

Periodic Table of the Elements

Atomic number, symbol, atomic mass (u). Brackets: no stable isotope; a representative mass number is shown.

Alkali metals · Alkaline earth · Transition metals · Post-transition · Metalloids · Nonmetals · Halogens · Noble gases · Lanthanides · Actinides

1 H 1.008																	2 He 4.003
3 Li 6.94	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [98]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	89-103	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [277]	109 Mt [268]	110 Ds [281]	111 Rg [272]	112 Cn [285]	113 Nh [286]	114 Fl [289]	115 Mc [289]	116 Lv [293]	117 Ts [294]	118 Og [294]

Lanthanides	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinides	89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	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 [262]

FORMULAS: MATH | PHYSICS | CHEMISTRY

Algebra

Quadratic: $x = (-b \pm \sqrt{(b^2-4ac)}) / (2a)$
$a^m a^n = a^{m+n}$; $(a^m)^n = a^{mn}$; $a^{-n} = 1/a^n$
$\log(xy) = \log x + \log y$; $\log(x/y) = \log x - \log y$; $\log x^n = n \log x$; $\log_b x = \ln x / \ln b$
$y = mx + b$; $m = (y_2-y_1)/(x_2-x_1)$

Trigonometry

$\sin^2\theta + \cos^2\theta = 1$; $\tan\theta = \sin\theta / \cos\theta$
$\sin 2\theta = 2 \sin\theta \cos\theta$; $\cos 2\theta = \cos^2\theta - \sin^2\theta$
$\sin(A\pm B) = \sin A \cos B \pm \cos A \sin B$
$\cos(A\pm B) = \cos A \cos B \mp \sin A \sin B$
Law of cosines: $c^2 = a^2 + b^2 - 2ab \cos C$

Calculus

$d/dx\, x^n = n x^{n-1}$; $d/dx\, e^x = e^x$; $d/dx \ln x = 1/x$
$d/dx \sin x = \cos x$; $d/dx \cos x = -\sin x$
Product: $(fg)' = f'g + fg'$; Quotient: $(f/g)' = (f'g - fg')/g^2$
Chain: $d/dx\, f(g(x)) = f'(g(x))\cdot g'(x)$
$\int x^n dx = x^{n+1}/(n+1) + C$ $(n \neq -1)$; $\int dx/x = \ln|x| + C$
$\int e^x dx = e^x + C$; $\int \sin x\, dx = -\cos x + C$; $\int \cos x\, dx = \sin x + C$

Geometry and statistics

Circle: $A = \pi r^2$, $C = 2\pi r$; Triangle: $A = \frac{1}{2}bh$
Sphere: $V = (4/3)\pi r^3$, $A = 4\pi r^2$; Cylinder: $V = \pi r^2 h$; Cone: $V = (1/3)\pi r^2 h$
mean $= \Sigma x/n$; $s = \sqrt{(\Sigma(x-\text{mean})^2/(n-1))}$; $z = (x-\mu)/\sigma$
z for 90% / 95% / 99% confidence: 1.645 / 1.960 / 2.576

Motion

$v = v_0 + at$; $\Delta x = v_0 t + \frac{1}{2}at^2$
$v^2 = v_0^2 + 2a\Delta x$; $\Delta x = \frac{1}{2}(v_0+v)t$
Projectile: $x = v_0 \cos\theta \cdot t$; $y = v_0 \sin\theta \cdot t - \frac{1}{2}gt^2$
$a_c = v^2/r$; $v = \omega r$; $\omega = 2\pi/T$

Forces and momentum

$\Sigma F = ma$; $W = mg$; $f = \mu N$; $F_{spring} = -kx$
$F_g = Gm_1m_2/r^2$; $\tau = rF \sin\theta$
$p = mv$; impulse $J = F\Delta t = \Delta p$

Work and energy

$W = Fd \cos\theta$; $P = W/t$; $KE = \frac{1}{2}mv^2$
$PE_g = mgh$; $PE_{spring} = \frac{1}{2}kx^2$; $E = KE + PE$

Waves and optics

$v = f\lambda$; $f = 1/T$; $n = c/v$
$n_1 \sin\theta_1 = n_2 \sin\theta_2$; $1/f = 1/d_o + 1/d_i$

Electricity

$V = IR$; $P = IV = I^2R = V^2/R$
Series: $R = R_1+R_2$; parallel: $1/R = 1/R_1+1/R_2$
$F = kq_1q_2/r^2$, $k = 8.99 \times 10^9\ N{\cdot}m^2/C^2$
$E = F/q$; $C = Q/V$; $\tau = RC$

Heat and fluids

$Q = mc\Delta T$; $Q = mL$ (phase change); $\Delta U = Q - W$
$\rho = m/V$; $P = F/A$; $P = P_0 + \rho gh$

Gases and moles

$PV = nRT$; $P_1V_1/T_1 = P_2V_2/T_2$; $P_{total} = P_1+P_2+\ldots$
$n = m/M$; $N = n \cdot N_A$; % yield = actual / theoretical × 100
M = mol solute / L solution; $M_1V_1 = M_2V_2$

Acids and bases

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$; $pH + pOH = 14$ (25 °C)
$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$; $pK_a = -\log K_a$
Buffer: $pH = pK_a + \log([A^-]/[HA])$
Strong acids: HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$
Strong bases: group 1 hydroxides, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

Energy and equilibrium

$q = mc\Delta T$ (c of water = 4.184 J/g·°C); $\Delta G = \Delta H - T\Delta S$
$K = [C]^c[D]^d / ([A]^a[B]^b)$ for $aA + bB \rightleftharpoons cC + dD$
$\Delta G° = -RT \ln K$; $E°_{cell} = E°_{cathode} - E°_{anode}$

Solubility rules

Soluble: group 1, NH_4^+, NO_3^-, $C_2H_3O_2^-$
Cl^-, Br^-, I^- soluble except Ag^+, Pb^{2+}, Hg_2^{2+}
SO_4^{2-} soluble except Ba^{2+}, Pb^{2+}, Sr^{2+}, Ca^{2+}
OH^-, S^{2-}, CO_3^{2-}, PO_4^{3-} insoluble except group 1 and NH_4^+

Common polyatomic ions

NH_4^+ ammonium; NO_3^- nitrate; SO_4^{2-} sulfate; CO_3^{2-} carbonate; PO_4^{3-} phosphate; OH^- hydroxide; HCO_3^- bicarbonate; $C_2H_3O_2^-$ acetate; MnO_4^- permanganate; CrO_4^{2-} chromate; CN^- cyanide

UNIT CONVERSIONS

Length
1 in = 2.54 cm
1 ft = 30.48 cm
1 yd = 0.9144 m
1 mi = 1.609 km
1 m = 3.281 ft

Mass
1 lb = 453.6 g
1 oz = 28.35 g
1 kg = 2.205 lb

Volume
1 gal = 3.785 L
1 qt = 0.9464 L
1 fl oz = 29.57 mL
1 L = 1000 cm^3

Temperature
°F = (9/5)°C + 32
K = °C + 273.15

Speed
1 mph = 0.4470 m/s
1 km/h = 0.2778 m/s

Pressure
1 atm = 101.3 kPa
= 760 mmHg
= 14.70 psi
1 bar = 100 kPa

Energy, power
1 cal = 4.184 J
1 kWh = 3.6 MJ
1 hp = 745.7 W
1 eV = 1.602×10^{-19} J

Time
1 day = 86,400 s
1 yr = 3.156×10^7 s

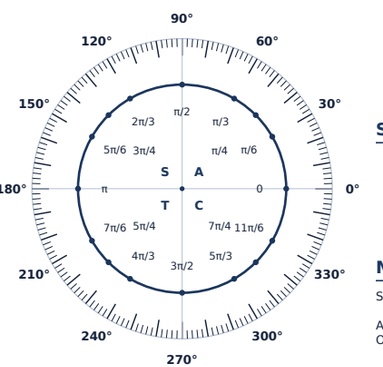
SI PREFIXES

tera	T	10^{12}	milli	m	10^{-3}
giga	G	10^9	micro	μ	10^{-6}
mega	M	10^6	nano	n	10^{-9}
kilo	k	10^3	pico	p	10^{-12}
centi	c	10^{-2}	femto	f	10^{-15}

PHYSICAL CONSTANTS

c	speed of light	2.998×10^8 m/s
g	gravity (Earth)	9.807 m/s^2
G	gravitational	$6.674\times10^{-11}\ N{\cdot}m^2/kg^2$
h	Planck	6.626×10^{-34} J·s
k_B	Boltzmann	1.381×10^{-23} J/K
N_A	Avogadro	6.022×10^{23} /mol
R	gas constant	8.314 J/(mol·K); 0.08206 L·atm/(mol·K)
e	elem. charge	1.602×10^{-19} C
m_e	electron mass	9.109×10^{-31} kg
m_p	proton mass	1.673×10^{-27} kg
ε_0	permittivity	8.854×10^{-12} F/m
F	Faraday	96,485 C/mol
V_m	gas molar vol.	22.41 L/mol (0 °C, 1 atm)

UNIT CIRCLE AND PROTRACTOR



Protractor: put the center on the vertex and read the ring (ticks every 2°, long ticks every 10°). Inside: radians. A S T C: All, Sin, Tan, Cos are positive.

GREEK ALPHABET

Α α alpha	Β β beta	Γ γ gamma	Δ δ delta	Ε ε epsilon	Ζ ζ zeta
Η η eta	Θ θ theta	Ι ι iota	Κ κ kappa	Λ λ lambda	Μ μ mu
Ν ν nu	Ξ ξ xi	Ο ο omicron	Π π pi	Ρ ρ rho	Σ σ sigma
Τ τ tau	Υ υ upsilon	Φ φ phi	Χ χ chi	Ψ ψ psi	Ω ω omega

SPECIAL ANGLES

θ	0°	30°	45°	60°	90°
rad	0	π/6	π/4	π/3	π/2
sin	0	1/2	√2/2	√3/2	1
cos	1	√3/2	√2/2	1/2	0
tan	0	√3/3	1	√3	—

MEMORY AIDS

SOH CAH TOA: sin = opp/hyp, cos = adj/hyp, tan = opp/adj
All Students Take Calculus: quadrants I, II, III, IV
OIL RIG: oxidation is loss, reduction is gain (of electrons)

RESISTOR COLOR CODE

0	1	2	3	4	5	6	7	8	9	5%	10%
black	brown	red	orange	yellow	green	blue	violet	gray	white	gold	silver

NUMBER SYSTEMS

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**

decimal / binary / hex

$2^4 = 16$ $2^8 = 256$ $2^{10} = 1{,}024$ $2^{16} = 65{,}536$ $2^{32} \approx 4.29\times10^9$

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