INTERNATIONAL STANDARD

ISO 31-13

Third edition
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Quantities and units —

Part 13: Solid state physics

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Grandeurs et unités —

Partie 13: Physique de l'état solide

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Reference number
ISO 31-13:1992(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.

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International Standard ISO 31-13 was prepared by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors*.

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This third edition cancels and replaces the second edition (ISO 31-13:1981). The major technical changes from the second 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;

— the quantity affinity has been included in the list of quantities;

— the unit ångström, Å, in use temporarily, has 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 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.

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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*

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Annex A forms an integral part of this part of ISO 31.

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.

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0.2 Tables of quantities

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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 (Conférence 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.

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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.

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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.

0.5 Special remark

In this part of ISO 31, vector notation is explicity used for vector quantities.

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Quantities and units —

Part 13:
Solid state physics

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1 Scope

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

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 31. At the time of publication, the editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 31-5:1992, *Quantities and units — Part 5: Electricity and magnetism.*

ISO 31-8:1992, *Quantities and units — Part 8: Physical chemistry and molecular physics.*

ISO 31-10:1992, *Quantities and units — Part 10: Nuclear reactions and ionizing radiations.*

3 Names and symbols

The names and symbols for quantities and units of solid state physics are given on the following pages.

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SOLID STATE PHYSICS				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
13-1.1	lattice vector	$\boldsymbol{R}$, $\boldsymbol{R}_0$, $\boldsymbol{T}$	Translation vector which maps the crystal lattice on itself	
13-1.2	fundamental lattice vector	$\boldsymbol{a}_1$, $\boldsymbol{a}_2$, $\boldsymbol{a}_3$ $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$	Fundamental translation vectors for the crystal lattice	$\boldsymbol{R} = n_1\boldsymbol{a}_1 + n_2\boldsymbol{a}_2 + n_3\boldsymbol{a}_3$ where n_1, n_2 and n_3 are integers.
13-2.1	angular reciprocal lattice vector	$\boldsymbol{G}$	Vector whose scalar products with all fundamental lattice vectors are integral multiples of 2π	In crystallography, however, the quantity $\boldsymbol{G}/(2\pi)$ is commonly used.
13-2.2	fundamental reciprocal lattice vectors	$\boldsymbol{b}_1$, $\boldsymbol{b}_2$, $\boldsymbol{b}_3$ $\boldsymbol{a}^*$, $\boldsymbol{b}^*$, $\boldsymbol{c}^*$	The fundamental translation vectors for the reciprocal lattice	$\boldsymbol{a}_i \cdot \boldsymbol{b}_k = 2\pi\delta_{ik}$ In crystallography, however, the quantities $\boldsymbol{b}_k/(2\pi)$ are also often used.
13-3	lattice plane spacing	d	Distance between successive lattice planes	
13-4	Bragg angle	ϑ	$2d \sin\vartheta = n\lambda$ where λ is the wavelength of the radiation in question and n is an integer	
13-5	order of reflexion	n		
13-6.1	short-range order parameter	σ	Fraction of nearest-neighbour atom pairs in an Ising ferromagnet having parallel magnetic moments, minus the fraction having antiparallel magnetic moments	Similar definitions apply to other order-disorder phenomena.
13-6.2	long-range order parameter	s	Fraction of atoms in an Ising ferromagnet having their magnetic moments directed in one direction, minus the fraction with magnetic moments in the opposition direction	
13-7	Burgers vector	$\boldsymbol{b}$	Vector characterizing a dislocation, i.e. the closing vector in a Burgers circuit encircling a dislocation line	

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Units				SOLID STATE PHYSICS
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
13-1.a	metre	m		ångström (Å), 1 Å = 10^{-10} m
13-2.a	reciprocal metre, metre to the power minus one	m^{-1}		
13-3.a	metre	m		ångström (Å), 1 Å = 10^{-10} m
13-4.a	radian	rad		
13-4.b	degree	°		1° = (π/180) rad = 0,017 453 29 rad
13-5.a	one	1		See the introduction, subclause 0.3.2.
13-6.a	one	1		See the introduction, subclause 0.3.2.
13-7.a	metre	m		ångström (Å), 1 Å = 10^{-10} m

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SOLID STATE PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
13-8.1	particle position vector	$\boldsymbol{r}$, $\boldsymbol{R}$		To distinguish between electron position vectors and ion or atom position vectors, lower case and capital letters are used, respectively.
13-8.2	equilibrium position vector of ion or atom	$\boldsymbol{R}_0$		
13-8.3	displacement vector of ion or atom	$\boldsymbol{u}$	$\boldsymbol{u} = \boldsymbol{R} - \boldsymbol{R}_0$	
13-9	Debye-Waller factor	D	Factor by which the intensity of a diffraction line is reduced because of lattice vibrations	D is sometimes expressed as $\exp(-2W)$; in Mössbauer spectroscopy it is also called the f-factor and denoted by f.
13-10.1	angular repetency, angular wavenumber	k, q	$k = 2\pi/\lambda$ where λ is the wavelength	The corresponding vector quantity $\boldsymbol{k}$ or $\boldsymbol{q}$ is called the propagation vector. When a distinction is needed between k and the symbol for the Boltzmann constant, k_B can be used for the latter. When a distinction is needed between k and q, q should be used for phonons and magnons, and k for particles like electrons and neutrons.
13-10.2	Fermi angular repetency, Fermi angular wavenumber	k_F	Angular repetency of electrons in states on the Fermi sphere	
13-10.3	Debye angular repetency, Debye angular wavenumber	q_D	Cut-off angular repetency in the Debye model of the vibrational spectrum of a solid	The method of cut-off shall be specified.
13-11	Debye angular frequency	ω_D	Cut-off angular frequency in the Debye model of the vibrational spectrum of a solid	The method of cut-off shall be specified.

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Units			SOLID STATE PHYSICS (*continued*)	
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
13-8.a	metre	m		
13-9.a	one	1		See the introduction, subclause 0.3.2.
13-10.a	radian per metre	rad/m		
13-10.b	reciprocal metre, metre to the power minus one	m^{-1}		
13-11.a	radian per second	rad/s		
13-11.b	reciprocal second, second to the power minus one	s^{-1}		

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