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Code—16

PHYSICS

Time Allowed : 3 Hours *Maximum Marks :* 150

Note : Attempt any *Five* questions. All questions carry equal marks. Q. No. **1** is compulsory. Answer *two* questions from Part I and *two* questions from Part II. The parts of the same question must be answered together and must not be interposed between answers to other questions.

1. Write critical notes on any *four* of the following : **(4×7½=30)**
   (a) Elastic and Inelastic Collisions
   (b) Joul-Kelvin Effect
   (c) Fourier Theorem
   (d) Quality Factor of a circuit (Q-factor)
   (e) Cyclotron
   (f) Logic Gates

P.T.O.

Part I

2. (a) State the fundamental postulates of special theory of relativity and deduce the Lorentz Transformations. (12)

   (b) Write Bernoulli's theorem for the flow of an ideal liquid. Use it to prove that the velocity of efflux of a liquid emerging from a hole in the wall of a vessel is $\sqrt{(2gh)}$, where h is the height of the liquid level above the hole. (12)

   (c) Prove that the centre of mass of two particles subject to their mutual interaction alone (central force) moves with a constant velocity. (6)

3. (a) State and explain Maxwell's law of distribution of velocities. Briefly explain 'conduction', 'mean free path' and 'viscosity' on the basis of kinetic theory. (12)

(b) Summarize the characteristics of black body radiation. Derive Plank's law of black body radiations and obtain Stefan's fourth power law from it. (12)

(c) The luminosity of a star is 20,000 times that of the sun. If the surface temperature of the sun is 6000°K, find the surface temperature of the star ? (6)

4. (a) Solve the differential equation of a damped harmonic oscillator. Investigate the conditions under which the oscillations are said to be under damped overdamped and critically damped. (12)

(b) Explain the process of stimulated emission. Draw a neat diagram tc represent the component of 'Ruby Laser'. Briefly explain the operation. (12)

(c) A diffraction grating which has 4000 lines to a *cm* is used at normal incidence. Calculate the dispersive power of the grating in the third order spectrum in the wavelength region 5000Å. (6)

Part II

5. (a) Define Faraday's law of electromagnetic induction. Express Faraday's law in integral and differential forms. Obtain an expression for induced e.m.f. (12)

(b) State and prove Gauss's law in electrostatics. Obtain an expression for electric field due to a charged cylindrical conductor. (12)

(c) A 50 Hz A.C. circuit has a 10 mH inductor and a 2 ohm resistor in series. What is the power factor ? (6)

6. (a) Write down Schrödinger equation for a particle in a box. Solve it to obtain eigen functions and show that the eigen values are discrete. (12)

(b) Describe briefly different mechanisms through which γ-rays are absorbed in matter. (12)

(c) Compute the value of Plank's constant h if photo-electron ejected from the surface of certain metal by light of frequency $2{\cdot}2 \times 10^{15}$ Hz are fully retarded by a reverse potential of 6·6V and those ejected by light of frequency $4{\cdot}6 \times 10^{15}$ Hz are stopped by a reverse potential of 16·5V. **(6)**

7. (a) Find the hole and electron concentrations in a p-type semiconductor, if the acceptor density is 10^{20} atoms/m^3 and the intrinsic concentration is $2{\cdot}5 \times 10^{19}$ per m^3 at 300°K. **(8)**

(b) A full-wave P-N diode rectifier uses load resistor of 1500 ohms. No filter is used. Assume each diode to have idealized characterized with $R_f = 10$ ohms and $R_r = \infty$. Since wave voltage applied to each diode has amplitude of 30 volts and frequency 50 Hz. Calculate peak current, dc load current and rms load current. **(10)**

(c) What is an Oscillator ? Explain the essentials of a transistor oscillator. **(12)**