Problem Set 7
Hund's rules

Consider an atom with many electrons i in states characterized by the orbital angular momentum $\mathbf{l}_i$ and the spin $\mathbf{s}_i$ (in units of $\hbar$). We define the total orbital angular momentum $\mathbf{L} = \sum_i \mathbf{l}_i$, the total spin $\mathbf{S} = \sum_i \mathbf{s}_i$, and the total angular momentum $\mathbf{J} = \mathbf{L} + \mathbf{S}$.

According to Hund's rules (1925), for the case of a partially filled shell, the lowest energy values are found in the following way:

(1) Maximize $S = |\mathbf{S}|$, respecting the Pauli exclusion principle.

(2) Maximize $L = |\mathbf{L}|$, respecting the Pauli exclusion principle and rule (1).

(3) $J = |\mathbf{J}| = L + S$ when the shell is more than half filled and $J = |L - S|$ when the shell is less than half filled.

The *term symbol* of the resulting configuration is ${}^{(2S+1)}L_J$, where the orbital angular momentum is usually given by a letter following the convention

L	0	1	2	3	4	5	6
symbol	S	P	D	F	G	H	I

Apply Hund's rules to determine the ground state angular momenta for the following cases:

(a) O in the configuration $1s^2\, 2s^2\, 2p^4$

(b) V in the configuration [Ar] $3d^3\, 4s^2$

(c) Eu^{2+} in the configuration [Xe] $4f^7$

(d) Dy^{3+} in the configuration [Xe] $4f^9$