Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Student Exploration: Element Builder**

**Vocabulary:** atom, atomic number, electron, electron dot diagram, element, energy level, ion, isotope, mass number, neutron, nucleus, periodic table, proton, radioactive, valence electrons

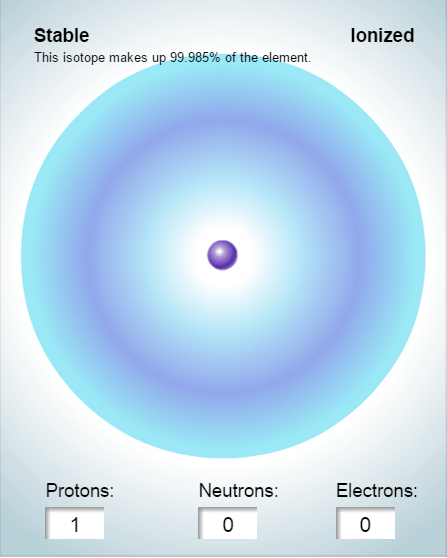
**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. What are some of the different substances that make up a pizza? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. What substances make up water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What substances make up an iron pot? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Elements** are pure substances that are made up of one kind of **atom**. Pizza is not an element because it is a mixture of many substances. Water is a pure substance, but it contains two kinds of atom: oxygen and hydrogen. Iron is an element because it is composed of one kind of atom.



**Gizmo Warm-up**

Atoms are tiny particles of matter that are made up of three particles: **protons**, **neutrons**, and **electrons**. The *Element Builder* Gizmo shows an atom with a single proton. The proton is located in the center of the atom, called the **nucleus**.

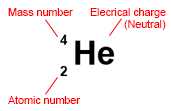
1. Use the arrow buttons () to add protons, neutrons, and electrons to the atom. Press **Play** (Play).
   1. Which particles are located in the nucleus?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Which particles orbit around the nucleus?

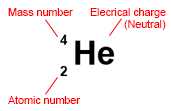
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1. Turn on **Show element name**. What causes the element name to change? \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



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| **Activity A:**  **Subatomic particles** | Get the Gizmo ready:   * Use the arrows to create an atom with two protons, two neutrons, and two electrons. * Turn on **Show element name**. | 424SE2 |

**Question: What are the properties of protons, neutrons, and electrons?**

1. Observe: Turn on **Show element symbol** and **Element notation**. Three numbers surround the element symbol: the **mass number** (*A*), electrical charge (no number is displayed if the atom is neutral), and the **atomic number** (*Z*).
2. Investigate: Watch how the numbers change as you add or remove particles.
   * 1. Which number is equal to the number of protons in the atom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. How can you calculate the number of neutrons (*N*) in an atom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. Which particle (proton, neutron, or electron) has a positive charge? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Negative charge? \_\_\_\_\_\_\_\_\_\_\_\_\_\_ No charge at all? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Analyze: An **isotope** is an alternative form of an element. Each isotope of an element has the same number of protons, but a different number of neutrons. The isotope is represented by the atomic symbol and mass number, such as He-4. Some isotopes are stable, while others are **radioactive**, which means the atoms decay over time and emit radiation.
   * 1. What are the stable isotopes of carbon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. What are the stable isotopes of nitrogen? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     3. List two radioactive isotopes of oxygen: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Practice: Use the Gizmo to answer the following questions.
   * 1. How many electrons are in a neutral atom of lithium? \_\_\_\_\_\_
     2. How many neutrons are in an atom of Mg-25? \_\_\_\_\_\_
     3. What is the mass number of an atom with 5 protons and 7 neutrons? \_\_\_\_\_\_
     4. When at atom is charged, it is called an **ion**. How many electrons are in O**2-**? \_\_\_\_\_\_
     5. How many electrons are in Mg**2+**? \_\_\_\_\_\_

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| **Activity B:**  **Electron arrangements** | Get the Gizmo ready:   * Create a neutral hydrogen atom (1 proton, 0 neutrons, 1 electron). | 424SE3 |

**Question: How are electrons arranged around the nucleus of an atom?**

1. Observe: Add electrons to the atom until you have used all the available electrons. How are the electrons arranged? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Analyze: Electrons are arranged in orbits called **energy levels**. The Gizmo shows all of the first two energy levels but only part of the third energy level.
2. How many electrons can fit in the first energy level? \_\_\_\_\_\_\_\_\_\_\_
3. How many electrons can fit in the second energy level? \_\_\_\_\_\_\_\_\_\_\_
4. How many electrons fit in the part of the third energy level shown? \_\_\_\_\_\_\_\_\_\_\_
5. Observe: Click **Reset** (Reset). The electrons in the outermost orbit, called **valence electrons**, help to create chemical bonds. Create a lithium atom (3 protons, 4 neutrons, 3 electrons).

How many *valence* electrons are in a neutral lithium atom? \_\_\_\_\_\_\_\_\_\_\_

1. Diagram: Turn on **Show electron dot diagram**. The valence electrons of an atom are shown in an **electron dot diagram**. Each dot represents a valence electron.

Draw the electron dot diagram for neutral lithium: \_\_\_\_\_\_\_\_\_\_\_

1. Practice: Turn off **Show electron dot diagram**. Use the Gizmo to create a neutral atom of each of the following elements. Draw an electron dot diagram for each. When you are finished, turn on **Show electron dot diagram** and check your answers.

H He Li Be B C N

O F Ne Na Mg Al Si

1. Extend your thinking: Many chemical properties are determined by the number of valence electrons. Elements with the same number of valence electrons will have similar properties.

Which element has similar properties to lithium? \_\_\_\_\_\_\_\_\_ Beryllium? \_\_\_\_\_\_\_\_\_

Explain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Extension:**  **The periodic table** | Get the Gizmo ready:   * Create a neutral hydrogen atom. * If you have access to a periodic table, open it now. (Not required.) | Element Builder SE5 |

**Question: The 117 or so known elements are arranged in the periodic table. Why does the periodic table have the shape it has?**

1. Form a hypothesis: Look at the first three rows of the periodic table below.



Why do you think the elements are arranged the way that they are? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Draw diagrams: Create an electron dot diagram for each of the elements below. Use the Gizmo to help you do this. To check your work, turn on **Show electron dot diagram**.

H He

Li Be B C N O F Ne

Na Mg Al Si P S Cl Ar

1. Analyze: What do the elements in each *column* of the periodic table have in common?

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1. Draw conclusions: How is the periodic table organized? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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