Atomic Structure

Unit: Atomic Structure

MA Curriculum Frameworks (2016): HS-PS1-1

Mastery Objective(s): (Students will be able to…)

- Identify subatomic particles and their locations within the atom.

Success Criteria:

- Protons and neutrons are correctly located in the nucleus.
- Electrons are correctly located outside the nucleus.
- Relative masses of protons, neutrons and electrons are correct.
- Chemical symbols are written correctly with correct value and placement of atomic symbol, atomic number, atomic mass and charge.

Tier 2 Vocabulary: nucleus, charge

Language Objectives:

- Correctly describe the parts of the atom and their locations within the atom.

Notes:

atom: the smallest piece of an element that retains the properties of that element.

nucleus: a dense region in the center of an atom. The nucleus is made of protons and neutrons, and contains almost all of an atom's mass.

proton: a subatomic particle found in the nucleus of an atom. It has a charge of +1, and a mass of 1 atomic mass unit (amu).

neutron: a subatomic particle found in the nucleus of an atom. It has no charge (is neutral), and has a mass of 1 amu.

electron: a subatomic particle found *outside* the nucleus of an atom. It has charge of −1 and a mass of 0 amu (really about $^{1}/_{2000}$ amu). Atoms can gain, lose, or share electrons in chemical reactions.

charge: electrical charges can be positive or negative. Opposite cancel each other out, so the charge of an atom is the difference between how many positive charges (protons) it has, and how many negative charges (electrons) it has. For example, a chlorine atom with 17 protons (+17) and 18 electrons (−18) would have a charge of −1. (The difference is 1, and it's negative because it has more negatives than positives.)

neutral atom: an atom with a charge of zero (positives = negatives).

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ion: an atom or molecule that has a charge (either positive or negative), because it has either gained or lost electrons. This means it has either more negatives (electrons) than positives (protons), or more positives (protons) than negatives (electrons).

atomic number (*Z*): the identity of an atom is based on the amount of (positive) charge in its nucleus. (This works because particles from the nucleus cannot be given to or shared with another atom.) The atomic number is the number of protons in the nucleus. Each element has a unique atomic number.

mass number (*A*): the total number of protons + neutrons in the nucleus of an atom. (Protons and neutrons each have a mass of almost exactly 1 amu, and the electrons are so small that their mass is negligible.) Generally equal to the whole number that is closest to the atomic mass.

atomic mass: the actual mass of an atom; the sum of the masses of its protons, neutrons, and electrons (minus a small amount of mass that is converted to energy to hold the atom together). Always close in value to the mass number.

isotopes: atoms of the same element (same atomic number = same # of protons), but that have different numbers of neutrons (and therefore different mass numbers) from each other.

Isotopes are described by their mass numbers. For example, carbon-12 (^{12}C) has 6 protons and 6 neutrons, which gives it a mass number of 12. Carbon-14 (^{14}C) has 6 protons and 8 neutrons, which gives it a mass number of 14.

element symbol: a one- or two-letter abbreviation for an element. (New elements are given temporary three-letter symbols.) The first letter in an element symbol is always capitalized. Other letters in an element symbol are always lower case. *This is important to remember.* For example, Co is the element cobalt, but CO is the compound carbon monoxide, which contains the elements carbon and oxygen.

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chemical symbol: a shorthand notation that shows information about an element, including its element symbol, atomic number, mass number, and charge. For example, the symbol for a magnesium-25 ion with a +2 charge would be:

$$^{25}_{12}Mg^{2+}$$

This notation shows the element symbol for magnesium (Mg) in the center, the atomic number (12, because it has 12 protons) on the bottom left, the mass number (25, because it has 12 protons + 13 neutrons = 25 amu) on the top left, and the charge (2+, which means it has somehow lost two of its electrons) on the top right. By convention, ions are labeled with the charge number before the charge sign, so we write 2+ instead of +2.

Homework Problems

Each row in this table is like a Sudoku puzzle. For each row, use the numbers given, the relationships between the columns, and the periodic table of the elements to fill in the rest of the row. Use the first row as an example.

symbol	atomic #	mass #	protons	neutrons	electrons	charge
$^{41}_{20}Ca^{2+}$	20	41	20	21	18	+2
B				6	5	
		56	24			0
Ca^{2+}				20		
	60			84	57	
		207			80	+2
				0	0	+1
Kr		84				0
			35	39	36	

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