Quantum and Atomic Physics

Equations:

Energy and Momentum of a single photon:

$$E = hf = \frac{hc}{\lambda} \qquad p = \frac{h}{\lambda}$$

Maximum energy of electron ejected from a photon hitting metal: (Photoelectric Effect)

$$E_{electron} = \frac{hc}{\lambda} - W$$

where W is the work function.

Wavelength of any particle:

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

Energy levels and orbital radii for Atoms with one electron:

$$E_n = -13.6 \cdot \frac{Z^2}{n^2} (\text{eV}) \qquad r_n = 5.29 \times 10^{-11} \frac{n^2}{Z} \text{ (meters)}$$

Photon energies for transitions in Hydrogen:

$$E_\gamma = 13.6 \cdot \left(\frac{1}{n^2} - \frac{1}{m^2} \right) \text{ (eV)}$$

Initial/final electronic states are n/m. Series: Lyman(n=1), Balmer(n=2), Paschen($n = 3$).

Multi-electron Atomic Configurations:

Orbital Quantum No.	Letter
0	s
1	p
2	d
3	f
4	g
5	h

Notation: $3d^7$ refers to seven electrons in the $n = 3$ $l = 2$ shell. e.g. Cl (17 electrons) $1s^2 2s^2 2p^6 3s^2 3p^5$.

Rules for filling shells

1. No two electrons can have the same quantum numbers. (Pauli Exclusion Principle)
2. The orbital quanum number ℓ is always less than n.
3. For any n, ℓ there are $(2\ell + 1)$ values of m_ℓ, $(-\ell \leq m_\ell \leq \ell)$.
4. For any n, ℓ, m_ℓ, there are 2 values of $m_s = \pm\frac{1}{2}$.
5. No more than $2 \cdot (2\ell + 1)$ electrons are in any n, ℓ shell.

Assorted Facts:

1. X-rays are high energy photons caused by transitions to the low-lying transitions in heavy atoms, and are measured in keV.
2. Fermions are particles that obey the Pauli exclusion principle.
3. Particles which are bosons can multiply occupy the same energy level.
4. Even numbers of fermions act like bosons.
5. Examples of bosons: photons, He^4 atoms, gluons, $\cdots$
6. Examples of fermions: electrons, protons, neutrons, He^3 atoms, quarks, $\cdots$