CSM – 59/21

Physics

Paper – II

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any **three** of the remaining questions, selecting at least **one** from each Section.*

SECTION – A

1. Answer any **three** of the following :

   (a) State the laws of photo-electric emission and mention the failure of the classical electromagnetic theory to explain the significance of photoelectricity. 20

   (b) Ultra violet light of wavelength 350 nm and intensity 1 watt/m^2 is directed at a potassium surface.

Find :

(i) The maximum kinetic energy of the photo electron

(ii) If 0.5% of incident photons produce photo electrons, then how many photo electrons are emitted per second if the surface of potassium is $1cm^2$? Given, work function of potassium is 2.1 eV.

20

(c) A particle moving along positive x-axis in a region of positive potential V(x) is represented by the wave packet given by $\varphi(x,t) = \frac{1}{\sqrt{2\pi\hbar}} \int A(p) e^{\frac{i}{\hbar}(px - Et)} dp$. Obtain the time dependent Schrodinger's wave equation for a non-relativistic total energy. 20

(d) Describe the Quantum theory of Raman effect. 20

2. (a) Using the wave equation, obtain an expression for three-dimensional time dependent Schrodinger's equation. 30

(b) Write the importance of uncertainty and deduce an expression for the Heisenberg's uncertainty principle. 30

3. (a) Discuss the quantum mechanical theory of fine structure of hydrogen-like atoms. 40

(b) (i) What is spin-orbit coupling ? Define total angular momentum vector J and discuss in detail the quantization of J. 10

(ii) Describe the experimental set up and theory of Stern Gerlach experiment. 10

4. (a) Explain Mossbauer Spectroscopy and discuss its advantages. 30

(b) Discuss the elementary theory of NMR and mention its applications. 30

SECTION – B

5. Answer any **three** questions of the following :

(a) Describe the properties of the nucleus. 20

(b) Explain the exchange nature of nuclear

forces. Discuss the Meson theory of nuclear forces. 20

(c) Discuss the origin of asymmetry term in semi-empirical mass formula and derive the asymmetry energy term. 20

(d) (i) Obtain an expression for the deuteron binding energy per particle. 10

(ii) Compare the specific binding energy of tritium and the light helium isotope.

Given, mass of proton = 1.0073 amu ; mass of neutron = 1.0087 amu mass of tritium = 3.016 amu and mass of $_2He^3$ = 3.016 amu. 10

6. (a) Solve the Schrodinger's wave equation for the ground state of deuteron. 30

(b) Explain the parity violation in β-decay. 30

7. (a) (i) Using band theory of solids explain the formation of valence and conduction bands. 15

(ii) Obtain an expression for Fermi energy gap of extrinsic semiconductors. 15

(b) (i) Describe the importance of critical field in superconductivity. 10

(ii) The critical field at 6K and 8K for a superconductivity alloy are 7.616 and 4.284 mAm^{-1} respectively. Determine the critical temperature and critical field at 0 K. 10

(iii) Describe the BCS theory of superconductivity. 10

8. (a) Draw the circuit diagram of p-n-p transistor with proper biasing voltages and direction of current. Distinguish between the working of p-n-p and n-p-n type bipolar junction transistor. 20

(b) Describe the working of two stage RC coupled transistor amplifier and mention its advantages. 20

(c) (i) Discuss op-amp as scale changer and voltage follower. 10

(ii) In Hartley's oscillator the values of L_1 and L_2 are given by 0.3 mH and 0.2 mH respectively. If the capacitor is set at 0.3 μF, calculate the frequency produced by the oscillator ? 10