The Structure of an Atom

Properties of Subatomic Particles

The atom is made up of three subatomic particles: protons, neutrons, and electrons.

A proton is a positively charged particle found in the nucleus. It is assigned a charge of 1^+.

It has a mass of 1 amu (atomic mass unit).

The neutron is a neutral particle also found in the nucleus. It is assigned a charge of 0. It has a mass of 1 amu.

The electron is a negatively charged particle found in the space outside the nucleus. It is assigned a charge of 1^-. It has a mass of 1/1836 amu. (This means it is 1836 times smaller than a proton or neutron).

Atomic Number and Mass Number

The atomic number of an element is the number of protons of that element. Each element contains a different number of protons.

Carbon has 6 protons so has an atomic number of 6. Sulfur has 16 protons so has an atomic number of 16.

The number of electrons is the same as the number of protons in an atom.

Carbon atoms have 6 electrons and sulfur atoms have 16 electrons.

The mass number is the number of protons and neutrons in the nucleus of the atom.

Carbon has a mass number of 12. Since carbon has 6 protons, we can find the number of neutrons by subtracting 6 from 12. This means that carbon has 6 neutrons.

To find the number of neutrons of any atom, just subtract the atomic number from the mass number.

Isotopes

Not all atoms of a particular element have the same number of neutrons. Sometimes they have a few more or a few less. We call these isotopes.

Carbon has 3 main isotopes:

carbon-12, carbon-13, and carbon-14.

Carbon-12 atoms have 6 protons and 6 neutrons.

Carbon-13 atoms have 6 protons and 7 neutrons.

Carbon-14 atoms have 6 protons and 8 neutrons.

$$^{24}_{12}Mg$$

The mass number is on top and is 24 for Mg.

The atomic number is on the bottom and is 12 for Mg.

The **atomic mass** of an element is obtained from the weighted average of the atomic masses of all isotopes present in nature.

We can figure out the average atomic mass of any element based on the percent distribution.

Ex. In nature, the element boron occurs as:

19.9% ^{10}B & 80.1% ^{11}B.

If the isotopic mass of ^{10}B is **10.013 amu** and the isotopic mass of ^{11}B is **11.009 amu**, what is the atomic mass of boron?

First we need to change the percent abundance to a decimal (move the decimal 2 places left or divide by 100). Then we multiply this decimal by the isotopic mass. Then we add them all up to get the final atomic mass.

$^{10}B = 0.199 \times 10.013 \text{ amu} = 1.99 \text{ amu}$

$^{11}B = 0.801 \times 11.009 \text{ amu} = \underline{8.82 \text{ amu}}$

10.81 amu

Lets try to find the average atomic mass of iron.

If you don't know the exact masses of each isotope, you can use the mass number to calculate the average atomic mass.

5.8%	^{54}Fe	5.8/100 = 0.058
91.72%	^{56}Fe	91.72/100 = 0.9172
2.2%	^{57}Fe	2.2/100 = 0.022
0.28%	^{58}Fe	0.28/100 = 0.0028

0.058 x 54 = 3.13 amu

0.9172 x 56 = 51.36 amu

0.022 x 57 = 1.25 amu

0.0028 x 58 = 0.16 amu

55.92 amu