



Isotopes

The Discovery of Neutrons

Oops! Dalton Goofed!

- Dalton's discovery of atoms depended on one major characteristic of atoms . . . **mass.**
- One of Dalton's postulates says the following about mass:

**Atoms of an element are identical.
They have the same mass.**

- But in 1911 while trying to study the atomic nucleus, J. J. Thomson accidentally discovered that neon could have two different atomic masses.

Isotopes

- Atoms of the same element with different atomic masses are called ***isotopes***.
- Atoms of the same element have the same properties.
- But what causes the chemical properties of an atom? **The electrons and protons.**
- So atoms of different isotopes of an element must have the same number of protons and electrons.
- Whatever causes isotopes to have different masses must be an electrically neutral particle.

The Discovery of Neutrons

- In 1930, scientists showed that bombardment of beryllium with alpha particles produced neutral radiation.
- Measurements by Sir James Chadwick in 1932 proved that this neutral radiation was a particle with a mass similar to a proton.
- This neutral particle is called a neutron.



James Chadwick

Summary of Subatomic Particles

- The types of particles found in an atom are:
 - Protons;
 - Electrons; and
 - Neutrons.

Particle	Location	Mass	Relative Mass	Charge
Proton	Nucleus	1.67×10^{-27} kg	1 amu	+1
Electron	Outside	9.11×10^{-31} kg	0 amu	-1
Neutron	Nucleus	1.67×10^{-27} kg	1 amu	0

Some Definitions

- Atomic number = number of protons (Z)
- Mass number = mass of an isotope (A)
- Isotopic notation = symbol showing the element (X), the atomic number (Z), and the mass number (A)



- Example: ${}_{11}^{23}\text{Na}$

Number of Neutrons

- The relative mass of electrons is 0 amu, while the relative masses of protons and neutrons are each 1 amu.
- The mass of an atom (A) must be the sum of the atom's atomic number (Z) and the number of neutrons (N).

$$A = Z + N$$

- The atomic number and atomic mass are both given on the periodic table. The number neutrons is not.
 - The mass listed on the periodic table for each element is the average mass of the isotopes. That is why it is not an integer.
 - When this mass is rounded off, it gives the mass number of the most common isotope. But how do you find the number of neutrons?
- The number of neutrons for the most common isotope of an element can be found by rounding off the mass of the element on the periodic table and subtracting the atomic number from it.

$$N = A - Z$$

- This same formula can be used for any isotope for which the mass number is known.