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Useful data and equations: Schrödinger equation: ($\hbar = h/2\pi$)

$$-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \psi(x) + V(x)\psi(x) = E\psi(x)$$

For two interacting bodies the m is replaced by reduced mass μ and x is the separation.Quantum mechanical angular momentum $|\mathbf{L}| = [l(l+1)]^{1/2}\hbar$ and $L_z = m_l \hbar$ Note the **h-bar**or more generally $|\mathbf{J}| = [j(j+1)]^{1/2}\hbar$ and $J_z = m_j \hbar$ with $m_j = j, j-1, \dots, -j$ Addition of orbital (l) and spin ($1/2$) angular momenta yields $j = l-1/2, l+1/2$.Addition of \mathbf{J}_1 and \mathbf{J}_2 yields sum \mathbf{J} with quantum number $j = |j_1 - j_2|, |j_1 - j_2| + 1, \dots, j_1 + j_2 - 1, j_1 + j_2$ Atomic electron spectroscopic notation: $n l^{1 \text{ or } 2 \text{ or } \dots}$, where n is principle quantum number, l is orbital angular momentum quantum number, $l=0, 1, 2, \dots, n-1$, with notation $l=0 \rightarrow s, 1 \rightarrow p, 2 \rightarrow d, 3 \rightarrow f, \dots$ Avogadro's Number: $N_A = 6.0 \times 10^{23}$ number of atoms, molecules or nuclei in a MOLE (or gram molecular wt)Non-relativistic Kinetic Energy $= mv^2/2$ Magnetic dipole interaction energy $= \mu_z B_z$ Lorentz Transformation frame S' moves in the $+x$ direction with V as seen in S :

$$x = \gamma(x' + Vt'), y = y', z = z', t = \gamma(t' + Vx'/c^2) \text{ where } \gamma = 1/\sqrt{1-v^2/c^2}$$

Doppler effect $\lambda' = \lambda \sqrt{(1+v/c)/(1-v/c)}$ Time dilation $t' = \gamma t$ Relativistic Energy $E = m_0 c^2 / \sqrt{1-v^2/c^2}$; Rest energy $= m_0 c^2$; Relativistic Kinetic Energy $= E - m_0 c^2$ Photon: $E = hf$; $c = \lambda f$; $k = 2\pi/\lambda$; $\omega = 2\pi f$ Electric dipole moment $p_{E1} = Q r$ (Q =charge, r =separation)Average Thermal Energy at Temperature T (Kelvin) $= k$ (Boltzmann) $T/2$ per degree of freedomDecay $N(t) = N(0)\exp(-\lambda t)$, $\lambda = 1/(\text{mean lifetime}) = \ln 2/T_{1/2}$ where $T_{1/2}$ is the half-lifeNuclear Binding Energy $E_b = (Zm(p) + Nm(n) - M_A) c^2$ Coulomb Potential $k_{EM} Q_1 Q_2 / r$ Newton Law of Gravitation : potential energy $= -Gm_1 m_2 / r$ Constants: Velocity of light: $c = 3.00 \times 10^8$ meter/sec electron charge: $e = 1.60 \times 10^{-19}$ CoulNewton gravitational constant $G = 6.67 \times 10^{-11}$ J*m/Kg² k (Boltzmann) $= 1.38 \times 10^{-23}$ J/°K $= 8.62 \times 10^{-5}$ eV/°KPlanck's constant: $h = 6.63 \times 10^{-34}$ J sec $= 4.14 \times 10^{-15}$ eV sec $\hbar = h/2\pi = 1.05 \times 10^{-34}$ J sec $= 6.58 \times 10^{-16}$ eV sec $k_{EM} = 1/4\pi\epsilon_0 = 8.99 \times 10^9$ Nm²/Coul² $hc = 1.24 \times 10^{-6}$ eV m Rest energy of electron $= m_e c^2 = 511$ keV $= 0.511$ MeV $m_e = 9.1 \times 10^{-31}$ KgUnified mass units $1 u = 1.66 \times 10^{-27}$ Kg $(1u)c^2 = 931.5$ MeVUnits: Energy: 1 J (joule) $= 1$ Kg m²/sec²; 1 eV (electron Volt) $= 1.6 \times 10^{-19}$ J