



9th edition

Physics for Scientists and Engineers

Serway/Jewett

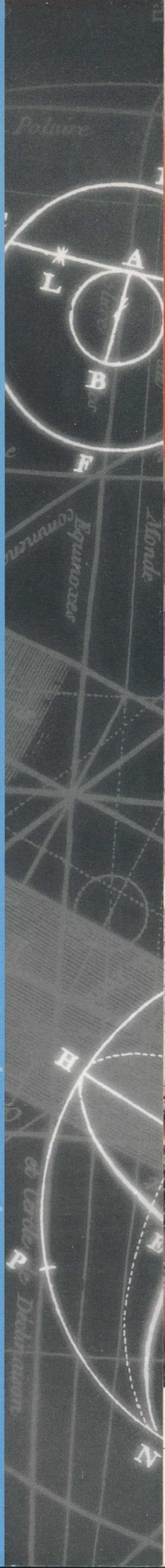
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Pedagogical Color Chart

Mechanics and Thermodynamics

Displacement and position vectors 


Displacement and position component vectors 

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

Velocity component vectors 

Force vectors (\vec{F}) 

Force component vectors 

Acceleration vectors (\vec{a}) 

Acceleration component vectors 

Energy transfer arrows  W_{eng}


 Q_c


 Q_h


Process arrow 


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

Linear and angular momentum component vectors 

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

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	$k_e = \frac{1}{4\pi\epsilon_0}$	$8.987\,551\,788 \dots \times 10^9$ 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	$\epsilon_0 = \frac{1}{\mu_0 c^2}$	$8.854\,187\,817 \dots \times 10^{-12}$ 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.

^aThe 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	—	—

^aIn 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

NINTH
EDITION

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About the Cover

The cover shows a view inside the new railway departures concourse opened in March 2012 at the Kings Cross Station in London. The wall of the older structure (completed in 1852) is visible at the left. The sweeping shell-like roof is claimed by the architect to be the largest single-span station structure in Europe. Many principles of physics are required to design and construct such an open semicircular roof with a radius of 74 meters and containing over 2 000 triangular panels. Other principles of physics are necessary to develop the lighting design, optimize the acoustics, and integrate the new structure with existing infrastructure, historic buildings, and railway platforms.



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We dedicate this book to our wives,
Elizabeth and Lisa, and all our children and
grandchildren for their loving understanding
when we spent time on writing
instead of being with them.

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