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 $(1.66 \times 10^{-27} \text{ kg})$
- 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
		1.67 × 10 ⁻²⁷ kg	
Neutron	Nucleus	1 amu =	0
		1.67 × 10 ⁻²⁷ kg	
Electron	Outside the	0.00055 amu =	-1
	nucleus	9.10 × 10 ⁻³¹ kg	

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).

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- 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	Gain 2	Oxygen anion	O ²⁻
8 protons	electrons	8 protons	
8 electrons		10 electrons	
Sodium atom	Lost one	Sodium cation	Na ⁺
11 protons	electron	11 protons	
11 neutrons		10 electrons	

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:

$${}^{A}_{Z}X^{C}_{\#}$$
 Where

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:

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e.g.: <sup>13</sup>C or Carbon-13
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Mass Number	Average Atomic Mass		
# of protons + # of	Weighted average of actual		
neutrons	mass of all isotopes		
Always a whole number	Not a whole number		
Talks about one specific	Takes into account all		
isotope	isotopes		
Is not found on the periodic	Is found on the periodic		
table	table.		

Calculating average atomic mass:

Atomic mass = Σ (fractional abundance)(mass of that isotope)

Atoms, Elements & Molecules						
Atoms	Elements		1	Molecules		
Composed of		Pure substance		Pure substance		
protons,						
neutrons &						
electrons						
Smallest piece		Every atom is		Atoms of more		
of matter		contains same		than one		
displaying		# of protons		element		
chemical				bonded		
properties of				together		
element						
"Building block		Found on the		Displays		
of matter"		periodic table		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).
 eg: NaCl or CaCl₂

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.