

## MasteringPhysics™ Constants

**Note:** The value of a constant given in the text of an item takes precedence over the values listed below.

### Mathematical Constants

Symbol	Value
$\pi$	3.14159...
$e$	2.71828...

### Astronomical Data<sup>†</sup>

Body	Mass (kg)	Radius (m)	Orbit radius (m)	Orbital period
Sun	$1.99 \times 10^{30}$	$6.96 \times 10^8$	—	—
Moon	$7.35 \times 10^{22}$	$1.74 \times 10^6$	$3.84 \times 10^8$	27.3 d
Mercury	$3.30 \times 10^{23}$	$2.44 \times 10^6$	$5.79 \times 10^{10}$	88.0 d
Venus	$4.87 \times 10^{24}$	$6.05 \times 10^6$	$1.08 \times 10^{11}$	224.7 d
Earth	$5.97 \times 10^{24}$	$6.37 \times 10^6$	$1.50 \times 10^{11}$	365.3 d
Mars	$6.42 \times 10^{23}$	$3.39 \times 10^6$	$2.28 \times 10^{11}$	687.0 d
Jupiter	$1.90 \times 10^{27}$	$6.99 \times 10^7$	$7.78 \times 10^{11}$	11.86 y
Saturn	$5.68 \times 10^{26}$	$5.82 \times 10^7$	$1.43 \times 10^{12}$	29.45 y
Uranus	$8.68 \times 10^{25}$	$2.54 \times 10^7$	$2.87 \times 10^{12}$	84.02 y
Neptune	$1.02 \times 10^{26}$	$2.46 \times 10^7$	$4.50 \times 10^{12}$	164.8 y
Pluto <sup>‡</sup>	$1.30 \times 10^{22}$	$1.19 \times 10^6$	$5.91 \times 10^{12}$	248.0 y

<sup>†</sup>Source: NASA (<http://solarsystem.nasa.gov/planets/>). For each body, "radius" is its average radius and "orbit radius" is its average distance from the sun or (for the moon) from the earth.

<sup>‡</sup>In August 2006, the International Astronomical Union reclassified Pluto and similar small objects that orbit the sun as "dwarf planets."

### Prefixes for Powers of 10

Power of ten	Prefix	Abbreviation	Pronunciation
$10^{-24}$	yocto-	y	yoc-toe
$10^{-21}$	zepto-	z	zep-toe
$10^{-18}$	atto-	a	at-toe
$10^{-15}$	femto-	f	fem-toe
$10^{-12}$	pico-	p	pee-koe
$10^{-9}$	nano-	n	nan-oe
$10^{-6}$	micro-	$\mu$	my-crow
$10^{-3}$	milli-	m	mil-i
$10^{-2}$	centi-	c	cen-ti
$10^3$	kilo-	k	kil-oe
$10^6$	mega-	M	meg-a
$10^9$	giga-	G	jig-a or gig-a
$10^{12}$	tera-	T	ter-a
$10^{15}$	peta-	P	pet-a
$10^{18}$	exa-	E	ex-a
$10^{21}$	zetta-	Z	zet-a
$10^{24}$	yotta-	Y	yot-a

#### Examples:

1 femtometer = 1 fm =  $10^{-15}$  m

1 picosecond = 1 ps =  $10^{-12}$  s

1 nanocoulomb = 1 nC =  $10^{-9}$  C

1 microkelvin = 1  $\mu$ K =  $10^{-6}$  K

1 millivolt = 1 mV =  $10^{-3}$  V

1 kilopascal = 1 kPa =  $10^3$  Pa

1 megawatt = 1 MW =  $10^6$  W

1 gigahertz = 1 GHz =  $10^9$  Hz

## Fundamental Physical Constants\*

Name	Symbol	Value
Speed of light in vacuum	$c$	$2.99792458 \times 10^8 \text{ m/s}$
Magnitude of charge of electron	$e$	$1.602176634 \times 10^{-19} \text{ C}$
Gravitational constant	$G$	$6.67408(31) \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$
Planck's constant	$h$	$6.62607015 \times 10^{-34} \text{ J} \cdot \text{s}$
Boltzmann constant	$k$	$1.380649 \times 10^{-23} \text{ J/K}$
Avogadro's number	$N_A$	$6.02214076 \times 10^{23} \text{ molecules/mol}$
Gas constant	$R$	$8.314462618 \dots \text{ J/mol} \cdot \text{K}$
Mass of electron	$m_e$	$9.10938356(11) \times 10^{-31} \text{ kg}$
Mass of proton	$m_p$	$1.672621898(21) \times 10^{-27} \text{ kg}$
Mass of neutron	$m_n$	$1.674927471(21) \times 10^{-27} \text{ kg}$
Magnetic constant	$\mu_0$	$1.25663706 \times 10^{-6} \text{ Wb/A} \cdot \text{m}$ (approximate) $\cong 4\pi \times 10^{-7} \text{ Wb/A} \cdot \text{m}$
Electric constant	$\epsilon_0 = 1/\mu_0 c^2$ $1/4\pi\epsilon_0$	$8.854187817 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$ (approximate) $8.987551787 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ (approximate)

## Other Useful Constants\*

Mechanical equivalent of heat		4.186 J/cal (15° calorie)
Standard atmospheric pressure	1 atm	$1.01325 \times 10^5 \text{ Pa}$
Absolute zero	0 K	$-273.15^\circ\text{C}$
Electron volt	1 eV	$1.6021766209(98) \times 10^{-19} \text{ J}$
Atomic mass unit	1 u	$1.660539040(20) \times 10^{-27} \text{ kg}$
Electron rest energy	$m_e c^2$	0.5109989461(31) MeV
Volume of ideal gas (0°C and 1 atm)		22.413962(13) liter/mol
Acceleration due to gravity (standard)	$g$	$9.80665 \text{ m/s}^2$

\*Source: National Institute of Standards and Technology (<http://physics.nist.gov/cuu>). Numbers in parentheses show the uncertainty in the final digits of the main number; for example, the number 1.6454(21) means  $1.6454 \pm 0.0021$ . Values shown without uncertainties are exact. The exact values of the magnitude of the charge of the electron, Planck's constant, the Boltzmann constant, Avogadro's number, and the gas constant are from the redefinitions adopted in 2018. As consequences of these redefinitions, the values of the magnetic constant and electric constant now have fractional uncertainties of about  $2 \times 10^{-10}$ . As of this writing (2018) it was expected that updated values of the magnetic and electric constants, as well as of all other constants with uncertainties, were to be announced in May 2019. These updated values will be available at <http://physics.nist.gov/cuu>.

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