



# First stage-Medical physics

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## Chapter one /(Lec.1)

### General Concept in Thermodynamic

By

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# Definitions and Fundamental Ideas of Thermodynamics

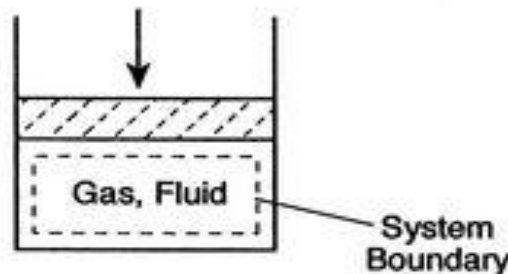
Thermodynamics deals with the quantitative relationship of interconversion of the various forms of energy. Any system, physical or chemical or even biological, can be considered as a thermodynamical system.

## The Concept of a ``System''

A thermodynamic system is a quantity of matter of fixed identity, around which we can draw a boundary (see figure [1.1](#) for an example).

## The system boundary

The boundaries may be fixed or moveable. Work or heat can be transferred across the system boundary. Everything outside the boundary is the surroundings.



# Types of thermodynamics system

## **Isolated system**

a system is said to be isolated when there is no exchange of energy or matter with the surroundings.

## **Closed system**

when there is an exchange of energy but not of matter then the system is said to be closed.

## **Open system**

when both matter and energy can be freely exchanged with the environment, then the system is an open one.

## Properties of a system

**Properties of a system** are a measurable characteristic of a system that is in equilibrium. Properties may be intensive or extensive.

**Intensive** – Are independent of the amount of mass: e.g: Temperature, Pressure, and Density, ....etc

**Extensive** – varies directly with the mass e.g: mass, volume, energy, enthalpy

**Specific properties** – The ratio of any extensive property of a system to that of the mass of the system is called an average specific value of that property (also known as intensive property)

For example:

$$\text{specific volume} = V/m = v.$$

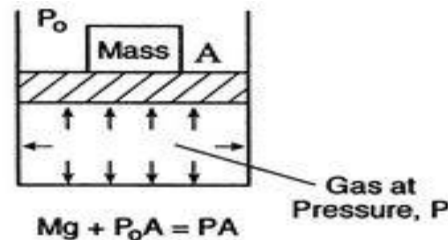
## The Concept of a "State"

The **thermodynamic state** of a system is defined by specifying values of a set of measurable **properties** sufficient to determine all other properties. For fluid systems, typical properties are pressure, volume and temperature.

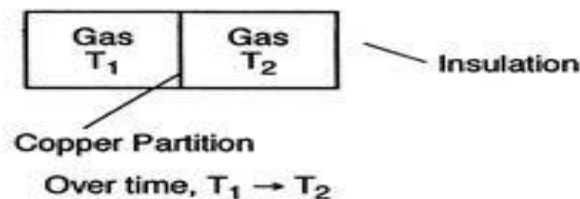
## The Concept of "Equilibrium"

The state of a system in which properties have definite, unchanged values as long as external conditions are unchanged is called an equilibrium state.

[Mechanical Equilibrium]



[Thermal Equilibrium]



## Thermodynamics Equilibrium•

No spontaneous change in macroscopic property ( i.e. isolated system) A system in thermodynamic equilibrium satisfies:

**1-mechanical equilibrium** ( No pressure gradient within the system and also between system & surroundings i.e.  $\delta P=0$ , or no unbalance force)

**2-thermal equilibrium** ( No transfer of heat across the boundary of system when it is separated from universe by means of Diathermic wall- that allows the heat or  $\delta T=0$ )

**3-chemical equilibrium.** (No transfer of mass by any chemical process across the boundary of system i.e. diffusion and no unbalanced chemical reaction within the system)

## **Equations of state**

It is an experimental fact that two properties are needed to define the state of any pure substance in equilibrium or undergoing a steady or quasi-steady process

## **The Concept of a ``Process''**

- If the state of a system changes, then it is undergoing a **process**.
- At the end of the process if the properties have returned to their original values, the system has undergone a **cyclic process** or a **cycle**.  
Note that even if a system has returned to its original state and completed a cycle, the state of the surroundings may have changed.

Adiabatic process - a process with no heat transfer into or out of the system.

Isochoric process - a process with no change in volume, in which case the system does no work.

Isobaric process - a process with no change in pressure.

Isothermal process - a process with no change in temperature.

**Irreversible process** - a process that cannot return both the system and surrounding to their original conditions

**Reversible process** - it is defined as a process that, once having take place it can be reversed. In doing so, it leaves no change in the system or boundary.

**Cyclic process** - when a system in a given initial state goes through various processes and finally return to its initial state, the system has undergone a cyclic process or cycle.



## process path

is the series of states that a system passes through as it moves from an initial state to a final state.

- **Work** is a transfer of energy that can be used to change the height of a weight somewhere in the surroundings.
- **Heat** may be defined as energy in transit from a high temperature object to a lower temperature object.
- Internal energy is the microscopic energy in an object is . The internal energy may be increased by transferring energy to the object from a higher temperature (hotter) object - this is properly called heating.

## **Zeroth Law of Thermodynamics**

**If two systems in thermal equilibrium with a third system then they are in thermal equilibrium with each other.**