PHYSICS FOR SCIENTISTS AND ENGINEERS

with Modern Physics

Eighth Edition

SERWAY | JEWETT

Pedagogical Color Chart

Mechanics and Thermodynamics

Displacement and position vectors

Displacement and position component vectors

Linear ($\vec{\mathbf{v}}$) and angular ($\vec{\boldsymbol{\omega}}$) velocity vectors

Velocity component vectors

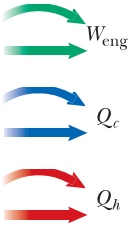
Force vectors ($\vec{\mathbf{F}}$)

Force component vectors

Acceleration vectors ($\vec{\mathbf{a}}$)

Acceleration component vectors

Energy transfer arrows



Process arrow

Linear ($\vec{\mathbf{p}}$) and angular ($\vec{\mathbf{L}}$) momentum vectors

Linear and angular momentum component vectors

Torque vectors ($\vec{\boldsymbol{\tau}}$)

Torque component vectors

Schematic linear or rotational motion directions

Dimensional rotational arrow

Enlargement arrow

Springs

Pulleys

Electricity and Magnetism

Electric fields

Electric field vectors

Electric field component vectors

Magnetic fields

Magnetic field vectors

Magnetic field component vectors

Positive charges

Negative charges

Resistors

Batteries and other DC power supplies

Switches

Capacitors

Inductors (coils)

Voltmeters

Ammeters

AC Sources

Lightbulbs

Ground symbol

Current

Light and Optics

Light ray

Focal light ray

Central light ray

Converging lens

Diverging lens

Mirror

Curved mirror

Objects

Images

Some Physical Constants

Quantity	**Symbol**	**Value**[a]
Atomic mass unit	u	$1.660\,538\,782\,(83) \times 10^{-27}$ kg 931.494 028 (23) MeV/c^2
Avogadro's number	N_A	$6.022\,141\,79\,(30) \times 10^{23}$ particles/mol
Bohr magneton	$\mu_B = \frac{e\hbar}{2m_e}$	$9.274\,009\,15\,(23) \times 10^{-24}$ J/T
Bohr radius	$a_0 = \frac{\hbar^2}{m_e e^2 k_e}$	$5.291\,772\,085\,9\,(36) \times 10^{-11}$ m
Boltzmann's constant	$k_B = \frac{R}{N_A}$	$1.380\,650\,4\,(24) \times 10^{-23}$ J/K
Compton wavelength	$\lambda_C = \frac{h}{m_e c}$	$2.426\,310\,217\,5\,(33) \times 10^{-12}$ m
Coulomb constant	$k_e = \frac{1}{4\pi\epsilon_0}$	$8.987\,551\,788\ldots \times 10^9$ N·m^2/C^2 (exact)
Deuteron mass	m_d	$3.343\,583\,20\,(17) \times 10^{-27}$ kg 2.013 553 212 724 (78) u
Electron mass	m_e	$9.109\,382\,15\,(45) \times 10^{-31}$ kg $5.485\,799\,094\,3\,(23) \times 10^{-4}$ u 0.510 998 910 (13) MeV/c^2
Electron volt	eV	$1.602\,176\,487\,(40) \times 10^{-19}$ J
Elementary charge	e	$1.602\,176\,487\,(40) \times 10^{-19}$ C
Gas constant	R	8.314 472 (15) J/mol·K
Gravitational constant	G	$6.674\,28\,(67) \times 10^{-11}$ N·m^2/kg^2
Neutron mass	m_n	$1.674\,927\,211\,(84) \times 10^{-27}$ kg 1.008 664 915 97 (43) u 939.565 346 (23) MeV/c^2
Nuclear magneton	$\mu_n = \frac{e\hbar}{2m_p}$	$5.050\,783\,24\,(13) \times 10^{-27}$ J/T
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ T·m/A (exact)
Permittivity of free space	$\epsilon_0 = \frac{1}{\mu_0 c^2}$	$8.854\,187\,817\ldots \times 10^{-12}$ C^2/N·m^2 (exact)
Planck's constant	h	$6.626\,068\,96\,(33) \times 10^{-34}$ J·s
	$\hbar = \frac{h}{2\pi}$	$1.054\,571\,628\,(53) \times 10^{-34}$ J·s
Proton mass	m_p	$1.672\,621\,637\,(83) \times 10^{-27}$ kg 1.007 276 466 77 (10) u 938.272 013 (23) MeV/c^2
Rydberg constant	R_H	$1.097\,373\,156\,852\,7\,(73) \times 10^7$ m^{-1}
Speed of light in vacuum	c	$2.997\,924\,58 \times 10^8$ m/s (exact)

Note: These constants are the values recommended in 2006 by CODATA, based on a least-squares adjustment of data from different measurements. For a more complete list, see P. J. Mohr, B. N. Taylor, and D. B. Newell, "CODATA Recommended Values of the Fundamental Physical Constants: 2006." *Rev. Mod. Phys.* **80:**2, 633–730, 2008.

[a]The numbers in parentheses for the values represent the uncertainties of the last two digits.

Solar System Data

Body	Mass (kg)	Mean Radius (m)	Period (s)	Mean Distance from the Sun (m)
Mercury	3.30×10^{23}	2.44×10^{6}	7.60×10^{6}	5.79×10^{10}
Venus	4.87×10^{24}	6.05×10^{6}	1.94×10^{7}	1.08×10^{11}
Earth	5.97×10^{24}	6.37×10^{6}	3.156×10^{7}	1.496×10^{11}
Mars	6.42×10^{23}	3.39×10^{6}	5.94×10^{7}	2.28×10^{11}
Jupiter	1.90×10^{27}	6.99×10^{7}	3.74×10^{8}	7.78×10^{11}
Saturn	5.68×10^{26}	5.82×10^{7}	9.29×10^{8}	1.43×10^{12}
Uranus	8.68×10^{25}	2.54×10^{7}	2.65×10^{9}	2.87×10^{12}
Neptune	1.02×10^{26}	2.46×10^{7}	5.18×10^{9}	4.50×10^{12}
Pluto[a]	1.25×10^{22}	1.20×10^{6}	7.82×10^{9}	5.91×10^{12}
Moon	7.35×10^{22}	1.74×10^{6}	—	—
Sun	1.989×10^{30}	6.96×10^{8}	—	—

[a]In August 2006, the International Astronomical Union adopted a definition of a planet that separates Pluto from the other eight planets. Pluto is now defined as a "dwarf planet" (like the asteroid Ceres).

Physical Data Often Used

Average Earth–Moon distance	3.84×10^{8} m
Average Earth–Sun distance	1.496×10^{11} m
Average radius of the Earth	6.37×10^{6} m
Density of air (20°C and 1 atm)	1.20 kg/m^3
Density of air (0°C and 1 atm)	1.29 kg/m^3
Density of water (20°C and 1 atm)	1.00×10^{3} kg/m^3
Free-fall acceleration	9.80 m/s^2
Mass of the Earth	5.97×10^{24} kg
Mass of the Moon	7.35×10^{22} kg
Mass of the Sun	1.99×10^{30} kg
Standard atmospheric pressure	1.013×10^{5} Pa

Note: These values are the ones used in the text.

Some Prefixes for Powers of Ten

Power	Prefix	Abbreviation	Power	Prefix	Abbreviation
10^{-24}	yocto	y	10^{1}	deka	da
10^{-21}	zepto	z	10^{2}	hecto	h
10^{-18}	atto	a	10^{3}	kilo	k
10^{-15}	femto	f	10^{6}	mega	M
10^{-12}	pico	p	10^{9}	giga	G
10^{-9}	nano	n	10^{12}	tera	T
10^{-6}	micro	μ	10^{15}	peta	P
10^{-3}	milli	m	10^{18}	exa	E
10^{-2}	centi	c	10^{21}	zetta	Z
10^{-1}	deci	d	10^{24}	yotta	Y

Physics

for Scientists and Engineers *with Modern Physics*

eighth edition

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