Atomic Mass

The term "Atomic Mass" indicates the mass of an atom. The mass of an atom depends on the number of protons, neutrons, and electrons. However, electrons contribute negligible amount to the mass. Atom is extremely tiny particle and due that we cannot pick an atom, put it on a balance, and weigh it, let alone its visibility to naked human eye. But we need an atomic mass of an atom. How do we get it? It is possible to determine the mass of an atom relative to some standard atom. Since Carbon-12 (it has 6 protons and 6 neutrons) is most abundant on this planet, it is chosen as the standard atom. Once, the standard atom is decided then there are two more steps to determine an atomic mass:

- First step is to assign a value to a mass of a standard atom.
- Second step is to weigh the atom in question against the standard atom, and assign the mass of an atom in question.

By international agreement, *the* **atomic mass** *(atomic weight) is the mass of an atom expressed in* **a***tomic* **m***ass* **u***nit* (amu). One **atomic mass unit (amu)** is defined as a *mass exactly equal to one-twelfth (1/12th) of one carbon-12 atom.* This means that the mass of one carbon-12 is assigned as exactly 12 amu.

Mass of one carbon-12 atom = 12 amu

Once the mass of a standard atom is decided, mass of other atoms are determined based on their relative weight. For example, the hydrogen atom weighs only 8.40 percent of carbon-12 atom. Then the mass of hydrogen atom is calculated as follows.

Atomic mass of hydrogen = mass of one atom carbon-12 x 8.40%
= 1.008 amu

Average Atomic Mass

But, there is one problem with such calculation. Almost all the elements in the periodic table have more than one isotope, meaning, all the atoms are not alike and have different masses. Therefore, the atomic mass should represent the masses of all the atoms, not just one atom. That means we should settle for an *average* atomic mass, which is the weighted average or mean (a statistical method) of all the isotopes based on their occurrence (relative abundances also known as percent (%) abundances) in nature. The general formula for the average atomic mass is

Average atomic mass = (Isotopic mass x percent abundance) $_1$+
(Isotopic mass x percent abundance) $_2$+
(Isotopic mass x percent abundance) $_3$ +
. . . (Isotopic mass x percent abundance) $_n$

Let us apply this formula to calculate the average atomic mass of carbon. The element carbon has two isotopes, carbon-12 and carbon-13. Carbon-12 has the atomic mass of

12.00000 amu with 98.90 % abundance and carbon-13 has the atomic mass of 13.00335 with 1.10 % abundance. The average atomic mass of carbon is,

Average atomic mass of carbon = (12.00000x 98.90% amu)
+ (13.00335 amu x 1.10%)
= 12.00000amu x 0.9890) + (13.00335 amu x .0110)
= 12.01 amu

This is the atomic mass you see in the periodic table.

Example

Copper metal is well-known since the dawn of civilization that has two isotopes, Cu-63 and Cu-65 that have atomic masses of 62.93 amu and 64.828 amu respectively. Their percent abundances are respectively 69.09 % and 30.91 %. Determine the average atomic mass of copper.

Answer

Average atomic mass = (62.93 amu x 0.6909) + (64.828 amu x 0.3091)
= 63.55 amu

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Hands on Practice to Calculate Average Atomic Mass