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THE CONVENIENCE OF THE METRIC SYSTEM

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In the near future, millions of people who had used British Imperial units will need to familiarise themselves with the metric system. They will need to forget almost everything they knew about numbers. They should also avoid attempts at conversion, because the process of conversion from one unit to another is not simple.

The best solution will be to learn the metric system as a whole from the very beginning, which should be relatively easy, especially for young people in schools.

Some islands in the Pacific, which have come under several outside influences, such as the New Hebrides, still use both systems. Others, such as Western Samoa, use metres and kilometres to measure distance, but use non-metric units to measure surfaces.

I. History

The two main virtues of the metric system are its unchanging standards and its decimal division. French scientists during the Revolution in 1739 decided to give the name "metre" to a fraction of the earth's circumference. The astronomers Delambre and Méchain calculated the length of an arc of the meridian by means of a triangulation extending from Dunkirk to Barcelona, a task which took six years to complete.

The definition of a metre was then "the length of the 1/10.000.000 of one fourth of an earth meridian". Since 1960, a new definition has been adopted: "the metre is the length equal to 1,650,763.73 wave lengths - in an empty space - of the radiation to the transition levels $2p_{10}$ and $5d_5$ of the krypton 86 atom.

The new system was adopted in France in 1790 on a proposal made by Talleyrand. Now it is called an "International System" with basic and secondary units. The basic units are the kilogramme[1], the second, the ampere[2], the Kelvin degree[3] and the candela[4].

II. The convenience of the system for measures of length, surface and volume

Apart from being an unchanging international standard, the decimal system makes calculations very easy because it is simple.

Multiples are powers of ten. Each multiple is a prefix which is placed in front of the name of the unit.

mega	M	=	10^6	=	x million
kilo	k	=	10^3	=	x thousand
hecto	h	=	10^2	=	x hundred
deca	dam	=	10	=	x ten
deci	dm	=	10^{-1}	=	x tenth
centi	cm	=	10^{-2}	=	x hundredth
milli	mm	=	10^{-3}	=	x thousandth.

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1. Kilogramme: the weight of a capacity of 1 dm^3 of pure water at the temperature of 20°C and at sea level.
2. Ampere: intensity of an electric current furnishing 1 coulomb per second.
3. Kelvin degree: degree on the thermodynamic scale of the absolute temperatures in which the temperature of the triple point of water is 273.16 °K.
4. Candela: unit of measure for light intensity.

The simplicity of this system means that one can forget all those old factors: 2240, 1760, 4840, 220, 22, 36, 12, 3, 112, 20, 14, 16.

To convert from units of length to units of surface is quite easy if one considers that one square metre (m^2) is the surface of a square with a side length of 1 m (or any combination of figures giving this result, for example a rectangle of 0.50 m x 2 m, or a triangle with a height of 1 m and a base of 2 m, etc.). For surfaces, we can give the following table:

sq. metre	1 m^2	= 1 x 1	also called: 1 centiare
sq. decametre	100 m^2	= 10 x 10	also called: 1 are
sq. hectometre	10,000 m^2	= 100 x 100	also called: 1 hectare
sq. kilometre	1,000,000 m^2	= 1000 x 1000	
sq. decimetre	0.01 m^2	= 0.1 x 0.1	
sq. centimetre	0.0001 m^2	= 0.01 x 0.01	
sq. millimetre	0.000001 m^2	= 0.001 x 0.001.	

For practical reasons in land surveying, the sq. metre, the sq. decametre and the sq. hectometre are more often called respectively centiare, are and hectare. Thus

1 hectare = 100 ares = 10,000 centiares = 10,000 m^2

1 are = 100 centiares = 100 m^2

1 centiare = 1 m^2.

The cubic metre is a cube the sides of which measure 1 metre. And here again we have:

1 cubic metre	1 m^3	= 1 x 1 x 1
1 cubic decametre	1,000 m^3	= 10 x 10 x10
1 cubic hectometre	1,000,000 m^3	= 100 x 100 x 100.

etc.

When we speak of cubic metres, we are speaking of measures of capacity, and this brings us to the interesting relationships between capacities, weights, temperatures, etc.

III. The convenience of the system for all kinds of measures

As a square metre can be divided into 100 sq. decimetres, it is obvious that one cubic metre contains 1,000 cubic decimetres. The capacity of one cubic decimetre is known as one litre. The result is the following relationship:

1 mml (millilitre)	=	0.001 litre	=	1 cubic centimetre
1 cl (centilitre)	=	0.01 litre	=	10 cubic centimetres
1 dl (decilitre)	=	0.1 litre	=	100 cubic centimetres
1 l (litre)	=	1 litre	=	1,000 cubic centimetres
		1 litre	=	1 cubic decimetre
1 dal (decalitre)	=	10 litres	=	10 cubic decimetres
1 hl (hectolitre)	=	100 litres	=	100 cubic decimetres
1 kl (kilolitre)	=	1,000 litres	=	1,000 cubic decimetre
		1,000 litres	=	1 cubic metre.

For a unit of mass, the designers of the metric system took 1,000 cubic centimetres (1 litre) of water and decided that the weight of it under fixed conditions of temperature and pressure would be 1 kilogramme (kg). Whence this new relationship table, taking into account that 1 kg = 1,000 g.

1 mml	=	1 g	=	0.001 kg
1 cl	=	10 g	=	0.01 kg
1 dl	=	100 g	=	0.1 kg
1 l	=	1,000 g	=	1 kg
10 l	=	10,000 g	=	10 kg
100 l	=	100,000 g	=	100 kg or 1 quintal
1,000 l	=	1,000,000 g	=	1,000 kg or 1 ton.

One gramme can again be divided into decigramme, centigramme and milligramme (1 g = 1,000 mg).

IV. Derived units

From this system, we obtain many other units:

- Speed: km/h (kilometres per hour)
  m/s (metres per second)
- Pressure: kg/cm^2 (kilogrammes per square centimetre)
- Work[1]: kgm (kilogrammes per metre)

1. Kilogrammetre (kgm) = work accomplished by a weight of 1 kg falling from a height of 1 metre.

- Hydraulics: m^3/s (cubic metres per second)
  m^3/h (cubic metres per hour)
  l/s (litres per second)
- Power: kgm/s (kilogrammes per metre per second)
- Rainfall intensity: mm/h (millimetres per hour).

Sometimes, the units are given a different name to avoid confusion. So:

1 joule (work unit) = 1 kgm/g or $\frac{1}{9.81}$ kgm $\neq$ 0.102 kgm

1 kgm = 981,000 x 100 = 9.81×10^7 ergs[1] = 9.81 joules

1 joule/sec = 1 Watt

1 CV = 75 kgm/s = 736 Watts = 736 joules/s

1 thermie = necessary heat to raise 1 metric ton water one more °C

Millithermie = kilocalorie = necessary heat to raise 1 kg water one more °C

Microthermie = calorie = necessary heat to raise 1 g water one more °C

1 calorie = 4.18 joules.

These examples may be multiplied without limitation. Any calculation is easy because the relationship is generally simple.

For instance, for a hydrologist it will be simple to calculate that a rainfall of 23 mm on a surface of 300 hectares represents a volume of 69,000 m^3 of water. Everybody familiar with the metric system is aware that 1 mm of water on 1 hectare gives 10,000 litres = 10 m^3. Whence:

V (Volume of water) = 23 x 10 x 300 = 69,000 m^3.

If in addition one knows the duration of the rainfall, for instance 3 hours, it is easy to convert this intensity of rain (23/3 mm/h = 7.7 mm/h) into a rate of flow, assuming that all the water is going to run off from the catchment area:

$$Q \text{ (Maximum rate of flow)} = \frac{23 \times 10 \times 300}{3{,}600 \times 3} = 6.400 \text{ m}^3/\text{s}.$$

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1) 1 erg = the work effected by a force of 1 dyne acting through a displacement of 1 cm in the direction of the force.

1 dyne = a force that would give a free mass of 1 g an acceleration of 1 cm per second per second.

Another example is the pressure of water. Any pressure expressed in kg/cm^2 can be immediately converted into piezometric height[1]. **One kilogramme of water (fresh water) is the** weight of a column of water the section of which is 1 cm^2 and the height 10 metres. The pressure unit can thus be transformed into a simple length, and this is quite normal since we have 1 kg = 1 litre water = 1 dm^3 = 0.001 m^3 and we can simplify:

$$\frac{0.001\ m^3}{0.0001\ m^2} = 10\ m.$$

V. CONCLUSION

The superiority of the International System is unquestionable. The purpose of the above short demonstration is to explain the units and more especially to show how easy it is to make conversions and calculations within the system.

Anyone who owns a camera will know that film and lenses have always been measured in millimetres, and scientists have for a long time made their measurements in grammes and cubic centimetres. The day is not far distant when the people of the South Pacific, as elsewhere in the world, will be speaking the same language.

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1. Piezometric height = pressure of water expressed in terms of height of water.

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