Atomic Mass & Isotopes

https://www.pastemagazine.com/blogs/lists/2014/07/the-100-greatest-simpsons-guest-stars.html?p=6

Outcome:

Determine average atomic mass using isotopes and their relative abundance. *Include: Atomic mass unit (amu)*

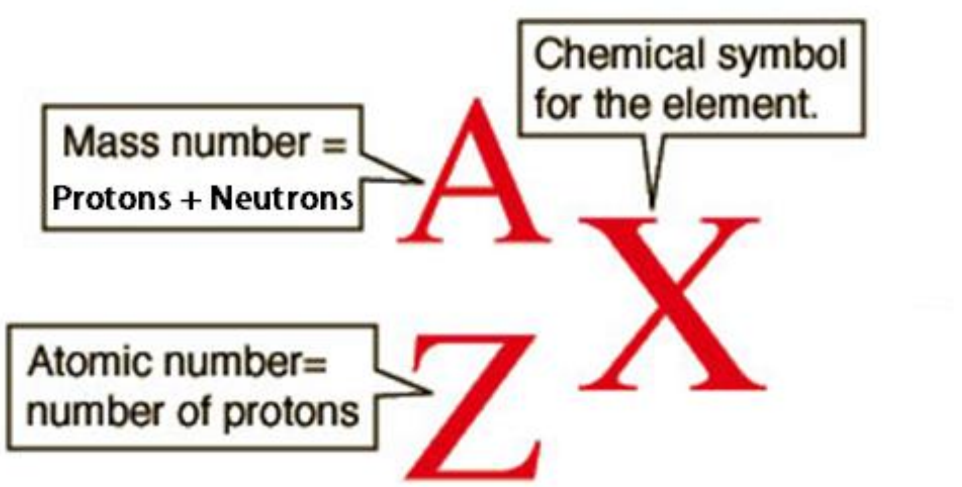
Periodic Table Review

Recall from Senior 1:

→ Atomic number = number of **PROTONS**

→ Atomic mass = number of **PROTONS** + number of **NEUTRONS**

→ Elements are usually denoted as follows:



http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/nucnot.html

Ex) ${}^{12}_{6}C$

More about atoms…

Protons Identify the element

The number of protons **CANNOT** change without changing the **ELEMENT**.

ie. If an atom has 6 protons, it MUST be carbon

In Neutral Atoms Electrons = Protons

The number of electrons **CAN** change, but it forms an **ION**.

Neutrons Stabilize the Nucleus

Neutrons are **NEUTRAL** and simply keep protons from **REPELLING** each other.

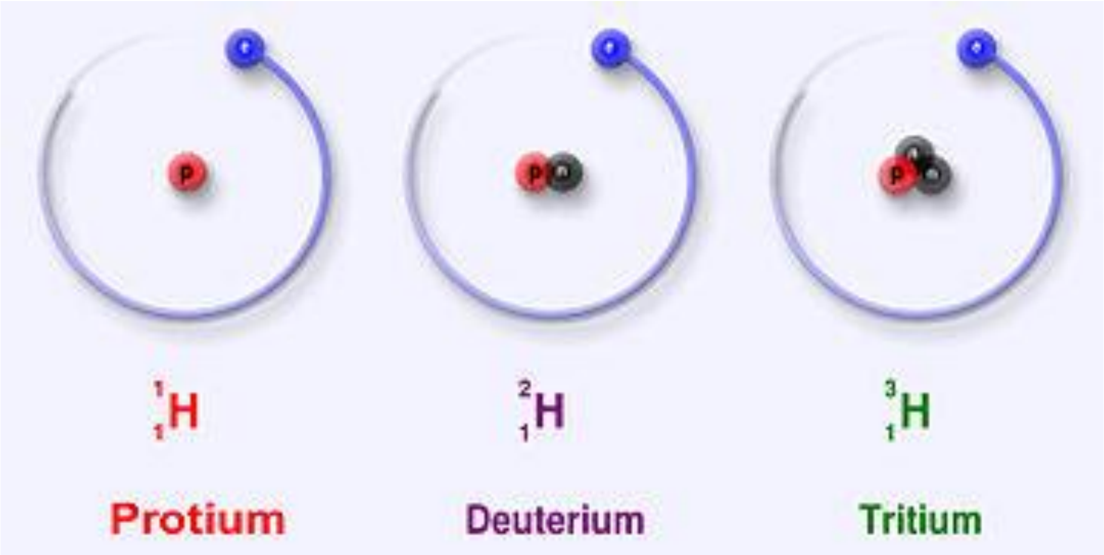
Isotopes:

- Isotopes are atoms of the same **ELEMENT** (same # of **PROTONS**), with different numbers of **NEUTRONS**.
- Neutrons **STABILIZE** the nucleus, which can be done in different **ARRANGEMENTS**.
- They have the same **ATOMIC** number, but different **MASSES**
- The **AVERAGE** mass of an isotope for an element is a **PROPERTY** of that element.
- Isotopes are usually represented as **SODIUM-24** or **^{24}Na**

Example:

Hydrogen has 3 naturally occurring isotopes:

Hydrogen Isotopes Analogy



https://en.wikipedia.org/wiki/Isotopes_of_hydrogen

Atomic Mass

Atomic Mass Unit (amu, u, or μ):

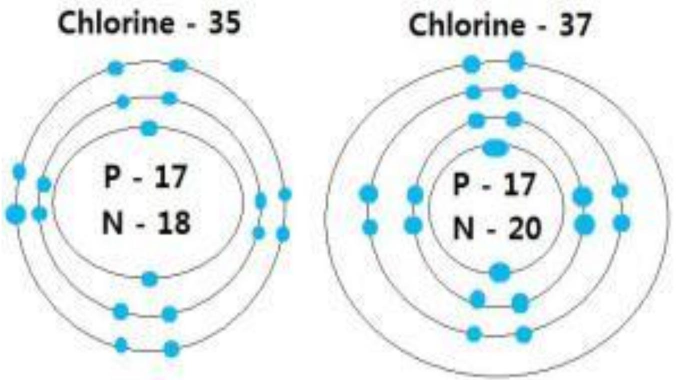
- Is 1/12th the mass of a **C-12** atom.
- The reasons for using the **C-12** isotope:
  - It is very **COMMON**
  - It results in nearly **WHOLE** number **MASSES** for most other elements
  - It gives **HYDROGEN** (lightest element) a mass of nearly **1AMU**
- It is extremely small! 1amu = ***1.66×10^{-27}kg***

Average Atomic Mass:

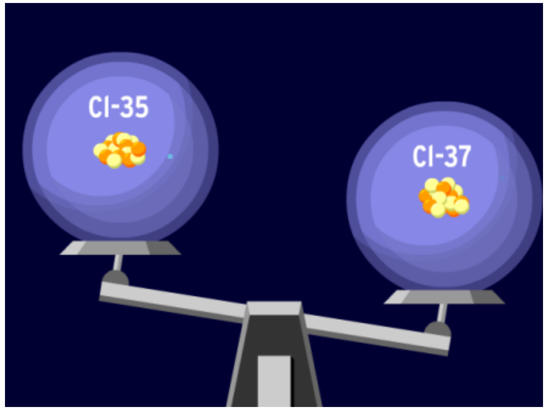
- Most elements have isotopes, meaning that there are atoms of the same element with different **MASS**.

Example:

Chlorine has two common isotopes: ***Chlorine-35*** and ***Chlorine-37***.



https://2009rt8sciafifa.wordpress.com/chemical-interactions-2/



- Any **SAMPLE** of chlorine atoms will have atoms of **BOTH ISOTOPES**.
- For most elements the **AMOUNTS** of each **ISOTOPE** in any **SAMPLE** is **CONSTANT**.
- Because the composition is constant, we can use an **AVERAGE MASS** for chlorine, taking the amount of each isotope into account.
- This percentage is called **RELATIVE ABUNDANCE.**

A sample of chlorine has 75% chlorine-35, and 25% chlorine-37.

- ***The average mass of Cl should be between 35 and 37amu (but closer to 35)***

How do we calculate average mass?

You need to know the **RELATIVE ABUNDANCE** of all isotopes.

Isotope	Abundance (%)
Silicon-28	92.23
Silicon-29	4.67
Silicon-30	3.10

Next, **MULTIPLY** the **MASS** of each isotope with its **ABUNDANCE**. (this **WEIGHTS** each isotope)

- ***Note:*** Use the exact mass of each isotope if given.

Finally, **ADD** the **WEIGHTED MASSES** to get the average atomic mass.

Try these ones…

Given the information below, find the average atomic mass of elemental Magnesium.

Isotope	% Natural Abundance
Magnesium-24	78.70
Magnesium-25	10.13
Magnesium-26	11.17

$$24 \times \frac{78.70}{100} = 18.89$$

$$25 \times \frac{10.13}{100} = 2.53$$

$$26 \times \frac{11.17}{100} = 2.90$$

24.32 u

Try these ones…

Elemental Boron is a combination of two naturally occurring isotopes: Boron-10 has a relative abundance of 19.78%, and boron-11 has a relative abundance of 80.22%.

$$10 \times \frac{19.78}{100} = 1.98$$

$$11 \times \frac{80.22}{100} = 8.82$$

10.8 amu