

Physical Constants

Acceleration of gravity at
sea level and equator
Atomic mass unit

$$g = 9.806 \text{ m s}^{-2}$$
$$1 \text{ amu} = 1.660566 \times 10^{-24} \text{ g} =$$
$$(6.022045 \times 10^{23})^{-1} \text{ g}$$

Avogadro's number

$$N = 6.022045 \times 10^{23} \text{ mole}^{-1} \text{ or amu g}^{-1}$$

Bohr radius

$$a_0 = 0.529177 \text{ \AA} = 5.29177 \times 10^{-11} \text{ m}$$

Boltzmann's Constant

$$k = 1.38066 \times 10^{-23} \text{ JK}^{-1} \text{ molecule}^{-1}$$

Electron charge

$$e = 1.602189 \times 10^{-19} \text{ C}$$

Faraday's constant

$$F = 96,484.6 \text{ C mole}^{-1}$$

Gas constant

$$R = 8.31441 \text{ J K}^{-1} \text{ mole}^{-1}$$

$$R = 0.082057 \text{ L atm K}^{-1} \text{ mole}^{-1}$$

Mass of electron

$$m_e = 9.109534 \times 10^{-31} \text{ kg} = 0.0005486 \text{ amu}$$

Mass of proton

$$m_p = 1.672649 \times 10^{-27} \text{ kg} = 1.007276 \text{ amu}$$

Mass of neutron

$$m_n = 1.674954 \times 10^{-27} \text{ kg} = 1.008665 \text{ amu}$$

Mass of proton plus electron

$$m_{p+e} = 1.673560 \times 10^{-27} \text{ kg}$$

Planck's constant

$$h = 6.626176 \times 10^{-34} \text{ J s}$$

$$\frac{h}{2\pi} = \hbar = 1.054589 \times 10^{-34} \text{ J s}$$

Rydberg Constant

$$R_\infty = 109,737.32 \text{ cm}^{-1}$$

Speed of light

$$c = 2.9979246 \times 10^8 \text{ m s}^{-1}$$

Mass of an alpha particle

$$6.6 \times 10^{-27} \text{ kg}$$

Conversion Factors

$$1 \text{ atm} = 101.3 \text{ kPa} = 760 \text{ mm Hg} = 760 \text{ torr}$$

$$0^\circ\text{C} = 273.15 \text{ K}$$

$$x^\circ\text{F} = (9^\circ\text{F}/5^\circ\text{C}) y^\circ\text{C} + 32^\circ\text{F}$$

$$1 \text{ electron volt (eV)} = 1.602189 \times 10^{-19} \text{ J}$$

$$1 \text{ calorie} = 4.184 \text{ J}$$

$$1 \text{ liter atm} = 101.325 \text{ J}$$

$$2.303 RT = 5.7061 \text{ kJ mol}^{-1} \text{ at } 298 \text{ K}$$

$$1 \text{ kJ mole}^{-1} = 83.593 \text{ cm}^{-1} \text{ (from } E = hc\bar{\nu})$$

$$1 \text{ amu} = 1.49244 \times 10^{-10} \text{ J} = 931.502 \text{ MeV}$$

$$1 \text{ curie (Ci)} = 3.7 \times 10^{10} \text{ Becquerel (Bq)} = 3.7 \times 10^{10} \text{ disintegrations s}^{-1}$$

SI Scale Prefixes

$$\begin{array}{llll} \text{Tera (T)} & 10^{12} & \text{Kilo (k)} & 10^3 \\ \text{Giga (G)} & 10^9 & \text{Deci (d)} & 10^{-1} \\ \text{Mega (M)} & 10^6 & \text{Centi (c)} & 10^{-2} \end{array}$$

$$\text{Milli (m)} \quad 10^{-3}$$

$$\text{Micro } (\mu) \quad 10^{-6}$$

$$\text{Nano (n)} \quad 10^{-9}$$

$$\text{Pico (p)} \quad 10^{-12}$$

Fundamental Units

$$1 \text{ Joule} = 1 \text{ J} = 1 \text{ m}^2 \text{ kg s}^{-2}$$

$$1 \text{ Newton} = 1 \text{ N} = 1 \text{ m kg s}^{-2}$$

$$1 \text{ Pascal} = 1 \text{ Pa} = 1 \text{ N m}^{-2} = 1 \text{ J m}^{-3} = 1 \text{ kg m}^{-1} \text{ s}^{-2}$$

Formulae

$$\text{Properties of Light: } E = hf = hc/\lambda, c = f\lambda$$

$$\text{DeBroglie Wavelength: } \lambda = h/p$$

$$\text{Ideal Gases: } PV = nRT, \rho = \frac{P(\text{molar mass})}{RT}$$

Geometric Formulae

$$\text{Circumference of a Circle} = 2\pi r$$

$$\text{Area of a Circle} = \pi r^2$$

$$\text{Volume of a Sphere} = \frac{4}{3}\pi r^3$$

$$\text{Surface area of a Sphere} = 4\pi r^2$$

Differentials

$$\frac{dx}{dx} = 1$$

$$\frac{dx^n}{dx} = nx^{n-1}$$

$$\frac{d \ln x}{dx} = 1/x$$

$$\frac{df(x)}{dy} = \frac{df(x)}{dx} \frac{dx}{dy}$$

Integrals

$$\int_{x_1}^{x_2} f(x) dx = - \int_{x_2}^{x_1} f(x) dx$$

$$\int_{x_1}^{x_2} dx = x_2 - x_1$$

$$\int_{x_1}^{x_2} x^n dx = \frac{x_2^{n+1} - x_1^{n+1}}{n+1}$$

$$\int_{x_1}^{x_2} \frac{dx}{x} = \ln \frac{x_2}{x_1}$$

Quadratic Formula

if $ax^2 + bx + c = 0$ then

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Periodic Table of the Elements																		7A	8A			
1A																		17	18			
1																		1	2			
H																		H	He			
1.008																		1.008	4.003			
2A ← Current American usage → 3A																		4A	5A	6A		
2 ← IUPAC notation → 13																		14	15	16		
3	4											5	6	7	8	9	10					
Li	Be											B	C	N	O	F	Ne					
6.941	9.012											10.81	12.01	14.01	16.00	18.00	20.18					
11	12	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13	14	15	16	17	18					
Na	Mg	3	4	5	6	7	8	9	10	11	12	Al	Si	P	S	Cl	Ar					
22.99	24.31											26.98	28.09	30.97	32.07	35.45	39.95					
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36					
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr					
39.10	40.08	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39	69.72	72.61	74.92	78.96	79.90	83.80					
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54					
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe					
85.47	87.62	88.91	91.22	92.91	95.94	(99)	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3					
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86					
Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn					
132.9	137.3	138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(209)	(210)	(222)					
87	88	89	104	105	106	107	108	109	110	111	112											
Fr	Ra	†Ac	Rf	Db	Sg	Bh	Hs	Mt	U	U												
(223)	226.0	227.0	(261)	(262)	(263)	(262)	(265)	(268)	(269)	(272)												

*Lanthanide series

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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†Actinide series

90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)
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All atomic masses have been rounded off to four significant figures.

‡ The International Union for Pure and Applied Chemistry has not adopted official names or symbols for these elements.