Useful constants and equations

$e = 1.602 \times 10^{-19}\ C \qquad \frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9\ N\,m^2/C^2 \qquad \frac{e^2}{4\pi\epsilon_0} = 1.44\ eV\,nm$

$c = 3.00 \times 10^8\ m/s \qquad h = 6.626 \times 10^{-34}\ J\,s = 4.136 \times 10^{-15}\ eV\,s \qquad \hbar = \frac{h}{2\pi}$

$hc = 1240\ eV\,nm \qquad \hbar c = 197.3\ eV\,nm = 197.3\ MeV\,fm \qquad 1\ eV = 1.602 \times 10^{-19}\ J$

$m_e = 9.11 \times 10^{-31}\ kg = 511\ keV/c^2 = 5.486 \times 10^{-4}\ u$ neutral $^{12}_{6}$C atom mass = 12.0000 u

$m_p = 1.673 \times 10^{-27}\ kg = 938.3\ MeV/c^2 = 1.0073\ u \qquad 1\ u = 931.5\ MeV$

$m_n = 1.675 \times 10^{-27}\ kg = 939.6\ MeV/c^2 = 1.0087\ u$

$a_0 = 0.0529\ nm \qquad E_0 = -13.6\ eV \qquad \alpha = 1/137$

Atomic Physics:

Hydrogen Atom: $E = \dfrac{-13.6\ eV}{n^2}$ with $n = 1, 2, 3, \cdots \qquad l < n \qquad -l \le m \le +l$

Angular Momentum: $L^2 = l(l+1)\,\hbar^2 \qquad l = 0, 1, 2, 3, ..$ (orbital)

$L_z = \left|\vec{L}\right| \cos\theta = m\,\hbar \qquad -l \le m_l \le l$ (integer steps)

Magnetic Moment: orbital: $\vec{\mu} = \dfrac{q}{2\,M}\vec{L}$

for electron: $|\mu_z| = 2 \cdot |m_s| \dfrac{e\hbar}{2\,m_e} = \mu_B = 5.8 \times 10^{-5} eV/T$

for proton: $|\mu_z| = |m_s| \dfrac{e\hbar}{2\,m_p} = \dfrac{1}{2}\,\mu_p = \dfrac{1}{2}\,(8.8 \times 10^{-7} eV/T)$

Energy of magnetic dipole in B field: $E = -\mu \cdot B$

Energy of particle in 3-dim ∞ square well: $E_{n_x n_y n_z} = \dfrac{(n_x^2 + n_y^2 + n_z^2)h^2}{8mL^2}$

Molecular excitations: vibrational: $E = (n + \dfrac{1}{2})\,\hbar\omega$ rotational: $E = \dfrac{L^2}{2\,I} = \dfrac{l(l+1)}{2\,I}\,\hbar^2$

Statistical Physics:

Maxwell Boltzmannc distribution: $f_{MB} = A\ e^{-E/kT}$

Bose-Einstein distribution: $f_{BE} = \dfrac{1}{B\ e^{E/kT} - 1}$

Fermi - Dirac distribution: $f_{FD} = \dfrac{1}{e^{(E-E_F)/kT} + 1}$

Boltzmann constant $k = 1.381 \times 10^{-23}\ J/K = 8.617 \times 10^{-5}\ eV/K$

For “gas” of free fermions: $g(E) = \dfrac{8\sqrt{2}\pi m^{3/2}}{h^3}\sqrt{E}$

$$E_F = \frac{h^2}{2m}\left(\frac{3N}{8\pi V}\right)^{2/3} \qquad E_m = \frac{3}{5}\,E_F$$