Chapter 2 Part 1

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Law of Conservation of Mass

Mass can neither be created nor destroyed.

$$O_2 + 2\ H_2 \rightarrow 2\ H_2O$$

- Notice that since this is a law, it is a rule about nature
- In order to explain the law of conservation of matter, one would need a theory

Law of Conservation of Mass

Which statement does *not* support the law of conservation of mass?

A. All the atoms present at the start of a chemical reaction are still present at the end.
B. The total mass of reactants in a chemical reaction is equal to the total mass of the products.
C. Mass is neither created nor destroyed during chemical reactions.
D. Compounds have a fixed ratio of element masses.

Law of Definite Proportions

- All samples of a pure compound contain the same elements in the same proportion by mass.

For example, both 10 g and 200 g samples of water (H_2O) have 11.19% of their mass come from hydrogen and 88.81% of their mass come from oxygen.

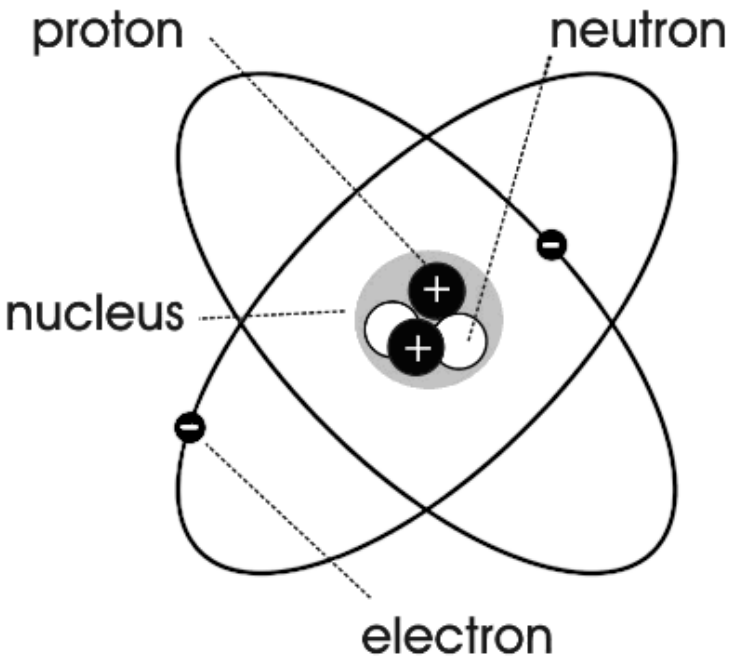
Thus, the inherent mass proportions of a compound are definite regardless of the total mass of that compound present.

Law of Definite Proportions

If 10 g of table salt, NaCl, contains 4 g of sodium, Na, what mass of Na is in 5 g NaCl?

A. 1 g
B. 2 g
C. 3 g
D. 4 g
E. 5 g

Components of an atom



Components of an atom

Components of an atom

	Relative Mass	Relative Charge
Proton	1836	+1
Neutron	1839	0
Electron	1	-1

- The electron cloud accounts for most of the volume of the atom
- The nucleus of an atom is about $\frac{1}{10{,}000}$ the diameter of a typical atom

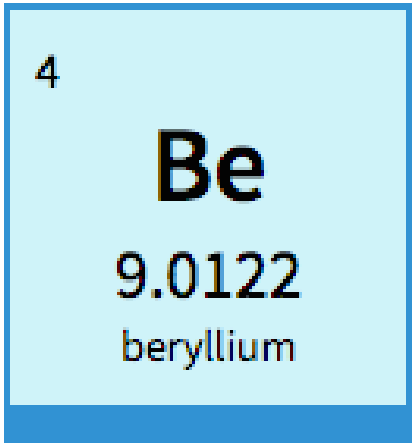
Components of an atom

- Atomic number (Z) = number of protons
  - Normally indicated in the upper left hand corner of the element box in the periodic table
- Mass number (A) = number of protons + neutrons
  - Not the same as the atomic mass on the periodic table
- A – Z = number of neutrons
- Atomic charge = number of protons – number of electrons

Components of an atom

How many protons are in a beryllium, Be, atom?

A. 4
B. 5
C. 9
D. 9.0122
E. 13



Mass Number

What is the mass number of an atom with 9 protons, 9 neutrons, and 9 electrons?

A. 9
B. 18
C. 27
D. More information is needed to determine mass number

Ions

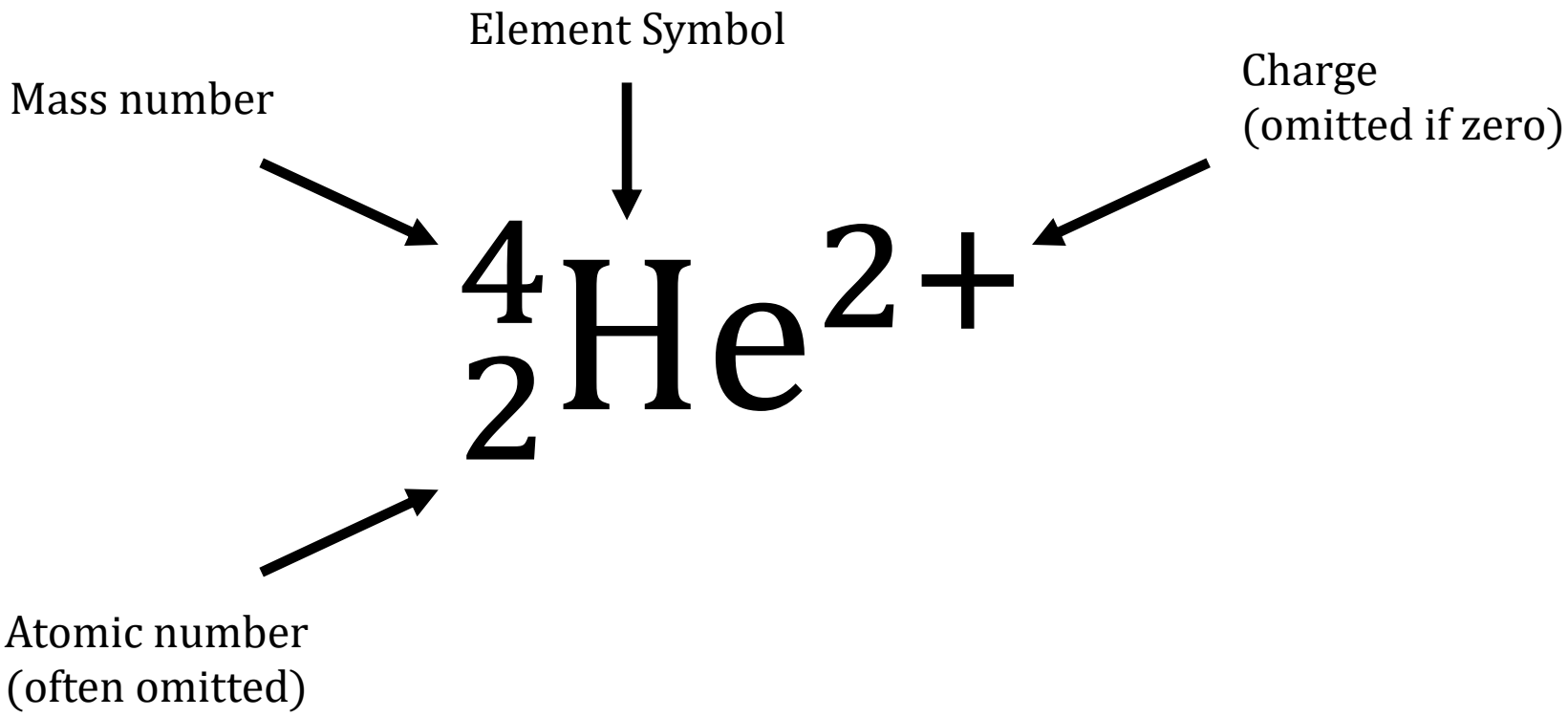
- Ions are charged atoms or molecules
- Therefore ions have an unequal number of protons and electrons
- Positive ions are called cations
  - "C" a "+" ion or "see a positive ion"
  - Cations have more protons than electrons
- Negative ions are called anions
  - A "n" ion or "a negative ion"
  - Anions have more electrons than protons

How to draw ions

- Start by writing the ion
- Charges are placed in the upper right corner
- The sign (+ or -) goes after the number
  - Ex. 2+, 3-, etc.
- The charges “+1” and “-1” are represented as “+” and “–” respectively

$$F^{-} \quad Ba^{2+}$$

Atomic Symbols



Atomic Symbols

- How many protons, neutrons, an electrons are in this atom?

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

Atomic Symbols

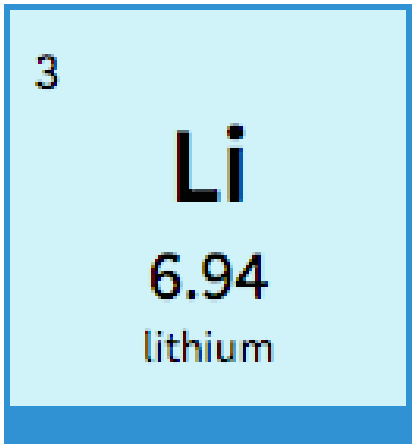
- What will the atomic symbol look like if we add an electron?

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

Atomic Symbols

How many electrons are in the Li^+ cation?

A. 1
B. 2
C. 3
D. 4
E. 6.94



Isotopes

- Isotopes are atoms of the same element with different numbers of neutrons
- Isotopes are distinguished by their mass numbers
- A carbon with a mass number of 12 can be written as
  - Carbon-12
  - C-12
  - ^{12}C
  - $^{12}_{6}C$

Atomic Symbols

- What will the atomic symbol look like if we add a neutron?

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

Changing the number of protons

- Changing the number of protons in an atoms changes the identity of the element to which it corresponds and changes the charge
  - Ex. Adding a proton to a carbon atom would make it a positively charged nitrogen atom
  - Ex. Adding a proton to a sodium atom would make it a positively charged magnesium atom

Atomic Symbols

- What will the atomic symbol look like if we add a proton?

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

Atomic Symbols

Draw the atomic symbol for an atom with 15 protons, 18 neutrons and 13 electrons

Average Atomic Mass

- The atomic mass of a single isotope of an atom is approximately equal to its mass number
- Average atomic mass is equal to the sum of each individual isotope's mass multiplied by its fractional abundance

$$\text{Average atomic mass} = \sum_{i} (\text{fractional abundance} \times \text{isotopic mass})$$

where i is the number of isotopes

Average Atomic Mass

Boron has two isotopes. About 19.9% of all boron atoms are ^{10}B with a mass of 10.0129 amu, and the remaining 80.1% are ^{11}B with a mass of 11.0093 amu. The average atomic mass for boron is calculated to be:

Average Atomic Mass

A new element has been identified with two isotopes of mass 542.41 amu and 554.78 amu. The relative percentage of the two isotopes are 42.8% and 57.2% respectively. Calculate the average atomic mass.

Average Atomic Mass

A new element has been identified with two isotopes of mass 542.41 amu and 554.78 amu. The average atomic weight of the element has been reported as 547.11 amu. Does this suggest that there is a greater abundance of the heavier isotope or lighter isotope?

Average Atomic Mass

Use the abundance and isotope mass information in the table to estimate the average atomic mass of fictional element Z.

A. less than 13 u
B. exactly 13.092 u
C. approximately 14 u
D. exactly 14.986 u
E. greater than 15 u

Abundance	Isotope Mass
51.392%	13.092 u
48.608%	14.986 u