MEDICAL PHYSICS

Medical physics (also called biomedical physics, medical biophysics or applied physics in medicine) is, generally speaking, the application of physics concepts, theories and methods to medicine

Physical Quantities:

1. Derived quantities: they can be expressed as combinations of a small number of basic quantities.
2. Basic quantities: there are three basic quantities are, length, mass and time. An international committee established a set of standards for the fundamental quantities of science. It is called the SI (System International), and its units of length (meter), mass(kilogram), and time (second). Other SI standards established by the committee are those for temperature (kelvin), electric current (ampere), luminous intensity (candela), and the amount of substance (mole).

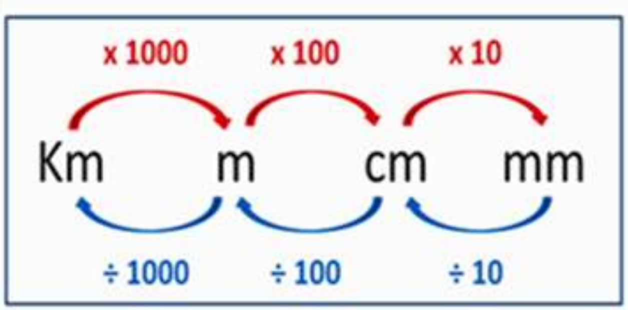
In addition to the basic SI units of meter, kilogram, and second, we can also use other units, such as millimeters and nanoseconds.

QUANTITY	SI UNIT (SYMBOL)	METRIC UNIT (SYMBOL)
Mass	Kilogram (kg)	Gram (g)
Length	Meter (m)	Meter (m)
Volume	Cubic meter (m^3)	Liter (L)
Temperature	Kelvin (K)	Celsius degree (°C)
Time	Second (s)	Second (s)

TABLE Some Prefixes for Multiples of Metric and SI Units

PREFIX	SYMBOL	BASE UNIT MULTIPLIED BY*	EXAMPLE
mega	M	$1,000,000 = 10^6$	1 megameter (Mm) = 10^6 m
kilo	k	$1000 = 10^3$	1 kilogram (kg) = 10^3 g
hecto	h	$100 = 10^2$	1 hectogram (hg) = 100 g
deka	da	$10 = 10^1$	1 dekaliter (daL) = 10 L
deci	d	$0.1 = 10^{-1}$	1 deciliter (dL) = 0.1 L
centi	c	$0.01 = 10^{-2}$	1 centimeter (cm) = 0.01 cm
milli	m	$0.001 = 10^{-3}$	1 milligram (mg) = 0.001 g
micro	μ	$0.000\,001 = 10^{-6}$	1 micrometer (μm) = 10^{-6} m
nano	n	$0.000\,000\,001 = 10^{-9}$	1 nanogram (ng) = 10^{-9} g
pico	p	$0.000\,000\,000\,001 = 10^{-12}$	1 picogram (pg) = 10^{-12} g
femto	f	$0.000\,000\,000\,000\,001 = 10^{-15}$	1 femtogram = 10^{-15} g

Converting LENGTH Units



5km = ? m Need to x 1000 5 x 1000 = 5000m ✓

120cm = ? m Need to ÷ 100 120 ÷ 100 = 1.2m ✓

Conversions of Units

cm2 = 10 mm x 10 mm =100 mm2

m2 = 100 cm x 100 cm = 10 000 cm2

m2 = 1000 mm x 1000 mm = 1 000 000 mm2

Thermodynamics :

The branch of science which deals with energy changes in physical and chemical processes is called thermodynamics.

In mechanics we deal with quantities such as mass, position, velocity, acceleration, momentum, etc.

In Thermodynamics we deal with quantities which describe our systems, usually (but not always) a gas. Volume, Temperature, Pressure, Heat Energy, Work.

Branches of Thermodynamics

- **Classical thermodynamics** is the description of the states of thermodynamical systems at near-equilibrum, using macroscopic, empirical properties directly measurable in the laboratory (Lab.). It is used to model exchanges of energy, work and heat based on the laws of thermodynamics.
- **Statistical mechanics** (or **statistical thermodynamics**) gives thermodynamics a molecular interpretation. This field relates the microscopic properties of individual atoms and molecules to the macroscopic or bulk properties of materials that can be observed in everyday life.
- **Chemical thermodynamics** is the study of the interrelation of energy with chemical reactions.

- **Biological thermodynamics** is the study of energy transformation in the biological systems

- **Pharmaceutical Thermodynamics**: is the chemical thermodynamics study of the drug action. Subjects in this field, include the thermodynamics of absorption, crystallization, encapsulation, partitioning.

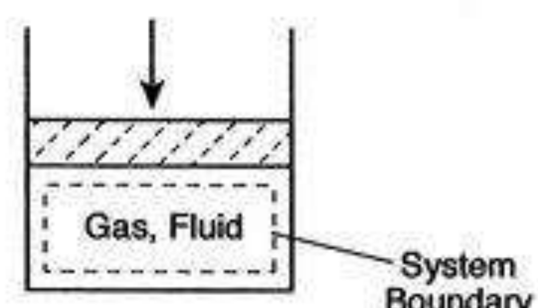
common terms of thermodynamics

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 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 system

Isolated system

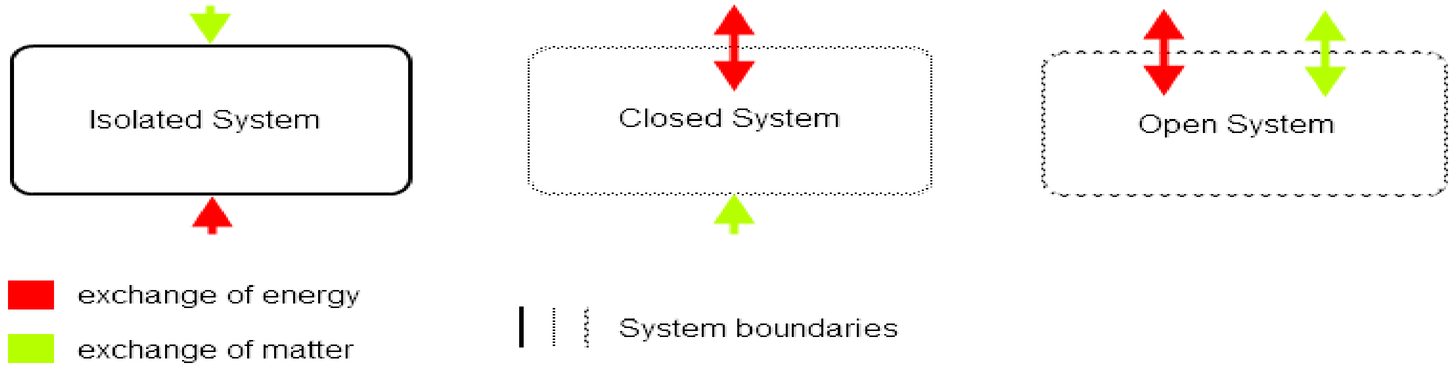
a system is said to be isolated when there is no exchange of energy or matter with the surroundings. An example of an isolated system is a completely insulated rigid container, such as a completely insulated gas cylinder.

Closed system

when there is an exchange of energy but not of matter then the system is said to be closed. A greenhouse is an example of a closed system exchanging heat but not work with its environment

Open system

when both matter and energy can be freely exchanged with the environment. The ocean would be an example of an open system.



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, ….etc

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

``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**
- There are many kinds of processes that can be carried out in thermodynamic system:

Adiabatic process a process with no heat transfer into or out of the system (**the system is completely isolated from the surrounding) .**

Iso choric process a process with no change in volume, in which case the system does no work**.(volume is constant V=const.)**

Iso baric process a process with no change in pressure. **(Pressure is constant p=const.)**

Iso thermal process a process with no change in temperature. **(temperature is constant T=const.)**

Classification of a process according to the releasing energy:

Exothermic process: is the process that releases energy as heat into its surroundings.

Endothermic process: is the process in which energy is acquired from its surroundings as heat.

Classification of a process according to the direction of reaction:

Reversible process: is a process in which the direction may be reversed at any stage by just a small change in a variable like temperature, pressure, etc.

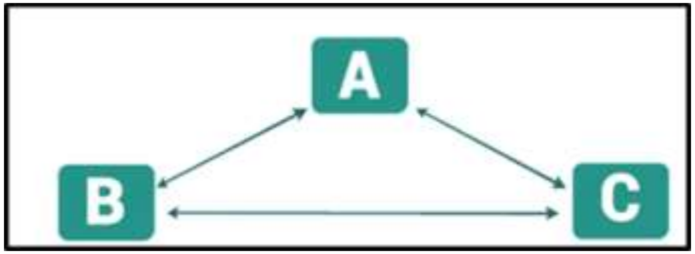
Irreversible process a process that cannot return both the system and surrounding to their original conditions . All natural process are irreversible.

Zeroth Law of Thermodynamics

(the law of equilibrium)

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

(If objects A and B are separately in thermal equilibrium with a third object C, then A and B are in thermal equilibrium with each other.)



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 betwen 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