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.

mynotes.in

(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 60^0. 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) Fi.nd the size and density of the $^{12}_{6}C$ nucleus. Given $R_0 = 1.2$fm. 5

mynotes.in

(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

$$^{27}_{12}Mg \rightarrow ^{27}_{13}Al + ?? + ??$$

$$^{236}_{94}Pu \rightarrow ^{232}_{92}U + ??$$

$$^{22}_{11}Mg \rightarrow ^{22}_{10}Ne + ?? + ??$$

Constants :

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

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

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

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

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

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

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

4

1500

mnotes.in