

12.12.18 (M)



[This question paper contains 4 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **461** **IC**

Unique Paper Code : 42227929

Name of the Course : **B.Sc.(Prog.) : DSE - 3A**

Name of the Paper : Elements of Modern
Physics

Semester : V

Time : 3 Hours **Maximum Marks : 75**

Instructions for Candidates :

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt **five** questions in **all**.
- (c) Question **NO.1** is compulsory.

1. Answer any five of the following : 3×5

- (a) For a relativistic massless particle establish

$$E = pc$$

where E is the total energy, p is the momentum and c is the velocity of light.

- (b) Enlist three problems of Rutherford's atomic model.

P.T.O.

- (c) How does the double-slit experiment establish the wave nature of an electron ?
- (d) Give the significance of the probability density of a particle.
- (e) The wave function for a particle confined in a 1-dimensional box is

$$\psi(x) = A \sin\left(\frac{n\pi x}{L}\right)$$

show that $A = \sqrt{\left(\frac{2}{L}\right)}$

- (f) The radius of C^{-12} is 3.0×10^{-15} m. Deduce the radius of He^4 .
- (g) Define work function and threshold frequency in the photoelectric effect.
- (h) 1 gram of an unknown radioactive substance, X^{226} , disintegrates at the rate of 6.02×10^{10} disintegrations per second. Calculate its mean life.
2. (a) Describe Davisson-Germer experiment and discuss its results. 10
- (b) One of the diffraction peaks observed by Davisson and Germer for a 65 keV electron beam was such that the angle between the incident beam and the scattered beam is 60° . For what value of crystal spacing is this peak seen in the first order ? 5

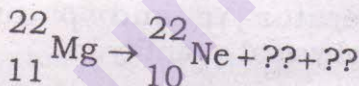
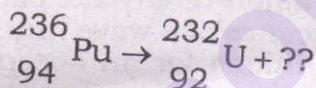
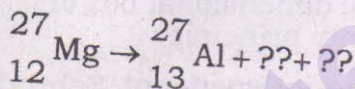
3. (a) Stating Bohr's postulates, obtain the expression for various energy levels of a hydrogen atom. 10
- (b) If an electron makes a transition from $n = 4$ to $n = 2$, determine the wavelength of emitted radiation. 5
4. (a) What is a wave packet? Prove that the deBroglie wave packet associated with a moving body travels with the same velocity as the body. 10
- (b) Estimate the ground state energy of a particle in a one dimensional box of length L using uncertainty principle. 5
5. (a) Obtain the time independent Schrodinger wave equation for a non-relativistic particle. What is the significance of a wave function? Also give the conditions for an acceptable wave function. 10
- (b) Correlate operator \hat{H} and \hat{p} to its corresponding physical quantity. 5
6. A particle of mass m and energy $E < V_0$ travelling along x -axis has a potential barrier defined by

$$V(x) = \begin{cases} 0 & x < 0 \\ V_0 & 0 < x < a \\ 0 & x > 0 \end{cases}$$

Derive the expressions for reflection and transmission coefficient of the particle. 15

7. (a) Find the size and density of the $^{12}_6C$ nucleus. 5
Given $R_0 = 1.2\text{fm}$.

- (b) What is binding energy? Obtain semi empirical binding-energy formula which gives the binding energy of a nucleus in terms of its atomic number Z and mass number A . Give the graph of variation of binding energy/nucleon versus atomic mass number. 10
8. (a) Discuss β -particle spectra in β -decay and hence the concept of neutrino. 10
- (b) Complete the following nuclear reactions : 5



Constants :

$$h = 6.62 \times 10^{-34} \text{ Js}$$

$$c = 3 \times 10^8 \text{ m/s}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$m_n = 1.6749 \times 10^{-27} \text{ kg} = 1.00866u$$

$$m_p = 1.6726 \times 10^{-27} \text{ kg} = 1.00728u$$

$$R = 1.097 \times 10^7 \text{ m}^{-1}$$