CSM : 14

PHYSICS
PAPER - I

Time Allowed : 3 hours
Full Marks : 100

Marks for each question is indicated against it.
Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.

PART A

1.  (a) What are the central forces? Discuss the characteristic features of central forces. Show that the angular momentum of a body moving under the influence of a central force remains constant.  
   
   (1+5+5=11)

   (b) State and explain Kepler’s laws of planetary motion. Using Newton’s laws of gravitation establish Kepler’s third law. 
   
   (3+6=9)

2.  (a) State Hooke’s law and define the relevant elastic constants. Establish the inter-relationship among the elastic constants of an isotropic solid.
   
   (2+4+7=13)

   (b) State and explain Bernoulli’s principle. Mention one of the practical applications of Bernoulli’s principle and explain its working.
   
   (5+2=7)

3.  (a) Describe Michelson-Morley experiment and its significance. Show as to how the negative results obtained from this experiment are interpreted.
   
   (5+3+3=11)

   (b) On the basis of Lorentz transformation, discuss the kinematic effect of length contraction.

   (5)

   (c) The half-life of a particle as measured in the laboratory comes out to be $4.0 \times 10^{-8}$ sec when its speed is 0.80$c$ and $3.0 \times 10^{-8}$ sec when its speed is 0.6$c$. Find its actual lifetime.(4)

4.  (a) Using Van der Waal’s equation of state for real gases obtain expressions for the critical constants in terms of the Van der Waal’s constants.

   (10)

   (b) Discuss the theory of Joule-Kelvin effect and explain its significance in the process of liquefaction of gases.

   (7+3=10)
5. (a) Discuss mathematically the phenomena of forced vibration and explain the term sharpness of resonance.

(b) What do you mean by group and phase velocity? Establish the relation between them.

(c) Explain the phenomena of refraction from Huygen’s principle.

6. (a) Discuss the Fraunhofer diffraction pattern due to a single slit. Derive the condition for production of maxima and minima and their position. Find the expression for the width of central maxima.

(b) What is a zone plate? Show that the radii of its half period zones are proportional to the square root of natural numbers. Derive an expression for its focal length and show that a zone plate has multiple foci.

(c) Two spectral lines with average wavelength 6000 AU are resolved in second order by a grating having 500 lines per cm. The least width of the grating is 2 cm. Find the difference in wavelength of the lines.

7. (a) An alternating e.m.f. $E_0 \sin \omega t$ is applied to a LCR series circuit. Obtain an expression for the instantaneous current, impedance, phase angle, condition for resonance and quality factor.

(b) Use Biot and Savart’s law to find an expression for the magnetic field at a point on the axis of a current carrying solenoid. Hence prove that the magnetic field at the end is half the magnetic field at the centre of a long solenoid.

8. (a) State and derive Poynting’s theorem. Discuss the physical significance of each term in the resulting equation.

(b) Write the Maxwell’s equation of Electromagnetic theory and identify the symbols used. Using these equations, derive the general wave equation for electric and magnetic vectors for electromagnetic waves in vacuum.

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