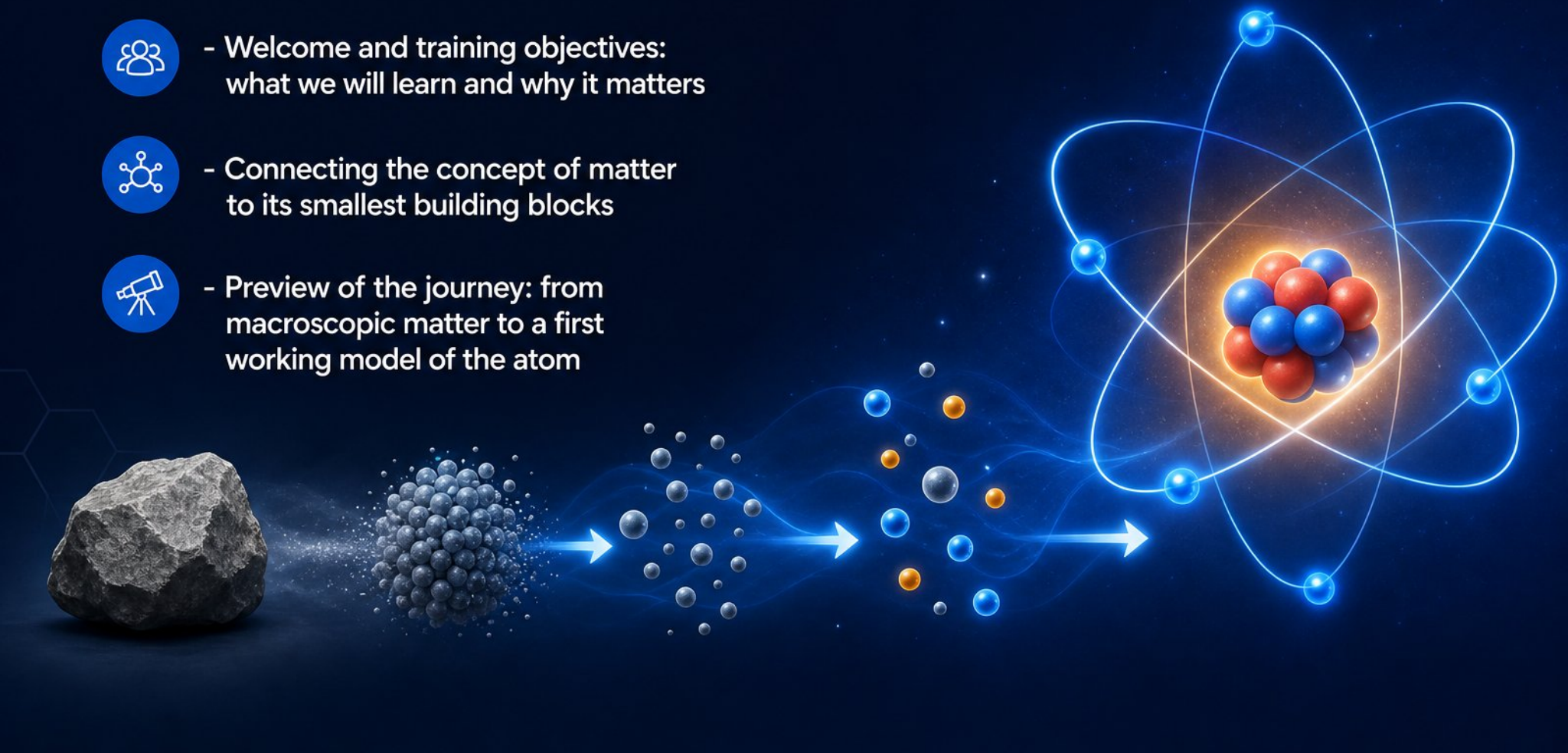
Introduction to Atomic Structure:

Protons, Neutrons, and Electrons

- Welcome and training objectives: what we will learn and why it matters
- Connecting the concept of matter to its smallest building blocks
- Preview of the journey: from macroscopic matter to a first working model of the atom

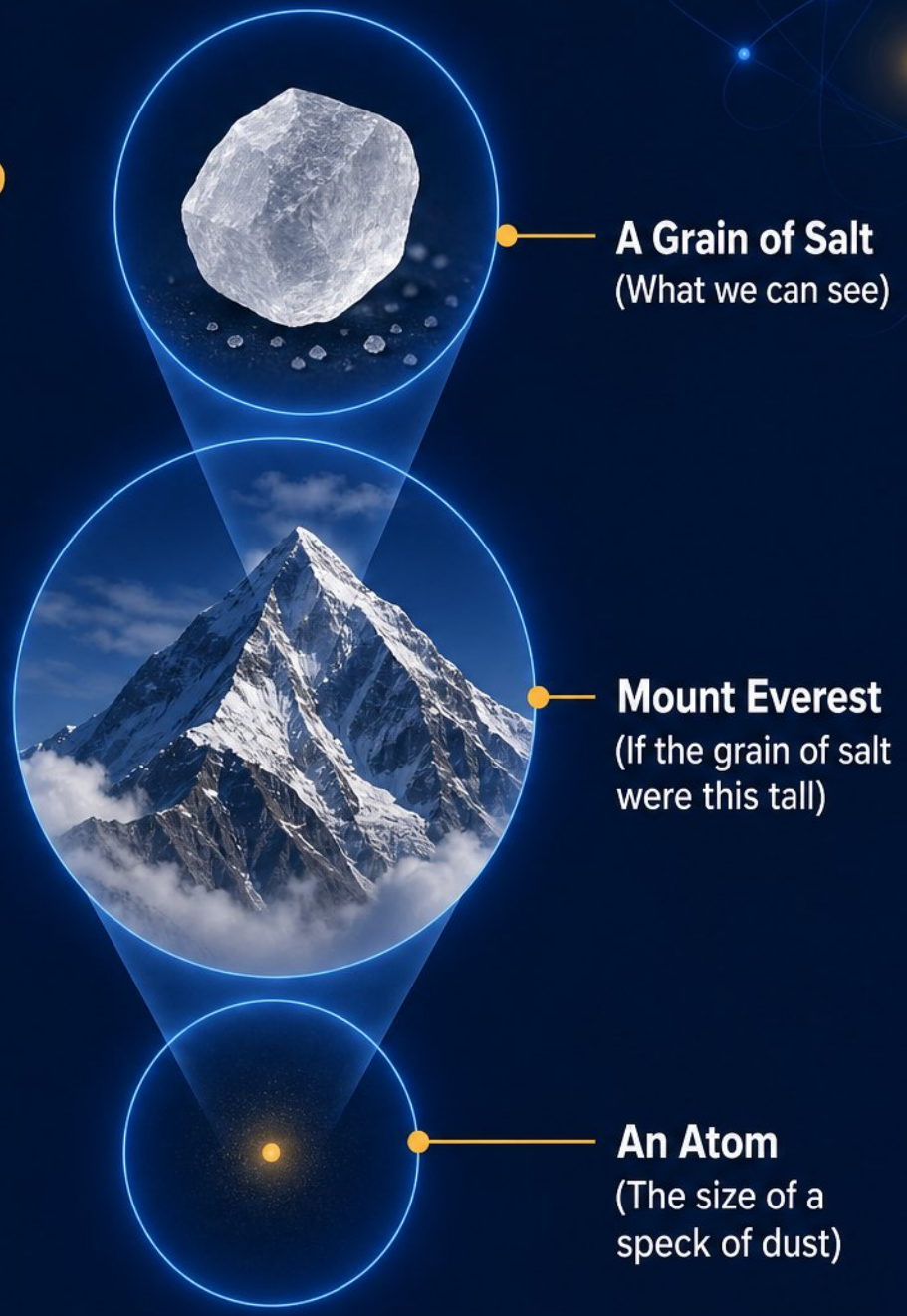


From Matter to Atoms: Why We Need a Model

- Matter is made of distinct substances with different properties.
- Atoms cannot be seen directly—they are a 'black box'.
- Scientific models simplify reality to explain and predict behavior.
- Models are already used for invisible phenomena (e.g., weather maps).

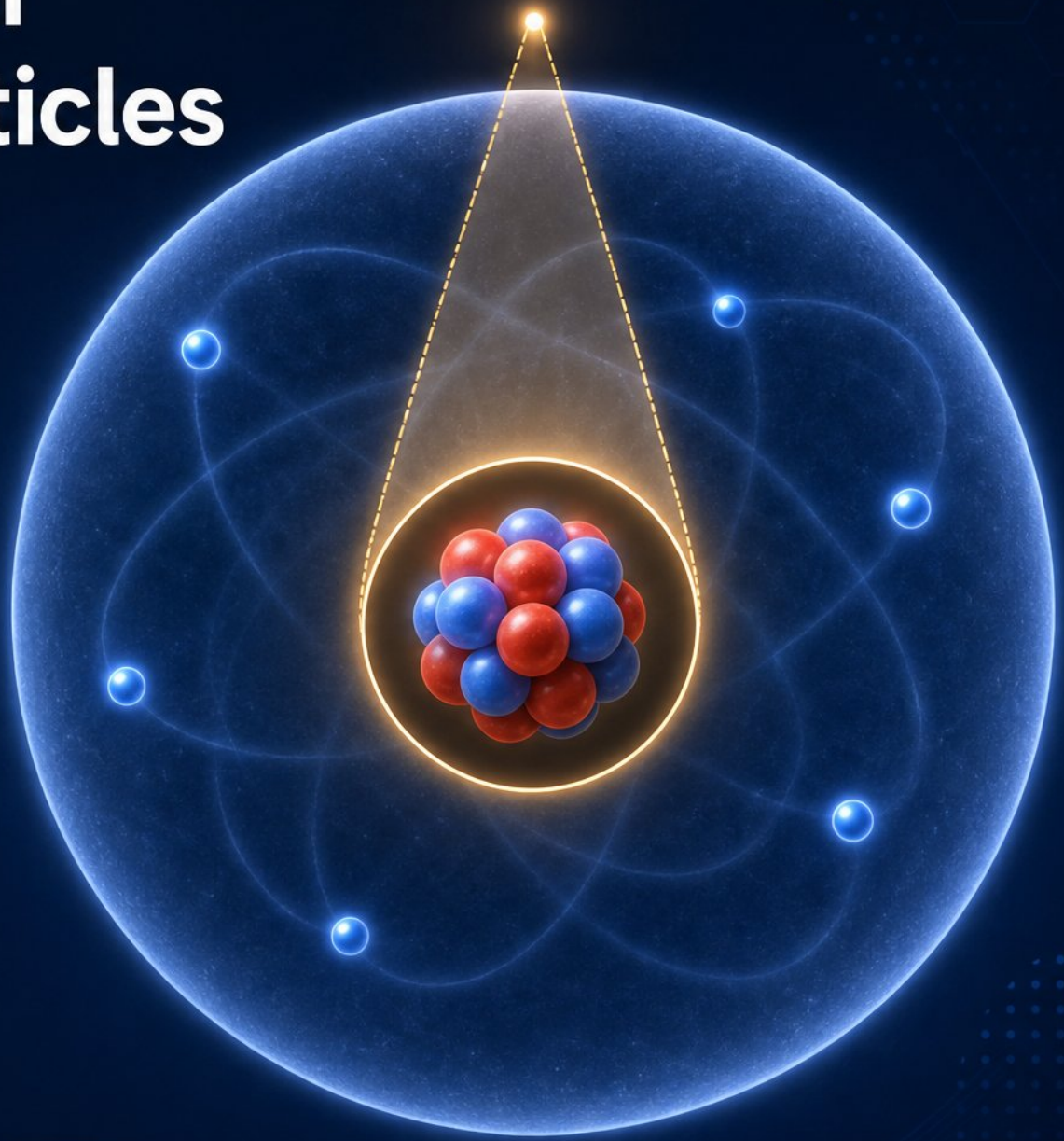
Understanding Scale:
How Small Is an Atom?

- Atoms are far smaller than anything visible with light microscopes.
- If a grain of salt were as tall as Mount Everest, an atom inside it would be the size of a speck of dust.
- Atoms are not alive, do not have cells, and are not miniature versions of bulk matter.
- Classroom microscopes cannot show individual atoms.



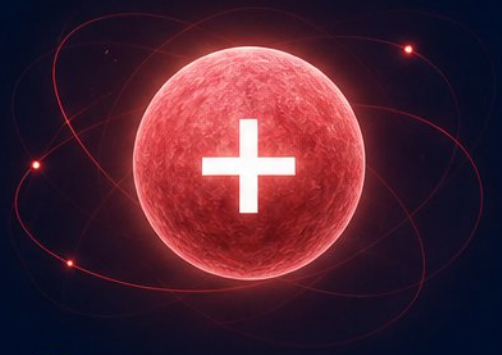
The Three Main Subatomic Particles

- Core components: protons, neutrons, and electrons.
- Protons and neutrons packed in a tiny, dense nucleus.
- Electrons found in a surrounding cloud, not fixed orbits.
- The nucleus is minuscule compared to the atom's total volume.



Charge and Relative Mass: Comparing the Particles

Proton



Charge: positive (+1)

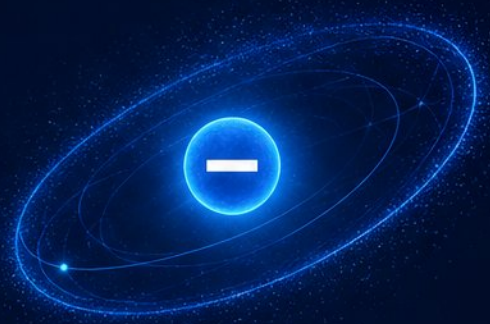
Relative mass: 1

Neutron

Charge: no charge (neutral)

Relative mass: 1

Electron



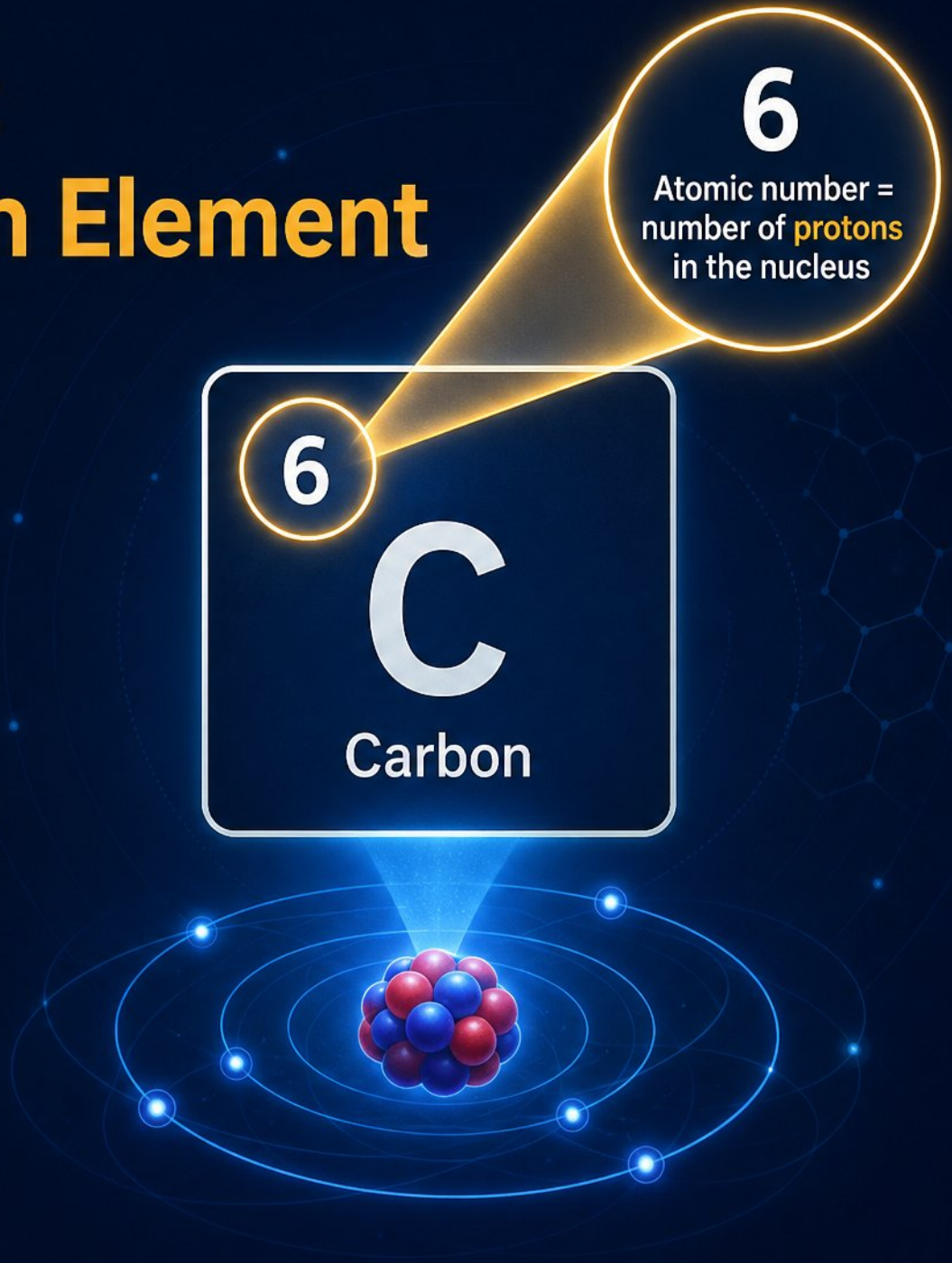
Charge: negative (-1)

Relative mass: negligible mass (~1/1836)

- **Neutral atom:** number of protons equals number of electrons

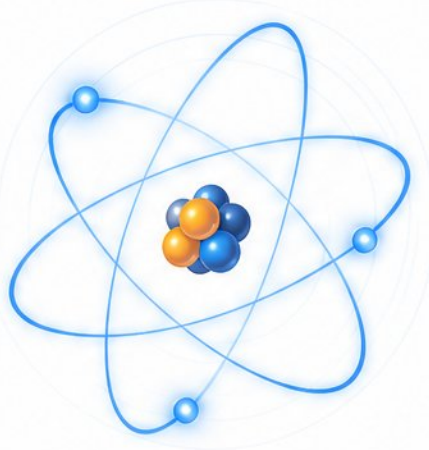
Atomic Number:
The Identity of an Element

- Atomic number = number of protons in the nucleus
- The atomic number uniquely defines the element
- Example: carbon always has 6 protons
- Find the atomic number on a periodic table tile
- Practice: identify element from atomic number and vice versa



Mass Number and Calculating Neutrons

- **Mass number (A)** = number of protons + number of neutrons
- **Atomic number (Z)** = number of protons; defines the element
- **Neutrons** = mass number − atomic number
- **Worked examples:** hydrogen (1-1=0), carbon (12-6=6), oxygen (16-8=8), sodium (23-11=12)



A
Mass Number
Total number of protons + neutrons

−

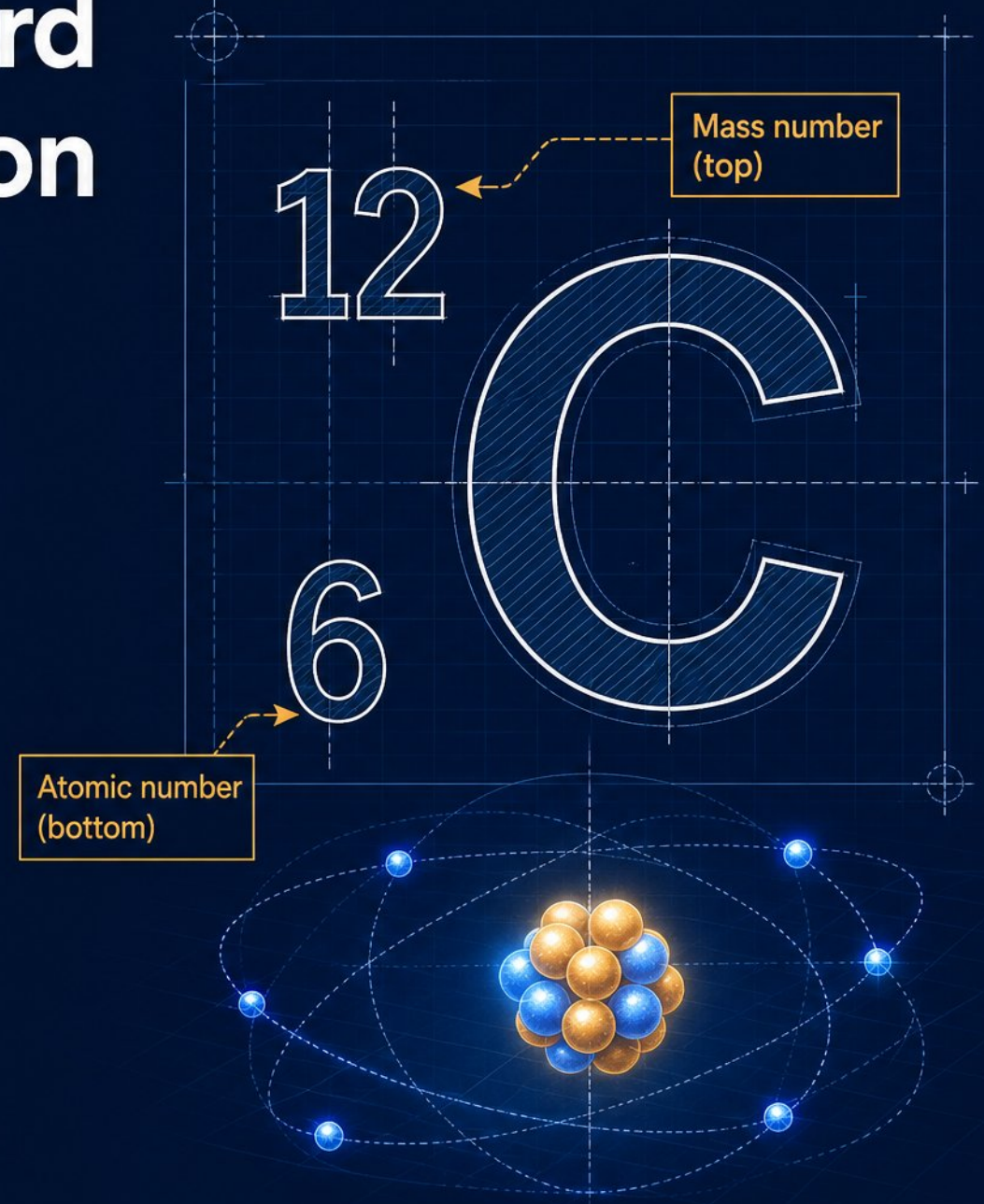
Z
Atomic Number
Number of protons

=

N
Number of Neutrons
Mass number − atomic number

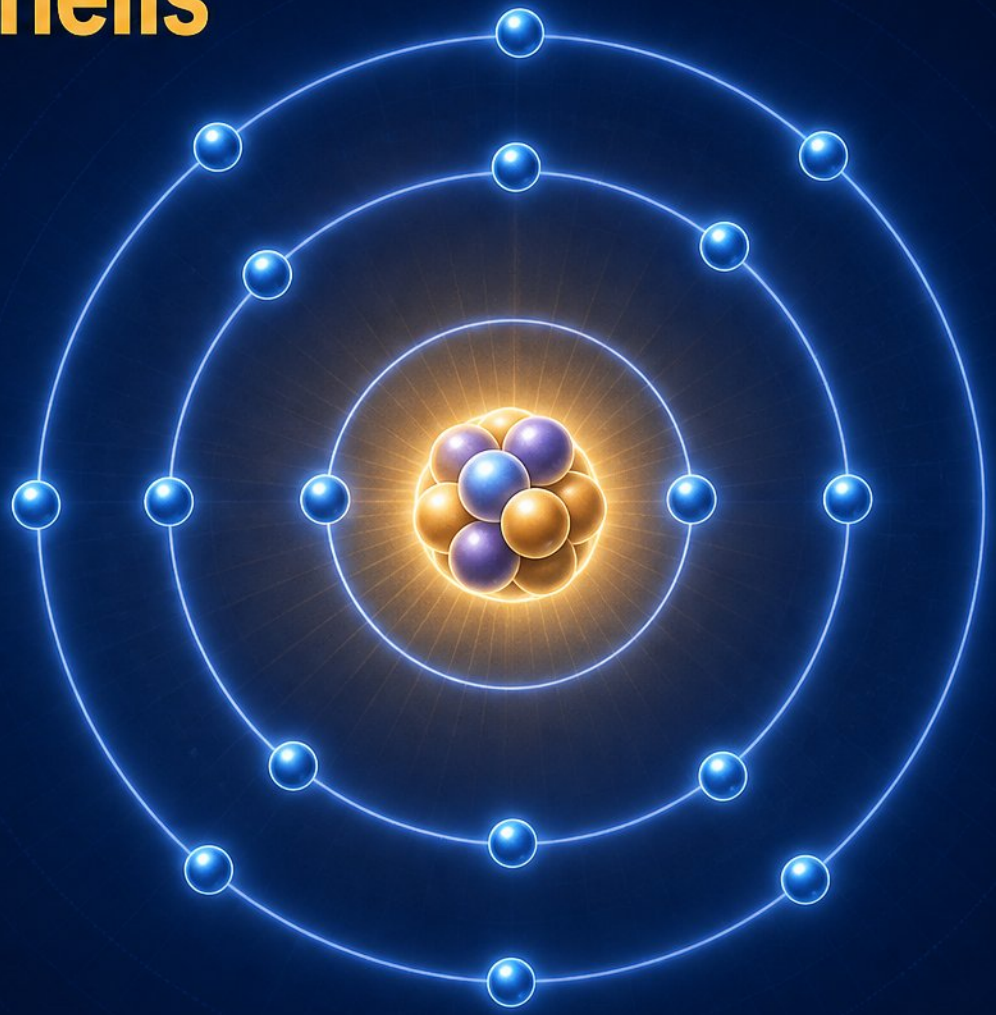
Reading Standard Element Notation

- - Element symbols use atomic number (bottom) and mass number (top), e.g. $^{12}_{6}C$
- - Atomic number = protons = identity of the element
- - Mass number = protons + neutrons
- - In a neutral atom, electrons = protons
- - Practice: translate notation into a table of subatomic particle counts



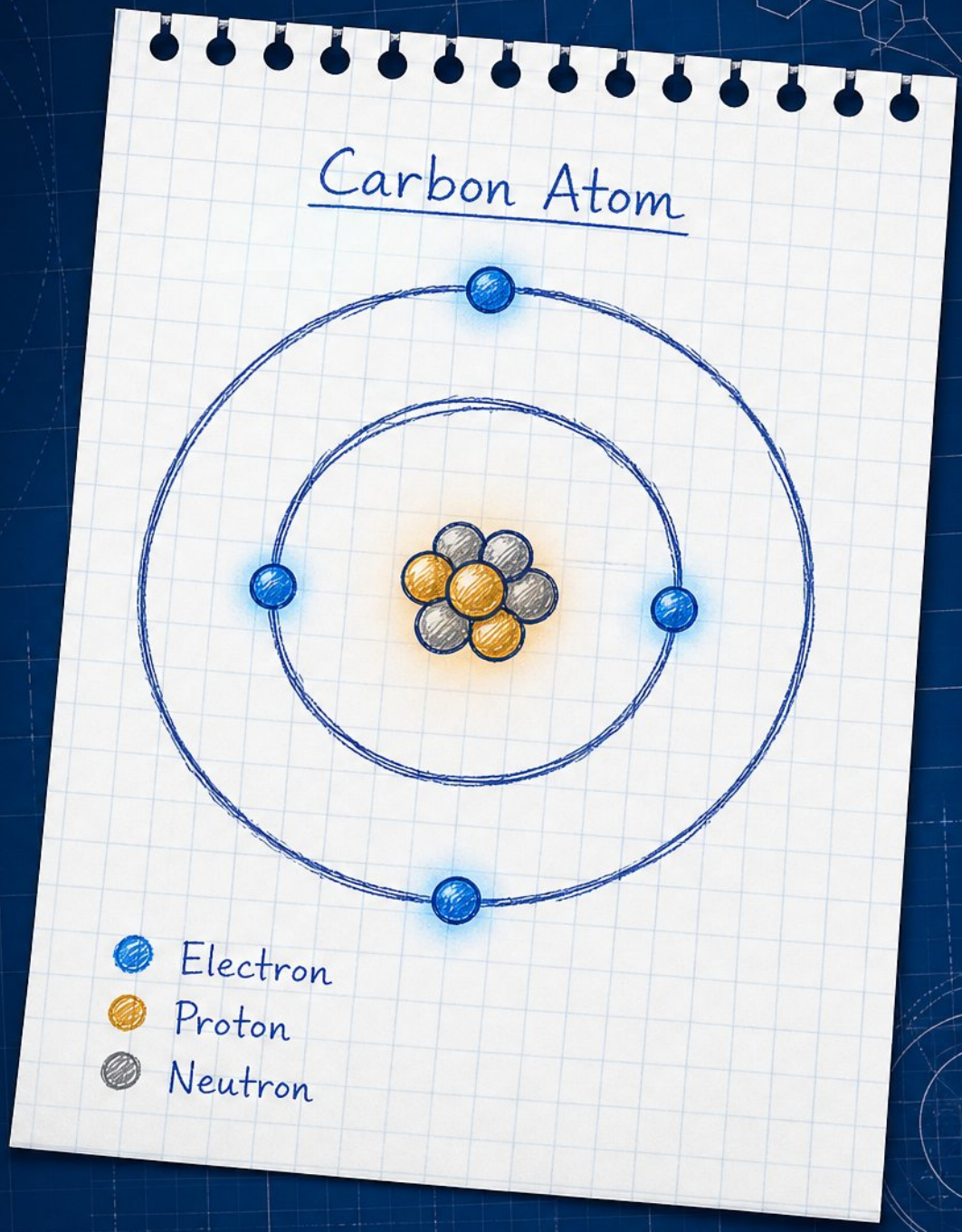
Electron Arrangement:
Energy Levels and Shells

- Electrons occupy energy levels (shells), not fixed orbits
- First shell holds a maximum of 2 electrons
- Second and third shells hold up to 8 electrons each
- Bohr model: a simple starting point with concentric circles
- Shells are regions of high probability, not physical eggshells



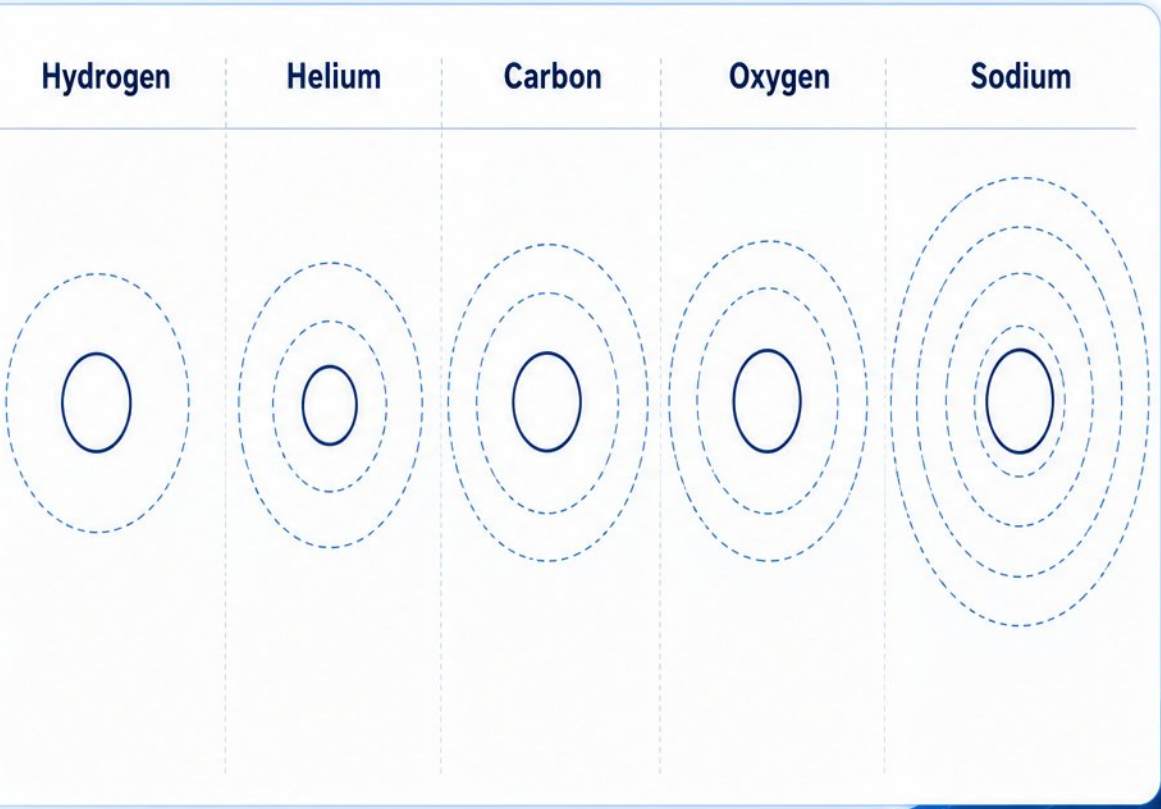
The Bohr Model: A First-Step Visualization

- Electrons drawn on concentric circles for a simple model
- Nucleus contains protons and neutrons; shells hold electrons
- Hydrogen: 1 electron in the first shell
- Carbon: 2 electrons in shell 1, then 4 in shell 2
- This model is a tool; electrons do not orbit like planets

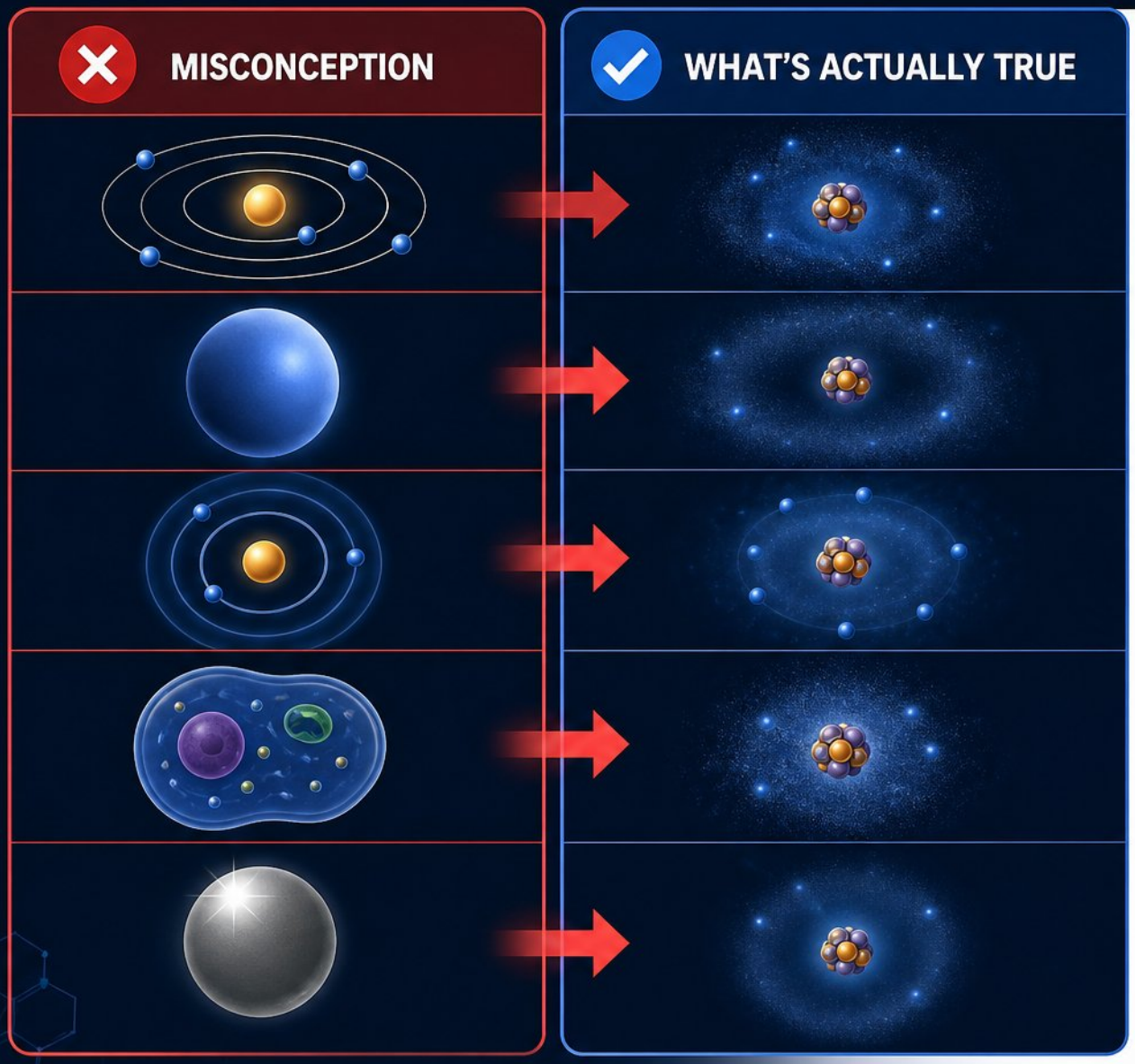


Building Atoms: Practice with the First 20 Elements

- **Step-by-step:** find protons, neutrons, and electrons from element data
- **Draw simple models** for hydrogen, helium, carbon, oxygen, and sodium
- **Accuracy check:** protons equal electrons, and shells fill in order
- **Use printable worksheets or** graphic organizers for guided practice



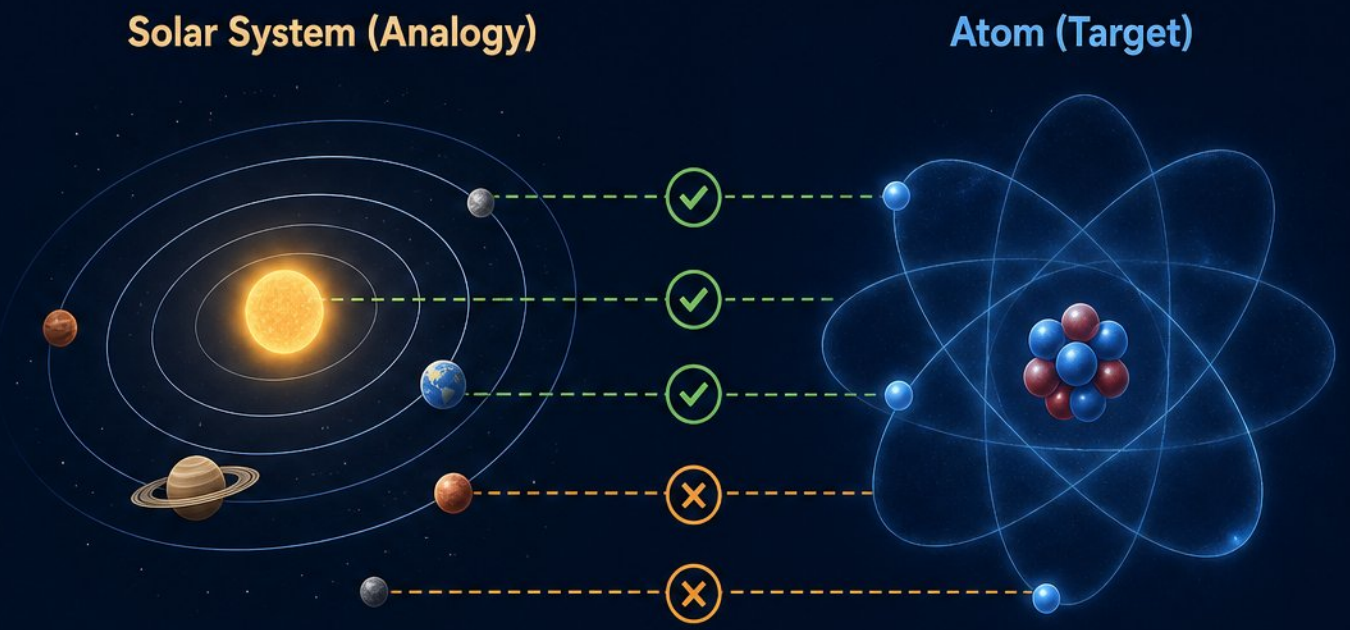
Common Misconceptions About Atomic Structure



- Electrons do not orbit like planets in fixed paths.
- Atoms are mostly empty space, not solid spheres.
- Electron shells are not physical protective layers.
- Atoms are not alive, cannot reproduce, and are not made of cells.
- Individual atoms do not show bulk properties like shine or conductivity.

Using Analogies Wisely: Strengths and Pitfalls

- Analogies make the unfamiliar familiar, but always break down
- Solar system analogy: central body, orbits, but different forces
- Map where an analogy matches and where it does not
- Check that the analogue is actually more familiar than the atom

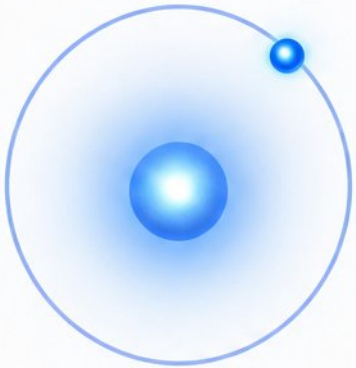


Match: Analogy captures a useful similarity

Does Not Match: Important differences exist

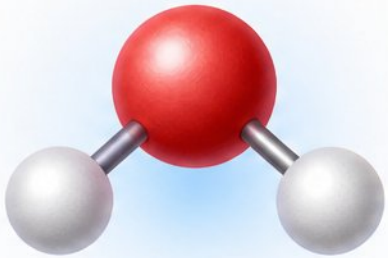
Distinguishing Atoms from Molecules and Ions

ATOM



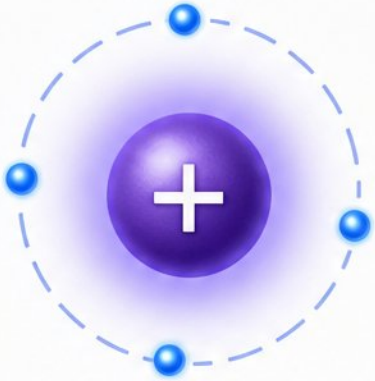
The smallest unit of an element retaining its chemical identity.

MOLECULE



Groups of two or more atoms bonded together (e.g., H_2O).

ION



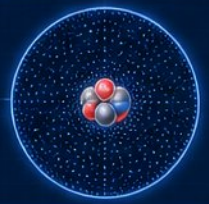
Atoms or groups of atoms with a net charge from electron loss or gain.

- An atom is the smallest unit of an element retaining its chemical identity.
- Molecules are groups of two or more atoms bonded together (e.g., H_2O).
- Ions are atoms or groups of atoms with a net charge from electron loss or gain.
- Atoms are not miniature molecules; individual atoms do not share bulk properties.
- “Atom” and “molecule” are not interchangeable terms.

Summary and Self-Check: Key Takeaways

- Protons, neutrons, and electrons define atomic identity and behavior

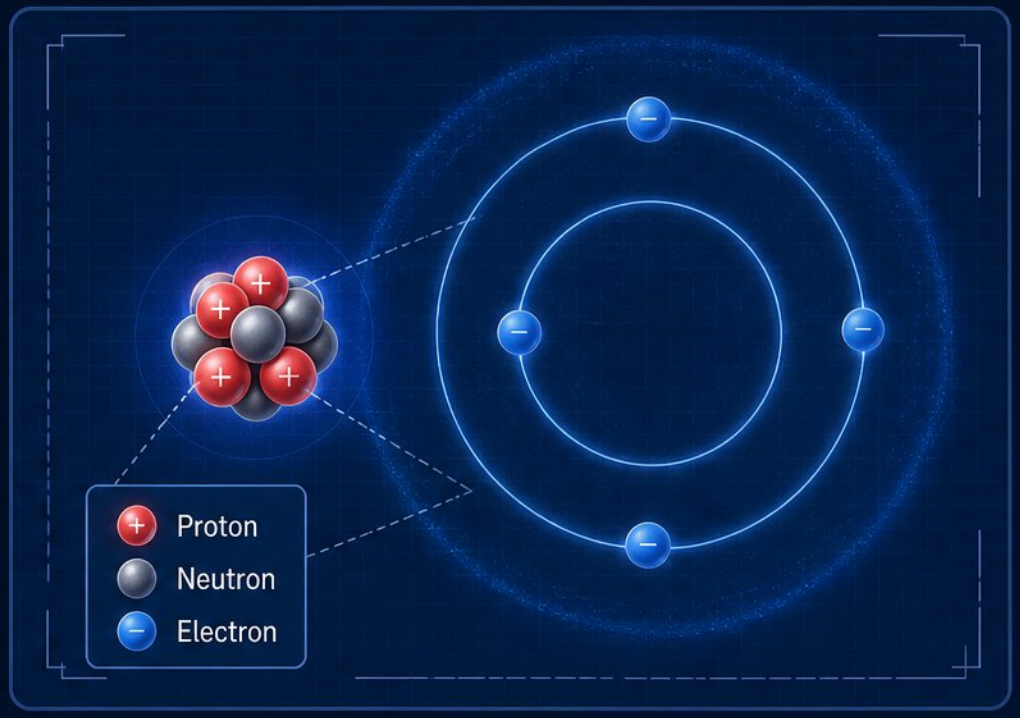
- Atomic number equals protons; mass number is protons plus neutrons



- Atoms are mostly empty space; the nucleus determines the element

- Electron arrangement in shells drives chemical properties

- Check: Calculate particles, draw Bohr models, and spot misconceptions



SELF-CHECK

- Calculate particles
- Draw Bohr models
- Spot misconceptions

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