Class : 11th Physics
Chapter- 12 : Thermodynamics

Thermodynamics

Branch of Science which deals with concepts of heat & temperature and their interconversion by thermodynamic process

Laws

Thermodynamics State variable
(i) Extensive – indicate the size of the system. e.g. U, volume, total mass.
(ii) Intensive – do not indicate size of the system. e.g. , pressure & temperature

Thermodynamics Equilibrium
Two systems are in thermal equilibrium with each other if they have the same temperature.

Zeroth Low of Thermodynamics
If two systems A&B are in thermal equilibrium with a third system C, then A&B are in thermal equilibrium with each other.

First Low of Thermodynamics
It is the statement of law of conservation of Energy;
$\Delta Q = \Delta U + \Delta W$
$= \Delta U + P\Delta U$ (Here, $\Delta U = P\Delta U$)

Second Low of Thermodynamics
It is impossible for an engine working between a cyclic process to extract heat from a reservoir and convert completely into work.

Reversible & Irreversible Process
Any process made to proceed in the reverse direction by changing its conditions is called Reversible Process.
Any process which cannot be retraced in the reverse direction exactly is called Irreversible Process.

Heat Engine
Converts continuously heat into mechanical energy in cyclic process.

Efficiency $\eta = \frac{W}{Q} = 1 - \frac{Q_2}{QT_1} = 1 - \frac{T_2}{T_1}$

Carnot Engine
An Ideal engine works on a reversible cycle of four operations in succession.
(i) isothermal expansion,
(ii) adiabatic expansion,
(iii) isothermal compression,
(iv)adiabatic compression.
Efficiency of Carnot's engine

$$\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_2}$$

Refrigerator and heat pump
Refrigerator is a heat engine working in the reverse direction.
Coefficient of performance,

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

Specific heat capacity Relation
- $\frac{C_P}{C_V} = \gamma$
- Mayer's Equation
$C_P - C_V = R$

Cyclic Process
In this process, system returns to initial state for a cyclic process $\Delta U = 0$ (zero)

Quasi - static Process
Infinity slow process such that systems remain in thermal & mechanical equilibrium with the surroundings throughout.

Property
The pressure (P) & temperature (T) of the environment can differ from those of the system only infinitesimally.

Adiabatic Process
A thermally insulated system neither gains nor loses heat
$PV^{\gamma} =$ Constant
$TV^{\gamma-1} =$ Constant
$\frac{P^{n-\gamma}}{T^{\gamma}} =$ Constant; $\frac{C_p}{C_v} = \gamma$

Isochoric Process
Volume = Constant
$\frac{P}{T} =$ Constant
$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Isothermal Process
Temperature = Constant
PV= Constant = n RT
$W = \int_{V_1}^{V_2} \frac{nRT}{V} dv$

Isobaric Process
Pressure = Constant
$\frac{V}{T} =$ Constant
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$