

# The International System of Units (SI)

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# The International System of Units

Le Système international d'unités (SI) [french]

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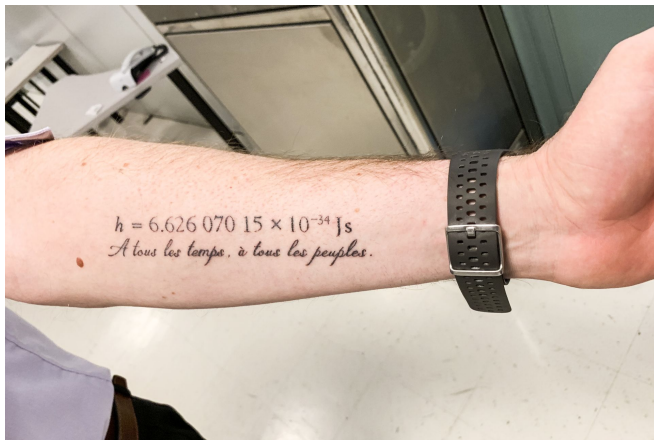
# SI units

- ▶ A *second* is about the time between heartbeats.
- ▶ A *meter* is about the length of an adult human leg.
- ▶ A *kilogram* is about the mass of a full 1-liter bottle of seltzer water.

In 2019, the SI underwent a major revision.



People are excited about the 2019 SI update.



## SI: Seven defining constants

Defining constant	Symbol	Numerical value	Unit
hyperfine transition frequency of Cs	$\Delta\nu_{\text{Cs}}$	9 192 631 770	Hz
speed of light in vacuum	$c$	299 792 458	$\text{m s}^{-1}$
Planck constant	$h$	$6.626\,070\,15 \times 10^{-34}$	J s
elementary charge	$e$	$1.602\,176\,634 \times 10^{-19}$	C
Boltzmann constant	$k$	$1.380\,649 \times 10^{-23}$	$\text{J K}^{-1}$
Avogadro constant	$N_{\text{A}}$	$6.022\,140\,76 \times 10^{23}$	$\text{mol}^{-1}$
luminous efficacy	$K_{\text{cd}}$	683	$\text{lm W}^{-1}$

# SI base units

Base quantity		Base unit	
Name	Typical symbol	Name	Symbol
time	$t$	second	s
length	$l, x, r, \text{etc.}$	meter	m
mass	$m$	kilogram	kg
electric current	$I, i$	ampere	A
temperature	$T$	kelvin	K
amount of substance	$n$	mole	mol
luminous intensity	$I_v$	candela	cd

# SI Logo





## SI base units

- ▶ A *second* is the time it takes for a Cesium-133 atom to make 9,192,631,770 periods of oscillation in its ground-state hyperfine transition.
- ▶ A *meter* is the distance light travels in  $1/299,792,458$  second.
- ▶ A *kilogram* is the mass that would result if  $(299,792,458)^2/6.62607015 \times 10^{-34}$  photons with frequency 1 Hz were transformed entirely into matter.

# SI prefixes

$10^{-24}$	yocto	(y)	$10^{24}$	yotta	(Y)
$10^{-21}$	zepto	(z)	$10^{21}$	zetta	(Z)
$10^{-18}$	atto	(a)	$10^{18}$	exa	(E)
$10^{-15}$	femto	(f)	$10^{15}$	peta	(P)
$10^{-12}$	pico	(p)	$10^{12}$	tera	(T)
$10^{-9}$	<b>nano</b>	(n)	$10^9$	<b>giga</b>	(G)
$10^{-6}$	<b>micro</b>	( $\mu$ )	$10^6$	<b>mega</b>	(M)
$10^{-3}$	<b>milli</b>	(m)	$10^3$	<b>kilo</b>	(k)
$10^{-2}$	<b>centi</b>	(c)	$10^2$	hecto	(h)
$10^{-1}$	deci	(d)	10	deca	(da)

In physics, variables contain units.

# Wrong

$$x = vt \text{ m}$$

$$x = 21$$

$$v = 7$$

$$t = 3$$

# Correct

$$x = vt$$

$$x = 21 \text{ m}$$

$$v = 7 \text{ m/s}$$

$$t = 3 \text{ s}$$