

Chemistry BC2001x PHYSICAL QUANTITIES, UNITS, AND CONSTANTS

Fundamental quantity	Common symbol	SI unit	Abbreviation
amount of substance	n	mole	mol
mass	m	kilogram	kg
length or distance	l or d or r	meter	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K

The above are defined **fundamental** physical quantities for SI units; those below are **derived**.

Derived quantity	Common symbol	Definition	Derived SI unit
volume	V	(length) ³	m ³
density	δ or ρ or d	mass / volume	kg / m ³ = kg·m ⁻³
velocity	v or u	distance / time	m / s = m·s ⁻¹
acceleration	a	velocity / time	m / s ² = m·s ⁻²
force	f	(mass) × (acceleration)	newton (N) = kg·m·s ⁻²
pressure	P or p	force / area	pascal (Pa) = N·m ⁻²
energy	E or U	(force) × (distance)	joule (J) = N·m
electric charge	Q	(current) × (time)	coulomb (C) = A·s
electric potential difference	E or script E	energy / charge	volt (V) = J / C = J·C ⁻¹

Memorize all the above definitions and units.

The information below on units and constants should also be familiar. Numerical values of conversion factors (except multiples of 10) and numerical values of physical constants will always be provided for examinations.

Powers of ten in SI units, with examples

In the SI system, the following special prefixes indicate multiplying by the listed powers of 10:

term	abbreviation	value	Example
mega-	M	10 ⁶	[1 MeV = 10 ⁶ eV]
kilo-	k	10 ³	[1 kilojoule = 1 kJ = 10 ³ J]
milli-	m	10 ⁻³	[1 mL = 10 ⁻³ L]
micro-	μ	10 ⁻⁶	[1 microsecond = 1 μ s = 10 ⁻⁶ s]
nano-	n	10 ⁻⁹	[1 nmol = 10 ⁻⁹ mol]
pico-	p	10 ⁻¹²	[1 picometer = 1 pm = 10 ⁻¹² m]

Definitions and conversions for other important, commonly used non-SI and SI units
(exactly) denotes numerical quantities defined by convention: no uncertainty

mass	1 gram (g) = 10^{-3} kg 1 milligram (mg) = 10^{-3} g = 10^{-6} kg
length	1 centimeter (cm) = 10^{-2} m 1 millimeter (mm) = 10^{-3} m 1 Ångstrom (Å) = 10^{-10} m = 10^{-8} cm = 0.1 nm = 100 pm
volume	1 liter (L) = 1000 mL = 1000 cm ³ = 10^{-3} m ³ 1 milliliter (mL) = 10^{-3} L = 1 cm ³ = 10^{-6} m ³
temperature	degrees Celsius or degrees Centigrade (°C) = K - 273.15 [0°C = 273.15 K (exactly)]
pressure	1 bar = 10^5 Pa 1 torr = 1 mmHg 1 atmosphere (atm) = 760 mmHg = 760 torr = 101325 Pa (exactly) = 1.01325×10^5 Pa = 1.01325 bar
energy	1 calorie (cal) = 4.184 J (exactly) 1 erg = 10^{-7} J 1 liter-atmosphere (L·atm) = 101.325 J (exactly) = 24.2173 cal
power energy	1 Watt = 1 J/sec so 1 J = 1 Watt-sec 1 kilowatt-hour (kWh) = 3600 kJ

Important fundamental physical constants [NIST web site; 2002 CODATA]
(values in parentheses are uncertainties in the rightmost digits)

Avogadro's number	N_A	= $6.0221415(10) \times 10^{23}$ mol ⁻¹	[1 amu = 1 / N_A g]
Ideal gas constant	R	= 8.314472(14) J·K ⁻¹ ·mol ⁻¹ = 1.987207 cal·K ⁻¹ ·mol ⁻¹ = 0.08205746 L·atm·K ⁻¹ ·mol ⁻¹ = 62.3637 L·mmHg·K ⁻¹ ·mol ⁻¹	
Boltzmann constant	$k = R / N_A$	= $1.3806505(24) \times 10^{-23}$ J·K ⁻¹	
proton charge	e	= $1.60217653(14) \times 10^{-19}$ C	[electron charge = -e]
Faraday	$F = N_A e$	= 96485.3383(83) C·mol ⁻¹	

Chang gives slightly different values for some of these (inside back cover). For example, he gives an older value for N_A : 6.0221367×10^{23} . This is a relative difference of 8×10^{-7} . This difference is negligible for any normal chemical calculation. You may use either.