

Appendix H: Common Units and Conversions

A Note on SI

The values in this catalog are expressed in International System of Units, or SI (from the French *Le Système International d'Unités*). Whenever possible, the common CGS or British equivalent has been parenthetically included as well.

These common conversions and constants have been included as a reference. Please refer to NIST Special Publication 811 "Guide for the Use of the International System of Units (SI)" for further standards and conversions.

References:

Barry N. Taylor, NIST Special Publication 811, 1995 Edition, *Guide for the Use of the International System of Units (SI)*, Washington, U.S. Government Printing Office, April 1995.

The NIST Reference on Constants, Units, and Uncertainty [online]. Available from the Internet: (<http://physics.nist.gov/cuu/Constants/index.html>), cited 03 February 2004.

Temperature

Fahrenheit to Celsius: $^{\circ}\text{C} = (^{\circ}\text{F} - 32)/1.8$

Celsius to Fahrenheit: $^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$

Fahrenheit to Kelvin: convert $^{\circ}\text{F}$ to $^{\circ}\text{C}$, then add 273.15

Celsius to Kelvin: add 273.15

Length

| | centimeter (cm) | meter (m) | inch (in) |
|-----------------|-----------------|------------------------|-----------|
| centimeter (cm) | 1 | 1.000×10^{-2} | 0.3937 |
| meter (m) | 100 | 1 | 39.37 |
| inch (in) | 2.540 | 2.540×10^{-2} | 1 |

1 micrometer (sometimes referred to as micron) = 10^{-6} m

1 mil = 10^{-3} in

Area

| | cm ² | m ² | in ² | circ mil |
|-----------------|------------------------|-------------------------|------------------------|---------------------|
| cm ² | 1 | 10^{-4} | 0.1550 | 1.974×10^5 |
| m ² | 10^4 | 1 | 1550 | 1.974×10^9 |
| in ² | 6.452 | 6.452×10^{-4} | 1 | 1.273×10^6 |
| circ mil | 5.067×10^{-6} | 5.067×10^{-10} | 7.854×10^{-7} | 1 |

Volume

1 liter (l) = 1.000×10^{-3} cubic meters (m³) = 61.02 cubic inches (in³)

Mass

1 kilogram (kg) = 1000 grams (g) = 2.205 pounds (lb)

Force

1 newton (N) = 0.2248 pounds (lb)

Pressure

| | pascal (Pa) | millibar (mbar) | torr (Torr) | atmosphere (atm) | psi (lbf/in ²) |
|----------------------------|---------------------|------------------------|------------------------|------------------------|----------------------------|
| pascal (Pa) | 1 | 1.000×10^{-2} | 7.501×10^{-3} | 9.868×10^{-6} | 1.450×10^{-4} |
| millibar (mbar) | 1.000×10^2 | 1 | 7.502×10^{-1} | 9.868×10^{-4} | 1.450×10^{-2} |
| torr (Torr) | 1.333×10^2 | 1.333×10^0 | 1 | 1.316×10^{-3} | 1.934×10^{-2} |
| atmosphere (atm) | 1.013×10^5 | 1.013×10^3 | 7.600×10^2 | 1 | 1.470×10^1 |
| psi (lbf/in ²) | 6.897×10^3 | 6.895×10^1 | 5.172×10^1 | 6.850×10^{-2} | 1 |

| | | |
|-----------------|----------|----------------------------|
| 1 torr (Torr) = | 133.332 | pascal (Pa) |
| | 1.33 | millibar (mbar) |
| | 0.001316 | atmosphere (atm) |
| | 0.01934 | psi (lbf/in ²) |

| | | |
|-----------------|-----------------------|----------------------------|
| 1 pascal (Pa) = | 0.001 | millibar (mbar) |
| | 0.007501 | torr (Torr) |
| | 9.87×10^{-6} | atmosphere (atm) |
| | 1.45×10^{-4} | psi (lbf/in ²) |

Electric Resistivity

$$\begin{aligned}
 1 \text{ micro-ohm-centimeter } (\mu\Omega\text{-cm}) &= 1.000 \times 10^{-6} \text{ ohm-centimeter } (\Omega\text{-cm}) \\
 &= 1.000 \times 10^{-8} \text{ ohm-meter } (\Omega\text{-m}) \\
 &= 6.015 \text{ ohm-circular mil per foot } (\Omega\text{-circ mil/ft})
 \end{aligned}$$

Magnetic Induction B

| | gauss (G) | kiloline/in ² | Wb/m ² | milligauss (mG) | gamma (γ) |
|--------------------------|-----------|--------------------------|------------------------|---------------------|---------------------|
| gauss (G) | 1 | 6.452×10^{-3} | 10^{-4} | 1000 | 10^5 |
| kiloline/in ² | 155.0 | 1 | 1.550×10^{-2} | 1.550×10^5 | 1.550×10^7 |
| Wb/m ² | 10^4 | 64.52 | 1 | 10^7 | 10^9 |
| milligauss (mG) | 0.001 | 6.452×10^{-6} | 10^{-7} | 1 | 100 |
| gamma (γ) | 10^{-5} | 6.452×10^{-8} | 10^{-9} | 0.01 | 1 |

$$1 \text{ ESU} = 2.998 \times 10^9 \text{ Wb/m}^2$$

Magnetomotive Force

| | abampere-turn | ampere-turn | Gilbert (Gi) |
|---------------|------------------------|-------------|--------------|
| abampere-turn | 1 | 10 | 12.57 |
| ampere-turn | 0.1 | 1 | 1.257 |
| Gilbert (Gi) | 7.958×10^{-2} | 0.7958 | 1 |

$$\begin{aligned}
 1 \text{ pragilbert} &= 4\pi \text{ ampere-turn} \\
 1 \text{ ESU} &= 2.655 \times 10^{-11} \text{ ampere-turn}
 \end{aligned}$$

Magnetic Field Strength H

| | abampere-turn/cm | ampere-turn/cm | ampere-turn/in | ampere-turn/m | oersted (Oe) |
|------------------|------------------------|----------------|------------------------|---------------|------------------------|
| abampere-turn/cm | 1 | 10 | 25.40 | 1000 | 12.57 |
| ampere-turn/cm | 0.1 | 1 | 2.540 | 100 | 1.257 |
| ampere-turn/in | 3.937×10^{-2} | 0.3937 | 1 | 39.37 | 0.4947 |
| ampere-turn/m | 0.001 | 0.01 | 2.540×10^{-2} | 1 | 1.257×10^{-2} |
| oersted (Oe) | 7.958×10^{-2} | 0.7958 | 2.021 | 79.58 | 1 |

$$\begin{aligned}
 1 \text{ Oe} &= 1 \text{ Gi} \\
 1 \text{ ESU} &= 2.655 \times 10^{-9} \text{ ampere-turn/m} \\
 1 \text{ praooersted} &= 4\pi \text{ ampere-turn/m}
 \end{aligned}$$

Energy, Work, Heat

| | Btu | erg | J | cal | kW-h |
|----------------------|-------------------------|------------------------|-------------------|------------------------|-------------------------|
| British thermal unit | 1 | 1.055×10^{10} | 1055 | 252.0 | 2.930×10^{-4} |
| erg | 9.481×10^{-11} | 1 | 10^{-7} | 2.389×10^{-8} | 2.778×10^{-14} |
| joule (J) | 9.481×10^{-4} | 10^7 | 1 | 0.2389 | 2.778×10^{-7} |
| calorie (cal) | 3.968×10^{-3} | 4.186×10^7 | 4.186 | 1 | 1.163×10^{-6} |
| kilowatt hour (kW-h) | 3413 | 3.6×10^{13} | 3.6×10^6 | 8.601×10^5 | 1 |

$$1 \text{ electronvolt (eV)} = 1.602 \times 10^{-19} \text{ joules (J)}$$

Heat Flow Rate

1 watt (W) = 3.413 Btu/h

1 British thermal unit per hour (Btu/h) = 0.2930 W

Fundamental Physical Constants

| Quantity | Symbol | Value* | Unit |
|--|-----------------|--|--|
| speed of light in a vacuum | c, c_0 | 299 792 458 | $\text{m} \cdot \text{s}^{-1}$ |
| magnetic constant | μ_0 | $4\pi \times 10^{-7} =$ $12.566370614... \times 10^{-7}$ | $\text{N} \cdot \text{A}^{-2}$ |
| electric constant $1/\mu_0 c^2$ | ϵ_0 | $8.854187817... \times 10^{-12}$ | $\text{F} \cdot \text{m}^{-1}$ |
| characteristic impedance of vacuum $\sqrt{\mu_0/\epsilon_0} = \mu_0 c$ | Z_0 | 376.730 313 461... | Ω |
| Planck constant | h | $6.6260693(11) \times 10^{-34}$ | $\text{J} \cdot \text{s}$ |
| in $\text{eV} \cdot \text{s}$ | | $4.13566743(35) \times 10^{-15}$ | $\text{eV} \cdot \text{s}$ |
| $\hbar/2\pi$ | \hbar | $1.05457168(18) \times 10^{-34}$ | $\text{J} \cdot \text{s}$ |
| in $\text{eV} \cdot \text{s}$ | | $6.58211915(56) \times 10^{-16}$ | $\text{eV} \cdot \text{s}$ |
| elementary charge | e | $1.60217653(14) \times 10^{-19}$ | C |
| magnetic flux quantum $h/2e$ | Φ_0 | $2.06783372(18) \times 10^{-15}$ | Wb |
| Avogadro constant | N_A, L | $6.0221415(10) \times 10^{23}$ | mol^{-1} |
| atomic mass constant $m_u = 1/12 m(^{12}\text{C}) = 1 \text{ u}$ | m_u | $1.66053886(28) \times 10^{-27}$ | kg |
| Faraday constant $N_A e$ | F | 96 485.3383(83) | $\text{C} \cdot \text{mol}^{-1}$ |
| molar gas constant | R | 8.314472(15) | $\text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$ |
| Boltzmann constant R/N_A | k | $1.3806505(24) \times 10^{-23}$ | $\text{J} \cdot \text{K}^{-1}$ |
| molar volume of ideal gas RT/p $T = 273.15 \text{ K}, p = 101.325 \text{ kPa}$ $T = 273.15 \text{ K}, p = 100 \text{ kPa}$ | V_m V_m' | $22.413996(39) \times 10^{-3}$ $22.710981(40) \times 10^{-3}$ | $\text{m}^3 \cdot \text{mol}^{-1}$ $\text{m}^3 \cdot \text{mol}^{-1}$ |
| Stefan-Boltzmann constant $(\pi^2/60)k^4/\hbar^3 c^2$ | σ | $5.670400(40) \times 10^{-8}$ | $\text{W} \cdot \text{m}^{-2} \cdot \text{K}^{-4}$ |
| electron volt: $(e/C)\text{J}$ | eV | $1.60217653(14) \times 10^{-19}$ | J |
| Bohr magneton $e\hbar/2m_e$ in $\text{eV} \cdot \text{T}^{-1} [\mu_B/(\text{J} \cdot \text{T}^{-1})](e/C)$ | μ_B | $927.400949(80) \times 10^{-26}$ $5.788381804(39) \times 10^{-5}$ | $\text{J} \cdot \text{T}^{-1}$ $\text{eV} \cdot \text{T}^{-1}$ |

*Values are shown in their concise form with uncertainty in parenthesis. Numbers with uncertainty values are subject to revision. Refer to the NIST Reference on Constants, Units, and Uncertainty website for the latest values (www.physics.nist.gov/cuu/index.html).