

Core VII

Thermal Physics

Course Outcomes

- Basic understanding of thermodynamics and various thermal variables.
- Understanding various thermodynamics potential applications and their properties.
- To Understand the concepts of ideal gas and its thermal properties.
- To Understand the concepts of real gas and its thermal properties.
- To Apply the acquired knowledge of thermodynamics in Experiments

Unit I

- **Introduction to Thermodynamics** Recapitulation of Zeroth and First law of thermodynamics,
- **Second Law of Thermodynamics:** Reversible and Irreversible process with examples, Kelvin-Planck and Clausius Statements and their Equivalence, Carnot's Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.
- **Entropy:** Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Principle of Increase of Entropy, Temperature Entropy diagrams for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

Unit II

- **Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables. Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, Their Definitions, Properties and Applications, Surface Films and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization.
- **Phase Transitions:** First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.
- **Maxwells Thermodynamic Relations:** Derivations and applications of Maxwells Relations, Maxwells
- Relations: (1) Clausius Clapeyron equation (2) Relation between C_p and C_v (3) TdS Equations, (4) Joule- Kelvin coefficient for Ideal and Vander Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process.

Unit III

- **Kinetic Theory of Gases**
- **Distribution of Velocities:** Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.
- **Molecular Collisions:** Mean Free Path, Collision Probability, Estimates of Mean Free Path,
- **Transport Phenomenon in Ideal Gases:** (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrews Experiments on CO₂ Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule- Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling.

Text Books:

- ✓ *Thermal Physics, A. B. Gupta (Books and allied Ltd)*
- ✓ *Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw- Hill)*

Reference Books:

- ✓ Theory and experiments on thermal Physics, P.K.Chakrabarty (New central book agency limited)
- ✓ Thermodynamics, Kinetic Theory and Statistical Thermodynamics- Sears and Salinger (Narosa)
- ✓ A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press) Heat, and thermodynamics and Statistical Physics, N.Subrahmanyam and Brij Lal (S.Chand Publishing)
- ✓ *Thermal and Statistical Physics M.Das, P.K. Jena, S. Mishra, R.N.Mishra (Shri Krishna Publication)*
- ✓ *Heat, Thermodynamics and statistical physics, Brijlal, Subhramanyam and Hemne, S.Chand Publication.*

LAB: Credit-1

(Minimum 5 experiments are to be done)

flow method.

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barnes constant flow method.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charltons disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To determine J by Calorimeter.
6. To determine the specific heat of liquid by the method of cooling.
7. To determine the specific heat of solid by applying radiation of correction.

Reference Books:

- ✓ *Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House*
- ✓ *A Text Book of Practical Physics, I.Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal*
- ✓ *Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers*
- ✓ *A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.*