Activity 2: Atomic Math and Shorthand

Objectives

Students will use information from the periodic table to calculate the number of protons, neutrons and electrons in a neutral atom.

NOTE: Students should be familiar atomic structure and particles. The atomic shorthand information may serve as an introduction to Activity 6: Radioactive Decay Chain.

Next Generation Science Standards

The concepts in this activity can be used to support the following science standard:

- PS1. Structure and Properties of Matter.

Materials and Resources

- Evolution of a Radioactive Atom: Teacher Background Information.
- Vocabulary Materials.
- Several objects that represent or are made of different elements (e.g., gold ring, copper twine or pipe or lead from a pencil).
- Periodic Table of Elements (one per student, pair or group).
- Atomic Calculations Worksheet (one per student, pair or group) and Atomic Calculations Teacher Answer Key.
- Radiation Baseball game sheet (re-create on the board; print and use; or print, laminate and use with a dry erase marker).

Time

45-60 minutes, not including optional activities or extensions.

Vocabulary

- Atom
- Electron
- Isotope
- Neutron
- Nucleus
- Proton

Directions

1. Start with a vocabulary activity if students are not familiar with radiation and the terms used in this activity, or provide students with the terms and definitions.

2. Explain that all matter is made up of elements, some of which we can see (e.g., metals) and others we cannot (e.g., colorless gases). The smallest form of elements and all matter is atoms. Display two or more objects representing different elements (e.g., gold ring, copper twine or pipe or lead from a pencil) for students to identify.

3. Ask students how the atoms of these elements are similar and how they differ. **All atoms are made up of the same particles: protons, neutrons and electrons. The atoms of each element have a unique number of protons, neutrons and electrons.**

4. Provide students with the Periodic Table of Elements.

5. Ask students what data on the periodic table can be used to determine the atomic structure of an atom. **The atomic number indicates the number of protons and the number of electrons in an atom. Each element has a unique atomic number. The atomic mass is used to calculate the number of neutrons by subtracting the atomic mass from the atomic number.**

6. Select an element or use the objects you showed at the beginning of the activity. Work through an example of how to use the periodic table to determine the atomic structure of the element. Reference the Determining the Structure of a Neutral Atom section of the Evolution of a Radioactive Atom: Teacher Background Information.

7. Provide students with a copy of the Atomic Calculations Worksheet. Direct them to complete the worksheet using the periodic table as a reference.

8. Optional activity or extension: NOTE: This information may serve as a prerequisite for Activity 6: Radioactive Decay Chain.
   - Explain that as scientists identified the nuclear properties of elements and found different forms of elements (called isotopes), they needed an easy way to write and keep track of the basic nuclear properties. Scientists developed atomic shorthand that combines the defining pieces of information about the various forms of an element. There is more than one way the shorthand may be written as shown in the examples.
   - Display the following:

     ${}_{Z}X^{A}$ ${}^{A}_{Z}X$

     - X = the chemical symbol of an element.
     - A = the atomic mass of an element (number of protons and neutrons).
     - Z = the atomic number of an element (number of protons).

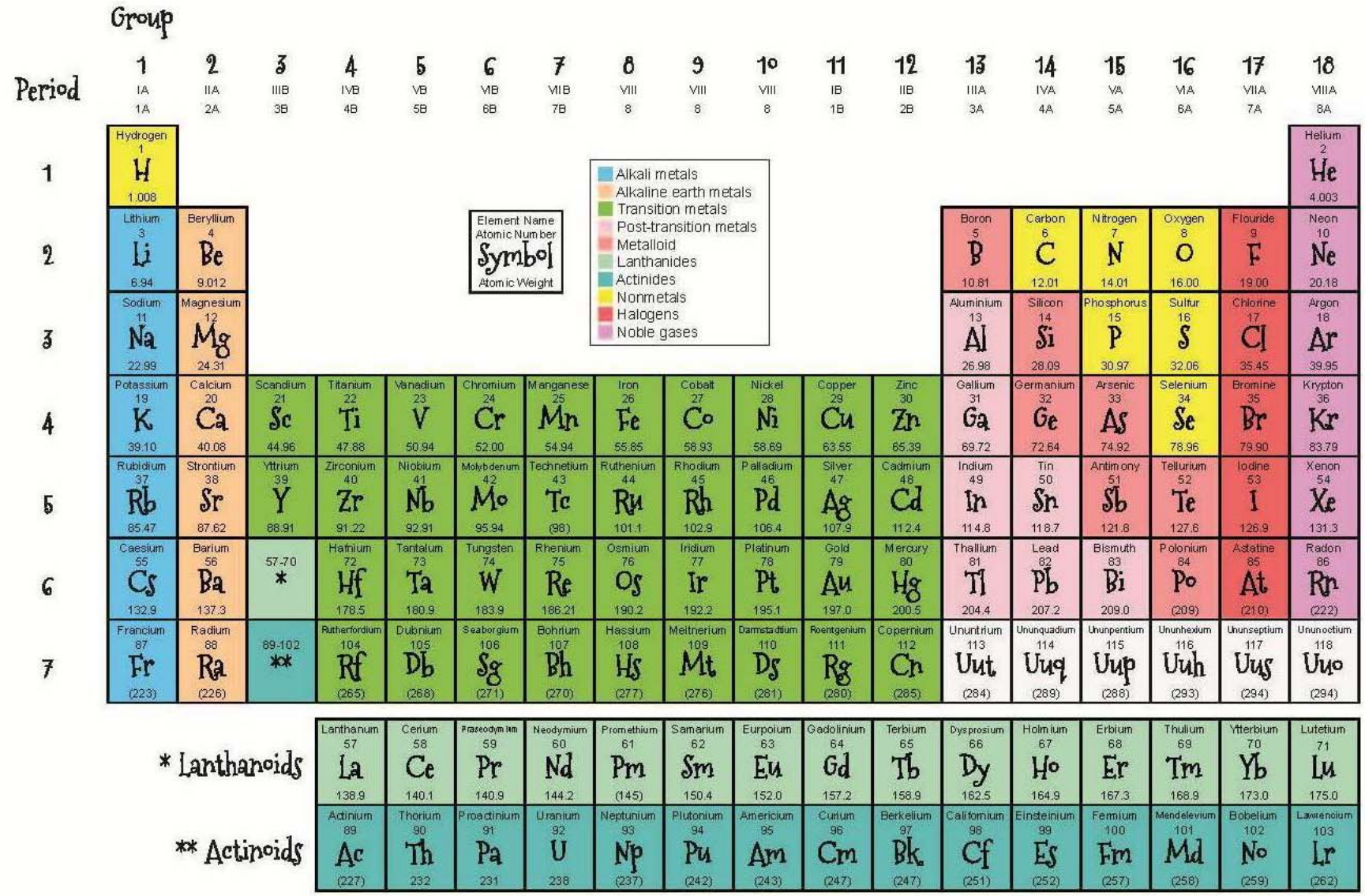
   - Ask students to describe the notations in the examples.
   - Display the following (or similar) examples of elemental shorthand or notations and ask students to decipher them. The notations are for two forms (or isotopes) of iron with different atomic masses: iron-54 and iron-56.

     ${}_{26}Fe^{54}$ ${}_{26}Fe^{56}$ ${}^{54}_{26}Fe$ ${}^{56}_{26}Fe$

9. Play Radiation Baseball to test students' newly acquired knowledge.
    - Prepare questions in advance or have students create questions for the game (e.g., Identify the number of protons in an iron (Fe) atom. How many nucleons are in a boron (B) atom?).
    - Draw a baseball diagram on the board or laminate a copy of the Radiation Baseball game sheet (and use a dry erase marker to track runs).
    - Divide the students into two teams. Students can select their team names (e.g., Particles or Rays).
    - Determine which team will start first. Each person that comes up to bat must answer a question. Incorrect responses equal a strike. Three strikes equal an out and the next team bats. A correct response means the student can move to the next base. You can mark students' progress with their name, a unique color or mark, or even small objects or magnets based on the surface you are using. As players cross home plate, they score a run. Tally or add the runs in the score area. NOTE: If time is limited, you can limit the number of strikes or questions per inning. The team with the most runs wins.

10. Conclude by having students share one or two things they learned about atomic structure and the periodic table.

Periodic Table of Elements



Atomic Calculations Worksheet

Name: _____ Date: _____

Use the Periodic Table of Elements to complete the following.

1. Determine the number of protons, neutrons and electrons for the following elements.

Elements	Number of Protons	Number of Neutrons	Number of Electrons
Hydrogen (H)			
Lithium (Li)			
Boron (B)			
Oxygen (O)			

2. Which element has a greater number of protons – Potassium (K) or Selenium (Se)?_____

3. Which element has a smaller number of electrons – Copper (Cu) or Silver (Ag)?

   _____

4. Which element has a greater number of neutrons – Magnesium (Mg) or Tin (Sn)?

   _____

Atomic Calculations: Teacher Answer Key

1. Determine the number of protons, neutrons and electrons for the following elements.

Example Elements	Number of Protons	Number of Neutrons	Number of Electrons
Hydrogen (H)	1	0	1
Lithium (Li)	3	4	3
Boron (B)	5	6	5
Oxygen (O)	8	8	8

2. Which element has a greater number of protons – Potassium (K) or Selenium (Se)? **Potassium has 19 protons and Selenium has 34 according to the elements' atomic numbers.**

3. Which element has a smaller number of electrons – Copper (Cu) or Silver (Ag)? **Copper has 29 electrons, and Silver has 47 electrons, equaling the number of protons in each element.**

4. Which element has a greater number of neutrons – Magnesium (Mg) or Tin (Sn)? **Magnesium has 12 neutrons and Tin has 69, calculated by subtracting the atomic number from the atomic mass (rounded to a whole number).**

Radiation Baseball

	1	2	3	4	5	6	7	8	9	Total