INTERNATIONAL STANDARD

ISO 80000-3

Second edition
2019-10

Quantities and units —

Part 3: **Space and time**

Grandeurs et unités —

Partie 3: Espace et temps

Reference number
ISO 80000-3:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 80000-3:2006), 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.

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.

Quantities and units —

Part 3: Space and time

1 Scope

This document gives names, symbols, definitions and units for quantities of space and time. Where appropriate, conversion factors are also given.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

Names, symbols, definitions and units for quantities of space and time are given in Table 1.

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/

Table 1 — Quantities and units of space and time

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-1.1	length	l, L	linear extent in space between any two points	m	Length does not need to be measured along a straight line. Length is one of the seven base quantities in the International System of Units (ISO 80000-1).
3-1.2	width, breadth	b, B	minimum length of a straight line segment between two parallel straight lines (in two dimensions) or planes (in three dimensions) that enclose a given geometrical shape	m	This quantity is non-negative.
3-1.3	height, depth, altitude	h, H	minimum length of a straight line segment between a point and a reference line or reference surface	m	This quantity is usually signed. The sign expresses the position of the particular point with respect to the reference line or surface and is chosen by convention. The symbol H is often used to denote altitude, i.e. height above sea level.
3-1.4	thickness	d, δ	width (item 3-1.2)	m	This quantity is non-negative.
3-1.5	diameter	d, D	width (item 3-1.2) of a circle, cylinder or sphere	m	This quantity is non-negative.
3-1.6	radius	r, R	half of a diameter (item 3-1.5)	m	This quantity is non-negative.
3-1.7	path length, arc length	s	length of a rectifiable curve between two of its points	m	The differential path length at a given point of a curve is: $\mathrm{d}s = \sqrt{(\mathrm{d}x)^2 + (\mathrm{d}y)^2 + (\mathrm{d}z)^2}$ where x, y, and z denote the Cartesian coordinates (ISO 80000-2) of the particular point. There are curves which are not rectifiable, for example fractal curves.
3-1.8	distance	d, r	shortest path length (item 3-1.7) between two points in a metric space	m	A metric space might be curved. An example of a curved metric space is the surface of the Earth. In this case, distances are measured along great circles. A metric is not necessarily Euclidean.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-1.9	radial distance	r_Q, ρ	distance (item 3-1.8), where one point is located on an axis or within a closed non self-intersecting curve or surface	m	The subscript Q denotes the point from which the radial distance is measured. Examples of closed non self-intersecting curves are circles or ellipses. Examples of closed non self-intersecting surfaces are surfaces of spheres or egg-shaped objects.
3-1.10	position vector	$\boldsymbol{r}$	vector (ISO 80000-2) quantity from the origin of a coordinate system to a point in space	m	Position vectors are so-called bounded vectors, i.e. their magnitude (ISO 80000-2) and direction depend on the particular coordinate system used.
3-1.11	displacement	$\Delta \boldsymbol{r}$	vector (ISO 80000-2) quantity between any two points in space	m	Displacement vectors are so-called free vectors, i.e. their magnitude (ISO 80000-2) and direction do not depend on a particular coordinate system. The magnitude of this vector is also called displacement.
3-1.12	radius of curvature	ρ	radius (item 3-1.6) of the osculating circle of a planar curve at a particular point of the curve	m	The radius of curvature is only defined for curves which are at least twice continuously differentiable.
3-2	curvature	κ	inverse of the radius of curvature (item 3-1.12)	m^{-1}	The curvature is given by: $\kappa = \frac{1}{\rho}$ where ρ denotes the radius of curvature (item 3-1.12).
3-3	area	A, S	extent of a two-dimensional geometrical shape	m^2	The surface element at a given point of a surface is given by: $\mathrm{d}A = g\, \mathrm{d}u\, \mathrm{d}v$ where u and v denote the Gaussian surface coordinates and g denotes the determinant of the metric tensor (ISO 80000-2) at the particular point. The symbol $\mathrm{d}\sigma$ is also used for the surface element.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-4	volume	V, (S)	extent of a three-dimensional geometrical shape	m^3	The volume element in Euclidean space is given by: $dV = dx\, dy\, dz$ where dx, dy, and dz denote the differentials of the Cartesian coordinates (ISO 80000-2). The symbol dτ is also used for the volume element.
3-5	angular measure	α, β, γ	measure of a geometric figure, called plane angle, formed by two rays, called the sides of the plane angle, emanating from a common point, called the vertex of the plane angle	rad 1	The angular measure is given by: $\alpha = \frac{s}{r}$ where s denotes the arc length (item 3-1.7) of the included arc of a circle, centred at the vertex of the plane angle, and r the radius (item 3-1.6) of that circle. Other symbols are also used.
3-6	rotational displacement, angular displacement	ϑ, φ	quotient of the traversed circular path length (item 3-1.7) of a point in space during a rotation and its distance (item 3-1.8) from the axis or centre of rotation	rad 1	The rotational displacement is given by: $\varphi = \frac{s}{r}$ where s denotes the traversed path length (item 3-1.7) along the periphery of a circle, centred at the vertex of the plane angle, and r the radius (item 3-1.6) of that circle. The rotational displacement is signed. The sign denotes the direction of rotation and is chosen by convention. Other symbols are also used.
3-7	phase angle	φ, ϕ	angular measure (item 3-5) between the positive real axis and the radius of the polar representation of the complex number in the complex plane	rad 1	The phase angle (often imprecisely referred to as the "phase") is the argument of a complex number. Other symbols are also used.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-8	solid angular measure	Ω	measure of a conical geometric figure, called solid angle, formed by all rays, originating from a common point, called the vertex of the solid angle, and passing through the points of a closed, non-self-intersecting curve in space considered as the border of a surface	sr 1	The differential solid angular measure expressed in spherical coordinates (ISO 80000-2) is given by: $\mathrm{d}\Omega = \frac{A}{r^2} \sin\vartheta \mathrm{d}\vartheta \mathrm{d}\varphi$ where A is area, r is radius, ϑ and φ are spherical coordinates.
3-9	duration	t	measure of the time difference between two events	s	Duration is often just called time. Time is one of the seven base quantities in the International System of Quantities, ISQ (see ISO 80000-1). Duration is a measure of a time interval.
3-10.1	velocity	$\boldsymbol{v}$, $(\vec{v})$ u, v, w, (u, v, w)	vector (ISO 80000-2) quantity giving the rate of change of a position vector (item 3-1.10)	m s^{-1}	The velocity vector is given by: $\boldsymbol{v} = \frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}t}$ where $\boldsymbol{r}$ denotes the position vector (item 3-1.10) and t the duration (item 3-9). When the general symbol $\boldsymbol{v}$ is not used for the velocity, the symbols u, v, w may be used for the components (ISO 80000-2) of the velocity.
3.10.2	speed	v, (v)	magnitude (ISO 80000-2) of the velocity (item 3.10.1)	m s^{-1}	
3-11	acceleration	$\boldsymbol{a}$	vector (ISO 80000-2) quantity giving the rate of change of velocity (item 3-10)	m s^{-2}	The acceleration vector is given by: $\boldsymbol{a} = \frac{\mathrm{d}\boldsymbol{v}}{\mathrm{d}t}$ where $\boldsymbol{v}$ denotes the velocity (item 3-10.1) and t the duration (item 3-9). The magnitude (ISO 80000-2) of the acceleration of free fall is usually denoted by g.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-12	angular velocity	$\boldsymbol{\omega}$	vector (ISO 80000-2) quantity giving the rate of change of the rotational displacement (item 3-6) as its magnitude (ISO 80000-2) and with a direction equal to the direction of the axis of rotation	rad s^{-1} s^{-1}	The angular velocity vector is given by: $\boldsymbol{\omega}=\frac{d\varphi}{dt}\boldsymbol{u}$ where φ denotes the angular displacement (item 3-6), t the duration (item 3-9), and $\boldsymbol{u}$ the unit vector (ISO 80000-2) along the axis of rotation in the direction for which the rotation corresponds to a right-hand spiral.
3-13	angular acceleration	$\boldsymbol{\alpha}$	vector (ISO 80000-2) quantity giving the rate of change of angular velocity (item 3-12)	rad s^{-2} s^{-2}	The angular acceleration vector is given by: $\boldsymbol{\alpha}=\frac{d\boldsymbol{\omega}}{dt}$ Where $\boldsymbol{\omega}$ denotes the angular velocity (item 3-12) and t the duration (item 3-9).
3-14	period duration, period	T	duration (item 3-9) of one cycle of a periodic event	s	A periodic event is an event that occurs regularly with a fixed time interval.
3-15	time constant	τ, T	parameter characterizing the response to a step input of a first-order, linear time-invariant system	s	If a quantity is a function of the duration (item 3-9) expressed by: $F(t) \propto e^{-t/\tau}$ where t denotes the duration (item 3-9), then τ denotes the time constant. Here the time constant τ applies to an exponentially decaying quantity.
3-16	rotation	N	number of revolutions	1	N is the number (not necessarily an integer) of revolutions, for example, of a rotating body about a given axis. Its value is given by: $N=\frac{\varphi}{2\pi}$ where φ denotes the measure of rotational displacement (item 3-6).

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-17.1	frequency	f, ν	inverse of period duration (item 3-14)	Hz s^{-1}	The frequency is given by: $f = \frac{1}{T}$ where T denotes the period duration (item 3-14).
3-17.2	rotational frequency	n	rate of change of rotation (item 3-16)	s^{-1}	The rotational frequency is given by: $n = \frac{dN}{dt}$ where N denotes the rotation (item 3-16) and t is the duration (item 3-9).
3-18	angular frequency	ω	rate of change of the phase angle (item 3-7)	rad s^{-1} s^{-1}	The angular frequency is given by: $\omega = 2\pi f$ where f denotes the frequency (item 3-17.1).
3-19	wavelength	λ	length (item 3-1.1) of the repetition interval of a wave	m	
3-20	repetency, wavenumber	σ, $\tilde{\nu}$	inverse of the wavelength (item 3-19)	m^{-1}	The repetency is given by: $\sigma = \frac{1}{\lambda}$ where λ denotes the wavelength (item 3-19).
3-21	wave vector	$\boldsymbol{k}$	vector normal to the surfaces of constant phase angle (item 3-7) of a wave, with the magnitude (ISO 80000-2) of repetency (item 3-20)	m^{-1}	
3-22	angular repetency, angular wavenumber	k	magnitude (ISO 80000-2) of the wave vector (item 3-21)	m^{-1}	The angular repetency is given by: $k = \frac{2\pi}{\lambda}$ where λ denotes the wavelength (item 3-19).

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
3-23.1	phase velocity, phase speed	c, v, (υ) c_φ, v_φ, (υ_φ)	speed with which the phase angle (item 3-7) of a wave propagates in space	m s^{-1}	The phase velocity is given by: $c = \frac{\omega}{k}$ where ω denotes the angular frequency (item 3-18) and k the angular repetency (item 3-22). If phase velocities of electromagnetic waves and other phase velocities are both involved, then c should be used for the former and υ for the latter. Phase velocity can also be written as $c = \lambda f$.
3-23.2	group velocity, group speed	c_g, v_g, (υ_g)	speed with which the envelope of a wave propagates in space	m s^{-1}	The group velocity is given by: $c_g = \frac{d\omega}{dk}$ where ω denotes the angular frequency (item 3-18) and k the angular repetency (item 3-22).
3-24	damping coefficient	δ	inverse of the time constant (item 3-15) of an exponentially varying quantity	s^{-1}	
3-25	logarithmic decrement	Λ	product of damping coefficient (item 3-24) and period duration (item 3-14)	1	
3-26.1	attenuation, extinction	α	gradual decrease in magnitude (ISO 80000-2) of any kind of flux through a medium	m^{-1}	If a quantity is a function of distance (item 3-1.8) expressed by: $f(x) \propto e^{-\alpha x}$ where x denotes distance (item 3-1.8), then α denotes attenuation. The inverse of attenuation is called attenuation length.
3-26.2	phase coefficient	β	change of phase angle (item 3-7) with the length (item 3-1.1) along the path travelled by a plane wave	rad m^{-1} m^{-1}	If a quantity is a function of distance expressed by: $f(x) \propto \cos \beta (x - x_0)$ where x denotes distance (item 3-1.8), then β denotes the phase coefficient.