INTERNATIONAL STANDARD

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AMENDMENT 1
1998-12-15

Quantities and units —

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 12: Characteristic numbers
Part 13: Solid state physics

AMENDMENT 1

Grandeurs et unités —

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Partie 2: Phénomènes périodiques et connexes
Partie 3: Mécanique
Partie 4: Chaleur
Partie 5: Électricité et magnétisme
Partie 6: Lumière et rayonnements électromagnétiques connexes
Partie 7: Acoustique
Partie 8: Chimie physique et physique moléculaire
Partie 9: Physique atomique et nucléaire
Partie 10: Réactions nucléaires et rayonnements ionisants
Partie 12: Nombres caractéristiques
Partie 13: Physique de l'état solide

AMENDEMENT 1

Reference number
ISO 31 (parts 1 to 10, 12 and 13):1992/Amd.1:1998(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.

Amendment 1 to parts 1 to 10, 12 and 13 of International Standard ISO 31:1992 was prepared by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors.*

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Quantities and units —

Part 1: Space and time
Part 2: Periodic and related phenomena
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Part 4: Heat
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Part 13: Solid state physics

AMENDMENT 1

Page v

Replace subclause 0.3.2 with the following text:

0.3.2 Remark on units for quantities of dimension one

The coherent unit for any quantity of dimension one is the number one, symbol 1. When the value of such a quantity is expressed, the unit symbol 1 is generally not written out explicitly.

EXAMPLE

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

Prefixes shall not be used to form multiples or submultiples of this unit. Instead of prefixes, powers of 10 may be used.

EXAMPLE

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

Considering that plane angle is generally expressed as the ratio of two lengths and solid angle as the ratio of two areas, in 1995 the CGPM has specified that, in the International System of Units, the radian, rad, and the steradian, sr, are "dimensionless" derived units. This implies that the quantities plane angle and solid angle are considered as derived quantities of dimension one. The units radian and steradian may be omitted, or they may be used in expressions for derived units to facilitate distinction between quantities of different nature but having the same dimension.

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Price based on 1 page

INTERNATIONAL STANDARD

ISO 31-13

Third edition
1992-09-01

Quantities and units —

Part 13:
Solid state physics

Grandeurs et unités —

Partie 13: Physique de l'état solide

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.

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

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*

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.

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 (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.

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.

0.5 Special remark

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

Quantities and units —

Part 13:
Solid state physics

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.

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	

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

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.

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}		

SOLID STATE PHYSICS (*continued*) Quantities

Item No.	Quantity	Symbol	Definition	Remarks
13-12	Debye temperature	Θ_D	$k\Theta_D = \hbar\omega_D$ where k is the Boltzmann constant and $\hbar$ is the Planck constant divided by 2π.	$k = (1{,}380\ 658 \pm 0{,}000\ 012) \times 10^{-23}$ J/K [1] $\hbar = (1{,}054\ 572\ 66 \pm 0{,}000\ 000\ 63) \times 10^{-34}$ J · s [1]
13-13	spectral concentration of vibrational modes (in terms of angular frequency)	g, N_ω	Number of vibrational modes in an infinitesimal interval of angular frequency, divided by the size of that interval and by volume	$g(\omega) = N_\omega(\omega) = \frac{dN(\omega)}{d\omega}$ where $N(\omega)$ is the total number of vibrational modes with angular frequency less than ω, divided by volume.
13-14	Grüneisen parameter	γ, Γ	$\gamma = \alpha_V/(\varkappa_T c_V \varrho)$ where α_V is the cubic expansion coefficient, $\varkappa_T$ is the isothermal compressibility, c_V is the massic heat capacity at constant volume and ϱ is the volumic mass	
13-15	Madelung constant	α	For a uni-univalent ionic crystal of specified structure, the electrostatic energy per pair of ions is $E = \alpha \cdot \frac{e^2}{4\pi\varepsilon_0 a}$ where e is the elementary charge, ε_0 is the permittivity of vacuum and a is a lattice constant which should be specified	
13-16.1	mean free path of phonons	l_{ph}, Λ		
13-16.2	mean free path of electrons	l, l_e		

1) CODATA Bulletin 63 (1986).

Units SOLID STATE PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-12.a	kelvin	K		
13-13.a	second per radian cubic metre	$s/(rad \cdot m^3)$		
13-13.b	second per cubic metre	s/m^3		
13-14.a	one	1		See the introduction, subclause 0.3.2.
13-15.a	one	1		See the introduction, subclause 0.3.2.
13-16.a	metre	m		

SOLID STATE PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
13-17	density of states	N_E, ϱ	$\varrho(E) = N_E(E) = \frac{\mathrm{d}N(E)}{\mathrm{d}E}$ where $N(E)$ is the total number of one-electron states with energy less than E, divided by volume	
13-18	residual resistivity	ϱ_R	For metals, the resistivity extrapolated to zero thermodynamic temperature	
13-19	Lorenz coefficient	L	$L = \lambda/\sigma T$ where λ is the thermal conductivity, σ is the electrical conductivity and T is the thermodynamic temperature	
13-20	Hall coefficient	A_H, R_H	In an isotropic conductor, the relation between electric field strength $\boldsymbol{E}$ and current density $\boldsymbol{J}$ is $\boldsymbol{E} = \varrho\boldsymbol{J} + R_H(\boldsymbol{B} \times \boldsymbol{J})$ where ϱ is the resistivity and $\boldsymbol{B}$ is the magnetic flux density	
13-21	thermoelectromotive force between substances a and b	E_{ab}		The positive direction for E_{ab} is from substance a to substance b at the cold junction.
13-22	Seebeck coefficient for substances a and b	S_{ab}, ε_{ab}	$S_{ab} = \frac{\mathrm{d}E_{ab}}{\mathrm{d}T}$ where T is the temperature of the hot junction	$S_{ab} = S_a - S_b$ where S_a is the Seeback coefficient of substance a.
13-23	Peltier coefficient for substances a and b	Π_{ab}	Peltier heat power developed at a junction, divided by the electric current flowing from substance a to substance b	$\Pi_{ab} = \Pi_a - \Pi_b$ where Π_a is the Peltier coefficient of substance a.

Units				SOLID STATE PHYSICS (*continued*)
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
13-17.a	reciprocal joule per cubic metre, joule to the power minus one per cubic metre	J^{-1}/m^3		
13-17.b	reciprocal electronvolt per cubic metre, electronvolt to the power minus one per cubic metre	eV^{-1}/m^3		$1\ eV^{-1}/m^3 = (6{,}241\ 506\ 4 \pm 0{,}000\ 001\ 9) \times 10^{18}\ J^{-1}/m^3$ [1)]
13-18.a	ohm metre	$\Omega \cdot m$		
13-19.a	volt squared per kelvin squared	V^2/K^2		
13-20.a	cubic metre per coulomb	m^3/C		
13-21.a	volt	V		
13-22.a	volt per kelvin	V/K		
13-23.a	volt	V		

1) CODATA Bulletin 63 (1986).

SOLID STATE PHYSICS (*continued*) — Quantities

Item No.	Quantity	Symbol	Definition	Remarks
13-24	Thomson coefficient	μ, τ	Thomson heat power developed divided by the electric current and temperature difference	μ is positive if heat is developed when the temperature decreases in the direction of the electric current.
13-25	work function	Φ	Energy difference between an electron at rest at infinity and an electron at the Fermi level in the interior of a substance	The contact potential difference between substances a and b is given by $V_a - V_b = (\Phi_b - \Phi_a)/e$ where e is the elementary charge.
13-26 (—)	electron affinity	χ	Energy difference between an electron at rest at infinity and an electron at the lowest level of the conduction band in an insulator or semiconductor	
13-27 (*13-26*)	Richardson constant	A	The thermionic emission current density J for a metal is $J = AT^2 \exp(-\Phi/kT)$ where T is the thermodynamic temperature, k is the Boltzmann constant and Φ is the work function	
13-28.1 (*13-27.1*)	Fermi energy	E_F, ε_F	In a metal, the highest energy of occupied states at zero thermodynamic temperature	At $T = 0$, E_F is equal to the chemical potential per electron.
13-28.2 (*13-27.2*)	gap energy	E_g	Difference in energy between lowest level of conduction band and highest level of valence band	
13-28.3 (*13-27.3*)	donor ionization energy	E_d		
13-28.4 (*13-27.4*)	acceptor ionization energy	E_a		

Units — SOLID STATE PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-24.a	volt per kelvin	V/K		
13-25.a	joule	J		
13-25.b	electronvolt	eV		1 eV = (1,602 177 33 ± 0,000 000 49) × 10^{-19} J [1)]

1) CODATA Bulletin 63 (1986).

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-26.a	joule	J		
13-26.b	electronvolt	eV		1 eV = (1,602 177 33 ± 0,000 000 49) × 10^{-19} J [1)]

1) CODATA Bulletin 63 (1986).

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-27.a	ampere per square metre kelvin squared	$A/(m^2 \cdot K^2)$		
13-28.a	joule	J		
13-28.b	electronvolt	eV		1 eV = (1,602 177 33 ± 0,000 000 49) × 10^{-19} J [1)]

1) CODATA Bulletin 63 (1986).

SOLID STATE PHYSICS (*continued*) — Quantities

Item No.	Quantity	Symbol	Definition	Remarks
13-29 (*13-28*)	Fermi temperature	T_F	$T_F = E_F/k$ where k is the Boltzmann constant	
13-30.1 (*13-29.1*)	electron number density, volumic electron number	n	Number density of electrons in conduction band	Subscripts n and p or − and + are often used to denote electrons and holes, respectively. n_n and n_p are also used for electron number densities, and p_n and p_p for hole number densities, in the n-type and p-type regions, respectively, of a p-n junction.
13-30.2 (*13-29.2*)	hole number density, volumic hole number	p	Number density of holes in valence band	
13-30.3 (*13-29.3*)	intrinsic number density, volumic intrinsic number	n_i	$np = n_i^2$	
13-30.4 (*13-29.4*)	donor number density, volumic donor number	n_d, N_d	Number density of donor levels	
13-30.5 (*13-29.5*)	acceptor number density, volumic acceptor number	n_a, N_a	Number density of acceptor levels	
13-31 (*13-30*)	effective mass	m^*		In semiconductors, m_n^* is used for electrons, and m_p^* for holes.
13-32 (*13-31*)	mobility ratio	b	$b = \mu_n/\mu_p$ where μ_n and μ_p are the mobilities of electrons and holes, respectively	For mobility, see ISO 31-10:1992, item No. 10-26.
13-33.1 (*13-32.1*)	relaxation time	τ	Time constant for exponential decay towards equilibrium	For electrons in metals, $\tau = l/v_F$ where l is the mean free path and v_F is the speed of electrons on the Fermi sphere.
13-33.2 (*13-32.2*)	carrier life time	τ, τ_n, τ_p	Time constant for recombination or trapping of minority charge carriers in semiconductors	See remark on 13-30.

Units — SOLID STATE PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-29.a	kelvin	K		
13-30.a	reciprocal cubic metre, metre to the power minus three	m^{-3}		
13-31.a	kilogram	kg		
13-32.a	one	1		See the introduction, subclause 0.3.2.
13-33.a	second	s		

SOLID STATE PHYSICS (*continued*) — Quantities

Item No.	Quantity	Symbol	Definition	Remarks
13-34 (*13-33*)	diffusion length	L, L_n, L_p	$L = \sqrt{D\tau}$ where D is the diffusion coefficient and τ is the life time	See remark on 13-30. For D, see ISO 31-8:1992, item No. 8-39.
13-35 (*13-34*)	exchange integral	J	Interaction energy arising from electron exchange	
13-36.1 (*13-35.1*)	Curie temperature	T_C	Critical temperature of a ferro- or ferrimagnet	T_{cr} is used for critical temperature in general.
13-36.2 (*13-35.2*)	Néel temperature	T_N	Critical temperature of an antiferromagnet	
13-36.3 (*13-35.3*)	superconductor transition temperature	T_c	Critical temperature of a superconductor	
13-37.1 (—)	thermodynamic critical magnetic flux density	B_c	$G_n - G_s = \frac{1}{2}\frac{B_c^2 \cdot V}{\mu_0}$ where G_n and G_s are the Gibbs free energies at zero magnetic flux density in a normal conductor and superconductor, respectively, μ_0 is the permeability of vacuum and V is the volume	In type I superconductors, B_c is the critical magnetic flux density for disappearance of superconductivity. The symbol B_{c3} is used for the critical magnetic flux density for disappearance of surface superconductivity. For the corresponding Gaussian quantities, see ISO 31-5:1992, annex A.
13-37.2 (—)	lower critical magnetic flux density	B_{c1}	For type II superconductors, the threshold magnetic flux density for magnetic flux entering the superconductor	
13-37.3 (—)	upper critical magnetic flux density	B_{c2}	For type II superconductors, the threshold magnetic flux density for disappearance of bulk superconductivity	

Units — SOLID STATE PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-34.a	metre	m		
13-35.a	joule	J		
13-35.b	electronvolt	eV		1 eV = (1,602 177 33 ± 0,000 000 49) × 10^{-19} J [1]
1) CODATA Bulletin 63 (1986).				
13-36.a	kelvin	K		
13-37.a	tesla	T	1 T = 1 Wb/m^2 = 1 $V \cdot s/m^2$	For the Gaussian CGS unit of magnetic flux density, the gauss, see ISO 31-5:1992, annex A.

SOLID STATE PHYSICS (*concluded*) Quantities

Item No.	Quantity	Symbol	Definition	Remarks
13-38 (*13-37*)	superconductor energy gap	Δ		
13-39.1 (*13-38.1*)	London penetration depth	λ_L	If an applied magnetic field is parallel to the plane surface of a semi-infinite superconductor, the field penetrates the superconductor according to the expression $B(x) = B(0)\ \exp(-x/\lambda_L)$ where x is the distance from the surface	
13-39.2 (*13-38.2*)	coherence length	ξ	The distance in a superconductor over which the effect of a perturbation is appreciable	
13-40 (*13-39*)	Landau-Ginzburg number	$\varkappa$	$\varkappa = \lambda_L/(\xi\sqrt{2})$ at $T = 0$	
13-41 (*13-40*)	magnetic flux quantum	Φ_0	$\Phi_0 = h/2e$	$\Phi_0 = (2{,}067\ 834\ 61 \pm 0{,}000\ 000\ 61) \times 10^{-15}$ Wb [1]

1) CODATA Bulletin 63 (1986).

Units — SOLID STATE PHYSICS (*concluded*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
13-38.a	joule	J		
13-38.b	electronvolt	eV		1 eV = (1,602 177 33 ± 0,000 000 49) × 10^{-19} J [1)]
13-39.a	metre	m		
13-40.a	one	1		See the introduction, subclause 0.3.2.
13-41.a	weber	Wb	1 Wb = 1 V · s	For the Gaussian CGS unit of magnetic flux, the maxwell, see ISO 31-5:1992, annex A.

1) CODATA Bulletin 63 (1986).

Annex A
(normative)

Symbols for planes and directions in crystals

Miller indices	h_1, h_2, h_3 or h, k, l
Single plane or set of parallel planes in lattice	(h_1, h_2, h_3) or (h, k, l)
Full set of planes in lattice equivalent by symmetry	$\{h_1, h_2, h_3\}$ or $\{h, k, l\}$
Direction in lattice	$[u, v, w]$
Full set of directions in lattice equivalent by symmetry	$\langle u, v, w \rangle$

NOTES

1 If the letter symbols are replaced by numbers in the bracketed expressions, it is customary to omit the commas.

2 A negative numerical value of h, k or l is commonly indicated by a bar above the number, for example $(\bar{1}10)$.

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Descriptors: international system of units, units of measurement, quantities, symbols, definitions, conversion of units, conversion factor, solid state physics.

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