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 accidently 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.

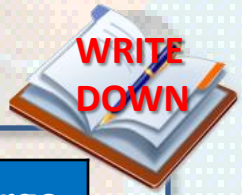
The Discovery of Neutrons

- 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.
- The neutral particle in an atom with a mass similar to a proton is called a ***neutron***.

James Chadwick

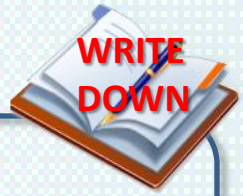
Summary of Subatomic Particles

- 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)

$$ {}^{A}_{Z}X $$

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

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 an element can be found by subtracting the atomic number from the mass number.

$$N = A - Z$$