

# Atomic Structure & Isotopes

Subatomic particles, atomic and mass number, isotopes, average atomic mass, shells, and Lewis dots.

## 01 Subatomic particles

CORE RULE

Proton: +1, in the nucleus. Neutron: 0 charge, in the nucleus.  
Electron: -1, outside the nucleus.  
Proton  $\approx$  neutron  $\approx$  1 amu; electron  $\approx$  0.00055 amu (far lighter).

## 02 Neutral atom

CORE RULE

In a neutral atom, electrons = protons. Nearly all the mass is in the nucleus.

## 03 Counting particles

METHOD

Z (atomic number) = number of protons; it identifies the element.  
A (mass number) = protons + neutrons = Z + N.  
Neutrons:  $N = A - Z$ .  
Ion electrons = Z - charge (positive: lost electrons; negative: gained electrons).

## 04 Isotopes

CORE RULE

Isotopes: same element (same protons), different neutron count and mass number.

## 05 Isotope notation

CORE RULE

Symbol notation: mass number A as left superscript, atomic number Z as left subscript (e.g.  $^{14}_6\text{C}$ ).  
Name notation: element name + hyphen + mass number (carbon-14, uranium-235).

## 06 Average atomic mass

METHOD

Weighted average =  $\Sigma$  (isotopic mass  $\times$  fractional abundance).  
Convert % abundance to decimal first; fractional abundances sum to 1.00.  
The more abundant isotope pulls the average toward its mass; that is why atomic masses are not whole numbers.

## 07 Electron shells (first 20 elements)

CORE RULE

Introductory fill pattern through calcium: 2, 8, 8, then up to 2 in shell 4 (not the full physical capacities).  
Valence electrons (main group) = electrons in the outermost occupied shell.

## 08 Lewis dot symbols

CORE RULE

Element symbol surrounded by one dot per valence electron.  
One dot on each side before pairing a second on any side. He is drawn with 2 (its first shell is full).

## 09 Common ion charges

REFERENCE

Group 1  $\rightarrow$  +1 · Group 2  $\rightarrow$  +2 · Al  $\rightarrow$  +3 · Group 16  $\rightarrow$  -2 · Group 17  $\rightarrow$  -1 · N, P  $\rightarrow$  -3. Introductory patterns, not universal.

## 10 Ionic formulas & naming

CORE RULE

Balance charge with the cross-over rule (each ion's charge magnitude becomes the other's subscript), then reduce to the smallest whole-number ratio.  
Binary ionic name: metal + nonmetal root + -ide.  $\text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl}$ ;  
 $\text{Mg}^{2+} + \text{O}^{2-} \rightarrow \text{MgO}$ ;  $\text{Li}^+ + \text{S}^{2-} \rightarrow \text{Li}_2\text{S}$ ;  $\text{Al}^{3+} + \text{N}^{3-} \rightarrow \text{AlN}$ .