02301

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 1Å.

(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 1.25×10^4V. What is the minimum wavelength of X-Rays produced ?

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

(i) $n \rightarrow p + e + \bar{\upsilon}_e$ (ii) $\lambda^\circ \rightarrow p + \pi^-$

(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 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 Å.

(b) Obtain the relativistic energy relation :

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

(c) The life time of muons is 2.2×10^{-6}s and their speed is 0.998 C, so that they can travel only 658.6 m in their entire life. However, they are said to travel about 10 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 5×10^{-11}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 :* **5x2=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 :* **5x2=10**

(a) Uranium mineral contain one atom of radium for every 2.8×10^6 atoms of Uranium. If the half lives of radium and Uranium are 1620 years and 4.5×10^9 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 :

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

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

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

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