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PHE-11

BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

December, 2012

PHYSICS

PHE-11 : MODERN PHYSICS

00040

Time : 2 hours *Maximum Marks : 50*

Note : *Attempt **all** questions. The marks for each question are indicated against it. Symbols have their usual meanings. You may use non-programmable calculators or logtables. The values of physical constants have been given at the end.*

1. *Answer **any five** parts :* **5x4=20**

(a) The total energy of a particle is exactly twice its rest energy. Calculate its speed.

(b) A ball of mass 0.1 kg moving with a velocity of 10 ms^{-1} is incident on a slit of width 1 mm. Obtain the deBroglie wavelength associated with it. Will a diffraction pattern be observed on a screen placed behind the slit ? Explain.

(c) Draw a labelled schematic diagram of a nuclear reactor. Name any two coolants used in a nuclear reactor.

(d) In the lab-frame, two particles are observed to travel in opposite directions with speed 2.0×10^8 ms^{-1}. Calculate the relative speed of the particles.

(e) Obtain the total number of degenerate eigen functions for a hydrogen atom for $n = 2$.

(f) How long does it take for 60% of a sample of radon to decay ? Half life of radon is 3.8 days.

(g) Write down the charge, baryon number and spin of a photon and a proton.

2. Answer ***any one*** part :

(a) Calculate the annual loss in the mass of the sun, if approximately 8.4 J of radiated energy is received by each square cm of the earth's surface per minute. The distance of the sun from the earth's surface is 1.15×10^{11} m. **5**

(b) A pion at rest decays into a muon and neutrino (zero rest mass). Using the relativistic laws of conservation of energy and momentum, obtain the momentum of muons in terms of m_π m_μ. **5**

3. Answer ***any one*** part :

(a) (i) The unnormalized wave function of a moving particle is given by $\psi = x \exp(-x^2/2)$. Determine the normalization constant and (ii) Prove that $[L_x, L_y] = ih\, L_z$. **4+6**

(b) Consider a particle of mass m confined in a I-D potential box given by **10**

$V(x) = 0 \quad -a \leq x \leq a$

$= \infty$ otherwise

Write the Schrodinger equation for the particle and specify the boundary conditions. Obtain the normalized wave function and the energy eigen values.

4. Answer ***any one*** part :

(a) State Hund's rules. Using Hund's rules obtain the spectral terms and ground state of Sc ($z = 21$). **3+7**

(b) Write the selection rules for x-ray spectra. Are the transitions from L_I shell to K shell and L_{II} shell to K shell allowed ? Explain. X-rays from a Cobalt ($z = 27$) tube have a strong K-line of wavelength 1.785Å and a weak line due to copper impurity ($z = 29$). Using Mosley's law, calculate the wavelength of the weak line. **2+2+6**

5. Answer ***any one*** part :

(a) Explain the liquid drop model of fission qualitatively with the help of schematic diagrams. **5**

(b) Explain the working of a cyclotron with the help of a schematic diagram. 5

PHYSICAL CONSTANTS :

$h = 6.6 \times 10^{-34}$ Js

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

$m_p = 1.67 \times 10^{-27}$ kg

$R = 13.6$eV