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Größen und Einheiten - Teil 10: Atom- und Kernphysik (ISO 80000-10:2019)

Grandeurs et unités - Partie 10: Physique atomique et nucléaire (ISO 80000-10:2019)

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European foreword

This document (EN ISO 80000-10:2019) has been prepared by Technical Committee ISO/TC 12 "Quantities and units" in collaboration with Technical Committee CEN/SS F02 “Units and symbols” the secretariat of which is held by CCMC.

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of an identical text or by endorsement, at the latest by April 2020, and conflicting national standards shall be withdrawn at the latest by April 2020.

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INTERNATIONAL STANDARD

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Quantities and units —

Part 10: **Atomic and nuclear physics**

Grandeurs et unités —

Partie 10: Physique atomique et nucléaire

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www. iso. org/directives).

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This document was prepared by Technical Committee ISO/TC 12, *Quantities and units*, in collaboration with Technical Committee IEC/TC 25, *Quantities and units.*

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This second edition cancels and replaces the first edition (ISO 80000-10:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the table giving the quantities and units has been simplified;

— some definitions and the remarks have been stated physically more precisely;

— definitions in this document have been brought in line with their equivalent ones in ICRU 85a.

A list of all parts in the ISO 80000 and IEC 80000 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

0 Special remarks

0.1 Quantities

Numerical values of physical constants in this document are quoted in the consistent values of the fundamental physical constants published in CODATA recommended values. The indicated values are the last known before publication. The user is advised to refer to the CODATA website for the latest values, https://physics.nist.gov/cuu/Constants/index.html.

The symbol $\hbar$ is the reduced Planck constant, it is equal to $\dfrac{h}{2\pi}$, where h is the Planck constant.

0.2 Special units

1 eV is the energy acquired by an electron in passing a potential difference of 1 V in vacuum.

0.3 Stochastic and non-stochastic quantities

Differences between results from repeated observations are common in physics. These can arise from imperfect measurement systems, or from the fact that many physical phenomena are subject to inherent fluctuations. Quantum-mechanical issues aside, one often needs to distinguish between a *stochastic* quantity, the values of which follow a probability distribution, and a *non-stochastic* quantity with its unique, expected value (expectation) of such distributions. In many instances the distinction is not significant because the probability distribution is very narrow. For example, the measurement of an electric current commonly involves so many electrons that fluctuations contribute negligibly to inaccuracy in the measurement. However, as the limit of zero electric current is approached, fluctuations can become manifest. This case, of course, requires a more careful measurement procedure, but perhaps more importantly illustrates that the significance of stochastic variations of a quantity can depend on the magnitude of the quantity. Similar considerations apply to ionizing radiation; fluctuations can play a significant role, and in some cases need to be considered explicitly. Stochastic quantities, such as the energy imparted and the specific energy imparted (item 10-81.2) but also the number of particle traversals across microscopic target regions and their probability distributions, have been introduced as they describe the discontinuous nature of the ionizing radiations as a determinant of radiochemical and radiobiological effects. In radiation applications involving large numbers of ionizing particles, e.g. in medicine, radiation protection and materials testing and processing, these fluctuations are adequately represented by the expected values of the probability distributions. “Non-stochastic quantities” such as particle fluence (item 10-43), absorbed dose (item 10-81.1) and kerma (item 10-86.1) are based on these expected values.

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This document contains definitions based on a differential quotient of the type $\mathrm{d}A/\mathrm{d}B$ in which the quantity A is of a stochastic nature, a situation common in ionizing radiation metrology. In these cases, quantity A is understood as the expected or mean value whose element ΔA falls into element ΔB. The differential quotient $\mathrm{d}A/\mathrm{d}B$ is the limit value of the difference quotient $\Delta A/\Delta B$ for $\Delta B \to 0$. In the remarks of the definitions falling in this category, a reference to this paragraph is made.

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Quantities and units —

Part 10:
Atomic and nuclear physics

1 Scope

This document gives names, symbols, definitions and units for quantities used in atomic and nuclear physics. Where appropriate, conversion factors are also given.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

The names, symbols, and definitions for quantities and units used in atomic and nuclear physics are given in Table 1.

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ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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Table 1 — Quantities and units used in atomic and nuclear physics

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
10-1.1	atomic number, proton number	Z	number of protons in an atomic nucleus	1	A nuclide is a species of atom with specified numbers of protons and neutrons. Nuclides with the same value of Z but different values of N are called isotopes of an element. The ordinal number of an element in the periodic table is equal to the atomic number. The atomic number equals the quotient of the charge (IEC 80000-6) of the nucleus and the elementary charge (ISO 80000-1).
10-1.2	neutron number	N	number of neutrons in an atomic nucleus	1	Nuclides with the same value of N but different values of Z are called isotones. $N - Z$ is called the neutron excess number.
10-1.3	nucleon number, mass number	A	number of nucleons in an atomic nucleus	1	$A = Z + N$ Nuclides with the same value of A are called isobars.
10-2	rest mass, proper mass	$m(\mathrm{X})$ m_X	for particle X, mass (ISO 80000-4) of that particle at rest in an inertial frame	kg u Da	EXAMPLE $m(H_2O)$ for a water molecule, m_e for an electron. Rest mass is often denoted m_0. 1 u is equal to 1/12 times the mass of a free carbon 12 atom, at rest and in its ground state. 1 Da = 1 u
10-3	rest energy	E_0	energy E_0 (ISO 80000-5) of a particle at rest: $E_0 = m_0 c_0^2$ where m_0 is the rest mass (item 10-2) of that particle, and c_0 is speed of light in vacuum (ISO 80000-1)	J N m kg m^2 s^{-2}	

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Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
10-4.1	atomic mass	$m(\mathrm{X})$ m_X	rest mass (item 10-2) of an atom X in the ground state	kg u Da	$\frac{m(\mathrm{X})}{m_\mathrm{u}}$ is called the relative atomic mass. 1 u is equal to 1/12 times the mass of a free carbon 12 atom, at rest and in its ground state. 1 Da = 1 u
10-4.2	nuclidic mass	$m(\mathrm{X})$ m_X	rest mass (item 10-2) of a nuclide X in the ground state	kg u Da	1 u is equal to 1/12 times the mass of a free carbon 12 atom, at rest and in its ground state. 1 Da = 1 u
10-4.3	unified atomic mass constant	m_u	1/12 of the mass (ISO 80000-4) of an atom of the nuclide $^{12}\mathrm{C}$ in the ground state at rest	kg u Da	1 u is equal to 1/12 times the mass of a free carbon 12 atom, at rest and in its ground state. 1 Da = 1 u
10-5.1	elementary charge	e	one of the fundamental constants in the SI system (ISO 80000-1), equal to the charge of the proton and opposite to the charge of the electron	C s A	
10-5.2	charge number, ionization number	c	for a particle, quotient of the electric charge (IEC 80000-6) and the elementary charge (ISO 80000-1)	1	A particle is said to be electrically neutral if its charge number is equal to zero. The charge number of a particle can be positive, negative, or zero. The state of charge of a particle may be presented as a superscript to the symbol of that particle, e.g. H^+, He^{++}, Al^{3+}, Cl^-, S^{--}, N^{3-}.

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