and momentum eigen functions for a particle trapped in one dimensional infinite potential well.

(b) Explain in detail the double slit experiment with particles. How does it explain the dual nature of the particles.

(c) Can one measure the difference between various energy levels of a ball of mass 10 gram moving in a ID box of length 10 cm? Give reasons in support of your answer. (8,5,5)

P.T.O.