

SYMBOLS FOR THERMODYNAMICAL AND PHYSICO-CHEMICAL
QUANTITIES AND CONVENTIONS RELATING TO THEIR
USE, ADOPTED AS RECOMMENDED PRACTICE BY THE
CHEMICAL SOCIETY.

(Where two or more symbols separated by commas or semicolons are given for a quantity, these symbols are to be regarded as alternatives for which no preference is expressed. On the other hand, where two symbols are separated by a dotted line, the former is the first preference.)

1. To be Printed in Black Italic.

(Certain important physical constants.)

F	Faraday's constant.
J	Mechanical equivalent of heat.
N	Avogadro's number.
R	{ Gas constant per mol. Rydberg's constant.
c	Velocity of light in vacuo.
e	Electronic charge (charge equal and opposite in sign to that of an electron).
g	Acceleration due to gravity (standard value, if variation from standard is significant).
h	Planck's constant.
k	Boltzmann's constant.
m	Rest mass of an electron.

2. To be Printed in Ordinary Italic, when not Greek.

General Physics and Chemistry.

Length	<i>l</i>
mean free path of molecules	<i>l</i>
height	<i>h</i>
diameter, distance	<i>d</i>
diameter of molecules	σ
radius	<i>r</i>
Mass	<i>m</i>
molecular weight	<i>M</i>
atomic weight	<i>A</i>
atomic number	<i>Z</i>
gram-equivalent weight	<i>Z, J</i>
Time	<i>t</i>
time interval, especially half- or mean-life	τ
frequency	ν
Velocity	<i>v; c, (u, v, w)</i>
of ions	<i>u</i> (with subscript)
angular	ω
Acceleration	<i>f a</i>
due to gravity (as variable)	<i>g</i>

Force	$F, (X, Y, Z)$
Moment of inertia	I
Pressure	p, P
especially osmotic	Π
Volume	v, V
Density	ρd
Compressibility	κK
Viscosity	η
Fluidity	ϕ
Surface area	$A s$
Angle of contact	θ
Surface tension	$\gamma \sigma$
Parachor	$[P]$
Surface concentration excess	Γ
Number of mols	n
Concentration, mol fraction	N, x
in other terms	c, C
Solubility	s
Diffusion coefficient	D
Chemical equilibrium constant (products/reactants)	K
solubility product	$K_s L$
Velocity constant of chemical reaction	k
Number of molecular collisions per second	Z
Partition function	f
Efficiency, of any process	η
Wave function	ψ

Heat and Thermodynamics.

Temperature, on absolute scale, ($^{\circ}\text{K}$)	T
on other scales	θt
Thermal conductivity	k
Energy (general symbol)	E
Work done by or on a system	$w W$
Heat entering a system	q
Specific heat	c_p and c_v
molecular heat	C_p and C
Ratio of specific heats	γ
Latent heat, per g.	l
per mol	L
Intrinsic energy	$U E$
Enthalpy, total heat, or heat content	H
Entropy	S
Free energy (Helmholtz)	$A F$
Thermodynamic potential, Gibbs function, free energy (G. N. Lewis)	G

Vapour pressure constant	i
Chemical potential	μ
Activity	a
coefficient (for molar concentration)	f
Osmotic coefficient	g
Van 't Hoff's factor	i

Electricity.

Quantity of electricity	Q
especially electrostatic charge	e
Potential (difference)	} V
Volta potential	
electrokinetic potential	ζ
especially electromotive force of voltaic cells	E
Potential gradient, in electric field	X
Electronic exit work function	ϕ
Current	I
Resistance	R
specific resistance	ρr
specific conductance	$\kappa \sigma$
Inductance, self	L
mutual	M
Electrostatic capacity	C
Dielectric constant	ϵ
Dipole moment	μ

Electrochemistry.

Degree of electrolytic dissociation	α
Valency of an ion	z
Ionic strength	I
Equivalent conductance	Λ
equivalent ionic conductance, "mobility"	l (with subscript)
Transport number	T (with subscript) n (with subscript)
Single electrode potential	e (with subscript), E (with subscript)
Electrolytic polarisation, overvoltage	$\eta \pi$

Magnetism.

Magnetic field strength	H
flux	ϕ
permeability	μ
susceptibility—volume	κ
mass	χ
moment	M
induction	B

Optics.

Wave length	λ
Wave number	ν
Intensity of light	I
Refractive index	n (with subscript)
	. . . μ (with subscript)
specific refraction	r (with subscript)
molecular refraction	$[R]$ (with subscript)
Molar extinction coefficient	ϵ
Angle of (optical) rotation	α
specific rotation	$[\alpha]$
Specific magnetic rotation	ω

3. To be Printed in Roman, when not Greek.(a) *Examples of Mathematical Constants and Operators.*

Base of natural logarithms	e
Ratio of circumference to diameter	π
Differential	d
partial	∂
Increment	Δ
very small increment	δ
Sum	Σ
Product	Π
Function	f, ϕ

(b) *Examples of single-letter abbreviations.*

*Ampère (in sub-units)	a.
Volt	v.
Ohm	Ω .
Watt	w.
Farad	f.
Henry	h.
Centigrade	c.
Fahrenheit	F.
Kelvin	K.
Ångstrom unit	Å.
micron	μ .
metre	m.
gram	g.
litre	l.
Röntgen unit	r.
†Normal (concentration)	N.
†Molar (concentration)	M.

* E.g. "ma." for "milliampère"; but "amp." is preferred for "ampère."

† Separated by a hyphen (and no full stop) from a chemical formula which follows it.

The following prefixes to abbreviations for the names of units should be used to indicate the specified multiples or sub-multiples of these units :

M	mega-	$10^6 \times$
k	kilo-	$10^3 \times$
d	deci-	$10^{-1} \times$
c	centi-	$10^{-2} \times$
m	milli-	$10^{-3} \times$
μ	micro-	$10^{-6} \times$

e.g., M Ω . denotes megohm; kw., kilowatt; and $\mu\text{g.}$, microgram. The use of $\mu\mu$. instead of $m\mu$. to denote 10^{-7} cm., or of γ to denote microgram is deprecated.

4. Subscripts and other Modifying Signs.

(a) *Subscripts to symbols for quantities.*

I, II . . .	} especially with symbols for thermodynamic functions, referring to different systems or different states of a system.
1, 2 . . .	
A B .	referring to molecular species A, B, etc.
i	referring to a typical ionic species i.
u	referring to an undissociated molecule.
+ , -	referring to a positive or negative ion, or to a positive or negative electrode.
p, v, T	indicating constant pressure, volume, and temperature respectively.
q	indicating adiabatic conditions.
w	indicating that no work is performed.
p, c, a	with symbol for an equilibrium constant, indicating that it is expressed in terms of pressure, concentration, or activity.
g, v, l, x	referring to gas, vapour, liquid, and crystalline states, respectively.
f, e, s, t, d	referring to fusion, evaporation (vaporisation of liquid), sublimation, transition, and dissolution or dilution respectively.
c	referring to the critical state or indicating a critical value.
o	referring to a standard state, or indicating limiting value at infinite dilution.
o, D F	with symbols for optical properties, referring to a particular wavelength.

Where a subscript has to be added to a symbol which already carries a subscript, the two subscripts may be separated by a comma or the symbol with the first subscript may be enclosed in parentheses with the second subscript outside.

(b) *Other modifying signs.*

o	as right-hand superscript to symbol (particularly to a symbol for a general thermodynamic function—see p. 5), referring to a standard state.
[]	enclosing formula of chemical substance, indicating its molar concentration.
{ }	enclosing formula of chemical substance, indicating its molar activity.

In crystallography it is recommended that :

Millerian indices be enclosed in parentheses, () ;
 Laue indices be unenclosed ;
 Indices of a plane family be enclosed in braces, { } ;
 Indices of a zone axis or line be enclosed in brackets, [] .

Numerals attached to a symbol for a chemical element in various positions have the following meanings :

upper left mass number of atom.
 lower left nuclear charge of atom.
 lower right number of atoms in molecule.

e.g., ${}^7_3\text{Li}$; ${}^2_1\text{H}_2$ (= D_2).

ALPHABETICAL INDEX OF RECOMMENDED SYMBOLS, and single-letter abbreviations.

including all those given in the above lists except prefixes, subscripts and other modifying signs.

The name of any quantity for which a given symbol is a second preference is printed in parentheses.

- A** free energy—Helmholtz ; atomic weight ; surface area
A. Ångstrom unit.
a activity ; (acceleration).
a. ampère, in sub-units—see footnote, p. 2093.
B magnetic induction.
C concentration ; electrostatic capacity.
with subscript : molecular heat capacity.
c. Centigrade.
c velocity of light in vacuo.
c velocity ; concentration.
with subscript : specific heat.
D diffusion coefficient.
d diameter ; distance ; (density).
d differential.
 ∂ partial differential.
E energy ; (intrinsic energy) ; potential difference, especially electromotive force of voltaic cells.
with subscript : single electrode potential.
e electronic charge—charge equal and opposite in sign to that of an electron.
e quantity of electricity, especially electrostatic charge.
with subscript : single electrode potential.
e base of natural logarithms.
F Faraday's constant.
F force ; (free energy—Helmholtz).
F. farad ; Fahrenheit.
F. acceleration ; activity coefficient, for molar concentration ; partition function.

- f** function.
G thermodynamic potential, Gibbs function, free energy—G. N. Lewis.
g acceleration due to gravity, standard value.
g acceleration due to gravity, as a variable; osmotic coefficient.
g. gram.
H enthalpy, total heat, heat content; magnetic field strength.
h. henry.
h Planck's constant.
h height.
I moment of inertia; ionic strength; electric current; intensity of light.
i vapour pressure constant; van 't Hoff's factor.
J mechanical equivalent of heat.
J gram-equivalent weight.
K chemical equilibrium constant; (compressibility).
K, solubility product.
κ. Kelvin.
k Boltzmann's constant.
k thermal conductivity; velocity constant of chemical reaction.
L latent heat per mol; self inductance; (solubility product).
l latent heat per g.; length; mean free path of molecules.
with subscript: equivalent ionic conductance, "mobility".
l. litre.
M molecular weight; mutual inductance; magnetic moment.
m. molar concentration.
m rest mass of an electron.
m mass.
m. metre.
N Avogadro's number.
N mol fraction.
n. normal concentration.
n number of mols.
with subscript: (transport number).
with subscript: refractive index.
P pressure.
[P] parachor.
p pressure.
Q quantity of electricity.
q heat entering a system.
R gas constant per mol; Rydberg's constant.
R electrical resistance.
[R] *with subscript*: molecular refraction.
r radius; (specific resistance).
with subscript: specific refraction.
r. Röntgen unit.
S entropy.
s solubility; (surface area).
T temperature, on absolute Kelvin scale.
with subscript: transport number.
 time; (temperature—not on absolute scale).

U	intrinsic energy.
u	velocity component. <i>with subscript</i> : velocity of ions.
V	volume; potential, potential difference, including Volta potential.
v.	volt.
v	volume; velocity; velocity component.
W	(work done by or on a system).
w.	watt.
w	work done by or on a system; velocity component.
X	force component; potential gradient in electric field.
x	mol fraction.
Y	force component.
Z	force component; g.-equivalent weight; number of molecular collisions per second; atomic number.
z	valency of an ion.
α	degree of electrolytic dissociation; angle of optical rotation.
$[\alpha]$	specific optical rotation.
Γ	surface concentration excess.
γ	ratio of specific heats; surface tension.
Δ	increment.
δ	very small increment.
ϵ	dielectric constant; molar extinction coefficient.
ζ	electrokinetic potential.
η	efficiency of any process; viscosity; electrolytic polarisation, overvoltage.
θ	angle of contact; temperature—not on absolute scale.
κ	compressibility; specific conductance; magnetic susceptibility—volume.
Λ	equivalent conductance.
λ	wave length.
μ	chemical potential; dipole moment; magnetic permeability. <i>with subscript</i> : (refractive index).
μ .	micron.
ν	frequency; wave number.
Π	pressure, especially osmotic pressure.
Π	product.
π	(electrolytic polarisation, overvoltage).
π	ratio of circumference to diameter.
ρ	density; specific resistance.
Σ	sum.
σ	diameter of molecules; (surface tension); (specific conductance).
τ	time interval, especially half or mean life.
ϕ	fluidity; electronic exit work function; magnetic flux.
ϕ	function.
χ	magnetic susceptibility—mass.
ψ	wave function.
Ω .	ohm.
ω	angular velocity; specific magnetic rotation.