

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)**

CLASS: IMSc
BRANCH: PHYSICS

SEMESTER : IV
SESSION : SP/2025

SUBJECT: PH201R1 THERMAL PHYSICS

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) What are the two essential and underlying themes of thermal physics? | [2] | 1 | I |
| Q.1(b) The ideal gas equation $PV \propto T$ is a combination of three law's. Explain those three law's. | [3] | 1 | II |
| Q.2(a) P , V , and T are functionally connected at equilibrium state by the equation of state. Write the equation of state. How these three variables are related to each other in terms of partial differential equation. | [2] | 1 | II |
| Q.2(b) Write the names and mathematical expressions of the two coefficients that play important roles in thermodynamics. Obtain the ratio of the two coefficients (in mathematical form). | [3] | 1 | III |
| Q.3(a) Under what condition the thermodynamic quantity heat and enthalpy are same. Prove it mathematically. | [2] | 2 | IV |
| Q.3(b) If the gas is compressed or expanded by motion of the piston, any change in internal energy results from the piston's motion is due to work W . Write the signs of W (work) and Q (heat) during compression of the gas by the motion of the system. State whether internal energy is changed or unchanged during the process of compression by the first law of thermodynamics | [3] | 2 | V |
| Q.4(a) What are the two statements of second law of thermodynamics? Explain these statements schematically. | [2] | 2 | III |
| Q.4(b) Refer to the Tick Marked (\checkmark) attributes in the Tabular data below and answer the question written below [Table Reference: <i>Analysis of Refrigerator-Freezer Systems</i> , C. W. Bullard, University of Illinois, Mechanical & Industrial Engineering Dept., Urbana, Illinois, USA]: | [3] | 2 | IV |

Refrigerant Charge (oz.)	Ambient Temperature (°F)	Fresh-Food Temperature (°F)	Freezer Temperature (°F)	Evaporator Load (W)	System Power (W)	COP
Uncertainty	±0.73°F	± 0.73°F	±0.73°F	±5.9 W	±8.1 W	±0.05
Steady-State Performance As Received from Factory						
4.5	69.2	41.3	3.3	187	170	1.1
5 ?	70	41.6	3.1	207	179	1.16
✓ 6.0	69.7	41.5	3.3	198	187	1.06
7.0	69.4	41.4	3.4	159	210	0.76

Write the mathematical expression of COP for a Carnot refrigerator, calculate COP values and write your inferences. Hint: Use the data as per the concept taught in the class-room.

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|---|-----|---|----|
| Q.5(a) Draw the schematic of thermodynamic square. | [2] | 3 | I |
| Q.5(b) Utilizing the schematic in question Q.5(a), write the expressions of thermodynamic identities and Maxwell's equations. | [3] | 3 | II |