4.1. Explain the term "Heat" and "Temperature.”

Ans:

Heat:

Heat is the transfer of thermal energy between two objects or systems that are at different temperatures. It flows spontaneously from a region of higher temperature to a region of lower temperature until thermal equilibrium is reached. Heat can be transferred through conduction (direct contact), convection (through a fluid medium), or radiation (through electromagnetic waves).

Temperature:

Temperature, on the other hand, is a measure of the average kinetic energy of the particles in a substance. It determines the direction of heat flow—heat flows from a region of higher temperature to a region of lower temperature. Temperature is an intensive property, meaning it does not depend on the amount of substance present.

4.2.

4.8. What is the internal energy of a system? "Internal energy is a state function and not a path function" explain.

Ans:

The internal energy of a system refers to the total energy possessed by the system, including the kinetic energy and potential energy of its particles (atoms, molecules, or other constituents) at the microscopic level. It is a fundamental concept in thermodynamics that helps describe the behavior and changes in a system.

Internal energy is considered a state function, which means it only depends on the current state of the system and not on how the system reached that state. This is in contrast to path functions, which depend on the specific path taken to reach a certain state. For example, the work done and heat transferred are path functions because their values can vary depending on the specific process or path used to reach a state.

4.9. Explain the terms

(A) isochoric process :

An isochoric process, also known as an isovolumetric process or a constant volume process, is a thermodynamic process in which the volume of a system remains constant while other properties, such as pressure, temperature, or internal energy, may change. In an isochoric process, no work is done by or on the system due to a change in volume since the volume remains constant throughout.

The key characteristic of an isochoric process is that the change in volume is zero (∆V = 0). This can be achieved, for example, by confining the system within a rigid container or by using a piston that prevents any movement of the system boundary.

ii. isobaric process: An isobaric process is a thermodynamic process in which the pressure of a system remains constant while other properties, such as volume, temperature, or internal energy, may change. In an isobaric process, the system is allowed to freely expand or contract to accommodate changes in volume without any restrictions.

The key characteristic of an isobaric process is that the change in pressure is zero (∆P = 0). This can be achieved, for example, by allowing the system to interact with its surroundings through a piston-cylinder arrangement where the pressure on the system is maintained constant by adjusting the external force applied to the piston.

iii. cyclic process: A cyclic process is a thermodynamic process in which a system undergoes a series of changes and returns to its initial state. In other words, the system completes a closed loop in its thermodynamic cycle. As a result, the overall change in the system's properties, such as temperature, pressure, or internal energy, is zero.

During a cyclic process, the system may go through various combinations of isothermal, isobaric, adiabatic, or other types of processes. The specific path taken by the system in the cycle can vary, but the important aspect is that it ultimately returns to its original state. This means that the final and initial states of the system have the same properties, even if there have been changes along the way.

Iv)isothermal process: An isothermal process is a thermodynamic process in which the temperature of a system remains constant while other properties, such as pressure, volume, or internal energy, may change. In an isothermal process, heat is added or removed from the system to maintain a constant temperature.

The key characteristic of an isothermal process is that the change in temperature is zero (∆T = 0). This can be achieved, for example, by allowing the system to interact with a heat reservoir that maintains a constant temperature throughout the process. The system and the heat reservoir are in thermal equilibrium, and heat is transferred between them to balance any changes in the system's internal energy.

(v) adiabatic process: An adiabatic process is a thermodynamic process in which there is no heat transfer between a system and its surroundings. In an adiabatic process, the system is thermally isolated, meaning that there is no exchange of heat with the environment.

The key characteristic of an adiabatic process is that the change in heat (∆Q) is zero (∆Q = 0). This implies that the system does not gain or lose energy in the form of heat during the process. While heat transfer is zero, work can still be done on or by the system, leading to changes in other properties such as temperature, pressure, or volume.

4.12. Explain the concepts of reversible and irreversible processes.

Ans: Reversible Process:

A reversible process is a theoretical idealized process in thermodynamics that can be reversed without leaving any trace on the surroundings or the system. In a reversible process, both the system and its surroundings can be restored to their original states by reversing the process exactly.

Key characteristics of a reversible process include:

Infinitesimally small steps: A reversible process consists of a series of infinitely small steps, ensuring that at each stage, the system is in equilibrium with its surroundings.

Quasi-static equilibrium: The system remains in quasi-static equilibrium throughout the process, meaning that it adjusts infinitesimally slowly to changes in its surroundings. This allows the system to always be in balance and have uniform properties.

No energy losses: A reversible process has no dissipative effects or irreversibility, such as friction or heat transfer across finite temperature differences. Energy conversions occur with maximum efficiency.

System and surroundings are always in equilibrium: At every point in the process, the system and its surroundings are in thermodynamic equilibrium, with no gradients or imbalances.

Irreversible Process:

An irreversible process is a thermodynamic process that cannot be reversed to return the system and its surroundings to their original states. Irreversible processes involve energy dissipation, such as the generation of heat, changes in entropy, or other forms of irreversible transformations.

Key characteristics of an irreversible process include:

Energy losses: Irreversible processes involve energy losses due to factors like friction, heat transfer across finite temperature differences, or other dissipative effects. These losses lead to a decrease in the useful energy available to do work.

Departure from equilibrium: The system and its surroundings are not in thermodynamic equilibrium throughout the process. There are gradients, imbalances, or non-uniform properties that result in deviations from equilibrium conditions.

Directionality: Irreversible processes have a definite direction of progression and cannot be reversed exactly to restore the initial state.

4.19. State first law of thermodynamics. Give its physical significance. What are the limitations of first law?

Ans:

The first law of thermodynamics, also known as the law of energy conservation, states that energy cannot be created or destroyed in an isolated system. It can only be transferred from one form to another or converted from one form to another. Mathematically, the first law can be expressed as:

∆U = Q - W

where:

∆U is the change in internal energy of the system,

Q is the heat transferred into or out of the system,

W is the work done by or on the system.

The physical significance of the first law of thermodynamics is that it establishes the principle of energy conservation in thermodynamic systems. It states that the total energy of an isolated system remains constant over time. Energy can be exchanged with the surroundings in the form of heat and work, but the total amount of energy within the system remains constant.

The first law has significant implications for various practical applications and systems:

Heat engines: The first law helps to analyze and understand the conversion of heat into useful work in heat engines. It provides the basis for determining the efficiency of these engines and the limitations imposed by energy conservation.

Energy transfer: The first law helps explain how energy is transferred and transformed in various processes, such as heating and cooling, chemical reactions, and phase changes. It allows for the calculation of energy changes and heat transfer in these processes.

Conservation of energy: The first law reinforces the fundamental principle of energy conservation in the universe. It establishes that energy is a conserved quantity and cannot be created or destroyed, but can only be converted from one form to another.

Despite its fundamental importance, the first law of thermodynamics has some limitations:

It does not provide information about the direction or feasibility of a process. It only states that energy is conserved, but not whether a process will occur spontaneously or how efficiently it will occur.

It does not account for factors like the irreversibility of processes, the nature of heat transfer, or the quality of energy. It does not distinguish between reversible and irreversible processes, which can have different efficiency and practical implications.

The first law does not provide information about the entropy changes within a system. Entropy is a measure of the system's disorder or the availability of energy for useful work. The second law of thermodynamics addresses the concept of entropy and its relation to energy transformations.

4.21. explain how first law of thermodynamics leads in the concept of internal energy

Ans:

The first law of thermodynamics is closely related to the concept of internal energy. The first law states that the change in internal energy (∆U) of a system is equal to the heat transfer into or out of the system (Q) minus the work done by or on the system (W). Mathematically, it can be expressed as:

∆U = Q - W

Internal energy refers to the total energy contained within a system. It includes the kinetic energy of particles within the system and the potential energy associated with the interactions between the particles. The internal energy of a system depends on its temperature, pressure, volume, and composition.

The first law of thermodynamics helps to understand the relationship between internal energy, heat, and work. here's how:

Heat transfer (Q): Heat transfer is the transfer of energy between a system and its surroundings due to a temperature difference. When heat is added to a system (Q > 0), it increases the internal energy of the system. The energy from heat is used to increase the kinetic energy of the particles, raising the temperature of the system.

Work done (W): Work is the energy transferred to or from a system as a result of mechanical forces acting on it. When work is done on a system (W > 0), it increases the internal energy of the system. Work can increase the potential energy of the particles or change the volume of the system, resulting in a change in internal energy.

Change in internal energy (∆U): The change in internal energy of a system (∆U) is the net result of the heat transfer and work done. If more heat is added to the system than the work done by the system, the internal energy increases (∆U > 0). Conversely, if more work is done by the system than the heat added, the internal energy decreases (∆U < 0).

4.22. What is the first law of thermodynamic Show that this law is a particular form of general law of conversation of energy?

Ans:

he first law of thermodynamics states that energy cannot be created or destroyed within a closed system. It can only be transferred from one form to another or converted from one form to another. This law is a specific application of the general law of conservation of energy, which states that the total energy of an isolated system remains constant.

Mathematically, it can be expressed as:

∆U = Q – W

This equation shows that the change in internal energy (∆U) is determined by the difference between the heat transfer (Q) and the work done (W). Heat transfer refers to the transfer of energy due to a temperature difference, while work refers to the transfer of energy due to mechanical forces.

The first law of thermodynamics is a specific form of the general law of conservation of energy because it applies this principle specifically to thermodynamic systems. It states that the total energy within a closed system, represented by the internal energy, remains constant. The energy can be transferred into or out of the system as heat or work, but the total amount of energy within the system does not change.

4.33. Explain why the gases have two specific heats? Explain why the specific heat at constant pressure Cp is greater than that Cv, the specific heat at constant volume. Prove Cp-Cv = R

Ans:

Gases have two specific heats, namely the specific heat at constant pressure (Cp) and the specific heat at constant volume (Cv), due to the different ways in which energy is transferred to them.

Specific heat at constant pressure (Cp):

Cp is the amount of heat energy required to raise the temperature of a gas by one unit when the pressure is held constant. When heat is added to a gas at constant pressure, some of the energy goes into increasing the internal energy of the gas (increase in temperature) and some is used to do work on the surroundings (expanding the gas against the constant pressure). Cp takes into account both the heat energy required to raise the temperature and the work done on the surroundings.

Specific heat at constant volume (Cv):

Cv is the amount of heat energy required to raise the temperature of a gas by one unit when the volume is held constant. When heat is added to a gas at constant volume, all the energy goes into increasing the internal energy of the gas (increase in temperature). No work is done on the surroundings because the volume is held constant. Therefore, Cv only accounts for the heat energy required to raise the temperature of the gas

Now, let's explain why Cp is greater than Cv:

Consider the ideal gas equation: PV = nRT, where P is pressure, V is volume, n is the number of moles, R is the ideal gas constant, and T is temperature.

For an ideal gas, we can express the change in internal energy (∆U) in terms of the work done (W) and heat transfer (Q) as:

∆U = Q - W

For a constant volume process (Cv), since no work is done (W = 0), we have:

∆U = Qv

where Qv is the heat transfer at constant volume.

For a constant pressure process (Cp), the work done is given by:

W = P∆V

Using the ideal gas equation, we can rewrite the work done as:

W = nR∆T

Substituting this into the equation for ∆U, we have:

∆U = Qp - nR∆T

Since ∆U = Cv∆T for a constant volume process, and ∆U = Cp∆T for a constant pressure process, we can rewrite the equation as:

Cv∆T = Qv

Cp∆T = Qp - nR∆T

Rearranging the second equation, we get:

Cp - Cv = nR

Since n is the number of moles, and R is the ideal gas constant, we can conclude that:

Cp - Cv = R

4.41. Distinguish between isothermal and adiabatic process.

Ans:

An isothermal process and an adiabatic process are two different types of thermodynamic processes that occur in systems. Here are the main distinctions between them:

Temperature Change:

Isothermal Process: In an isothermal process, the temperature of the system remains constant throughout the process. This means that the system is in thermal equilibrium with its surroundings, and any heat added to or removed from the system is perfectly balanced by an equal amount of heat transfer.

Adiabatic Process: In an adiabatic process, there is no heat transfer between the system and its surroundings. The system is thermally insulated, so there is no exchange of heat. Consequently, the temperature of the system can change during an adiabatic process.

Heat Transfer:

Isothermal Process: In an isothermal process, heat transfer occurs to maintain the constant temperature. If the system absorbs heat, it releases an equal amount of heat to maintain equilibrium. If the system loses heat, it absorbs an equal amount of heat from the surroundings.

Adiabatic Process: In an adiabatic process, there is no heat transfer between the system and its surroundings. The process is thermally isolated, meaning that the system neither gains nor loses heat to or from its surroundings.

Work Done:

Isothermal Process: In an isothermal process, work can be done on or by the system. The work done is a result of the expansion or compression of the system while maintaining constant temperature. The amount of work done depends on the pressure and volume changes of the system.

Adiabatic Process: In an adiabatic process, work can also be done on or by the system. However, the work done is a result of changes in pressure and volume without any heat transfer. The specific relationship between pressure, volume, and work can vary depending on the specific adiabatic process (e.g., adiabatic expansion or adiabatic compression).

Efficiency:

Isothermal Process: In an isothermal process, the system operates at maximum efficiency because heat is added or removed at the same temperature. This allows for a complete conversion of heat energy into work.

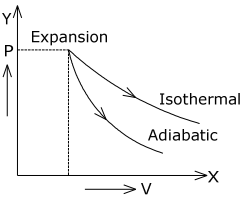
Adiabatic Process: In an adiabatic process, the efficiency can be lower compared to an isothermal process. This is because some energy is inevitably lost due to the temperature change during the process.

4.42. Draw P-V diagrams representing isothermal and adiabatic processes.

Ans:

Isothermal Process:

In an isothermal process, the temperature remains constant. As a result, the graph on the P-V diagram is a rectangular hyperbola, indicating that the pressure and volume are inversely proportional.



In the diagram, the curve represents the isothermal process. The initial and final points of the process are labeled as A and B, respectively. The area under the curve represents the work done during the process.

Adiabatic Process:

In an adiabatic process, there is no heat transfer between the system and its surroundings. As a result, the graph on the P-V diagram is steeper compared to an isothermal process. The exact shape of the adiabatic curve depends on the specific adiabatic process (e.g., expansion or compression).

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Description automatically generated

In the diagram, the curve represents the adiabatic process. The initial and final points of the process are labeled as A and B, respectively. The steepness of the curve indicates the rapid change in pressure and volume during the adiabatic process.

4.51. Calculate the work done in a Carnot's cycle of operations. Deduce the efficiency of a Carot's engine in terms of the temperature between which it works.

Ans:

In a Carnot cycle, the work done by the engine can be calculated by finding the area enclosed by the PV diagram. The efficiency of the Carnot engine can be deduced by comparing the work done with the heat input.

The Carnot cycle consists of four reversible processes: two isothermal processes and two adiabatic processes. Let's denote the high-temperature reservoir as TH and the low-temperature reservoir as TL.

The steps of the Carnot cycle are as follows:

Isothermal Expansion (Step 1-2):

In this step, the working substance (ideal gas) expands isothermally at temperature TH, absorbing heat (QH) from the high-temperature reservoir. The work done (W12) during this expansion can be calculated using the equation:

W12 = QH - QH' (where QH' is the heat lost during the process)

Adiabatic Expansion (Step 2-3):

In this step, the gas expands adiabatically, meaning there is no heat transfer. The temperature of the gas decreases from TH to TL. The work done (W23) during this expansion can be calculated using the equation:

W23 = (QH' - QL') (where QL' is the heat lost during the process

Isothermal Compression (Step 3-4):

In this step, the gas is compressed isothermally at temperature TL, releasing heat (QL) to the low-temperature reservoir. The work done (W34) during this compression can be calculated using the equation:

W34 = QL - QL' (where QL' is the heat lost during the process)

Adiabatic Compression (Step 4-1):

In this step, the gas is compressed adiabatically back to its initial state. The temperature of the gas increases from TL to TH. The work done (W41) during this compression can be calculated using the equation:

W41 = (QH' - QL') (where QH' is the heat lost during the process)

The net work done (Wnet) in the Carnot cycle is the sum of the work done in each step:

Wnet = W12 + W23 + W34 + W41

The efficiency of the Carnot engine (η) can be calculated by comparing the net work done with the heat input:

η = Wnet / QH

= (W12 + W23 + W34 + W41) / QH

Now, let's deduce the efficiency of the Carnot engine in terms of the temperatures TH and TL.

For the isothermal processes, the heat absorbed or released can be calculated using the equation:

Q = nRT ln(V2/V1)

where n is the number of moles, R is the gas constant, and V2/V1 is the ratio of volumes during the process.

For the adiabatic processes, the relationship between pressure and volume can be expressed as:

P \* V^γ = constant

where γ is the heat capacity ratio (Cp/Cv) for the working substance.

4.52. Derive an expression for the efficiency of an ideal heat engine, working between the temperatures T and T, K. Prove that the efficiency of a reversible engine is maximum for the given source and sink .

Ans:

To derive an expression for the efficiency of an ideal heat engine working between temperatures T1 and T2, we can use the Carnot efficiency. The Carnot efficiency represents the maximum possible efficiency for a heat engine operating between two temperatures and is achieved by a reversible engine.

The Carnot efficiency (η\_carnot) is given by:

η\_carnot = 1 - T2/T1

where T1 is the temperature of the high-temperature reservoir (source) in Kelvin, and T2 is the temperature of the low-temperature reservoir (sink) in Kelvin.

Now, let's prove that the efficiency of a reversible engine is maximum for the given source and sink temperatures.

Let's assume there are two heat engines, one reversible (Engine R) and one irreversible (Engine I), both operating between the same source and sink temperatures T1 and T2.

The efficiency of Engine R (η\_R) is given by the Carnot efficiency:

η\_R = 1 - T2/T1

The efficiency of Engine I (η\_I) is given by:

η\_I = 1 - Q2/Q1

where Q1 is the heat absorbed from the source and Q2 is the heat rejected to the sink.

For a given amount of heat absorbed from the source (Q1), the heat rejected to the sink (Q2) is the same for both engines.

Since both engines operate between the same temperatures, T1 and T2 are constant. Therefore, the only different between the two efficiencies is the ratio Q2/Q1

Since Q2 is constant for both engines, the only way for η\_I to be greater than η\_R is if Q1 for Engine I is greater than Q1 for Engine R.

However, this violates the second law of thermodynamics, which states that it is not possible to have a heat engine with higher efficiency than a reversible engine operating between the same temperatures.

Hence, we conclude that the efficiency of a reversible engine (Carnot efficiency) is maximum for a given source and sink temperatures.

4.53. State the Second Law of thermodynamics. Describe Carol's cycle and deduce the efficiency of an ideal heat engine.

Ans:

The Second Law of Thermodynamics states that the entropy of an isolated system always increases over time, or in a reversible process, it remains constant. This law encompasses several important principles:

Kelvin-Planck Statement: It is impossible to create a heat engine that operates in a cycle and extracts heat from a single reservoir and converts it entirely into work.

Clausius Statement: It is impossible to have a heat transfer from a cooler body to a hotter body without the aid of external work or energy input.

The Carnot cycle is a theoretical thermodynamic cycle that represents the most efficient operation of a heat engine between two temperature reservoirs. It consists of four reversible processes:

Isothermal Expansion: The working substance (usually an ideal gas) expands while in thermal equilibrium with the high-temperature reservoir, absorbing heat and doing work.

Adiabatic Expansion: The gas continues to expand without any heat exchange, resulting in a decrease in temperature.

Isothermal Compression: The gas is compressed while in thermal equilibrium with the low-temperature reservoir, releasing heat and doing work.

Adiabatic Compression: The gas continues to be compressed without any heat exchange, resulting in an increase in temperature.

4.54. Describe Camot's cycle and obtain an expression for the efficiency of an ideal heat engine in terms

temperatures.

Ans:

The Carnot cycle is a theoretical thermodynamic cycle that represents the most efficient operation of a heat engine between two temperature reservoirs. It consists of four reversible processes: two isothermal processes and two adiabatic processes.

Isothermal Expansion:

In this process, the working substance (typically an ideal gas) expands while in thermal equilibrium with the high-temperature reservoir (TH). The temperature of the gas remains constant, and it absorbs heat (QH) from the reservoir. The expansion occurs at the high temperature TH.

Adiabatic Expansion:

In this process, the gas continues to expand without any heat exchange with its surroundings. The temperature of the gas decreases as it expands. This expansion is adiabatic, meaning no heat is transferred. The expansion continues until the gas reaches the low temperature TL

Isothermal Compression:

In this process, the working substance is compressed while in thermal equilibrium with the low-temperature reservoir (TL). The temperature of the gas remains constant, and it releases heat (QL) to the reservoir. The compression occurs at the low temperature TL.

Adiabatic Compression:

In this process, the gas continues to be compressed without any heat exchange. The temperature of the gas increases as it is compressed. The compression continues until the gas reaches the high temperature TH.

4.56. What is the principle used in the working of a refrigerator. Define coefficient of performance. Is it greater than 1? Explain

Ans:

The principle used in the working of a refrigerator is based on the Second Law of Thermodynamics. It utilizes the transfer of heat from a low-temperature reservoir (inside the refrigerator) to a high-temperature reservoir (outside the refrigerator), against the natural direction of heat flow. This process is achieved by utilizing work input from an external source.

A refrigerator operates using a refrigeration cycle, which typically involves a working fluid (refrigerant) that undergoes compression, condensation, expansion, and evaporation. The basic components of a refrigerator include a compressor, condenser, expansion valve, and evaporator.

The refrigeration cycle works as follows:

Compression: The refrigerant is compressed by the compressor, which raises its pressure and temperature.

Condensation: The high-pressure and high-temperature refrigerant flows into the condenser, where it releases heat to the surroundings and condenses into a liquid.

Expansion: The condensed liquid refrigerant passes through an expansion valve, which causes a drop in pressure. As a result, the refrigerant becomes a low-pressure, low-temperature mixture of liquid and vapor.

Evaporation: The low-pressure refrigerant enters the evaporator, where it absorbs heat from the interior of the refrigerator, causing the refrigerant to evaporate into a low-temperature vapor.

By absorbing heat from the interior of the refrigerator and releasing it to the surroundings, the refrigeration cycle maintains a lower temperature inside the refrigerator compared to the ambient temperature.

The coefficient of performance (COP) is a measure of the efficiency of a refrigerator or heat pump. It is defined as the ratio of the desired output (heat removed from the low-temperature reservoir) to the required input (work input or energy consumed).

For a refrigerator, the coefficient of performance (COP\_refrigerator) is given by:

COP\_refrigerator = QL / W

where QL is the amount of heat removed from the low-temperature reservoir (inside the refrigerator) and W is the work input required to drive the refrigeration cycle

The COP of a refrigerator is always greater than 1. This implies that for a given amount of work input, the refrigerator can remove more heat from the low-temperature reservoir than the work input it consumes. In other words, it achieves a cooling effect greater than the work input. This is possible due to the utilization of external work and the transfer of heat against its natural direction.

The COP of a refrigerator indicates its efficiency in providing cooling, with a higher COP value indicating a more efficient refrigerator.

4.67. Write short notes on:

(i) Efficiency of Carnot's Heat Engine:

The efficiency of a Carnot's heat engine is the maximum possible efficiency that can be achieved by any heat engine operating between two temperature reservoirs. It is given by the equation:

Efficiency = 1 - (T\_Low / T\_High)

where T\_Low is the temperature of the low-temperature reservoir and T\_High is the temperature of the high-temperature reservoir. The efficiency is always less than 1 (expressed as a decimal or percentage) and represents the fraction of input energy that is converted into useful work.

(ii) Carnot's Theorem:

Carnot's theorem states that no heat engine operating between two temperature reservoirs can be more efficient than a Carnot heat engine operating between the same two reservoirs. It implies that the Carnot cycle, which consists of reversible processes, represents the most efficient operation of a heat engine. Carnot's theorem provides a theoretical limit for the maximum possible efficiency of any heat engine.

(iii) Efficiency of Carnot's Heat Engine:

The efficiency of a Carnot's heat engine is given by the equation:

Efficiency = 1 - (T\_Low / T\_High)

where T\_Low is the temperature of the low-temperature reservoir and T\_High is the temperature of the high-temperature reservoir. This efficiency represents the maximum efficiency achievable for a heat engine operating between those two temperatures.

(iv) Second Law of Thermodynamics:

The Second Law of Thermodynamics states that the entropy of an isolated system always increases over time, or remains constant in a reversible process. It provides fundamental principles regarding energy conversion, heat transfer, and the direction of natural processes. It includes concepts such as the impossibility of a perpetual motion machine of the second kind and the concept of entropy as a measure of the disorder or randomness in a system.

(v) Zeroth Law of Thermodynamics:

The Zeroth Law of Thermodynamics establishes the concept of temperature and thermal equilibrium. It states that if two systems are in thermal equilibrium with a third system, they are also in thermal equilibrium with each other. This law forms the basis for temperature measurement and the establishment of temperature scales.

(vi) First Law of Thermodynamics:

The First Law of Thermodynamics, also known as the Law of Energy Conservation, states that energy cannot be created or destroyed in an isolated system. It can only be converted from one form to another or transferred between systems. This law establishes the principle of energy conservation in various thermodynamic processes, including heat transfer, work done, and changes in internal energy.

(vii) Internal Energy:

Internal energy refers to the total energy possessed by a system due to the molecular motion and interactions of its constituent particles. It includes the kinetic energy of particles and the potential energy associated with their interactions. Internal energy is a state function and depends only on the current state of the system, not on the path taken to reach that state.

(viii) Quasi-Static Process:

A quasi-static process, also known as a quasi-equilibrium process, is a theoretical idealization in thermodynamics. It assumes that a system changes its state infinitesimally slowly, maintaining thermodynamic equilibrium at all times. In a quasi-static process, the system is always very close to being in equilibrium, allowing precise calculations and analysis based on the laws of thermodynamics.

(ix) External and Internal Work:

External work refers to the work done by or on a system as a result of the system's volume changing against an external force. It involves mechanical work, such as the expansion or compression of a gas against a piston. Internal work refers to the work done within a system due to molecular interactions, such as the work associated with changes in the internal energy of a substance. Both external and internal work contribute to the overall energy