	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	Department of Science 2022 – 23 Subject: Physics	Note: A4 FILE FORMAT
Handouts: Chapter 12	Chapter: THERMODYNAMICS	

Thermodynamics:

It deals with the transfer of heat energy from one place to another and the conversion of heat energy into mechanical work or vice versa.

Thermodynamic system:

A collection of an extremely large number of atoms or molecules confined within certain boundaries such that it has certain values of pressure(P), volume(V) and temperature(T) is called a thermodynamic system.

Surroundings:

Anything outside the thermodynamic system to which energy or matter is exchanged is called its surroundings.

Three classes of system:

(1) Open system: A system is said to be an open system if it can exchange both energy and matter with its surroundings.

(2) Closed system: A system is said to be closed system if it can exchange only energy (not matter) with its surroundings.

(3) Isolated system: A system is said to be isolated if it can neither exchange energy nor matter with its surroundings.

Thermal equilibrium:

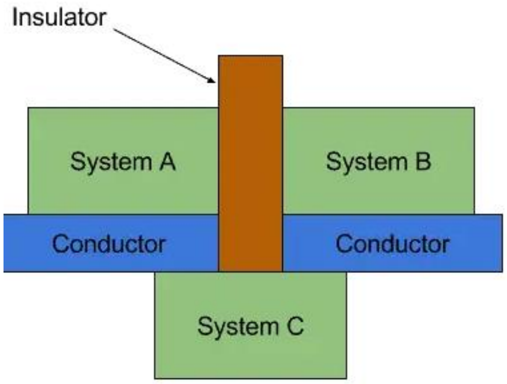
Two bodies or system in contacts are said to be in thermal equilibrium if both are at the same temperature.

When two bodies having different temperatures are placed in contact, then the energy flows from a body at higher temperature to a body at lower temperature.

The flow of energy continues from one body to another body till both bodies attain the same temperature. When both the bodies in contact have the same temperature and there is no energy flow between them, then these bodies are in thermal equilibrium.

Zeroth law of thermodynamics:

Statement: Two systems in thermal equilibrium with a third system separately are in thermal equilibrium with each other.



Consider two systems A and B, separated by a wall which does not allow any exchange of energy between them. Such a wall is known as insulating wall or adiabatic wall. The third system C is separated from the systems A and B by a conducting wall.

Since, energy can be exchanged between the systems A and B. so both A and B are at thermal equilibrium. Similarly, energy can be exchanged between the systems B and C. So both B and C are also in thermal equilibrium. In other words, both the systems A and B are in thermal equilibrium with the third systems separately.

Let T_A, T_B and T_C be the temperature of three systems A, B and C respectively. If the systems A and B are separately in equilibrium with C then $T_A = T_c$ and $T_B = T_{c.}$ This implies that $T_A = T_B$. That means the systems A and B are also in thermal equilibrium,

Significance of zeroth law of thermodynamics:

The two systems in thermal equilibrium must have a common characteristic called temperature.

Temperature:

Temperature of system is defined as the property which determines whether or not a system is in thermal equilibrium with another system.

Temperature of a system is measure of the hotness of a body. It determines the direction of flow of heat energy when two bodies are placed in contact.

Heat:

Heat is a form of energy which flows from the body at a higher temperature to the body at lower temperature.

The flow of heat energy stops when the temperatures of the two bodies become equal. i.e. when the bodies are in thermal equilibrium.

- When energy is transferred to the system, heat is positive. When energy is transferred to the surroundings, heat is negative.

Internal energy:

Internal energy of a system is the total energy possessed by the system due to the molecular motion and molecular configuration.

In other words, the sum of kinetic and potential energies of the molecules is the internal energy of the system.

The internal energy of a system is represented by the symbol U.

- When heat flows into the system its internal energy increases. When heat flows out of the system its internal energy decreases.

Work:

The energy that is transferred from one system to another by a force, moving its point of application in its own direction is work.

- When work is done on the system (compression of gas) its internal energy increases. When work is done by the system (expansion of gas) its internal energy decreases.

First law of thermodynamics: Statement: The heat energy given to the system is equal to the sum of the increase in internal energy and the external work done by the system.

If ΔQ is the amount of heat added to a system. ΔU is the increase in internal energy of the system and ΔW is the external work done by the system, then

$$\Delta Q = \Delta U + \Delta W$$

Note:

- If the system absorbs heat in a process, ΔQ is positive and if it loses heat ΔQ is negative.
- If work is done by the system during a process ΔW is positive and if work is done on the system ΔW is negative.
- When temperature of the system increases in a process ΔU is positive and when temperature of the system decreases ΔU is negative.
- Change in internal energy $\Delta U = U_2 - U_1$
  Where U_2 and U_1 are the internal energies of the system in the final and initial states.

Thermodynamic state variables:

i) **Extensive variables:** Indicate the size of the system.
ii) **Intensive variables:** Such as pressure and temperature do not indicate the size of the system.

Note:

For an ideal gas, the equation of state is the ideal gas equation

PV=nRT where n is the number of moles of an ideal gas.

Thermodynamic processes:

Any process in which the thermodynamic variables of a thermodynamic system change is known as thermodynamic process.

i. **Isothermal process:** A process in which pressure and volume of the system change at constant temperature is called isothermal process.
Since the temperature remains constant, the internal energy of the system remains constant.
The change in internal energy $\Delta U = 0$, applying the first law thermodynamics, we get

$$\Delta Q = \Delta W$$

During isothermal expansion, heat supplied to the system ΔQ equals the external work done ΔW by the gas.

During isothermal compression the amount of heat released to the surroundings equals the amount of work done ΔW on the system.

Ex: the expansion of a gas in a metallic cylinder placed in a large reservoir of fixed temperature.

ii. **Isobaric process:** During this process, change in volume and temperature takes place at constant pressure.

Ex: heating of any liquid at atmospheric pressure.

iii. **Isochoric process:** During this process change in pressure and temperature take place at constant volume.

Ex: melting of a solid into liquid is nearly an isochoric process, as there is a negligible change in the volume.

iv. **Adiabatic process:** In this process, heat energy neither enters nor leaves the system.

Here system is insulated from the surroundings.

$\Delta Q=0$, applying the first law of thermodynamics

$$\Delta U = -\Delta W$$

v. **Cyclic process:** In a cyclic process, the system undergoes a series of changes and finally returns to the initial state.

Second law of thermodynamics:

Kelvin – plank statement:

No process is possible whose sole result is the absorption of heat from a reservoir and the complete conversion of the heat into work.

Reversible and Irreversible process:

A reversible process is one which can be made to go in the reverse direction so that all changes occurring in the direct process are exactly reversed.

Ex: A very slow isothermal expansion or compression of a gas.

An irreversible process is one which cannot be made to go in the reverse direction.

Ex: An explosion is an irreversible process.

Prepared by: **Ms Vivette Shirly Lasrado**	Checked by HOD - Science