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:

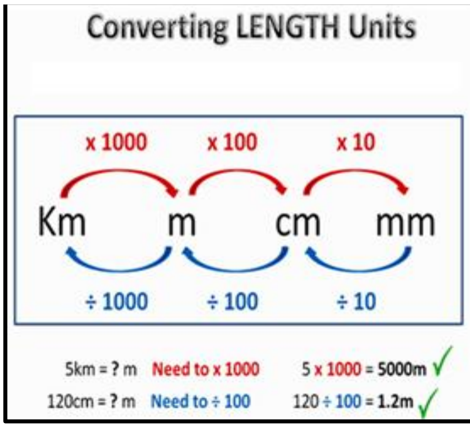
1. Derived quantities: they can be expressed as combinations of a small number of basic quantities. 2. Basic quantities: there are three basic quantities are, length, mass and time. An international committee established a set of standards for the fundamental quantities of science. It is called the SI (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



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

1)Classical thermodynamics: is the description of the states of thermodynamical systems at near equilibrium, using macroscopic, empirical properties directly measurable in the laboratory. It is used to model exchanges of energy, work and heat based on the laws of thermodynamics.

2)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.

3)Chemical thermodynamics: is the study of the interrelation of energy with chemical reaction.

4)Biological thermodynamics: is the study of energy transformation in the biological systems.

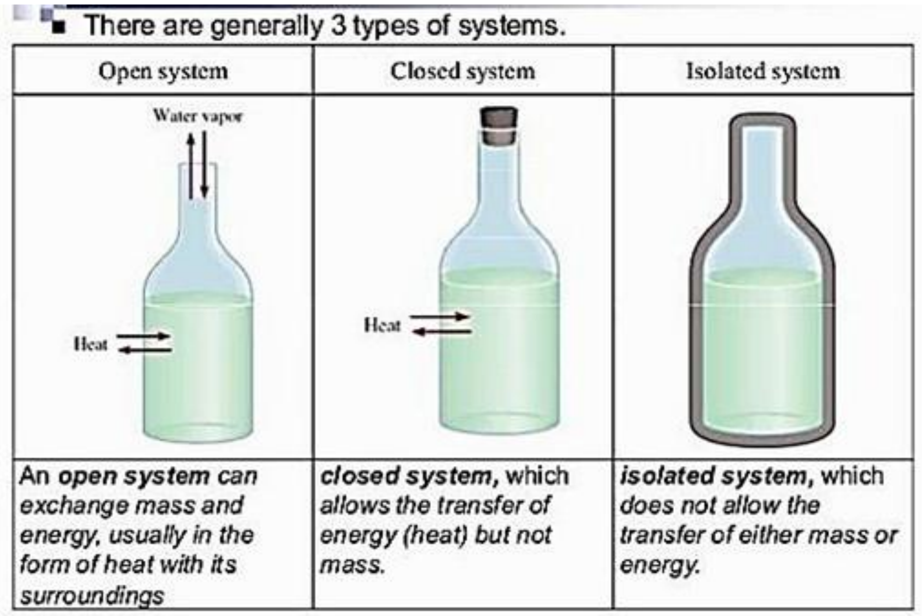
5)Pharmaceutical Thermodynamics: is the chemical thermodynamics study of the drug action. Subjects in this field, include the thermodynamics of adsorption, crystallization, encapsulation, partitioning, as well as drug-receptor thermodynamics. Synonyms seem to include: physical pharmacology, physical pharmacy, or pharmacological thermodynamics.

common terms of thermodynamics

system- parameter- condition(state)- process

System

is a specified part of the universe which is under observation. The remaining portion of the universe which is not a part of the system is called the surroundings, the system is separated by real or imaginary



boundaries.

For instance, if two immiscible solvents, water and carbon tetrachloride, are confined in a closed container and iodine is distributed between the two phases, each phase is an open system, yet the total system made up of the two phases is closed because it does not exchange matter with its surroundings.

Parameter

-Intensive (p, T, C, viscosity, surface tension, vapour pressure) The properties of the system whose value does not depend upon the amount of substance present in the system.

-Extensive (m, V, U, H, G, S, c) The properties of the system whose value depends upon the amount of substance present in the system.

Process

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

Iso-thermic process: temperature is constant, T=constant.

Iso-meric process: volume is constant, V=constant.

Iso-baric process: pressure of the system is constant, P=constant.

Adia-batic process: the system is completely isolated from the surroundings. For an adiabatic (Q=0) system of constant mass, ▲U=W

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.

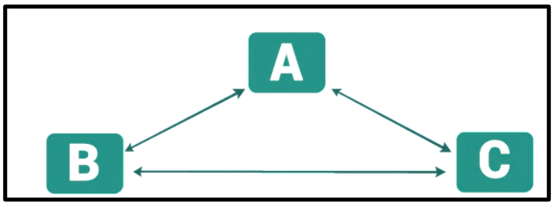
Classification of a process according to the direction of reaction:

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

Irreversible process: is a process which is not reversible. All natural process are irreversible.

zeroth law of thermodynamics
(the law of equilibrium)

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.



Thermal contact: let us imagine that two objects are placed in an insulated container such that they interact with each other but not with the rest of the world. If the objects are at different temperature, energy is exchanged between them. Heat is the transfer of energy from one object to another object as a result of a different in temperature between the two.

Thermal equilibrium: is a situation in which two objects in thermal contact with each other cease to exchange energy by the process of heat.

State of a system

means the condition of the system , which is described in terms of certain observable (measurable) properties such as temperature (T), pressure (p), volume (V).

State function (thermodynamic function)

1) Internal energy U [J/mol]

2) Enthalpy H [kJ/mol] or [kJ]

3) Entropy S [J/mol K] or [J/K]

4) Gibbs energy G [J/mol] or [J]

State function depends only upon the initial and final state of the system and not on the path by which the change from initial to final state is brought about.

Internal energy (U)

It is the sum of different types of energies associated with atoms and molecules such as electronic energy, nuclear energy, chemical bond energy and all type of the internal energy except potential and kinetic energies.

Heat (Q)

Is a form of energy which the system can exchange with the surroundings. If they are at different temperatures, the heat flows from higher temperature to lower temperature.

Work(W)

Is said to be performed if the point of application of force is displaced in the direction of the force. It is equal to the distance through which the force acts.

There are two main types of work electrical and mechanical. Electrical work is important in systems where reaction takes place between ions. Mechanical work is important specially in systems that contains gases. This is also known as pressure-volume work.

In thermodynamic systems, work is defined in terms of pressure and volume change. Imagine a system of gas in a cylinder fitted with a piston, as shown in Figure.

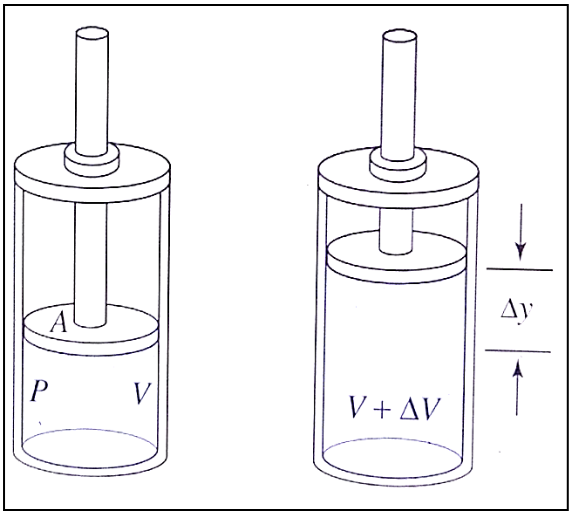
As the gas in the cylinder expands, the force exerted by the gas on the piston is $F = PA$.

The piston moves up a distance Δy; therefore, the work done by

the gas is $W = F\,\Delta y = PA\,\Delta y$, or

$W = P\,\Delta V$ because $A\,\Delta y$ is the increase

in volume (V) of the gas.



Example:

A gas expands by 0.5liter against a constant pressure of 0.5atm at 25°C. what is the work in ergs and in joules done by the system?

solution:

$$W = p\Delta V$$

$$1\text{atm} = 1.013 * 10^6 dyne/cm^2$$

$W = (0.507 * 10^6 dyne/cm^2)$*$500cm^3$

$W = 2.53 * 10^8 ergs = 25.3 joules$