

2019

B.Sc. (Hons)

4th Semester Examination

PHYSICS

Paper - C9T

Full Marks : 40

Time : 2 Hours

*The figures in the margin indicate full marks.
Candidates are required to give their answers
in their own words as far as practicable.*

1. Answer any *five* questions : 5×2=10

- (a) A π^0 meson at rest decays into two photons of equal energy. What is the wavelength of photon?
(Mass of π^0 is $135 \text{ MeV}/c^2$)
- (b) Write Einstein Photoelectric equation. What is the maximum wavelength of light required to produce photoelectric effect from a material of work function 4.7 eV .

[Turn Over]

- (c) Calculate the de-Broglie wavelength of thermal neutrons at 0°C and compare it with that of electrons of the same average energy.
- (d) Using uncertainty principle estimate the kinetic energy (in eV) of an electron in hydrogen atom. Diameter of hydrogen atom $\sim 0.53 \times 10^{-10}$ m
- (e) The state of a free particle is described by the following wave function.

$$\psi(x) = 0 \text{ for } x < -3a$$

$$= c \text{ for } -3a < x < a$$

$$= 0 \text{ for } x > a$$

Find the probability of finding the particle between 0 to a.

- (f) Find the spin and parity of ground state of ${}_{6}\text{C}^{13}$ using shell model.
- (g) What is pair production? Why pair production can not occur in vacuum?
- (h) Calculate the amount of ${}^{235}\text{U}$ consumed per day in Canada Deuterium reactor 'Cirus' operating at 40 MW of power. Energy released per fission of ${}^{235}\text{U}$ is 200 MeV.

2. Answer any *four* questions : 4×5=20

- (a) Derive the change in wavelength of a photon scattered in the direction of ϕ by an electron of rest mass m_0 .
- (b) What do you mean by Hermitian operator ? Show that the momentum operator is Hermitian.
- (c) Define quantum mechanical probability current density. Derive the probability current density of particles represented by the wavefunction.

$$\psi(x) = Ae^{ikx} + Be^{-ikx}$$

- (d) Define binding energy nucleus. Find the binding energy per nucleon of ${}_{15}\text{P}^{31}$. Given mass of

$${}_{15}\text{P}^{31} = 30.973763 \text{ u}$$

$$M_{\text{H}} = 1.007825 \text{ u}$$

$$M_{\text{n}} = 1.008665 \text{ u}$$

- (e) What is straggling range of alpha particles ? Why it occurs ? Discuss fine structure of alpha ray spectrum.

[Turn Over]

- (f) Show that the relation between Einstein's A and B co-efficient for transition between two states

$$1 \text{ and } 2 \text{ is given by } \frac{A_{21}}{B_{21}} = \frac{8\pi h \nu^3}{C^3}$$

3. Answer any *one* question : 10×1=10

- (a) (i) Derive the energy eigen values and normalized wavefunctions of a particle in a 1-D-box with rigid walls confined between $x = 0$ to $x = a$.

- (ii) Find the probability that the particle located in the region $\frac{a}{3} < x < \frac{2a}{3}$ for $n = 3$.

- (iii) Sketch the wavefunction and the corresponding probability density for $n = 1$ and $n = 2$. 6+2+2

- (b) (i) Describe Davisson - German experiment to demonstrate the wave like behaviour of moving electrons.

- (ii) Using uncertainty relation show that the electron cannot exist in the nucleus. 7+3