

P. R. Thakur Govt. College
Department of Physics

B.Sc. Semester-III (GE) Internal Examination, 2023-24

Paper - PSHGEC03T

Thermal Physics & Statistical Mechanics

Time: 1 Hour

Full Marks: 20

1. Answer any *five* questions from the following:

2 x 5=10

- (a) State and explain the Zeroth law of thermodynamics.
- (b) Calculate the change in entropy for a substance of mass m and specific heat c_p when its temperature raised from T_1 to T_2 .
- (c) Define coefficient of thermal expansion and isothermal compressibility.
- (d) From the general relation between C_p and C_V derive $C_p - C_V$ for 1-mole ideal gas.
- (e) Define Emissive power of a body.
- (f) Derive Newton's Law of cooling from Stefan's law.
- (g) There are two particles in three quantum states $g_i = 1, 2, 3$. Distribute the particles according to B.E statistics.
- (h) The number of particles per unit volume having velocity between c and $c + dc$ is given by $dn_c = 4\pi n a^3 e^{-bc^2} c^2 dc$. Calculate the most probable velocity. Here $a^3 = (\frac{m}{2\pi kT})$ and $b = \frac{m}{2kT}$. Symbols have their usual meaning.

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2. Answer any *one* question from the following:

10

- (a) Calculate the workdone to bring a gas adiabatically from the initial state (p_1, V_1) to final state (p_2, V_2)
What is heat engine? Draw the schematic diagram of a heat engine. Hence find the efficiency of a Carnot engine operating between temperatures T_1 and T_2 where $T_1 > T_2$.

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1+1+4

- (b) Derive Planck's formula of energy distribution in blackbody radiation at an absolute temperature T . Show Wien's formula and Rayleigh -Jeans formula are particular cases of Planck's formula.
What are the key differences between classical and quantum statistics?

(4+2+2+2)

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1. Answer any *five* questions from the following:

2 x 5=10

- (a) Draw the T-S diagram for a Carnot cycle.
- (b) Define entropy. State its physical interpretation.
- (c) State Carnot's theorem.
- (d) Starting from the general relations between the C_P , C_V and k_T , k_S , prove that $\frac{C_P}{C_V} = \frac{k_T}{k_S}$. Symbols have their usual meaning.
- (e) Why does the pressure of a gas on the container wall increase when it is heated?
- (f) List the main assumptions of the kinetic theory.
- (g) What are fermions ? Give at least two examples.
- (h) State Pauli's Exclusion Principle.

2. Answer any *two* questions from the following:

5 x 2=10

- (a) Calculate the work done by an ideal gas having adiabatic exponent γ during an adiabatic expansion from initial pressure P_1 and volume V_1 to final pressure P_2 and volume V_2 .

Write down the four Maxwell's relations.

3+2

- (b) Two bodies, one with temperature T_1 and another with temperature $T_2 (< T_1)$ having equal mass and made of same material are brought in contact. After a while, the two bodies settle to a common temperature. Find the total change in entropy in this process.

Calculate the work done in isothermal compression of 2 moles of an ideal gas at 27°C to one-third of its volume.

3+2

- (c) Write down the comparative statement of MB, BE and FD statistics. There are two particles in three quantum states. Show how the particles can be distributed among the states if particles obey FD statistics.
- (d) Use the Maxwell's distribution function to find the mean of reciprocal of velocity of the molecule in an ideal gas at a temperature T . Take ' m ' as mass of the molecule.

3+2

5

P. R. Thakur Govt. College
CBCS Semester-III First Internal Examination, 2019
Thermal Physics and Statistical Mechanics
Paper -GE-T3

Time: 1 Hour

Full Marks: 20

1. Answer *any five* questions:

$2 \times 5 = 10$

- (a) State Kirchhoff's law of black body radiation.
- (b) State the characteristics of a black body and the black body radiation.
- (c) State Wien's displacement law regarding the radiation spectrum of a Black body.
- (d) How do you define the state of a particle through the phase space?
- (e) At what temperature will the *r.m.s.* velocity of a gas be half its value at 0°C ?
- (f) Write down the first law of thermodynamics. Which quantity is conserved as a consequence of this law?
- (g) What do you mean by cyclic process in thermodynamics? Draw a typical p - V diagram for a simple cyclic process.

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2. Answer *any two* questions:

$5 \times 2 = 10$

- (a) State Stefan-Boltzmann law. Establish Newton's law of cooling from it.
- (b) What do you mean by ultraviolet catastrophe? Explain why the black body are not necessarily so black. Mention Planck's black body radiation formula with explanations of the symbols used.
- (c) If an ideal gas has initial pressure p_1 and volume V_1 and it expands adiabatically obeying the equation $pV^\gamma = \text{const.}$ to a final state that has pressure p_2 and volume V_2 , show that the work done by the gas is $\frac{p_1 V_1 - p_2 V_2}{\gamma - 1}$.
- (d) Find the phase space trajectory of a simple harmonic oscillator.

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