Unit Plan: Atomic Structure

FOR THE TEACHER

Summary
The AACT high school classroom resource library has everything you need to put together a unit plan for your classroom: lessons, activities, labs, projects, videos, simulations, and animations. We constructed a unit plan using AACT resources that is designed to teach Atomic Structure to your students.

Grade Level
High School

Objectives
By the end of this unit, students should be able to
- Understand past and current theories regarding the structure of the atom.
- Use the number of protons, neutrons, and electrons in an element to predict an atom’s identity.
- Calculate atomic mass.
- Calculate atomic number.
- Understand the meaning of ion.
- Calculate the molar mass of a substance.
- Calculate the number of moles of a compound in a given mass.
- Calculate the number of molecules of a compound in a given mass.
- Understand the concept of the mole.
- Convert mass data for an element or a compound into values of moles, atoms or molecules.
- Explain how the atomic mass shown on the periodic table for an element was determined.
- Define an isotope.
- Accurately calculate the average atomic mass of an element given the atomic mass of each isotope and its abundancy.
- Explain the meaning of a weighted average and calculate it.
- Identify which subatomic particle(s) affect the atomic mass of an atom.
- Determine the atomic mass from a mixture of isotopes.
- Discuss the mass number in relation to an atom’s protons and neutrons.
- Understand the law of conservation of matter.
- Visualize how orbitals are superimposed upon one another within an atom.
- Explain the meaning of conservation of energy.
- Describe that it takes energy to excite an electron, and energy is released when an electron relaxes to its ground state.
- Understand that energy is quantized.
- Use flame tests to identify a metal or metallic salt by the color that it produces when it is put into a flame.
- Calculate the frequency of light given its wavelength.
- Calculate the wavelength of light given its frequency.
- Identify an unknown metal by the color it emits when passed through a flame.
Chemistry Topics
This unit supports students’ understanding of

- Atomic Structure
- Atomic Theory
- Model of the Atom
- Subatomic Particles
- Atomic Mass
- Atomic Number
- Isotopes
- Orbitals
- Electrons
- Atomic Spectra
- Electromagnetic Spectrum
- Quantitative Chemistry
- Mole Concept
- Molar Mass
- Moles
- Measurement
- Dimensional Analysis
- History of Chemistry
- Chemical Reactions
- Balancing Chemical Equations
- Law of Conservation of Matter
- Law of Conservation of Energy
- Activity series

Time
Teacher Preparation: See individual resources.
Lesson: 7-10 class periods, depending on class level.

Materials
- Refer to the materials list given with each individual activity.

Safety
- Refer to the safety instructions given with each individual activity.

Teacher Notes
- The activities shown below are listed in the order that they should be completed.
- The teacher notes, student handouts, and additional materials can be accessed on the page for each individual activity.
- Please note that most of these resources are AACT member benefits.

Atomic Theory:
- Founders of Chemistry Series: Introduce the development of atomic theory by using one or more of our Founders of Chemistry videos. The Ancient Chemistry Video traces the history of chemistry from the discovery of fire, through the various metal ages, and finally to the great philosophers. Students can learn about Rutherford’s initial research on alpha particles in the Ernest Rutherford Video and hear about how he hypothesized that they were helium nuclei. The Niels Bohr Video tells the story of Niels Bohr, a great scientist who redefined how we think about atoms and the electron. Each of these includes an activity sheet that include questions for students to answer as they watch the videos.
• **The Scientists Behind the Atom Project:** After viewing the videos, use this project to have your students create a digital or paper book about the scientists who contributed to our understanding of the atom. This project will help students explain the specific contributions of several scientists and understand past and current theories regarding the structure of the atom.

• **Building an Atom Simulation:** Additionally, use this simulation to have your students manipulate the number of protons, neutrons, and electrons in an element and determine how these effect the mass number, atomic number, and other properties of an atom. This lesson, which is guided by a PhET simulation, allows students to see how they can use the number of protons, neutrons, and electrons in an element to predict its identity.

**The Mole Concept:**

• **Amedeo Avogadro Video:** Show your students another video from our Founders of Chemistry collection to begin their exploration of the mole concept. This one tells the story of Amedeo Avogadro, the scientist given credit for the mole concept as the result of his study of gases. It also includes an activity sheet that includes questions for students to answer as they watch the videos.

• **It’s Mole Time:** Your students can then complete this lab to learn how to calculate the molar mass of a substance, the number of moles of a compound in a given mass, and the number of molecules of a compound in a given mass. During the lab, students determine the number of moles of chalk used to write their name, the moles of sucrose ingested while chewing gum, and the moles of alcohol evaporated when using hand sanitizer.

• **Calculating Moles in Daily Life:** This easy to set up and inexpensive lab activity is another good option for giving students additional practice with mole conversion calculations using coins and common household materials.

• **Calculating Moles:** If your students need a bit more practice, have them use this lab to help them understand the mole concept and convert mass data into values of moles, atoms, or molecules. Students can work individually or with a partner to practice using dimensional analysis to solve mole conversion problems.

**Isotopes and Average Atomic Mass:**

• **Isotopes & Calculating Average Atomic Mass:** Students can learn how the average atomic mass is determined through a tutorial based on the isotope abundance for Carbon with this simulation. They then select the number of isotopes, the mass of each isotope, as well as the abundance of each to successfully build a mystery element and calculate its average atomic mass.

• **Bebium Isotopes:** If you prefer a hands-on activity, this lab will lead your students through the steps that they will take to calculate the average atomic mass of an imaginary element called Bebium.

• **Candy Isotopes & Atomic Mass:** This is an alternate activity you can use to introduce the concept of average atomic mass. This simple and inexpensive lesson uses M&M candies to model ratios that approximate real world atomic mass values on the periodic table. The resource can be used with middle or high school students and includes alignment with NGSS performance expectations.
Conservation of Mass:

- **Antoine Lavoisier**: Introduce the concepts of conservation of mass and the law of definite proportion with this [Founders of Chemistry](#) video, which tells the story of how, who many consider to be the father of modern chemistry, discovered oxygen and hydrogen and first proposed the Law of Conservation of Mass. It also includes an activity sheet that includes questions for students to answer as they watch the videos.

- **Balancing Legos**: Following the video, have your students use this hands on activity to model the reactants and products in a chemical reaction. They then use these “atoms” and “molecules” to balance the chemical reaction to demonstrate the law of conservation of matter.

- **Chemistry in a Bag**: Use this lesson as an activity or a demonstration to have your students make observations about the Law of Conservation of Mass.

Electrons, Electron Configurations, and Electromagnetic Radiation:

- **Orbitals Animation**: With the use of the Bohr model to introduce atomic structure, students visualize electrons “orbiting” around the nucleus. Help them expand their knowledge with this animation, which allows students to visualize how orbitals are superimposed upon one another within an atom in three dimensions. The orbitals depicted in this animation are 1s, 2s, 2p, 3s, 3p, 4s, and 3d.

- **Exciting Electrons**: Then use this simulation from the March 2015 issue of *Chemistry Solutions* to let your students explore what happens when electrons within a generic atom are excited from their ground state. They will see that when an electron returns to its ground state from an excited state, energy is released in the form of electromagnetic radiation.

- **Flame Test (Rainbow Demo)**: Finish up your study of electrons with this safer version of the traditional demonstration that is commonly used in high school chemistry classrooms. It can be used to show students the variety of colors that are produced when different metallic salts are heated in a flame. You can view a video of this demonstration on [The Flame Test](#) page of the ACS website. Read more about this in the ACS Safety Alert about the Rainbow Demonstration.

- **Flame Test: Going Further**: In additions to the demonstration, have your students investigate the colors produced when several mixtures of metallic ions are placed in a flame. Note that this procedure also uses wooden splints and aqueous solutions in place of the traditional flammable solvent.