SLOVENSKI STANDARD
oSIST prEN ISO 80000-10:2016

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Veličine in enote - 10. del: Atomska in jedrska fizika (ISO/DIS 80000-10:2016)

Quantities and units - Part 10: Atomic and nuclear physics (ISO/DIS 80000-10:2016)

Größen und Einheiten - Teil 10: Atom- und Kernphysik (ISO/DIS 80000-10:2016)

Grandeurs et unités - Partie 10: Physique atomique et nucléaire (ISO/DIS 80000-10:2016)

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01.060	Veličine in enote	Quantities and units
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Quantities and units —

Part 10:
Atomic and nuclear physics

Grandeurs et unités —

Partie 10: Physique atomique et nucléaire

ICS: 01.060

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

This draft is submitted to a parallel vote in ISO and in IEC.

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 12, Quantities and units.

This second edition cancels and replaces the first edition of ISO 80000-10:2009.

ISO 80000 consists of the following parts, under the general title *Quantities and units*:

— *Part 1: General*

— *Part 2: Mathematics*

— *Part 3: Space and time*

— *Part 4: Mechanics*

— *Part 5: Thermodynamics*

— *Part 7: Light and Radiation*

— *Part 8: Acoustics*

— *Part 9: Physical chemistry and molecular physics*

— *Part 10: Atomic and nuclear physics*

— *Part 11: Characteristic numbers*

— *Part 12: Condensed matter physics*

IEC 80000 consists of the following parts (in collaboration with IEC/TC 25), under the general title *Quantities and units*:

— *Part 6: Electromagnetism*

— *Part 13: Information science and technology*

— *Part 14: Telebiometrics related to human physiology*

Introduction

0 Special remarks

0.1 Quantities

Numerical values of physical constants in ISO 80000-10 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, http://physics.nist.gov/cuu/Constants/index.html

0.2 Special units

Individual scientists should have the freedom to use non-SI units when they see a particular scientific advantage in their work. For this reason, non-SI units that are relevant for atomic and nuclear physics are listed in Annex A.

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 values, the expected values (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 10-80.2) 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 the particle fluence (item10-42), the absorbed dose (item 10-80.1) and the kerma (item10-85) are based on these expected values.

Quantities and units — Part 10: Atomic and nuclear physics

1 Scope

ISO 80000-10 gives the names, symbols, and definitions for quantities and units used in atomic and nuclear physics. Where appropriate, conversion factors are also given.

Radiation with quantum energies up to an including 10 eV is covered in ISO 80000-7. Radiation with quantum energies above this value is covered in this Standard. In some applications, like e.g. in far-ultraviolet lithography, radiation with energies above 10 eV is applied without intentionally making use of the ionizing property of this radiation. For these cases ISO 80000-7 is applicable.

2 Normative references

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

ISO 80000-3:2006, *Quantities and units — Part 3: Space and time*

ISO 80000-4:2006, *Quantities and units — Part 4: Mechanics*

ISO 80000-5:2007, *Quantities and units — Part 5: Thermodynamics*

IEC 80000-6:2008, *Quantities and units — Part 6: Electromagnetism*

ISO 80000-7:2008, *Quantities and units — Part 7: Light and radiation*

ISO 80000-9:2009, *Quantities and units — Part 9: Physical chemistry and molecular physics*

3 Quantities, units and definitions

The names, symbols, and definitions for quantities and units used in atomic and nuclear physics are given on the following pages.

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition	Symbol	
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 charge of the nucleus divided by the elementary charge (item 10-5.1).
10-1.2	neutron number	N	number of neutrons in an atomic nucleus		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		$A = Z + N$ Nuclides with the same value of A are called isobars.

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition	Symbol	
10-2	rest mass, proper mass	$m(\mathrm{X}), m_\mathrm{X}$	for particle X, mass (ISO 80000-4:2006, item 4-1) of that particle at rest	kg u Da	Specifically, for an electron: $m_e = 9{,}109\ 382\ 91(40) \cdot 10^{-31}$ kg Rest mass is often denoted m_0. 1 dalton 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 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 the speed of light in vacuum (ISO 80000-7:2008, item 7-4.1)	J N m $\mathrm{m^2\,kg\,s^{-2}}$	
10-4.1	atomic mass, nuclidic mass	$m(\mathrm{X}), m_\mathrm{a}$	rest mass (ISO 80000-4:2006, item 4-1) of an atom or a nuclide X in the ground state	kg u Da	$\frac{m_\mathrm{a}}{m_\mathrm{u}}$ is called the relative atomic mass. For a nuclide X, the rest mass may be denoted $m(\mathrm{X})$. 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	unified atomic mass constant	m_u	1/12 of the mass (ISO 80000-4:2006, item 4-1) of an atom of the nuclide $^{12}\mathrm{C}$ in the ground state at rest		

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition	Symbol	
10-5.1	elementary charge	e	quantum of electric charge, equal to the charge of the proton and opposite to the charge of the electron (IEV-113-05-17)	C s A	
10-5.2	charge number, ionization number	c	for a particle, the electric charge (IEC 80000-6:2008, item 6-2) divided by the elementary charge (item 10-5.1)	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., $H^+, He^{++}, Al^{3+}, Cl^-, S^{--}, N^{3-}$
10-6	Bohr radius	a_0	radius of the electron orbital in the hydrogen atom in its ground state in the Bohr model of the atom $a_0 = \frac{4\pi\varepsilon_0\hbar^2}{m_e e^2}$, where ε_0 is the electric constant (IEC 80000-6:2008, item 6-14.1), $\hbar$ is the reduced Planck constant (ISO 80000-1, item ??), m_e is the rest mass of electron (item 10-2), and e is the elementary charge (item 10-5.1)	m Å	The radius of the electron orbital in the H atom in its ground state is a_0 in the Bohr model of the atom. ångström (Å), 1 Å := 10^{-10} m
10-7	Rydberg constant	R_∞	spectroscopic constant that determines the wave numbers of the lines in the spectrum of hydrogen $R_\infty = \frac{e^2}{8\pi\varepsilon_0 a_0 h c_0}$, where	m^{-1}	The quantity $R_y = R_\infty \cdot hc_0$ is called the Rydberg energy.