

Total number of printed pages-4

1 (Sem-5/FYUGP) PHY03MJ

2025

PHYSICS

(Major)

Paper : PHY0500304

(Heat and Thermodynamics)

Full Marks : 45

Time : 2 hours

***The figures in the margin indicate
full marks for the questions.***

1. Answer the following questions : $1 \times 5 = 5$

- (a) Define the state variables of a thermodynamic system.
- (b) Define Thermodynamic equilibrium of a thermodynamic system.
- (c) Why the real gas equation deviates from ideal gas equation ?
- (d) State the third law of thermodynamics.
- (e) What is Brownian motion ?

2. Answer **any five** of the following :

$$2 \times 5 = 10$$

- (a) Define Mean, RMS and most probable speed of a gas.
- (b) Calculate the root mean square velocity of air molecules at N.T.P.
(Given, density of air = 1.293 kg/m^3).
- (c) What are degrees of freedom? State the law of equipartition of energy in a gas.
- (d) Distinguish between reversible and irreversible process.
- (e) State the second law of thermodynamics in terms of entropy.
- (f) Draw the temperature-Entropy diagram of a Carnot Cycle.
- (g) A certain amount of gas at temperature 27°C is compressed adiabatically to half of its volume. Calculate the new temperature of the gas. Given, $\gamma = 1.4$ and $2^{0.4} \approx 1.32$.
- (h) Is internal energy of a thermodynamic system a state function? Explain.
- (i) Explain why a heat engine can't be more than 100% efficient.

- (j) State the Clausius inequality in thermodynamics.
- (k) Mention *two* main limitations of Van der Waal's Equation of State for real gas.

3. Answer the following : **(any four)**

5×4=20

- (a) Obtain an expression for work done during an adiabatic process.
- (b) What is the physical significance of entropy? Show that the entropy of system remains unchanged during a reversible process.
- (c) A Carnot engine is working between steam and ice temperate of water. If the temperature of the source is increased by 10%, calculate the change in its efficiency.
- (d) Obtain the relation between C_p , and C_v using first law of Thermodynamics.
- (e) Obtain the expression for reduced equation of state for a real gas. Also write down the law of corresponding state.
- (f) Explain Joule-Thomson porous plug experiment.

- (g) Write down the physical significance of *four* thermodynamic potentials.
- (h) Deduce Maxwell's *three* TdS equations of Thermodynamics.

4. Answer the following : (**any one**) $10 \times 1 = 10$

(a) Deduce the expression for Van der Waal's Equation of State for a real gas. Obtain Van der Waal's constants in terms of critical constants. $6 + 4 = 10$

(b) Define Kelvin's absolute thermodynamic scale of temperature. Show that the Kelvin's absolute thermodynamic scale of temperature is identical with the perfect gas scale of temperature. $5 + 5 = 10$

(c) Obtain Clausius-Clapirron equation using Maxwell's first thermodynamic relation. Water boils at 99.5°C and 100.5°C when the atmospheric pressures are 74.650 and 77.371 cm of mercury respectively. Calculate the volume of 1 gm of steam at 100°C the latent heat being 540 cal./gm. $5 + 5 = 10$

(d) Write short notes on : $5 + 5 = 10$

(i) Brownian Motion and

(ii) Andrew's experiment on CO_2