Tesla (unit)

The **tesla** (symbol: **T**) is the unit of magnetic flux density (also called magnetic B-field strength) in the International System of Units (SI).

One tesla is equal to one weber per square metre. The unit was announced during the General Conference on Weights and Measures in 1960 and is named[1] in honour of Serbian-American electrical and mechanical engineer Nikola Tesla

List of scientists whose names are used as units

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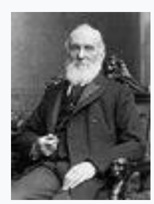
Many scientists have been recognized with the assignment of their names as international units by the International Committee for Weights and Measures or as non-SI units. The International System of Units (abbreviated SI from French: *Système international d'unités*) is the most widely used system of units of measurement. There are 7 base units and 22 derived units[1] (excluding compound units). These units are used both in science and in commerce. Two of the base SI units and 17 of the derived units are named after scientists.[2] 28 non-SI units are named after scientists. By this convention, their names are immortalised. As a rule, the SI units are written in lowercase letters, but symbols of units derived from the name of a person begin with a capital letter.

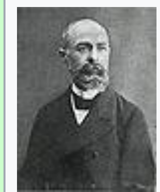
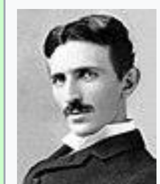
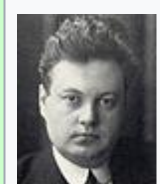
Scientists and SI units[edit]

Base unit[note 1]	Derived unit	(colour legend)

Name[3][4]	Life	Nationality	Quantity[5]	SI unit	Image
André-Marie Ampère[6]	1775–1836	French	Electric current[7]	ampere (A) (Base unit)	
William Thomson, 1st Baron Kelvin[8]	1824–1907	British (Irish-Scottish)	Thermodynamic temperature[9]	kelvin (K) (Base unit)	

Name[3][4]	Life	Nationality	Quantity[5]	SI unit	Image
Blaise Pascal[10]	1623–1662	French	Pressure[11]	pascal (Pa)	
Isaac Newton[12]	1643–1727	British (English)	Force[13]	newton (N)	
Anders Celsius[14]	1701–1744	Swedish	Temperature[15]	degree Celsius (°C)	
Charles-Augustin de Coulomb[16]	1736–1806	French	Electric charge[17]	coulomb (C)	
James Watt[18]	1736–1819	British (Scottish)	Power[19]	watt (W)	
Alessandro Volta[20]	1745–1827	Italian	Electric potential[21]	volt (V)	

Name[3][4]	Life	Nationality	Quantity[5]	SI unit	Image
Georg Simon Ohm[22]	1789–1855	German	Electrical resistance[23]	ohm (Ω)	
Michael Faraday[24]	1791–1867	British (English)	Capacitance[25]	farad (F)	
Joseph Henry[26]	1797–1878	American	Inductance[27]	henry (H)	
Wilhelm Eduard Weber[28]	1804–1891	German	Magnetic flux[29]	weber (Wb)	
Ernst Werner von Siemens[30]	1816–1892	German	Conductance[31]	siemens (S)	
James Prescott Joule[32]	1818–1889	British (English)	Energy[33]	joule (J)	

Name[3][4]	Life	Nationality	Quantity[5]	SI unit	Image
Antoine Henri Becquerel[34]	1852–1908	French	Radioactivity	becquerel (Bq)	
Nikola Tesla[35]	1856–1943	Serbian[note 2]-American	Magnetic flux density[36]	tesla (T)	
Heinrich Rudolf Hertz[37]	1857–1894	German	Frequency[38]	hertz (Hz)	
Rolf Maximilian Sievert[39]	1896–1966	Swedish	Dose equivalent of radiation[citation needed]	sievert (Sv)	
Louis Harold Gray[40]	1905–1965	British (English)	Absorbed dose of radiation[41]	gray (Gy)	

proposal of the Slovenian electrical engineer France Avčin.

Definition[edit]

A particle, carrying a charge of one coulomb (C), and moving perpendicularly through a magnetic field of one tesla, at a speed of one metre per second (m/s), experiences a force with magnitude one newton (N), according to the Lorentz force law. That is, As an SI derived unit, the tesla can also be expressed in terms of other units. For example, a magnetic flux of 1 weber (Wb) through a surface of one square meter is equal to a magnetic flux density of 1 tesla.[2] That is,

Expressed only in SI base units, 1 tesla is:

where A is ampere, kg is kilogram, and s is second.[2]

Additional equivalences result from the derivation of coulombs from amperes (A), :

the relationship between newtons and joules (J), :

and the derivation of the weber from volts (V), :

The tesla is named after Nikola Tesla. As with every SI unit named for a person, its symbol starts with an upper case letter (T), but when written in full, it follows the rules for capitalisation of a common noun; i.e., *tesla* becomes capitalised at the beginning of a sentence and in titles but is otherwise in lower case.

Electric vs. magnetic field[edit]

In the production of the Lorentz force, the difference between electric fields and magnetic fields is that a force from a magnetic field on a charged particle is generally due to the charged particle's movement,[3] while the force imparted by an electric field on a charged particle is not due to the charged particle's movement. This may be appreciated by looking at the units for each. The unit of electric field in the MKS system of units is newtons per coulomb, N/C, while the magnetic field (in teslas) can be written as N/(C·m/s). The dividing factor between the two types of field is metres per second (m/s), which is velocity. This relationship immediately highlights the fact that whether a static electromagnetic field is seen as purely magnetic, or purely electric, or some combination of these, is dependent upon one's reference frame (that is, one's velocity relative to the field).[4][5]

In ferromagnets, the movement creating the magnetic field is the electron spin[6] (and to a lesser extent electron orbital angular momentum). In a current-carrying wire (electromagnets) the movement is due to electrons moving through the wire (whether the wire is straight or circular).

Conversion to non-SI units[edit]

One tesla is equivalent to:[7][page needed]

- 10,000 (or 10^4) G (gauss), used in the CGS system. Thus, 1 G = 10^{-4} T = 100 μT (microtesla).
- 1,000,000,000 (or 10^9) γ (gamma), used in geophysics.[8]

For the relation to the units of the magnetising field (ampere per metre or Oersted), see the article on permeability.

Examples[edit]

Main article: Orders of magnitude (magnetic field)

The following examples are listed in the ascending order of the magnetic-field strength.

- 3.2×10^{-5} T (31.869 μT) – strength of Earth's magnetic field at 0° latitude, 0° longitude
- 4×10^{-5} T (40 μT) – walking under a high-voltage power line[9]
- 5×10^{-3} T (5 mT) – the strength of a typical refrigerator magnet
- 0.3 T – the strength of solar sunspots
- 1 T to 2.4 T – coil gap of a typical loudspeaker magnet
- 1.5 T to 3 T – strength of medical magnetic resonance imaging systems in practice, experimentally up to 17 T[10]
- 4 T – strength of the superconducting magnet built around the CMS detector at CERN[11]
- 5.16 T – the strength of a specially designed room temperature Halbach array[12]
- 8 T – the strength of LHC magnets
- 11.75 T – the strength of INUMAC magnets, largest MRI scanner[13]
- 13 T – strength of the superconducting ITER magnet system[14]
- 14.5 T – highest magnetic field strength ever recorded for an accelerator steering magnet at Fermilab[15]
- 16 T – magnetic field strength required to levitate a frog[16] (by diamagnetic levitation of the water in its body tissues) according to the 2000 Ig Nobel Prize in Physics[17]
- 17.6 T – strongest field trapped in a superconductor in a lab as of July 2014[18]
- 20 T - strength of the large scale high temperature superconducting magnet developed by MIT and Commonwealth Fusion Systems to be used in fusion reactors[citation needed]
- 27 T – maximal field strengths of superconducting electromagnets at cryogenic temperatures
- 35.4 T – the current (2009) world record for a superconducting electromagnet in a background magnetic field[19]

- 45 T – the current (2015) world record for continuous field magnets[19]
- 97.4 T – strongest magnetic field produced by a "non-destructive" magnet[20]
- 100 T – approximate magnetic field strength of a typical white dwarf star
- 1200 T – the field, lasting for about 100 microseconds, formed using the electromagnetic flux-compression technique[21]
- 10^9 T – Schwinger limit above which the electromagnetic field itself is expected to become nonlinear
- 10^8 – 10^{11} T (100 MT – 100 GT) – magnetic strength range of magnetar neutron stars

Notes and references[edit]

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