PHYSICS

PAPER - I

SECTION A

1. Answer any four of the following: (10 x 4 = 40)

   (a) Two space ships are moving with a relative speed of 0.5 c. Calculate the speed of one ship with respect to earth to overtake the other whose speed with respect to the earth is 0.9 c.

   (b) Describe the principle and working of a gyroscope.

   (c) Show with simple experimental schemes how the reading and writing of an object can be accomplished by using holographic technique.

   (d) Write down the relation between Einstein's A-and B-coefficients. What is the physical process that corresponds to the A-coefficient?

   (e) Explain chromatic and spherical aberration. Suggest the ways to remove them.

2. (a) What is the physical significance of the centre of mass? How far is the centre of mass of the Earth—Moon system from the centre of the Earth? Use the following data:

   Mass of the Earth = 5.98×10^{24} kg

   Mass of the Moon = 7.36×10^{22} kg

   Distance between Earth and Moon = 3.82×10^{8} m

   (14)

   (b) What are holonomic and non-holonomic constraints? Give an example of each kind. How does one incorporate constraints in the generalized coordinated? Mention the importance of generalized coordinates in describing the motion of a system of particles.

   (13)

   (c) Using Euler's equations for force free motion derive an expression for the precession frequency of a symmetrical rigid body.

   (13)

3. (a) Give a brief account of Michelson- Morley experiment and its implications.

   (13)

   (b) Define nodal planes of a lens system. Are they always different from the principal planes? Comment.

   (13)

   (c) An external driving force with angular frequency ω acts on an oscillating system with natural angular frequency ω_0. When does the amplitude of the system becomes maximum? What is this condition known as?

   Why aircraft designers make sure that none of the natural frequencies at which a wing can vibrate matches the angular frequency of engine at a cruising speed?

   (14)

4. (a) An air tight chamber 5 cm long with glass windows is placed on one arm of a Michelson interferometer. Light of wave length 500 nm is used. The air is being slowly evacuated by a vacuum pump. While the air is being removed, 60 fringes are observed to pass through the view. Find the refractive index of air at atmospheric pres sure. (13)

(b) Why does a diffraction grating has closely placed rulings? Why is it necessary to have a large number of rulings?

Find the separation of two points on the surface of the Moon that can be barely resolved by a 5.08 m telescope. Assume that the distance is determined by diffraction effects and the wavelength of light used is 565 nm. Also given is the distance between Moon and Earth = 3.82×10^8 m. (14)

(c) In a ruby laser, what role is played by Cr_2O_3? Explain with the energy-level scheme, the working of a ruby laser. (13)

SECTION B

5. Answer any four of the following: (4 x 10 = 40)

(a) How do you use the hysteris curve to select the material for the construction of

(i) permanent magnet;

(ii) electromagnet.

(b) A cube of side a has a charge q at each of its corners. Calculate the potential due to these charges at the centre of the cube.

(c) What do you understand by vector potential? Discuss its significance.

(d) What is Chandrasekhar limit in astrophysics ? Explain briefly the formation of a neutron star.

(e) Using Fresnel's relation, obtain the energy fraction reflected from a glass surface of refractive index 1.5 at normal incidence.

6. (a) Describe the method of electrical image. Use this method to calculate the potential due to a conducting sphere placed in a uniform electric field. (14)

(b) Find the expression for the field at a point on the axis of an electric dipole situated at a distance l from the centre of the dipole. (13)

(c) The inductance of a circuit is 20 mH and its resistance is 20 ohms. A 50 cycle e.m.f. is applied to it. Calculate the values of the impedance and phase angle. (13)

7. (a) Explain the phenomena of reflection and refraction of electromagnetic waves at the interface of non-conducting media. (14)

(b) What do you understand by Pointing Vector? Calculate the electric and magnetic fields at the surface of the sun if the power radiated by the sun is 3.8×10^{26} W and the radius of the sun = 7×10^8 m. (13)

(c) What is black body radiation? Outline the main ideas put-forth by Max Planck to explain it. (13)

8. (a) Obtain Maxwell-Boltzmann distribution of molecular velocities of a perfect gas. How does the distribution change with changing temperature? (20)

(b) Outline Debye's theory of specific heat of solids. Compare its merits and demerits in relation to Einstein's theory of specific heat. (20)

PHYSICS

PAPER – II

SECTION A

1. Answer any four of the following:

(a) How does the classical Harmonic oscillator differ from quantum mechanical Harmonic oscillator? Explain.

(10)

(b) Calculate the de Broglie wavelength of Thermal neutrons at 300° K. ($K = 1.38 \times 10^{-23}$ J/°K).

(10)

(c) Define angular momentum. Write the expression for the angular momentum operator and the commutation relations of angular momentum.

(10)

(d) An electron and a photon both have momenta of 1.0 MeV/C. Find the total energy of each.

(10)

(e) Distinguish between fluorescence and phosphorescence.

(10)

2. (a) Derive expressions for time independent and time dependent Schrödinger wave equation for a free particle.

(20)

(b) What is WKB approximation? Calculate the transition probability of a particle through a potential barrier.

(20)

3. (a) Obtain Schrödinger equations for Hydrogen atom in terms of spherical polar coordinates. What are the advantages of writing Schrödinger equation in spherical polar coordinates?

(20)

(b) Explain the J-J coupling and L-S coupling schemes and discuss their applications.

(20)

4. (a) Explain the salient features of Raman effect and discuss how molecular structure can be obtained with the help of Raman Spectroscopy.

(20)

(b) Describe the principle of Nuclear Magnetic Resonance (NMR). How Lande 'g' factor is derived and what information is obtained from Lande 'g' factor?

(20)

SECTION B

5. (a) Answer any four of the following-

(a) From the Binding Energy curve explain the nuclear fission and nuclear fusion. (10)

(b) Calculate the recoil energy of Fe^{57} nucleus when it emits a gamma photon of 14 KeV en[illegible]. (10)

(c) What is the mechanism of Cooper pair formation in superconductors? (10)

(d) Distinguish between Hadrons and Leptons. (10)

(e) What is the effect of feed back in an amplifier? What is the minimum feedback factor and the nature of the feedback required in order to convert an amplifier of gain A into an oscillator? (10)

6. (a) What are magic numbers? Discuss the salient features of shell model of the nucleus. (20)

(b) Calculate the spins and parities of $_2He^4$ and $_1N^{12}$ nuclei (10)

(c) Describe the nuclear properties that cannot be explained by shell model. (10)

7. (a) Discuss the Gellman-Nishijima classification of elementary particles. (20)

(b) Explain the Meissner effect and the Josephson effect What are their applications on superconductors? (20)

8. (a) State the De Morgan's laws. Show that the +ve AND logic circuit works as -ve OR logic circuit. (20)

(b) What is a Solar cell? Discuss its structure. Explain how a Solar cell gets forward biased when the light falls on it. (20)