BACHELOR OF SCIENCE EXAMINATION, 2018

(Final Year, 2nd Semester)

PHYSICS (HONOURS)

Paper : HO - 13

Time : Two hours Full Marks : 50

Use separate Answer Script for each group

Group- A

Answer any five of the following questions (5x2=10)

1. Approximately how much energy is required to break up a nucleus (mass no A) into constituent neutrons and protons?
2. The ground state spin of a nucleus is never very large- Why?
3. Is it possible to create a proton-anti proton pair due to interaction of gamma rays (from natural radioactive nuclei) with matter?
4. What is the kinetic energy of the daughter nucleus formed in alpha decay(of energy 4.19 MeV) of the parent nucleus ^{238}U ?
5. Cosmic Ray intensity varies with latitude-explain.
6. Identify the type of nuclear reactions
   a. X(x,x)X*
   b. X(γ,y)Y
7. Name two materials which will produce scintillation for alpha and gamma rays respectively.

Answer any three of the following questions (3x5=15)

8. Write down the relevant equations for e^-, e^+ and electron capture processes. Draw the e^+ spectrum. Why is it continuous in nature? [3+1+1]
9. Thermal neutrons can induce fission in ^{235}U but fast neutrons are required to produce fission in ^{238}U . Explain.
   What is critical, sub-critical and super-critical mass in the context of fission reaction? Is it possible to have a critical mass for ^{238}U. [2.5+1.5+1]
10. What is inverse beta decay? How was it utilized to detect a neutrino? [1+4]
11. What is the main difficulty in accelerating heavy charged particles to high energies using Linear accelerators? How this problem was solved by using Cyclotron?
    An alternating p.d. of 50kV maximum value is applied to the dees of radius 40cm of a Cyclotron by an oscillator. A deuteron of mass 2 amu acquires energy of 4 MeV in the cyclotron. Calculate i)magnetic field strength, ii) frequency of the oscillator and iii) number of revolutions which the deuteron has to make inside the cyclotron to gain the energy. (1amu=1.6X10^{-27}kg) [1+1+3]
12. Explain the principle of operation of Geiger Muller Counter. What is "dead time" of a G-M counter? [3+2]

Ref. No. Ex/B. Sc/PHY/32/GR-B/79/2018

BACHELOR OF SCIENCE FINAL EXAMINATION, 2018
(2^{nd} Semester)
PHYSICS (Honours)
Paper - HO-13

Time : Two hours Full Marks: 50

(25 marks for each group)

GROUP - B

Answer question No. 1 and any two from the rest.

1. (a) What type of bonding do silicon and diamonds have in common ? $1 \times 5 = 5$

   (b) What does the term "polycrystalline" mean?

   (c) Diffraction pattern from a compoud does not contain reflections from (100), (300), (111), (221) planes. Identify possible lattice type.

   (d) How do we come to know that the origin of paramagnetism or ferromagnetism are due to electronic spins ?

   (e) Why is Drude model cosistent with the Wiedemann-Franz law in spite of over-simplified classical model?

2. Derive the expression for atomic form factor and structure factor of the basis in a unit cell. Hence establsih the conditions for maximum scattering intensity for bcc lattice. Reduce the expression of atomic form factor for spherically symmetric electron distribution. $3 + 2 + 3 + 2.$

3. Consider the periodic boundary condition within a cube of side L. Calculate the density of states in the Debye model. Hence establsih the Debye T^3 law. Debye law is not valid at temperature $T < 0.1\theta_D$, where θ_D is the Debye temperature. Why is this dicrepency? $4 + 4 + 2$

4. What do you mean by first Brillouin zone? Find the expression for frequencies of optical and acoustical branches within the first Brillouin zone due to vibration of diatomic lattice . Show that, in the optical branch, two types of atoms move in opposite direction. $2 + 5 + 3$

5. (a) Derive general expression for magnetisation of a paramagnetic material containing N atoms , each having anglular momentum quantum number J, in terms of Brilloin function $B_J(x)$, where $x = \frac{gJ\mu_B B}{k_B T}$, where symbals have their usual meaning. In the limit $x << 1$, determine the susceptibility χ in term of effective Borh magneton, i.e. establish the Curie law. $B_J(x) = \frac{2J+1}{2J} coth\frac{(2J+1)x}{2J} - \frac{1}{2J} coth(\frac{x}{2J})$. $3 + 3$

(b) Derive the Curie Weiss law in the context of ferromagetism using mean field approach. Hence show that χ diverges with a critical exponent equal to one. Use the expression for Curie constant identify the Ferromagnetic to paramagnetic phase transition temperature (T_C). 3 + 2