

Atomic Structure (Review)

Unit: Quantum and Particle Physics

NGSS Standards/MA Curriculum Frameworks (2016): N/A

AP® Physics 2 Learning Objectives/Essential Knowledge (2024): 15.2.A, 15.2.A.1, 15.2.A.1.i, 15.2.A.1.ii, 15.2.A.1.iii, 15.2.A.1.iv, 15.2.A.2, 15.2.A.2.i, 15.2.A.2.ii, 15.2.A.2.iii

Mastery Objective(s): (Students will be able to...)

- Describe the basic subatomic particles (proton, neutron, electron)
- Describe various properties of subatomic particles, including their electrical charges, relative masses, and where they are found within an atom.

Success Criteria:

- Students demonstrate a correct understanding of the above objectives.

Language Objectives:

- Be able to explain and draw & label representations of an atom.

Tier 2 Vocabulary: atom, charge, nucleus

Notes:

Atomic & particle physics is concerned with the behaviors of atoms and the particles that they are made of. For this reason, it is useful to review some basic information about atoms that you should remember from your chemistry classes:

- Atoms have an internal structure consisting of a small, positively charged nucleus surrounded by negatively-charged electrons.
- The nucleus of an atom contains protons (which carry a positive charge) and neutrons (which do not carry an electrical charge). Each element has a unique number of protons, which means that the number of protons determines the element's identity.
- The number of protons and neutrons in an atom can be represented by nuclear notation. For example, ${}^{56}_{26}\text{Fe}$ would denote an iron atom, with atomic number 26. This atom would have 26 protons and $56 - 26 = 30$ neutrons.
- Protons carry a charge of $1.60 \times 10^{-19} \text{ C} = 1$ elementary charge. Electrons carry a charge of $-1.60 \times 10^{-19} \text{ C} = -1$ elementary charge. An atom that has equal numbers of protons and electrons is electrically neutral.

- Protons and neutrons remain in the nucleus of an atom, but electrons are outside of the nucleus and can be added to or removed from the atom by various processes (chemical, electrical, thermal). An atom that has a positive or negative charge due to its having gained or lost electrons is called an ion. For example, ${}^{56}_{26}\text{Fe}^{2+}$ would denote an iron ion with a +2 charge, indicating that it has 26 protons but only 24 electrons.
- Because electrons can be transferred between atoms, the chemical properties of an atom are determined by the number and arrangements of its electrons.
- The mass of an atom is dominated by the total mass of its protons and neutrons. Electrons have roughly $\frac{1}{2000}$ of the mass of a proton or neutron and contribute very little to the atom's mass.
- Protons and neutrons have nearly identical masses. This means that the atomic mass of an element is determined by the number of protons + neutrons that it contains. The mass number of an element is called its isotope. For example, ${}^{56}_{26}\text{Fe}$ (or just ${}^{56}\text{Fe}$) would denote the isotope iron-56.