EP Homework 12

Adam Kit - 3707437

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1 Angular Momentum

Although not a direct proof, we know that in completely-filled shells, each electron that is spinning up has a corresponding electron spinning down that is paired with it. In other words, when we apply the Angular momentum operator $\hat{J}$ on a single closed shell, which would have quantum number $m = -j, -j+1, \ldots, j$, and then sum over all j, we recieve 0.

2 Multiplicities

Spin multipliciy, $2S + 1$ is written as a subscript before the $S, P, D \ldots$ symbol.

Sr^+

Strontium has normally 38 electrons, however with this ion, we have 37. Thus the electron configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ thus a corresponding term symbol ${}^2S_{1/2}$ and multiplicities $2S + 1 = 2 \rightarrow S = 1/2$

Fe

Iron has 26 electrons and thus a term symbol of ${}^5D_4$ which corresponds to an electron configuration for its outermost electron shell of $4s^2 3d^5$, and $2S + 1 = 5 \rightarrow S = 2$.

Ca^+

Cadmium has normally 20 electrons, however in this ion there is 19, which gives us an outer most electron shell of $4s^1$ with corresponding term symbol ${}^2S_{1/2}$ and spin multiplicity $2S + 1 = 2 \rightarrow S = 1/2$

C^{++}

Carbon, which normally has 6 electrons, has 2 removed, leaving it with 4 electrons and the corresponding configuration $1s^2 2s^2$ and term symbol ${}^2S_0$ meaning it has a multplicity of $2S + 1 = 1 \rightarrow S = 0$

Cl

Chlorine has a term symbol of ${}^2P_{3/2}$ corresponding to the energetic level $3s^2 3p^5$ and spin multiplicity $2S + 1 = 2 \rightarrow S = 1/2$

O^{++++}

Oxygen in its ground state has a term symbol $^3P_2$ which means that with four less electrons, its ion has in total 4 electrons, thus our electron configuration is $1s^2 2s^2$ which has a term symbol $^1S_0$ and spin multiplicity $2S + 1 = 1 \rightarrow S = 0$

3 Magnets

If a material is attraacted to the magnetic field it is called paramagnetic, while one that is repulsed is called diamagnetic. For the paramagnetic material, not every electron has a pair, thus in an magnetic field the unpaired electrons will align the sign of their spins in the.

Iron in its ground state has 26 electrons, so in this ion representation, it has only 23 electrons, which the electron configuration has gone from $4s^2 3d^6 \rightarrow 4s^2 3d^3$, meaning there is one unpaired electron, so it is *paramagnetic*. For the Zinc normally has 30, but now has lost two electrons, leaving it with 28, and a corresponding change in electron configuration of $4s^2 3d^{10} \rightarrow 4s^2 3d^8$, and all electrons are paired, and this Zinc ion is *diamagnetic*. Therefore, the ion that is attracted to the magnetic field is then Fe^{+++}.