The Modern Model of Atomic Structure

Strand	Matter	
Topic	Investigating the modern model of atomic structure	
Primary SOL	PS.3	The student will investigate and understand the modern and historical models of atomic structure. Key concepts include b) the modern model of atomic structure.
Related SOL	PS.1	The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which m) models and simulations are constructed and used to illustrate and explain phenomena.

Background Information

All matter is composed of atoms. Inside the atom is a nucleus composed of positively-charged protons and neutrons, which do not have a charge. Negatively-charged electrons are located outside the nucleus in energy levels. Protons and neutrons are considered the heavy parts of an atom and are about equal in mass. Electrons are much smaller. The mass of one proton would equal the mass of approximately 2,000 electrons.

To identify the number of protons, neutrons, and electrons for any element, there are two numbers listed on the periodic table: the atomic number and the mass number. The atomic number of an element equals the number of protons. If there is no charge on the element, the number of protons equals the number of electrons. The mass number of an element is equal to the number of protons plus the number of neutrons. Therefore, to arrive at the total number of neutrons, subtract the number of protons (or the atomic number) from the mass number (rounded to the nearest whole number).

Materials

- Periodic table of the elements
- Paper

Vocabulary

atom, atomic mass, atomic number, electron, neutron, nucleus, proton

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Have students sketch a representation of the inside of an atom. Lead the class in a discussion of their drawings.

Modeling Atoms

2. Cut up small pieces of paper and number them from 1 to the maximum number of students in the class (e.g., for a class of 25, cut and number 25 pieces of paper). The number represents the atomic number of an element. Put the numbered pieces of paper in

a container for students to draw to determine their element. On another page, students should draw the diagram described in the next step.

3. Students should identify their element from the number they drew and label their diagrams accordingly. The students should add the atomic number and mass number of their element and label the nucleus. From those numbers, the students should determine the number of protons, neutrons, and electrons for their element and add them to their diagrams. Students should add charge symbols to represent each particle: "+" for protons, "–" for electrons, and "•" for neutrons.
4. Once students complete their diagrams, place them into groups of two, have partners trade and check their diagrams for accuracy, and correct any mistakes. Then, have students exchange partners with a group near them and again check each other's diagrams for accuracy. After each student checks his/her diagram with two other students and corrects mistakes, have students create their final drafts that will be posted in the classroom.
5. Have students arrange their diagrams on a wall in the classroom in the same arrangement as the periodic table.

Assessment

- **Questions**
  - Complete the following table:

	Location	Charge
Proton		
Neutron		
Electron		

  - What do the atomic number and mass number of an element represent?
  - Which number is always larger? Why?
  - Complete the following table:

	Atomic Number	Mass Number	Protons	Neutrons	Electrons
Hydrogen					
Calcium					
Sulfur					
Gold					

Extensions and Connections (for all students)

- Have students look for items in and around their homes (e.g., uncooked beans, uncooked rice, uncooked macaroni noodles, small pebbles, cotton balls) that can be used to represent protons, neutrons, and electrons in a new diagram they create. The materials representing the protons, neutrons, and electrons should be accurate in scale.
- Students may question why the mass number of an element on the periodic table contains a decimal. Discuss the concept of isotopes and explain that the mass number is a weighted average of all the isotopes of an element. Extend the discussion to common uses of particular isotopes (e.g., radioactive isotopes used in nuclear reactions).
- Students should be taught that electrons exist in energy levels and that only a specific number of electrons fit into each energy level. Electrons in the outermost energy level are called *valence electrons*, which are responsible for bonding.

Strategies for Differentiation

- Use three different colored note cards (or tokens) to represent the three components of the atom—proton, neutron, and electron. Give one card to each student. Select an element, and help students create a "human atomic model" of the selected element by grouping the correct numbers of protons and neutrons in the center (nucleus) and moving the correct number of electrons around the nucleus in the electron cloud. Then, allow students to choose other elements, from among elements 1-15, to model for the class. Check student work for accuracy.
- When designing the model of the atom on paper, allow students to use other materials to represent the parts of the atom to support student's needs for tactile stimulation.
- Have students research the method for calculating a weighted average. Then have each student choose an element, determine the mass number of each of its isotopes, and calculate the weighted average of the element's mass numbers. Have students verify that their calculations are correct by comparing their weighted averages with the mass numbers reported on a periodic table.
- Have students create a set of vocabulary flash cards for a memory- or concentration-type game.