

Specification for

Quantities, units and symbols —

Part 8: Physical chemistry and
molecular physics

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- Chartered Institution of Building Services Engineers
- Department of Trade and Industry (National Physical Laboratory)
- Department of Trade and Industry (National Weights and Measures Laboratory)
- EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
- Institute of Physics
- Institute of Trading Standards Administration
- Institution of Chemical Engineers
- Institution of Electrical Engineers
- Institution of Mechanical Engineers
- Institution of Structural Engineers
- Royal Society
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- Schools Mathematics Project
- Society of Chemical Industry

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National foreword

This Part of BS 5775 has been prepared under the direction of the Systems Department Steering Committee. It is identical with ISO 31-8:1992 *Quantities and units — Part 8: Physical chemistry and molecular physics*, published by the International Organization for Standardization (ISO). ISO 31-8 was prepared by Technical Committee ISO/TC 12 “Quantities, units, symbols, conversion factors” with the active participation and approval of the UK.

This Part of BS 5775 supersedes BS 5775-8:1982 which is withdrawn. The principal changes made in this revised version are as follows:

- a) 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;
- b) a number of new items have been added;
- c) a number of new chemical elements have been added in Annex A.

BS 5775 comprises the following Parts, each of which is identical with the corresponding Part of ISO 31.

- *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.*

Cross-references

International Standard	Corresponding British Standard
	BS 5775 <i>Specification for quantities, units and symbols</i>
ISO 31-4:1992	Part 4:1993 <i>Heat</i> (Identical)
ISO 31-9:1992	Part 9:1993 <i>Atomic and nuclear physics</i> (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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 (Conference 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 submultiples 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 $c(\text{H}_2\text{SO}_4)$.

The superscript * is used to mean “pure”. The superscript $^\ominus$ is used to mean “standard”.

EXAMPLES

$V_m(\text{K}_2\text{SO}_4, 0,1 \text{ mol}\cdot\text{dm}^{-3} \text{ in } \text{H}_2\text{O}, 25 \text{ }^\circ\text{C})$
for molar volume.

$C_{p,m}^\ominus(\text{H}_2\text{O}, \text{g}, 298, 15 \text{ K}) = 33,58 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$
for standard molar heat capacity at constant pressure.

In an expression such as $\varphi_B = x_B V_{m,B}^* / \sum x_A V_{m,A}^*$, 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 $\sum x_A = 1$.

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

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 $A_r(\text{Cl}) = 35,453$ 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	$n, (\nu)$		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. $N_A = N/n$	$N_A = (6,022\ 136\ 7 \pm 0,000\ 003\ 6) \times 10^{23} \text{ mol}^{-1}$ 1) CODATA Bulletin 63 (1986).
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 $V_{m,0} = (0,022\ 414\ 10 \pm 0,000\ 000\ 19) \text{ m}^3/\text{mol}^{(1)}$ 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		$M = 10^{-3} M_r \text{ kg/mol} = M_r \text{ kg/kmol} = M_r \text{ g/mol}$ 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 (<i>continued</i>)				Quantities
Item No.	Quantity	Symbol	Definition	Remarks
8-7	molar thermodynamic energy	U_m	Thermodynamic energy divided by amount of substance. $U_m = U/n$	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. $C_m = C/n$	See ISO 31-4.
8-9	molar entropy	S_m	Entropy divided by amount of substance. $S_m = S/n$	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	volume 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].