Chemistry Unit 3: Atomic Structure and the Periodic Table, Part 1

Goals:	**Course Essential Questions**
• Describe the experimental evidence for historical models of the atom. • Explain the role of experimental evidence in our understandings of the natural world. • Explain how experimental evidence shaped the development of the currently accepted model of the atom. • Use Avodagro's number and what we know about the mass of atoms and different elements to do useful calculations about chemicals.	• How can I use my experience in chemistry to learn to think and communicate clearly, logically, and critically in preparation for college and a career? • How can I best assess my own learning and progress? • How can I better use technology in my learning and become a better digital citizen? • How can I think more divervently, create, innovate? • How can we learn about things that are to small to see? • How are a system's characteristics, form, and function attributed to the quantity, type, and nature of its components? • How might scientific inquiry be used to investigation the natural world?
Unit Essential Questions	**Understandings**
1.What experimental evidence led to the development of models of the atom? 2.What changes were made to each model as questions were asked? 3.What model of the atom is currently accepted by the scientific community? Why? 4.How are the characteristics of elements attributed to the quantity, type, and nature of atoms? 5.How do the combinations of the smallest atomic units affect the mass and charge of matter? 6.What's the difference between the mass of one atom and the average mass of many atoms?	1.Experimental evidence leads to the development of models and/or theories as possible explanations. 2.Scientific models are refined as questions about the model lead to further investigation. 3.Atomic structure is responsible for the physical and chemical properties of elements. 4.Atoms are counted by weighing them.
Prior Knowledge	**Prior Skills**
1.Use of the terms *law*, *theory*, *hypothesis*, *mode*l as as used in science. (Ch 2.1 or biology notes for review) 2.Symbols and names for 44 common elements, and their location on the periodic table 3.Families of elements and their regions on the periodic table (handout).	1.Count the number and types of atoms in a chemical formula

Students will know….	**Students will be able to….**
• Terms: 1. *Atom*. Define it. 2. Use the *atomic number*, *atomic mass*, and *mass number* to find the number of *protons*, *neutrons*, and *electrons* in a neutral atom of a given element 3. *Ions* are charged atoms or groups of chemically bonded atoms. Ions form when atoms or group of chemically bonded atoms gain or lose electrons. 4. Electrons in the outer energy level of an atom are known as *valence electrons*. *Core electrons* are found in the inner energy levels and do not usually take part in chemical reactons. 5. Use numbers of subatomic particles present in an atom to define *ion*, *isotope*. 6. Explain the difference between *relative atomic mass* and *atomic mass numbe*r. • Experiments: 1. Cathode Ray tube 2. Oil Droplet 3. Gold Foil	1.Define *theory*. Explain why the Atomic Theory is a theory. 2.Explain the laws of conservation of mass, definite proportions, and multiple proportions. 3.Summarize the 5 essential points of Dalton's atomic theory. 4.Explain the relationship between Dalton's atomic theory and the laws of conservation of mass, definite proportions, and multiple proportions. 5.Interpret the experiments of Thomson, Millikan, and Rutherford and explain how their results impacted the formation of an early atomic model. 6.Formulate 2 investigative questions about atomic structure that are not explained by the Plum Pudding Model. 7.Describe Rutherford' work and explain how he used the results to formulate the Solar System Model. 8.Describe the charge and mass of protons, electrons, and neutrons. 9.Explain what every atom of a given element have in common. 10. Explain how isotopes of an element are similar and how they differ. 11. Calculate the relative atomic mass of an element, given percents and mass numbers of a set of its isotopes. 12. Find the molar mass of an element on the periodic table, or calculate the molar mass of a compound. 13. Create conversion factors from molar masses and use them to convert between grams and moles.

Chapter 3.1 The Atom: Philosophical Idea to Scientific Theory - Learning Targets

- Three basic laws describe how matter behaves in chemical reactions. List and describe each.
- List and explain or offer an example of each of the 5 statements that make up Dalton's Atomic Theory. Explain why this is a theory. What does the atomic theory explain?
- Which statement in Dalton's Atomic Theory was modified after it was tested? Explain.
- Use one of the laws explained by Dalton's Atomic Theory to write a response to Critical Thinking Question 3 on pg 67.

Chapter 3.2 The Structure of the Atom

- Use a chart to track scientists, their experiments, their results, and the significance of the results for the model of the atom, and the limitations of each model. You will add more scientists and their work later.
  - JJ Thomson - cathode rays 1897; Robert Millkan - oil drop 1909; plum pudding model
  - Ernest Rutherford(geiger, Marsden) - gold foil and alpha particles 1911; beginning of solar system model
  - James Chadwick (not in text - what did he do?)
- Describe the sizes and charges of subatomic particles

Chapter 3.3 Counting Atoms

- Explain how protons (atomic number) determine the identity of an atom.
- Explain the relationship between atomic number, mass number, and numbers of protons, neutrons, and electrons in an atom.
- Atoms with the same number of protons but different numbers of neutrons are isotopes of the same element.
- The unified atomic mass unit (*u*; amu) is based on the mass of the C-12 atom (1.660540 X 10^{-24} g).
- The average atomic mass of an element is calculated using a weighted average of the atomic masses of all naturally occurring isotopes of the element.
- Avogadro's number: the number of representative particles in an element as 6.022 X 10^{23}particles = 1 mole. Use this relationship to convert between moles and representative particles.
- 1 mole = the average relative atomic mass in grams. Use this equality to convert between grams and moles.
- Calculate molar mass, and use molar mass in a mass-moles conversion.

Resources

- Ions to Know handout and study guide
- Mole Lab handout

Links

- Cathode Ray Tube - deflection of electrons (youtube)
- Crookes tube with Maltese Cross
- Crookes Tube - paddlewheel
- Rutherford's Gold Foil Experiment, explained (youtube)
- Collection of videos about Rutherford scattering. Second one is short and basic animation.
- Rutherford Scattering - PHeT simulation
- Millikan's Oil Drop Experiment
- Elementary Particles - from the University of Oregon

Original Works

- Cathode Rays, Philosophical Magazine, 44, 293 (1897). J. J. Thomson (original paperpaper)
- On the Elementary Electrical Charge and the Avogadro Constant - R. A. Millikan (original paper)
- The Scattering of alpha and beta particles by Matter and the Structure of the Atom, Philosophical Magazine, 1911. E. Rutherford (original paper)

Daily Learning Activities

Day 26 A	• Review of the use of the terms law, theory, hypothesis in science. • Dalton's Atomic Theory and history • POGIL - Inside the Atom, up to Question 10 • Development of a model for determining the number of valence electrons in an atom by its position on the periodic table • Assignment: Read Chapter 3.1 and 3.2; do a reading journal for each.Complete ion cards and do the Ion Study guide
Day 26B	• Review the Ion Study Guide and ways to make the ideas useful • Review of the use of the terms law, theory, hypothesis in science. • Dalton's Atomic Theory and history • POGIL - Inside the Atom, up to Question 10 (save this in your notes for later work)
Day 27	• Review the Ion Study Guide and more ways to make the ideas useful • What is a model? Review law, theory, hypothesis • ODG chart and atomic model flowchart • Characteristics of subatomic particles • Read Ch 3.3 and do a reading journal. Pay very close attention to the construction and use of conversion factors in mass-mole calculations and particles-moles calculations
Day 28	• Atomic Structure quiz • Chemical Calculations: average atomic mass as weighted average • Complete Inside the Atom POGIL • Definition of the mole • Assignment: Begin preparation for Avogadro's Number: The Mole Lab. Do all except the introduction.
Day 29	• Conversion factors, revisited: (review on pg 84 of textbook) ◦ moles - representative particles <—> moles ◦ moles - grams <—> moles • Write the introduction for Avogadro's Number: the Mole lab
Day 30	• Peer review of lab books • Avogadro's Number: Mole Lab- due next class
Day 31	• Quiz, Review, and Quiz over mole calculations and atomic structure
Day 32	• Proficiency - Unit 3, Atomic Structure, Moles, and Mole Calculations
Day 33	• Candy project on Google doc to share - should we add anything? • Research on candy, online. Choose recipe, solution calculations, measurement, crystal formation and why it sometimes doesn't work
Day 34	• Crystallization of a Supersaturated Sucrose Solution Lab - books due next class • Read Chapter 1. 3 and Chapter 5.1. Do a reading journal for each section.