

Total Page - 4

UG/4th Sem/PHY/19

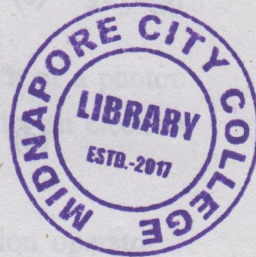
2019

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.*

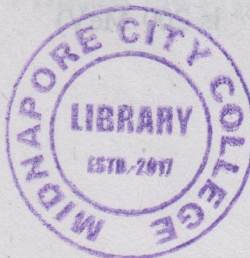
1. Answer any *five* questions : 5×2=10

(a) A  $\pi^0$  meson at rest decays into two photons of equal energy. What is the wavelength of photon?

(Mass of  $\pi^0$  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  $4.7 \text{ eV}$ .

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[ Turn Over ]

( 2 )

- (c) Calculate the de-Broglie wavelength of thermal neutrons at  $0^{\circ}\text{C}$  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 Indian reactor 'Cirus' operating at 40 MW of power. (Energy released per fission of  $\text{U}^{235}$  is 200 MeV)

( 3 )

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

- (a) Derive the change in wavelength of a photon scattered in the direction of  $\phi$  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 the structure of alpha ray spectrum.

[ Turn Over ]

( 4 )

- (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