E 75 Electromagnetic Theory

FUNDAMENTAL AND DERIVED CONSTANTS

Name	Symbol	Computational value	Best (1969) experimental value*
Speed of light	c	3.00×10^{8} meters/sec	2.9979250(10)
Permeability constant	μ_0	1.26×10^{-6} henry/meter	$4\pi \times 10^{-7}$ exactly
Permitivity constant	ϵ_0	8.85×10^{-12} farad/meter	8.8541853(59)
Elementary charge	e	1.60×10^{-19} coul	1.6021917(70)
Avogadro's number	N_0	6.02×10^{23}/mole	6.022169(40)
Electron rest mass	m_e	9.11×10^{-31} kg	9.109558(54)
Proton rest mass	m_p	1.67×10^{-27} kg	1.672614(11)
Neutron rest mass	m_n	1.67×10^{-27} kg	1.674920(11)
Planck's constant	h	6.63×10^{-34} joule sec	6.626196(50)
Electron charge/mass ratio	e/m_e	1.76×10^{11} coul/kg	1.7588028(54)
Quantum/charge ratio	h/e	4.14×10^{-15} joule sec/coul	4.135708(14)
Electron Compton wavelength	λ_c	2.43×10^{-12} meter	2.4263096(74)
Rydberg constant	R_∞	1.10×10^{7}/meter	1.09737312(11)
Bohr radius	a_0	5.29×10^{-11} meter	5.2917715(81)
Bohr magneton	μ_B	9.27×10^{-24} joule/tesla	9.274096(65)
Nuclear magneton	μ_N	5.05×10^{-27} joule/tesla	5.050951(50)
Proton magnetic moment	μ_p	1.41×10^{-26} joule/tesla	1.4106203(90)
Universal gas constant	R	8.31 joule/°K mole	8.31434(35)
Standard volume of ideal gas	—	2.24×10^{-2} meter^3/mole	2.24136(30)
Boltzmann's constant	k	1.38×10^{-23} joule/°K	1.380622(59)
Stefan-Boltzmann constant	σ	5.67×10^{-8} watt/meter^2 °K^4	5.66961(96)
Gravitational constant	G	6.67×10^{-11} nt meter^2/kg^2	6.6732(31)

*Same units and power of ten as the computational value. The numbers in parentheses are the standard deviation uncertainties in the last digits of the quoted value.

from Physics, Resnick & Halliday, 1966.

Symbols, Dimensions, and Units for Physical Quantities

APPENDIX F

All units and dimensions are in the mksq (rationalized) system. The primary units can be found by reading kilograms for M, meters for L, seconds for T, and coulombs for Q. The symbols are those used in the text.

In practice, Q is defined in terms of M, L, and T. However, the addition of Q to the traditional M, L, and T enables us to avoid the use of fractional exponents in dimensional considerations. The term 'rationalized' simply means that a factor $1/4\pi$ is separated out of Coulomb's law in order to remove the factor 4π that would otherwise appear in many other formulas in electricity.

Quantity	Symbol	Dimensions	Derived Units
Acceleration	$\mathbf{a}$	LT^{-2}	meters/sec^2
Angular acceleration	α	T^{-2}	radians/sec^2
Angular displacement	θ	—	radian
Angular frequency and speed	ω	T^{-1}	radians/sec
Angular momentum	$\mathbf{L}$	ML^2T^{-1}	kg-m^2/sec
Angular velocity	$\boldsymbol{\omega}$	T^{-1}	radians/sec
Area	A, S	L^2	meter^2
Displacement	$\mathbf{r}, \mathbf{d}$	L	meter

Quantity	Symbol	Dimensions	Derived Units
Energy, total	E	ML^2T^{-2}	joule
kinetic	K	ML^2T^{-2}	joule
potential	U	ML^2T^{-2}	joule
Force	$\mathbf{F}$	MLT^{-2}	newton
Frequency	ν	T^{-1}	herts ≡ cycles/sec
Gravitational field	$\mathbf{g}$	LT^{-2}	nt/kg
Gravitational potential	V	L^2T^{-2}	joules/kg
Length	l	L	meter
Mass	m	M	kilogram
Mass density	ρ	ML^{-3}	kg/m^3
Momentum	$\mathbf{p}$	MLT^{-1}	kg-m/sec
Period	T	T	second
Power	P	ML^2T^{-3}	watt
Pressure	p	$ML^{-1}T^{-2}$	nt/m^2
Rotational inertia	I	ML^2	kg-m^2
Time	t	T	second
Torque	τ	ML^2T^{-2}	nt-m
Velocity	$\mathbf{v}$	LT^{-1}	meters/sec
Volume	V	L^3	meter^3
Wavelength	λ	L	meter
Work	W	ML^2T^{-2}	joule
Entropy	S	ML^2T^{-2}	joules/$K°$
Internal energy	U	ML^2T^{-2}	joule
Heat	Q	ML^2T^{-2}	joule
Temperature	T	—	Kelvin degree
Capacitance	C	$M^{-1}L^{-2}T^2Q^2$	farad
Charge	q	Q	coulomb
Conductivity	σ	$M^{-1}L^{-3}TQ^2$	(ohm-meter)$^{-1}$
Current	i	$T^{-1}Q$	ampere
Current density	$\mathbf{j}$	$L^{-2}T^{-1}Q$	amp/meter^2
Electric dipole moment	$\mathbf{p}$	LQ	coul-meter
Electric displacement	$\mathbf{D}$	$M^{-2}Q$	coul/meter^2
Electric polarization	$\mathbf{P}$	$M^{-2}Q$	coul-meter^2
Electric field	$\mathbf{E}$	$MLT^{-2}Q^{-1}$	volts/meter
Electric flux	Φ_E	$ML^3T^{-2}Q^{-1}$	volt-meter
Electric potential	V	$ML^2T^{-2}Q^{-1}$	volt
Electromotive force	$\mathcal{E}$	$ML^2T^{-2}Q^{-1}$	volt
Inductance	L	ML^2Q^{-2}	henry
Magnetic dipole moment	μ	$L^2T^{-1}Q$	amp-meter^2
Magnetic field	$\mathbf{H}$	$LT^{-1}Q$	amp-meter
Magnetic flux	Φ_B	$ML^2T^{-1}Q^{-1}$	weber = volt-sec
Magnetic induction	$\mathbf{B}$	$MT^{-1}Q^{-1}$	tesla ≡ webers/meter^2
Magnetization	$\mathbf{M}$	$L^{-1}T^{-1}Q$	amp/meter
Permeability	μ	MLQ^{-2}	henrys/meter
Permittivity	ϵ	$M^{-1}L^{-3}T^2Q^2$	farads/meter
Resistance	R	$ML^2T^{-1}Q^{-2}$	ohm
Resistivity	ρ	$ML^3T^{-1}Q^{-2}$	ohm-meter
Voltage	V	$ML^2T^{-2}Q^{-1}$	volt