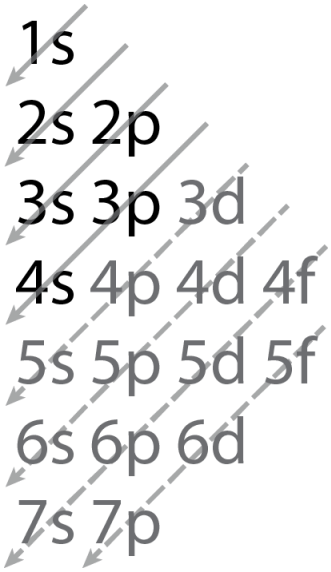
Lab 2 – Electron Configurations

Rules for Orbital Filling

There are three rules we need to remember in order to correctly determine how electrons will fill the orbitals of an atom:

1. **Pauli's exclusion principle:** Only *two* electrons can occupy one orbital
2. **The Aufbau principle:** Electrons occupy orbitals in order of *increasing* energy
3. **Hund's rule:** *Within a subshell*, electrons occupy empty orbitals firsts

Here's a reminder of how to work out the order in which orbitals increase in energy, it is called the Madelung Rule:



Madelung's Rule is a useful guide to the order in which orbitals will be filled BUT it is not completely valid for higher atomic number elements (i.e., those with d and f orbitals).

For today's lab we can use this approach, just bear in mind that it is only a general rule and there are plenty of exceptions!

Abbreviating Electron Configurations

For atoms that have many orbitals filled, it is common to abbreviate the electron configuration using the noble gases. Noble gases always have full outer shells, for example:

Neon = $1s^2 2s^2 2p^6$

Argon = $1s^2 2s^2 2p^6 3s^2 3p^6$

We can therefore use these elements to replace the first part of an element's electron configuration. Let's look at the example of silicon (Si). Silicon has 14 electrons, so if we follow Madelung's Rule, we get the following electron configuration:

Silicon = $1s^2 2s^2 2p^6 3s^2 3p^2$

We can see that the first part of this configuration is the same as the configuration of neon:

Si = $1s^2 2s^2 2p^6 3s^2 3p^2$ Ne = $1s^2 2s^2 2p^6$

To abbreviate the electron configuration of Si, we can substitute the electron configuration of Ne using square brackets:

Si = $1s^2 2s^2 2p^6 3s^2 3p^2$ = [Ne]$3s^2 3p^2$

This is especially useful for high atomic number elements. For example, Cadmium has an atomic number of 48 and the following electron configuration:

Cd = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2$

Using the noble gas krypton, we can abbreviate this to a form that is much easier to read and write:

Cd =[Kr] $4d^{10} 5s^2$

Exercise

1. Using the periodic table on page 3 of this handout and the rules for orbital filling described above, write the electron configuration of all the elements with an atomic number less than 21. Use the following format:

Element Name	Atomic Number	Electron Configuration
Hydrogen	1	$1s^1$
Helium	….	….

2. Look at the electron configuration of aluminum you wrote down in part 1. Which noble gas could be used to abbreviate the electron configuration of this element?