Periodic Table of the Elements

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.70	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc 98.906	44 Ru 101.07	45 Rh 102.906	46 Pd 106.4	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.33	57–71 *	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.966	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	89–103 †	104 Ku (257)	105 Ha (260)	106 ?	107 ?											

*	57 La 138.906	58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97
†	89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lr (257)

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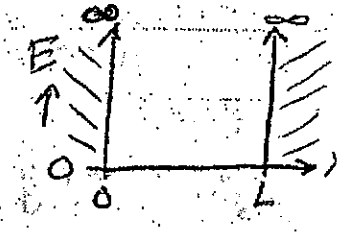
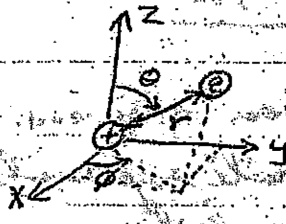
Possibly useful information:

Particle in a box: $E_n = \frac{h^2 n^2}{8 m L^2}$

$\psi_n = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L}x\right)$



H-atom: $E_n = -\frac{Z^2 e^4 \mu}{2\hbar^2 n^2}$



$\psi = R_{nl}(r)\,\Theta_{lm}(\theta)\,\Phi_m(\phi) = R_{nl}(r)\,Y_{lm}(\theta,\phi)$

$\Phi_m = \frac{1}{\sqrt{2\pi}} e^{im\phi}$ $\quad R_{10} = 2\left(\frac{Z}{a_0}\right)^{3/2} e^{-\sigma}$

$\vec{L} = \vec{r} \times \vec{p}$ $\quad \Theta_{00} = \frac{1}{2}\sqrt{2}$ $\quad R_{20} = \left(\frac{Z}{2a_0}\right)^{3/2}(2-\sigma)e^{-\sigma/2}$

$L^2 Y_{lm} = l(l+1)\hbar^2 Y_{lm}$ $\quad \Theta_{10} = \left(\frac{3}{2}\right)^{1/2}\cos\theta$ $\quad R_{21} = 3^{-1/2}\left(\frac{Z}{2a_0}\right)^{3/2}\sigma e^{-\sigma/2}$

$L_z Y_{lm} = m\hbar Y_{lm}$ $\quad \Theta_{11} = \left(\frac{3}{4}\right)^{1/2}\sin\theta$ $\quad \sigma = Zr/a_0;\ a_0 = \frac{\hbar^2}{me^2}$

$\int_a^b x^n dx = \left.\frac{x^{n+1}}{n+1}\right|_a^b \ (n \neq -1)$; $\int_a^b \sin^2 x\,dx = \frac{1}{2}x - \frac{1}{4}\sin 2x$

$\int_a^b x\sin^2 x\,dx = \left.\frac{x^2}{4} - \frac{x\sin 2x}{4} - \frac{\cos 2x}{8}\right|_a^b$

$\int_a^b x^2\sin^2 x\,dx = \left.\frac{x^3}{6} - \left(\frac{x^2}{4} - \frac{1}{8}\right)\sin 2x - \frac{x\cos 2x}{4}\right|_a^b$

$k = 1.381 \times 10^{-23}\ \mathrm{J\,K^{-1}}$ $\quad m_p = 1.673 \times 10^{-27}$ Kg

$\quad$ amu $= 1.660 \times 10^{-27}$ Kg

$h = 6.626 \times 10^{-27}$ erg-sec $\quad a_0 = 0.529$ Å

$c = 3.00 \times 10^8\ \mathrm{m\,sec^{-1}}$ $\quad$ Å $= 10^{-8}$ cm

$m_e = 9.109 \times 10^{-31}$ kg $\quad 1\ \mathrm{erg} = 10^{-7}\ \mathrm{J} = \frac{\mathrm{g\,cm^2}}{\mathrm{sec^2}}$

$N_0 = 6.022 \times 10^{23}\ \mathrm{mole^{-1}}$ $\quad 1\ \mathrm{eV} = 1.602 \times 10^{-19}$ J

$R = 8.314\ \mathrm{J\cdot mole^{-1}\,K^{-1}}$ $\quad R$ (rydberg) $= 13.60$ eV

$= 0.08204\ \mathrm{l\cdot atm\,mole^{-1}\,K^{-1}}$ $\quad = 109{,}677\ \mathrm{cm^{-1}}$

$e = 1.602 \times 10^{-19}$ Coulomb $\quad \hat{\nu} = 1/\lambda = \nu/c$ $\quad \mathrm{J = kg\,m^2 s^{-2}}$

$\varepsilon_0 = 8.854 \times 10^{-12}\ \mathrm{J^{-2}C^{-2}m^{-1}}$ $\quad 1\ \mathrm{eV} = 8065.5\ \mathrm{cm^{-1}}$ $\quad \mathrm{N = kg\,m\,s^{-2}}$

Hermite Polynomials

recursion formula: $H_v(y) = (-1)^v e^{y^2} \frac{d^v}{dy^v}(e^{-y^2})$

$y = \alpha q$ $\quad \alpha = 2\pi\sqrt{mk}/h = \sqrt{mk}/\hbar$

∴ Hermite polynomials:

ex: $H_0 = 1$
$H_1 = 2y$
$H_2 = 4y^2 - 2$
$H_3 = 8y^3 - 12y$

note: - odd-even progression
- alternate exponents
- ∞ # solutions
- exponential damping

thus: $\psi_v = \left(\alpha / 2^v v!\, \pi^{1/2}\right)^{1/2} H_v(y)\, e^{-y^2/2}$ norma

Supplementary Information

$\int \sin^2 x\,dx = \frac{1}{2}x - \frac{1}{4}\sin 2x$

$\int \cos^2 x\,dx = \frac{1}{2}x + \frac{1}{4}\sin 2x$

$\int x\cos^2 x\,dx = \frac{x^2}{4} + \frac{x\sin 2x}{4} + \frac{\cos 2x}{8}$

$\int x\sin^2 x\,dx = \frac{x^2}{4} - \frac{x\sin 2x}{4} - \frac{\cos 2x}{8}$

$\int \sin(x)\cos(x)\,dx = \frac{1}{2}\sin^2 x$

$\int xe^{ax}\,dx = \frac{e^{ax}}{a^2}(ax-1)$

$e^{ix} = \cos(x) + i\sin(x)$ $\qquad \sin(x \pm y) = \sin(x)\cos(y) \pm \sin(y)\cos(x)$

$\cos x = \frac{e^{ix} + e^{-ix}}{2}$ $\qquad \sin x = \frac{e^{ix} - e^{-ix}}{2i}$

$z \sim r\cos\theta$
$x \sim r\cos\phi\,\sin\theta$
$y \sim r\sin\phi\,\sin\theta$

$(x, y, z) \longrightarrow (r, \theta, \phi)$

Taylor series:
$f(x) = f(x_0) + \frac{\partial f}{\partial x}\Big|_{x_0}(x - x_0) + \frac{1}{2}\frac{\partial^2 f}{\partial x^2}(x - x_0)^2 + \cdots$

$\int \sin mx \sin nx\,dx = \frac{\sin(m-n)x}{2(m-n)} - \frac{\sin(m+n)x}{2(m+n)}$

$\int \sin mx \cos nx\,dx = -\frac{\cos(m-n)x}{2(m-n)} - \frac{\cos(m+n)x}{2(m+n)}$

Useful relations

At 298.15 K

$RT = 2.4790$ kJ mol^{-1}

$RT \ln 10/F = 59.160$ mV

$kT/e = 25.693$ meV

$RT/F = 25.693$ mV

$kT/hc = 207.23$ cm^{-1}

$V_m^{\ominus} = 2.4790 \times 10^{-2}$ m^3 mol^{-1}
$= 24.790$ L mol^{-1}

Selected derived units

Name	Symbol	Definition	Name	Symbol	Definition
newton	1 N	1 kg m s^{-2}	joule	1 J	1 kg m^2 s^{-2}
pascal	1 Pa	1 kg m^{-1} s^{-2}	watt	1 W	1 J s^{-1}
volt	1 V	1 J C^{-1}	ampere	1 A	1 C s^{-1}
tesla	1 T	1 kg s^{-2} A^{-1}	poise	1 P	10^{-1} kg m^{-1} s^{-1}
ohm	1 Ω	1 V A^{-1}	siemens	1 S	1 A V^{-1} (= 1 Ω^{-1})

Conversion factors

1 eV = 1.602 18 × 10^{-19} J
96.485 kJ mol^{-1}
8065.5 cm^{-1}

1 cal = 4.184* J

1 atm = 101.325* kPa
760* Torr

1 cm^{-1} = 1.9864 × 10^{-23} J

1 D = 3.335 64 × 10^{-30} C m

1 Å = 10^{-10} m*

*Exact value.

General data and fundamental constants

Quantity	Symbol	Value	Power of 10	Units
Speed of light	c	2.997 924 58*	10^{8}	m s^{-1}
Elementary charge	e	1.602 177	10^{-19}	C
Faraday's constant	$F = N_A e$	9.648 53	10^{4}	C mol^{-1}
Boltzmann's constant	k	1.380 66	10^{-23}	J K^{-1}
Gas constant	$R = N_A k$	8.314 51		J K^{-1} mol^{-1}
		8.314 51	10^{-2}	L bar K^{-1} mol^{-1}
		8.205 78	10^{-2}	L atm K^{-1} mol^{-1}
		6.236 40	10	L Torr K^{-1} mol^{-1}
Planck's constant	h	6.626 08	10^{-34}	J s
	$\hbar = h/2\pi$	1.054 57	10^{-34}	J s
Avogadro's constant	N_A	6.022 14	10^{23}	mol^{-1}
Atomic mass unit	u	1.660 54	10^{-27}	kg
Mass				
electron	m_e	9.109 39	10^{-31}	kg
proton	m_p	1.672 62	10^{-27}	kg
neutron	m_n	1.674 93	10^{-27}	kg
Vacuum permittivity	ε_0	8.854 19	10^{-12}	J^{-1} C^2 m^{-1}
	$4\pi\varepsilon_0$	1.112 65	10^{-10}	J^{-1} C^2 m^{-1}
Magneton				
Bohr	$\mu_B = e\hbar/2m_e$	9.274 02	10^{-24}	J T^{-1}
nuclear	$\mu_N = e\hbar/2m_p$	5.050 79	10^{-27}	J T^{-1}
g value	g_e	2.002 32		
Bohr radius	$a_0 = 4\pi\varepsilon_0\hbar^2/m_e e^2$	5.291 77	10^{-11}	m
Standard acceleration of free fall	g	9.806 65*		m s^{-2}
Gravitational constant	G	6.672 59	10^{-11}	N m^2 kg^{-2}

*Exact value.

Auxillary Information

Integrals: $\int x^n dx = \frac{x^{n+1}}{n+1}$ except $n = -1$

$\int x^{-1} dx = \ln x$

$\int e^{ax} dx = e^{ax}/a$

Gas Constant: $R = 0.08205$ ℓ-atm/mole·K

$= 1.987$ cal/mol·K

$= 8.314$ joule/mole·K

numbers: $\pi = 3.1416$ $\qquad h = 6.625 \times 10^{-27}$ erg·s

$e = 2.718$ $\qquad N_0 = 6.023 \times 10^{23}$

$\ln x = 2.303 \log x$ $\qquad F = 23.06 \frac{\text{kcal}}{\text{mol}\cdot\text{eV}}$

$k_B = R/N_0 = 1.38 \times 10^{-23} \frac{J}{K}$ $\qquad J = 10^7 \text{ erg} = \frac{\text{kg m}^2}{\text{s}^2}$

Formulas for 2nd orders: $\frac{a}{(b[A_0] - a[B_0])} \ln \frac{[A][B_0]}{[A_0][B]} = kt$

Activated complex: $k = \kappa \frac{RT}{N_0 h} e^{(\Delta S^{\ddagger}/R + 1)} e^{-(\Delta H^{\ddagger} + RT)/RT}$

Collision theory: $k = p(2\times10^3) N_0 \left(\frac{\pi RT}{M}\right)^{1/2} \sigma^2 e^{-1/2} e^{-(E_0 + \frac{RT}{2})/RT}$

Diffusion controlled: $k_d = 4\times10^3 \pi N_0 (D_1 + D_2) R_{12}$

Relaxation time: $\tau = \{k_{-1} + k_1[(A)_{eq} + (B)_{eq}]\}^{-1}$

Enzyme catalysed: $V = \frac{k_2(E)(S)_0}{K_m + (S)_0}$, $K_m = \frac{k_2 + k_{-1}}{k_1}$

Inhibition: $V_0 = V_s / [1 + \frac{K_M'}{[S]}]$ $\qquad K_M' = K_M(1 + I/K_I)$

$K_I = [E][I]/[EI]$