# SYSTEMIC INTERNATIONAL d' UNITS

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The Systemic International d' Units, which is abbreviated as S.I. Units was introduced in the hospital practice only in the year 1975.[1] This would mean learning the new measurements and symbols in place of old ones and interpreting them in their equal or equivalent values.[2]

The history of this system is fairly old. Metric system, adopted in early 1900, has the original basic units of time, mass and length as the second, the gram and the centimetre.[3] Three more units were added which were the metre, the kilogram and the ampere. Because of tremendous advances in scientific knowledge it was realised that the system was not adequate.[4] In 1960, the General Conference on Weights and Measurements was convened and it extended the existing system on more scientific lines and now it is used world wide.

The introduction of S.I. Units has brought uniformity in scientific and industrial work throughout the world. Because of this system, errors and misinterpretations have been reduced to minimum. This system is extremely valuable for human life because the result of the laboratory investigations are given in figures which are universal.[5]

The S.I. system comprises of seven basic units (Table–1).

TABLE–1

| Physical quantity | Name of unit | Symbol |
|---|---|---|
| Mass | Kiogram | Kg |
| Length | Metre | m |
| Time | Second | s |
| Current | Ampere | A |
| Temperature | Kelvin | K |
| Luminous intensity | Candela | Cd |
| Substance | Mole | mol |

## THE KILOGRAM (Kg)

Adopted since 1875, the kilogram is based on the weight of a cylinder of platinium– iridium kept at Sevres, France.

## THE METRE (M)

The international metre was adopted in 1962. It is based on the wave length of an orange line in the krypton spectrum.

## THE SECOND (S)

This unit is presently based on the frequency of cesium–133 atom.

## THE AMPERE (A)

This unit is based on the attractive force produced when an electric current flows through two straight and parallel conductors of infinite length of negligible circular cross section, which are kept one metre apart.

## THE KELVIN (K)

This unit is described in relation to degrees Celsius (centigrade).

Absolute O°K = –273.16°C

For practical purposes, Celsius degrees are still used.

Body temperature

37°C=210°K (Kelvin).

## THE CANDELA (Cd)

The candela is defined as $1/600{,}000^{th}$ of the luminous intensity per square meter of platinium at 1773°C.

## THE MOLE (mol)

A mole is the amount of a substance which contains the same number of elementary entities as there are atoms in 0.012 kg of Carbon–12. For practical purposes a mol is the molecular weight of a compound or atomic weight of an element expressed in grams. For example:

i) One mole of HgC1 has a mass of 0.23604 kg.

ii) One mole of Hg has a mass of 0.20059 kg.

iii) One mole of Sodium Chloride has a mass of 58.5 Kg. The atomic weight of Sodium is 23 and Chloride is 35.5. The molecular weight of Sodium Chloride is 23+35.5 = 58.5.

## THE MILLIMOLE (mmol)

As mole is a very large unit and for practical purposes it would be cumbersome for interpretation of the biochemical results. Instead a millimole, which is one thousandth part of a mole, is used. Serum concentrations of various biochemicals and drugs added to the intravenous infusions such as sodium or potassium chloride are expressed in millimoles per litre (mmol/litre).

The molar system cannot be used where the molecular weight of a substance is uncertain as in case of serum proteins. These are, therefore, expressed as grams or milligrams per litre or decilitre.

Serum electrolytes are read in both old and new S.I. units as they are monovalent.

Sodium = 135–143 mmol/1 or 135–143 meq/1.

Potassium = 3.6–5.0 mmol/1 or 3.6–5.0 meq/1.

Chloride = 98–107 mmol/1 or 98–107 meq/1.

## THE LITRE (1)

The unit of volume is the cubic metre. Due to its large volume it is subdivided into the cubic decimetre of litre. One litre is also expressed as 1000 millilitres (ml).

## THE NEWTON (N)

This is defined as force which will accelerate a mass of one kilogram by one metre per second.[6]

## THE PASCAL (PA)

Pascal is a unit of pressure, derived as the ratio of force to area. It results by applying a force of 1 newton per square metre.

Blood gases are estimated as Kilopascals (kPa) or mm Hg.

1 kPa = 7.2727 mmHg.

$Pco_2$ = 5–6 kPa = 38–45 mm Hg.

$Po_2$ = 11–15 kPa = 80–110 mm Hg.

## THE JOULE (J)

This is a unit of the potential energy, released as a result of fall of 1 kilogram weight through 1 metre height. Joule is also used as an energy unit for expression of dietary requirements.

1 Calorie = 4.184 Joules

1 kilocalorie = 4184 Joules

## TIME

It is always expressed in seconds and is not converted into minutes and hours.

## DERIVED UNITS

In addition to the seven units, mentioned above, there are also units which are derived from combination of these basic units. Some are of medical importance (Table–2).

TABLE–2

DERIVED UNITS

| Physical quantity | Name of unit | Symbol |
|---|---|---|
| Volume | Litre | l |
| Pressure | Pascal | Pa |
| Force | Newton | N |
| Energy | Joule | J |

## FORMULAE FOR CONVERSION

i) Conversion from milliequivalent/litre to mmol/litre.

Initially divide the value by molecular weight to convert from milligram (mg) to millimole (mmol) and then multiply by 10 to convert from 100 ml to 1 litre.

ii) Conversion from mmol/l to meq/l.

meq/gm x1000 / eq weight
= wt (mg) x valency x 1000
mol wt.

The molecular weight of a substance can be taken from the periodic table.

## RULES FOR THE USE OF S.I. UNITS

For margin of safety, the General Conference on Weights and Measures has advised the way in which the symbols should be abbreviated and written down. The abbreviations should not alter in the plural.

Mass: One kilogram = 1 kg
Ten kilogram = 10 kg

Multiples and submultiples are formed by using prefixes.

1 mg =1/1000th of 1 gram

1 kg =1 gram x 1000

## DECIMAL POINTS

The decimal point is shown as a full stop on the line. A raised point indicates a multiplication sign. It is now acceptable to use a comma as decimal point. Thus two and a half might be written as 2.5 or 2,5. When writing large numbers, the figures should be grouped in threes. Thus three million three thousand should be written in the following way:

3,300,000

with a space between the figure group. The number can be expressed more shortly as

$3.3 \times 10^6$

$10^6$ being ten of the power of 6 or the number multiplied by itself 6 times.[1]

Example of decimal multiples and submultiples of S.I. Units.[3]

| Figure | Prefix | Sign |
|---|---|---|
| $10^{-12}$ | pico | p |
| $10^{-9}$ | nano | n |
| $10^{-6}$ | micro | u |
| $10^{-3}$ | milli | m |
| $10^{-2}$ | centi | c |
| $10^{-1}$ | deci | d |
| $10^{3}$ | kilo | k |
| $10^{6}$ | mega | M |
| $10^{9}$ | giga | G |
| $10^{12}$ | tera | T |

Practical advantages of S.I. Units are easy understanding of the biochemical results and easy administration of intravenous additives.

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