INTERNATIONAL STANDARD ISO 31/0

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General introduction to ISO 31
General principles concerning quantities, units and symbols

Principes généraux concernant les grandeurs, les unités et les symboles

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 31/0 (originally Draft No. 2180) was drawn up by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors and conversion tables*, and circulated to the Member Bodies in July 1970.

It has been approved by the Member Bodies of the following countries :

Australia	Finland	Poland
Belgium	France	Portugal
Canada	India	South Africa, Rep. of
Ceylon	Korea, Rep. of	Sweden
Chile	Netherlands	Thailand
Czechoslovakia	New Zealand	United Kingdom
Denmark	Norway	U.S.S.R.

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Germany
Greece

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General principles concerning quantities, units and symbols

A. Preface

The scope of the Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors and conversion tables*, includes the establishment of agreement on units and on symbols for quantities and units used within the different fields of science and technology, and further to give mathematical signs and symbols for use in the physical sciences and technology. In fulfilment of this responsibility, ISO/TC 12 has prepared ISO 31, which contains the following parts[1]:

Part 0: *General introduction — General principles concerning quantities, units and symbols.*
Part I: *Basic quantities and units of the SI and quantities and units of space and time.*
Part II: *Quantities and units of periodic and related phenomena.*
Part III: *Quantities and units of mechanics.*
Part IV: *Quantities and units of heat.*
Part V: *Quantities and units of electricity and magnetism.*
Part VI: *Quantities and units of light and related electromagnetic radiations.*
Part VII: *Quantities and units of acoustics.*
Part VIII: *Quantities and units of physical chemistry and molecular physics.*
Part IX: *Quantities and units of atomic and nuclear physics.*
Part X: *Quantities and units of nuclear reactions and ionizing radiations.*
Part XI: *Mathematical signs and symbols for use in physical sciences and technology.*
Part XII: *Dimensionless parameters.*[2]

The purpose of this *General introduction* is to give information about the general principles concerning quantities and equations, units and symbols and to give recommendations for printing symbols and numbers. Each of the other parts has an introduction with special remarks related to the particular subject.

B. Quantities and units

B.1 Introduction

B.1.1 Physical quantity, unit and numerical value

Physical quantities are concepts used for qualitative and quantitative descriptions of physical phenomena. Such quantities may be classified into categories, each category containing only quantities which are mutually comparable. If one of the quantities in such a category is chosen as a reference quantity, called the *unit*, any other quantity in this category can be expressed as a product of this unit and a number, called the *numerical value* of the quantity.

For a quantity symbolized by A, this relationship may be expressed in the form

$$A = \{A\} \cdot [A]$$

where $[A]$ is here used to symbolize the unit chosen for the quantity A, and $\{A\}$ to symbolize the numerical value of the quantity A when expressed in the unit $[A]$.

In the case of vector and tensor quantities the magnitude of the components may be expressed as described above.

[1] Parts I, II, III, IV, V, VII, and XI exist at the moment in the form of ISO Recommendations.

[2] Not yet issued.

If the quantity A is expressed in another unit, $[A]'$, which is k times as large as $[A]$ (i.e. $[A]' = k[A]$), then the new numerical value, $\{A\}'$, becomes k times as small as $\{A\}$ (i.e. $\{A\}' = \{A\}/k$). The product $\{A\} \cdot [A]$ equals the product $\{A\}' \cdot [A]'$, i.e. the quantity A itself is independent of the choice of unit.

Example: The wavelength of one of the yellow sodium lines is:

$$\lambda = 5896 \text{ Å}$$

Changing the unit $[\lambda]$ for the wavelength from the ångström to the metre (which is 10^{10} times larger) leads to

$$\lambda = 5896 \text{ Å} = 5896 \times (10^{-10} \text{ m}) = (5896 \times 10^{-10}) \text{ m}$$

Thus the numerical value $\{\lambda\}$ of the quantity λ is 5896 when expressed in ångströms and 5896×10^{-10} when expressed in metres.

Remark on notation for numerical values:
It is essential to distinguish between the quantity itself and the numerical value of the quantity expressed in a particular unit. The numerical value of a quantity expressed in a particular unit could be indicated by placing curly brackets around the quantity symbol and using the unit symbol as a subscript. The curly brackets may however be omitted without ambiguity, using the quantity symbol with the unit symbol as a subscript to indicate the numerical value. It is often convenient, instead of using the subscript notation, to write the numerical value explicitly as the ratio of the quantity to the unit; this applies in particular to headings of columns in tables, and to the coordinates in graphs.

Example: $\lambda_{\text{Å}} = 5896$ or $\dfrac{\lambda}{\text{Å}} = 5896$ or $\lambda/\text{Å} = 5896$

B. 2 Quantities and equations

B. 2.1 Mathematical operations with quantities

Physical quantities belonging to the same category can be added or subtracted.
Physical quantities are multiplied or divided by one another according to the rules of algebra; the product of two quantities, A and B, satisfies the relation

$$AB = \{A\}\{B\} \cdot [A][B]$$

Example: The velocity v of a particle in uniform motion is

$$v = l/t$$

where l is the distance travelled in the time interval t.
Thus if the particle traverses a distance $l = 6$ cm in the time interval $t = 2$ min, the velocity v is equal to

$$v = \frac{l}{t} = \frac{6 \text{ cm}}{2 \text{ min}} = 3 \frac{\text{cm}}{\text{min}}$$

The arguments of exponential, logarithm and trigonometric functions etc. must be numbers, numerical values or dimensionless combinations of quantities, see B. 2. 6.

Examples: $\exp(W/kT)$, $\ln(p/\text{atm})$, $\sin(2\pi \frac{t}{T})$

B. 2.2 Equations between quantities and equations between numerical values

Two types of equations are used in science and technology: *equations between quantities* in which a letter symbol denotes the totality of the physical quantity (i.e. numerical value × unit), and *equations between numerical values.* The equations between numerical values depend on the choice of the units, whereas the equations between quantities have the advantage of being independent of this choice. Therefore the use of equations between quantities should normally be preferred.

Example:

A simple example of an equation between quantities is:

$$v = l/t$$

as given in B. 2.1.

Introducing numerical values by expressing v in kilometres per hour, l in metres and t in seconds,

$$v = v_{\mathrm{km/h}} \cdot \frac{\mathrm{km}}{\mathrm{h}} \qquad l = l_{\mathrm{m}} \cdot \mathrm{m} \qquad t = t_{\mathrm{s}} \cdot \mathrm{s}$$

one obtains the equation

$$v_{\mathrm{km/h}} \cdot \frac{\mathrm{km}}{\mathrm{h}} = \frac{l_{\mathrm{m}} \cdot \mathrm{m}}{t_{\mathrm{s}} \cdot \mathrm{s}} \quad \text{or} \quad v_{\mathrm{km/h}} = \frac{\mathrm{h}}{\mathrm{s}} \cdot \frac{\mathrm{m}}{\mathrm{km}} \cdot \frac{l_{\mathrm{m}}}{t_{\mathrm{s}}}$$

from which, using 1 h = 3600 s and 1 km = 1000 m, follows the *equation between numerical values*

$$v_{\mathrm{km/h}} = 3600 \cdot \frac{1}{1000} \cdot \frac{l_{\mathrm{m}}}{t_{\mathrm{s}}} = 3{,}6\ \frac{l_{\mathrm{m}}}{t_{\mathrm{s}}}$$

The number 3,6 which occurs in this equation between numerical values results from the particular units chosen; if the velocity is expressed in miles per hour, the distance in yards and the time in seconds, this number becomes $3600/1760 \approx 2{,}045$.
Consequently the equation between quantities $v = l/t$ leads to various equations between numerical values each of which depends on the particular units chosen. In equations between numerical values these units should therefore always be indicated, e.g. by subscripts.

An equation like $v_{\mathrm{km/h}} = 3{,}6\ l_{\mathrm{m}}/t_{\mathrm{s}}$ should not be shortened to $v = 3{,}6\ l/t$.

B. 2.3 Empirical constants

An empirical relation is often expressed in the form of an equation between the numerical values of certain physical quantities. Such a relation depends on the units in which the various physical quantities are expressed.
An empirical relation between numerical values can be transformed into an equation between physical quantities, containing one or more empirical constants. The introduction of an equation between physical quantities has the advantage that the form of the equation is independent of the choice of the units. The numerical values of the empirical constants occurring in such an equation depend, however, on the units in which they are expressed, as is the case with other physical quantities.

Example: The results of measuring the reduced length l and the periodic time T at a certain station, for each of several pendulums, can be represented by the equations between numerical values

$$T_{\mathrm{min}} = 0{,}031\,97\ (l_{\mathrm{yd}})^{\frac{1}{2}}$$

and

$$T_{\mathrm{s}} = 2{,}006\ (l_{\mathrm{m}})^{\frac{1}{2}}$$

By writing these relations in the form:

$$\frac{T}{\mathrm{min}} = 0{,}031\,97 \left(\frac{l}{\mathrm{yd}}\right)^{\frac{1}{2}}$$

and

$$\frac{T}{\mathrm{s}} = 2{,}006 \left(\frac{l}{\mathrm{m}}\right)^{\frac{1}{2}}$$

these empirical relations can be expressed in the form of one quantity equation

$$T = C \cdot l^{\frac{1}{2}}$$

where the expression for the empirical constant C (in terms of the two types of units) is given by

$$C = 0{,}031\,97 \text{ min/yd}^{\frac{1}{2}} = 2{,}006 \text{ s/m}^{\frac{1}{2}}$$

Theory shows that $C = 2\pi g^{-\frac{1}{2}}$, where g is the local acceleration of free fall.

B. 2.4 Numerical factors in quantity equations

The equations between quantities sometimes contain *numerical factors*. These numerical factors depend on the definitions chosen for the quantities occurring in the equations.

Examples: 1. The kinetic energy of a particle of mass m and velocity v is

$$E_k = \tfrac{1}{2}\, m\, v^2.$$

2. The capacitance of a sphere with radius r in a medium of (rationalized) permittivity ε is

$$C = 4\,\pi\,\varepsilon r.$$

Controversy about the choice of numerical factors in quantity equations has mainly arisen in the field of electricity and magnetism where *rationalized* and *non-rationalized* equations are in use, which differ in the places where the numerical factor $4\,\pi$ appears in the equations. For further details see Part V (Electricity and magnetism).

B. 2.5 Systems of quantities and equations; base and derived quantities

Physical quantities are related to each other through equations expressing laws of nature and/or defining new quantities.
For the purpose of defining unit systems and introducing the concept of dimensions it is convenient to consider some quantities as mutually independent, i.e. to regard these as *base quantities*, in terms of which the other quantities can be defined or expressed by means of equations; the latter quantities are called *derived quantities*.
It is a matter of choice how many and which quantities are considered to be base quantities.

Examples: 1. The whole set of quantities included in ISO 31 Parts I–X may be considered as being founded on seven base quantities: length, mass, time, electric current, temperature, amount of substance, and luminous intensity.

2. In the field of mechanics a system of equations, founded on three base quantities, is generally used. In ISO 31 Parts I–III the base quantities are chosen to be length, mass, and time, but other choices are possible, e.g. length, time and force or length, time and energy.

3. In the field of electricity and magnetism a system of quantities and equations founded on four base quantities, length, mass, time, and electric current is generally used.
However, systems founded on the three base quantities, length, mass and time are still used; for further details of these systems see introduction and appendix to Part V (Electricity and magnetism).

4. In addition, plane angle and solid angle are sometimes considered to be basic quantities

B. 2.6 Dimension of a quantity

A quantity A can be expressed as a product of powers of a chosen set of base quantities (sometimes multiplied with a numerical factor). The exponents of the powers to which the various base quantities are raised are called the *dimensional exponents* of the quantity A.

Example: If the derived quantity work is expressed in terms of the base quantities length, mass and time, the dimensional exponents of this quantity are 2, 1 and —2 respectively.

If in the field of mechanics the system of quantities and equations is based on the three base quantities length, mass and time, the *dimensional product* or *dimension* of a quantity A in this particular system is denoted as dim $A = \mathrm{L}^{\alpha}\mathrm{M}^{\beta}\mathrm{T}^{\gamma}$, where α, β and γ are the dimensional exponents. For the three base quantities themselves the dimensions are L, M and T respectively. These are therefore called the base dimensions of the system.

Note: Sometimes an upright sanserif type is used for the base dimensions.

Example: The dimensional product or dimension of the quantity work thus becomes dim $W = \mathrm{L}^2\mathrm{M}\mathrm{T}^{-2}$.

A quantity which has all dimensional exponents equal to zero is called a *dimensionless* quantity. Its dimensional product or dimension is $\mathrm{L}^0\mathrm{M}^0\mathrm{T}^0 = 1$.

In the system founded on the seven base quantities length, mass, time, electric current, temperature, amount of substance and luminous intensity, the base dimensions may be denoted by L, M, T, I, Θ, N and J respectively and the dimension of a quantity A becomes in general

$$\dim A = \mathrm{L}^{\alpha}\,\mathrm{M}^{\beta}\,\mathrm{T}^{\gamma}\,\mathrm{I}^{\delta}\,\Theta^{\varepsilon}\,\mathrm{N}^{\eta}\,\mathrm{J}^{\zeta}$$

Examples:

Quantity	*Dimensions*
velocity	$\mathrm{L\,T^{-1}}$
force	$\mathrm{L\,M\,T^{-2}}$
energy	$\mathrm{L^2\,M\,T^{-2}}$
entropy	$\mathrm{L^2\,M\,T^{-2}\,\Theta^{-1}}$
electric potential	$\mathrm{L^2\,M\,T^{-3}\,I^{-1}}$
permittivity	$\mathrm{L^{-3}\,M^{-1}\,T^4\,I^2}$
magnetic flux	$\mathrm{L^2\,M\,T^{-2}\,I^{-1}}$
luminance	$\mathrm{L^{-2}\,J}$
molar entropy	$\mathrm{L^2\,M\,T^{-2}\,\Theta^{-1}\,N^{-1}}$
Faraday constant	$\mathrm{T\,I\,N^{-1}}$
plane angle	1
relative density	1

In ISO 31 the dimensions of the quantities are not explicitly stated, but when the quantity is considered as dimensionless this is explicitly noted.

B. 3 Units

B. 3.1 Coherent unit systems

Units might be chosen arbitrarily, but making an independent choice of a unit for each category of mutually comparable quantities would lead in general to the appearance of several additional numerical factors in the equations between the numerical values.

It is possible, however, and in practice more convenient, *to choose a system of units in such a way that the equations between numerical values, including the numerical factors, have exactly the same form as the corresponding equations between the quantities.*

A unit system defined in this way is called *coherent* with respect to the system of quantities and equations in question. Equations between units of a coherent unit system contain as numerical factors only the number 1.

Examples: 1. The equation between the kinetic energy of a particle and its mass and velocity is

$$E_k = \tfrac{1}{2} m v^2 \qquad (1)$$

Written in terms of products of numerical values and units, this equation becomes:

$$\{E_k\} [E_k] = \tfrac{1}{2} \{m\} [m] \cdot \{v\}^2 [v]^2 \qquad (2)$$

The condition for coherence requires that this equation reduces to the equation between numerical values

$$\{E_k\} = \tfrac{1}{2} \{m\} \cdot \{v\}^2 \qquad (3)$$

having exactly the same form as the equation between quantities, equation (1). This occurs provided the units are so chosen that

$$[E_k] = [m] \cdot [v]^2 \qquad (4)$$

It is seen from equation (3) and (4) that the coherent unit of kinetic energy is 2 times the energy of a particle with the mass of one unit moving with a velocity of one unit.
In a system of units where $[m] = 1$ kg and $[v] = 1$ m/s, the coherent unit of kinetic energy is $[E_k] = 1 \text{ kg} \cdot \text{m}^2/\text{s}^2$ which is twice the kinetic energy of a particle of mass 1 kg moving with velocity 1 m/s.

2. The equation for the capacitance of a sphere with radius r in a medium of (rationalized) permittivity ε is

$$C = 4 \pi \varepsilon r$$

For coherent units, related by the equation

$$[C] = [\varepsilon] \cdot [r],$$

the equation between numerical values is

$$\{C\} = 4 \pi \{\varepsilon\} \cdot \{r\}$$

A coherent system of units, corresponding to a particular system of quantities and equations, is constructed by first defining — in terms of actual physical phenomena — units for the base quantities (see B.2.5). These are called the *base units.* For each derived quantity the corresponding *derived unit* is defined in terms of the base units by an algebraic expression, which is obtained from the dimensional product of that quantity by replacing the symbols for the base dimensions by those of the base units. The derived units often have special names and symbols.

Example: If in the field of mechanics, electricity and magnetism the quantities are considered to be founded on the four base quantities: length, l, mass, m, time, t, and electric current, I, the corresponding coherent unit system should be founded on four base units $[l]$, $[m]$, $[t]$, and $[I]$ for these four base quantities respectively. Expressions for the coherent unit for some of the derived quantities in this system are (compare B.2.6):

velocity	$[v] = [l]\,[t]^{-1}$
force	$[F] = [l]\,[m]\,[t]^{-2}$
energy	$[E] = [l]^2\,[m]\,[t]^{-2}$
electric potential	$[V] = [l]^2\,[m]\,[t]^{-3}\,[I]^{-1}$
permittivity	$[\varepsilon] = [l]^{-3}\,[m]^{-1}\,[t]^4\,[I]^2$
magnetic flux	$[\Phi] = [l]^2\,[m]\,[t]^{-2}\,[I]^{-1}$
relative density	$[d] = 1$

The coherent unit of quantities which are dimensionless with respect to the base quantities chosen, is the ratio of two identical units, which may be expressed by the number 1. Sometimes it is given a special name and symbol like radian and rad for the unit of plane angle and steradian and sr for the unit of solid angle; otherwise it is omitted.

B. 3.2 SI Units and their Decimal Multiples and Sub-multiples

The name Système International d'Unités (International System of Units), with the abbreviation SI was adopted by the 11th Conférence Générale des Poids et Mesures in 1960.

This system includes three classes of units:

base units
supplementary units
derived units

which together form the coherent system of SI units.

Base units

The International System of Units is founded on the seven base units

Quantity	*Name of base unit*	*Symbol*
length	metre[1])	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Supplementary units

The Conférence Générale des Poids et Mesures has not yet classified certain units of the International System under either base units or derived units.

These units are called "supplementary units" and may be regarded either as base units or as derived units.

Quantity	*Name of supplementary unit*	*Symbol*
plane angle	radian	rad
solid angle	steradian	sr

In ISO 31 Parts I-X these two units are considered to be derived units for the dimensionless quantities plane angle and solid angle respectively.

Derived units

The expressions for the coherent derived units in terms of the base units can be obtained from the dimensional products by using the following formal substitutions:

1) See also D.2.2.

L → m		I → A	
M → kg		Θ → K	
T → s		N → mol	
		J → cd	

Examples:

Quantity	*SI unit expressed in terms of the base units*
velocity	m/s
force	$kg \cdot m/s^2$
energy	$kg \cdot m^2/s^2$
entropy	$kg \cdot m^2/(s^2 \cdot K)$
electric potential	$kg \cdot m^2/(s^3 \cdot A)$
permittivity	$A^2 \cdot s^4/(kg \cdot m^3)$
magnetic flux	$kg \cdot m^2/(s^2 \cdot A)$
luminance	cd/m^2
Faraday constant	$A \cdot s/mol$.
relative density	1

For some of the derived units special names and symbols exist, e.g. newton (N), joule (J) and volt (V) for the SI units of force, energy and electric potential respectively. It is often of advantage to use these special names and symbols.

Examples: 1. Using the derived unit joule ($1\ J = 1\ m^2 \cdot kg \cdot s^{-2}$), one may write

Quantity	*SI unit*
molar entropy	$J \cdot K^{-1} \cdot mol^{-1}$
magnetic flux	$J \cdot A^{-1}$

2. Using the derived unit volt ($1\ V = 1\ m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$), one may write

Quantity	*SI unit*
permittivity	$s \cdot A \cdot m^{-1} \cdot V^{-1}$
magnetic flux	$V \cdot s$

The SI units are placed first in ISO 31 Parts I-X.

Decimal multiples and sub-multiples of the SI units are formed by use of the prefixes (SI prefixes) given in C.2.5.
The SI units and their decimal multiples and sub-multiples are specially recommended.

B. 3.3 CGS systems[1]

The CGS system of *mechanical units* is a coherent system the base units of which are

centimetre
gram
second

for the three base quantities length, mass, and time.
In practice this system was enlarged by adding the kelvin, the candela and the mole as base units for the base quantities temperature, luminous intensity and amount of substance, thus furnishing a coherent system covering all fields except electricity and magnetism. The relations between the units of this enlarged CGS system and the corresponding SI units are obtained by replacing 1 cm by 10^{-2} m and 1 g by 10^{-3} kg in the CGS unit expressions in terms of the base units.

Electric and magnetic units have been incorporated in the CGS system in several ways, leading to the following unit systems:

1) See also D.2.

The electrostatic CGS system, coherent with respect to the electrostatic system of quantities and equations founded on three base quantities;

The electromagnetic CGS system, coherent with respect to the electromagnetic system of quantities and equations founded on three base quantities;

The symmetric CGS system, coherent with respect to the symmetric system of quantities and equations founded on three base quantities.

For further information concerning the unit systems of electricity and magnetism, see Part V.

It is in general preferable not to use CGS units with special names and symbols together with SI units.

B. 3.4 Miscellaneous units

Other coherent systems of units are used, e.g. a system based on the units foot, pound and second and a system based on the units metre, kilogram-force and second.

Apart from these, other units are used, which do not belong to any coherent system e.g. the atmosphere, the nautical mile, the electronvolt and the curie.

Some of these coherent and non-coherent units are included in the tables of ISO 31 Parts I-X in order to give the definitions and/or the conversion factors.

C. Recommendations for printing symbols and numbers

C. 1 Symbols for quantities

C. 1.1 Symbols

The symbols for quantities are in general single letters of the Latin or Greek alphabet, sometimes with subscripts or other modifying signs. These symbols are printed in italic (sloping) type (irrespective of the type used in the rest of the text).

It is recommended to consider as a guiding principle for printing symbols carrying indices (subscripts or superscripts) the criterion: only indices which are symbols for physical quantities (including symbols for running numbers) be printed in italic (sloping) type.

The symbol is not followed by a full stop.

Note: Consideration of vectorial and other non-scalar quantities is deferred to Part XI on mathematical signs and symbols.

Note: Exceptionally symbols made up from two letters are sometimes used for dimensionless combinations of quantities. If such a symbol made of two letters appears as a factor in a product, it is recommended that it be separated from the other symbols.

C. 1.2 Combination of symbols for quantities (elementary operations with quantities)

When symbols for quantities are combined in a product, this process of combination may be indicated in one of the following ways:

$$ab, \quad a\,b, \quad a \cdot b, \quad a\,.\,b, \quad a \times b$$

Note: For multiplication of numbers see item C. 3.3.

When one quantity is divided by another, this may be indicated in one of the following ways:

$$\frac{a}{b}, \quad a/b \quad \text{or by writing the product of } a \text{ and } b^{-1}$$

The procedure can be extended to cases where the numerator or the denominator, or both, are themselves products or quotients, but in no case should more than one solidus (/) on the same line be included in such a combination unless parentheses be inserted to avoid all ambiguity.

Examples: $\frac{ab}{c} = ab/c = abc^{-1}$;

$\frac{a/b}{c} = (a/b)/c = ab^{-1}c^{-1}$; but not $a/b/c$; however $\frac{a/b}{c/d} = \frac{ad}{bc}$

$\frac{a}{bc} = a/bc$

The solidus can also be used in cases where the numerator and the denominator involve addition or subtraction. If there is doubt about where the numerator starts and the denominator ends, parentheses (or brackets or braces) should be used.

Example: $(a+b)/(c+d)$ means $\frac{a+b}{c+d}$ the parentheses are required.

$a+b/c+d$ means $a+\frac{b}{c}+d$, but misunderstanding may be avoided by writing it as $a+(b/c)+d$

Parentheses should also be used to remove ambiguities which may arise from the use of certain other signs and symbols for mathematical operations.

C. 2 Symbols for units

C. 2.1 International symbols for units

In cases where international symbols for units exist these should be used. They should be printed in roman (upright) type (irrespective of the type used in the rest of the text), should remain unaltered in the plural, should be written without a final full stop (period) and be placed after the complete numerical value in the expression for a quantity, leaving a space between the numerical value and the unit.
The unit symbols should be printed in lower case letters except that the first letter is printed in upper case when the name of the unit is derived from a proper name.

Examples:

m	metre
g	gram
s	second
A	ampere
Wb	weber

C. 2.2 Combination of symbols for units

When a compound unit is formed by multiplication of two or more units this may be indicated in one of the following ways:

N·m N.m N m

Note: When using for a prefix a symbol which coincides with the symbol for a unit, special care should be taken to avoid confusion. The unit newton metre for torque should be written, for example, N m or m·N to avoid confusion with mN, the millinewton.

When a compound unit is formed by dividing one unit by another, this may be indicated in one of the following ways:

$\frac{\mathrm{m}}{\mathrm{s}}$, m/s or by writing the product of m and s^{-1}, e.g. $\mathrm{m \cdot s^{-1}}$

In no case should more than one solidus (/) on the same line be included in such a combination unless parentheses be inserted to avoid all ambiguity. In complicated cases negative powers or parentheses should be used.

C. 2.3 Abbreviations for names of units

In cases where no internationally adopted symbol exists for a unit, and where abbreviations for the names of units exist in the various languages, these abbreviations should be printed in roman (upright) type. They are in some cases followed by a full stop.

C. 2.4 No recommendation is made or implied about the fount of upright type in which symbols for units and abbreviations for names of units are to be printed.

C. 2.4.1 In this series of publications the fount used in such cases happens generally to be that of the associated text, but this does not constitute a recommendation.

C. 2.5 Prefixes indicating decimal multiples or sub-multiples of units

Multiple	Name of Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Symbols for prefixes should be printed in roman (upright) type without space between the prefix and the symbol for the unit.

Compound prefixes should not be used.

Example: Write nm (nanometre) instead of mµm.

The symbol of a prefix is considered to be combined with the single unit symbol in letter form to which it is directly attached, forming with it a new unit symbol which can be raised to a positive or negative power, and which can be combined with other unit symbols to form symbols for compound units (see C. 2.2).

Examples:

$$1\ \mathrm{cm}^3 = (10^{-2}\ \mathrm{m})^3 = 10^{-6}\ \mathrm{m}^3$$
$$1\ \mu\mathrm{s}^{-1} = (10^{-6}\ \mathrm{s})^{-1} = 10^6\ \mathrm{s}^{-1}$$
$$1\ \mathrm{kA/m} = (10^3\ \mathrm{A})/\mathrm{m} = 10^3\ \mathrm{A/m}$$

C. 3 Numbers

C. 3.1 Numbers

Numbers should generally be printed in roman (upright) type.

To facilitate the reading of numbers with many digits, these may be separated into suitable groups, preferably of three, counting from the decimal sign towards the left and the right; the groups should be separated by a small space but never by a comma, a point, or by other means.

C. 3.2 Decimal sign

The decimal sign is a comma on the line. In documents in the English language, a comma or a dot on the line may be used.
If the magnitude of the number is less than unity, the decimal sign should be preceded by a zero.

C. 3.3 Multiplication of numbers

The sign for multiplication of numbers is a cross ($\times$) or a dot half-high.

C. 3.3.1 If a dot half-high is used as the multiplication sign, a dot must not be used as the decimal sign.

C. 3.3.2 In ISO documents, the dot is not to be used directly between numbers to indicate multiplication.

C. 4 Symbols for chemical elements and nuclides

Symbols for chemical elements should be written in roman (upright) type (irrespective of the type used in the rest of the text). The symbol is not followed by a full stop.

Examples: H He C Ca

The attached numerals specifying a nuclide or a molecule should have the following positions and meanings:

mass number $^{14}\mathrm{N}_2$ *number of atoms per molecule*

The atomic number should be indicated in the left subscript place, if it is needed.

The right superscript place should be used, if required, for indicating a state of ionization or an excited state.

Examples:	State of ionization:	Na^+
		PO_4^{3-}
	Electronic excited state:	He^*, NO^*
	Nuclear excited state:	$^{110}\mathrm{Ag}^*$, $^{110}\mathrm{Ag}^{\mathrm{m}}$

C. 5 Mathematical signs and symbols

Mathematical signs and symbols recommended for use in the physical sciences and technology are given in Part XI.

C. 6 Greek alphabet (upright and sloping types)

alpha	Α	α	A	α	nu	Ν	ν	N	ν
beta	Β	β	B	β	xi	Ξ	ξ	Ξ	ξ
gamma	Γ	γ	Γ	γ	omicron	Ο	ο	O	o
delta	Δ	δ	Δ	δ	pi	Π	π, ϖ	Π	π, ϖ
epsilon	Ε	ε, ϵ	E	ε, ϵ	rho	Ρ	ρ	P	ϱ
zeta	Ζ	ζ	Z	ζ	sigma	Σ	σ	Σ	σ
eta	Η	η	H	η	tau	Τ	τ	T	τ
theta	Θ	ϑ, θ	Θ	ϑ, θ	upsilon	ϒ	υ	Υ	υ
iota	Ι	ι	I	ι	phi	Φ	φ, ϕ	Φ	φ, ϕ
kappa	Κ	ϰ, κ	K	$\varkappa$, κ	chi	Χ	χ	X	χ
lambda	Λ	λ	Λ	λ	psi	Ψ	ψ	Ψ	ψ
mu	Μ	μ	M	μ	omega	Ω	ω	Ω	ω

C. 7 Gothic letters

$\mathfrak{A}\ \mathfrak{B}\ \mathfrak{C}\ \mathfrak{D}\ \mathfrak{E}\ \mathfrak{F}\ \mathfrak{G}\ \mathfrak{H}\ \mathfrak{I}\ \mathfrak{J}\ \mathfrak{K}\ \mathfrak{L}\ \mathfrak{M}\ \mathfrak{N}\ \mathfrak{O}\ \mathfrak{P}\ \mathfrak{Q}\ \mathfrak{R}\ \mathfrak{S}\ \mathfrak{T}\ \mathfrak{U}\ \mathfrak{V}\ \mathfrak{W}\ \mathfrak{X}\ \mathfrak{Y}\ \mathfrak{Z}$

$\mathfrak{a}\ \mathfrak{b}\ \mathfrak{c}\ \mathfrak{d}\ \mathfrak{e}\ \mathfrak{f}\ \mathfrak{g}\ \mathfrak{h}\ \mathfrak{i}\ \mathfrak{j}\ \mathfrak{k}\ \mathfrak{l}\ \mathfrak{m}\ \mathfrak{n}\ \mathfrak{o}\ \mathfrak{p}\ \mathfrak{q}\ \mathfrak{r}\ \mathfrak{s}\ \mathfrak{t}\ \mathfrak{u}\ \mathfrak{v}\ \mathfrak{w}\ \mathfrak{x}\ \mathfrak{y}\ \mathfrak{z}$