UNIT CONVERSION

1 Purpose

For the physical quantities used in its product data sheets and other technical documents SPINNER generally utilizes the International System of Units (SI units). The aim of the present document is to provide the necessary relations for converting SI units into non-SI units and vice versa.

2 Length

	meter; m	millimeter; mm	inch; in	mil	foot; ft	yard; yd	mile; mi
1 m	1 m	1000 mm	39.37 in	39370 mil	3.2808 ft	1.0936 yd	$621.371 \cdot 10^{-6}$ mi
1 mm	0.001 m	1mm	0.03937 in	39.37 mil	$3.281 \cdot 10^{-3}$ ft	$1.0936 \cdot 10^{-3}$ yd	$621.371 \cdot 10^{-9}$ mi
1 in	$25.4 \cdot 10^{-3}$ m	25.4 mm	1 in	1000 mil	$\frac{1}{12}$ ft	$\frac{1}{36}$ yd	$15.783 \cdot 10^{-6}$ mi
1 mil	$25.4 \cdot 10^{-6}$ m	$25.4 \cdot 10^{-3}$ mm	0.001 in	1 mil	$\frac{1}{12000}$ ft	$\frac{1}{36000}$ yd	$15.783 \cdot 10^{-9}$ mi
1 ft	0.3048 m	304.8 mm	12 in	12000 mil	1 ft	$\frac{1}{3}$ yd	$189.394 \cdot 10^{-6}$ mi
1 yd	0.9144 m	914.4 mm	36 in	36000 mil	3 ft	1 yd	$568.182 \cdot 10^{-6}$ mi
1 mi	1609.344 m	1609344 mm	63360 in	$63.36 \cdot 10^{6}$ mil	5280 ft	1760 yd	1 mi

Note:
- 1 nautical mile = 1852 meter was adopted by the First International Extraordinary Hydrographic Conference (Monaco, 1929) under the name "International nautical mile".
- 1 mile (mi) ≠ 1 nautical mile.

3 Volume (Fluid)

	cubic meter; m³	liter; l	gallon (U.S.); gal	cubic inch; in³	pint (U.S. liquid); liq pt
1 m³	1 m^3	1000 l	264.2 gal	61024 in^3	2113 pt
1 l	10^{-3} m^3	1 l	0.264 gal	61.02 in^3	2.113 pt
1 gal	$3.785 \cdot 10^{-3}$ m^3	3.785 l	1 gal	231 in^3	8 pt
1 in³	$16.39 \cdot 10^{-6}$ m^3	$16.39 \cdot 10^{-3}$ l	$4.329 \cdot 10^{-3}$ gal	1 in^3	$34.63 \cdot 10^{-3}$ pt
1 liq pt	$473.2 \cdot 10^{-6}$ m^3	0.4732 l	$\frac{1}{8}$ gal	28.875 in^3	1 pt

Note:
- In 1964 the General Conference on Weights and Measures reestablished the name "liter" as a special name for the cubic decimeter. The recommended symbol for the liter in the United States is L.

4 Mass

	kilogram; kg	gram; g	ounce; oz	pound; lb
1 kg	1 kg	1000 g	35.27 oz	2.205 lb
1 g	0.001 kg	1 g	$35.27 \cdot 10^{-3}$ oz	$2.205 \cdot 10^{-3}$ lb
1 oz	$28.35 \cdot 10^{-3}$ kg	28.35 g	1 oz	$\frac{1}{16}$ lb
1 lb	$453.6 \cdot 10^{-3}$ kg	453.6 g	16 oz	1 lb

5 Force

	newton; N	kilogram-force, kilopond; kp	pound-force; lbf
1 N	1 N	0.10197 kp	0.22482 lbf
1 kp	9.80665 N	1 kp	2.2046 lbf
1 lbf	4.448 N	0.45359 kp	1 lbf

6 Pressure

	pascal; Pa	bar	pound-force per square inch; psi
1 Pa	1 Pa	$10 \cdot 10^{-6}$ bar	$0.145 \cdot 10^{-3}$ psi
1 bar	$0.1 \cdot 10^{6}$ Pa	1 bar	14.5 psi
1 psi	$6.895 \cdot 10^{3}$ Pa	$68.95 \cdot 10^{-3}$ bar	1 psi

Notes:
- absolute pressure: psia = psi-*absolute*
- relative pressure: psig = psi-*gauge*

7 Torque

	newton meter; Nm	pound-force foot; lbf·ft	ounce-force inch; ozf·in	pound-force inch; lbf·in
1 Nm	1 Nm	0.738 lbf·ft	141.6 ozf·in	8.851 lbf·in
1 lbf·ft	1.356 Nm	1 lbf·ft	192.0 ozf·in	12.00 lbf·in
1 ozf·in	$7.062 \cdot 10^{-3}$ Nm	$5.208 \cdot 10^{-3}$ lbf·ft	1 ozf·in	$62.5 \cdot 10^{-3}$ lbf·in
1 lbf·in	0.113 Nm	$83.333 \cdot 10^{-3}$ lbf·ft	16 ozf·in	1 lbf·in

8 Temperature

	degree Celsius; °C	Kelvin; K	degree Fahrenheit; °F
$\frac{\vartheta_C}{°C}$	$= \frac{\vartheta_C}{°C}$	$= \frac{T}{K} - 273.15$	$= (\frac{\vartheta_F}{°F} - 32) \cdot \frac{5}{9}$
$\frac{T}{K}$	$= \frac{\vartheta_C}{°C} + 273.15$	$= \frac{T}{K}$	$= (\frac{\vartheta_F}{°F} + 459.67) \cdot \frac{5}{9}$
$\frac{\vartheta_F}{°F}$	$= \frac{\vartheta_C}{°C} \cdot 1.8 + 32$	$= \frac{T}{K} \cdot 1.8 - 459.67$	$= \frac{\vartheta_F}{°F}$

9 Leak Rate and Mass Flow Rate [3]

	millibar liter per second	cubic centimeter per second	pascal liter per second
$1 \frac{mbar \cdot l}{s}$ @ T_n	$1 \frac{mbar \cdot l}{s}$ @ T_n	$0.9869 \frac{cm^3}{s}$ @ T_n, p_n	$100 \frac{Pa \cdot l}{s}$ @ T_n
$1 \frac{cm^3}{s}$ @ T_n, p_n	$1.01 \frac{mbar \cdot l}{s}$ @ T_n	$1 \frac{cm^3}{s}$ @ T_n, p_n	$101 \frac{Pa \cdot l}{s}$ @ T_n
$1 \frac{Pa \cdot l}{s}$ @ T_n	$1 \cdot 10^{-2} \frac{mbar \cdot l}{s}$ @ T_n	$\sim 1 \cdot 10^{-2} \frac{cm^3}{s}$ @ T_n, p_n	$1 \frac{Pa \cdot l}{s}$ @ T_n
$1 \frac{Torr \cdot l}{s}$ @ T_n	$1.33 \frac{mbar \cdot l}{s}$ @ T_n	$1.32 \frac{cm^3}{s}$ @ T_n, p_n	$133 \frac{Pa \cdot l}{s}$ @ T_n
$1 \frac{kg}{h}$ air @ 20 °C	$230 \frac{mbar \cdot l}{s}$ @ T_n	$230 \frac{cm^3}{s}$ @ T_n, p_n	$2.3 \cdot 10^4 \frac{Pa \cdot l}{s}$ @ T_n
$1 \frac{mol}{s}$	$2.27 \cdot 10^4 \frac{mbar \cdot l}{s}$ @ T_n	$2.25 \cdot 10^4 \frac{cm^3}{s}$ @ T_n, p_n	$2.26 \cdot 10^6 \frac{Pa \cdot l}{s}$ @ T_n

	torr liter per second	kilogram per hour air	mole per second
$1 \frac{mbar \cdot l}{s}$ @ T_n	$0.75 \frac{Torr \cdot l}{s}$ @ T_n	$4.3 \cdot 10^{-3} \frac{kg}{h}$ air @ 20 °C	$4.41 \cdot 10^{-5} \frac{mol}{s}$
$1 \frac{cm^3}{s}$ @ T_n, p_n	$0.76 \frac{Torr \cdot l}{s}$ @ T_n	$4.3 \cdot 10^{-3} \frac{kg}{h}$ air @ 20 °C	$4.45 \cdot 10^{-5} \frac{mol}{s}$
$1 \frac{Pa \cdot l}{s}$ @ T_n	$7.5 \cdot 10^{-3} \frac{Torr \cdot l}{s}$ @ T_n	$4.3 \cdot 10^{-5} \frac{kg}{h}$ air @ 20 °C	$4.41 \cdot 10^{-7} \frac{mol}{s}$
$1 \frac{Torr \cdot l}{s}$ @ T_n	$1 \frac{Torr \cdot l}{s}$ @ T_n	$5.7 \cdot 10^{-3} \frac{kg}{h}$ air @ 20 °C	$5.87 \cdot 10^{-5} \frac{mol}{s}$
$1 \frac{kg}{h}$ air @ 20 °C	$175 \frac{Torr \cdot l}{s}$ @ T_n	$1 \frac{kg}{h}$ air @ 20 °C	$1.01 \cdot 10^{-2} \frac{mol}{s}$
$1 \frac{mol}{s}$	$1.7 \cdot 10^4 \frac{Torr \cdot l}{s}$ @ T_n	$99 \frac{kg}{h}$ air @ 20 °C	$1 \frac{mol}{s}$

Notes:
- Standard reference conditions: T_n = 0°C, p_n = 1013.25 mbar.
- $\frac{p \cdot V}{T} = \text{const}$

10 Barometric Formula (Atmospheric Pressure versus Altitude) [1]

atmospheric pressure p_h	altitude h
$p_h/\mathrm{hPa} = 1013.25\left(1 - \frac{0.0065 \cdot h/\mathrm{m}}{288.15}\right)^{5.255}$	$h/\mathrm{m} = \frac{\left(1 - \left(\frac{p_h/\mathrm{hPa}}{1013.25}\right)^{\frac{1}{5.255}}\right) \cdot 288.15}{0.0065}$

Conditions:
- Standard temperature lapse rate: $0.0065\ \mathrm{K \cdot m^{-1}}$
- Standard temperature (sea level): 15°C = 288.15 K
- Static pressure (sea level): 1013.25 hPa
- Gravitational acceleration: $9.807\ \mathrm{m \cdot s^{-2}}$
- Molar mass of Earth's air: $0.02896\ \mathrm{kg \cdot mol^{-1}}$
- Universal gas constant for air: $8.314\ \mathrm{J \cdot K^{-1} \cdot mol^{-1}}$

h/m	h/ft	p_h/hPa	p_h/psia
0	0	1013.3	14.69
457	1500	959.5	13.91
1000	3281	898.8	13.03
2000	6562	795.0	11.53
2438	8000	752.7	10.91
3000	9842	701.1	10.17
4000	13123	616.5	8.94
4572	15000	571.9	8.29
5000	16404	540.3	7.83
6000	19685	471.9	6.84
7000	22966	410.7	5.95
8000	26246	356.1	5.16
9000	29527	307.5	4.46

h/m	h/ft	p_h/hPa	p_h/psia
10000	32808	264.4	3.83
11000	36089	226.4	3.28
12000	39370	192.9	2.80
12192	40000	186.9	2.71
13000	42650	163.5	2.37
14000	45931	137.9	2.00
15000	49212	115.6	1.68
16000	52493	96.4	1.40
16764	55000	83.5	1.21
17000	55774	79.8	1.16
18000	59054	65.6	0.95
19000	62335	53.5	0.78
20000	65616	43.3	0.63

11 Acceleration

angular acceleration α	tangential acceleration a_T
$\alpha = \frac{a_T}{r}$	$a_T = r \cdot \alpha$

angular acceleration α in $\mathrm{rad \cdot s^{-2}}$; tangential acceleration a_T in $\mathrm{m \cdot s^{-2}}$; radius r in m

12 References

[1] Horst Kuchling: Physik, 16. Auflage, VEB Fachbuchverlag, Leipzig, 1983, p. 143.
[2] Ambler Thompson, Barry N. Taylor, "Guide for the Use of the International System of Units (SI)", NIST Special Publication 811, 2008 Edition.
(http://physics.nist.gov/cuu/pdf/sp811.pdf)
(http://physics.nist.gov/Pubs/SP811/appenB9.html)
[3] Max Wutz, Hermann Adam, Wilhelm Walcher, Handbuch Vakuumtechnik: Theorie und Praxis, 6. Auflage, Vieweg Verlag, Braunschweig, Wiesbaden, 1997, p. 479.