Chemistry Lecture #20: Atomic Mass Unit, Atomic Mass

Atomic Mass Unit

How is the mass of a single atom measured? This is done by comparing the mass of the atom to the mass of a standard atom. Carbon-12, which is made of 6 protons and 6 neutrons, was chosen as the standard atom.

1/12 the mass of a carbon-12 atom is defined as an atomic mass unit (amu). Thus, the mass of a carbon-12 atom is defined as exactly 12 amu. The mass of atoms is measured in atomic mass units. For example, sulfur-36 has a mass of 35.9670 amu, which is roughly 3 times the mass of carbon-12.

When expressed in atomic mass units, the mass of an atom approximately equals the number of protons and neutrons it has. For example, nitrogen-14 has a mass of 14.003074 amu, and also has a total of 14 protons and neutrons (7 protons + 7 neutrons).

Sometimes instead of writing "amu" we just write "u."

1 amu = 1.6605×10^{-24} g. An amu is really tiny!

Atomic Mass

How would you figure out the average height of your school basketball team? Suppose there were ten members. Three players are 5 feet tall, 6 players are 6 feet tall, and one player is 7 feet tall. The average height is calculated as follows:

$$\text{Average height} = \frac{3(5) + 6(6) + 1(7)}{10} = 5.8 \text{ feet tall}$$

In chemistry, we use the average mass of an element. Most elements have two or more isotopes, so we take the average mass of the isotopes when we ask for the mass of an element.

Atomic mass is the average mass of the isotopes of an element. The relative abundance of each isotope used to calculate the average.

For example, there are two isotopes of lithium: lithium-6 and lithium-7. Lithium-6 has a mass of 6.015121 amu and a percent abundance of 7.5%. Lithium-7 has a mass of 7.016003 amu and a percent abundance of 92.5%. Find the atomic mass of lithium.

If lithium-6 has a 7.5 percent abundance, it means that if you have 100 lithium atoms, 7.5 of them will lithium-6. Likewise, a 92.5 percent abundance of lithium-7 means that out of 100 lithium atoms you find in nature, 92.5 of them will be lithium-7.

Atomic mass of lithium =

$$\frac{7.5(6.015121) + 92.5(7.016003)}{100}$$

= 6.9409, or about 6.941 amu.

Look for lithium on your periodic chart. The number with decimals is the atomic mass of lithium. What value do they give? It is not 6.015121, and it is not 7.016003. It is, however, the average mass of the two isotopes of lithium, 6.941 amu.

Thus, the periodic chart gives the average mass of the isotopes for an element.