PHYSICS

Time Allowed: 3 Hours　　　　　　　　　　　　　　　　　*Maximum Marks: 300*

Candidates should attempt Question 1 and 5 which are compulsory, and any three of the remaining questions selecting at least one question from each Section. All questions carry equal marks.

PAPER - I
SECTION A

1.　Attempt any three of the following:

(a)　Two objects (M_1=2 gm: M_2=5 gm) process Velocities $V_1 = 10x$ cm/sec, $V_2 = 3\hat{x} + 5\hat{y}$ cm/sec just prior to a collision during which they become permanently attached to each other. What is the final momentum of combination of the laboratory system?

(b)　What is the angular momentum (referred to the centre of the orbit) of a satellite of mass M, which moves round the earth in a circular orbit of radius r? The result is to be expressed in terms only r, G.M, and M_e (the mass of the earth).

(c)　A vessel of mass 10^7 kg is gyrostabilsed by a uniform circular disc of mass 5×10^4 kg and radius 2m which rotates at 15 rev/sec. What is the angular momentum of the stabilizer?

(d)　Water is flowing through a horizontal pipe line of varying cross-section. If the pressure of water equals 2cm of mercury at a point where velocity or the flow is 32 cm/sec. What is the pressure at another point where velocity of flow is 40 cm/sec?

2.　(a)　Show from the Lorentz transformation that two events (t_1=t_2) at different points ($x_1 \neq x_2$) in reference frame S are not in general simultaneous in reference frame S which is moving in the + direction with the constant velocity V with respect to S.

(b)　What is the momentum of a proton having kinetic energy 1 BeV? The energy equivalent to proton rest mass is 0.93 BeV.

(c)　What is the recoil energy in electron-volts of a nucleus of mass 10^{-23} gm after emission of x-ray of energy 1 MeV?

3.　(a)　What is understood by the term 'Coriolis force'? Obtain expressions for velocity and acceleration of a particle in rotating coordinate systems.

(b)　Find the temperature at which root mean square velocity of nitrogen molecules in earth's atmosphere equals the velocity of escape from the earth's gravitational field. Mass of N_2 atom = 23.24 x 10^{24} g. Mean radius of earth = 6370 km.

4.　(a)　Write down the expression for energy distribution of a black-body radiation at temperature T and deduce Wien's displacement law.

(b)　A gas possesses a Maxwellian velocity distribution function. Show that the fraction of molecules in a given volume that possess a velocity (+v_x) in one direction only and whose magnitude is greater than some selected value v_0 is

$$\int_{V_0}^{\infty} f(V_x)\, dv_x = \frac{1}{2}\left[1 - \frac{1}{\sqrt{\pi}} erf\left(\frac{1/4 m v_0^2}{KT} \right)^{4/2} \right]$$

Symbols have their usual meanings.

(c)   A Cornot's engine is made to work between 0°C and -200°C. Calculate us efficiency. Derive the expression you use of calculation.

SECTION B

5.   Answer three of the following:

(a)   A volume of one gm-mole of an ideal gas expands isothermally to four times its initial volume. Calculate the change in its entropy in terms of gas constant.

(b)   Calculate the mean fat path of helium atoms at NTP, the coefficient of viscosity being 190 x 10^{-7} kg m^{-1} s^{-1}. 1 atmospheric pressure = 0.076 x 136 x 10^3 x 9.81 Nm^{-2}.

(c)   If two pipes one closed at one end and the other open at both ends, have fist overtones of the same frequency, what is the ratio of their respective lengths?

(d)   The diameter of the central zone of a zone-plate is 2:3 mm. If a point source of light (λ=589.3 nanometer) is placed at a distance of 6 metre from it, calculate the position of the first image.

6.   (a)   Show that the resolving power of a diffraction grating used with light of wavelength λ at normal incidence is W sin θ/λ, where W is the total width of the grating θ the angle of diffraction.

(b)   The above expression shows that, for given W, θ and λ, the resolving power is independent of number of grooves on the grating. Why do most diffraction gratings have several hundred grooves per mm?

(c)   A beam of linearly polarised light is change into circularly polarised light by passing it through a slice crystal 0.003 cm thick. Calculate the difference in refractive index of two rays in crystal assuming this to by minimum thickness that will produce the effect and that the wavelength of light is 6 x 10^7 m.

7.   A thick wire of mass per unit length m, density p, and Young's Modulus E, is stretched between two supports and has a tension T.

Obtain from first principles an expression for the velocity of longitudinal waves in the wire.

Write down the equivalent expression for velocity of transverse waves in the same wire.

(b)   Calculate the rate of energy dissipation by a damped harmonic oscillator, in the weak damping limit with $\omega_0 r \gg 1$, so that $\omega = \omega_0$. Symbols have their usual meanings.

(c)   Two express trains travelling at 10 km/hour are meeting each other while one of them is whistling. If the frequency of the note is 800 Hz. find the aparent pitch as heard by an observer in the other train after they passed each other. Velocity of sound in air = 340 ms^{-1}.

8.   Write short notes on am' three of the following:

(a)   Holography

(b)   Spatial and temporal coherence

(c)   Negative temperature

(d)   Production of low temperature using adiabatic demagnetisation

(c)   Motion of rocket under constant force field.

PHYSICS

Time Allowed: 3 Hours   **Maximum Marks: 300**

Candidates should attempt Question 1 and 5 which are compulsory, and any three of the remaining questions selecting at least one question from each Section.

PAPER - II
SECTION A

1. Answer any three of the following;

(a) An electron moves with a speed of 10^3 m/sec, accurate to 0.008%. Find the accuracy with which the position of the electron can be located.

(b) A 220 volt, 50 cycle, supply is connected to a circuit containing a resistance of 20 ohms in series with a 100µF capacitor. Determine the current and the phase.

(c) State and explain Pauli's exclusion principle. Estimate the total number of electron states in a many electron atom for a given principal quantum number n.

(d) Discuss briefly the various ways of modulation of electromagnetic waves for the purpose of communication through radio and television.

2. State Kirchoff's laws or the distribution of currents

(a) in the usual form for steady currents and

(b) in a form applicable to alternating current networks.

Discuss the method for comparing inductances by using Maxwell's bridge. State the disadvantages of the method.

3. Derive an expression for the Poynting's vector and explain us significance

A light source (one kilowast) is radiating energy uniformly. Determine the intensity of the electric field at a distance of one metre from the sources.

4. Discuss the origin of line spectrum and continuous spectrum of X-rays. What is Duance and Hunt limit for X-ray spectrum? Can you obtain the value of 'h' (Planck's const.) precisely from a knowledge of the Duane and Hunt limit.

An X-ray tube is operated it 20 kV. Determine the wavelength limit of continuous X-rays.

SECTION B

5. Answer any thin of the following:

(a) State and explain Einstein's photoelectric emission equation, Distinguish between extrinsic and intrinsic photo ectric effects. What is "quantum field"? On what factors does the quantum yield depend?

(b) A singly charged positive ion is accelerated through a potential difference of one kV, and the ion passes through a uniform magnetic field of $B=0.2$ Wb/m^2 and consequently gets deflected through a circular path of radius 0.1 metre. Find out the mass number of the ion.

(c) What is deuterium? Is deuterium the same as hydrogen? Hon can you obtain deuteron from deuterium?

Calculate the frequency of the oscillating potential applied to a cyclotron as to accelerate deuterons when the magnetic induction has a constant value of 2.5 Wb/m^2.

(d) Discuss briefly the three types of interaction between elementary particles, and explain the relative strength of the various kinds of interaction between elementary particles.

6. Derive Schrodinger equation for a linear harmonic oscillator, and determine its eigenvalue and eigenfunctions. Discuss the significance zero point energy.

7. What is alpha decay? Deduce an expression for the potential barrier penetrability for alpha particle in a nucleus. Show how the penetrability is related to the alpha decay constant.

8. What is a P.N. junction? Describe with energy level diagram the formation of double layer of charges which generates a potential difference (V) across, the junction. Hence show that the capacitance of the double layer. $C=KV^{-1/2}$, where K is a constant. State some practical use of this relation between C and V.