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 —

Partie 1: Espace et temps
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.*

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

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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
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Part 12: Characteristic numbers
Part 13: Solid state physics

AMENDMENT 1

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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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INTERNATIONAL STANDARD

ISO 31-8

Third edition
1992-12-15

Quantities and units —

Part 8:
Physical chemistry and molecular physics

Grandeurs et unités —

Partie 8: Chimie physique et physique moléculaire

Reference number
ISO 31-8:1992(E)

Foreword

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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 31-8 was prepared by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors.*

This third edition cancels and replaces the second edition (ISO 31-8:1980). 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;

— a number of new items have been added;

— a number of new chemical elements have been added in annex A.

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*

Annexes A, B and C form an integral part of this part of ISO 31.

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 remarks

In this part of ISO 31, symbols for substances are shown as subscripts, for example c_B, w_B, p_B.

Generally it is advisable to put symbols for substances and their states in parentheses on the same line as the main symbol, for example $c(H_2SO_4)$.

The superscript * is used to mean "pure". The superscript $^{\ominus}$ is used to mean "standard".

EXAMPLES

$V_m(K_2SO_4$, 0,1 mol · dm^{-3} in H_2O, 25 °C)
for molar volume.
$C^{\ominus}_{p,m}(H_2O$, g, 298,15 K) = 33,58 J · K^{-1} · mol^{-1}
for standard molar heat capacity at constant pressure.

In an expression such as $\varphi_B = x_B V^*_{m,B} / \Sigma x_A V^*_{m,A}$, where φ_B denotes the volume fraction of a particular substance B in a mixture of substances A, B, C, ..., where x_A denotes the mole fraction of the substance A and $V^*_{m,A}$ the molar volume of the pure substance A, and where all the molar volumes $V^*_{m,A}$, $V^*_{m,B}$, $V^*_{m,C}$, ..., are taken at the same temperature and pressure, the summation on the right-hand side is that over all the substances A, B, C, ..., of which a mixture is composed, so that $\Sigma x_A = 1$.

The names and symbols of the chemical elements are given in annex A.

Quantities and units —

Part 8:
Physical chemistry and molecular physics

1 Scope

This part of ISO 31 gives names and symbols for quantities and units of physical chemistry and molecular 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 31-4:1992, *Quantities and units — Part 4: Heat.*

ISO 31-9:1992, *Quantities and units — Part 9: Atomic and nuclear physics.*

3 Names and symbols

The names and symbols for quantities and units of physical chemistry and molecular physics are given on the following pages.

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS — Quantities

Item No.	Quantity	Symbol	Definition	Remarks
8-1.1	relative atomic mass	A_r	Ratio of the average mass per atom of an element to 1/12 of the mass of an atom of the nuclide ^{12}C	EXAMPLE $A_r(Cl) = 35{,}453$ Formerly called atomic weight.
8-1.2	relative molecular mass	M_r	Ratio of the average mass per molecule or specified entity of a substance to 1/12 of the mass of an atom of the nuclide ^{12}C	Formerly called molecular weight. The relative atomic or molecular mass depends on the nuclidic composition.
8-2	number of molecules or other elementary entities	N	Number of molecules or other elementary entities in a system	
8-3	amount of substance	n, (ν)		Amount of substance is one of the base quantities on which the SI is based. ν may be used as an alternative to n when n is used for number density of particles (see 8-10.1).
8-4	Avogadro constant	L, N_A	Number of molecules divided by amount of substance. $N_A = N/n$	$N_A = (6{,}022\ 136\ 7 \pm 0{,}000\ 003\ 6) \times 10^{23}\ mol^{-1}$ [1]

1) CODATA Bulletin 63 (1986).

Item No.	Quantity	Symbol	Definition	Remarks
8-5	molar mass	M	Mass divided by amount of substance. $M = m/n$	m is the mass of the substance.
8-6	molar volume	V_m	Volume divided by amount of substance. $V_m = V/n$	The molar volume of an ideal gas at 273,15 K and 101,325 kPa is $V_{m,0} = (0{,}022\ 414\ 10 \pm 0{,}000\ 000\ 19)\ m^3/mol$ [1]

1) CODATA Bulletin 63 (1986).

Units				PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
8-1.a	one	1		See the introduction, subclause 0.3.2.
8-2.a	one	1		See the introduction, subclause 0.3.2.
8-3.a	mole	mol	The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0,012 kilogram of carbon 12. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles	The definition applies to unbound atoms of carbon 12, at rest and in their ground state.
8-4.a	reciprocal mole, mole to the power minus one	mol^{-1}		
8-5.a	kilogram per mole	kg/mol		$M = 10^{-3} M_r$ kg/mol = M_r kg/kmol = M_r g/mol where M_r is the relative molecular mass of a substance of definite chemical composition.
8-6.a	cubic metre per mole	m^3/mol		

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
8-7	molar thermodynamic energy	U_{m}	Thermodynamic energy divided by amount of substance. $U_{\mathrm{m}} = U/n$	This quantity is also called molar internal energy. See ISO 31-4. Similar definitions apply to other molar thermodynamic functions, for example H_{m}, A_{m}, G_{m}.
8-8	molar heat capacity	C_{m}	Heat capacity divided by amount of substance. $C_{\mathrm{m}} = C/n$	See ISO 31-4.
8-9	molar entropy	S_{m}	Entropy divided by amount of substance. $S_{\mathrm{m}} = S/n$	See ISO 31-4.
8-10.1	volumic number of molecules (or particles), number density of molecules (or particles)	n	Number of molecules or particles divided by volume. $n = N/V$	
8-10.2	molecular concentration of B	C_{B}	Number of molecules of B divided by the volume of the mixture	
8-11.1	volumic mass, mass density, density	ϱ	Mass divided by volume	
8-11.2	mass concentration of B	ϱ_{B}	Mass of B divided by the volume of the mixture	
8-12	mass fraction of B	w_{B}	Ratio of the mass of B to the mass of the mixture	
8-13	concentration of B, amount-of-substance concentration of B	c_{B}	Amount of substance of B divided by the volume of the mixture	In chemistry also indicated as [B].

Units — PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
8-7.a	joule per mole	J/mol		For the various types of calorie, see ISO 31-4:1992, annex B.
8-8.a	joule per mole kelvin	$J/(mol \cdot K)$		
8-9.a	joule per mole kelvin	$J/(mol \cdot K)$		
8-10.a	reciprocal cubic metre, metre to the power minus three	m^{-3}		
8-11.a	kilogram per cubic metre	kg/m^3		
8-11.b	kilogram per litre	kg/l, kg/L		$1\ kg/l = 10^3\ kg/m^3 = 1\ kg/dm^3$ The symbol L was adopted by the CGPM (1979) as an alternative to l for the litre.
8-12.a	one	1		See the introduction, subclause 0.3.2.
8-13.a	mole per cubic metre	mol/m^3		
8-13.b	mole per litre	mol/l, mol/L		$1\ mol/l = 10^3\ mol/m^3 = 1\ mol/dm^3$

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
8-14.1 (*8-15.1*)	mole fraction of B	x_B, (y_B)	Ratio of the amount of substance of B to the amount of substance of the mixture	Alternative names for these quantities are "amount-of-substance fraction" and "amount-of-substance ratio" respectively.
8-14.2 (*8-15.2*)	mole ratio of solute B	r_B	Ratio of the amount of substance of B to the amount of substance of the solvent substance	For a one-solute solution, $r = x/(1-x)$
8-15 (*8-14.1*)	volume fraction of B	φ_B	For a mixture of substances, $\varphi_B = \frac{x_B V^*_{m,B}}{\Sigma x_A V^*_{m,A}}$ where the $V^*_{m,A}$ are the molar volumes of the pure substances A at the same temperature and pressure and where Σ denotes summation over all the substances	An alternative definition in which the molar volumes $V^*_{m,A}$ of the pure substances A are replaced by the partial molar volumes $(\partial V/\partial n_A)_{T,p,n_B,...}$ of the substances A is also used.
8-16	molality of solute B	b_B, m_B	Amount of substance of solute B in a solution divided by the mass of the solvent	
8-17	chemical potential of B	μ_B	For a mixture of substances B, C, ..., $\mu_B = (\partial G/\partial n_B)_{T,p,n_C,...}$ where n_B is the amount of substance of B and G is the Gibbs function	For a pure substance, $\mu = G/n = G_m$ where G_m is the molar Gibbs function. The symbol μ is also used for the quantity G_m/N_A, where N_A is the Avogadro constant.
8-18	absolute activity of B	λ_B	$\lambda_B = \exp(\mu_B/RT)$	For R, see 8-36. T is the thermodynamic temperature.
8-19	partial pressure of B (in a gaseous mixture)	p_B	For a gaseous mixture, $p_B = x_B \cdot p$ where p is the pressure	
8-20	fugacity of B (in a gaseous mixture)	$\tilde{p}_B$, (f_B)	For a gaseous mixture, $\tilde{p}_B$ is proportional to the absolute activity λ_B, the proportionality factor, which is a function of temperature only, being determined by the condition that at constant temperature and composition $\tilde{p}_B/p_B$ tends to 1 for an infinitely dilute gas	$\tilde{p}_B = \lambda_B \cdot \lim_{p \to 0} (x_B p/\lambda_B)$

Units			PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)	
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
8-14.a	one	1		See the introduction, subclause 0.3.2.
8-15.a	one	1		See the introduction, subclause 0.3.2.
8-16.a	mole per kilogram	mol/kg		
8-17.a	joule per mole	J/mol		
8-18.a	one	1		See the introduction, subclause 0.3.2.
8-19.a	pascal	Pa		
8-20.a	pascal	Pa		

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
8-21	standard absolute activity of B (in a gaseous mixture)	$\lambda_B^\ominus$	$\lambda_B^\ominus = (p^\ominus / x_B) \cdot \lim_{p \to 0} (\lambda_B / p)$ where $p^\ominus$ is a standard pressure, usually 101,325 kPa	This quantity is a function of temperature only.
8-22.1	activity coefficient of B (in a liquid or a solid mixture)	f_B	For a liquid mixture, $f_B = \lambda_B / (\lambda_B^* x_B)$ where λ_B^* is the absolute activity of the pure substance B at the same temperature and pressure	The name "activity factor" would be more systematic.
8-22.2	standard absolute activity of B (in a liquid or a solid mixture)	$\lambda_B^\ominus$	$\lambda_B^\ominus = \lambda_B^*(p^\ominus)$	This quantity is a function of temperature only.
8-23	activity of solute B, relative activity of solute B (especially in a dilute liquid solution)	a_B, $a_{m,B}$	For a solute B in a solution, a_B is proportional to the absolute activity λ_B, the proportionality factor, which is a function of temperature and pressure only, being determined by the condition that at constant temperature and pressure a_B divided by the molality ratio $m_B/m^\ominus$ tends to 1 at infinite dilution; $m^\ominus$ is a standard molality, usually 1 mol/kg	$a_B = \lambda_B \cdot \lim_{\Sigma m_A \to 0} \frac{m_B/m^\ominus}{\lambda_B}$ The quantity $a_{c,B}$ similarly defined in terms of the concentration ratio $c_B/c^\ominus$ is also called the activity or relative activity of solute B; $c^\ominus$ is a standard concentration, usually 1 mol/dm³. $a_{c,B} = \lambda_B \cdot \lim_{\Sigma c_A \to 0} \frac{c_B/c^\ominus}{\lambda_B}$ where Σ denotes summation over all the solute substances. The subscript c in $a_{c,B}$ is often omitted.

Units			PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)	
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
8-21.a	one	1		See the introduction, subclause 0.3.2.
8-22.a	one	1		See the introduction, subclause 0.3.2.
8-23.a	one	1		See the introduction, subclause 0.3.2.

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
8-24.1	activity coefficient of solute B (especially in a dilute liquid solution)	γ_B	For a solute in a solution, $\gamma_B = \frac{a_B}{m_B/m^\ominus}$	The name activity coefficient of solute B is also used for the quantity y_B defined as $y_B = \frac{a_{c,B}}{c_B/c^\ominus}$ See item 8-23. The name "activity factor" would be more systematic.
8-24.2	standard absolute activity of solute B (especially in a dilute liquid solution)	$\lambda_B^\ominus$	For a solute B in a solution, $\lambda_B^\ominus = \lim_{\Sigma m_B \to 0} [\lambda_B(p^\ominus) m^\ominus / m_B]$ where Σ denotes summation over all solutes	This quantity is a function of temperature only.
8-25.1	activity of solvent A, relative activity of solvent A (especially in a dilute liquid solution)	a_A	For the solvent A in a solution, a_A is equal to the ratio of the absolute activity λ_A to that, λ_A^*, of the pure solvent at the same temperature and pressure	$a_A = \lambda_A / \lambda_A^*$
8-25.2	osmotic coefficient of solvent A (especially in a dilute liquid solution)	φ	$\varphi = -(M_A \Sigma m_B)^{-1} \ln a_A$ where M_A is the molar mass of the solvent A and where Σ denotes summation over all the solutes	The name "osmotic factor" would be more systematic.
8-25.3	standard absolute activity of solvent A (especially in a dilute liquid solution)	$\lambda_A^\ominus$	For the solvent A in a solution, $\lambda_A^\ominus = \lambda_A^*(p^\ominus)$	This quantity is a function of temperature only.
8-26	osmotic pressure	Π	Excess pressure required to maintain osmotic equilibrium between a solution and the pure solvent separated by a membrane permeable only to the solvent	
8-27	stoichiometric number of B	ν_B	Numbers or simple fractions occurring in the expression for a chemical reaction: $0 = \Sigma \nu_B B$, where the symbol B indicates the molecules, atoms or ions involved in the reaction	By convention, the stoichiometric numbers for reactants are negative and those for products are positive.

Units — PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)

Item No.	Name of unit	International symbol for unit	Definition	Conversion factors and remarks
8-24.a	one	1		See the introduction, subclause 0.3.2.
8-25.a	one	1		See the introduction, subclause 0.3.2.
8-26.a	pascal	Pa		
8-27.a	one	1		See the introduction, subclause 0.3.2.

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*) Quantities

Item No.	Quantity	Symbol	Definition	Remarks
8-28	affinity (of a chemical reaction)	A	$A = -\Sigma \nu_B \mu_B$	If A is used as symbol for Helmholtz free energy, an italic bold-face $\boldsymbol{A}$, sans serif A or script $\mathscr{A}$ is often used as symbol for affinity.
8-29 (—)	extent of reaction	ξ	$dn_B = \nu_B\, d\xi$ where n_B is the amount of substance of B	
8-30 (*8-29.1*)	standard equilibrium constant	$K^\ominus$	For a chemical reaction, $K^\ominus$ is the product $\prod_B \left(\lambda_B^\ominus\right)^{-\nu_B}$	This quantity is a function of temperature only. Other "equilibrium constants" depend on temperature and pressure. EXAMPLES $K_f = \prod_B (f_B)^{\nu_B}$ for gases, $K_{xf} = \prod_B (x_B f_B)^{\nu_B}$ for mixtures and $K_a = \prod_B (a_B)^{\nu_B}$ for solutions. Others depend on temperature, pressure and composition. EXAMPLES $K_p = \prod_B (p_B)^{\nu_B}$ for gases, $K_x = \prod_B (x_B)^{\nu_B}$ for mixtures and $K_m = \prod_B (m_B)^{\nu_B}$ or $K_c = \prod_B (c_B)^{\nu_B}$ for solutions. Some of them (K_f, K_p, K_m, K_c) are not always of dimension one (dimensionless). Similarly, the standard "solubility product" of a solution saturated by an electrolyte C_xA_y is the quantity of dimension one $K^\ominus = x^x y^y \left(m\gamma/m^\ominus\right)^{x+y}$ where m is the molality and γ the activity coefficient of C_xA_y in the solution, and $m^\ominus$ is a standard molality, usually 1 mol/kg.
8-31 (*8-30.1*)	mass of molecule	m		$m = M_r\, m_u$ where m_u is the (unified) atomic mass constant. For m_u see ISO 31-9.

Units			PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)	
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
8-28.a	joule per mole	J/mol		
8-29.a	mole	mol		
8-30.a	one	1		See the introduction, subclause 0.3.2.
8-31.a	kilogram	kg		
8-31.b	unified atomic mass unit	u	$1\ \text{u} = m(^{12}\text{C})/12$	$1\ \text{u} = (1{,}660\ 540\ 2 \pm 0{,}000\ 001\ 0) \times 10^{-27}\ \text{kg}$ [1)] See ISO 31-9.

1) CODATA Bulletin 63 (1986).

PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)				Quantities
Item No.	**Quantity**	**Symbol**	**Definition**	**Remarks**
8-32 (*8-31.1*)	electric dipole moment of molecule	p, μ	Vector quantity, the vector product of which with the electric field strength is equal to the torque. $\boldsymbol{p} \times \boldsymbol{E} = \boldsymbol{T}$	
8-33 (*8-32.1*)	electric polarizability of molecule	α	Induced electric dipole moment divided by electric field strength	γ is also used.
8-34.1 (*8-33.1*)	microcanonical partition function	Ω	$\Omega = \Sigma_r 1$ where the sum is over all quantum states consistent with given energy, volume, external fields and content	$S = k \ln \Omega$ where S is the entropy.
8-34.2 (*8-33.2*)	canonical partition function	Q, Z	$Z = \Sigma_r \exp(-E_r/kT)$ where the sum is over all quantum states consistent with given volume, external fields and content, and where E_r is the energy of the rth quantum state	For k see 8-37. $A = -kT \ln Z$ where A is the Helmholtz free energy.
8-34.3 (*8-33.3*)	grand-canonical partition function, grand partition function	Ξ	$\Xi = \sum_{N_A, N_B, \ldots} Z(N_A, N_B, \ldots) \cdot \lambda_A^{N_A} \cdot \lambda_B^{N_B} \cdot \ldots$ where $Z(N_A, N_B, \ldots)$ is the canonical partition function for given numbers of particles A, B, ..., and $\lambda_A, \lambda_B, \ldots$, are the absolute activities of particles A, B, ...	$A - \Sigma \mu_B n_B = -kT \ln \Xi$ where μ_B is the chemical potential of B.
8-34.4 (*8-33.4*)	molecular partition function, partition function of a molecule	q	$q = \Sigma_i \exp(-\varepsilon_i/kT)$ where ε_i is the energy of the ith allowed quantum state of the molecule consistent with given volume and external fields	
8-35 (*8-34.1*)	statistical weight	g	Multiplicity (degeneracy) of quantum energy level	

Units	PHYSICAL CHEMISTRY AND MOLECULAR PHYSICS (*continued*)			
Item No.	**Name of unit**	**International symbol for unit**	**Definition**	**Conversion factors and remarks**
8-32.a	coulomb metre	C · m		The Gaussian CGS unit of electric dipole moment of a molecule corresponds to $3{,}335\ 641 \times 10^{-12}$ C · m
8-33.a	coulomb metre squared per volt	$C \cdot m^2/V$		The Gaussian CGS unit of polarizability of a molecule equal to 1 cm^3 corresponds to $1{,}112\ 650 \times 10^{-16}$ $C \cdot m^2/V$
8-34.a	one	1		See the introduction, subclause 0.3.2.
8-35.a	one	1		See the introduction, subclause 0.3.2.