## Thermal Physics

**THEORY**

**Paper No. : 5.4**
**Maximum Marks : 100**
**Credits :**
**Teaching Period :**

**Thermodynamics**

Zeroth and First Law of Thermodynamics :- Thermodynamical Equilibrium. Zeroth Law of Thermodynamics and Concept of Temperature. Work and Heat Energy. State Functions. First Law of Thermodynamics. Differential form of First Law. Internal Energy. First Law and Various Processes. Applications of First Law : General Relation between Cp and Cv. Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficient. Atmosphere and Adiabatic Lapse Rate.

**(4 Lectures)**

Second Law of Thermodynamics :- Reversible and Irreversible Changes. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot Cycle. Carnot Engine and its Efficiency. Refrigerator and its Efficiency. Second Law of Thermodynamics : Kelvin-Planck and Clausius Statements and their Equivalence. Carnot Theorem. Applications of Second Law of Thermodynamics : Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

**(8 Lectures)**

Entropy :-. Change in Entropy. Entropy of a State. Clausius Theorem. Clausius Inequality. Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Impossibility of Attainability of Absolute Zero : Third Law of Thermodynamics. Temperature-Entropy Diagrams. First and second order Phase Transitions.

**(6 Lectures)**

Thermodynamic Potentials :- Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials U, H, F and G : Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work. Cooling due to Adiabatic Memagnetization. Approach to Absolute Zero.

**(6 Lectures)**

Maxwell's Thermodynamic Relations:- Derivations of Maxwell's Relations. Applications of Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations, (4) Joule-Kelvin Coefficient for Ideal and Van der Waal Gases, (5) Energy Equations and (6) Change of Temperature during an Adiabatic Process.

**(6 Lectures)**

**Kinetic Theory of Gases**

Distribution of Velocities :- Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.

**(6 Lectures)**



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.
**(4 Lectures)**
**Real gases :** Behavior of Real Gases:- Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's 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.
**(8 Lectures)**
**Suggested Books:**
1. Thermodynamics By Enrico Fermi (Courier Dover Publications, 1956)
2. A Treatise on Heat : Including Kinetic Theory of Gases, Thermodynamics and Recent Advances in Statistical Thermodynamics By Meghnad Saha, B. N. Srivastava (Indian Press, 1958)
3. Heat and Thermodynamics: An Intermediate Textbook By Mark Waldo Zemansky, Richard Dittman (McGraw-Hill, 1981
4. Thermal Physics by Garg, Bansal and Ghosh (Tata McGra-Hill, 1993)
5. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics by Francis W. Sears & Gerhard L. Salinger.( Narosa, 1986).

**PRACTICALS Marks: 50**

**1 : Mechanical Equivalent of Heat**

1. To determine J by Callender and Barne's constant flow method.

**2 : Thermal Conductivity**

1. To determine the Coefficient of Thermal Conductivity of Copper by Searle's

Apparatus.

2. To determine the Coefficient of Thermal Conductivity of Copper by Angstrom's

Method.

3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and

Charlton's disc method.

**3 : Resistance Temperature Devices**

1. To determine the Temperature Coefficient of Resistance by Platinum Resistance

Thermometer (PRT). Assume .

2. To calibrate a Resistance Temperature Device (RTD) to measure temperature in a

specified range using Null Method/ Off-Balance Bridge with Galvanometer based Measurement.

**4 : Thermocouples**

1. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

2. To Calibrate a Thermocouple to measure Temperature in a Specified Range using (1) Null Method (2) Direct Measurement using an Op-Amp Difference Amplifier and to determine Neutral Temperature.

**Note**

1. Each college should set up all the Practicals from the above list.

2. Each student is required to perform at least 6 Practicals by taking at least 1 Practical from each of the units 305.1 to 305.4.

**Text and Reference Books**

**1.** Geeta Sanon, BSc Practical Physics, 1st Edn. (2007), R. Chand & Co.

**2.** B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.

**3.** Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.

**4.** D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

**5.** Nelson and Jon Ogborn, Practical Physics.