**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI**
**(MID SEMESTER EXAMINATION SP/2023)**

**CLASS: IMSc** | **SEMESTER : VI**
**BRANCH: PHYSICS** | **SESSION : SP/2023**

**SUBJECT: PH316 STATISTICAL MECHANICS**

**TIME: 02 Hours** | **FULL MARKS: 25**

**INSTRUCTIONS:**
**1. The question paper contains 5 questions each of 5 marks and total 25 marks.**
**2. Attempt all questions.**
**3. The missing data, if any, may be assumed suitably.**
**4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

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| Q.1(a) | Define microstates and macrostates. | [2] | 1 | 1 |
| Q.1(b) | Derive the relation between the Boltzmann constant $k_B$ and the universal gas constant R. | [3] | 1 | 3 |
| Q.2(a) | Explain the difference between the microcanonical, canonical and grand canonical ensembles. | [2] | 1 | 2 |
| Q.2(b) | How does the quantum indistinguishability of particles leads to the resolution of the Gibbs paradox? | [3] | 1 | 2 |
| Q.3(a) | A cavity has its walls maintained at the temperature T. Explain whether the shape, size or material of the walls should affect the spectral energy density of the radiations enclosed by it. | [2] | 2 | 1 |
| Q.3(b) | Sunlight falls on the earth with power per unit area given by 1370 W/m$^2$. Estimate the radiation pressure. | [3] | 2 | 3 |
| Q.4(a) | Briefly describe Wien's Displacement Law. | [2] | 2 | 2 |
| Q.4(b) | In a 3D cavity, the number of modes of radiation in the frequency range $\nu$ to $\nu$+d$\nu$ is given by $N(\nu)d\nu = (8\pi V/c^3)\nu^2 d\nu$. Explain how this leads to the ultraviolet catastrophe. | [3] | 2 | 2 |
| Q.5(a) | What were the properties of radiations proposed by Planck that led to the resolution of the UV catastrophe? | [2] | 3 | 1 |
| Q.5(b) | Derive the Stefan-Boltzmann Law using the Planck's Radiation Law. | [3] | 3 | 2 |

**::::::21/02/2023::::::M**