UndergraduateExamination, 2018

Semester–III (CBCS)

Physics

Generic Elective Course: GEC-3

(Thermal Physics and Statistical Mechanics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***anyfour*** questions

1. Answer any *five* questions. **2 × 5**

   (a) What are the State functions of a system? Name two such functions.

   (b) Represent an isobaric and an isochoric process on $P - V$ diagram .

   (c) A quantity of a gas at 100°C is adiabatically compressed to $\frac{1}{4}$-th of its initial volume. Calculate the final temperature. Given $\gamma = 1.4$.

   (d) State the conditions of reversibility of a thermodynamic process.

   (e) Draw the phase space diagram for a particle performing simple harmonic motion with energy E.

   (f) Define ensemble. What is the basic difference between canonical and micro-canonical ensemble?

   (g) State the principle of equipartition of energy.

2. (a) State the first law of thermodynamics with mathematical form. **2**

   (b) Show that work done by a system is not perfect differential, it depends on the path. **2**

   (c) Calculate the work done during i) an isothermal expansion and ii) an adiabatic expansion of an ideal gas. **2+2**

   (d) Show that for an adiabatic change in a perfect gas PV^{γ} = constant, where γ is equal to the ratio of the two specific heats C_p and C_v. **2**

3. (a) State Carnot's Theorem. **2**

   (b) Explain Carnot's cycle on a P-V diagram for an ideal gas. Derive an expression for the work done in a cycle of operation and calculate its efficiency. **2+2+1**

   (c) A Carnot's engine whose low temperature reservior is at 280K has an efficiency of 40%. It is desired to increase the efficiency by 10%. By how many degrees should the temperature of the source be increased? **2**

   (d) What do you mean by enthalpy of a system? **1**

4. (a) Define entropy? What is its significance? **2+1**

   (b) Show that entropy remains constant in a reversible process but increases in an irreversible process. **2**

   (c) Calculate the change in entropy of a perfect gas between two states of an isothermal process. **2**

   (d) Establish Maxwell's four thermodynamics relations. **3**

5. (a) Derive an expression for the Maxwell's velocity distribution law. **6**

   (b) Hence, find the ratio of average velocity, most probable velocity and r.m.s velocity. **4**

P.T.O.

6. (a) What do you mean by mean free path? **1**

   (b) Derive an expression for the viscosity of a gas in terms of mean free path. **6**

   (c) What are the drawbacks of Rayleigh-Jeans formula for blackbody radiation? Explain how Planck's law can explain the observed spectrum. **1+2**

7. (a) What is the dimension of phase space for a three dimensional classical ideal gas system having N number of particles? What is the significance of a phase point? $\mathbf{1\frac{1}{2}+1\frac{1}{2}}$

   (b) For a classical ideal gas system having N number of particles in a volume V with energy E, express the entropy as $S = k_B \ln\Omega(N, E, V)$, where Ω is the number of microstate. **4**

   (c) Consider a system containing N noninteracting, distinguishable particles. If each these particles can be two different states, find the entropy of the system. **3**
