

Part VI

Data & Information

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1

Units and Conversion Tables

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1.1

Introduction

The many units of measurements used in this book – not to mention among our different regions and cultures – reflect the fascinating and beneficial diversity of our planet. Our daily work requires a wide variety of information, often available only in different languages, and it all demands data in different units and in different orders of magnitude. The work often becomes cumbersome because of the very richness of the means we use for measuring. While it is the purpose of Part VI, to provide the reader with the data and information to render the quantitative part of their work easier, this chapter is concerned specifically with the units of measurement.

1.1.1

Presentation of Units

The decimal sign between digits in a number should be a point on the line, not a line-centered dot.

The comma for dividing figures into groups of three for numbers larger than four digits for better readability should be avoided, e.g. 252,004,700 is better written 252 004 700 or 2.52×10^8 .

In any number where the decimal sign is placed before the first digit of the number, a zero should always precede it, e.g. 0.251 and not .251.

The combination of a prefix and a symbol for a unit is regarded as a single symbol and the characters should be written with no space between them, e.g. cm and not c m.

Note that the expression μm for the micron (one-millionth of a meter) replaces μ , the symbol often used previously.

When writing the symbol for a derived unit formed from several basic units, the individual symbols should be separated by a solidus (/), a space or a line-centered dot ($\cdot$), e.g. the unit for velocity—meters per second—is written m/s, m s^{-1} , $\text{m}\cdot\text{s}^{-1}$ or mps, but not ms^{-1} (as ms would represent a millisecond).

When a unit is raised to a power, the power refers only to the units and not to any number preceding them, e.g. 2.3 cm^3 is the equivalent of $2.3 \times 1 \text{ cm}^3$.

One, but not more than one, solidus (/) may be used instead of a negative power, e.g. g dm^{-3} may be written g/dm^3 .

In printed text, both numbers and SI unit symbols are printed in upright type (SI is the international system of weights and measures; from the French, *Système International des Unités*). Algebraic symbols

should be printed in *italic type* so they can be distinguished from SI symbols [5]. For further information on the use of SI units please refer to Section 1.6 (Bibliography).

1.1.2

Symbols and Abbreviations

Abbreviation	Name	Used for
²	square	second power
³	cube, cubic	third power
/	per or solidus	
μ	micro (10 ⁻⁶)	of units
Å	Ångstrom	length
°	degree	
°C	degrees Celsius	temperature
°F	degree Fahrenheit	temperature
K	Kelvin	temperature
°R	degree Rankine	temperature
°Re	degree Réaumur	temperature
a	are	area
ac	acre	area
arp	arpent	area
atm	atmosphere	pressure
avdp	avoirdupois	weight
bbl	barrel	capacity
Btu	British thermal unit	energy
bu	bushel	volume
cal	calorie	energy
cc	cubic centimeter	volume
cd	candela	luminous intensity
cm	centimeter	length
ch	chain	length
cu	cubic	
CV	metric horsepower	power
cwt	hundredweight	weight
dm	decimeter	length
dr	dram	weight

<i>Abbreviation</i>	<i>Name</i>	<i>Used for</i>
dwt	pennyweight	weight
EC	electrical conductivity	
Ewt	equivalent weight	
fa	fathom	length
F	furlong	length
fl oz	fluid ounce	capacity
ft or '	foot	length
g	gram	weight
gal	gallon	capacity
gpm	gallon per minute	flow
gr	grain	weight
h	hour	time
ha	hectare	area
hp	horsepower	power
hph	horsepower-hour	energy
in or ''	inch	length
J	Joule	energy
kg	kilogram	weight
km	kilometer	length
kn	knot	speed
kW	kilowatt	power
l	liter	capacity
lb	pound	weight
m	meter	length
MC	moisture content	
meq	milliequivalent	chemical analysis
mi	mile	length
min	minute	time
ml	milliliter	capacity
mS	millisiemens or milliho	conductivity
Mz	manzana	area
oz	ounce	weight
P	poise	viscosity
pH	potential of Hydrogen	chemical analysis
ppb	parts per billion (10^{-9})	density
ppm	parts per million (10^{-6})	density

<i>Abbreviation</i>	<i>Name</i>	<i>Used for</i>
psi	pounds per square inch	pressure
pt	pint	capacity
Q	quintal	weight
qt	quart	capacity
RH (%)	relative humidity (percent)	
rd	rod	length
s	second	time
sq	square	
st	stere	volume
t	ton	weight
tn	short ton	weight
ton	long ton	weight
tr	troy	weight
W	Watt	power
yd	yard	length

1.2

Metric Units of Measures

1.2.1

Prefixes, Symbols and Powers of 10

<i>Prefix</i>	<i>Symbol</i>	<i>Meaning in the US</i>	<i>In other countries</i>	<i>Multiplication factor</i>
exa	E	one quintillion times	trillion	$1\,000\,000\,000\,000\,000\,000 = 10^{18}$
peta	P	one quadrillion times	thousand billions	$1\,000\,000\,000\,000\,000 = 10^{15}$
tera	T	one trillion times	billion	$1\,000\,000\,000\,000 = 10^{12}$
giga	G	one billion times	milliard	$1\,000\,000\,000 = 10^9$
mega	M	one million times		$1\,000\,000 = 10^6$
kilo	k	one thousand times		$1000 = 10^3$
hecto	h	one hundred times		$100 = 10^2$
deca	da	ten times		$10 = 10^1$
deci	d	one tenth of		$0.1 = 10^{-1}$
centi	c	one hundredth of		$0.01 = 10^{-2}$
milli	m	one thousandth of		$0.001 = 10^{-3}$

Prefixes, Symbols and Powers of 10 (continued)

<i>Prefix</i>	<i>Symbol</i>	<i>Meaning in the US</i>	<i>In other countries</i>	<i>Multiplication factor</i>
micro	μ	one millionth of		$0.000\,001 = 10^{-6}$
nano	n	one billionth of	millardth	$0.000\,000\,001 = 10^{-9}$
pico	p	one trillionth of	billionth	$0.000\,000\,000\,001 = 10^{-12}$
femto	f	one quadrillionth of	thousand billionth	$0.000\,000\,000\,000\,001 = 10^{-15}$
atto	a	one quintillionth of	trillionth	$0.0000\,000\,000\,000\,000\,001 = 10^{-18}$

1.2.2

Length

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
kilometer	km	1000 m
meter	m	1000 mm
decimeter	dm	100 mm
centimeter	cm	10 mm
millimeter	mm	10^{-3} m
micrometer	μm	10^{-6} m
Ångstrom	Å	10^{-10} m

1.2.3

Area

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
square kilometer	km^2	10^6 m^2
hectare	ha	100 ac
are	a	100 m^2
square meter	m^2	100 dm^2
square decimeter	dm^2	100 cm^2
square centimeter	cm^2	100 mm^2
square millimeter	mm^2	$10^6 \mu\text{m}^2$
square micrometer	μm^2	10^{-6} mm^2

1.2.4

Volume and Capacity

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
Volume		
cubic meter	m ³	1000 dm ³
cubic decimeter	dm ³ (= l)	1000 cm ³
cubic centimeter	cm ³	1000 mm ³
cubic millimeter	mm ³	10 ⁹ μm ³
cubic micrometer	μm ³	10 ⁻⁹ mm ³
Capacity		
hectoliter	hl	100 l
liter	l (= dm ³)	10 dl
deciliter	dl	0.1 l
milliliter	ml (= cm ³)	0.001 l
microliter	μl (= mm ³)	10 ⁻⁶ l

1.2.5

Weight

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
metric ton	t	1000 kg
kilogram	kg	1000 g
gram	g	1000 mg
milligram	mg	1000 μg
microgram	μg	1000 ng
nanogram	ng	10 ⁻³ μg

Note: 1 l water weighs 1 kg; 1 ml weighs 1 g.

1.3

UK and US Units of Measures

1.3.1

Length

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
inch	in	exactly 2.54 cm
foot	ft	12 in
yard	yd	3 ft
rod (or pole or perch)	rd	5.5 yd
chain (Gunter's: 66 ft)	ch (G)	4 rd
chain (Ramden's: 100 ft)	ch (R)	100 ft
furlong	F	10 ch (G)
mile	mi	8 F
		80 ch
		320 rd
		1760 yd
		5280 ft
		1.609 344 km
fathom	fa	6 ft
nautical mile (1 knot)		6 076 ft
		1.853 km

1.3.2

Area

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
square inch	in ²	6.4516 cm ²
square foot	ft ²	144 in ²
square yard	yd ²	9 ft ²
square rod	rd ²	30.25 yd ²
square chain	ch ²	16 rd ²
acre	ac	10 ch ²
		160 rd ²
		4840 yd ²
		43 560 ft ²
square mile	mi ²	640 ac
		2.59 km ²

1.3.3

Volume and Capacity

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
cubic inch	in ³	16.39 cm ³
cubic foot	ft ³	1728 in ³
cubic yard	yd ³	27 ft ³
UK fluid ounce	fl oz	28.4122 cm ³
UK gill	gi	5 fl oz
UK pint	pt	4 gi
UK quart	qt	2 pt
UK gallon	gal	4 qt 160 fl oz 1.201 US gal
UK bushel	bu	8 gal
UK bulk barrel	bbl	36 gal
US fluid ounce	fl oz	29.5727 cm ³
US gill	gi	4 fl oz
US pint	pt	4 gi
US quart	qt	2 pt
US gallon	gal	4 qt 128 fl oz 0.833 UK gal
US bushel	bu	9.308 gal
US barrel	bbl	31.5 gal
US dry pint	pt (dry)	550.5 cm ³
US dry quart	qt (dry)	2 pt
US peck	pk	8 qt
US bushel	bu	4 pecks

1.3.4

Weight (Avoirdupois)

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
grain	gr	0.064 807 7 g
dram	dr	27.34 gr
ounce	oz	16 dr
pound	lb	16 oz 7000 gr exactly 0.453 592 37 kg

<i>Unit</i>	<i>Symbol</i>	<i>Equivalent</i>
UK stone	st	14 lb
hundredweight short	cwt short	100 lb
short ton	tn	2000 lb
hundredweight long	cwt long	112 lb
long ton	ton	20 cwt long

1.4

Units of Measures from around the World

The following four lists always represent a unit of the particular measure converted to its metric equivalent; occasionally other equivalents are appended.

1.4.1

Length

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
ana, aun, aune		1.19 m	
Ångström (Å)		10^{-10} m	
archin	Turkey	1.0 m	
archine	Russia	0.71 m	
arpent (length)	Canada	58.52 m	180 French feet (= 12.8 in)
azumbre		5.5 m	
bolt		38.41 m	
bow		1.83 m	
braça	Brazil	2.2 m	2 varas
brasse		1.83 m	approx. 6 ft
braza		1.67 m	
cable	UK	182.88 m	600 ft
cable	US	219.456 m	720 ft
cana		1.56 m	
centimeter (cm)		0.01 m	
ch'ek, ch'ih		0.36 m	
chain (R)		30.48 m	100 ft
chain (G)		20.117 m	66 ft
chi	China	0.33 m	1.0936 ft
cho	Japan	109.09 m	60 ken

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
codo		0.55 m	
coil		204.83 m	
cuadra		125.39 m	
cuarta		0.25 m	
cuerda	Puerto Rico	0.39 ha	
danda		1.83 m	
decameter		10.0 m	
decimeter (dm)		0.1 m	
destre		4.21 m	
dhara		0.48 m	
dhra		0.75 m	
digit		2.31 cm	
diraa		0.75 m	
dvim	Indonesia	2.61 cm	
elle		1.09 m	
estadio		201.168 m	
farsach	Iran	6.72 km	
fathom	nautical	1.8288 m	6 ft
foot	Commonwealth	30.479 cm	
foot	South Africa	31.480 cm	1.033 ft
foot	Mauritius	32.484 cm	1.066 ft
foot (ft) current	UK, US, South Africa, Australia, New Zealand	30.480 cm	12 in
foot, fot	Sweden	29.69 cm	11.689 in
fot	Norway	31.37 cm	12.35 in
furlong	UK	201.168 m	10 chains
gudze, gueza, el, ell, ella		1.0 m	
guz	India	0.9144 m	1 yd
hand		10.16 cm	
hath		0.457 m	
hectometer		100.0 m	
hindaza		0.67 m	
hiro		1.515 m	
inch	Turkey	3.138 cm	1.24 in
inch	Swaziland	2.624 cm	1.033 in

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
inch	El Salvador	2.32 cm	0.913 in
inch (in) current	UK, US	2.54 cm	
jareb		20.12 m	
jo		3.03 m	
karam		1.67 m	1 braza
ken	Japan	1.8 m	6 shahv
keup	Thailand	0.247 m	
kilometer (km)		1 000.0 m	
knot, noeud, nudo (naut.)		1.852 km	1 mi
koss		1.839 km	
koss	India	2.011 km	
league	international nautical	5.556 km	3 nautical mi
league statute		4.828 km	3 mi
legna	Argentina	5.200 km	
legna	Brazil	6.600 km	3000 braças
legna	Bolivia	5.196 km	
legna	Chile	4.514 km	
legna	Colombia, Ecuador	5.000 km	
legna	Cuba	4.240 km	
legna	Guatemala	4.444 km	or 5.572 km
legna	Honduras	4.174 km	
legna	Mexico	4.190 km	
legna	Paraguay	4.330 km	
legna	Peru	5.556 km	
legna	Uruguay	5.154 km	
legna current	Spain, Central and South America	5.572 km	
lei		0.68 km	
li	China	0.50 km	
lieve	Quebec	4.827 km	
lieve	Mauritius	4.000 km	
lieve	Paraguay	4.330 km	
lieve (terr.)		4.828 km	
line		0.21 cm	
link (engineers)		30.479 cm	

Unit	Origin	Metric equivalent	Other equivalents
link (Gunter's)		20.116 cm	
megameter		1 000 km	
micron, micrometer (μm)		0.001 mm	
mile, mille, nautical		1.8523 km	
mile statute, mille (mi)		1.6093 km	
millimeter (mm)		0.001 m	
millimicron		0.001 μm	
miriameter		10.0 km	
mlha	Brazil	2.2 km	1000 braças
niev	Thailand	2.08 cm	
paal		1.51–1.85 km	
pace	(milit.)	0.76 m	
palm		7.6–8.9 cm	
palmo	Brazil	0.22 m	8 polegadas
pé	Brazil	0.33 m	1.5 palmas
perch	UK	5.029 m	
pic, pik		0.686 m	
pie	Egypt	0.75 m	
pié	Spain	27.9 cm	
pied	France	32.5 cm	
pied, pié		30.479 cm	
point		0.35 mm	
pole	UK	5.029 m	16.5 ft
polegada	Brazil	2.75 cm	
pouce		2.539 cm	
pulgada		2.539 cm	
qasaba	Egypt	3.55 m	
quarter		22.86 cm	0.25 yd
ri	Japan	3.927 km	36 cho
rod (rd)		5.029 m	
rope	UK	6.096 m	20 ft
sauk, sawk	Thailand	0.5 m	
sen	Thailand	40.0 m	
shakukane	Japan	0.301 m	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
span	East Africa	0.23–0.28 m	18 wanda
t'sun		3.58 cm	
thira		45.72 cm	
tjenkal		3.66 m	
toise		1.94 m	
ugul	Thailand Argentina Brazil Central America Chile, Colombia Costa Rica Cuba, USA Ecuador Honduras Mexico Paraguay Spain, Central and South America Domin. Republic	1.9 cm	
vaj, wah		2.0 m	
vara		0.866 m	
vara		1.100 m	
vara		0.861 m	
vara		0.800 m	
vara		0.836 m	
vara		0.848 m	
vara		0.850 m	
vara		0.835 m	
vara		0.838 m	
vara		0.800 m	
vara current		0.84 m	
vara-tarea		2.75 m	
ver		0.68–0.99 m	
verst	Russia	1.067 km	12 diums
voet	Indonesia	31.4 cm	
wanda	East Africa	2.54 cm	
wari	East Africa	91.44 cm	
yard (yd)	UK, US	91.44 cm	3 ft

1.4.2

Area

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
acre (ac)	Brazil	0.404 686 9 ha	160 rd ² = 4840 yd ²
alqueire mineiro		cuadra = 4.84 ha	100 braças × 100 braças
alqueire paulista		2.42 ha	100 braças × 50 braças
aranzada		0.37–0.48 ha	
are, area (a)		100 m ² = 0.01 ha	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
arpent	France	0.422 ha	
bahu, bahoe, bouw	China, Indonesia	0.71 ha	
baropny		0.16 ha	
bigha	India, Sri Lanka, Bangladesh	0.0809 ha	
bovate		5.67 ha	
braças quadrada	Brazil	4.84 ha	
bu		3.31 m ²	
bunder		1.0 ha	
caballería	Cuba	13.42 ha	
caballería	Mexico	42.8 ha	
caballería	Guatemala, Honduras, El Salvador	45.0 ha	
caballería	Costa Rica	45.2 ha	
caballería	Puerto Rico	78.6 ha	
Cana real		0.61 ha	
cavadura		0.04 ha	
cawny		0.53 ha	
cent	India, Sri Lanka	40.4686 m ²	1/100 ha
centare		1.0 m ²	1/100 a
chattak		4.18 m ²	
cho	Japan	0.992 ha	10 tan
concesión		33.0 ha	
cord		2.74 m ²	
cottah		66.89 m ²	
cuadra	Peru	0.7244 ha	
cuadra	San Paolo	0.08 ha	
cuadra	Uruguay	0.7378 ha	
cuadra	Chile	125.4 m ²	
cuartal		238.4 m ²	
cuarterada		0.71 ha	
cuerda	Puerto Rico	0.39 ha	
cuerda	Guatemala	43.7 m ²	
cuerda	Venezuela	7.14 m ²	
cuerda	Mexico	6.25 m ²	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
dalag wha	Thailand	4.0 m ²	
deciare		10.0 m ²	
deciatrine	Russia	1.09 ha	
dekare		0.1 ha	
destre		17.76 m ²	
deunam, donum, dunam	Iraq, Lebanon	0.25 ha	
día-buey		0.13 ha	
djerib	Iran	1.0 ha	
djo-eng.	West Java	1.41 ha	
émina		0.06–0.09 ha	
estadal		11.18 m ²	
fanega	Colombia	64.00 m ²	
fanega	Venezuela	0.6987 ha	
fanega española	Peru	2.8978 ha	
fanegada	Central America	0.64 ha	
feddan	Egypt, Sudan	0.418 ha	
feddan massi		0.4201 ha	
ferrado		437–639.6 m ²	
hectare (ha)		100 a = 10 000 m ²	2.471 ac
hectárea	El Salvador	0.1 ha	
hide		40.5 ha	
hold		0.575 ha	
huebra		0.22 ha	
jemba		13.38 m ²	
jerib		0.1 ha	
jornal		0.44–0.48 ha	
kanal	India, Sri Lanka	505.85 m ²	
khajjan	North Africa	1000 m ²	
koh	Japan	0.99 ha	
kunte	India	0.16 ha	
legna cuadrada	Ecuador	31.05 km ²	
legna cuadrada	Uruguay	26.57 km ²	
legna cuadrada	Brazil	43.56 km ²	
lima	Zambia	2 500 m ²	
manzana	Mexico	0.672 ha	

Unit	Origin	Metric equivalent	Other equivalents
manzana	Costa Rica, Guatemala, Honduras, El Salvador	0.699 ha	
manzana	Argentina	1.0 ha	
manzana	Nicaragua	0.750 ha	
marco		0.34 ha	
marla		25.32 m ²	
mishara		0.25 ha	
mojada		0.49 ha	
morabba		10.12 ha	
morgen	South Africa	0.857 ha	
mou, mow	China	0.0674 ha	
mu	China	666.66 m ²	
ngan	Thailand	400 m ²	
obrada		0.39–0.54 ha	
paal		227.09 ha	
pantjar	East Java	2.82 ha	
partido		1.21 ha	
peonada		0.34–0.39 ha	
plaza	Colombia	0.64 ha	
qu'ser	Iran	1.1 m ²	
quadra de Sesmaria	Brazil	87.12 ha	60 braças × 1 legna
quadra quadrada	Brazil	1.742 ha	1.32 m × 1.32 m
rai	Thailand	0.16 ha	
relong	Malaysia	0.28 ha	
robada		0.09 ha	
rood	UK	1011.7 m ²	0.25 ac
sarsani		2.8 m ²	
se	Japan	99.2 m ²	30 tsubo
square foot (ft ²)	UK, US, South Africa, Australia	929 cm ² (0.0929 m ²)	144 in ²
square inch (in ²) (current)	UK, US, South Africa, Australia	6.4516 cm ²	
square kilometer (km ²)		1 000 000 m ² (100 ha)	0.3861 mi ²
square mile (mi ²) or section		258.998 ha (2.59 km ²)	640 ac

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
square rod (rd ²)	UK, US, South Africa, Australia	25.293 m ²	1 perch ²
square yard (yd ²)		0.8361 m ²	9 ft ²
stremma		0.1 ha	
tahulla		0.11 ha	
tan	Japan	992.0 m ²	10 se
tanab	Iran	0.44–0.45 ha	
tarca	Dominican Republic	0.625 ha	
tarefa	Brazil	0.4356 ha	50 braças × 30 braças
topo	Peru	0.3494 ha	
topo		0.35 ha	
township		93.233 km ²	36 sections = 23.04 ac
tsubo	Japan	3.31 m ²	
vara (conquera)		0.64 m ²	
vara, tarca	Mexico	312.5 m ²	
vasana		0.22 ha	
woh ²	Thailand	4 m ²	
yard (yd ²)		12.15 ha	
yoke		0.575 ha	

1.4.3

Volume and Capacity

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
Almud	Peru	16.96 l	
1 second foot	US (vary according to State)		40–50 miners inches
acre × foot			43.56 ft ³ 323.136 gal of water
acre × inch			113 t of water (approx.)
Almud	Spain	4.6–5.6 l	
anker	South Africa	34.1 l	
ardeb		197.99 l	
ármina		34.66 l	
arroba	Chile	40 l	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
arroba	South and Central America	11.5 l	
artabal		65.92 l	
aum	South Africa	40.92 l	
balde		18 l	
ban	Thailand	10.0 hl	
ban	Thailand	1000.0 l	50 sat
barrel	Belize	125 l	
barrel	Haiti	1.10 m ³	
barrel	Argentina	76 l	
barrel	Paraguay	96.928 l	
barrique	Mauritius	227.3 l	
barrique	Haiti	225.0 l	
basket	Myanmar	40.6 l	
bota	South and Central America	484.1 l	
botella		0.65–0.9 l	
botella	Guatemala	0.75 l	
botella	Colombia	0.7 l	
bottle	UK, US	0.758 l	
bouteille		0.8 l	
cahiz	South and Central America	666.0 l	
cañado		32.7–37.0 l	
cántara	South and Central America	16.33 l	
cargueiro		80 l	
cavan		75.0 l	
celemín		4.63 l	
centiliter		0.01 l	
chaldron (dry)		1309.32 l	36 UK bu
chopin		0.85 l	
chopinne		0.4 l	
chupa		0.375 l	
chupak		1.14 l	
coomb	South Africa	145.47 l	4 UK bu

Unit	Origin	Metric equivalent	Other equivalents
copo		25 cm ³	
cord (cd) of wood		3.6246 m ³	8 ft × 4 ft × 4 ft = 128 ft ³
cuarta		0.78 l	
cuartán		4.15–18.08 l	
cuartera		69.5–70.8 l	
cuarterola		100.0 l	
cuartillo		0.47–2.46 l	
cuarto		3.2–3.46 l	
cuarto		0.96 l	
cubic centimeter (cm ³)		0.001 l	0.06102338 in ³
cubic foot (ft ³)	UK, South Africa, US, Australia, New Zealand	28.371 l = 0.0283 m ³	1.728 in ³
cubic inch (in ³)	UK, South Africa, US, Australia, New Zealand	16.387 cm ³	
cubic yard (yd ³)	UK, South Africa, US, Australia New Zealand	764.6 l = 0.7645 m ³	27 ft ³
cubic meter (m ³)		1000 l	1.308 yd ³
cup		0.24 l	approx. 8 fl oz
decaliter		0.1 hl = 10 l	
deciliter (dl)		0.1 l	
decimo		40.0 l	
decistère		100.0 l	
din		36.37 l	
dram (fl)		3.696 ml	
émina		18.11 l	
fanega	Spain	57.4 l	
fanega		22.5–137.0 l	
firkin		40.91 l	
gallon	Haiti	3.75 l	
gallon	Honduras	3.456 l	
Gallon Imperial	UK	4.546 l	4 UK qt
gallon	US	3.785 l	4 US qt
galón	Argentina	3.819 l	
galón	Bolivia, Costa Rica, Ecuador	3.364 l	
galón	Peru	4.546 l	1 UK gal

Unit	Origin	Metric equivalent	Other equivalents
galón	Barbados, Cuba, El Salvador	3.78 l	
ganta		3.0 l	
gantang		4.5–8.6 l	
gantang	East Java	1.1 l	
gantang	Malaysia	4.546 l	1 UK gal
gantang	Central Java	8.6 l	
garrafa		5 l	
gill (gi)	UK	0.142 l	5 fl oz
gill (gi)	US	0.118 l	4 fl oz
go		0.18 l	
gwe		18.18 l	
half aum	South Africa	70.463 l	
hectoliter		$0.1 \text{ m}^3 = 100 \text{ l}$	
hogshead		239.48 l	
kadah		2.06 l	
keila		16.5 l	
koku	Japan	180.38 l	100 sho
kwien	Thailand	2000 l	
kwien	Thailand	2000 l	2 ban
last	UK	2907.8 l	
last	The Netherlands	3000 l	
last	South Africa	2909 l	10 UK pt
leaguer	South Africa	581.9 l	128 UK gal
liter (l)		$1 \text{ dm}^3 = 1000.0 \text{ ml}$	
meter cube (m^3)		1000 l	36.31 ft^3
mallal		15.48 l	
microliter		0.001 ml	
milliliter		$1 \text{ cm}^3 = 0.001 \text{ l}$	
mminim		0.062 ml	
moio		12.64 l	
moyo	South and Central America	258.63 l	
mud, muid		$8.0 \text{ l} = 109.0 \text{ l}$	
muid	South Africa	109.140 l	

Unit	Origin	Metric equivalent	Other equivalents
naggin	Myanmar	0.14 l	
nozibn		0.3 l	
octavo		125 cm³	
ounce fluid (fl oz)	UK	28.41 ml	
ounce fluid (fl oz)	US	29.57 cm³	
ounce, once, onza,		29.57 cm³	
pau	0.28 l		
peck (pk)	UK	9.092 l	
peck	US	8.809 l	
pint (pt)	UK (16 fl oz)	0.568 l	20 fl oz
pint	US	0.473 l	16 fl oz
pint dry	US	0.551 l	
pipa	Spain	4.47 hl	
pipa	South and Central America	4.357 l	
pipe		4.16–5.46 hl	
pottle		2.27 l	
pyi	Myanmar	2.5 l	
quart dry (qt)	US	1.101 l	
quart (qt)	US	0.946 l	2 US pt
quart	UK	1.136 l	2 UK pt
quart dry	UK dry	1.136 l	1.2009 cuartus
quarter	UK	2.908 hl	
register ton	UK, US, South Africa, Australia, New Zealand	2.83 m³	100 ft³
rob	Thailand	8.25 l	
robo		28.13 l	
sale		0.57 l	
sat		20.0 l	
sayut		4.55 l	
second		UK gal: 34.1 l/s; US gal: 1.7 m³/min	7.5 gal/s; 450 gal/min
second foot		28.32 l/s	1 ft³/s flow past a given point
seil		9.09 l	
ser		1.0 l	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
shaku		0.018 l	
sheng	China	1.0 l	
sho	Japan	1.804 l	
sinquena		20.65 l	
stere		1000.0 l	
strike	South Africa	72.74 l	2 UK bu
tablespoon		15 ml	3 teaspoons
2 tablespoons		30 ml	approx. 1 fl oz
16 tablespoons		0.24 l	approx. 1 cup
tambolha	Mexico	200 l/ha	
tan		113.65 l	
tanan	Thailand	1.0 l	
tanan	Thailand	1.0 l	
tang	Thailand	10.0 l	
tasse, taza		0.237 l	
tate tsubo	Japan	6.01 m ³	
teaspoon		4.93 ml	
thang	Thailand	10.0 l	
to		18.05 l	
tonel		500.0 l	
winchester	US	35.23 l	1.244 ft ³

1.4.4

Weight

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
acheintaya		165.65 kg	
acre × foot of soil		1800 t	
acre × foot of water		1234 m ³	
acre × inch		102.8 m ³	
ardeb groundnut	Sudan	75 kg	
ardeb groundnut	Egypt	74.88 kg	
ardeb maize	Egypt	140 kg	
ardeb maize	Sudan	198 kg	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
arratel ólibra	Spain	0.46 kg	dry green coffee beans
arroba	Spain, Colombia	11.5 kg	
arroba	Brazil	15.0 kg	
arroba	Guatemala, Peru, Bolivia, Mexico	11.5 kg	
arroba	Honduras	11.34 kg	
bag		45–76.2 kg	
bahar, behar		204.12 kg	
bahra	Malaysia	181.44 kg	
baht, bat		8–16 g	
barrel	US	88.9 kg	
bath	Thailand	15 g	3 pikul
batman	Iran	2.95 g	
beittha		1.66 kg	
box		33.4–40.85 kg	
bunch		14.5–25.4 kg	
bundle	South Africa	3.175 kg	
bundle	RSA	3.17 kg	
cade		254.01 kg	
caja	Mexico	66 kg	
cajou	Chile	2.941 kg	
canasta	Mexico	10 kg	fresh coffee cherries
candareen		0.38 g	
candy		226–355.62 kg	
candy	India	254.2 kg	
candy	Sri Lanka	254.2 kg	
cantar	Arabia	44.93 kg	
cantar	Greece, Turkey	56.52 kg	
cantar	Libya, Syria	255.83 kg	
cantar coffee	Sudan	198 kg	
cantaro	Spain, Cuba	46.0 kg	
Cape ton	RSA	907.2 kg	2000 lb
carat		0.19 g	
carga	Colombia	125 kg	
carga	current	91 kg	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
carga	Bolivia	69.01 kg	
carga algodón	Peru	167.44 kg	
case		18.4–40.82 kg	
cask	US	304.8 kg	
cental	UK, US, South Africa	45.369 kg	100 lb
cental	RSA	50.8 kg	112 lb
centner	metric	100.0 kg	
centner, zentner		50.0 kg	
chang	Thailand	1.2 kg	20 tamlung
chetwert		139.25 kg	
chiquihuite		10 kg	
Chittak	Bangladesh	58.3 kg	5 toflas
clove		3.63 kg	
coyan		1.2 mt	
cran		170.5 kg	
crate		31.75 kg	
dang	China	50 kg	100 jin
decagram		10 g	
decigram		0.1 g	
dirhem	Egypt	3.12 g	
drachme	apoth.	3.888 g	
dram	Avard.	1.772 g	
dram	Greece	0.115 g	
fan		0.38 g	
fanega		51–129.0 kg	approx. 400 l of coffee
fanega	Costa Rica	255 kg	green coffee beans
faunt		1.77 kg	
firkin		25.4–45.4 kg	
firlot		25.8–33.1 kg	
frasilia	East Africa	16.329 kg	36 lb
gisla	East Africa	163 kg	360 lb
gong-jin	China	1 kg	
gong-liang	China	100 g	
grain	Mauritius	53.1 mg	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
grain (gr), grano	UK, India Pakistan	64.799 mg	current
gram (g)		1000 mg	
haab	Thailand	60 kg	50 chang
heml		249.6 kg	
hiaku-mé		0.375 kg	
hobbet		76.2 kg	
hogga		1.27 kg	
hundredweight long	UK	50.802 kg	112 lb
hundredweight short		45.36 kg	100 lb
kantar, cantaro		44.93–255.83 kg	
kati	China, Thailand, Malaysia	0.604 kg	
kati, kin		0.6–1.2 kg	
kela		3.22 kg	
kemple		199.6 kg	
khavar, kharwar	Iran	294.84 kg	
kilogram (kg)		1000 g	2.205 lb
kin	Japan	0.6 kg	
kintar		288.45 kg	
kintar-shami		256.4 kg	
kip		453.59 kg	
koyan	Malaysia	2419.2 kg	40 pikul
kwan, kan	Japan	3.75 kg	
kwet		16.57 kg	
kyat		8.0–16.0 g	
lata		11.34 kg	
lata	Mexico	18 kg	wet parchment coffee
leung, liang		37.8 g	
liang	China	50 g	
libra	Spain	350–460.009 g	
libra	Colombia	500 g	
libra	Mexico, Peru, Bolivia, Cuba	460 g	
livre	apoth.	373 g	Troy weight pound
livre	France, Mauritius	460 g	pound

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
livre, libra	avdp	453.592 g	avdp lb
load	East Africa	22.679 kg	50 lb
load	Nairobi	27.215 kg	60 lb
load	Kisumu	36.287 kg	80 lb
mace		3.77 g	
man	Iran	2 kg	
maund	India, Sri Lanka, Bangladesh	37.324 kg	40 seers
maund	Arabia	25.42 kg	
meskal	Iran	4.54 g	
metemasza		100.0 kg	
microgram (o)		0.001 mg	
milligram (o)		0.001 g	
minim	apoth.	0.065 g	
momme, me	Japan	3.74 g	
muid		68–90.7 kg	
nijo		15.0 g	
oke, okka	Egypt	1.248 kg	
okiya		0.21 kg	
ounce, once, onza (oz)	current	28.3495 g	1 avdp oz
ounce, once, onza	Troy weight	31.104 g	1 Troy or apoth. oz
ounce	Brazil	28.69 g	
	India	28.69 g	
	Damascus	213.5 g	
	Syria	320.5 g	
	Mauritius	30.594 g	
	Zanzibar	28 g	
	Netherlands	100 g	
	Cuba	28.75	
	Philippines	28.75 g	
	Spain	28.75 g	
	Argentina	28.71 g	
	Colombia	31.25 g	
	Dominican Rep.	28.35 g	
	Honduras	28.8 g	
	Mexico	28.765 g	
	Guatemala	28.75 g	
	Peru	28.75 g	
	Paraguay	28.69 g	
	Bulgaria	30 g	
	Pakistan	28.35 g	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
pack		108.9 kg	
pennyweight		1.555 g	
Pfund	Germany	0.5 kg	
pickul, picul	Indonesia	61.76 kg	
pikul	Malaysia	60.48 kg	
poud, pood, pud	Russia	14.62 kg	
pound (lb)	current	453.592 g	16 oz, 7000 g
pound	The Netherlands, RSA	494.42 g	
pound (lb)	Troy weight	373.241 g	apoth.
pyi		2.13 kg	
quantar	Egypt	45 kg	
quarter	US	12.701 kg	2 stones
quilate	Brazil	0.2 gr	
quintal	Mexico	40 kg 57.5 kg 80 kg 245 kg	dry coffee beans dry parchment coffee dry coffee cherries fresh cherries
quintal	Indonesia	100 kg	
quintal	Spain	46.01 kg	
quintal	Brazil	60 kg	4 arrobas
quintal	Colombia	50 kg	
quintal	Central America	45.36 kg	100 lb
quintal largo	Portugal	58.76 kg	
quintal metric		100 kg	
quintal short		45.36 kg	100 lb
rafa		254.01 kg	
ratel		0.45–3.0 kg	
roba	some Arabian countries	25.4 kg	
rotl, rottolo	Egypt	0.495 kg	
ruba		9.34 kg	
sack		60–127.0 kg	
saco (café)		62.5 kg	
scruple		1.296 g	
seer	India, Sri Lanka, Bangladesh	0.9331 kg	
shih		71.61 kg	

<i>Unit</i>	<i>Origin</i>	<i>Metric equivalent</i>	<i>Other equivalents</i>
sieve		21.8–25.4 kg	
stone	UK, US, Brazil	6.35 kg	14 lb
taam, tam	China	60.45 kg	
tael, tahl		37.8 g	
tamlung	Thailand	60 g	4 baths
tan	China	60.56 kg	
tenate		10 kg	
tercio	Honduras	45.36 kg	100 lb
tical		8.0–16.0 kg	
tierce		138.0–170.1 kg	
tola	India, Bangladesh	11.66 kg	
ton, tonne, tonelada	short	907.185 kg	2000 lb
ton, tonne, tonelada	metric	1000.0 kg	
ton, tonne, tonelada	long	1016.047 kg	2240 lb
tonelada	Portugal	792.88 kg	
tonelada	Argentina	918.8 kg	
tonelada	Chile, Guatemala, Mexico	919.9 kg	
tonelada	Spain	1150 kg	
tonelada	Colombia, Uruguay	1000 kg	
truss		16.3–27.2 kg	
ts'in		3.77 g	
tub		38.1 kg	
Tughar		2.032 mt	
Visham		1.36 kg	
Viss		1.66 kg	
wazna	Iraq	101.6 kg	
wazna	other Arabian countries	1.59 kg	
windle		99.79 kg	

1.5 Conversions

1.5.1

Conversions of UK and US Units to Metric Units

1.5.1.1 Decimal and Metric Equivalents of Fractions of 1 in

1/2	1/4	1/8	1/16	1/32	1/64	inch	mm
					1	0.015 625	0.397
				1	2	0.031 25	0.794
					3	0.046 875	1.191
			1	2	4	0.0625	1.588
					5	0.078 125	1.984
				3	6	0.093 75	2.381
					7	0.109 375	2.778
		1	2	4	8	0.1250	3.175
					9	0.140 625	3.572
				5	10	0.156 25	3.959
					11	0.171 875	4.366
			3	6	12	0.1875	4.762
					13	0.203 125	5.159
				7	14	0.128 75	5.556
					15	0.234 375	5.953
	1	2	4	8	16	0.2500	6.350
					17	0.265 625	6.747
				9	18	0.281 25	7.144
					19	0.296 875	7.541
			5	10	20	0.3125	7.938
					21	0.328 125	8.334
				11	22	0.343 75	8.731
					23	0.359 375	9.128
		3	6	12	24	0.3750	9.525
					25	0.390 625	9.922
				13	26	0.406 25	10.319
					27	0.421 875	10.716
			7	14	28	0.4375	11.112
					29	0.453 125	11.509
				15	30	0.468 75	11.906
					31	0.484 375	12.303

1/2	1/4	1/8	1/16	1/32	1/64	inch	mm
1	2	4	8	16	32	0.5000	12.700
					33	0.515 625	13.097
				17	34	0.531 25	13.494
					35	0.546 875	13.891
			9	18	36	0.5625	14.288
					37	0.578 125	14.684
				19	38	0.593 75	15.081
					39	0.609 375	15.478
		5	10	20	40	0.6250	15.875
					41	0.640 625	16.272
				21	42	0.656 25	16.669
					43	0.671 875	17.066
			11	22	44	0.6875	17.462
					45	0.703 125	17.859
				23	46	0.718 75	18.256
					47	0.734 375	18.653
	3	6	12	24	48	0.7500	19.050
					49	0.765 625	19.447
				25	50	0.781 25	19.844
					51	0.796 875	20.241
			13	26	52	0.8125	20.638
					53	0.828 125	21.034
				27	54	0.843 75	21.431
					55	0.859 375	21.828
		7	14	28	56	0.8750	22.225
					57	0.809 625	22.622
				29	58	0.906 25	23.019
					59	0.921 875	23.416
			15	30	60	0.9375	23.812
					61	0.953 125	24.209
				31	62	0.968 75	24.606
					63	0.984 375	25.003
					64	1.000	25.400
2	4	8	16	32	64	1.000	25.400

1.5.1.2 Length

Unit	Symbol	Metric equivalent
inch	in	exactly 2.54 cm
foot	ft	30.48 cm
yard	yd	91.44 cm
rod (or pole or perch)	rd	5.029 m
chain (Gunter's: 66 ft)	ch (G)	20.12 m
chain (Ramden's: 100 ft)	ch (R)	30.48 m
furlong	F	201.168 m
mile	mi	1.609 344 km
fathom	fa	1.8288 m
UK cable (608 ft)		185.3184 m
US cable (720 ft)		219.456 m
UK nautical mile (6080 ft)		1.853 184 km
mile intern. nautical		1.852 km

1.5.1.3 Area

Unit	Symbol	Metric equivalent
square inch	in ²	6.4516 cm ²
square foot	ft ²	0.0929 m ²
square yard	yd ²	0.8361 m ²
square rod	rd ²	25.293 m ²
square chain	ch ²	4.047 ac
acre	ac	0.4047 ha
square mile	mi ²	2.590 km ²

1.5.1.4 Volume and Capacity

Unit	Symbol	Metric equivalent
cubic inch	in ³	16.39 cm ³
cubic foot	ft ³	28.317 dm ³
cubic yard	yd ³	0.765 m ³
UK fluid ounce	fl oz	28.4122 ml
UK gill	gi	0.142 l
UK pint	pt	0.568 l
UK quart	qt	1.136 l
UK gallon	gal	4.546 l
UK bushel	bu	36.368 l
UK bulk barrel	bbl	163.656 l
US fluid ounce	fl oz	29.5727 ml
US gill	gi	0.118 l
US pint	pt	0.473 l
US quart	qt	0.946 l
US gallon	gal	3.785 l
US bushel	bu	35.241 l
US barrel	bbl	119.228 l
US dry pint	pt (dry)	550.6 cm ³
US dry quart	qt (dry)	1.101 dm ³
US peck	pk	8.80965 dm ³
US bushel	bu	35.283 dm ³

1.5.1.5 Weight (Avoirdupois)

Unit	Symbol	Equivalent
grain	gr	64.799 mg
dram	dr	1.772 g
ounce	oz	28.349 g
pound	lb	exactly 0.453 592 37- kg
UK stone	st	6.350 kg
hundredweight short	cwt short	45.359 kg
hundredweight long	cwt long	50.802 kg
short ton	tn	0.907 t
long ton	ton	1.016 t

1.5.1.6 Household Measures

<i>Unit</i>	<i>Equivalent metric</i>	<i>Equivalents</i>
teaspoon (tsp)	5 ml	60–80 drops
dessert spoon	8 ml	
tablespoon (tbsp)	15 ml	0.5 fl oz
glass	60–120 ml	2–4 fl oz
1 teacup	1.2 dl	4 fl oz
1 cup	2.4 dl	8 fl oz

1.5.2

Volume per Area

<i>Unit</i>	<i>ml/ha</i>	<i>l/ha</i>	<i>US gal/ac</i>	<i>US pt/ac</i>	<i>US fl oz/ac</i>	<i>UK gal/ac</i>	<i>UK pt/ac</i>	<i>UK fl oz/ac</i>
ml/ha	1	0.001			0.013			0.014
l/ha	1000	1	0.107	0.855	13.68	0.089	0.712	14.24
US gal/ac		9.353	1	8 000	128.0	0.833	6.661	133.2
US pt/ac		1.169	0.125	1	16.00	0.104	0.833	16.65
US fl oz/ac		0.073	0.008	0.062	1	0.006	0.052	1.041
UK gal/ac		11.23	1.201	9.608	153.7	1	8 000	160.0
UK pt/ac		1.404	0.150	1.201	19.22	0.125	1	20.00
UK fl oz/ac		0.070	0.008	0.060	0.961	0.006	0.050	1

1.5.3

Weight per Area

1.5.3.1 Application Rate and Yield

<i>Unit</i>	<i>Equivalents</i>		
1 kg/ha	0.892 lb/ac	14.275 oz/ac	
1 lb/ac	1.121 kg/ha	16.000 oz/ac	
1 oz/ac	0.070 kg/ha	0.062 lb/ac	
100 kg/ha	0.796 cwt long/ac		
1 bu US/ac	87.075 l/ha		
1 bu UK/ac	89.89 l/ha		
1 quintal (100 lb)/ha	45.35 kg/ha		
1 quintal (100 kg)/ha	100 kg/ha		

Unit	Equivalents		
1 quintal (100 lb)/acre	112 kg/ha		
1 quintal (100 lb)/manzana	65 kg/ha		
1 $\mu\text{g}/\text{cm}^2$	100 g/ha		
1 g/ha	0.01 $\mu\text{g}/\text{cm}^2$		
1 lb/100 ft^2	488.172 kg/ha		
1 lb/ yd^2	0.543 kg/m^2		
1 kg/m^2	0.205 lb/ ft^2		
1 kg/m^2	1.842 lb/ yd^2		
1 kg/feddham	2.38 kg/ha	2.123 lb/ac	33.875 oz/ha
1 lb/feddham	1.079 kg/ha	0.962 lb/ac	13.731 oz/ha

1.5.3.2 Double Conversion

kg/ha	kg or lb	lb/ac
1.121	1	0.892
2.242	2	1.784
3.363	3	2.677
4.483	4	3.569
5.604	5	4.461
6.725	6	5.353
7.846	7	6.245
8.967	8	7.137
10.088	9	8.030
11.209	10	8.922
22.417	20	17.844
33.626	30	26.765
44.834	40	35.687
56.043	50	44.609
67.251	60	53.531
78.460	70	62.453
89.668	80	71.374
100.877	90	80.296
112.085	100	89.218

The central figure refers to either the left or the right-hand column (i.e. 3 kg/ha = 2.677 lb/ac or 3 lb/ac = 3.363 kg/ha).

1.5.4

Volume per Volume (Concentration or Dilution)

Metric units	UK units
623 ml/100 l	1 fl oz/gal
78 ml/100 l	1 fl oz/bu
125 ml/100 l	1 pt/100 gal
290 ml/100 l	1 pt/bbl
99.6 g/100 l	1 lb/gal
1.248 kg/100 l	1 lb/bu

Metric units	US units
782 ml/100 l	1 fl oz/gal
82.5 ml/100 l	1 fl oz/bu
125 ml/100 l	1 pt/100 gal
396 ml/100 l	1 pt/bbl
120 g/100 l	1 lb/gal
1.288 kg/100 l	1 lb/bu
17.14 g/m^3	1 gr/gal

1.5.5

Weight per Volume

<i>UK and US units</i>	<i>Metric units</i>
1 long ton/yd ³	1.329 t/m ³
1 short ton/yd ³	1.186 t/m ³
1 lb/yd ³	0.593 kg/m ³
1 lb/in ³	0.027 kg/cm ³
1 oz/in ³	1.73 g/cm ³
1 lb/Imperial gal	0.0998 kg/dm ³
1 lb/US gal	0.1198 kg/dm ³
1 lb/pt	0.9584 kg/dm ³

1.5.6

Concentrations per Parts

<i>Parts</i>	<i>Symbol</i>	<i>Weight/volume</i>	<i>Weight/weight</i>
per cent	%	10 g/l = 1 kg/100 l	10 g/kg = 1kg/100 kg
per mille	‰	1 g/l = 1 kg/1000 l	1 g/kg = 1 kg/1000 kg
part per million	ppm	1 µg/ml = 1 mg/l	1 µg/g = 1 mg/kg
part per billion (US)	ppb	1 ng/ml = 1 µg/ml	1 ng/g = 1 µg/kg

1.5.7

Temperature**1.5.7.1 Temperature conversion formulas**

degree Celsius (°C)	$= (°F - 32) \times 5/9$ $= (°Re \times 5/4))$ $= (°K - 273.15)$
degree Fahrenheit (°F)	$= (°C \times 9/5) + 32$ $= (°Re \times 9/4) + 32$ $= (1.8 \times K) - 459.67$
Kelvin (K)	$= (°C + 273.15)$ $= (°F + 459.67) \div 1.8$ $= (°R \div 1.8)$
degree Rankine (°R)	$= (°F + 459.67)$ $= (K \times 1.8)$
degree Réaumur (°Re)	$= (°C \times 4/5)$ $= (°F - 32) \times 4/9$

Note: the word “degree” is not used with Kelvin; the abbreviation is “K”.

1.5.7.2 Examples of Temperature Conversion

100 degrees Celsius	$= (100 \times 1.8) + 32^{\circ}\text{F}$	$= 212^{\circ}\text{F}$
212 degrees Fahrenheit	$= (212 - 32) \div 1.8$	$= 100^{\circ}\text{C}$
212 degrees Fahrenheit	$= (212 + 459.67) \div 1.8$	$= 373.15\text{ K}$
80 degrees Réaumur	$= (80 \times 1.25)$	$= 100^{\circ}\text{C}$

1.5.7.3 Scale Comparison

	Kelvin	Celsius	Fahrenheit
boiling point of water	373.15	100	212
freezing point of water	273.15	0	32
absolute zero	0	-273.15	-459.67

1.5.7.4 Boiling Temperatures of Water and Barometric Pressures at Various Altitudes

Altitude		Temperature		Pressure		
ft	m	F	C	mm Hg	in Hg	psi
0	0	212.0	100.0	760	29.92	14.70
3000	914	206.4	96.9	677	26.65	13.09
5000	1524	202.6	94.8	629	24.76	12.16
7000	2134	198.8	92.7	582	22.91	11.25

1.5.8

Pressure

Unit	mm Hg	in H ₂ O	ft H ₂ O	in Hg	lb/in ²	kg/cm ²	atm
mm of mercury	1	0.2353	0.04460	0.03937	0.01934	0.00136	0.00132
inches of water	1.868	1	0.08333	0.07355	0.03613	0.00254	0.00246
feet of water	22.42	12	1	0.8826	0.4335	0.03048	0.02950
inches of mercury	25.40	13.60	1.133	1	0.4912	0.03453	0.03342
lb/in ²	51.71	27.67	2.307	2.04	1	0.07031	0.06805
kg/cm ²	735.6	393.7	32.81	28.96	14.22	1	0.9678
Atmospheres	760	406.8	33.90	29.92	14.70	1.033	1

Note: lb/in² = psi

1.5.9

Energy1.5.9.1 **Units of Work**

<i>Units</i>	<i>J</i>	<i>kWh</i>	<i>kcal</i>	<i>Btu</i>	<i>hph</i>
Joule	1	2.778×10^{-7}	2.388×10^{-4}	9.478×10^{-4}	3.725×10^{-7}
kilowatt-hour	3.600×10^6	1	859.8	3412	1.341
kilocalorie	4187	1.163×10^{-3}	1	3.968	1.560×10^{-3}
British thermal unit	1055	2.931×10^{-4}	0.252	1	3.930×10^{-4}
horsepower-hour	2.684	0.746	641.2	2544	1

1.5.9.2 **Units of Power**

<i>Units</i>	<i>Watt</i>	<i>kcal/h</i>	<i>hp</i>	<i>Btu/h</i>
Watt	1	0.860	1.341×10^{-3}	3.412
kilocalorie/hour	1.163	1	1.560×10^{-3}	3.968
horsepower	745.7	641.2	1	2544
Btu/hour	0.293	0.251	3.930×10^{-5}	1

1.5.10

Wind (Beaufort Scale)

<i>Wind strength</i>	<i>Description</i>	<i>Visible signs</i>	<i>Approximate air speed</i>	
			<i>mph</i>	<i>km/h</i>
force 0	calm	smoke goes up vertically	0–0.5	0–0.7
force 1	light air	direction shown by smoke drift	up to 1	up to 1.5
force 2	light breeze	leaves rustle, wind felt on face	2–4	3–6.5
force 3	gentle breeze	leaves and small twigs in constant motion	4–6	6.5–10
force 4	moderate	small branches move, raising dust and loose paper	6–9	10–15

1.5.11

Speed

<i>Units</i>	<i>km/h</i>	<i>m/min</i>	<i>m/s</i>	<i>mi/h</i>	<i>ft/min</i>	<i>kn</i>
kilometer/hour	1	16.667	0.278	0.621	54.682	0.540
meter/minute	0.060	1	0.017	0.037	3.208	0.032
meter/second	3.600	60.000	1	2.237	196.850	1.944
miles/hour	1.609	26.817	0.447	1	88.000	0.869
feet/minute	0.018	0.305	~0.005	0.011	1	~0.010
knot	1.852	30.866	0.514	1.151	101.269	1
miles/minute	96.56	1609.34	26.822	60	5280	52.138

1.5.12

Fuel Consumption

<i>Units</i>	<i>Equivalent</i>
l/km	1.609 l/mi
l/km	1.852 l/kn
l/km	0.425 US gal/mi
l/km	0.489 US gal/kn
l/km	0.354 UK gal/mi
l/km	0.407 UK gal/kn
US gal/mi	2.352 l/km
US gal/kn	2.044 l/km
UK gal/mi	2.825 l/km
UK gal/kn	2.455 l/km

Note: 1 knot = 1 nautical mile, but also used as unit of speed for nautical miles per hour.

1.5.13

Precipitation and Irrigation

1 inch of rain or irrigation per acre	= 22 613 UK gal/ac = 27 158 US gal/ac = 102 798 l/ha
1 mm of rain or irrigation per ha	= 10 000 l/ha or 1 l/m ² = 1070 US gal/ac = 890 UK gal/ac

1.5.14

Flow Rates

Units	Equivalent US gpm (1 US gpm = 0.227 m³/h)	Equivalent UK gpm (1 UK gpm = 0.333 m³/h)
ft ³ /s	448.8	373.8
l/s	15.88	13.23
l/h	0.0044	0.0037
m ³ /min	264.2	220.5
m ³ /h	4.4	3.67
ac × in/h	452.6	377.0
ac × ft/day	226.3	188.6
1000 UK gal/day	0.834	0.694

1.5.15

Flow Rate Calculation

Flow rates can be calculated by using the following formula:

Flow rate = forward speed × run width × application rate

= (length per time) × length × (volume per area) = volume per time

while using conversion factors according to the different units of measurements involved:

Calculation examples			
l/min	=	$\frac{\text{m/min} \times \text{width in m}}{10\,000}$	× l/ha
l/min	=	$\frac{\text{km/min} \times \text{width in m}}{600}$	× l/ha
gal/min	=	$\frac{\text{mph} \times \text{width in ft}}{495}$	× gal/ac
l/min	=	$\frac{2.7 \times \text{mph} \times \text{width in m}}{1000}$	× l/ha
l/min	=	$\frac{3.1 \times \text{kts/min} \times \text{width in m}}{1000}$	× l/ha
gal/min	=	$\frac{2.0 \times \text{mph/min} \times \text{width in ft}}{1000}$	× gal/ac

1.5.16

Water Analysis Equivalents of (CaCO₃)

Units	ppm	g/gal UK	g/gal US
ppm or mg/l	1	0.07	0.058
grains per UK gallon or Clark degrees	14.3	1	0.83
grains per US gallon or German degrees (practically)	17.1	1.2	1

1.5.17

Soil Chemistry: Common Soil-related Conversions

		<i>Data to convert</i>	<i>Multiply by</i>	<i>Result</i>
1	Soluble ions concentrations	meq/l	saturation % $\times$ 0.001	meq/100 g
2	Conductivity	EC (mS/cm)	10.0	meq/l (covers range 0.1–5.0 mS/cm)
		EC mS/cm)	0.36	atm osmotic pressure (covers range 3–30 mS/cm)
		EC (mS/cm)	640 (approx)	total soluble salts in ppm or mg/l (covers range 0.1–5 mS/in water)
3	Concentrations	mg/100g	10	ppm
		meq/100 g	$10 \times \text{Ewt}$	ppm
		meq/l	Ewt	ppm
4	Chemical concentrations by weight			
	Calcium	CaO	0.715	Ca
		Ca	1.399	CaO
		meq/100 g Ca	200.400	ppm Ca
	Magnesium	MgO	0.603	Mg
		Mg	1.658	MgO
		meq/100 g Mg	121.600	ppm Mg
	Nitrogen	N	6.067	NaNO ₃
		N	7.218	KNO ₃
		N	4.717	(NH ₄) ₂ SO ₄
		NaNONaNO ₃	0.165	N
		KNO ₃	0.138	N
		(NH ₄) ₂ SO ₄	0.212	N
	Phosphorous	P ₂ O ₅	0.436	P
		P	2.292	P ₂ O ₅
	Potassium	K ₂ O	0.830	K
		K	1.205	K ₂ O
		meq/100 g K	391.000	ppm K
	Sodium	Na ₂ O	0.742	Na
		Na	1.348	Na ₂ O
		meq/100 g NA	230.000	ppm Na
	Sulfur	S	2.497	SO ₃
		SO ₃	0.400	S
5	Gypsum concentrations	meq/100 g	0.086	% by weight

1.5.18

Dry Soil

<i>Unit dry soil</i>	<i>weight</i>
1 ft ³ muck	25–30 lb
1 ft ³ clay and silt	68–80 lb
1 ft ³ sand	100–110 lb
1 ft ³ loam	80–95 lb
1 ft ³ of average soil	80–90 lb

1 acre $\times$ feet³ = 43,560 ft³ or 2000 tons = 3 500 000–4 000 000 lb.

A surface plow depth of 6.66 inches is usually calculated at 2 million lb or 1000 tons per acre.

The volume of compact soil increases by approximately 20% when it is excavated or tilled.

1.5.19

Slope Data

1.5.19.1 Degrees to Percent and Percent to Degrees

<i>Degrees and half degrees to percent</i>			<i>Percent to degrees</i>	
<i>degrees (°)</i>	<i>percent % of (°)</i>	<i>% of (° + 30')</i>	<i>percent %</i>	<i>degrees and minutes (°)(')</i>
0	0	0.87	1	0°34'
1	1.75	2.62	2	1°09'
2	3.49	4.37	3	1°43'
3	5.24	6.12	4	2°18'
4	6.99	7.87	5	2°52'
5	8.75	9.63	6	3°26'
6	10.51	11.39	7	4°00'
7	12.28	13.17	8	4°34'
8	14.05	14.95	9	5°09'
9	15.84	16.73	10	5°43'
10	17.63	18.53	11	6°17'
11	19.44	20.35	12	6°51'
12	21.16	22.17	13	7°24'
13	23.09	24.01	14	7°58'
14	24.93	25.86	15	8°32'
15	26.80	27.73	16	9°05'
16	28.68	29.62	17	9°39'

<i>Degrees and half degrees to percent</i>			<i>Percent to degrees</i>	
<i>degrees (°)</i>	<i>percent % of (°)</i>	<i>% of (° + 30')</i>	<i>percent %</i>	<i>degrees and minutes (°)(')</i>
17	30.57	31.53	18	10°12'
18	32.49	33.46	19	10°45'
19	34.43	35.41	20	11°19'
20	36.40	37.39	25	14°02'
21	38.39	39.39	30	16°42'
22	40.40	41.42	35	19°45'
23	42.45	43.48	40	21°48'
24	44.52	44.57	45	24°14'
25	46.63	47.70	50	26°34'
26	48.77	49.86	55	28°49'
27	50.95	52.06	60	30°38'
28	53.17	54.30	65	33°01'
29	55.43	56.58	70	35°00'
30	57.74	58.91	75	36°52'
31	60.09	61.28	80	38°40'
32	62.49	63.71	85	40°2'
33	64.94	66.19	90	42°00'
34	67.45	68.73	95	43°32'
35	70.02	71.33	100	45°00'
36	72.65	74.00		
37	75.36	76.33		
38	78.13	79.54		
39	80.98	82.43		
40	83.91	85.41		
41	86.93	88.47		
42	90.04	91.63		
43	93.25	94.90		
44	96.57	98.27		
45	100			

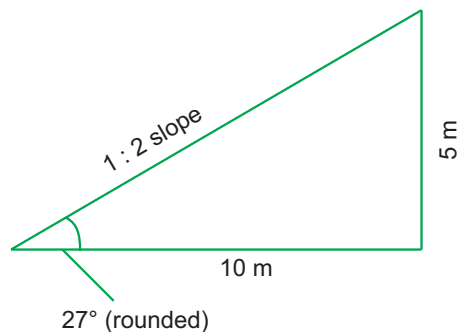
Note: Percentage slope = natural tangent $\times$ 100, e.g. 1:2 = 50%.

1.5.19.2 Natural Tangent to Degrees

Ratio (tan)	Degrees (rounded)
1:0.25	76
1:0.5	63
1:1	45
1:1.5	34
1:2	27
1:2.5	22
1:3	18
1:3.5	16
1:4	14

Note: the first figure refers to the height, the second figure refers to the horizontal distance

In the following example with a 1:2 smooth slope, there is a climb (or a descent) of 5 m for every 10 m traversed horizontally along a line parallel to the maximum gradient.



1.5.20

Maps

Scale	Distance in m or km represented by 1 cm		Distance in cm representing 1 km	Area in ha km ² represented by 1 cm ²		Area in cm ² representing 1000 ha
1:1000	10		100	0.01		10 ⁵
1:2500	25		40	0.0625		1.6 × 10 ⁴
1:5000	50		20	0.25		4 × 10 ³
1:7500	75		13	0.56		1786
1:10 000	100		10	1.00		10 ³
1:15 000	150		6.7	2.25		444
1:20 000	200		5.0	4.00		250
1:25 000	250		4.0	6.25		160
1:30 000	300		3.3	9.00		111
1:40 000	400		2.5	16.0		62.5
1:50 000	500		2.0	25.0		40
1:100 000	1 000	1 km	1.0	100	1.0 km ²	10
1:250 000		2.5 km	0.4		6.25 km ²	1.6
1:500 000		5 km	0.2		25 km ²	0.4
1:750 000		7.5 km	0.1		56.25 km ²	0.18
1:1 000 000		10 km	0.1		100 km ²	0.1

1 cm² representing 1 ha is, effectively, the minimum mappable area for planning work.

1.5.21

Coffee Classification1.5.21.1 **Bean Sizing**

Screen number	Diameter of screen in mm[†]	AFNOR and ISO norm	English description for Brazilian coffees
20	7.94	8.00	Very large beans
19.5	7.74	7.75	
19	7.54	7.50	Extra large beans
18.5	7.34	7.25	
18	7.14	7.10	Large beans
17	6.75	6.70	Bold beans
16	6.35	6.30	Good beans
15	5.95	6.00	Medium beans
14	5.55	5.60	Small beans
13	5.16	5.00	
12	4.76	4.75	
11	4.36	4.50	
10	3.97	4.00	
9	3.57	3.50	
8	3.17	3.00	

[†] number of screen $\times$ 1/64 inch, i.e. = number of screen $\times$ 0.396875 mm.

1.5.21.2 **Flat Bean Separation**

Roasting of coffee beans in their natural range of sizes is not practical, because small beans roast faster than large beans. Hence roasted bean colors – and particularly flavor development – would be non-uniform. Therefore the flat beans are separated by sieving through perforated screens with round holes or equivalent meshes. Thereby they are categorized by size into groups.

1.5.21.3 **Peabean Separation**

Peabeans, which have no flat faces, but are spherically oval beans, are first separated from the flat beans by letting them roll off an inclined belt. Then they are separated and categorized by sieving through screens with slotted holes. These slots, normally 1/2 in long, have different widths such as 14S/5.5; 13S/5.0; 12S/4.5; 11S/4.0 and 10S/3.5. The first number indicating the slot width in 1/64 in, the second number in millimeters.

Each bean size range is roasted separately. As broken and small beans fall through or jam the 12/64 inch roaster cylinder perforations, they are roasted in a non-perforated cylinder. After roasting the beans are rebled before grinding. Dust and chaff are removed at all stages.

1.5.22

Net Weight per Bag used in Producing Countries/Regions

<i>Country/region</i>	<i>kg</i>	<i>packing</i>	<i>UK (lb)</i>	<i>Tare (kg)</i>
Angola	60	J	132	1.00
Brazil	60	J	132	0.50
Cameroon	60	J	132	0.43–0.90
Colombia	70	S	154	0.70–0.90
Congo (DRC)	60	J	132	0.90–1.00
Costa Rica	69	S, K	152	0.69
Cuba	60	J	132	0.69
Dominican Republic	75	S	165	1.00
Ecuador	60	S	132	0.50
El Salvador	69	J	152	0.46
Ethiopia	60	J	132	0.80
Guatemala	69	J, K	152	0.69
Haiti	60	S	132	0.90
Hawaii	45,3	J	100	0.35
Honduras	69	J	152	1.00
India, Malabar	50	J	132	0.80
Indonesia	60	J	132	1.00–1.20
Ivory Coast	60	J, S	132	0.80–0.90
Jamaica	60	J	132	1.00
Kenya	60	S	132	1.10
Madagascar	90	J, P, S	132	0.85
Mexico	69	S	152	1.00
Nicaragua	69	J, K	152	0.60 (Maragogipe 1.00 kg)
Peru	69	J	152	1.00
Tanzania	60	S	132	1.10
Togo	60	S	132	1.00
Uganda	60	J	132	1.00
Venezuela	60	S	132	0.70
West Africa region	60	J, S	132	variable
Yemen	60	J	132	1.00

J = Jute, K = Kenaf, S = Sisal, P = Paka

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