



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

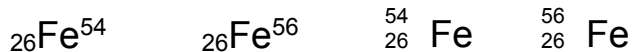
45-60 minutes, not including optional activities or extensions.

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:
 - ${}_z\text{X}^A$
 - ${}_Z^A\text{X}$
 - 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

		Group																		
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
	IA	IIA	IIIB	IVB	VB	VB	VIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VA	VIA	VIA	VIIA	VIIIA
	1A	2A	3B	4B	5B	6B	7B	8	8	8	1B	2B	3A	4A	5A	6A	7A	8A		
1	Hydrogen 1 H 1.008																	Helium 2 He 4.003		
2	Lithium 3 Li 6.94	Beryllium 4 Be 9.012											Boron 5 B 10.81	Carbon 6 C 12.01	Nitrogen 7 N 14.01	Oxygen 8 O 16.00	Fluorine 9 F 19.00	Neon 10 Ne 20.18		
3	Sodium 11 Na 22.99	Magnesium 12 Mg 24.31											Aluminum 13 Al 26.98	Silicon 14 Si 28.09	Phosphorus 15 P 30.97	Sulfur 16 S 32.06	Chlorine 17 Cl 35.45	Argon 18 Ar 39.95		
4	Potassium 19 K 39.10	Calcium 20 Ca 40.08	Scandium 21 Sc 44.96	Titanium 22 Ti 47.88	Vanadium 23 V 50.94	Chromium 24 Cr 52.00	Manganese 25 Mn 54.94	Iron 26 Fe 55.85	Cobalt 27 Co 58.93	Nickel 28 Ni 58.69	Copper 29 Cu 63.55	Zinc 30 Zn 65.39	Gallium 31 Ga 69.72	Germanium 32 Ge 72.64	Arsenic 33 As 74.92	Selenium 34 Se 78.96	Bromine 35 Br 79.90	Krypton 36 Kr 83.79		
5	Rubidium 37 Rb 85.47	Strontium 38 Sr 87.62	Yttrium 39 Y 88.91	Zirconium 40 Zr 91.22	Niobium 41 Nb 92.91	Molybdenum 42 Mo 95.94	Technetium 43 Tc (98)	Ruthenium 44 Ru 101.1	Rhodium 45 Rh 102.9	Palladium 46 Pd 106.4	Silver 47 Ag 107.9	Cadmium 48 Cd 112.4	Indium 49 In 114.8	Tin 50 Sn 118.7	Antimony 51 Sb 121.8	Tellurium 52 Te 127.6	Iodine 53 I 126.9	Xenon 54 Xe 131.3		
6	Caesium 55 Cs 132.9	Barium 56 Ba 137.3	* 57-70	Hafnium 72 Hf 178.5	Tantalum 73 Ta 180.9	Tungsten 74 W 183.9	Rhenium 75 Re 186.21	Osmium 76 Os 190.2	Iridium 77 Ir 192.2	Platinum 78 Pt 195.1	Gold 79 Au 197.0	Mercury 80 Hg 200.5	Thallium 81 Tl 204.4	Lead 82 Pb 207.2	Bismuth 83 Bi 209.0	Polonium 84 Po (209)	Astatine 85 At (210)	Radon 86 Rn (222)		
7	Francium 87 Fr (223)	Radium 88 Ra (226)	** 89-102	Rutherfordium 104 Rf (261)	Dubnium 105 Db (268)	Seaborgium 106 Sg (271)	Bohrium 107 Bh (270)	Hassium 108 Hs (277)	Mtlerium 109 Mt (276)	Darmstadtium 110 Ds (281)	Roentgenium 111 Rg (280)	Copernicium 112 Cn (285)	Ununtrium 113 Uut (284)	Ununquadium 114 Uuq (289)	Ununpentium 115 Uup (288)	Ununhexium 116 Uuh (293)	Ununseptium 117 Uus (294)	Ununoctium 118 Uuo (294)		

Element Name
Atomic Number
Symbol
Atomic Weight

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

* Lanthanoids

Lanthanum 57 La 138.9	Cerium 58 Ce 140.1	Praseodymium 59 Pr 140.9	Neodymium 60 Nd 144.2	Promethium 61 Pm (145)	Samarium 62 Sm 150.4	Europium 63 Eu 152.0	Gadolinium 64 Gd 157.2	Terbium 65 Tb 158.9	Dysprosium 66 Dy 162.5	Holmium 67 Ho 164.9	Erbium 68 Er 167.3	Thulium 69 Tm 168.9	Ytterbium 70 Yb 173.0	Lutetium 71 Lu 175.0
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** Actinoids

Actinium 89 Ac (227)	Thorium 90 Th 232	Protactinium 91 Pa 231	Uranium 92 U 238	Neptunium 93 Np (237)	Plutonium 94 Pu (242)	Americium 95 Am (243)	Curium 96 Cm (247)	Berkelium 97 Bk (247)	Californium 98 Cf (251)	Einsteinium 99 Es (252)	Fermium 100 Fm (257)	Mendelevium 101 Md (258)	Nobelium 102 No (259)	Lawrencium 103 Lr (262)
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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

