

Activity 6: Isotopes and Atomic Mass

Learning Objectives

Part 1 *Develop a working definition for isotope, mass number, and atomic number*

Distinguish atoms and ions

Determine the number of subatomic particles in an atom or an ion given its symbolic notation

Part 2 *Distinguish mass number and atomic mass*

Estimated Completion Time 90 Minutes

Instructor Information

Students will be inclined to look up the definition of isotope in their textbook- but should be encouraged to develop the definition from the activity. The difference between atomic mass and mass number is an important distinction.

ANSWERS TO QUESTIONS

Part 1. Isotopes

Isotopes, Atoms, and Subatomic Particles

1. There are 20 protons in each.
2. Calcium-42 has 22 neutrons, and calcium-40 has 20 neutrons.
3. In an atom, the number of protons equals the number of electrons
4. All calcium atoms have the same number of protons and the same number of electrons (20).

5. The atomic number Z equals the number of protons (and in the case of atoms, the number of electrons).
6. The mass number is the number of protons plus the number of neutrons.
7. Two atoms with the same number of protons but different numbers of neutrons, or two atoms with the same atomic number but different mass numbers.
8. The protons and neutrons are located in the center of an atom (nucleus), and the electrons are in a cloud surrounding the nucleus.
9. They all have the same number of protons. They have different numbers of neutrons.
10. Most of the mass of an atom is in the center of the atom.
- 11.

| Isotope | Protons | Neutrons | Electrons |
|-----------------------|---------|----------|-----------|
| $^{37}_{17}\text{Cl}$ | 17 | 20 | 17 |
| $^{35}_{17}\text{Cl}$ | 17 | 18 | 17 |

Isotopes, Ions, and Subatomic Particles

1. An ion is a charged particle; atoms are neutral.
2. The atomic number is the number of protons in all cases.
3. It is the difference between the number of protons and electrons. If there are more protons, the charge is positive; if there are more electrons, the charge is negative.
4. Positive
5. Negative
6. Each calcium ion has the same number of protons and electrons. They have different numbers of neutrons.

7.
 - a. All atoms and ions of nitrogen have the same number of protons.
 - b. All atoms and ions of hydrogen have the same number of protons.
 - c. 1 protons, 0 neutrons, 0 electrons

8.

| Isotope | Protons | Neutrons | Electrons |
|------------------------------|---------|----------|-----------|
| ${}_{13}^{27}\text{Al}^{3+}$ | 13 | 14 | 24 |
| ${}_{17}^{37}\text{Cl}^{-}$ | 17 | 20 | 18 |

Activity 6: Skill Development–Isotopes

1.
 - a. ${}^7_3\text{Li}$
 - b. ${}^{17}_7\text{N}$
 - c. ${}^7_3\text{Li}^{+}$
 - d. ${}^{31}_{15}\text{P}$
 - e. ${}^{19}_9\text{F}^{-}$
 - f. ${}^{31}_{15}\text{P}^{3-}$
 - g. ${}^{56}_{26}\text{Fe}^{2+}$
 - h. ${}^{106}_{46}\text{Pd}$
2.
 - a. 47 protons, 61 neutrons, 47 electrons
 - b. 82 protons, 125 neutrons, 82 electrons
 - c. 8 protons, 10 neutrons, 10 electrons
 - d. 12 protons, 12 neutrons, 10 electrons
3.
 - a. 7 protons, 8 neutrons, 7 electrons
 - b. 13 protons, 14 neutrons, 13 electrons
 - c. 11 protons, 12 neutrons, 10 electrons
 - d. 35 protons, 45 neutrons, 36 electrons

Part 2. Distinguishing Mass Number and Atomic Mass

- 1 -3. Answers will vary. Students can usually calculate an average, look at data, and note a common age and calculate a percentage. In this case, the age of each student is analogous to the mass number of an individual isotope.
4. Because the atomic mass of copper is 63.55, which is closer to 63, the copper-63 isotope is more abundant.

5.

| Symbol | Number of Protons | Number of Neutrons | Number of Electrons | Mass Number | Atomic Mass of Element |
|------------------------------|-------------------|--------------------|---------------------|-------------|------------------------|
| ${}^1_1\text{H}$ | 1 | 1 | 1 | 1 | 1.008 |
| ${}^{24}_{12}\text{Mg}^{2+}$ | 12 | 12 | 10 | 24 | 24.31 |
| ${}^9_4\text{Be}$ | 4 | 5 | 4 | 9 | 9.012 |

6. Mass number applies to an individual isotope. It is the number of protons and neutrons, and it is an integer number. Atomic mass is the average of all the isotopes on earth and usually is not an integer since it is an average. The mass number for the isotope carbon-12 is 12. The atomic mass of the element carbon is 12.01.
7. a. tin-118: 68 neutrons, tin-119: 69 neutrons, tin-120: 70 neutrons, and tin-124: 74 neutrons
 b. ${}^{118}_{50}\text{Sn}$, ${}^{119}_{50}\text{Sn}$, ${}^{120}_{50}\text{Sn}$, ${}^{124}_{50}\text{Sn}$
8. a. magnesium-24: 12 neutrons, magnesium-25: 13 neutrons, and magnesium-26: 14 neutrons.
 b. ${}^{24}_{12}\text{Mg}$, ${}^{25}_{12}\text{Mg}$, ${}^{26}_{12}\text{Mg}$
 c. Magnesium- 24

Activity 6: Skill Development—Atomic Mass

- Chlorine-35
- The abundance of the two isotopes is approximately equal (50:50).