Remote Examination 2021-22

PH100: Mechanics and Thermodynamics

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Time: 40 Minutes **Marks: 20**

- **All questions are compulsory and their marks is indicated in square bracket.**
- **<u>All questions needs to be answered sequentially</u> without fail. Non-compliance of instruction will invite deduction in marks.**
- **In case you feel any question/s is/are incorrect or have insufficient instruction then write in the answer book with your justification without wasting any time**
- **Except question number 8, all other questions are of 2 marks.**

1. Two non-interacting particles m_1 and m_2 move toward each other with velocities v_1 and v_2. Their paths are offset by distance b, ~~as shown in the sketch~~. Let us investigate the equivalent one body description of this system.

2. Compare the spectral energy density curve w.r.t frequency using Rayleigh Jean and Planck's radiation laws.

3. Write down two phenomenon's which shows the particle properties of waves and wave properties of particle.

4. How many photons/s are contained in a beam of electromagnetic radiation of total power 180 W if the source is (a) an AM radio station of 1100 kHz, (b) 8.0-nm x rays, and (c) 4.0-MeV gamma rays?

5. A proton in a one-dimensional box has an energy of 400 keV in its first excited state. How wide is the box?

6. What do you understand from thermal equilibrium?

7. Write down the time-dependent and independent forms of Schrodinger's equation.

8. A particle is in a cubic box with infinitely hard walls whose edges are L long. The wave functions of the particle are given by

$$\psi = A \sin\frac{n_x \pi x}{L} \sin\frac{n_z \pi y}{L} \sin\frac{n_z \pi z}{L} \qquad \begin{matrix} n_x = 1, 2, 3, \ldots \\ n_y = 1, 2, 3, \ldots \\ n_z = 1, 2, 3, \ldots \end{matrix}$$

Find the value of the normalization constant A. Find the possible energies of the particle in the box by substituting above wave function in 3D Schrödinger's equation and solving for E. Compare the ground-state energy of a particle in a one-dimensional box of length L with that of a particle in the three-dimensional box. [4 Marks]

9.

The equation of state of an ideal gas is $PV = nRT$, where n and R are constants.

(a) Show that the volume expansivity β is equal to $1/T$.

(b) Show that the isothermal compressibility κ is equal to $1/P$.

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