Prefixes

a=10^{-18}, f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}

Physical Constants

$k = 1/4\pi\epsilon_0 = 8.988$ GNm^2/C^2 (Coulomb's Law)
$e = 1.602 \times 10^{-19}$ C (proton charge)
$c = 3.00 \times 10^8$ m/s (speed of light)
$m_e = 9.1094 \times 10^{-31}$ kg (electron mass)
$m_n = 1.67493 \times 10^{-27}$ kg = (neutron mass)
$h = 6.62607 \times 10^{-34}$ J·s (Planck's constant)

$\epsilon_0 = 1/4\pi k = 8.854$ pF/m (permittivity of space)
$\mu_0 = 4\pi \times 10^{-7}$ T·m/A (permeability of space)
$c = 2.99792458 \times 10^8$ m/s (exact value in vacuum)
$m_p = 1.67262 \times 10^{-27}$ kg (proton mass)
$hc = 1239.84$ eV·nm (photon energy = hc/λ)
$\hbar = 1.05457 \times 10^{-34}$ J·s (Planck's constant/2π)

Units

$N_A = 6.02 \times 10^{23}$/mole (Avogadro's #)
1.0 eV = 1.602×10^{-19} J (electron-volt)
1 F = 1 C/V = 1 farad = 1 C^2/J
1 A = 1 C/s = 1 ampere = 1 coulomb/second
1 T = 1 N/A·m = 1 tesla = 1 newton/ampere·meter
1 Bq = 1 becquerel = 1 decay/s

1 u = 1 g/N_A = 1.6605×10^{-27} kg = 931.5 MeV/c^2 (mass unit)
1 V = 1 J/C = 1 volt = 1 joule/coulomb
1 H = 1 V·s/A = 1 henry = 1 J/A^2
1 Ω = 1 V/A = 1 ohm = 1 J·s/C^2
1 G = 10^{-4} T = 1 gauss = 10^{-4} tesla
1 Ci = 1 curie = 3.70×10^{10} decays/s = 37.0 GBq

Some Masses (for neutral atoms)

electron = ${}^{0}_{-1}$e = 0.00054858 u = 0.51100 MeV/c^2
neutron = ${}^{1}_{0}$n = n = 1.008665 u = 939.57 MeV/c^2
deuterium = ${}^{2}_{1}$H = d = 2.014102 u
helium-3 = ${}^{3}_{2}$He = 3.016029 u

proton = ${}^{1}_{1}$p = p =1.007276 u = 938.27 MeV/c^2
hydrogen = ${}^{1}_{1}$H = 1.007825 u = 938.78 MeV/c^2
tritium = ${}^{3}_{1}$H = t = 3.016049 u
helium-4 = ${}^{4}_{2}$He = α = 4.002603 u

OpenStax Chapter 30 Equations - Atomic Physics

Bohr Model:

$hf = E_n - E_{n'}$ (quantum jump)
$r_n = \frac{n^2}{Z} r_1$ (Bohr radii)
$E_n = -(13.6\text{ eV})\frac{Z^2}{n^2}$ (Bohr energies)
$n = 1, 2, 3, ...$ (Bohr's quantum number)

$L = mvr = n\frac{h}{2\pi}$ (Bohr's quantization)
$r_1 = \frac{h^2}{4\pi^2 mke^2} = 52.9$ pm (1$^{\text{st}}$ Bohr radius)
$E_n = \frac{1}{2}mv^2 - \frac{kZe^2}{r_n}$ (total energy)
$E = hc/\lambda = (1240\text{ eV} \cdot \text{nm})/\lambda$ (photons)

Quantum numbers for atoms:

principle quantum number $n = 0, 1, 2, 3...$
orbital quantum number $l = 0, 1, 2...(n-1)$
magnetic quantum number $m_l = -l$ to $+l$
spin quantum number $m_s = -\frac{1}{2}, +\frac{1}{2}$
shell ($2n^2$ states) means a value of (n) is given.
orbital (2 states) means particular (n, l, m_l) are given.

$E_n = -(13.6\text{ eV})/n^2$ (energy of hydrogen states)
$L = \sqrt{l(l+1)}\,\hbar$ (angular momentum magnitude)
$L_z = m_l\hbar$ (z-component of $\vec{L}$)
$S_z = m_s\hbar$ (z-comp., spin angular momentum)
sub-shell [$2(2\ell+1)$ states] means values of (n, l) are given.
state means particular (n, l, m_l, m_s) are given.

$l = 0, 1, 2, 3, 4, 5, 6...$ are indicated with respective letters: s, p, d, f, g, h,...

Pauli exclusion principle: *No two electrons in an atom can occupy the same quantum state.*

Subshells in order of increasing energy: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p

(They fill in order of increasing $n + l$, or increasing n if there is a tie.)

OpenStax Chapter 31 Equations - Radioactivity & Nuclear Physics

Nuclides:

$A = N + Z$, (mass, neutron, proton numbers) — $r = (1.2\text{ fm})\ A^{1/3}$ (nuclear radius)

$\Delta E =$[(mass of parts) - (mass of nuclide)]c^2 — $\leftarrow$ (binding energy)

$Q = [M_{\text{parent}} - M_{\text{products}}]c^2$ — $\leftarrow$ (disintegration energy)

1 u = 1 gram / 6.02×10^{23} (atomic mass unit) — 1 u $\cdot\, c^2 = 931.5$ MeV (energy unit)

Half-life $T_{1/2}$ and decay constant λ

$N = N_0 e^{-\lambda t}$ (decay of parent nuclei) — $N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$ (decay by half-lives)

$t = \frac{-1}{\lambda} \ln(N/N_0)$ (time when N nuclei remain) — $\mathcal{A} = \left|\frac{\Delta N}{\Delta t}\right| = N\lambda$ (radio-activity)

$\lambda T_{\frac{1}{2}} = \ln 2$ (decay constant, half-life) — $M = Nm$ = mass = (# of nuclei)×(nuclear mass)

$\#({}^{14}_{6}C)/\#({}^{12}_{6}C) = 1.3 \times 10^{-12}$ (live carbon ratio) — 1 year = 3.156×10^7 seconds

OpenStax Chapter 32 Equations - Applications of Nuclear Physics

Radiation doses:

absorbed dose = energy absorbed / mass affected — $\leftarrow$ SI unit = 1 gray = 1 Gy = 1 J/kg = 100 rad.

effective dose = absorbed dose × RBE — $\leftarrow$ SI unit = 1 sievert = 1 Sv = 1 J/kg = 100 rem.

RBE = relative biological effectiveness — RBE = QF = quality factor (units = Sv/Gy).

radiation:	γ-rays	slow β's	fast β's	slow neutrons	fast neutrons	protons	α's	heavy ions
RBE =	1	1.7	1	2–5	10	10	10–20	10–20

Reactions:

$Q = [M_{\text{reactants}} - M_{\text{products}}]c^2$ (reaction energy)

$Q > 0$ (Q = mass converted to energy) — $Q < 0$ ($|Q|$ = threshold energy)

Energy, power and mass in nuclear reactors:

$E = mc^2$ (Einstein's mass-energy equivalence) — $P = E/t$ (power)

$E = NQ$ [energy= (# of reactions)×(reaction energy)] — 1 u $\cdot\, c^2 = 931.5$ MeV

$M = Nm$ [mass used= (# of reactions)×(reaction mass)]

$E_{\text{out}} = eE_{\text{in}}$ [output energy = (efficiency)×(input energy)]

Periodic Table of the Elements§

Symbol — Cl 17 — Atomic Number
Atomic Mass§ — 35.4527
$3p^5$ — Electron Configuration (outer shells only)

Group I	Group II	Transition Elements										Group III	Group IV	Group V	Group VI	Group VII	Group VIII
H 1 1.00794 $1s^1$																	He 2 4.002602 $1s^2$
Li 3 6.941 $2s^1$	Be 4 9.012182 $2s^2$											B 5 10.811 $2p^1$	C 6 12.0107 $2p^2$	N 7 14.00674 $2p^3$	O 8 15.9994 $2p^4$	F 9 18.9984032 $2p^5$	Ne 10 20.1797 $2p^6$
Na 11 22.989770 $3s^1$	Mg 12 24.3050 $3s^2$											Al 13 26.981538 $3p^1$	Si 14 28.0855 $3p^2$	P 15 30.973761 $3p^3$	S 16 32.066 $3p^4$	Cl 17 35.4527 $3p^5$	Ar 18 39.948 $3p^6$
K 19 39.0983 $4s^1$	Ca 20 40.078 $4s^2$	Sc 21 44.955910 $3d^14s^2$	Ti 22 47.867 $3d^24s^2$	V 23 50.9415 $3d^34s^2$	Cr 24 51.9961 $3d^54s^1$	Mn 25 54.938049 $3d^54s^2$	Fe 26 55.845 $3d^64s^2$	Co 27 58.933200 $3d^74s^2$	Ni 28 58.6934 $3d^84s^2$	Cu 29 63.546 $3d^{10}4s^1$	Zn 30 65.39 $3d^{10}4s^2$	Ga 31 69.723 $4p^1$	Ge 32 72.61 $4p^2$	As 33 74.92160 $4p^3$	Se 34 78.96 $4p^4$	Br 35 79.904 $4p^5$	Kr 36 83.80 $4p^6$
Rb 37 85.4678 $5s^1$	Sr 38 87.62 $5s^2$	Y 39 88.90585 $4d^15s^2$	Zr 40 91.224 $4d^25s^2$	Nb 41 92.90638 $4d^45s^1$	Mo 42 95.94 $4d^55s^1$	Tc 43 (98) $4d^55s^2$	Ru 44 101.07 $4d^75s^1$	Rh 45 102.90550 $4d^85s^1$	Pd 46 106.42 $4d^{10}5s^0$	Ag 47 107.8682 $4d^{10}5s^1$	Cd 48 112.411 $4d^{10}5s^2$	In 49 114.818 $5p^1$	Sn 50 118.710 $5p^2$	Sb 51 121.760 $5p^3$	Te 52 127.60 $5p^4$	I 53 126.90447 $5p^5$	Xe 54 131.29 $5p^6$
Cs 55 132.90545 $6s^1$	Ba 56 137.327 $6s^2$	57–71†	Hf 72 178.49 $5d^26s^2$	Ta 73 180.9479 $5d^36s^2$	W 74 183.84 $5d^46s^2$	Re 75 186.207 $5d^56s^2$	Os 76 190.23 $5d^66s^2$	Ir 77 192.217 $5d^76s^2$	Pt 78 195.078 $5d^96s^1$	Au 79 196.96655 $5d^{10}6s^1$	Hg 80 200.59 $5d^{10}6s^2$	Tl 81 204.3833 $6p^1$	Pb 82 207.2 $6p^2$	Bi 83 208.98038 $6p^3$	Po 84 (209) $6p^4$	At 85 (210) $6p^5$	Rn 86 (222) $6p^6$
Fr 87 (223) $7s^1$	Ra 88 (226) $7s^2$	89–103‡	Rf 104 (261) $6d^27s^2$	Db 105 (262) $6d^37s^2$	Sg 106 (266) $6d^47s^2$	Bh 107 (264) $6d^57s^2$	Hs 108 (269) $6d^67s^2$	Mt 109 (268) $6d^77s^2$	Ds 110 (271) $6d^97s^1$	111 (272) $6d^{10}7s^1$	112 (277) $6d^{10}7s^2$						

†Lanthanide Series	La 57 138.9055 $5d^16s^2$	Ce 58 140.115 $4f^15d^16s^2$	Pr 59 140.90765 $4f^35d^06s^2$	Nd 60 144.24 $4f^45d^06s^2$	Pm 61 (145) $4f^55d^06s^2$	Sm 62 150.36 $4f^65d^06s^2$	Eu 63 151.964 $4f^75d^06s^2$	Gd 64 157.25 $4f^75d^16s^2$	Tb 65 158.92534 $4f^95d^06s^2$	Dy 66 162.50 $4f^{10}5d^06s^2$	Ho 67 164.93032 $4f^{11}5d^06s^2$	Er 68 167.26 $4f^{12}5d^06s^2$	Tm 69 168.93421 $4f^{13}5d^06s^2$	Yb 70 173.04 $4f^{14}5d^06s^2$	Lu 71 174.967 $4f^{14}5d^16s^2$
‡Actinide Series	Ac 89 (227.02775) $6d^17s^2$	Th 90 232.0381 $6d^27s^2$	Pa 91 (231) $5f^26d^17s^2$	U 92 238.0289 $5f^36d^17s^2$	Np 93 (237) $5f^46d^17s^2$	Pu 94 (244) $5f^66d^07s^2$	Am 95 (243) $5f^76d^07s^2$	Cm 96 (247) $5f^76d^17s^2$	Bk 97 (247) $5f^96d^07s^2$	Cf 98 (251) $5f^{10}6d^07s^2$	Es 99 (252) $5f^{11}6d^07s^2$	Fm 100 (257) $5f^{12}6d^07s^2$	Md 101 (258) $5f^{13}6d^07s^2$	No 102 (259) $5f^{14}6d^07s^2$	Lr 103 (262) $5f^{14}6d^17s^2$

§ Atomic mass values averaged over isotopes in the percentages they occur on Earth's surface. For unstable elements, mass of the longest-lived known isotope is given in parentheses. 2003 revisions. (See also Appendix B.)