



## 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

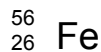
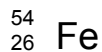
## Directions

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 handout 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:



- 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.



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

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Group	IA 1A	IIA 2A	IIIB 3B	IVB 4B	VB 5B	VIB 6B	VII B 7B	VIII 8	VIII 8	VIII 8	IB 1B	IIB 2B	IIIA 3A	IIIA 3A	IVA 4A	VA 5A	VIA 6A	VIA 7A	VIIA 8A
1	Hydrogen 1 <b>H</b> 1.008	Beryllium 4 <b>Be</b> 9.012																	Helium 2 <b>He</b> 4.003
2	Lithium 3 <b>Li</b> 6.94	Sodium 11 <b>Na</b> 22.99																	Neon 10 <b>Ne</b> 20.18
3	Potassium 19 <b>K</b> 39.10	Calcium 20 <b>Ca</b> 40.08	Scandium 21 <b>Sc</b> 44.96	Titanium 22 <b>Ti</b> 47.88	Vanadium 23 <b>V</b> 50.94	Chromium 24 <b>Cr</b> 52.00	Manganese 25 <b>Mn</b> 54.94	Iron 26 <b>Fe</b> 55.85	Cobalt 27 <b>Co</b> 58.93	Nickel 28 <b>Ni</b> 58.69	Copper 29 <b>Cu</b> 63.55	Zinc 30 <b>Zn</b> 65.39		Boron 5 <b>B</b> 10.81	Carbon 6 <b>C</b> 12.01	Nitrogen 7 <b>N</b> 14.01	Oxygen 8 <b>O</b> 16.00	Fluorine 9 <b>F</b> 19.00	Argon 18 <b>Ar</b> 39.95
4	Rubidium 37 <b>Rb</b> 85.47	Strontium 38 <b>Sr</b> 87.62	Yttrium 39 <b>Y</b> 88.91	Zirconium 40 <b>Zr</b> 91.22	Niobium 41 <b>Nb</b> 92.91	Molybdenum 42 <b>Mo</b> 95.94	Technetium 43 <b>Tc</b> (98)	Ruthenium 44 <b>Ru</b> 101.1	Rhodium 45 <b>Rh</b> 102.9	Palladium 46 <b>Pd</b> 106.4	Silver 47 <b>Ag</b> 107.9	Cadmium 48 <b>Cd</b> 112.4		Aluminum 13 <b>Al</b> 26.98	Silicon 14 <b>Si</b> 28.09	Phosphorus 15 <b>P</b> 30.97	Sulfur 16 <b>S</b> 32.06	Chlorine 17 <b>Cl</b> 35.45	Krypton 36 <b>Kr</b> 83.79
5	Cesium 55 <b>Cs</b> 132.9	Barium 56 <b>Ba</b> 137.3	* 57-70	Hafnium 72 <b>Hf</b> 178.5	Tantalum 73 <b>Ta</b> 180.9	Tungsten 74 <b>W</b> 183.9	Rhenium 75 <b>Re</b> 186.21	Osmium 76 <b>Os</b> 190.2	Iridium 77 <b>Ir</b> 192.2	Platinum 78 <b>Pt</b> 195.1	Gold 79 <b>Au</b> 197.0	Mercury 80 <b>Hg</b> 200.5		Gallium 31 <b>Ga</b> 69.72	Germanium 32 <b>Ge</b> 72.64	Arsenic 33 <b>As</b> 74.92	Selenium 34 <b>Se</b> 78.96	Bromine 35 <b>Br</b> 79.90	Xenon 54 <b>Xe</b> 131.3
6	Francium 87 <b>Fr</b> (223)	Radium 88 <b>Ra</b> (226)	** 89-102	Rutherfordium 104 <b>Rf</b> (261)	Dubnium 105 <b>Db</b> (268)	Seaborgium 106 <b>Sg</b> (271)	Bohrium 107 <b>Bh</b> (270)	Hassium 108 <b>Hs</b> (277)	Mitlerium 109 <b>Mt</b> (276)	Darmstadtium 110 <b>Ds</b> (281)	Roentgenium 111 <b>Rg</b> (280)	Copernicium 112 <b>Cn</b> (285)		Ununquadium 114 <b>Uuq</b> (289)	Ununpentium 115 <b>Uup</b> (288)	Ununhexium 116 <b>Uuh</b> (293)	Ununseptium 117 <b>Uus</b> (284)	Ununoctium 118 <b>Uuo</b> (294)	Radon 86 <b>Rn</b> (222)
7				Lanthanum 57 <b>La</b> 138.9	Cerium 58 <b>Ce</b> 140.1	Praseodymium 59 <b>Pr</b> 140.9	Neodymium 60 <b>Nd</b> 144.2	Promethium 61 <b>Pm</b> (145)	Samarium 62 <b>Sm</b> 150.4	Europium 63 <b>Eu</b> 152.0	Gadolinium 64 <b>Gd</b> 157.2	Terbium 65 <b>Tb</b> 158.9	Dysprosium 66 <b>Dy</b> 162.5	Holmium 67 <b>Ho</b> 164.9	Erbium 68 <b>Er</b> 167.3	Thulium 69 <b>Tm</b> 168.9	Ytterbium 70 <b>Yb</b> 173.0	Lutetium 71 <b>Lu</b> 175.0	Actinoids
				Actinium 89 <b>Ac</b> (227)	Thorium 90 <b>Th</b> 232	Protactinium 91 <b>Pa</b> 231	Uranium 92 <b>U</b> 238	Neptunium 93 <b>Np</b> (237)	Plutonium 94 <b>Pu</b> (242)	Americium 95 <b>Am</b> (243)	Curium 96 <b>Cm</b> (247)	Berkelium 97 <b>Bk</b> (247)	Californium 98 <b>Cf</b> (251)	Einsteinium 99 <b>Es</b> (252)	Fermium 100 <b>Fm</b> (257)	Mendelevium 101 <b>Md</b> (258)	Nobelium 102 <b>No</b> (259)	Lawrencium 103 <b>Lr</b> (262)	

Legend:

- Alkali metals
- Alkaline earth metals
- Transition metals
- Post-transition metals
- Metalloid
- Lanthanides
- Actinides
- Nonmetals
- Halogens
- Noble gases

Element Name  
Atomic Number  
**Symbol**  
Atomic Weight

\* Lanthanoids  
\*\* Actinoids

# 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
_____										
_____										

