2103000205021004
EXAMINATION FEBRUARY-MARCH 2024
BACHELOR OF SCIENCE (FIFTH SEMESTER)
PHYSICS-IX (PH-509 STATISTICAL MECHANICS AND SPECIAL THEORY OF RELATIVITY) LEVEL 2

[Time: As Per schedule] **[Max. Marks: 50]**

Instructions:
1. Fill up strictly the following details on your answer book
   a. Name of the Examination : **BACHELOR OF SCIENCE (FIFTH SEMESTER)**
   b. Name of the Subject : **PHYSICS-IX (PH-509 STATISTICAL MECHANICS AND SPECIAL THEORY OF RELATIVITY) LEVEL 2**
   c. Subject Code No : **2103000205021004**
2. Sketch neat and labelled diagram wherever necessary.
3. Figures to the right indicate full marks of the question.
4. All questions are compulsory.

Seat No:

Student's Signature

Q.1 Each question carries one mark only. **10**

1. What do you mean by isochoric process?
2. What do you mean by Doppler effect?
3. A large number of identical tea-pots stored in perfectly insulation thermos flask is an example of _____ ensemble.
4. Give the definition of an ensemble.
5. What is the difference between kinetic theory and thermodynamics?
6. The stone at rest falls freely the trajectory of a phase point is _____
7. In a Michelson – Morley experiment if we move one mirror by a distance λ/4 which corresponds to path difference of _____
8. If the value of $(1-\beta^2)^{1/2} = 0.995$ than velocity v = _____
9. Define an inertial reference frame?
10. A beam of light moves along right with speed c. If the earth also moves along right with speed v then the speed of beam of light relative to earth is _____

Q.2 **(a) Attempt any one.** **7**

1. Derive the Planck's law for black body radiation.
2. Prove that the quality of radiation does not change due to adiabatic expansion.

(b) Attempt any one. **3**

1. Discuss the limitations of the Wien's displacement law.
2. Black body radiation in a cavity at 2000K is subject to adiabatic reversible expansion through 10^3 cm^3. Calculate the change in temperature of the radiations. Given $\sigma = 5.672 \times 10^8$ $Jm^{-2}K^{-4}S^{-1}$.

Q.3 **(a) Attempt any one.** **7**

1. Deduce the Boltzmann's entropy relation.
2. Considering a particle in the three dimensional box explain the energy quantization.

(b) Attempt any one. **3**

1. Give the three fundamental postulates for statistical mechanics.
2. A proton inside a nucleus (radius = 10^{-14}m) whose momentum cannot exceed 10^{-19} $kgms^{-1}$ Calculate the number of quantum states available to it.

Q.4 **(a) Attempt any one.** **7**

1. Describe the Michelson Morley experiment. What is the result obtained?
2. Explain the Lorentz – Fitzgerald contraction hypothesis and ether drag hypothesis as attempt to preserve the concept of ether.

(b) Attempt any one. **3**

1. A particle of mass $m_1 = 3$kgs, moving at a velocity of $u_1 = 4$ m/sec along the x- axis of frame S, approaches a second particle of mass $m_2 = 1$kg, moving at a velocity $u_2 = -3$ m/sec along this axis. After a head-on collision, it is found that m_2 has a velocity U_2 =3 m/sec along the x-axis, calculate the expected velocity U_1 of m_1 after the collision.

2. When the movable mirror of a Michelson Interferometer is shifted through 0.0589 mm, 200 fringes cross the field. What is the wavelength of the light?

Q.5 (a) Attempt any one. **7**

1. Using Lorentz transformation equations, derive velocities transformation equations.
2. Derive the Lorentz transformation equation and show that at low speed it reduce to Galilean transformation equation.

(b) Attempt any one **3**

1. Is simultaneity an absolute quantity? Explain
2. Show that the electromagnetic waves are invariant under Lorentz transformation.

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