2020

PHYSICS (Honours)

Paper Code : VIII

[Old Syllabus]

Full Marks : 90 Time : Four Hours

The figures in the margin indicate full marks.

Answer question no. 1 and any *five* from the rest, taking at least *one* from each group but not more than *two* from any group.

1. (a) Calculate the skin depth for radio waves of wavelength 3m (in free space) in copper, given that the electric conductivity of copper is $6\times10^{7}\,ohm^{-1}m^{-1}$. 3

(b) Can two independent laser beams produce an interference pattern? Justify your answer. 3

(c) For a doubly refracting crystal plate, n_0 = 1.54 and the ratio of the velocity of ordinary ray (v_0) to that of the extraordinary ray (v_e) is 1.007. What is the value of n_e and what is the nature of the crystal? 2+1

(d) A particle is moving with a relative speed of 2.22×10^{8} ms^{-1} with respect to the laboratory frame of reference. It has a proper mean life of 2.5×10^{8}s. Find the distance travelled by the particle in one mean life, as measured from the laboratory frame. 3

(e) Prove that $\vec{E}=\hat{k}E_0\cos\alpha\left(y-ct\right)$ and $\vec{B}=\hat{i}B_0\cos\alpha\left(y-ct\right)$ constitute a possible electromagnetic field. 3

Group - A

(Physical Optics)

2. Give Huygen's theory of double refraction. Write a short note on the use of polarids. 5+10

3. Describe the construction and action of a Nicolprism. Explain how a Nicolprism can be used to produce and analyse plane polarised light. 10+5

4. (a) What is optical rotation? Deduce Fresnel'sequation of optical rotation. 4+6

(b) Calculate the thickness of a quarter wave plate for light of wavelength 5893Å, given refractive indices for ordinary ray and extraordinary ray as 1.544 and 1.553, respectively. 5

Group - B

(Electromagnetic Theory and Special Theory of Relativity)

5. (a) Show that the kinetic energy of a relativitically free particle of rest mass m_0 is given by $T = \sqrt{p^2c^2 + m_0^2c^4} - m_0c^2$, terms being usual. Prove that the above formula reduces to the classical formula, if $\frac{v}{c} << 1$. 8+3

(b) Calculate the speed of an electron which has a kinetic energy of 1.02 MeV. Given : rest mass energy of an electron = 0.51 MeV. 4

6. Derive the equations of Lorentz transformation and deduce the relation for addition of velocities. 8+7

7. (a) Using Maxwell's electromagnetic field equations, find the expression for velocity of electromagnetic wave in free space.

(b) Show that in the Rayleigh scattering, scattering cross-section is inversely proportional to the fourth power of wavelength of incident light. 8+7

Group - C

(Solid Sate Physics and Electric and Magnetic Properties of Matter)

8. Deduce Langevin's theory of diamagnetism and hence show that the diamagnetic susceptibility of an element is independent of temperature but increases linearly with atomic number 'Z'. 9+6

9. (a) Derive the Widemann-Franz law on the basis of Drude model of free electrons.

(b) An insulator has an optical absorption which occurs for all wavelengths shorter than 1800Å. Find the width of the forbidden gap in *ev* of the insulator. 10+5

10. How are energy bands formed in solids? Distinguish among a metal, a semiconductor and an insulator on the basis of band theory of solids. 8+7
