Symbols for Units of Measurement

Since the symbols—names, or their abbreviations—for physical units may be incorporated in physical equations in exactly the same manner as are the letter symbols for physical quantities and the numerical symbols, it follows that the rules for selecting and using these unit-symbols should be formulated in the light of established mathematical procedures. [See editorial page of this issue.]

A number of the symbols listed in Table 1 do not conform with the following rules but are so firmly established that attempts to change them would be futile. Exceptions to rules of language are a common occurrence and provide no good argument against having rules that facilitate a choice between several well-established symbols or the selection of a symbol for a new unit.

1) *The symbol preferably should consist of two or three letters, and never more than four.* Thus "lu" is preferable to "l" for "lumen." Well-established exceptions to this rule include "gamma" for "gamma," "j" for "joule," and "v" for "volt." If the name of a unit contains only two or three letters, this name, rather than an abbreviation, should be used; examples are "bar," "day," "erg," "lux," and "ohm."

2) *The symbol preferably should consist of the first two or three letters of the name of the unit.* This facilitates recognition and pronunciation, as in "dy" for "dyne," "lu" for "lumen," and "oer" for "oersted." Among the firmly established exceptions to this rule are "ct," "ft," "hr," "hy," "lb," and "oz."

3) *Preferably there should be only one symbol for a particular unit.* However, it seems desirable to recommend certain exceptions; for example, both "a" and "amp" for "ampere," and "b" and "bel" for "bel," the "a" and "b" to be used only with combining forms, as in "ma" and "db."

As the rule implies, the same symbol should be used for both singular and plural forms; thus, 10 amp, *not* 10 amps.

One of several objections to such symbols for secondary (derived) units as "fps" and "rpm" is that the "f," "s," "r," and "m" are used in place of the well-established "ft," "sec," "rev," and "min."

4) *Periods should be omitted from symbols.* An exception is "in.," for "inch," since omission of the period would often result in confusion.

5) *The symbol for a combining form denoting a multiple or submultiple should be a single letter.* Thus "μ" for "micro-," "M" for "mega-," and so on.

Use of Unit Symbols in Printed Text

1) *Set the symbol for a unit in roman type.*

2) *Use an abbreviated unit-symbol only when it:* (i) *is preceded by a numerical value, or* (ii) *appears in headings of tables or in crowded text, in which cases the symbol is enclosed in parentheses.* Thus: "25 cm"; "several centimeters"; "volumes, in cubic centimeters"; "volumes (cm^3)"; "*v* (cm^3)."

3) *Use standard signs to indicate all mathematical operations with unit symbols.* Thus indicate: (i) multiplication by a space, a center dot, or even ×; (ii) division by a solidus, a negative exponent, or the ordinary fractional form; (iii) a power by a positive exponent; (iv) a root by a fractional exponent or √. Thus dy cm, dy · cm, or even dy × cm, but *not* dy-cm; ft/sec, ft sec^{-1}, or $\frac{ft}{sec}$, *not* fps, fs, or (in equations) ft per sec; cm^3, *not* cu cm or cc.

A hyphen should not be used to indicate multiplication, or a "p" to indicate division, since these devices are not used elsewhere in mathematics for these purposes. A hyphen should be used only when it is desired to separate parts of a single unit symbol; thus a hyphen is appropriately used in "ft-ca," since the "foot-candle" does not represent the product of "foot" and "candle."

It is not uncommon to see abbreviations such as the following used for secondary units: cfm (*for* ft^3/min); kgps (*for* kg/sec); mphps (*for* mi/hr sec); psf (*for* lb/ft^2); rpm (*for* rev/min). A form such as "rpm" may be used on crowded diagrams or apparatus labels; but from the standpoint of suitability for substitution in physical equations and ease of mathematical manipulation, the afore-mentioned forms are comparable to such unconventional and ambiguous algebraic expressions as: *cab* (for a^3/b); *apb* (for a/b); *apbpc* (for a/bc); *asb* for (a/b^2); and so on. Of course, forms such as "cfm" or "mphps" may be regarded merely as special names for secondary units, in the sense that "dyne" and "erg" are names for such units. But the suggestion that special names, many of them unpronounceable, be given to all commonly used secondary units, metric and English, multiple and submultiple, is certainly not a move in the direction of greater economy of thought and learning.—D. R.

Table 1. Proposed symbols for units.

Unit or combining form	Symbol	Examples of use; comments
ab-	ab	abamp, abcoul/cm^2
acre	acre	acre ft
ampere	amp	amp turn/m
	a	With prefixes: ma, μa
angstrom	A	
are [$\equiv 10^2\ m^2$]	are	Use sparingly
atom	atom	atom/gm-awu, atom/mole
atomic mass unit	amu	1 amu=931 Mev
atomic weight unit	awu	1 awu=1.0002 amu
atmosphere, standard	atm, A_s	
atmosphere at 45°	atm_{45}, A_{45}	
bar [$\equiv 10^6$ dy/cm^2]	bar	
barn [$\equiv 10^{-24}\ cm^2$]	barn	
barrel	bbl	
barye [$\equiv$dy/cm^2]	...	Use μbar or dy/cm^2
bel	bel	
	b	With prefixes: db

Unit or combining form	Symbol	Examples of use; comments
billion [$\equiv 10^9$ or 10^{12}]	...	Ambiguous; deprecated
Bohr magneton, electronic	μ_0	1 $\mu_0 = 9.27 \times 10^{-21}$ erg/gauss
Bohr magneton, nuclear	μ_I	1 $\mu_I = \mu_0/1836$ erg/gauss
Brinell hardness number	Bhn	
British thermal unit	Btu	Btu/lb F°
bushel	bu	bu/acre
calory	cal	
Calory	...	*See* kilocalory
candle	ca	ca hr, ca/m²
candlepower	...	*See* candle
Celsius degree (*temp. difference*)	C°	cal/cm sec C° 100C° ≡ 180F°
Celsius temperature		*See* degree Celsius
cent (*acous.*)	cent	
cent (*monetary*)	ct	ct/gal, ct/kw hr
	¢	In crowded tables, etc.
centi- [$\equiv 10^{-2}$]	c	cm
centigrade	...	*See* Celsius
centimeter-gram-second unit	cgsu	Use sparingly
centimeter-of-mercury	cm-hg	
centimeter-of-oil	cm-oil	
cgs electromagnetic unit	cgsm	*See also* ab-
cgs electrostatic unit	cgse	*See also* stat-
circular (*adj.*)	cir	cir-mil [$\equiv 0.7854$ mil²]
coulomb	coul	coul/m²
count	count	count/min
cubic	³	cm³ (never "cc"), ft³/sec
curie	c	mc, μc
cycle	cy	cy/sec [≡hz]
	c	Often used with prefixes: kc, Mc
day	day	
deca- [≡10]	...	Deprecated
deci- [$\equiv 10^{-1}$]	d	db, dm
degree (*of arc*)	deg	deg/sec (*ang. velocity*)
	°	90°
degree absolute	...	*See*: degree Kelvin; degree Rankine
degree Baumé	°B	
degree Celsius	°C	0°C ≡ 32°F
degree Fahrenheit	°F	32.000°F (*ice point*)
degree Kelvin	°K	273.16°K
degree Rankine	°R	491.69°R
deka- [≡10]	...	Deprecated
diopter	diop	
division	div	div/sec, div/μv
dollar	dol	dol/hr, dol/ton
	$	In tables, etc.
dozen	doz	doz/hr
dyne	dy	dy/cm², dy cm (*torque*)
electromagnetic unit	emu	Ambiguous: deprecated
electron (*charge*)	e	
electron volt	ev	1 ev = 1.601×10^{-12} erg
electrostatic unit	esu	Ambiguous; deprecated

Unit or combining form	Symbol	Examples of use; comments
erg	erg	erg sec, erg/C°, erg/deg
Fahrenheit degree (*temp. difference*)	F°	Btu/F°
farad	fd	fd/m
	f	With prefixes: abf; μf
foot	ft	ft/sec²
foot-candle [≡lu/ft²]	ft-ca	lu/ft² is preferable
foot-lambert [≡ca/π ft²]	ft-lam	
foot-pound-second unit	fpsu	Use sparingly
fresnel [$\equiv 10^{12}$ cy/sec]	fr	
gallon	gal	gal/min
gamma [10^{-5} oer]	gamma	
gamma [≡μg]	...	Deprecated; use microgram, μg
gauss	gauss	
geepound	...	Synonym for slug
giga- [$\equiv 10^9$]	G	Gev
gilbert	gil	
gill	gill	
grad [$\equiv 10^{-2}$ rt. angle]	grad	
grain	gr	
gram	gm	
	g	With prefixes: kg; mg
gram atomic weight	gm-awu	
gram calory	...	*See* calory
gram molecular weight	...	*See* mole
grav [≡32.174 ft/sec²]	grav	
Hartree unit	hu	
hecto-, hect- [$\equiv 10^2$]	h	Use sparingly: hm
hekto-	...	Variant of hecto-
henry	hy	hy/m
	h	With prefixes: mh
hertz [≡cy/sec]	hz	hz sec [≡cy]
horsepower	hp	hp hr
hour	hr	hr/day
	h	Astron. text and tables: 3h
inch	in.	in./sec
inch-of-mercury	in.-hg	
inch-of-oil	in.-oil	
joule	j	j/mole deg
Kelvin degree (*temp. difference*)	K°	
	deg	Use when not ambiguous: erg/deg molecule
kilo- [$\equiv 10^3$]	k	kcal, kev, kmole
kilogram-calory	...	*See* kilocalory
kilocalory	kcal	
kilogram-mole	...	*See* kilomole
kilomega- [$\equiv 10^9$]	kM	*Also see* giga-
kilomole	kmole	
knot	knot, kn	knot hr, kn hr
lambert [≡ca/π cm²]	lam	
large calory	...	*See* kilocalory
light-year	lt-yr	
line	line	line/cm²

Unit or combining form	Symbol	Examples of use; comments
liter	lit	
	l	With prefixes: ml, k
lumen	lu	lu hr, lu/watt
lux [≡lu/m^2]	lux	lux sec
magnetic pole	. . .	*See* pole
magneton	. . .	*See* Bohr magneton
maxwell	max	
mega-, meg- [≡10^6]	M	Mev, Mm
megamega- [≡10^{12}]	. . .	*See* tera-
megohm [≡10^6 ohm]	meg, Mohm	meg/m, Mohm/m
meter	m	
meter-candle [≡lux]	m-ca	lux is preferable
meter-kilogram-second unit	mksu	Use sparingly
mho	mho	mho/cm
micro-, micr- [≡10^{-6}]	μ	μsec, μv, μg
micrometer	. . .	*See* micron
micromicro- [≡10^{-12}]	. . .	*See* pico-
micron [≡10^{-6} m]	μm, μ	
mil [≡10^{-3} in.]	mil	
mile	mi	mi/gal
mil-foot	mil-ft	ohm/mil-ft
milli- [≡10^{-3}]	m	ma, ml (not "cc")
millimicro- [≡10^{-9}]	. . .	*See* nano-
millimicron [≡10^{-9} m]	mμ	
million [≡10^6]	M	Mgal/day; *see* mega-
minute (*of arc*)	min	min/sec (*ang. velocity*)
	′	In tables, etc.
minute (*of time*)	min	
	^{m}	Astron. text and tables: 5^m
mks electromagnetic unit	mksm	
mole	mole	
molecule	molecule	
month	mo	
myria- [≡10^4]	myria	Use sparingly
nano- [≡10^{-9}]	n	
neper [≡8.686 db]	nep	
newton [≡kg m/sec^2]	new	new/m^2
normal atmosphere	. . .	*See* atmosphere, standard
number	no.	no./hr
ohm	ohm	ohm cm
	Ω	In crowded diagrams, etc.
oersted	oer	
ounce	oz	
phon	phon	
phot [≡lu/cm^2]	phot, ph	
pico- [≡10^{-12}]	p	
pint	pt	
pole, unit magnetic	pole	dy/pole
poise [≡dy sec/cm^2]	poise	
pound	lb	
pound		
poundal	pdl	ft pdl
pulse	pulse	pulse/sec
quart	qt	
radian	rad	rad/sec
Rankine degree (*temp. difference*)	R°	Btu/lb R°
revolution	rev	rev/min, rev/sec ("rpm" and "rps" only in crowded tables, etc.)
rhe [≡1/poise]	rhe	
rod	rod	
roentgen	r	mr
rowland	row	
r-unit	. . .	Synonym for roentgen
rutherford	rd	
second (*of arc*)	sec	
	″	In tables, etc.
second (*of time*)	sec	
	^{s}	Astron. text and tables: 10^s
slug [≡32.174 lbm]	slug	slug/ft^3 (*density*)
Siegbahn unit	. . .	Synonym for x-unit
small calory	. . .	*See* calory
square	^{2}	$in.^2$
stat-	stat	statamp, statcoul
steradian	srad	
stilb [≡ca/cm^2]	. . .	Deprecated; use ca/cm^2
tera- [≡10^{12}]	T	
thousand [≡10^3]	k	kBtu, kft
ton	ton	
turn	turn	
vibration	vib	vib/sec
volt	v, volt	v coul, volt coul
watt	watt	watt hr
	w	With prefixes: kw
weber	web	web/m^2
x-unit	xu	1 xu=1.0020 mA
week	wk	
yard	yd	
year	yr	

. . . the French Empire recognized Davy's work in electrolysis which had been the subject of the Bakerian lecture for 1806. While the two nations were at war, he went to Paris and received a medal which Napoleon Bonaparte had established for the Institute to award for "the best experiment which should be made in the course of each year on the galvanic fluid."—G. A. Foote, *Isis* 42, *205 (1951)*.