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Part 9:
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Partie 9: Chimie physique et physique moléculaire

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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 80000-9:2009), which has been technically revised. It also incorporates the Amendment ISO 80000-9:2009/Amd. 1:2011.

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.

Introduction

In this document, symbols for substances are shown as subscripts, for example c_B, w_B, p_B for substance 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 $c(\mathrm{H_2SO_4})$.

In the following, the letter s is used to denote the solid state, the letter l the liquid state, and the letter g the gaseous state.

The symbol * used as a superscript means "pure".

The plimsoll sign $^\ominus$ is used to denote a standard in general.

EXAMPLE 1 $\mu_\mathrm{B}^*(T,p)$ for chemical potential of pure substance B concerning a mixture system including the substance B.

EXAMPLE 2 $C_{\mathrm{m},p}^\ominus(\mathrm{H_2O, g}, 298{,}15\ \mathrm{K}) = 33{,}58\ \mathrm{J \cdot K^{-1} \cdot mol^{-1}}$ for standard molar heat capacity at constant pressure.

In an expression such as

$$\varphi_\mathrm{B} = x_\mathrm{B} \frac{V_\mathrm{m,B}}{\sum x_i V_{\mathrm{m},i}}$$

where

φ_B is the volume fraction of a particular substance B in a mixture of substances A, B, C, ...;

x_i is the amount-of-substance fraction of i; and

$V_{\mathrm{m},i}$ is the molar volume of the pure substance i, where all the molar volumes $V_\mathrm{m,A}$, $V_\mathrm{m,B}$, $V_\mathrm{m,C}$, ... 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 $\sum x_i = 1$. Throughout the document sums are running over the respective index.

Additional qualifying information on a quantity symbol may be added as a subscript or superscript (see e.g. item 9-21) or in parentheses after the symbol.

Quantities and units —

Part 9:
Physical chemistry and molecular physics

1 Scope

This document gives names, symbols, definitions and units for quantities of physical chemistry and molecular physics. 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 used in physical chemistry and molecular physics 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 used in physical chemistry and molecular physics

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-1	number of entities	$N(\mathrm{X})$, N_X	number of elementary entities of kind X in a system	1	The elementary entities must be specified and can be atoms, molecules, ions, electrons, other particle, or a specified group of such particles. It is important to always give a precise specification of the entity involved; this should preferably be done by the empirical chemical formula of the material involved.
9-2	amount of substance DEPRECATED: number of moles	$n(\mathrm{X})$	quotient of number N of specified elementary entities of kind X (item 9-1) in a sample, and the Avogadro constant N_A (ISO 80000-1): $n(\mathrm{X})=N(\mathrm{X})/N_\mathrm{A}$	mol	Amount of substance is one of the seven base quantities in the International System of Quantities, ISQ (see ISO 80000-1). Elementary entities, such as molecules, atoms, ions, electrons, holes and other quasi-particles, double bonds can be used. It is necessary to specify precisely the entity involved, e.g. atoms of hydrogen H vs. molecules of hydrogen H_2, preferably by giving the molecular chemical formula of the material involved. In the name "amount of substance", the words "of substance" could be replaced by words specifying the substance concerned, e.g. "amount of hydrogen chloride, HCl", or "amount of benzene, C_6H_6". The name "number of moles" is often used for "amount of substance", but this is deprecated because the name of a quantity should be distinguished from the name of the unit.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-3	relative atomic mass	$A_r(X)$	quotient of the average mass (ISO 80000-4) of atom X and the unified atomic mass (ISO 80000-10)	1	A similar quantity "relative molecular mass" can be defined for molecules. EXAMPLE $A_r(Cl) \approx 35{,}453$, $A_r(CO_2) \approx 44$. The relative atomic or relative molecular mass depends on the nuclidic composition. The International Union of Pure and Applied Chemistry (IUPAC) accepts the use of the special names "atomic weight" and "molecular weight" for the quantities "relative atomic mass" and "relative molecular mass", respectively. The use of these traditional names is deprecated.
9-4	molar mass	$M(X)$	for a pure substance X, quotient of mass $m(X)$ (ISO 80000-4) and amount n of substance (item 9-2): $M = m/n$	g/mol kg mol^{-1}	
9-5	molar volume	V_m	for a pure substance, quotient of its volume V (ISO 80000−3) and amount n of substance (item 9-2): $V_m = V/n$	m^3 mol^{-1}	
9-6.1	molar internal energy	U_m	quotient of internal energy U (ISO 80000-5) and amount n of substance (item 9-2): $U_m = U/n$	J/mol kg m^2 s^{-2} mol^{-1}	Molar quantities are normally only used with reference to pure substances.
9-6.2	molar enthalpy	H_m	quotient of enthalpy H (ISO 80000-5) and amount n of substance (item 9-2): $H_m = H/n$	J/mol kg m^2 s^{-2} mol^{-1}	Molar quantities are normally only used with reference to pure substances.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-6.3	molar Helmholtz energy	F_m	quotient of the Helmholtz energy F (ISO 80000-5) and amount n of substance (item 9-2): $F_m = F/n$	J/mol kg m^2 s^{-2} mol^{-1}	Molar quantities are normally only used with reference to pure substances.
9-6.4	molar Gibbs energy	G_m	quotient of the Gibbs energy G (ISO 80000-5) and amount n of substance (item 9-2): $G_m = G/n$	J/mol kg m^2 s^{-2} mol^{-1}	Molar quantities are normally only used with reference to pure substances.
9-7	molar heat capacity	C_m	quotient of heat capacity C (ISO 80000-5) and amount of substance n (item 9-2): $C_m = C/n$	J/(mol K) kg m^2 s^{-2} K^{-1} mol^{-1}	Conditions (constant pressure or volume etc.) must be specified.
9-8	molar entropy	S_m	quotient of entropy S (ISO 80000-5) and amount n of substance (item 9-2): $S_m = S/n$	J/(mol K) kg m^2 s^{-2} K^{-1} mol^{-1}	Conditions (constant pressure or volume etc.) must be specified.
9-9.1	particle concentration	n, (C)	quotient of number N of particles (item 9-1) and volume V (ISO 80000–3): $n = N/V$	m^{-3}	The term “number density” is also used.
9-9.2	molecular concentration	$C(\mathrm{X})$, C_X	for substance X in a mixture, quotient of number N_X of molecules of substance X and volume V (ISO 80000–3) of the mixture: $C_\mathrm{X} = N_\mathrm{X}/V$	m^{-3}	
9-10	mass concentration	γ_X, (ρ_X)	for substance X in a mixture, quotient of mass m_X (ISO 80000-4) of substance X and volume V (ISO 80000–3) of the mixture: $\gamma_\mathrm{X} = m_\mathrm{X}/V$	g/l kg m^{-3}	Decided by the 16th CGPM (1979), both “l” and “L” are allowed for the symbols for the litre.
9-11	mass fraction	w_X	for substance X in a mixture, quotient of mass m_X (ISO 80000-4) of substance X and total mass m of the mixture: $w_\mathrm{X} = m_\mathrm{X}/m$	1	

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-12.1	amount-of-substance concentration	c_X	for substance X in a mixture, quotient of amount n_X of substance (item 9-2) of X and volume V (ISO 80000−3) of the mixture: $c_X = n_X / V$	mol/l mol m^{-3}	In chemistry, the name “amount-of-substance concentration” is generally abbreviated to the single word “concentration”, it being assumed that the adjective “amount-of-substance” is intended. For this reason, however, the word “mass” should never be omitted from the name “mass concentration” in item 9-10. Decided by the 16th CGPM (1979), both “l” and “L” are allowed for the symbols for the litre.
9-12.2	standard amount-of-substance concentration	$c^{\ominus}(X)$	for substance X, one mole per litre	mol/l mol m^{-3}	Decided by the 16th CGPM (1979), both “l” and “L” are allowed for the symbols for the litre.
9-13	amount-of-substance fraction mole fraction	x_X, y_X	for substance X in a mixture, quotient of amount of substance n_X (item 9-2) of X and total amount n of substance (item 9-2) in the mixture: $x_X = n_X / n$	1	For condensed phases, x_X is used, and for gaseous mixtures y_X may be used. The unsystematic name “mole fraction” is still used. However, the use of this name is deprecated. For this quantity, the entity used to define the amount of substance should always be a single molecule for every species in the mixture.
9-14	volume fraction	φ_X	for substance X, quotient of product of amount of substance fraction x_X (item 9-13) of X and molar volume $V_{m,X}$ (item 9-5) of the pure substance X at the same temperature (ISO 80000-5) and pressure(ISO 80000-4), and sum over all substances i of products of amount-of-substance fractions x_i (item 9-13) of substance i and their molar volumes $V_{m,i}$ (item 9-5): $\varphi_X = \frac{x_X V_{m,X}}{\sum_i x_i V_{m,i}}$	ml/l 1	Generally, the volume fraction is temperature dependent. Decided by the 16th CGPM (1979), both “l” and “L” are allowed for the symbols for the litre.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-15	molality	b_B, m_B	quotient of amount of substance (item 9-2) of solute B and mass m_A (ISO 80000-4) of the solvent substance A $b_B = n_B/m_A$	mol/kg	The alternative symbol m_B should be avoided in situations where it might be mistaken for the mass of substance B. However, the symbol m_B is much more commonly used than the symbol b_B for molality, despite the possible confusion with mass.
9-16	latent heat of phase transition, enthalpy of phase transition	C_{pt}	energy (ISO 80000-5) necessary to be added or subtracted isothermally and isobarically to a system to completely undergo the phase transition	J kg m^2 s^{-2}	Mostly, molar or specific quantity is used and phase transition is expressed explicitly, e.g. molar latent heat of evaporation. The subscript “pt” is the qualifier for the phase transition, which may be changed to e.g. “l-g”. The term “enthalpy of phase transition” is mainly used in theory.
9-17	chemical potential <chemistry>	μ_X	partial derivative of the Gibbs energy (ISO 80000-5) with respect to amount n_X of substance X (item 9-2) at constant temperature T (ISO 80000-5) and pressure p (ISO 80000-4): $\mu_X = (\partial G/\partial n_X)_{T,p}$	J/mol kg m^2 s^{-2} mol^{-1}	For a pure substance, where G_m is the molar Gibbs energy. In a mixture, μ_B is the partial molar Gibbs energy. In condensed matter physics, the chemical potential of electrons is energy.
9-18	absolute activity	λ_X	for substance X, exponential of quotient of chemical potential μ_X of substance B (item 9-17), and product of molar gas constant R (item 9-37.1) and thermodynamic temperature T (ISO 80000-5): $\lambda_X = \exp\left(\frac{\mu_X}{RT}\right)$	1	
9-19	partial pressure	p_X	for substance X in a gaseous mixture, product of amount-of-substance fraction y_X of substance X (item 9-13) and total pressure p (ISO 80000-4): $p_X = y_X p$	Pa kg m^{-1} s^{-2}	

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-20	fugacity	$\tilde{p}_X$	for substance X, quantity proportional to the absolute activity, λ_X (item 9-18), the proportionality factor, which is a function of temperature (ISO 80000-5) only, being determined by the condition that, at constant temperature and composition, $p_X / \tilde{p}_X$ tends to 1 for an indefinitely dilute gas	Pa kg m^{-1} s^{-2}	$\tilde{p}_X = \lambda_X \cdot \lim_{p \to 0} (p_X / \lambda_X)$ where p is total pressure (ISO 80000-4). The IUPAC preferred symbol for fugacity is f.
9-21	standard chemical potential	$\mu_B^\ominus$, $\mu^\ominus$	for substance B, value of the chemical potential (item 9-17) at specified standard conditions	J/mol kg m^2 s^{-2} mol^{-1}	$\mu_B^\ominus = RT \ln \lambda^\ominus$ where $\mu_B^\ominus$ is a function of temperature T at the standard pressure $p = p^\ominus$. The standard chemical potential depends on the choice of standard state, which must be specified. In a liquid or solid solution, the standard state is referenced to the ideal dilute behaviour of the solute (substance B).
9-22	activity factor	f_X	for substance X in a liquid or a solid mixture, quotient of absolute activity λ_X (item 9-18) of substance X and the product of absolute activity λ_X^* of the pure substance X at the same temperature (ISO 80000-5) and pressure (ISO 80000-4) and amount-of-substance fraction x_X of substance X (item 9-13): $f_X = \lambda_X / (\lambda_X^* x_X)$	1	The systematic name is “activity factor”, but the name “activity coefficient” is also commonly used (see item 9-25). Activity factors can also be obtained applying Raoult’s law or Henry’s law.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-23	standard absolute activity <in a mixture>	$\lambda_X^{\ominus}$	for substance X in a liquid or a solid mixture, absolute activity λ_X^* (item 9-18) of the pure substance X at the same temperature (ISO 80000-5) but at standard pressure (ISO 80000-4) 10^5 Pa: $\lambda_X^{\ominus} = \lambda_X^*(p^{\ominus})$	1	This quantity is a function of temperature only.
9-24	activity of solute, relative activity of solute	a_X, $a_{m,X}$	for a solute X in a solution, quantity proportional to the absolute activity, λ_X (item 9-18), the proportionality factor, which is a function of temperature (ISO 80000-5) and pressure (ISO 80000-4) only, being determined by the condition that, at constant temperature and pressure, a_X divided by the molality (item 9-15) ratio, $b_X/b^{\ominus}$, tends to 1 at infinite dilution; b_X is the molality of solute X (item 9-15), and $b^{\ominus}$ is standard molality: $a_X = \lambda_X \cdot \lim_{\sum b_X \to 0} \frac{b_X/b^{\ominus}}{\lambda_X}$	1	The quantity $a_{c,X}$, similarly defined in terms of the concentration ratio $c_X/c^{\ominus}$, is also called the activity or relative activity of solute X; $c^{\ominus}$ is a standard amount-of-substance concentration (item 9-12.2): $a_{c,X} = \lambda_X \cdot \lim_{\sum c_X \to 0} \frac{c_X/c^{\ominus}}{\lambda_X}$ where $\sum$ denotes summation over all the solute substances. This especially applies to a dilute liquid solution.
9-25	activity coefficient	γ_B	for a solute B in a solution, quotient of activity a_B of solute B (item 9-24), and quotient of the molality (item 9-15) b_B of substance B and standard molality $b^{\ominus}$: $\gamma_B = \frac{a_B}{b_B/b^{\ominus}}$	1	The name "activity coefficient of solute B" is also used for the quantity γ_B defined as: $\gamma_B = \frac{a_{c,B}}{c_B/c^{\ominus}}$ See item 9-22.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-26	standard absolute activity <in a solution>	$\lambda_B^\ominus$	for a solute B in a solution: $\lambda_B^\ominus = \lim_{\sum b_B \to 0} \left[\lambda_B \frac{(p^\ominus) b^\ominus}{b_B} \right]$ where $\sum$ denotes summation over all solutes, $p^\ominus$ is a standard pressure (ISO 80000-4), $b^\ominus$ is standard molality, and b_B is the molality of substance B (item 9-15)	1	This quantity is a function of temperature only. It especially applies to a dilute liquid solution. The standard pressure is 10^5 Pa.
9-27.1	activity of solvent, relative activity of solvent	a_A	for the solvent A in a solution, quotient of the absolute activity of substance A, λ_A (item 9-18), and that, λ_A^*, of the pure solvent at the same temperature (ISO 80000-5) and pressure (ISO 80000-4): $a_A = \lambda_A / \lambda_A^*$	1	
9-27.2	osmotic factor of solvent, osmotic coefficient of solvent A	φ	quantity given by: $\varphi = -(M_A \sum b_B)^{-1} \ln a_A$ where M_A is the molar mass (item 9-4) of the solvent A, $\sum$ denotes summation over all the solutes, b_B is the molality of solute B (item 9-15), and a_A is the activity of solvent A (item 9-27.1)		The name "osmotic coefficient" is generally used, although the name "osmotic factor" is more systematic. This concept especially applies to a dilute liquid solution.
9-27.3	standard absolute activity of solvent <in a dilute solution>	$\lambda_A^\ominus$	for solvent A, standard absolute activity (item 9-23) of the pure substance A at the same temperature (ISO 80000-5) and at a standard pressure $p^\ominus$ (ISO 80000-4): $\lambda_A^\ominus = \lambda_A^* p^\ominus$		
9-28	osmotic pressure	Π	excess pressure (ISO 80000-4) required to maintain osmotic equilibrium between a solution and the pure solvent separated by a membrane permeable to the solvent only	Pa $kg\ m^{-1}\ s^{-2}$	

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-29	stoichiometric number of substance	ν_B	for substance B, an integer number or a simple fraction, being negative for a reactant and positive for a product, occurring in the expression for a chemical reaction: $0=\sum \nu_B$ where the symbol B denotes the reactants and products involved in the reaction	1	EXAMPLE $(1/2)N_2 + (3/2)H_2 = NH_3$ ν $(N_2) = -1/2$, ν $(H_2) = -3/2$, ν $(NH_3) = +1$.
9-30	affinity of a chemical reaction	A	negative of the sum over all substances B of products of stoichiometric number ν_B of substance B (item 9-29) and chemical potential μ_B of substance B (item 9-17): $A=-\sum \nu_B \mu_B$	J/mol kg m^2 s^{-2} mol^{-1}	The affinity of a reaction is a measure of the “driving force” of the reaction. When it is positive, the reaction goes spontaneously from reactants to products, and when it is negative, the reaction goes in the opposite direction. Another way to write the definition is: $A=(\partial G/\partial \xi)_{p,T}$ where G is Gibbs energy (ISO 80000-5) and ξ is the extent of the reaction (item 9-31). Note that ν_B is negative for reactants and positive for products.
9-31	extent of reaction	ξ	difference of initial amount $n_{B\,in}$ of substance B (item 9-2) and equilibrium amount $n_{B\,eq}$ of substance B (item 9-2) divided by stoichiometric number ν_B of substance B (item 9-29): $\xi=\frac{n_{B\,eq}-n_{B\,in}}{\nu_B}$	mol	See remark to item 9-30.
9-32	standard equilibrium constant, thermodynamic equilibrium constant	$K^{\ominus}$	for a chemical reaction, product for all substances B of standard absolute activity $\lambda_B^{\ominus}$ of substance B (item 9-26) in power of minus stoichiometric number ν_B of substance B (item 9-29): $K^{\ominus}=\Pi_B\left(\lambda_B^{\ominus}\right)^{-\nu_B}$	1	This quantity is a function of temperature only. Others depend on temperature, pressure, and composition. One can define in an analogous way an equilibrium constant in terms of fugacity, K_f, molality, K_m, etc.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-33	equilibrium constant <pressure basis>	K_p	for gases, product for all substances B of partial pressure p_B of substance B (item 9-19) in power of its stoichiometric number ν_B (item 9-29): $K_p = \Pi_B (p_B)^{\nu_B}$	$Pa^{\sum \nu_B}$ $(kg\,m^{-1}\,s^{-2})^{\sum \nu_B}$	
9-34	equilibrium constant <concentration basis>	K_c	for solutions, product for all substances B of concentration c_B of substance B (item 9-9.1) in power of its stoichiometric number ν_B (item 9-29): $K_c = \Pi_B (c_B)^{\nu_B}$	$(mol/m^3)^{\sum \nu_B}$	
9-35.1	microcanonical partition function	Ω	number of all quantum states r consistent with given energy E (ISO 80000-4), volume (ISO 80000−3), and external fields: $\Omega = \sum_r 1$	1	$S = k \ln \Omega$ where S is entropy (ISO 80000-5) and k is the Boltzmann constant (ISO 80000-1).
9-35.2	canonical partition function	Z	sum over quantum states of energy E_r (ISO 80000-4), expressed by: $Z = \sum_r \exp\left(\frac{-E_r}{kT}\right)$ where k is the Boltzmann constant (ISO 80000-1), and T is thermodynamic temperature (ISO 80000-5)	1	$A = -kT \ln Z$ where A is Helmholtz energy (ISO 80000-5).
9-35.3	grand-canonical partition function, grand partition function	Ξ	sum of canonical partition function $Z(N_A, N_B, ...)$ for the given number of particles A, B multiplied by absolute activities (item 9-18) λ_A, λ_B, ... of particles A, B: $\Xi = \sum_{N_A, N_B, ...} Z(N_A, N_B, ...) \cdot \lambda_A^{N_A} \cdot \lambda_B^{N_B} \cdot ...$	1	$A - \sum \mu_B n_B = -kT \ln \Xi$ where A is Helmholtz energy (ISO 80000-5), μ_B is the chemical potential of substance B, and n_B is the amount of substance B.

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-35.4	molecular partition function, partition function of a molecule	q	quantity given by: $q = \sum_r \exp\left(\frac{-\varepsilon_r}{kT}\right)$ where ε_r is the energy (ISO 80000-5) of the r-th level of the molecule consistent with given volume (ISO 80000-3) and external fields, k is the Boltzmann constant (ISO 80000-1), and T is thermodynamic temperature (ISO 80000-5)	1	
9-36.1	statistical weight of subsystem	g	number of different microstates in a subsystem	1	
9-36.2	degeneracy, multiplicity	g	for quantum level, statistical weight of that level	1	If $g = 1$, the level is called non-degenerate.
9-37.1	molar gas constant	R	product of the Boltzmann constant (ISO 80000-1) and the Avogadro constant (ISO 80000-1)	J/(mol K) kg m^2 s^{-2} K^{-1} mol^{-1}	For an ideal gas, $pV_m = RT$
9-37.2	specific gas constant	R_s	quotient of molar gas constant R (item 9-37.1) and molar mass (item 9-4) M, i.e. $R_s = R/M$	J/(kg K) m^2 s^{-2} K^{-1}	
9-38	mean free path <chemistry>	l, λ	for a particle, the average distance d (ISO 80000−3) between two successive collisions with other particles	m	
9-39	diffusion coefficient <chemistry>	D	proportionality coefficient of local molecular concentration C_B (item 9-9.2) of substance B in the mixture multiplied by the local average velocity (ISO 80000−3) $\boldsymbol{v}_B$ of the molecules of B, and minus the gradient of the local molecular concentration C_B (item 9-9.2) of substance B in the mixture, expressed by: $C_B \langle \boldsymbol{v}_B \rangle = -D\, \mathbf{grad} C_B$	m^2 s^{-1}	

Table 1 *(continued)*

Item No.	Quantity			Unit	Remarks
	Name	Symbol	Definition		
9-40.1	thermal diffusion ratio	k_T	in a steady-state of a binary mixture in which thermal diffusion occurs, proportionality factor between gradient of the amount-of-subsstance fraction x_B (item 9-13) of the heavier substance B, and negative gradient of the local thermodynamic temperature T (ISO 80000-5) divided by that temperature (ISO 80000-5): $\mathbf{grad}\, x_B = -(k_T/T)\, \mathbf{grad}\, T$	1	
9-40.2	thermal diffusion factor	α_T	quotient of the thermal diffusion ratio k_T (item 9-40.1), and the product of the local amount-of-substance fractions x_A, x_B (item 9-13) of two substances A and B: $\alpha_T = k_T / (x_A\, x_B)$	1	
9-41	thermal diffusion coefficient	D_T	product of the thermal diffusion ratio k_T (item 9-40.1) and the diffusion coefficient D (item 9-39): $D_T = k_T \cdot D$	$m^2\ s^{-1}$	
9-42	ionic strength	I	in a sample, one half of the sum of square of the charge number z_i (ISO 80000-10) of i-th ion multiplied by its molality b_i (item 9-15) over any involved ion: $I = \frac{1}{2}\sum z_i^2 b_i$	mol kg^{-1}	
9-43	degree of dissociation, dissociation fraction	α	in a sample, quotient of the number n_d of dissociated molecules and the total number n of molecules: $\alpha = n_d / n$	1	
9-44	electrolytic conductivity	κ	quotient of the magnitude of electric current density J (IEC 80000-6) and the magnitude electric field strength E (IEC 80000-6) in an electrolyte: $\kappa = J / E$	S/m $kg^{-1}\ m^{-3}\ s^3\ A^2$	For anisotropic media, κ is a tensor. In IEC 80000-6 the symbols σ, γ are used.
9-45	molar conductivity	Λ_m	in an electrolyte, quotient of electrolytic conductivity κ (item 9-44) and amount-of-substance concentration c_B (item 9-12.1): $\Lambda_m = \kappa / c_B$	S m^2/mol $kg^{-1}\ s^3\ A^2\ mol^{-1}$	