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THE ENCYCLOPEDIA OF

APPLIED GEOLOGY

Edited by

CHARLES W. FINKL, JNR.

ENCYCLOPEDIA OF EARTH SCIENCES, VOLUME XIII

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pressure but the millibar is still found in many practices; kinematic viscosity should be expressed as square meters per second (m^2/s) or square millimeters per second (mm^2/s), but the use of stokes (St) will probably continue for some time.

With such a wide range of topics in applied geology, it is impossible to list here all the units used in this volume. Most units are defined locally as they are used in each article, but for those readers wishing to brush up on refinements of the International System of Units (S.I.), the following tables may be useful. Table 2 gives values and symbols for basic S.I. units. Table 3 provides prefixes, symbols, and multiplying factors that can be applied to basic units. These prefixes, which indicate fractions or multiples of basic or derived S.I. units, are useful because some primary S.I. units have been found to be of inconvenient size for practical applications. Some units that are not part of S.I. but widely used by specialists are listed in Table 4. Even though most nations use S.I. units in scientific and industrial applications, the United States, Brunei, Burma, and North and South Yemen remain the last to officially make the transition from Customary Units to S.I. Because momentum of the national conversion process has been temporarily stifled in the United States, both kinds of units continue to be used by geoscientists working in applied situations. Table 5 is provided to facilitate working in both systems. It lists a number of traditional units that can be converted from Customary to metric units using a multiplying factor. Other specialized units used to advantage by geoscientists are given in Table 6 for drilling, cementing, and formation testing; general geology; reservoir geology and engineering; pipeline operations; seismological investigations; gravity and magnetic survey; and applications in rock mechanics. A more detailed discussion of abbreviations, units, and symbolization may be found in the entry entitled "Units, Numbers, Constants and Symbols" in Volume II in this series.

TABLE 1. Published and Planned Volumes in The Encyclopedia of Earth Science Series

Volume

I THE ENCYCLOPEDIA OF OCEANOGRAPHY/*Rhodes W. Fairbridge*
II THE ENCYCLOPEDIA OF ATMOSPHERIC SCIENCES AND ASTROGEOLOGY/*Rhodes W. Fairbridge*
III THE ENCYCLOPEDIA OF GEOMORPHOLOGY/*Rhodes W. Fairbridge*
IVA THE ENCYCLOPEDIA OF GEOCHEMISTRY AND ENVIRONMENTAL SCIENCES/*Rhodes W. Fairbridge*
IVB THE ENCYCLOPEDIA OF MINERALOGY/*Keith Frye*
VI THE ENCYCLOPEDIA OF SEDIMENTOLOGY/*Rhodes W. Fairbridge and Joanne Bourgeois*
VII THE ENCYCLOPEDIA OF PALEONTOLOGY/*Rhodes W. Fairbridge and David Jablonski*
VIII THE ENCYCLOPEDIA OF WORLD REGIONAL GEOLOGY, Part 1: Western Hemisphere (Including Antarctica and Australia/*Rhodes W. Fairbridge*
XII THE ENCYCLOPEDIA OF SOIL SCIENCE, Part 1: Physics, Chemistry, Biology, Fertility, and Technology/*Rhodes W. Fairbridge and Charles W. Finkl, Jnr.*
XIII THE ENCYCLOPEDIA OF APPLIED GEOLOGY/*Charles W. Finkl, Jnr.*
XV THE ENCYCLOPEDIA OF BEACHES AND COASTAL ENVIRONMENTS/*Maurice L. Schwartz*

To Be Published

THE ENCYCLOPEDIA OF WORLD REGIONAL GEOLOGY, Part 2: Europe and Asia
THE ENCYCLOPEDIA OF STRUCTURAL GEOLOGY
THE ENCYCLOPEDIA OF FIELD AND GENERAL GEOLOGY
THE ENCYCLOPEDIA OF IGNEOUS AND METAMORPHIC PETROLOGY, VOLCANOLOGY, AND GEOTHERMAL RESOURCES
THE ENCYCLOPEDIA OF SOIL SCIENCE, Part 2: Morphology, Genesis, Classification, and Geography
THE ENCYCLOPEDIA OF WORLD REGIONAL GEOLOGY, Part 3: Africa and the Middle East
THE ENCYCLOPEDIA OF GEO-ARCHEOLOGY
THE ENCYCLOPEDIA OF SNOW, ICE, AND GLACIOLOGY
THE ENCYCLOPEDIA OF CLIMATOLOGY
THE ENCYCLOPEDIA OF GEOPHYSICS
THE ENCYCLOPEDIA OF STRATIGRAPHY

TABLE 2. The International System of Units (S.I.).

Physical Quantity	Name of Unit	Value	Symbol
Length	meter	base unit	m
	millimeter	0.001 m	mm
	centimeter	0.01 m	cm
	kilometer	1,000 m	km
	international nautical mile (navigation)	1,852 m	n mi
Mass (commonly called "weight")	kilogram	base unit (1,000 g)	kg
	gram	0.001 kg	g
	tonne	1,000 kg	t
Time interval	second	base unit	s
Area	square meter	S.I. unit	m^2
	square millimeter	0.000001 m^2	mm^2
	square centimeter	0.0001 m^2	cm^2
	hectare	10,000 m^2	ha
Volume	cubic meter	S.I. unit	m^3
	cubic millimeter	10^{-9} m^3	mm^3
	cubic centimeter	0.000001 m^3	cm^3
	cubic decimeter	0.001 m^3	dm^3
Volume (fluids only)	liter	0.001 m^3	*l*
	milliliter	0.001 *l*	m*l*
	kiloliter	1,000 *l* (1 m^3)	k*l*
Velocity and speed	meter per second	S.I. unit	m/s or m s^{-1}
	kilometer per hour	0.27 m/s	km/h or km h^{-1}
	knot (navigation)	1 n mi/h or 0.514 m/s	kn
Force	newton[a]	S.I. unit	N
Energy	joule[a]	S.I. unit	J
Power	watt[a]	S.I. unit	W
Density	kilogram per cubic meter	S.I. unit	kg/m^3 or kg m^{-3}
	tonne per cubic meter	1,000 kg/m^3	t/m^3 or tm^{-3}
	gram per cubic centimeter	1,000 kg/m^3	g/cm^3 or g cm^{-3}
Density (fluids only)	kilogram per liter	1,000 kg/m^3	kg/*l* or kgl^{-1}
	gram per milliliter	1,000 kg/m^3	g/m*l* or g ml^{-1}
Pressure	pascal	S.I. unit (N/m^2)	Pa
Pressure (meteorology)	bar	100,000 Pa	bar
	millibar	100 Pa	mbar
Electric current	ampere[b]	base unit	A
Potential difference or electromotive force	volt[a, b]	S.I. unit	V
Electrical resistance	ohm[a, b]	S.I. unit	
Frequency	hertz[a]	S.I. unit	Hz
	revolution per minute	$\frac{1}{60}$ Hz	rpm or rev/min
Temperature	kelvin	base unit	K
	degree Celsius[c]	K	°C
Plane angle	radian	S.I. unit	rad
	milliradian	0.001 rad	mrad
	degree	$\pi/180$ rad	°
	minute	$\frac{1}{60}$°	′
	second	$\frac{1}{60}$′	″
Amount of substance	mole	base unit	mol

[a]Decimal multiples commonly associated with this unit are *kilo* (× 1,000), *mega* (× 1,000,000), and *giga* (× 1,000,000,000).

[b]Decimal submultiples associated with this unit are *milli* (× 0.001) and *micro* (× 0.0000001).

[c]The units of temperature on the Celsius scale (°C) and the thermodynamic scale (K) are equal. A temperature t on the Celsius scale is related to a temperature T on the thermodynamic scale by the relationship $t = T - 273.15$.

Source: After Berkman, D. A., 1976. *Field Geologists' Manual.* Parkville, Victoria: Australasian Institute of Mining and Metallurgy, pp. 275-276.

TABLE 3. Prefixes, Symbols, and Multiplying Factors

Multiplying Factor	Prefix	Symbol
1,000,000,000,000 = 10^{12}	tera	T
1,000,000,000 = 10^{9}	giga	G
1,000,000 = 10^{6}	mega	M
1,000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000001 = 10^{-6}	micro	μ
0.000000001 = 10^{-9}	nano	n
0.000000000001 = 10^{-12}	pico	p
0.000000000000001 = 10^{-15}	femto	f
0.000000000000000001 = 10^{-18}	atto	a

TABLE 4. Some Non-S.I. Units with S.I.

Condition of Use	Unit	Symbol	Value in S.I. Units
Permissable Universally with S.I.	minute	min	1 min = 60 s
	hour	h	1 h = 3,600 s
	day	d	1 d = 86,400 s
	year	a	1 a = 3.1536×10^{7} s
	degree (of arc)	°	1° = (π/180) rad
	minute (of arc)	′	1′ = (π/10,800) rad
	second (of arc)	″	1″ = (π/648,000) rad
	liter[a]	*l*	1 *l* = 1dm^3
	tonne[b]	t	1 t = 10^3 kg
	degree Celius	°C	[f]
	revolution	r	1 r = 2πrad
Permissible in Specialized fields	electronvolt	eV	1 eV = 1.60219×10^{-19} J
	unit of atomic mass	u	1 u = 1.66053×10^{-27} kg
	astronomical unit[c]		1 AU = 149.600 Gm
	parsec	pc	1 pc = .30857 Tm
Permissible for a Limited Time	nautical mile		1 nautical mile = 1,852 m
	knot[d]		1 nautical mile per hour = (1,852/3,600) m/s
	angstrom	Å	1 Å = 0.1 nm = 10^{-10} m
	hectare[e]	ha	1 ha = 10^4m^2
	bar	bar	1 bar = 100kPa
	standard atmosphere	atm	1 atm = 101.325 kPa

[a]The word liter standing alone must be typed in full unless the typewriter is equipped with a special looped "ell."
[b]Care must be taken in the interpretation of this word when it occurs in French text of Canadian origin where the implication may be a "ton of 2,000 lb."
[c]This unit does not have an international symbol. The abbreviations used are AU in French and UA in French.
[d]There is no internationally recognized symbol for knot (1 nautical mile per hour), but kn is frequently used.
[e]The "acre" and "hectare," by international agreement, can be used for a limited period of time as needed in the agriculture and surveying sectors.
[f]The S.I. unit of temperature is the kelvin. The Celsius temperature scale (previously called Centigrade) is the commonly used scale for temperature measurements, except for some scientific work where a thermodynamic scale is used.
Source: After Kenting Limited, n. d. *The International System of Units (S.I.) for the Petroleum Industry in Canada.* Calgary, Alberta, Canada.

TABLE 5. Alphabetical List of Traditional Units Showing the Conversion Factor to Selected Metric (S.I.) Units

Traditional Unit	Multiply Value in Traditional Units by Factor × 10E to Obtain Value in Metric Units[a] Factor E	Selected Metric (S.I.) Unit Name	Symbol
acre	4.046856 E + 03	square meter	m^2
acre	4.046856 E − 01	hectare	ha
acre-foot	1.233482 E + 03	cubic meter	m^3
ampere hour	3.6* E + 00	kilocoulomb	kC
API gravity at 60°F	ASTM D1250 Table 3 × 1000	kilogram per cubic meter at 15°C	kg/m^3
angstrom unit	1.0* E − 01	nanometer	nm
arpent	3.418894 E − 01	hectare	ha
atmosphere (atm)	1.01325* E + 02	kilopascal	kPa
atmosphere technical (at or atm)	9.80665* E + 01	kilopascal	kPa
bar	1.0* E + 02	kilopascal	kPa
barrel (42 U.S. gal)	1.589873 E − 01	cubic meter	m^3
barrel per foot	5.216118 E − 01	cubic meter per meter	m^3/m
barrel per inch	6.25934 E − 01	cubic meter per centimeter	m^3/cm
barrel per acre-foot	1.28893 E − 04	cubic meter per cubic meter	m^3/m^3
barrel per cubic mile	3.81431 E − 02	cubic meter per cubic kilometer	m^3/km^3
barrel per long ton (U.K.)	1.564763 E − 01	cubic meter per tonne	m^3/t
barrel per short ton (U.S.)	1.752535 E − 01	cubic meter per tonne	m^3/t
barrel per day	6.624471 E − 03	cubic meter per hour	m^3/h
barrel per day psi	2.305916 E − 02	cubic meter per day kilopascal	m^3/(d · kPa)
BCF (billion cubic feet: 60°F 1 atm)	2.826231 E + 07	cubic meter (API)	m^3(API)
	1.195307 E + 00	gigamole	Gmol
Btu (International Table)	1.055056 E + 00	kilojoule	kJ
Btu per barrel	6.636102 E + 00	kilojoule per cubic meter	kJ/m^3
Btu per brake horsepower hour	3.930148 E − 01	watt per kilowatt	W/kW
Btu per square foot second	1.135653 E + 01	kilowatt per square meter	kW/m^2
Btu inch per square foot second °F	5.192204 E − 01	kilowatt per meter degree Celsius	kW/(M · °C)
Btu per square foot hour °F	5.678263 E − 03	kilowatt per square meter degree Celsius	kW/(m^2 · °C)
Btu per square foot second °F	2.044175 E +01	kilowatt per square meter degree Celsius	kW/(m^2 · °C)
Btu per cubic foot	3.725895 E + 01	kilojoule per cubic meter	kJ/m^3
Btu per standard cubic foot (60°F − 1 atm)	8.826705 E − 01	kilojoule per mole	kJ/mol
Btu per gallon	2.320808 E − 01	kilojoule per liter	kJ/*l*
Btu per gallon (U.S.)	2.787163 E − 01	kilojoule per liter	kJ/*l*
Btu per hour	2.930711 E − 04	kilowatt	kW
Btu per minute	1.758427 E − 02	kilowatt	kW
Btu per pound	2.326010 E + 00	kilojoule per kilogram	kJ/kg
Btu per pound °F	4.1868 E + 00	kilojoule per kilogram degree Celsius	kJ/(kg · °C)
Btu per pound mole	2.326000 E + 00	joule per mole	J/mol
Btu per second	1.055056 E + 00	kilowatt	kW
Btu foot per square foot hour °F	1.73073 E + 00	watt per meter degree Celsius	W/(m · °C)
calorie (International Table)	4.1868* E + 00	joule	J
calorie (thermochemical)	4.184* E + 00	joule	J

*The conversion factor is exact.
[a]To go from metric to customary units, divide the conversion factor instead of multiplying.

continued

TABLE 5. continued

Traditional Unit	Multiply Value in Traditional Units by Factor × 10E to Obtain Value in Metric Units[a] Factor E	Selected Metric (S.I.) Unit Name	Symbol
calorie per centimeter °C second	4.1868* E + 02	watt per meter degree Celsius	W/m · °C)
calorie (IT) per cubic centimeter second	4.1868* E + 12	microwatt per cubic meter	$\mu W/m^3$
calorie (IT) per square centimeter second	4.1868* E + 07	milliwatt per square meter	mW/m^2
calorie (IT) per gram °C	4.1868* E + 00	kilojoule per kilogram degree celsius	kJ/(kg · °C)
calorie (thermochemical) per pound	9.224141 E + 00	joule per kilogram	J/kg
centigrade (= Celsius)			
centipoise	1.0* E + 00	millipascal second	mPa · s
centistoke	1.0* E + 00	square millimeter per second	mm^2/s
chain	2.01168* E + 01	meter	m
cubem (cubic mile)	4.168182 E + 00	cubic kilometer	km^3
cubic inch	1.638706 E − 02	cubic decimeter	dm^3
cubic foot (see standard cu. ft.)	2.831685 E − 02	cubic meter	m^3
cubic foot gas (60°F 1 atm)	9.690510 E − 04	mole per cubic meter	mol/m^3
per acre foot	2.291262 E − 05	cubic meter API per cubic meter	m^3API/m^3
cubic foot of gas (60°F − 1 atm) per barrel	1.777646 E − 01	cubic meter API per cubic meter	m^3API/m^3
cubic foot of gas per barrel of oil	7.518255 E + 00	mole per cubic meter	mol/m^3
cubic foot per foot	9.290304* E − 02	cubic meter per meter	m^3/m
cubic foot per pound	6.242797 E + 01	cubic decimeter per kilogram	dm^3/kg
cubic yard	7.645549 E − 01	cubic meter	m^3
cycle per second	1.0* E + 00	hertz	Hz
"cc"	1.0* E + 00	cubic centimeter	cm^3
CV (cheval vapeur)	7.354990 E − 01	kilowatt	kW
darcy	9.869233 E − 01	square micrometer	μm^2
decibel	0.1 × $\log_{10}$ (ratio of two intensities, e.g., watts)		dB
degree (angle) per foot	5.726145 E − 02	radian per meter	rad/m
degree (angle)	1.745329 E − 02	radian	rad
degree Centigrade (= Celsius)			
degree Fahrenheit	(°F − 32) 5/9* E + 00	degree Celsius	°C
degree Fahrenheit as interval	5/9* E + 00	degree Celsius	°C
degree Rankine	5/9* E + 00	kelvin	K
degree F per hundred foot	1.822689 E − 02	degree Celsius per meter	°C/m
dyne	1.0* E − 05	newton	N
dyne per centimeter	1.0* E + 00	millinewton per meter	mN/m
dyne per square centimeter	1.0* E − 01	pascal	Pa
erg	1.0* E − 07	joule	J
erg per square centimeter	1.0* E + 00	millijoule per square meter	mJ/m^2
erg per year	3.170979 E − 15	watt	W
fathom	1.8288* E + 00	meter	m
foot	3.048* E − 01	meter	m
foot-candle	1.076391 E + 01	lux	lx

*The conversion factor is exact.
[a]To go from metric to customary units, divide the conversion factor instead of multiplying.

continued

TABLE 5. continued

Traditional Unit	Multiply Value in Traditional Units by Factor × 10E to Obtain Value in Metric Units[a] Factor E	Selected Metric (S.I.) Unit Name	Symbol
foot per barrel	1.917134 E + 00	meter per cubic meter	m/m^3
foot per cubic foot	1.07639 E − 01	meter per cubic meter	m/m^3
foot per °F	5.4864* E − 01	meter per kelvin	m/K
foot per gallon (U.S.)	8.051964 E + 01	meter per cubic meter	m/m^3
foot per gallon	6.7046 E + 01	meter per cubic meter	m/m^3
foot per mile	1.893939 E − 01	meter per kilometer	m/km
foot pound-force	1.355818 E + 00	joule	J
foot pound-force per minute	2.259697 E − 02	watt	W
gal (see milligal)			
gallon (Cdn. & new U.K.)	4.54609* E + 00	liter	*l*
gallon (old U.K.)	4.546092 E + 00	liter	*l*
gallon (U.S.)	3.785412 E + 00	liter	*l*
gallon (U.S.) per foot	1.241933 E − 02	cubic meter per meter	m^3/m
gallon per foot	1.4914 E − 02	cubic meter per meter	m^3/m
gallon per horsepower hour	1.693466 E + 00	liter per megajoule	*l*/MJ
gallon per mile	2.824809 E + 02	liter per 100 kilometer	*l*/100km
gallon (U.S.) per mile	2.352146 E + 02	liter per 100 kilometer	*l*/100km
gallon per pound	1.002241 E + 01	liter per kilogram	*l*/kg
gallon (U.S.) per pound	8.345405 E + 00	liter per kilogram	*l*/kg
gallon (U.S.) per short ton	4.172702 E + 00	liter per tonne	*l*/t
gallon (U.S.) per long ton	3.725627 E + 00	liter per tonne	*l*/t
gamma (magnetic flux density)	1.0* E + 00	nanotesla	nT
gas constant: value	8.31432 E + 00	joule per mole kelvin	J/(mol · K)
gas gravity (density relative to air)	2.896 E + 01	gram per mole	g/mol
grain	6.479891* E + 01	milligram	mg
grain per 100 SCF	2.292768 E + 01	milligram per cubic meter API	mg/m^3
	5.421110 E − 01	milligram per mole	mg/mol
grain per gallon	1.42538 E − 02	gram per liter	g/*l*
gram mole	1.0* E + 00	mole	mol
horsepower (boiler)	9.80950 E + 00	kilowatt	kW
horsepower (550 ft-lb/s	7.456999 E − 01	kilowatt	kW
horsepower (electric)	7.46* E − 01	kilowatt	kW
horsepower (hydraulic)	7.46043 E − 01	kilowatt	kW
horsepower (metric)	7.35499 E − 01	kilowatt	kW
horsepower (U.K.) & "indicated" or "brake"	7.457 E − 01	kilowatt	kW
hundredweight	4.535924 E + 01	kilogram	kg
inch	2.54* E + 00	centimeter	cm
inch to the fourth power	4.162314 E + 05	millimeter to the fourth power	mm^4
inch of mercury (Hg) at 0°C	3.386389 E + 00	kilopascal	kPa
inch of mercury (Hg) at 60°C	3.37685 E + 00	kilopascal	kPa
inch of water (H_2O) at 60°F	2.48843 E − 01	kilopascal	kPa
kilogram-force (kgf)	9.80665* E + 00	newton	N
kilogram-force per square centimeter	9.80665* E + 01	kilopascal	kPa
kilogram-force per square millimeter	9.80665* E + 00	megapascal	MPa

*The conversion factor is exact.
[a]To go from metric to customary units, divide the conversion factor instead of multiplying.

continued

TABLE 5. continued

Traditional Unit	Multiply Value in Traditional Units by Factor × 10E to Obtain Value in Metric Units[a] Factor E	Selected Metric (S.I.) Unit Name	Symbol
kilopond (kp)	9.80665* E + 00	newton	N
kilowatt hour	3.6* E + 02	kilojoule	kJ
kip	4.448222 E + 00	kilonewton	kN
knot (international)	5.144444 E − 01	meter per second	m/s
link	2.01168 E − 01	meter	m
magnetic permeability (cgs e.m.u.)	1.256637 E + 00	microhenry per meter	μH/m
magnetic susceptibility (cgs e.m.u.)	1.579137 E + 01	microhenry per meter	μH/m
MCF (thousand cubic foot 60°F−1 atm)	2.826231 E + 01	cubic meter (API)	m^3API
	1.195307 E + 00	kilomole	kmol
MCF per acre foot (60°F−1 atm)	9.690510 E − 01	mole per cubic meter	mol/m^3
	2.291262 E − 02	cubic meter API per cubic meter	m^3API/m^3
microcalorie per square centimeter second	4.1868* E + 01	milliwatt per square meter	mW/m^2
micron	1.0* E + 00	micrometer	μm
microsecond per foot	3.280840 E + 00	microsecond per meter	μs/m
mil	2.54* E + 01	micrometer	μm
mile (U.S. and Canada)	1.609344* E + 00	kilometer	km
mile per gallon	3.540060 E − 01	kilometer per liter	km/l
mile per U.S. gallon	4.251437 E − 01	kilometer per liter	km/l
mile (international nautical)	1.852* E + 00	kilometer	km
millicalorie per second centimeter °C	4.1868* E + 02	milliwatt per meter degree Celsius	mW/(m · °C)
millidarcy	9.869233 E − 04	square micrometer	μm^2
milligal	1.0* E + 01	micrometer per second squared	$\mu m/s^2$
millimeter of mercury (Hg) 0°C	1.333222 E − 01	kilopascal	kPa
millimho	1.0* E + 00	millisiemens	mS
millimicron	1.0* E + 00	nanometer	nm
millimicrosecond	1.0* E + 00	nanosecond	ns
MMCF (million cubic foot 60°F − 1 atm	2.826231 E + 04	cubic meter (API)	m^3API
	1.195307 E + 00	megamole	Mmol
million years	1.0* E + 00	megayear	Ma
millisecond per foot	3.289474 E + 00	millisecond per meter	ms/m
neper per foot	3.777207 E − 01	decibel per meter	dB/m
oersted	7.957747 E + 01	ampere per meter	A/m
ounce (avdp)	2.834952 E + 01	gram	g
ounce (fluid UK)	2.841308 E + 01	cubic centimeter	cm^3
parts per billion (mass basis)	1.0* E + 00	microgram per kilogram	μg/kg
parts per million (ppm) (mass basis)	1.0* E + 00	milligram per kilogram	mg/kg
parts per million (ppm) (by volume)	1.0* E + 00	cubic meter per liter	m^3/l
	multiply parts by density in kg/m^3	milligram per cubic meter	mg/m^3
parts per thousand (0/00) (mass basis)	1.0 E + 00	gram per kilogram	g/kg
parts per thousand (0/00) (by volume)	1.0* E + 00	cubic centimeter per liter	cm^3/l
pint	5.68261 E − 01	liter	l
pound-force	4.448222 E + 00	newton	N
pound-force foot (see foot pound-force)			

*The conversion factor is exact.
[a]To go from metric to customary units, divide the conversion factor instead of multiplying.

continued

TABLE 5. continued

Traditional Unit	Multiply Value in Traditional Units by Factor × 10E to Obtain Value in Metric Units[a] Factor E	Selected Metric (S.I.) Unit Name	Symbol
poundal	1.382550 E − 01	newton	N
pound-force per 100 square foot	4.788026 E − 01	pascal	Pa
pound-force per square foot	4.788026 E + 01	pascal	Pa
pound-force per square inch (psi)	6.894757 E + 00	kilopascal	kPa
pound-force second per square foot	4.788026 E + 01	pascal second	Pa · s
pound-mass (avdp)	4.535924 E − 01	kilogram	kg
pound-mass per horsepower hour	1.689659 E + 02	milligram per kilojoule	mg/kJ
pound-mass per barrel	2.853010 E + 00	kilogram per cubic meter	kg/m^3
pound-mass per foot	1.488164 E + 00	kilogram per meter	kg/m
pound-mass foot per second	1.352549 E − 01	kilogram meter per second	kg · m/s
pound-mass per cubic foot	1.601846 E + 01	kilogram per cubic meter	kg/m^3
pound-mass per gallon	9.97763 E + 01	kilogram per cubic meter	kg/m^3
pound-mass per gallon (U.S.)	1.198264 E + 02	kilogram per cubic meter	kg/m^3
pound-mass per cubic inch	2.767990 E + 04	kilogram per cubic meter	kg/m^3
pound-mass per thousand cubic foot	1.601846 E − 02	kilogram per cubic meter	kg/m^3
pound-mass per square foot	4.882428 E + 00	kilogram per square meter	kg/m^2
pound mole	4.535924 E − 01	mole	mol
psi (pound-force per square inch)	6.894757 E + 00	kilopascal	kPa
psi per foot	2.262059 E + 01	kilopascal per meter	kPa/m
quart	1.136522 E + 00	liter	l
quart (U.S.)	9.463529 E − 01	liter	l
quarter section (160 acres)	6.474970 E + 01	hectare	ha
RPM	1.0* E + 00	revolution per minute	r/min
second per quart (U.S.)	1.056882 E + 00	second per liter	s/l
section (640 acres)	2.589988 E + 02	hectare	ha
square inch	6.4516* E + 00	square centimeter	cm^2
square foot	9.290304* E − 02	square meter	m^2
square mile	2.589988 E + 00	square kilometer	km^2
square yard	8.361274 E − 01	square meter	m^2
standard cubic foot	2.826231 E − 02	cubic meter API	m^3API
(60°F 1 atm − ideal gas)	1.195307 E + 00	mole	mol
TCF (trillion cubic foot 60°F 1 atm)	1.195307 E + 00	teramole	Tmol
	2.826231 E + 10	cubic meter (API)	m^3API
"thou"	2.54* E + 00	micrometer	μm
thirty-second of an inch	7.93750 E − 01	millimeter	mm
ton (U.S. short−2,000 lb)	9.071847 E − 01	tonne	t
ton (U.K. long−2,240 lb)	1.016047 E + 00	tonne	t
ton-mile	1.431744 E + 01	megajoule	MJ
ton-mile per foot	4.697322 E + 01	megajoule per meter	MJ/m
ton (metric)	1.0* E + 00	tonne	t
yard	9.144* E − 01	meter	m

Note: Although the conversion factors have been calculated for the S.I. unit judged to be the most frequently required, for any particular application reference should be made to other tables of recommended units.
*The conversion factor is exact.
[a]To go from metric to customary units, divide the conversion factor instead of multiplying.
Source: From Kenting Limited, n. d. *The International System of Units (S.I.) for the Petroleum Industry in Canada.* Calgary, Alberta, Canada.

TABLE 6. S.I. Units Commonly Used

Item	Name	Symbol	Printer
	Drilling, Cementing, and Formation Testing		
Linear	meter	m	M
(tool dimensions—always)	millimeter	mm	MILLIM
Area	square meter	m^2	M2
	hectare	ha	HECTARE
Volume and capacity	cubic meter	m^3	M3
	liter	*l*	LITRE
Mass	kilogram	kg	KG
	tonne	t	TONNE
	Other		
Time	second	s	S
	minute	min	MIN
	hour	h	HR
	day	day	D
	week	wk	WEEK
	month	mo	MONTH
	year	yr	ANN
	General Geology, Geophysics, and Reservoir Engineering		
Dip, gradient	meter per kilometer	m/km	M/KILOM
	degree	°	DEG
Geographical coordinates	degree or decimal degree	°	DEG
	minute	′	MNT
	second	″	S
Universal transverse mercator coordinates	meter	m	M
Distance	kilometer	km	KILOM
Elevation	meter	m	M
Depth	meter	m	M
Thickness of formations	meter	m	M
Area	square meter	m^2	M2
	hectare	ha	HECTARE
Volume of sediment in a basin	cubic kilometer	km^3	KILOM3
Geological age	megayear	Ma	MEGAANN
	Reservoir Geology and Engineering		
Volume of reservoir or fluid	cubic meter	m^3	M3
Volume of pore space or fluid per volume of sediment	cubic meter per cubic meter	m^3/m^3	M3/M3
Permeability	square micrometer	μm^2	MICROM2
Formation pressure	megapascal	MPa	MEGAPA
Capillary pressure	pascal	Pa	PA
Head	meter	m	M
Pressure gradient	kilopascal per meter	kPa/m	KILOPA/M
Gas-oil ratio	cubic meter API per cubic meter	m^3API/m^3	M3/M3
	kilomole per cubic meter	kmol/m^3	KILOMOL/M3
Productivity index	cubic meter per day kilopascal	$m^3/(d \cdot kPa)$	M3/(D.KILOPA)
	Pipeline Operations		
Flow	liter per second	*l*/s	LITRE/S
	cubic meter per second	m^3/s	M3/S
	cubic meter per hour	m^3/hr	M3/HR
Pressure	pascal	Pa	PA
Force	newton	N	N
Energy, work			
—quantity of heat	joule	J	J
Compressor rating:			
—compressor heads	kilopascal	kPa	KILOPA
—flow	cubic meter per second	m^3/s	M3/S
Pumping rating:			
—dynamic head	meter	m	M
—flow	liter per second	*l*/s	LITRE/S
—conversion factor	kilopascal per meter	kPa/m	KILOPA/M

TABLE 6. continued

Item	Name	Symbol	Printer
Gradient:			
—pressure	kilopascal	kPa/km	KILOPA/KILOM
—slope	meter per kilometer	m/km	M/KILOM
Viscosity:			
—dynamic (gas)	micropascal second	$\mu Pa \cdot s$	MICROPA.S
—kinematic	square millimeter per second	mm^2/s	MILLIM2/S
Rotational frequency	revolution per minute	r/min	R/MIN
	radian per second	rad/s	RAD/S
Concentration	mole per cubic meter	mol/m^3	MOL/M3
	gram per cubic meter	g/m^3	G/M3
	milligram per kilogram	mg/kg	MILLIG/KG
	cubic centimeter per cubic meter	cm^3/m^3	CENTIM3/M3
Density—gas	kilogram per cubic meter	kg/m^3	KG/M3
	gram per mole	g/mol	G/MOL
Gravity—liquid density	kilogram per cubic meter	kg/m^3	KG/M3
Velocity	meter per second	m/s	M/S
	kilometer per hour	km/hr	KILOM/HR
Sound intensity	watt per square meter	W/m^2	W/M2
	decibel	dB	DECIBEL
	Seismological Investigations and Survey		
Amount of explosive	kilogram	kg	KG
Attenuation	decibel	dB	DECIBEL
Energy of source	megajoule	MJ	MEGAJ
Frequency	hertz	Hz	HZ
Pressure of shock wave	gigapascal	GPa	GIGAPA
Travel time	second	s	S
Velocity	meter per second	m/s	M/S
Wavelength	meter	m	M
	Gravity and Magnetic Surveys		
Gravitational variation	micrometer per second squared	$\mu m/s^2$	MICROM/S2
Density	kilogram per cubic meter	kg/m^3	KG/M3
Magnetic flux density (intensity)	nanotesia	nT	NANOT
Magnetic permeability	microhenry per meter	$\mu H/m$	MICROH/M
Magnetic susceptibility	microhenry per meter	$\mu H/m$	MICROH/M
	Rock Mechanics		
Strength, stress,	megapascal	MPa	MEGAPA
bulk modulus, elastic constant	gigapascal	GPa	GIGAPA
Elastic modulus	gigapascal	GPa	GIGAPA
Viscosity	pascal second	$Pa \cdot s$	PA.S

Source: From Kenting Limited, n. d. *The International System of Units (S.I.) for the Petroleum Industry in Canada.* Calgary, Alberta, Canada.

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