INTERNATIONAL STANDARD

ISO 31-3

Second edition
1992-09-01

Quantities and units —

Part 3:
Mechanics

Grandeurs et unités —

Partie 3: Mécanique

Reference number
ISO 31-3:1992(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 31-3 was prepared by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors*.

This second edition cancels and replaces the first edition (ISO 31-3:1978). The major technical changes from the first edition are the following:

— the decision by the International Committee for Weights and Measures (Comité International des Poids et Mesures, CIPM) in 1980 concerning the status of supplementary units has been incorporated;

— a number of new items have been added;

— the non-mechanical units watt hour and electronvolt have been deleted from this part of ISO 31 (they have been transferred to ISO 31-5 and ISO 31-9, respectively);

— units in use temporarily have been transferred to the "Conversion factors and remarks" column.

The scope of Technical Committee ISO/TC 12 is standardization of units and symbols for quantities and units (and mathematical symbols) used within the different fields of science and technology, giving, where necessary, definitions of these quantities and units. Standard conversion

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Printed in Switzerland

factors for converting between the various units also come under the scope of the TC. In fulfilment of this responsibility, ISO/TC 12 has prepared ISO 31.

ISO 31 consists of the following parts, under the general title *Quantities and units*:

— *Part 0: General principles*

— *Part 1: Space and time*

— *Part 2: Periodic and related phenomena*

— *Part 3: Mechanics*

— *Part 4: Heat*

— *Part 5: Electricity and magnetism*

— *Part 6: Light and related electromagnetic radiations*

— *Part 7: Acoustics*

— *Part 8: Physical chemistry and molecular physics*

— *Part 9: Atomic and nuclear physics*

— *Part 10: Nuclear reactions and ionizing radiations*

— *Part 11: Mathematical signs and symbols for use in the physical sciences and technology*

— *Part 12: Characteristic numbers*

— *Part 13: Solid state physics*

Annexes A, B and C of this part of ISO 31 are for information only.

Introduction

0.1 Arrangement of the tables

The tables of quantities and units in ISO 31 are arranged so that the quantities are presented on the left-hand pages and the units on the corresponding right-hand pages.

All units between two full lines belong to the quantities between the corresponding full lines on the left-hand pages.

Where the numbering of an item has been changed in the revision of a part of ISO 31, the number in the preceding edition is shown in parentheses on the left-hand page under the new number for the quantity; a dash is used to indicate that the item in question did not appear in the preceding edition.

0.2 Tables of quantities

The most important quantities within the field of this document are given together with their symbols and, in most cases, definitions. These definitions are given merely for identification; they are not intended to be complete.

The vectorial character of some quantities is pointed out, especially when this is needed for the definitions, but no attempt is made to be complete or consistent.

In most cases only one name and only one symbol for the quantity are given; where two or more names or two or more symbols are given for one quantity and no special distinction is made, they are on an equal footing. When two types of italic (sloping) letter exist (for example as with ϑ, θ; φ, ϕ; g, g) only one of these is given. This does not mean that the other is not equally acceptable. In general it is recommended that such variants should not be given different meanings. A symbol within parentheses implies that it is a "reserve symbol", to be used when, in a particular context, the main symbol is in use with a different meaning.

0.3 Tables of units

0.3.1 General

Units for the corresponding quantities are given together with the international symbols and the definitions. For further information, see ISO 31-0.

The units are arranged in the following way:

a) The names of the SI units are given in large print (larger than text size). The SI units have been adopted by the General Conference on Weights and Measures (Conference Générale des Poids et Mesures,

CGPM). The SI units and their decimal multiples and sub-multiples are recommended, although the decimal multiples and sub-multiples are not explicitly mentioned.

b) The names of non-SI units which may be used together with SI units because of their practical importance or because of their use in specialized fields are given in normal print (text size).

These units are separated by a broken line from the SI units for the quantities concerned.

c) The names of non-SI units which may be used temporarily together with SI units are given in small print (smaller than text size) in the "Conversion factors and remarks" column.

d) The names of non-SI units which should not be combined with SI units are given only in annexes in some parts of ISO 31. These annexes are informative and not integral parts of the standard. They are arranged in three groups:

1) special names of units in the CGS system;

2) names of units based on the foot, pound and second and some other related units;

3) names of other units.

0.3.2 Remark on units for quantities of dimension one

The coherent unit for any quantity of dimension one is the number one (1). When the value of such a quantity is expressed, the unit 1 is generally not written out explicitly. Prefixes shall not be used to form multiples or sub-multiples of this unit. Instead of prefixes, powers of 10 may be used.

EXAMPLES

Refractive index $n = 1,53 \times 1 = 1,53$

Reynolds number $Re = 1,32 \times 10^3$

Considering that plane angle is generally expressed as the ratio between two lengths, and solid angle as the ratio between an area and the square of a length, the CIPM specified in 1980 that, in the International System of Units, the radian and steradian are dimensionless derived units. This implies that the quantities plane angle and solid angle are considered as dimensionless derived quantities. The units radian and steradian may be used in expressions for derived units to facilitate distinction between quantities of different nature but having the same dimension.

0.4 Numerical statements

All numbers in the "Definition" column are exact.

When numbers in the "Conversion factors and remarks" column are exact, the word "exactly" is added in parentheses after the number.

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Quantities and units —

Part 3:
Mechanics

1 Scope

This part of ISO 31 gives names and symbols for quantities and units of mechanics. Where appropriate, conversion factors are also given.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 31. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 31 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 31-4:1992, *Quantities and units — Part 4: Heat.*

3 Names and symbols

The names and symbols for quantities and units of mechanics are given on the following pages.

MECHANICS				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
3-1	mass	m		Mass is one of the base quantities on which the SI is based.
3-2	volumic mass, mass density, density	ϱ	Mass divided by volume	
3-3	relative volumic mass, relative mass density, relative density	d	Ratio of the density of a substance to the density of a reference substance under conditions that should be specified for both substances	
3-4	massic volume, specific volume	v	Volume divided by mass. $v = 1/\varrho$	
3-5	lineic mass, linear density	ϱ_l	Mass divided by length	
3-6	areic mass, surface density	ϱ_A, (ϱ_S)	Mass divided by area	
3-7 (*3-9.1*)	moment of inertia	I, J	The moment of inertia of a body about an axis is the sum (integral) of the products of its elements of mass and the squares of their distances from the axis	To be distinguished from 3-20.1 and 3-20.2. If there is a risk of confusion, the symbol J shall be used for the quantity 3-7.
3-8 (*3-7.1*)	momentum	p	Product of mass and velocity	

Units				MECHANICS
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
3-1.a	kilogram	kg	The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram	Names of decimal multiples and sub-multiples of the unit of mass are formed by attaching prefixes to the word "gram" [CIPM (1967)]. $1\ g = 10^{-3}\ kg$
3-1.b	tonne	t	$1\ t = 1\ 000\ kg$	In the English language also called metric ton.
3-2.a	kilogram per cubic metre	kg/m^3		
3-2.b	tonne per cubic metre	t/m^3		In the English language also called metric ton per cubic metre. $1\ t/m^3 = 1\ g/cm^3 = 1\ kg/l = 10^3\ kg/m^3$
3-2.c	kilogram per litre	kg/l		
3-3.a	one	1		See the introduction, subclause 0.3.2.
3-4.a	cubic metre per kilogram	m^3/kg		
3-5.a	kilogram per metre	kg/m		
3-6.a	kilogram per square metre	kg/m^2		
3-7.a	kilogram metre squared	$kg \cdot m^2$		
3-8.a	kilogram metre per second	$kg \cdot m/s$		

MECHANICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
3-9.1 (*3-10.1*)	force	F	The resultant force acting on a body is equal to the derivative with respect to time of the momentum of the body	
3-9.2 (*3-10.2*)	weight	F_g, (G), (P), (W)	The weight of a body in a specified reference system is that force which, when applied to the body, would give it an acceleration equal to the local acceleration of free fall in that reference system	When the reference system is the Earth, the quantity defined here has commonly been called the local force of gravity on the body. It is noteworthy that this weight comprises not only the resultant of the gravitational forces existing at the place where the body is, but also the local centrifugal force due to the rotation of the Earth. The effect of atmospheric buoyancy is excluded, and consequently the weight defined is the weight in vacuum. [See also Comptes rendus, 3rd CGPM (1901), p. 70]. In common parlance, the word "weight" continues to be used to mean mass, but this practice is deprecated.
3-10 (—)	impulse	I	$\boldsymbol{I} = \int \boldsymbol{F}\, dt$	For the time interval $[t_1, t_2]$, $\boldsymbol{I} = \boldsymbol{p}(t_2) - \boldsymbol{p}(t_1)$ where $\boldsymbol{p}$ is momentum.
3-11 (*3-8.1*)	moment of momentum, angular momentum	L	The moment of momentum of a particle about a point is equal to the vector product of the radius vector from this point to the particle and the momentum of the particle. $\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p}$	

Units			MECHANICS (*continued*)	
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
3-9.a	newton	N	$1\ N = 1\ kg \cdot m/s^2$	1 N is that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of $1\ m/s^2$.
3-10.a	newton second	$N \cdot s$		
3-11.a	kilogram metre squared per second	$kg \cdot m^2/s$		