Atomic Physics

Photon energy

$$E_{Photon} = \frac{hc}{\lambda} = hf = \hbar\omega$$

Photoelectric effect

$$hf = W_{Out} + K = W_{Out} + eU_0$$

DeBroglie wavelength

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

Square well potential

$$E_n = \left(\frac{h^2}{8mL^2}\right) \cdot n^2$$

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

Bohr radius

$$r = \frac{\epsilon_0 h^2}{\pi \mu e^2}\frac{n^2}{Z} \approx a_0 \cdot \frac{n^2}{Z}$$

$$a_0 = 0.529 \text{ Å}$$

Rydberg's formula

$$\frac{1}{\lambda} = R_M \cdot Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$R_M = \frac{e^4}{8\varepsilon_0^2 h^3 c} \cdot \mu$$

$$\mu = \frac{m \cdot M}{m + M} \text{ Reduced mass}$$

$$R_M = R_\infty \cdot \frac{M}{M + m}$$

$$R_\infty = 109737.31568 \text{ cm}^{-1}$$

Energy levels in Hydrogen

$$E_n = -Z^2\frac{E_0}{n^2} \text{ where } E_0 = \frac{mk^2e^4}{2\hbar^2} = 13.6 \text{ eV}$$

Quantized angular momentum z component

$$L = \hbar\sqrt{l(l+1)}$$

Quantized angular momentum

$$L_z = m_l \hbar$$

Ratio between the proton mass and the electron mass

$$\frac{m_p}{m_e} = 1836.152673$$

Characteristic X-ray emission

$$\frac{1}{\lambda_{K_\alpha}} = \frac{3}{4} R_\infty \cdot (Z-1)^2$$

$$\frac{1}{\lambda_{L_\alpha}} = \frac{5}{36} R_\infty \cdot (Z-7.4)^2$$

Bremsstrahlung

$$\lambda_{min} = \frac{hc}{eU}$$

Reduced mass

$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

Moment of inertia

$$I = \mu r^2$$

Angular momentum

$$L = \mu r v = \mu r^2 \omega = I\omega$$

Quantized angular momentum

$$|L| = \hbar\sqrt{l(l+1)}$$

Rotational energy diatomic molecule

$$E_{rot} = \frac{l(l+1)\hbar^2}{2I},\ I = \mu r^2$$

Rotational constant

$$B = E_{0r} = \frac{\hbar^2}{2I}$$

Vibrational energy diatomic molecule

$$E_{vib} = \hbar\omega_0 \cdot (\nu + 1/2)$$

Fermi energy at T=0 K

$E_F = \frac{h^2}{8m}\left(\frac{3}{\pi}n\right)^{2/3}$, where n is the electron density

Fermi temperature

$$T_F = \frac{E_F}{k}$$

Fermi speed

$$u_F = \sqrt{\frac{2E_F}{m_e}}$$

Free electrons in conductors

$n_e = f \cdot \frac{\rho \cdot N_A}{M}$, where f is the number of free electrons per atom

Resestivity

$$\rho = \frac{m_e v_{av}}{n_e e^2 \lambda}$$

Mean free path

$$\lambda = \frac{vt}{n_{ion}\pi r^2 vt} = \frac{1}{n_{ion}\pi r^2} = \frac{1}{n_{ion}A}$$

Specific heat due to conduction electrons

$$c_v = \frac{1}{2}\pi^2 \cdot R \cdot \frac{T}{T_F}$$