

HW 3

How to Write the Electron Configuration of an Atom

Electron configuration is a way of showing where the electrons are located in an atom. Before learning how to write an electron configuration, it is helpful to understand four terms:

shell → subshell → orbital → electron

You can think of them as different levels of organization. A shell contains subshells, a subshell contains orbitals, and orbitals contain electrons.

1. How Many Electrons Does an Atom Have?

Atoms contain three main types of particles:

- Protons have a positive charge (+1).
- Electrons have a negative charge (−1).
- Neutrons have no charge.

In a neutral atom, the number of electrons is equal to the number of protons. The positive and negative charges therefore cancel each other.

The number of protons in an atom is called its atomic number.

Therefore, for a neutral atom:

Number of electrons = number of protons = atomic number

For example, nitrogen (N) has an atomic number of 7. This means that nitrogen has:

- 7 protons
- 7 electrons

So, when writing the electron configuration of nitrogen, we need to place 7 electrons.

2. Shells

Electrons occupy different energy levels around the nucleus. These energy levels are also called shells.

Shells are represented by the letter n and are numbered:

$n = 1, 2, 3, 4, \dots$

The first shell, $n = 1$, is closest to the nucleus.

Higher-numbered shells are generally farther from the nucleus and can contain more electrons.

3. Subshells

Each shell is divided into smaller regions called subshells.

Subshells are identified by the letters:

s, p, d, and f

The number of possible subshells increases as the shell number increases:

- Shell 1 contains 1s
- Shell 2 contains 2s and 2p
- Shell 3 contains 3s, 3p, and 3d
- Shell 4 contains 4s, 4p, 4d, and 4f

The number tells you the shell, while the letter tells you the type of subshell.

For example:

2p

means the p subshell in the second shell.

4. Orbitals

Each subshell is made of one or more orbitals.

An orbital is a region around the nucleus where there is a high probability of finding an electron.

The most important rule to remember is:

Each orbital can contain a maximum of 2 electrons.

Different types of subshells contain different numbers of orbitals:

Subshell	Number of Orbitals	Maximum Number of Electrons
s	1	2
p	3	6
d	5	10
f	7	14

For example, a p subshell contains 3 orbitals.

Since each orbital can hold 2 electrons:

$$3 \text{ orbitals} \times 2 \text{ electrons} = 6 \text{ electrons}$$

Therefore, a p subshell can contain a maximum of 6 electrons.

Similarly:

- s: $1 \text{ orbital} \times 2 = 2 \text{ electrons}$
- p: $3 \text{ orbitals} \times 2 = 6 \text{ electrons}$
- d: $5 \text{ orbitals} \times 2 = 10 \text{ electrons}$
- f: $7 \text{ orbitals} \times 2 = 14 \text{ electrons}$

So:

$$s^2, p^6, d^{10}, f^{14}$$

These are the maximum numbers of electrons that each type of subshell can hold.

5. How Electrons Fill the Orbitals

Electrons do not simply fill shell 1, then shell 2, then shell 3.

Instead, electrons fill the available orbitals starting with the lowest-energy orbital and then move to higher-energy orbitals.

For the elements you will commonly work with, use this filling order:

$1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p \rightarrow 4s \rightarrow 3d \rightarrow 4p \rightarrow 5s \rightarrow 4d \rightarrow 5p \rightarrow 6s \rightarrow 4f \rightarrow 5d \rightarrow 6p \rightarrow 7s$

You can follow this order one subshell at a time until all of the atom's electrons have been placed.

Remember the maximum number of electrons that each subshell can hold:

$s = 2$

$p = 6$

$d = 10$

$f = 14$

6. How to Write an Electron Configuration

Follow these steps.

Step 1: Find the atomic number.

The atomic number tells you how many protons the atom has.

For a neutral atom, this is also the number of electrons.

Step 2: Determine how many electrons you need to place.

For example, nitrogen has atomic number 7.

Therefore:

Nitrogen has 7 electrons.

Step 3: Start with the lowest-energy subshell.

The first subshell is 1s.

An s subshell can hold a maximum of 2 electrons, so we place the first two electrons there:



The superscript 2 tells us that there are 2 electrons in the 1s subshell.

We have now placed 2 of nitrogen's 7 electrons.

$$7 - 2 = 5 \text{ electrons remaining}$$

Step 4: Move to the next subshell.

The next subshell is 2s.

It can also hold 2 electrons:



We have now placed:

$$2 + 2 = 4 \text{ electrons}$$

Nitrogen has 7 electrons total, so:

$$7 - 4 = 3 \text{ electrons remaining}$$

Step 5: Place the remaining electrons.

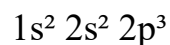
The next subshell is 2p.

A p subshell can hold up to 6 electrons, but nitrogen has only 3 electrons remaining.

Therefore:



The complete electron configuration of nitrogen is:



Check the total number of electrons:

$$2 + 2 + 3 = 7$$

This matches nitrogen's atomic number, so the electron configuration is correct.

Understanding What $1s^2 2s^2 2p^3$ Means

Let's read the electron configuration piece by piece.



- 1 = first shell
- s = s subshell
- ² = 2 electrons in that subshell

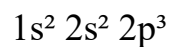


- 2 = second shell
- s = s subshell
- ² = 2 electrons in that subshell



- 2 = second shell
- p = p subshell
- ³ = 3 electrons in that subshell

Therefore:



contains a total of:

$$2 + 2 + 3 = 7 \text{ electrons}$$

The Main Idea to Remember

When writing an electron configuration:

1. Find the atomic number.

This tells you how many electrons you need for a neutral atom.

2. Fill the subshells in order from lower energy to higher energy.

3. Remember the maximum number of electrons:

$$s = 2, p = 6, d = 10, f = 14$$

4. Write the number of electrons in each subshell as a superscript.

5. Add the superscripts at the end to make sure they equal the total number of electrons.

Try to answer the following questions:

1. Write down the electron configuration of ${}_8\text{O}$, ${}_9\text{F}$, ${}_{16}\text{S}$ (Note that the number next to the element symbol is the element's atomic number).
2. What elements have the following electron configurations: a) $1s^22s^22p^4$; b) $1s^22s^22p^63s^23p^1$