

## 05: Atoms and Molecules

### Key Chemistry Terms

- **Atom:** Smallest piece of matter that retains the chemical properties of the element.
- **Nucleus:** Center of the atom—contains the protons and neutrons.
- **amu:** Atomic Mass Unit ( $1.66 \times 10^{-27}$  kg)
- **Ion:** Atom with a charge, resulting from the loss or gain of electrons.
- **Anion:** Atom with a negative charge.
- **Cation:** Atom with a positive charge.
- **Periodic Table:** Organizes the elements.
- **Isotopes:** Atoms of the same element with a different number of neutrons.
- **Mass Number:** # of protons + # of neutrons.
- **Average Atomic Mass:** Weighted average of the masses of all isotopes of that element.
- **Molecules:** Atoms of different elements combined in a definite ratio to form a new "unit".

### What is an Atom?

Atom is composed of sub-atomic particles

Particle	Location	Mass	Charge
Proton	Nucleus	1 amu = $1.67 \times 10^{-27}$ kg	+1
Neutron	Nucleus	1 amu = $1.67 \times 10^{-27}$ kg	0
Electron	Outside the nucleus	0.00055 amu = $9.10 \times 10^{-31}$ kg	-1

#### Nucleus:

- Overall positive charge.
- Most of the mass of the atom in a small space (dense).
- Outside the nucleus:
  - Overall negative charge
  - Very little mass in a large space (low density)
  - Atom overall:
    - Charge depends on ratio of protons to electrons
    - Mass depends on number of protons & neutrons

#### Protons:

- # of determine the identity of the element—each element has a different number of protons.
- The atomic number (on periodic table) = # of protons.
- Cannot be lost or gained without changing the identity of the element (nuclear reaction).

#### Electrons:

- # of and configuration determine the "chemistry" of the element.
- Determined by the charge and the # of protons.
- Can be lost or gained to form charged atoms (ions).

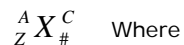
### Ions

- Atoms can gain or lose electrons to form ions (atoms with a charge).
- The charge depends on the ratio of protons to electrons.

Before	Change	After	Charge
Oxygen atom 8 protons 8 electrons	Gain 2 electrons	Oxygen anion 8 protons 10 electrons	$O^{2-}$
Sodium atom 11 protons 11 neutrons	Lost one electron	Sodium cation 11 protons 10 electrons	$Na^+$

### Chemistry Symbology

- Element symbols (one or two letters, always beginning with a capital letter) are found on the periodic table.
- Elements are organized by atomic number.
- Element symbols can be written to include many pieces of information:



- A = mass number
- Z = atomic number
- C = charge
- # = number of atoms

**Atomic number** = # of protons

**Mass #** = # of protons + # of neutrons

**Charge** = # of protons - # of electrons

### Isotopes

**Atoms of the same element can contain a different number of neutrons.**

- Neutrons do not affect charge.
- Neutrons do affect mass (neutron mass = 1 amu).
- Isotopes of the same element will have different masses.
- Masses are shown in the upper right corner of the symbol or after the elements name:  
e.g.:  $^{13}C$  or Carbon-13

Mass Number	Average Atomic Mass
# of protons + # of neutrons	Weighted average of actual mass of all isotopes
Always a whole number	Not a whole number
Talks about one specific isotope	Takes into account all isotopes
Is not found on the periodic table	Is found on the periodic table.

**Calculating average atomic mass:**

Atomic mass =  $\Sigma(\text{fractional abundance})(\text{mass of that isotope})$

### Atoms, Elements & Molecules

Atoms	→ Elements	→ Molecules
Composed of protons, neutrons & electrons	Pure substance	Pure substance
Smallest piece of matter displaying chemical properties of element	Every atom is contains same # of protons	Atoms of more than one element bonded together
"Building block of matter"	Found on the periodic table	Displays properties different from the individual elements

- Molecules are written with element symbols to show which type of atoms are present & subscripts to show how many atoms are present.
- The most metallic element (closest to Group 1A) is written first (except in organic molecules).  
e.g: NaCl or  $CaCl_2$

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then recite it out on a blank sheet of paper. Review it again before the exams.