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 : 1×5=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 : $2\times5=10$

(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)*** 10×1=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) Brawnian Motion and

(ii) Andrew's experiment on CO_2