

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.)*

<b><i>F</i></b>	Faraday's constant.
<b><i>J</i></b>	Mechanical equivalent of heat.
<b><i>N</i></b>	Avogadro's number.
<b><i>R</i></b>	{ Gas constant per mol. Rydberg's constant.
<b><i>c</i></b>	Velocity of light in vacuo.
<b><i>e</i></b>	Electronic charge (charge equal and opposite in sign to that of an electron).
<b><i>g</i></b>	Acceleration due to gravity (standard value, if variation from standard is significant).
<b><i>h</i></b>	Planck's constant.
<b><i>k</i></b>	Boltzmann's constant.
<b><i>m</i></b>	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 . . . . .	
height . . . . .	<i>h</i>
diameter, distance . . . . .	<i>d</i>
diameter of molecules . . . . .	<i>σ</i>
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 . . . . .	<i>τ</i>
frequency . . . . .	<i>ν</i>
Velocity . . . . .	<i>v; c, (u, v, w)</i>
of ions . . . . .	<i>u</i> (with subscript)
angular . . . . .	<i>ω</i>
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 . . . . .	$\Pi$
Volume . . . . .	$v, V$
Density . . . . .	$\rho \dots d$
Compressibility . . . . .	$\kappa \dots K$
Viscosity . . . . .	$\eta$
Fluidity . . . . .	$\phi$
Surface area . . . . .	$A \dots s$
Angle of contact . . . . .	$\theta$
Surface tension . . . . .	$\gamma \dots \sigma$
Parachor . . . . .	$[P]$
Surface concentration excess . . . . .	$\Gamma$
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 . . . . .	$K_s \dots L$
Velocity constant of chemical reaction . . . . .	$k$
Number of molecular collisions per second . . . . .	$Z$
Partition function . . . . .	$f$
Efficiency, of any process . . . . .	$\eta$
Wave function . . . . .	$\psi$

*Heat and Thermodynamics.*

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

Vapour pressure constant . . . . .	$i$
Chemical potential . . . . .	$\mu$
Activity . . . . .	$a$
coefficient (for molar concentration) . . . . .	$f$
Osmotic coefficient . . . . .	$\xi$
Van 't Hoff's factor . . . . .	$i$

*Electricity.*

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

*Electrochemistry.*

Degree of electrolytic dissociation . . . . .	$\alpha$
Valency of an ion . . . . .	$z$
Ionic strength . . . . .	$I$
Equivalent conductance . . . . .	$\Lambda$
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 . . . . .	$\eta \dots \pi$

*Magnetism.*

Magnetic field strength . . . . .	$H$
flux . . . . .	$\phi$
permeability . . . . .	$\mu$
susceptibility—volume . . . . .	$\kappa$
mass . . . . .	$\chi$
moment . . . . .	$M$
induction . . . . .	$B$

*Optics.*

Wave length . . . . .	$\lambda$
Wave number . . . . .	$\nu$
Intensity of light . . . . .	$I$
Refractive index . . . . .	$n$ (with subscript)
. . . . .	$\mu$ (with subscript)
specific refraction . . . . .	$r$ (with subscript)
molecular refraction . . . . .	$[R]$ (with subscript)
Molar extinction coefficient . . . . .	$\epsilon$
Angle of (optical) rotation . . . . .	$\alpha$
specific rotation . . . . .	$[\alpha]$
Specific magnetic rotation . . . . .	$\omega$

**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 . . . . .	$\pi$
Differential . . . . .	d
partial . . . . .	$\partial$
Increment . . . . .	$\Delta$
very small increment . . . . .	$\delta$
Sum . . . . .	$\Sigma$
Product . . . . .	$\Pi$
Function . . . . .	f, $\phi$

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

*Ampère (in sub-units) . . . . .	a.
Volt . . . . .	v.
Ohm . . . . .	$\Omega$ .
Watt . . . . .	w.
Farad . . . . .	F.
Henry . . . . .	H.
Centigrade . . . . .	C.
Fahrenheit . . . . .	F.
Kelvin . . . . .	K.
Ångstrom unit . . . . .	A.
micron . . . . .	$\mu$ .
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-	$10^{-3} \times$
$\mu$	micro-	$10^{-6} \times$

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

#### 4. Subscripts and other Modifying Signs.

##### (a) *Subscripts to symbols for quantities.*

I, II . . .	}	<i>(especially with symbols for thermodynamic functions, referring to different systems or different states of a system.</i>
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.
$p, c, a$		<i>with symbol for an equilibrium constant, indicating that it is expressed in terms of pressure, concentration, or activity.</i>
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.
0		referring to a standard state, or indicating limiting value at infinite dilution.
$\lambda, \nu, \nu$		<i>with symbols for optical properties, referring to a particular wavelength.</i>

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

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<sub>2</sub>).

### 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.  
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<sub>s</sub>** solubility product.  
**K.** 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.  
**t** 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.
$\alpha$	degree of electrolytic dissociation; angle of optical rotation.
$[\alpha]$	specific optical rotation.
$\Gamma$	surface concentration excess.
$\gamma$	ratio of specific heats; surface tension.
$\Delta$	increment.
$\delta$	very small increment.
$\epsilon$	dielectric constant; molar extinction coefficient.
$\zeta$	electrokinetic potential.
$\eta$	efficiency of any process; viscosity; electrolytic polarisation, overvoltage.
$\theta$	angle of contact; temperature—not on absolute scale.
$\kappa$	compressibility; specific conductance; magnetic susceptibility—volume.
$\Lambda$	equivalent conductance.
$\lambda$	wave length.
$\mu$	chemical potential; dipole moment; magnetic permeability. <i>with subscript</i> : (refractive index).
$\mu$ .	micron.
$\nu$	frequency; wave number.
$\Pi$	pressure, especially osmotic pressure.
$\Pi$	product.
$\pi$	(electrolytic polarisation, overvoltage).
$\pi$	ratio of circumference to diameter.
$\rho$	density; specific resistance.
$\Sigma$	sum.
$\sigma$	diameter of molecules; (surface tension); (specific conductance).
$\tau$	time interval, especially half or mean life.
$\phi$	fluidity; electronic exit work function; magnetic flux.
$\phi$	function.
$\chi$	magnetic susceptibility—mass.
$\psi$	wave function.
$\Omega$ .	ohm.
$\omega$	angular velocity; specific magnetic rotation.