National Metrology Laboratory
of South Africa

World Metrology Day
20 May 2000

SI Base units

The International System of Units (SI) is the modern form of the metric system. The propagation and the improvement of the SI is ensured under the Convention du Mètre. The Convention du Mètre was signed in Paris, France on 20 May 1875 by seventeen States during the final session of the diplomatic Conference of the Metre which also lead to the establishment of the Bureau International des Poids et Mesures (BIPM).

South Africa adhered to this treaty in 1964 and became the 40th signatory of the Convention. The Measuring Units and National Measuring Standards Act, Act 76 of 1973, delegates the responsibility of the maintenance of the South African National Measuring Standards to the CSIR where the function is performed through the support and sponsorship of the Department of Trade and Industry.

SI units are divided into *base* units and *derived* units. From the scientific point of view, the division of SI units into these two classes is to a certain extent arbitrary, because it is not essential to the physics of the subject. Nevertheless, considering the advantages of a single, practical, world-wide system of units for international relations, for teaching and for scientific work, these units were decided and agreed upon under the Convention du Mètre as a choice of seven well-defined units which by convention are regarded as independent.

The first base unit was approved in 1889 and the most recent in 1983. These definitions are modified from time to time as techniques of measurement evolve and allow more accurate realisations.

Unit of length (metre) m

The metre is the length of the path traveled by light in vacuum during a time interval of 1/299 792 458 of a second.
NOTE: The definition was adopted in 1983 and has the effect of fixing the speed of light at exactly 299 792 458 $m \cdot s^{-1}$

Unit of mass (kilogram) kg

The kilogram is the unit of mass; It is equal to the mass of the international prototype of the kilogram.
NOTE: The definition was adopted in 1889 and the international prototype of the kilogram, made of platinum-iridium, is kept at the BIPM.

Unit of time (second) s

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom.
NOTE: The definition was adopted in 1968 and it was affirmed in 1997 that the definition refers to a caesium atom in its ground state at a temperature of 0 K.

Unit of electric current (ampere) A

The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.
NOTE: The definition was adopted in 1948 and has the effect of fixing the permeability of vacuum at exactly $4\pi \times 10^{-7}$ $H \cdot m^{-1}$.

Unit of thermodynamic temperature (kelvin) K

The kelvin, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
NOTE: The definition was adopted in 1968. The unit of Celsius temperature is the degree Celsius, symbol °C, which is by definition equal in magnitude to the Kelvin, the unit of thermodynamic temperature T. The numerical value of a Celsius temperature t expressed in degrees Celsius is given by $t/°C = T/K - 273.15$

Unit of amount of substance (mole) mol

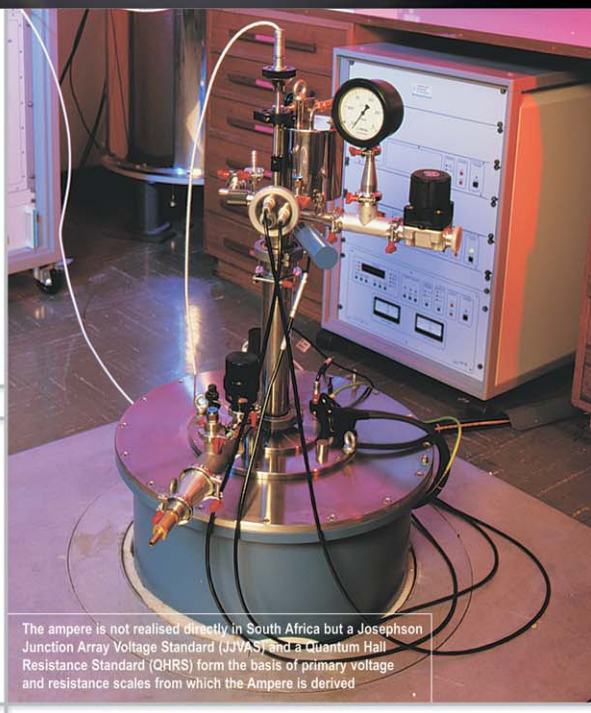
1. The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12; its symbol is "mol".
2. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

NOTE: The definition was adopted in 1971. It is understood that unbound atoms of carbon 12, at rest and in their ground state, are referred to.

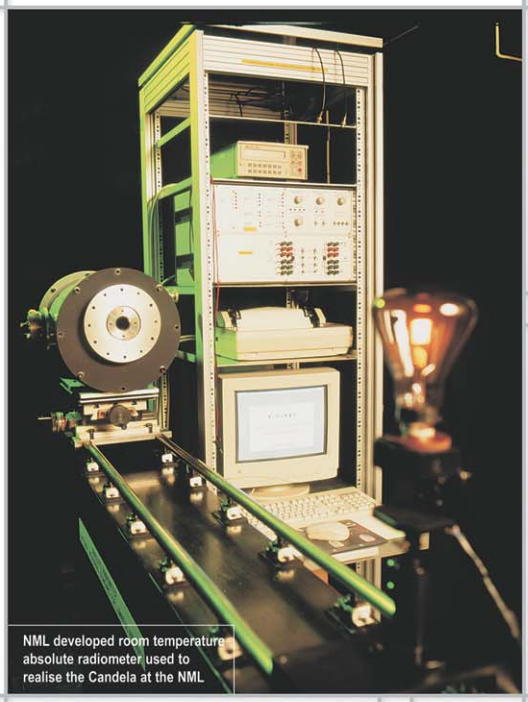
Unit of luminous intensity (candela) cd

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.
NOTE: The definition was adopted in 1979 due to the experimental difficulties in realising a Planck radiator at high temperatures and the new possibilities offered by radiometry at the time.

NML developed Iodine-Stabilised Laser operating at a wavelength of 632 nm

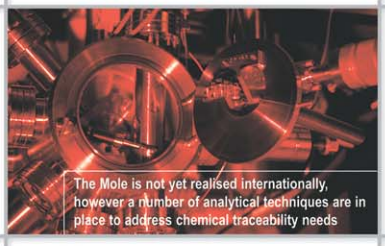


The ampere is not realised directly in South Africa but a Josephson Junction Array Voltage Standard (JJVAS) and a Quantum Hall Resistance Standard (QHRS) form the basis of primary voltage and resistance scales from which the Ampere is derived

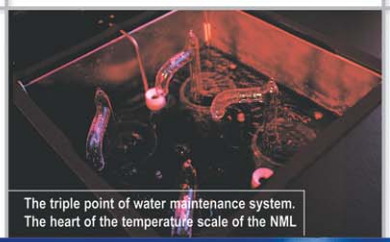


NML developed room temperature absolute radiometer used to realise the Candela at the NML

This system is used at the NML to contribute to the international time scale (Universal coordinated time - UTC). It consists of two Caesium clocks, GPS satellite receivers and controlling equipment



The Mole is not yet realised internationally, however a number of analytical techniques are in place to address chemical traceability needs



The triple point of water maintenance system. The heart of the temperature scale of the NML

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