

## BACHELOR OF SCIENCE (B.Sc.)

## Term-End Examination

June, 2012

## PHE-11 : MODERN PHYSICS

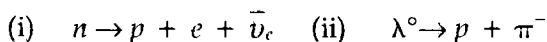
Time : 2 hours

Maximum Marks : 50

*Note : Attempt all questions. The marks for each question are indicated against it. You may use log tables and calculator. The values of Physical constants are given at the end.*

1. Answer any five parts : 2x5=10
- (a) Calculate the de-Broglie wavelength of a 2 MeV neutron.
  - (b) What is the rest mass of a photon ? Calculate the mass of a photon of Wavelength  $1\text{\AA}$ .
  - (c) What are the properties of a wave function for acceptable solution of Schrodinger equation ?
  - (d) A rod of proper length 2 m measures only 1 m in a reference frame moving with respect to it. Calculate the speed of the moving frame.
  - (e) An X-Ray tube operates at  $1.25 \times 10^4\text{V}$ . What is the minimum wavelength of X-Rays produced ?

(f) Explain, with reason, whether the following reactions are possible or not



(g) Explain the use of radioisotopes as tracer in pipelines.

2. Attempt **any two** parts : 5x2=10

(a) Protons are accelerated to a velocity of  $10^6 \text{ ms}^{-1}$  and then neutralised to hydrogen atoms. What is the Doppler shift of the wave length of light emitted in this process? The wavelength of light emitted by the atom when it is at rest is  $4861 \text{ \AA}$ .

(b) Obtain the relativistic energy relation :

$$E = \sqrt{p^2 c^2 + m_0^2 c^4}$$

(c) The life time of muons is  $2.2 \times 10^{-6} \text{ s}$  and their speed is  $0.998 C$ , so that they can travel only  $658.6 \text{ m}$  in their entire life. However, they are said to travel about  $10 \text{ km}$  before decay. Explain how this is possible on the basis of special theory of relativity.

3. Attempt **any two** parts : 5x2=10

(a) Show that  $H$  and  $t$  do not commute.

(b) The electron in H-atom may be thought of as confined to a radius of  $5 \times 10^{-11} \text{ m}$ . Calculate the minimum Uncertainty in the momentum of electron. Also calculate the minimum kinetic energy of the electron.

- (c) Show that all operators which are invariant under space inversion commute with the parity operator.

4. Attempt any two parts : 5×2=10

- (a) Obtain the wave function of a particle in one dimensional box of length  $l$ . Show that the wave functions for two different states are orthogonal to each other.
- (b) Obtain the average value of potential energy for the ground state of hydrogen atom :

$$\psi(r) = \left( \frac{1}{\pi a_0^3} \right)^{1/2} e^{-r/a_0}$$

- (c) Obtain the ground state term of Lithium (Li).

5. Attempt any two parts : 5×2=10

- (a) Uranium mineral contain one atom of radium for every  $2.8 \times 10^6$  atoms of Uranium. If the half lives of radium and Uranium are 1620 years and  $4.5 \times 10^9$  years respectively. Is the radioactive equilibrium attained by Uranium mineral secular or transient ? Explain.
- (b) What do you mean by a nuclear chain reaction to be supercritical, critical and Subcritical ? How is a critical chain reaction achieved ?

- (c) Calculate the energy released when a neutron decays into a proton and an electron.

**Physical Constants :**

$$h = 6.626 \times 10^{-34} \text{ Js.}$$

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

$$m_p = 1.6725 \times 10^{-27} \text{ kg}$$

$$m_n = 1.6747 \times 10^{-27} \text{ kg}$$

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