$$V(x)=\begin{cases}\infty & x<-a/2\\ 0 & -a/2\le x\le a/2\\ \infty & x>a/2\end{cases}$$

Find the wave function associated with the particle and its energy E.

(b) What are quantum dot particles? How are they related with quantum mechanics? (10,5)

6. (a) On the basis of the liquid drop model of a nucleus, explain the various terms of semi-empirical mass formula for calculation of binding energy of a nucleus.

(b) Gold $^{197}_{79}Au$ is the most ductile metal. Calculate is average radius, nuclear volume and nuclear density. (10,5)

7. (a) Discuss the variation of binding energy per nucleon with mass number, A, and hence explain the concept of (i) nuclear stability, (ii) nuclear fission, and (iii) nuclear fusion.

(b) Consider the following decay process:

$$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He + Q$$

Determine the kinetic energies of the α-particles and the daughter nuclei. (10,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3007 **H**

Unique Paper Code : 32221402

Name of the Paper : Elements of Modern Physics

Name of the Course : **B.Sc. Hons Physics Core Repeat Paper**

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. **Q1** is compulsory.
4. **All** questions carry equal marks.
5. Use of non-programmable scientific calculator is allowed.

1. Attempt any five questions : (3×5=15)

(a) Find the minimum energy of an electron confined in a one-dimensional box of size 10 nm.

(b) What is the number of photons that strike a surface of $1cm^3$ in one second if the incoming light of 650nm wavelength has an intensity of 100 watts/ m^2?

(c) What are spontaneous and stimulated emissions? Why stimulated emission is necessary for lasing action?

(d) The wavefunction associated with a particle is given as $\psi(x) = A \cos\left(\frac{n\pi x}{L}\right)$ in region $0 \leq x \leq L$. Find the value of normalization constant A.

(e) The position and momentum of a 1 KeV electron are simultaneously measured, if the position is located within 0.1 nm, what is the percentage of uncertainty in momentum?

(f) The binding energy of $^{24}Mg_{12}$ is 198.28 MeV. Find its atomic mass, (take mass of neutron to be 1.674×10^{-27}kg and mass of proton to be 1.672×10^{-27}kg)

(g) The half-life of ^{24}Na is 15 hours. How long will it take for 70% of sample of this nuclide to decay?

2. (a) What is photoelectric effect? Discuss the observations of the experiment illustrating photoelectric effect. How does the classical electromagnetic theory fail to explain these results?

(b) If blue light of wavelength 460 nm impinges on a metal surface, a stopping potential of 1.1 eV is obtained. What will be the work function of the given metal? (10,5)

3. (a) State Heisenberg's uncertainty principle for position and momentum and illustrate it using gamma ray microscope thought experiment.

(b) A photon is emitted in a process characterized by a time interval of 1.0 millisecond. What will be the inherent uncertainty in the energy and frequency of the emitted photon. (7,8)

4. (a) Obtain the time independent Schrodinger's wave equation from the time dependent Schrodinger equation.

(b) Prove the relation $\partial P/\partial t + \nabla.J = 0$, where J is the probability current density and P is the probability density. Give the physical interpretation of the equation. What are the states called for which $\nabla.J = 0$. (5,10)

5. (a) A particle of mass m is confined in a one dimensional infinitely rigid box having potential