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Quantities and units - Part 1: General (ISO 80000-1:2009 + Cor 1:2011)

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Foreword

The text of ISO 80000-1:2009 + Cor 1:2011 has been prepared by Technical Committee ISO/TC 12 “Quantities and units” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 80000-1:2013.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2013, and conflicting national standards shall be withdrawn at the latest by October 2013.

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Endorsement notice

The text of ISO 80000-1:2009 + Cor 1:2011 has been approved by CEN as EN ISO 80000-1:2013 without any modification.

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Introduction

0.1 Quantities

Systems of quantities and systems of units can be treated in many consistent, but different, ways. Which treatment to use is only a matter of convention. The presentation given in this International Standard is the one that is the basis for the International System of Units, the SI (from the French: *Système international d'unités*), adopted by the General Conference on Weights and Measures, the CGPM (from the French: *Conférence générale des poids et mesures*).

The quantities and relations among the quantities used here are those almost universally accepted for use throughout the physical sciences. They are presented in the majority of scientific textbooks today and are familiar to all scientists and technologists.

NOTE For electric and magnetic units in the CGS-ESU, CGS-EMU[1)] and Gaussian systems, there is a difference in the systems of quantities by which they are defined. In the CGS-ESU system, the electric constant ε_0 (the permittivity of vacuum) is defined to be equal to 1, i.e. of dimension one; in the CGS-EMU system, the magnetic constant μ_0 (permeability of vacuum) is defined to be equal to 1, i.e. of dimension one, in contrast to those quantities in the ISQ where they are not of dimension one. The Gaussian system is related to the CGS-ESU and CGS-EMU systems and there are similar complications. In mechanics, Newton's law of motion in its general form is written $\boldsymbol{F} = c \cdot m\boldsymbol{a}$. In the old technical system, MKS[2)], $c = 1/g_n$, where g_n is the standard acceleration of free fall; in the ISQ, $c = 1$.

The quantities and the relations among them are essentially infinite in number and are continually evolving as new fields of science and technology are developed. Thus, it is not possible to list all these quantities and relations in this International Standard; instead, a selection of the more commonly used quantities and the relations among them is presented.

It is inevitable that some readers working in particular specialized fields may find that the quantities they are interested in using may not be listed in this International Standard or in another International Standard. However, provided that they can relate their quantities to more familiar examples that are listed, this will not prevent them from defining units for their quantities.

Most of the units used to express values of quantities of interest were developed and used long before the concept of a system of quantities was developed. Nonetheless, the relations among the quantities, which are simply the equations of the physical sciences, are important, because in any system of units the relations among the units play an important role and are developed from the relations among the corresponding quantities.

The system of quantities, including the relations among them the quantities used as the basis of the units of the SI, is named the *International System of Quantities*, denoted "ISQ", in all languages. This name was not used in ISO 31, from which the present harmonized series has evolved. However, ISQ does appear in ISO/IEC Guide 99:2007 and in the SI Brochure[8], Edition 8:2006. In both cases, this was to ensure consistency with the new *Quantities and units* series that was under preparation at the time they were published; it had already been announced that the new term would be used. It should be realized, however, that ISQ is simply a convenient notation to assign to the essentially infinite and continually evolving and expanding system of quantities and equations on which all of modern science and technology rests. ISQ is a shorthand notation for the "system of quantities on which the SI is based", which was the phrase used for this system in ISO 31.

1) CGS = centimetre-gram-second; ESU = electrostatic units; EMU = electromagnetic units.

2) MKS = metre-kilogram-second.

0.2 Units

A system of units is developed by first defining a set of base units for a small set of corresponding base quantities and then defining derived units as products of powers of the base units corresponding to the relations defining the derived quantities in terms of the base quantities. In this International Standard and in the SI, there are seven base quantities and seven base units. The base quantities are length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity. The corresponding base units are the metre, kilogram, second, ampere, kelvin, mole, and candela, respectively. The definitions of these base units, and their practical realization, are at the heart of the SI and are the responsibility of the advisory committees of the International Committee for Weights and Measures, the CIPM (from the French: *Comité international des poids et mesures*). The current definitions of the base units, and advice for their practical realization, are presented in the SI Brochure [8], published by and obtainable from the International Bureau of Weights and Measures, the BIPM (from the French: *Bureau international des poids et mesures*). Note that in contrast to the base units, each of which has a specific definition, the base quantities are simply chosen by convention and no attempt is made to define them otherwise then operationally.

0.3 Realizing the values of units

To realize the value of a unit is to use the definition of the unit to make measurements that compare the value of some quantity of the same kind as the unit with the value of the unit. This is the essential step in making measurements of the value of any quantity in science. Realizing the values of the base units is of particular importance. Realizing the values of derived units follows in principle from realizing the base units.

There may be many different ways for the practical realization of the value of a unit, and new methods may be developed as science advances. Any method consistent with the laws of physics could be used to realize any SI unit. Nonetheless, it is often helpful to review experimental methods for realizing the units, and the CIPM recommends such methods, which are presented as part of the SI Brochure.

0.4 Arrangement of the tables

In parts 3 to 14 of this International Standard, the quantities and relations among them, which are a subset of the ISQ, are given on the left-hand pages, and the units of the SI (and some other units) are given on the right-hand pages. Some additional quantities and units are also given on the left-hand and right-hand pages, respectively. The item numbers of quantities are written pp-nn.s (pp, part number; nn, running number in the part, respectively; s, sub-number). The item numbers of units are written pp-nn.l (pp, part number; nn, running number in the part, respectively; l, sub-letter).

Quantities and units

Part 1:
General

1 Scope

ISO 80000-1 gives general information and definitions concerning quantities, systems of quantities, units, quantity and unit symbols, and coherent unit systems, especially the International System of Quantities, ISQ, and the International System of Units, SI.

The principles laid down in ISO 80000-1 are intended for general use within the various fields of science and technology, and as an introduction to other parts of this International Standard.

Ordinal quantities and nominal properties are outside the scope of ISO 80000-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 99:2007, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE The content in this clause is essentially the same as in ISO/IEC Guide 99:2007. Some notes and examples are modified.

3.1
quantity
property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed by means of a number and a reference

