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Medizinische Informatik – Darstellung der Ergebnisse von Messungen in den Gesundheitswissenschaften; Englische Fassung EN 12435:2006

Health Informatics –
Expression of results of measurements in health sciences;
English version EN 12435:2006

Informatique de santé –
Expression des résultats de mesure dans le domaine de la santé;
Version anglaise EN 12435:2006

Gesamtumfang 118 Seiten

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Nationales Vorwort

Diese Norm enthält unter Berücksichtigung des Präsidialbeschlusses 13/1983 den englischen Originaltext der Europäischen Norm EN 12435, Ausgabe 2006-01. Diese Europäische Norm wurde in der WG II „Terminology and knowledge representation“ des CEN/TC 251 „Medizinische Informatik“ erarbeitet. Der Arbeitsausschuss NA 063-07-03 AA „Terminologie“ des Fachbereichs 7 „Medizinische Informatik“ des Normenausschusses Medizin im DIN hat an der Erarbeitung mitgewirkt. Diese Norm legt die Darstellung der Ergebnisse von Messungen in den Gesundheitswissenschaften fest, wobei auf vorhandene Systeme zurückgegriffen wird.

Für die im Abschnitt 2 zitierten Internationalen Normen wird im Folgenden auf die entsprechenden Deutschen Normen hingewiesen:

ISO 31 siehe DIN 1302 (modifiziert)

Änderungen

Gegenüber DIN V ENV 12435:2000-02 wurden folgende Änderungen vorgenommen:

a) der Vornormcharakter wurde aufgehoben;

b) der Inhalt wurde redaktionell überarbeitet.

Frühere Ausgaben

DIN V ENV 12435:2000-02

Nationaler Anhang NA
(informativ)

Literaturhinweise

DIN 1302:1994-04, *Allgemeine mathematische Zeichen und Begriffe*

(Ersetzt durch DIN 1302:1999-12)

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12435

January 2006

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Supersedes ENV 12435:1999

English Version

Health informatics - Expression of results of measurements in health sciences

Informatique de santé - Expression des résultats de mesure dans le domaine de la santé

Medizinische Informatik - Darstellung der Ergebnisse von Messungen in den Gesundheitswissenschaften

This European Standard was approved by CEN on 14. December 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 12435:2006) has been prepared by Technical Committee CEN/ TC 251 "Health informatics", the secretariat of which is held by NEN.

This document falls under mandate BC/CEN/03/ 255/97/23 of the European Commission and the European Free Trade Association.

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 July 2006, and conflicting national standards shall be withdrawn at the latest by July 2006.

This document supersedes ENV 12435:1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Introduction

Results of measurements on the human or animal body, and its environment are essential in the health sciences. The disciplines involved in measurement often use different ways of expressing their results. Conventions within user groups are not universally applicable. The situation is further complicated by differences in the ways they are expressed in national legislation and in local administration. From the many available conventions, a consensus must therefore be reached on how to express the results of measurements on the body and its environment, particularly for exchange between information systems.

Universal principles for the expression of measurements have been laid down by Technical Committee 12 of the International Organization for Standardization in its series of standards ISO 31 and ISO 1000, which implement the International System of Units (SI) defined by the General Conference on Weights and Measures. Those principles have been applied to biological systems and certain units have been added by the International Council on Radiological Protection, International Council on Standardization in Haematology, the International Federation of Clinical Chemistry, the International Union of Biochemistry and Molecular Biology, the International Union of Pure and Applied Chemistry and the World Health Organization. Implementation of this EN will provide wider comprehension and interaction between countries and specialities.

The main normative provisions of this European standard are expressed in Clauses 5, 6 and 7. They include the following aspects of the performance of a device or system related to the result of a measurement:

— the selection of kind-of-quantity and the unit in which to express it in accordance with the provisions of Clause 5

— where reported, the uncertainty of the value in accordance with the provisions of Annex D

— for the purposes of display, printing, transmission and storage, the elements of the results of measurement in accordance with the provisions of Clause 7.

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1 Scope

This document is intended for use by parties to the design, development, acquisition, use and monitoring of health-care related information and information systems. It provides a list of units of measurement to be used in representing values of measurable quantities in health sciences.

The International System of Units forms the basis for this EN. Units with their associated kinds-of-quantity are arranged in order of dimension in Tables 1, 2 and 4 (Clause 5), and in Annex A.

Different kinds-of-quantity may apply to a given combination of component(s) and system. Often the different quantities are interconvertible and examples of such interconvertibility are given in Annex C.

Tables of conversion factors (Annex A) are provided from units in current use to SI units or their multiples.

To represent the result of a measurement (Clause 6), this EN addresses requirements for the following:

— relational operator (Clause 4)

— numerical value (Subclause 6.1)

— uncertainty of measurement (Subclause 6.2; Annex D)

— unit of measurement (Clause 5).

This EN covers the requirements for representation of these data elements in displayed and printed form, and provides an approach for support of languages in non-Roman alphabets (Clause 7).

The scope of this standard is limited to textual representation. Support is not provided for the display or printing of images or graphs.

This standard does not cover the requirements for expression of the results of measurements in speech, speech synthesis or handwriting. It does not cover the form and syntax of requests for clinical measurements, nor detailed aspects of data transmission. It refers the user to other CEN standards that address the detailed specification of the interchange format. It does not address the syntax for recording of natural-language statements about quantities, such as those used in recording information about drugs dispensed or about treatment of patients. It does not cover the units of financial quantities, which are covered by ISO 4217.

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 31-11:1992, *Quantities and units – Part 11: Mathematical signs and symbols for use in the physical sciences and technology.*

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3 Definitions, abbreviations and acronyms

3.1 Definitions

3.1.1
base kind-of-quantity
one of the kinds-of-quantity that, in a system of kinds-of-quantity, are conventionally accepted as functionally independent of one another (after VIM)

3.1.2
base unit
unit of measurement of a base kind-of-quantity in a given system of kinds-of-quantity (after VIM)

3.1.3
character
member of a set of elements used for the organization, control or representation of information (after ISO 10 646-1)

3.1.4
coded character
character in its coded representation (after ISO 10 646-1)

3.1.5
coherent unit
derived unit of measurement that may be expressed as a product of powers of base units with the proportionality factor one (VIM)

3.1.6
component
definable part of a system (ENV 1614)

NOTE In analytical chemistry, component is sometimes called constituent or analyte.

3.1.7
derived kind-of-quantity
kind-of-quantity defined, in a system of kinds-of-quantity, as a function of base kinds-of-quantity of that system (after VIM)

3.1.8
derived unit
unit of measurement of a derived kind-of-quantity in a given system of kinds-of-quantity (after VIM)

3.1.9
dimension of quantity
expression that represents a quantity in a system of quantities as the product of powers of factors that represent the base kinds-of-quantity of the system (after VIM)

NOTE The use of this term is explained in Annex B.

3.1.10
entity
that which can be individually described and considered

[ISO 8402:1994]

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NOTE 1 The word unit is used for this concept in statistics and in counting for what is counted, which may be, for instance, physical objects, physical particles, repetitive operations or repetitive processes, or any combination of such (detected, for instance, by pattern recognition).

NOTE 2 The concept is called element in set theory, in which a collection of elements constitute a set:

element - set

In this context, a component may be considered as a set of entities:

entity - component

NOTE 3 An entity, in contrast to a unit of measurement, constitutes part of the specification of a component (on the left side of the equation in Subclause 4.2) and not part of the unit of measurement (on the right side of the equation). The entity thus forms part of the specification of the measurable quantity. Some examples of such measurable quantities based on counting are given in Subclause 5.6.5.

3.1.11
factor prefix
prefix word or symbol for attachment to the name or symbol of a unit in order to form units that are multiples or submultiples of that unit

NOTE Factor prefixes provide a series to allow submultiples and multiples of SI units in the range 10-24 to 1024.

3.1.12
graphic character
character in its visible representation

[ISO 10 646-1]

3.1.13
interchange
transfer of character-coded data from one user to another, using telecommunication means or interchangeable carriers (after ISO 10 646-1)

3.1.14
International System of Units (SI)
coherent system of units adopted and recommended by the General Conference on Weights and Measures (VIM)

3.1.15
kind-of-quantity
element of information common to a set of mutually comparable measurable quantities and necessary for the definition of a measurable quantity, along with a system and often a component

NOTE 1 The definition of this concept is under discussion in ISO/TC12.

NOTE 2 The unqualified word quantity is also widely used for this concept, which VIM calls quantity in a general sense.

NOTE 3 A kind-of-quantity can be designated by a name or a symbol, but cannot be measured.

EXAMPLES:

— pressure p

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— substance concentration c

— length l

3.1.16
measurable quantity
attribute of a phenomenon, body or substance that may be distinguished qualitatively and determined quantitatively (VIM)

NOTE 1 Phenomenon, body or substance correspond to the concepts of system and component as used in clinical laboratory sciences. Qualitatively refers to the need to define a quantity before it can be measured.

NOTE 2 A measurable quantity is defined by several elements of information, here called kind-of-quantity, component and system.

EXAMPLES:

— pressure (kind-of-quantity) of air (component) in surgical theatre of hospital X at 1995-05-01 10:00 (system)

— substance concentration (kind-of-quantity) of dioxygen (component) in blood of John Smith (born at place X on 1950-01-1) at time 1995-05-01 10:00 (system)

— length (kind-of-quantity) of John Smith (born at place X on 1950-01-1) at time 1995-05-01 10:00 (system)

3.1.17
measurement
set of operations having the object of determining a value of a quantity (VIM)

3.1.18
numerical value
quotient of the value of a quantity and the unit used in its expression (after VIM)

3.1.19
octet
ordered sequence of eight bits considered as an entity (after ISO 10 646-1)

3.1.20
off-system unit
unit of measurement that does not belong to a given system of units (VIM)

3.1.21
quantity
see kind-of-quantity and measurable quantity.

3.1.22
result of measurement
value attributed to a measurable quantity obtained by measurement (after VIM)

NOTE For the purposes of this ENV, result is taken to include the relational operator (Subclauses 4.1 and 4.3) and a measurable value of uncertainty (Annex D).

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3.1.23
scale
set of possible values that may be attributed to a quantity of a certain kind (after ENV 1614)

NOTE In instrumentation, scale also means the ordered set of marks … forming part of the display on a measuring instrument (VIM).

3.1.24
symbol
representation of a concept by letters, numerals, pictograms or any combination thereof (after ISO 1087:1990)

3.1.25
system
demarcated arrangement of a set of elements and a set of relationships between these elements (ENV 1614)

3.1.26
systematic name
name consistent with the principles of a nomenclature (ENV 1614)

3.1.27
uncertainty of measurement
parameter that is associated with the result of a measurement and that characterizes the dispersion of the values attributable to the quantity measured (after VIM)

3.1.28
unit of measurement
measurable quantity, defined and adopted by convention, with which other quantities of the same dimension are compared in order to express their magnitudes relative to that quantity (after VIM)

NOTE The word unit is also used in statistics and in counting for what is here called entity (Subclause 3.1.10).

3.1.29
value of quantity
magnitude of a measurable quantity generally expressed as a number multiplied by a unit of measurement (after VIM)

3.2 Abbreviations, initialisms and acronyms

BIPM International Bureau of Weights and Measures = Bureau International des Poids et Mesures

CEN European Committee for Standardization = Comité Européen de Normalisation = Europäisches Komitee für Normung

CGPM General Conference on Weights and Measures = Conférence Générale des Poids et Mesures

CQU IUPAC Commission on Quantities and Units in Clinical Chemistry and IFCC Committee on Quantities and Units

EDIFACT Electronic Data Interchange for Administration, Commerce and Transport

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ENV	European Prestandard = Prénorme Européenne = Europäisches Vornorm
EU	European Union
ICRP	International Council on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
ICSH	International Council on Standardization in Haematology
IEC	International Electrotechnical Commission
IFCC	International Federation of Clinical Chemistry
ISO	International Organization for Standardization
IUBMB	International Union of Biochemistry and Molecular Biology
IUPAC	International Union of Pure and Applied Chemistry
IUPAC-CT	IUPAC Commission on Toxicology
IUPAP	International Union of Pure and Applied Physics
OIML	International Organization for Legal Metrology
OSI	Open Systems Interconnection
SEPCR	European Society for Clinical Respiratory Physiology
SI	International System of Units
VIM	International vocabulary of basic and general terms in metrology (Clause 2)
WHA	World Health Assembly
WHO	World Health Organization
WMO	World Meteorological Organization

4 Elements of data in a measurable quantity and its result

4.1 A measurement can be expressed in a logical statement, which includes the following possible elements:

— system

— component

— kind-of-quantity

— relational operator

— numerical value

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— unit of measurement

— uncertainty.

4.2 In symbolic language

$$q = \{q\} \cdot [q] \pm \{uc\} \cdot [q]$$

where q is any measurable quantity (designated by a kind-of-quantity, a system and any component), [q] is a unit of measurement of the quantity q and {q} is its numerical value in that unit, {uc} is the numerical value of combined uncertainty in that same unit.

EXAMPLE

Blood (venous; fasting patient) – Glucose; substance concentration

= 4,9 mmol L^{-1} ± 0,2 mmol L^{-1} where the quantity after the ± is combined standard uncertainty

4.3 The relation sometimes requires other relational operators than equals (=), such as < (is less than), > (is more than), ≤ (is less than or equal to), ≥ (is more than or equal to), ≈ (is approximately equal to) or ≠ (is not equal to) (ISO 31-11: 1992, Clause 3).

NOTE ENV 1614 "Medical informatics – Messages for the exchange of laboratory information" concentrates on the elements of information on the left of the relational operator. This ENV complements that work and concentrates on the right of the relational operator.

5 Units for reporting information in health sciences

5.1 Representation of results of measurements

In the representation of results of measurements, the unitary expressions shall include any of the following:

— SI units (Clauses 5.1 to 5.3)

— units formed from SI units by use of prefix symbols (Clause 5.4)

— certain off-system units (Clause 5.5)

— certain dimensionless units (Clause 5.6).

5.1.1 Annex A provides conversion factors with which algorithms can be designed to convert other units in local use and Annex C provides some criteria for conversion between kinds-of-quantity.

5.1.2 Table 1 lists SI base units each with its associated base kind-of-quantity. Definitions of the SI base units are given in Annex A. Number of entities is sometimes also treated as base and has the coherent SI unit `one'. For the choice of kilogram (with a prefix) as a base unit see Clause 5.4.6.

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Table 1 —Base kinds-of-quantity, base units and their dimensional symbols in the International System of Units (SI). The base kinds-of-quantity are in the sequence used by CGPM and in Annex A. Entries begin with the references (Ref.) to that annex.

Ref.	Base kind-of-quantity		Base unit		Dimension
	name	symbol	name	symbol	
A.1	number (of entities)	*N*	one	1	1
A.2	length	l	metre	m	L
A.10	mass	m	kilogram	kg	M
A.19	time	t	second	s	T
A.66	electrical current	I	ampere	A	I
A.87	thermodynamic temperature	T, ϑ	kelvin	K	Θ
A.102	luminous intensity	Iv	candela	cd	J
A.107	amount-of-substance	n	mole	mol	N

5.2 Derived coherent units of SI and mathematical operations with units

5.2.1 Most coherent units of derived kinds-of-quantity are represented with **compound units** obtained by multiplication or division or both of the component base units. Such expressions require the mathematical operations of multiplication, division and raising to a power.

EXAMPLE Mole per square metre second (mol m^{-2} s^{-1}) is the SI-coherent compound unit of areic substance rate (Annex A.120).

5.2.2 Multiplication between units shall be represented by either a space, by a half-raised point (·) or by raising to a power.

EXAMPLES The product of pascal and second (called pascal second) is represented as Pa s or Pa · s.

The product of 2 Pa s with 5 s^{-1} is 2 Pa s X 5 s^{-1} = (2 Pa s) · (5 s^{-1}) = 10 Pa.

NOTE 1 The multiplication sign X is not recommended by ISO 31-0 for expression of units.

NOTE 2 The space between a numerical value and a unit also represents multiplication.

NOTE 3 Raising a unit u to a power is usually expressed as `unit squared' ($u^2$), `unit cubed' (u^3) or `unit to the fourth power' ($u^4$). For units of length, the designations `square unit' and `cubic unit' (e.g. square metre and cubic metre) are used as long as the derived quantity can be viewed as an area and a volume, respectively. Otherwise

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designations like metre squared and metre cubed are used. In Annex A, only designations like square metre and cubic metre are listed.

5.2.3 **Division** of units shall be represented by multiplication of negative powers (example above) or by a slash (/). Not more than one slash shall be used in one compound unit, unless brackets are used in the expression to avoid ambiguity.

EXAMPLE mol m^{-2} s^{-1} = mol·m^{-2}·s^{-1} = mol/(m^2 s) = (mol/m^2)/s *but not* mol/m^2/s

5.3 Derived coherent units of SI with special names and symbols

Special names or **symbols**, usually both, are allowed for certain derived SI units (Table 2).

5.4 Multiples and submultiples of units: prefix names and symbols

5.4.1 If a system of units is chosen with only one unit for each dimension, there are bound to be some **very large and very small numerical values**, which can be expressed more briefly by use of **powers of 10**, such that numerical values (i.e. the mantissas) can almost always be between 0,1 and 1000 (Subclause 6.1.3).

EXAMPLES

Molar number constant, N_A, ≈ 602 213 670 000 000 000 000 000 mol^{-1}

= 602,213 67·10^{21} mol^{-1}

Rest mass of an electron, m_e ≈ 0,000 000 000 000 000 000 000 000 000 000 9 kg

= 0,9·10^{-30} kg

5.4.2 Instead of using powers of 10 with numerical values, **decimal prefixes** may be attached to SI units. The prefixes

Table 2 — Kinds-of-quantity associated with derived SI units with special names or symbols. The sequence of the list is as in Annex A, to which the references (Ref.) apply, essentially by order of dimension (Table 1) with increasing magnitude of powers of those dimensions, first positive and then negative. The trivial names of some kinds-of-quantity (A.44, equivalent dose) imply also an unnamed generalized component (marked by the modulus sign, |, in the systematic name). Systematic names of electrical and luminous kinds-of-quantity are based on electrical charge (unit C = A s) and quantity of light (unit lm s = cd sr s), respectively. The distinction *electric* and *electrical* is a non-normative mental aid in marking those kinds-of-quantity in which electrical charge forms part of the denominator and numerator, respectively, of the definition. The name and symbol of the katal have been recognized by IUPAC, IFCC, IUBMB and WHO; other units are recognized also by BIPM (1991). The symbols t, ϑ and Φ have several meanings in Table 1 and 2, those of □ being distinguished here by subscripts.

Ref. name	Kind-of-quantity		Unit symbol		Definition in SI-base units
	symbol	name			
A.1	plane angle γ, ϑ	α, β,	radian	rad	m m^{-1} = 1
A.1	solid angle	$\underline{\Omega}$	steradian	sr	m^2 m^{-2} = 1

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A.20	number rate | of regular events; frequency	f, ν	hertz	Hz	s^{-1}
A.20	radioactivity	A	becquerel	Bq	s^{-1}
A.44	massic energy | of ionizing radiation absorbed; absorbed dose	D	gray	Gy	$m^2\ s^{-2}$
A.44	effective massic energy | of ionizing radiation absorbed; equivalent dose	H	sievert	Sv	$m^2\ s^{-2}$
A.48	force	F	newton	N	$kg\ m\ s^{-2}$
A.50	pressure	p	pascal	Pa	$kg\ m^{-1}\ s^{-2}$
A.51	energy	E, Q_e	joule	J	$kg\ m^2\ s^{-2}$
A.58	energy rate; power	P, Φ_e	watt	W	$kg\ m^2\ s^{-3}$
A.61	electrical charge	Q	coulomb	C	A s
A.72	magnetic induction;	B	tesla	T	$kg\ A^{-1}\ s^{-2}$
	magnetic flux density				$= kg\ C^{-1}\ s^{-1}$
A.74	magnetic flux	Φ_m	weber	Wb	$kg\ m^2\ A^{-1}\ s^{-2}$
					$= kg\ m^2\ C^{-1}\ s^{-1}$
A.76	electric potential	U, V	volt	V	$kg\ m^2\ A^{-1}\ s^{-3}$
	difference				$= kg\ m^2\ C^{-1}\ s^{-2}$
A.78	mutual inductance	L	henry	H	$kg\ m^2\ A^{-2}\ s^{-2}$
					$= kg\ m^2\ C^{-2}$
A.80	electrical conductance	G	siemens	S	$A^2\ s^3\ kg^{-1}\ m^{-2}$
					$= s\ C^2\ kg^{-1}\ m^{-2}$
A.81	electric resistance	R	ohm	Ω	$kg\ m^2\ A^{-2}\ s^{-3}$
					$= kg\ m^2\ C^{-2}\ s^{-1}$
A.85	electrical	C	farad	F	$A^2\ s^4\ kg^{-1}\ m^{-2}$

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	capacitance				
					$= C^2\ s^2\ kg^{-1}\ m^{-2}$
A.87	Celsius temperature	t, ϑ	degree	°C	K
A.102	light rate; luminous flux	Φ_v	lumen	lm	cd sr
A.103	areic light rate | of incident radiation; illuminance	M_v	lux	lx	$cd\ sr\ m^{-2}$
A.119	catalytic activity	z	katal	kat	$mol\ s^{-1}$

Table 3. SI prefixes denoting decimal factors, 10^n. *m = 3n.* **The origins of the prefixes are indicated as an aid for memorization: Da, Danish; Es, Spanish; Gr, Greek; It, Italian; La, Latin; No Norwegian.**

Name	**Symbol**	***n***	***m***	**Mnemonic**
yotta	Y	24	8	La octo (8)
zetta	Z	21	7	La septem (7)
exa	E	18	6	Gr hexa (6)
peta	P	15	5	Gr penta (5)
tera	T	12	4	Gr (monster)
giga	G	9	3	Gr gigas (giant)
mega	M	6	2	Gr megas (great)
kilo	k	3	1	Gr chilioi (1000)
hecto	h	2		Gr hekaton (100)
deca	da	1		Gr deka (10)
deci	d	-1		La decem (10)
centi	c	-2		La centum (100)
milli	m	-3	-1	La mille (1000)

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micro	µ	-6	-2	Gr mikros (small)
nano	n	-9	-3	La nanus (dwarf)
pico	p	-12	-4	Es pico, It piccolo (small)
femto	f	-15	-5	Da, No femten (15)
atto	a	-18	-6	Da, No atten (18)
zepto	z	-21	-7	La septem (7)
yocto	y	-24	-8	La octo (8)

shall be in accordance with Table 3, forming a series from 10^{-24} to 10^{24}. Since the distinction between capital letters and lower-case letters is significant for the meaning of the prefix symbols, capitals shall be used consistently for the higher positive powers from mega (10^6) upwards.

5.4.3 In data formatted for interchange, the decimal factors and decimal prefixes should give **steps of a factor 1000** (i.e. a power of 10^{3n}, where *n* is a positive or negative integer).

NOTE For convenience in health sciences, the prefixes hecto, deca, deci and centi can usually be avoided (Table 3, separated by dotted lines), though they have equal legal standing.

5.4.4 A **unit together with a prefix** forms a **new unit**, which shall be displayed or printed according to the rules for units. The new unit as a whole can be multiplied, divided or raised to a power.

EXAMPLE A kilometre (km) is 1000 m and square kilometre (km^2) is $(1000\ m)^2$, i.e. 1 000 000 m^2, *not* 1000 m^2.

5.4.5 A **second prefix shall be avoided** in units already containing a prefix, either in simple units (e.g. not µµg but pg) or compound units.

EXAMPLE The substance concentration of a pollutant in air shall be expressed as 8 µmol m^{-3} and not as nmol dm^{-3} (but may alternatively be expressed as 8 nmol/L, Subclause 5.5.2).

5.4.6 Since the base unit kilogram (kg) already contains a prefix, multiples shall be constructed by adding prefixes to the submultiple unit gram (g).

EXAMPLES The multiple 10^3 kg shall be expressed as megagram (Mg) equal to 10^3 kg (not 10^6 kg). It is not called kilokilogram (kkg).

Multiples of the unit kilogram metre (kg m) shall be made by replacing the `k-' of kg and not by inserting an additional prefix to metre: mg m, not kg µm.

5.4.7 A **prefix shall be attached to a numerator unit** rather than to a denominator unit or to a unit raised to a power, because of difficulties of interpretation.

EXAMPLE 100 m^{-1} $= (10^{-2}\ m)^{-1} = cm^{-1}$ (though recognized for wavenumber, Annex A.3)

0,01 m^{-1} $\neq cm^{-1}$

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5.4.8 If a compound unit has to be simplified, it should first be converted to numerical factors and coherent units.

EXAMPLE

10^{-18} mol m^{-2} s^{-1} = amol m^{-2} s^{-1} (preferred) = mol $(10^9\ m)^{-2}$ s^{-1} = mol Gm^{-2} s^{-1} (avoid)

= mol m^{-2} $(10^{18}\ s)^{-1}$ = mol m^{-2} Es^{-1} (avoid)

5.4.9 Quantities with mass in the denominator of the definition should be expressed in compound units with kg^{-1} rather than g^{-1}.

EXAMPLE Molality is expressed in mol kg^{-1} or mmol kg^{-1}, rather than mmol g^{-1} or µmol g^{-1}.

5.4.10 The order of unit-symbols in compound units is not strictly determined in normal usage. Criteria should include the following:

— positive powers precede negative powers

— the unit of mass (e.g. kg, g, mg) precedes other units in the numerator and in the denominator.

— if avoidable, a letter that might be misunderstood as a prefix symbol should not be initial.

EXAMPLE N m (newton metre) rather than m N (metre newton), which may be confused with mN (millinewton)

5.5 Units outside SI: off-system units

5.5.1 For certain kinds-of-quantity, results may be expressed in either SI units and their multiples, or units outside SI. If units outside SI are used, they shall be in accordance with Table 4, in accordance with recognition by CGPM, the EU Directive, IUPAC, IFCC, IUBMB and WHO (or WHA). In medical informatics, those with asterisks (Table 4) are discouraged.

Table 4 —Units outside SI recognized for use together with SI in health sciences. For experimentally obtained values, with combined standard uncertainty u_c (explained in Annex D). Units marked with an asterisk (*) are not normally required for health sciences, though they have general, specialized or temporary legal recognition (EU* meaning temporary or limited recognition by the European directive); month and year have various definitions, those given here being the month of 30,4 days and the tropical year. References (Ref.) are to Annex A.

Ref. name	Unit	symbol	Value in SI unit or multiple	Authority
A.1	degree (of arc)	°	= (π/180) rad	CGPM, EU
A.1	*minute (of arc)	′	= (π/10 800) rad	CGPM, EU

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A.1	*second (of arc)	″	= (π/648 000) rad	CGPM, EU
A.3	*dioptre	dpt, d	= m^{-1}	EU*
A.4	*hectare	ha	= 10 000 m^2	CGPM, EU
A.4	*are	a	= 100 m^2	CGPM, EU*
A.6	litre	L, l	= 0,001 m^3 = dm^3	CGPM, EU
A.10	*tonne;	t	= 1000 kg	CGPM, EU
	*metric ton			
A.10	dalton;	Da	≈1,660 540 2 yg;	IUBMB
	*atomic mass unit	u	u_c = 0,000 001 0 yg	CGPM, EU
A.19	year	-	≈ 31,556 9 Ms	
A.19	*month	-	≈ 2,626 56 Ms	
A.19	week	-	= 604 800 s	
A.19	day	d	= 86 400 s	CGPM, EU
A.19	hour	h	= 3600 s	CGPM, EU
A.19	minute	min	= 60 s	CGPM, EU
A.50	*bar	bar	= 100 kPa	EU
A.50	millimetre-mercury	mmHg	= 133,322 Pa	EU*, WHA
A.51	electronvolt	eV	≈ 160,217 733 zJ;	CGPM, EU
			u_c = 0,000 049 zJ	
A.135 internati onal unit	int.unit, iu	variable	WHO, IUPAC, IFCC	
A.135 arbitrary unit	arb.unit	variable	IUPAC, IFCC	

5.5.2 A stumbling block for acceptance of SI in health sciences is the **coherent unit of volume**, the **cubic metre**. The **litre** (Table 4, A.6) is the preferred unit of volume in expressing concentrations.

NOTE 1 A switch to the cubic metre requires only a switch by a factor 10^{-3}. The preferred way of expressing concentration is usually as **substance concentration** in **moles per litre** and its multiples (mol L^{-1}, mmol L^{-1}, …) rather than in kilomoles per cubic metre and its multiples (kmol m^{-3}, mol m^{-3}, …) (Annex A.113.2).

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NOTE 2 The symbols L and l have equal legal status. The capital L has been used in this document. The letter l is inadvisable if the letter type does not allow distinction from the numeral 1.

5.5.3 The name **dalton** and symbol Da (Table 4, A.10) are used in biochemistry, molecular biology and clinical sciences instead of **unified atomic mass unit** (u); the size of macromolecules, cell components and virus particles should preferably be expressed as molar mass (Annex A.117.2).

5.5.4 **Minute** and **hour**, and sometimes **day, week, month** and **year** are often needed for expression of **calendar time, clock time** and **time intervals**. For **derivatives of time**, the **second** is preferred, though other units are hard to avoid. In the compound units of rates (i.e. time derivatives), use of minute, hour and day should be avoided to simplify comparison of data. If such stringency is not possible, the same unit of time (e.g. day) should at least be used throughout a set of data.

EXAMPLE For substance rate (Annex A.119.1), preferably mol s^{-1}, mmol s^{-1}, …mol s^{-1}, … but alternatively kmol d^{-1}, mol d^{-1}, mmol d^{-1} … .

5.6 Units of dimensionless quantities and compound units with the unit `one' in the numerator

5.6.1 If the exponents of the dimensional term (Annex B) are all zero, the quantity is said to be **of dimension one** or **dimensionless**:

$$L^0M^0T^0I^0\theta^0J^0N^0 = 1$$

EXAMPLES

- number of entities of component (Subclause 5.1, Table 1; Annex A.1.1),
- dim N_B = 1
- substance fraction (Annex A.1.1), dim x_B = 1
- relative quantities such as relative volumic mass (Annex A.1.1), dim ρ_r = 1

5.6.2 For quantities of dimension one, the coherent unit in any system of units is the unit one (symbol 1), often called unity. It is generally not recorded explicitly when such a quantity is measured or reported (Annex A.1). Values of ≥1000 or <0,1 should be represented by multiplication by a power of 10^{3n}, where n is an integer (Subclause 5.4.1).

5.6.3 Apart from the units of plane angle and solid angle, the following are in use without clear legal status:

— per cent (%) for the unit 0,01

— part per thousand (ppt) or part per mille (‰) for 0,001

— part per million (ppm) for 10^{-6}

— part per hundred million (pphm) for 10^{-8}

— part per billion (ppb) for either 10^{-9} or 10^{-12}.

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These and expressions such as %(*V*/*V*) or %(v/v), and %(*m*/*m*) or %(w/w) are discouraged and should be converted for exchange in medical information systems complying with this European Standard.

5.6.4 The expression of large and small values of dimensionless quantities remains a problem and source of misunderstanding (especially in tabular or graphic representation). The decimal prefixes of Table 3 should not be used to form multiples or submultiples of the unit one, except in **redundant units**.

EXAMPLES

- The factor 10^{-3} may be introduced by the redundant unit mL L^{-1} or g kg^{-1}, but not m1 (`milli-one').

- A mass fraction of 0,000 000 005 X 1 may be expressed as 5 X 10^{-9}, $5 \cdot 10^{-9}$ or 5 µg kg^{-1}, but to 5 n1 (`nano-ones').

5.6.5 Likewise any measurable quantity in which the numerator is number of entities and the numerical value is large is also awkward to express and may be difficult to compare if a decimal prefix is used with a denominator unit (Subclause 5.4.7). The entity of component counted (Subclause 3.1.10) should not be treated as a unit of measurement (Subclause 3.1.28).

EXAMPLES

- Blood – *Erythrocytes*; number concentration = $5 \cdot 10^{12}$ L^{-1} (preferred)

= 5 X 10^{12} L^{-1} (preferred)

= 5 pL^{-1} = 5 X $(10^{-12}\ L)^{-1}$

= 5E12/L (Subclause 7.1.4, Note 2)

but not "blood count" = 5 RBC/pL

- Milk – *Escherichia coli* (colony-forming particle); number content(medium X)

= 10^{9} kg^{-1}

= 10^{6} g^{-1}

= 1E9/kg (Subclause 7.1.4, Note 2)

- Hospital ward – Nursing care; labour requirement(1995-06-07)

= 5 d

(taking `labour requirement' as meaning the time integral of number of nurses)

but not labour requirement = 5 man-d

Dimensionless quantities can be expressed logarithmically. However logarithms cannot be taken of quantities of any other dimension, including `counts'.

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EXAMPLE

- On the basis of the second example of Subclause 5.6.5, "log count of colony-forming particles (often called `units', Subclause 3.1.10) of *Escherichia coli* in milk" would have a value of 9 or 6. The expression "log c.f.u.", though sometimes used, is ambiguous for the same reason.

6 Expression of numerical value and uncertainty

6.1 Numerical values

6.1.1 Large or small numerical values shall be displayed or printed with spaces between groups of three digits to the left and right of the decimal mark, for which the comma is preferred but the point in the line is recognized in English texts as an alternative. The half-raised point (·) shall not be used as a decimal, being reserved for the multiplication operator.

EXAMPLE

- 123 456,789 012 ≈ $123{,}5 \cdot 10^3$ (further examples in Subclause 5.6.5)

NOTE 1 The space is optional for values with four digits to the left or to the right of the decimal, e.g. 1234 or 1 234.

NOTE 2 As an alternative multiplication sign, the asterisk is widely used in computer languages but is not recognized as such in ISO 31:1992. Since countries using the decimal point sometimes write it as a raised point, the asterisk may be appropriate as multiplier in local reporting systems to avoid confusion with the decimal marker.

6.1.2 If the magnitude of the numerical value is less than one, a zero shall precede the decimal mark.

6.1.3 The unit-prefix or power of ten should be so chosen to give numerical values in the range 0,1 to 999.

NOTE Where the typical range of a quantity or the range of a measuring system exceeds ~34 orders of magnitude, it may be more appropriate for interpretation to accept numerical values in a wider range or, for instance in bacteriology, to use different powers of 10 rather than different decimal unit-prefixes. The primary criterion must be ease of interpretation of the numerical values.

6.1.4 Rules for **rounding** of numerical values are given in Annex E.

6.1.5 A **set of values** may be represented by round brackets, and with space or comma and space between the values.

EXAMPLE - (2,1, 2,3, 2,2) mol L^{-1} or (2,1 2,3 2,2) mol L^{-1} for a set of three values 2,1 mol L^{-1}, 2,3 mol L^{-1} and 2,2 mol L^{-1}

6.1.6 Instead of `less than' and `more than' operators, closed ranges may be represented by reversed square brackets and open ranges by square brackets.

EXAMPLE - for the values in the example of 6.1.5,

c =]2,0; 2,4[mol L^{-1}

= [2,1; 2,3] mol L^{-1}

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= [2,1; 2,4[mol L^{-1}

6.2 Uncertainty of measurement

Full interpretation of the value of a quantity obtained by measurement requires also evaluation of the doubt attached to its value. Manufacturers and laboratories shall supply information that can be used in assessing the uncertainty of measurements based on their products.

NOTE It is not usual practice to report uncertainty with each result of a laboratory measurement but Annex D provides the means of estimating it where it is required as an element of data. It also needs to be considered in rounding of numerical values (Annex E).

7 Representation of the results of measurement

This clause covers the representation of the following elements associated with the results of measurement:

- relational operator

- numerical value

- uncertainty of measurement

- unit of measurement.

7.1 Display and printing

7.1.1 Whenever the numerical value of the result of a measurement is displayed or printed, it shall be accompanied by the name or symbol of the associated unit of measurement (with the optional exception of the unit one) and, where applicable, by an expression of uncertainty of measurement (Subclause 6.2; Annex D).

NOTE The unit need not be carried on the same information carrier or in the same transferred file. It may, for instance, be printed alongside a digital display or be preprinted on a printout of results.

7.1.2 The **displayed or printed characters** shall include the following:

- appropriate relational operator (Subclauses 4.1 and 4.3)

- numerical value in decimal notation (Subclause 6.1), including a power of 10 where appropriate (Subclauses 5.4.1 and 5.6.2)

- appropriate unit-symbol (Clause 5; Annex A)

- components of uncertainty, if included, in a format compatible with Annex D.

7.1.3 A device need not possess displaying or printing capability for those characters and signs which are not required for the measurement types and ranges for which the device is designed to be used, whether for minimum requirements (Subclause 7.1.4) or full requirements (Subclause 7.1.5).

NOTE For devices with narrow application, minimum and full requirements may coincide. Such a device may require only a few characters. Related information for the full record may be supplied by another device in the information system.

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7.1.4 Subject to the exception of Subclause 7.1.3, a device for which compliance with the **minimum requirements** of this Standard is claimed shall provide the capability of displaying and printing the full upper-case and lower-case Latin alphabet, the numerals 0 to 9, the relational operators =, < and >, the degree sign (°) and the lower-case upright Greek letter mu (μ) (SI unit prefix symbol for "micro-"), and the symbols for plus (+) and minus (-). The display or printing system shall support the use of superscript and subscript characters. The device shall also provide the decimal mark (",” or ".") appropriate to the country in which the device is to be used.

NOTE 1 In this Subclause, the term *Latin alphabet* refers to the alphabetic characters included in the lower half of the character table of the standard ISO 8859-1:1987.

NOTE 2 At this level of compliance, powers of 10 may be represented in "E-notation", e.g. 2,5E3 for 2,5 X 10^3, and the asterisk may be used as a multiplication sign. E-notation may be used also in transmission between systems meeting minimum compliance. Though appropriate for specialists working with particular instruments, it is not encouraged for printing and display of data. The letters D and Q are used in some computer languages and in some outputs, but are not encouraged.

NOTE 3 At this level of compliance, the unit symbol upper-case upright omega (Ω) may be replaced by the unit name (ohm) in full.

NOTE 4 The technical means used to implement these capabilities are not prescribed by this European Standard. However the requirements are met by the use of the ISO 8859-1:1987 character set, which also provides the characters needed by most Western European languages. In countries whose written language requirements are not covered by this character set, other solutions will be needed.

NOTE 5 The capability of the full Latin alphabet does not apply to languages not using the Latin alphabet. An appropriate coded character set for Greek is provided by ISO 5428.

7.1.5 Subject to the exception of Subclause 7.1.3, a device for which compliance with the **full requirements** of this European Standard is claimed shall, in addition to the requirements specified in 7.1.4, provide the capability of displaying or printing the Greek letter Ω, the relational operators ≤, ≥, ≈ and ≠, and the arithmetic signs ± and X. The display or printing system shall also support the use of superscript and subscript characters and italic (sloping) type.

NOTE As for minimum requirements (Subclause 7.1.4), the technical means used to implement these capabilities are not prescribed by this European Standard. It should be noted, however, that the requirement for additional signs, superscript and subscript may be satisfied by the use of the Unicode character set (an implementation of the two-octet subset (UCS-2) of ISO/IEC 10 646-1).

7.2 Transmission and storage

7.2.1 Any coding scheme which provides sufficient information to allow the recipient of a message to display or print results of measurement in accordance with Subclause 7.1 shall be regarded as satisfying the requirements of this European Standard. This document does not provide a set of codes to represent the elements of the results of measurement; suitable codes are available from other sources.

7.2.2 Where the results of measurement are encoded for storage or transmission within messages, the encoding shall be in accordance with any European standard or international standard appropriate to the application, such as ENV 1613.

7.2.3 Where information includes the expression of the results of measurement as text, the requirements of Subclause 7.1 shall apply.

NOTE Text may here be understood as including both literal representation in an appropriate character set (e.g. μmol/l) and "partially encoded" text using 7-bit characters, such as text in SGML format (e.g. &gm;mol/l) (ISO 8879:1986).

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8 Deprecation of the use of "limited" (e.g. 7-bit) character sets

This document deprecates representations of units such as that given in ISO 2955:1983 for the display and printing of the results of measurement in the clinical sciences.

NOTE The ISO 2955 standard was introduced at a time when most computer systems lacked the capability to display and print text correctly in languages other than English and to represent font information. It provided a means for the unambiguous representation of units in such systems. With present technology, users in any country require that computer systems display and print text correctly in their own language. ISO 2955 may therefore be considered obsolete.

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Annex A
(informative)

Table of kinds-of-quantity, their units and conversion factors (informative)

A.0 Introduction

Annex A represents an application of principles elaborated in Clauses 4 and 5 for kinds-of-quantity and their units listed in ISO 31 or in use in health sciences. Each Clause includes a Subclause on associated kinds-of-quantity and a Subclause on units of measurement in which those kinds-of-quantity should be expressed and have been expressed. The `units' Subclause includes information about the values of constants, where appropriate.

The Subclause on kinds-of-quantity forms a tabular list with the following information for each kind-of-quantity:

— systematic name and some other widely used names. The logic of the systematic names is described in recommendations of CQU, including the IUPAC & IFCC Silver Book (1995). Where trivial names represent more than the kind-of-quantity, commonly also a generalized component or system, a marker (|) is inserted in the systematic name to indicate its semantic parts, which are used in making entries in the index of kinds-of-quantity. The head entry to such a group of kinds-of-quantity is marked in bold.

— symbol(s) of the kind-of-quantity recommended or regularly encountered in the literature

— ISO 31:1993 Item Number or, if not listed by ISO, the acronym of another authority providing fuller information.

The conventions on modifying symbols (usually subscript) are in general line with international recommendations in chemistry and physics (e.g. IUPAC & IFCC 1995): A, a major component, e.g. solvent; B, any other component; C, any second component; E, an enzymic component; R, a reference component; 0, a reference system; 1, any other system; 2, a second system.

The Subclause on units of measurement includes the following information:

— SI unit and any distinction in the way of expressing the SI unit for certain kinds-of-quantity. Though there are at least three ways of naming a unit of the type u^{-n} (per unit; reciprocal unit; one per unit), only the shortest form, per unit, is listed and in units of the form $u^{-m}\ u'^{-n}$, the per is not repeated.

— any other unit recommended for use in health sciences. For compound units derived from time, further options are indicated by the rule of Subclause 5.5.4.

— definition of base units of SI

— names and symbols of other units and of physical constants tabulated in order of declining magnitude and their definition in terms of the SI unit; for experimentally defined units and constants (mostly taken from Codata Bulletin 63 of 1986), the table also indicates combined uncertainty (uc)

— notes on usage.

The tables include mainly simple units and only a few compound units. The value of other compound units in SI can be worked out by the principles of Subclause 5.4.

EXAMPLE

Conversion factors for compound units such as calorie per gram (which would belong in A.44.2) can be calculated from the information about the gram and kilogram in A.10.2 and about the calorie and joule in A.51.2.

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In the tables, the name of each recommended unit is given in bold type; units printed in normal type are discouraged in medical information systems and can be converted to SI with the information provided. The names of more strongly discouraged units (obsolete or ambiguous) are marked with a dagger (†).

EXAMPLE

In Clause A.19.2, †man-day represents a combination of an entity (Subclause 3.1.10) and a unit of measurement (Subclause 3.1.28) and should be replaced by the unit day (d).

Multiples and submultiples (Subclause 5.4) of recommended and other units are not listed. Their values (e.g. kcal%) can be calculated from the factor given for the unprefixed unit (e.g. cal%, A.44.2). Besides the unit(s) indicated for expression and exchange of data (usually SI), prefixed units formed according to the rules of Subclause 5.4 may be used, e.g. not only J kg-1 (A.44.2) but also kJ kg-1 and MJ kg-1.

The tables of units also list authorities recognizing or deprecating some of the more relevant units, namely the CGPM, EU Directive, IUPAC, IFCC and CQU, ICRP, IUBMB and WHO. The authorities for some units with only temporary recognition or recognition for limited use are marked with an asterisk, for instance *EU and *CGPM, and their use is then usually to be discouraged. Units of the obsolete centimetre-gram-second system are marked `cgs'. Where an organization deprecates the use of a unit, the acronym is preceded by a degree sign, e.g. °CGPM.

A.1 Kinds-of-quantity of dimension 1 and their units

A.1.1 Kinds-of-quantity

Name	Symbol	Authority
number of entities	N	8-2
number | of photons	N_Φ	6-22
stoichiometric | number	ν_B	8-27
number | of protons	Z_B	8-42; 9-1
number | of neutrons	N_B	9-2
number | of nucleons; mass number	A_B	9-3
number | of elementary charges | on ion; charge number	z_B	8-44
number | of ionizations; total ionization	N_i	10-24
number | of replicates | in sample; sample size	n	ISO 3534.1
number | of degrees of freedom		ν
quantity ratio	$(Q_B/Q_R)_1$	
plane angle	α, β, γ,	
	ϑ, ϕ	1-1
angle | of optical rotation; rotance	α	8-51

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solid angle	Ω	1-2
thermal diffusion ratio	k_T	8-40.1
ratio of massic kelvic enthalpies	γ	4-17.1
substance ratio	$r_{B/A}$	8-14.2
quantity fraction	Q_B/Q_1	
number fraction	δ_B	CQU
probability; confidence level	P	IAEA
volume fraction	φ_B	8-15
mass fraction	w_B	8-12
electrical charge fraction; transport number	t_B	8-50
substance fraction	x_B	8-14.1
quantity efficiency	Qoutput/Qinput	
energy efficiency	η	3-28
relative quantity	Q_1/Q_0	
relative volumic mass; relative density	d, ρ_r	3-3
relative molar mass	M_r	
relative molar mass | of compound B; molecular weight		$M_{r,B}$
relative molar mass | of element B;atomic weight	$A_{r,B}$	8-1
relative lineic time | of radiation | through medium 1; refractive index	n_1	6-44
relative frictional force (to normal force); friction factor	μ, f	3-22
relative areic energy emitted (to perfect radiator); emissivity	ε	6-21.1
relative chemical activity	a_B	8-23; 8-25.1
relative permittivity	ε_r	5-11
relative permeability	μr	5-25
difference fraction	$\Delta Q_B/Q_{tot}$	

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substance fraction | of component dissociated; degree of dissociation	α	8-47
energy fraction | of radiation (or sound) absorbed; absorptance	α	7-27.1; (6-40.1)
energy fraction | of radiation (or sound) reflected; reflectance	r	7-27.2; (6-40.2)
energy fraction | of radiation transmitted; transmittance	τ	7-27.3
energy fraction | of radiation transmitted | within medium; internal transmittance	τ_i, T	6-40.3
energy fraction | of sound dissipated; dissipance	δ, ψ	7-27.1
relative difference	(ΔQ/Q1)	
relative length increment; linear strain	ε	3-16.1
shear strain	γ	3-16.2
relative volume increment; volume strain	κ	3-16.3
Poisson ratio	μ, ν	3-17
electric susceptibility	X	5-12
magnetic susceptibility quantity factor	κ	5-26
chemical activity factor	f_B, γ_B	8-22.1; 8-24.1
osmotic factor	φ	8-25.2
thermal diffusion factor	α_T	8-40.2
Napierian difference	Δln Q	2-9; 2-10
logarithmic decrement	Λ, ξ	7-25; 10-38
Napierian difference of pressure; sound pressure level	Lp	7-21
Napierian difference of power; sound power level	LW	7-22
lethargy	u	10-37
quantity-decremence; Napierian decrement	-δln Q	= -δQ/Q
decadic difference	Δlg Q	
attenuance	D_i	6-41
decadic absorbance	A	CQU

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sound reduction index	R	7-28
binary difference		ΔIb Q
frequency interval	-	7-3
exponential quantity		
chemical activity	κ_B	8-18
pH	pH	CQU

A.1.2 Units of measurement

Coherent unit one (1)
SI unit of plane angle radian (rad = 1)
SI unit of solid angle steradian (sr = 1)

Unit		**Value in SI unit**	**Authority**
name	**symbol**		
billion (EU); trillion (US)	-	= 10^{12}	
milliard (EU);billion (US)	-	= 10^{9}	
million	-	= 10^{6}	
thousand	-	= 10^{3}	
hundred	-	= 100	
unit one; unity	1	= 1	ISO
radian	rad	= 1	SI
steradian	sr	= 1	SI
neper	Np	= 1	ISO
bel	B	= 1	ISO
absorbance unit	A.U.	= 1	
degree of arc	°	= (π/180)	CGPM, EU
		≈ 17,453 29·10-3	
gon; grade	gon, g, gr	= (π /200)	
		≈ 15,707 96·10-3	

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per cent	%	$= 10^{-2}$	ISO
†part per thousand;	ppt	$= 10^{-3}$	
†per mille	‰		
†part per hundred thousand	ppht	$= 0{,}1 \cdot 10^{-6}$	
†part per million	ppm	$= 1 \cdot 10^{-6}$	
minute of arc	′	$\approx 290{,}888\ 2 \cdot 10^{-6}$	CGPM
second of arc	″	$\approx 4{,}848\ 137 \cdot 10^{-6}$	CGPM
†part per billion (US)	ppb	$= 1 \cdot 10^{-9}$	
†part per milliard (EU)	-	$= 1 \cdot 10^{-9}$	
†part per trillion (US)	ppt	$= 1 \cdot 10^{-12}$	
†part per billion (EU)	ppb	$= 1 \cdot 10^{-12}$	
†part per trillion (EU)	ppt	$= 1 \cdot 10^{-18}$	

NOTE Various notations are in use to combine an indication of the kind-of-quantity with the unit symbol of dimensionless kinds-of-quantity: %(v/v), vol%, ml% or %(V/V) for volume fractions, volume ratios or relative volumes; %(w/w), Gew.%, g% or %(m/m) for mass fractions, mass ratios or relative masses; mol% for substance fractions, substance ratios or relative amounts-of-substance. Such expressions are deprecated. The general rule should be followed that specification of the kind-of-quantity belongs on the left of the relational operator (Clause 4) and should not be confused with the unit of measurement.

A.2 Dimension L

A.2.1 Kinds-of-quantity

Name	**Symbol**	**Authority**
length	l, L	1-3.1
linear coordinates	(x,y,z), x,y,z	-3.9
linear displacement	ξ	7-10
length | of travel; length | of migration; distance travelled or migrated; pathlength; length of path	*d, r, s, l*	1-3.7̃-8
length | of focus; focal distance; focal length	*f*	6-45.3
breadth	*b, y*	1-3.2

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height	*h, z*	1-3.3
depth	*d, -z,*	CQU
radius	*r, R*	1-3.5
radius | of curvature	ρ	1-3.10
radius | of rotation; centrifugal radius	r	CQU
radius| of electron; electron radius	r_e	9-26
diameter	2r	CQU
entitic length	l_1/N_B	CQU
entitic length | of wave;		
wavelength	Λ	2-5; 6-3; 7-5
entitic path | of particles;		
mean free path l,	*ι*, Λ	8-38; 10-39
decrementic length	dl/dln Q	
decrementic length of high-energy particles; mean linear range	R_l	10-21
binary decrementic length; half-thickness	d0,5, d½ = Δl/Δlb φ	10-17
areic volume	V_B/A_1	CQU

NOTE 1 Length is a base quantity of SI.

NOTE 2 For use of wavelength in definition of a radiation, see C.2 and Table C.1.

A.2.2 Units of measurement and constants

SI base unit metre (m)

The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second (17th CGPM 1983, Resolution 1).

Unit or constant		**Value in SI unit**	**Authority**
name	**symbol**		
†nautical mile (int.)	n.mile	= 1 852 m	*CGPM
†(statute) mile	mile, mi	= 1 609,344 m	*EU

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†fathom	ftm, fm	= 1,828 8 m	EU
metre	m	= 1 m	SI
†yard (GB; US)	yd	= 0,914 4 m	EU
†foot (GB; US)	ft	= 0,304 8 m	EU
†inch	in	= 0,025 4 m	EU
†mil (GB; US)	mil	= 0,000 025 4 m	
†micron	µ, u, mu	= 10^{-6} m	˚CGPM
†ångström	Å	= $0{,}1 \cdot 10^{-9}$ m	*CGPM
Bohr radius	a_0	≈ 52,917 724 $9 \cdot 10^{-12}$ m;	9-8;
	uc	= 0,000 002 $4 \cdot 10^{-12}$ m	Codata 1986
†X-unit	XU, X	≈ 100,207 $72 \cdot 10^{-15}$ m	CGPM
electron radius	re	≈ 2,817 940 $92 \cdot 10^{-15}$ m;	9-26
	uc	= 0,000 000 $38 \cdot 10^{-15}$ m	Codata 1986
†fermi	f	= 10-15 m	·CGPM

NOTE The ångström should not be introduced where it is not already in use (BIPM 1991, p.80). It is not mentioned in the European directive.

A.3 Dimension L-1

A.3.1 Kinds-of-quantity

Name	Symbol	Authority
curvature	κ	1-4
vergence	f^{-1}	6-45
lineicnumber	dN/dl	CQU
lineicnumber| of waves | in medium; wavenumber in medium; repetancy	σ	2-6; 6-4; 7-6
lineic number | of waves | in vacuum; wavenumber in vacuum	v	6-3, Remark
lineicnumber of ionizations; linear ionization	$N_{i,l,B}$	10-23

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angular wavenumber; angular repetancy	k	2-7; 6-5; 7-7
lineicdecremence; linear Napierian attenuation coefficient	-dln Q/dl, μ	6-42.1; 10-13
lineic decremence | of sound	α	7-26.1
lineic decremence | to ionizing particles	Σ	10-7
lineic decadic decremence; lineic attenuance	m(λ)	2-13.1; CQU
lineic Napierian absorbance	$\alpha_l(\lambda)$	6-42.2
lineic decadic absorbance; linear decadic absorption coefficient	a_l, a, K	IUPAC; CQU
pH gradient	▼pH	CQU

A.3.2 Units of measurement and constants

SI unit per metre (m^{-1})

SI unit of angular wavenumber radian per metre (rad m^{-1} = m^{-1})

Unit or constant		**Value in SI unit**	**Authority**
name	**symbol**		
per centimetre	cm-1	= 100 m^{-1}	cgs
†kayser	K	= 100 m^{-1}	cgs
†mesh	in-1	≈ 39,370 08 m^{-1}	*GB
per metre	m-1	= 1 m^{-1}	SI
†dioptre	dpt, d	= 1 m^{-1}	*EU
Rydberg constant	R_∞	≈ 109,737 315 34·10-9 m^{-1};	9-9
	uc	= 0,000 000 13·10-9	Codata 1986

NOTE The customary multiple for wavenumber in optical spectroscopy is cm^{-1}.

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A.4 Dimension L2

A.4.1 Kinds-of-quantity

Name	Symbol	Authority
area	A	1-5
effective area | for acoustic absorption	A	7-29
nuclear quadruple moment	Q	9-16
entitic area decremence; atomic Napierian attenuation coefficient; cross-section	μ_{at}, σ	10-3; 10-16
steradic entitic area decremence; angular cross-section	σ_{Ω}	10-4

A.4.2 Units of measurement and constants

SI unit square metre (m^2)

SI unit of steradic entitic area decremence square metre per steradian ($m^2\ sr^{-1} = m^2$)

Unit or constant		Value in SI unit	Authority
name	symbol		
hectare	ha	= 10 000 m^2	*CGPM
†acre	acre, ac	≈ 4 046,856 4 m^2	GB; US
†are	a	= 100 m^2	*CGPM
square metre	m^2	= 1 m^2	SI
†darcy	D	≈ 0,986 923 3·10^{-12} m^2	rheology
†barn	b	= 10^{-28} m^2	*CGPM

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