SN
EDUCATOR GUIDE

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Activity Guide for Students: Atoms, Ions and Isotopes, Oh Why?

Directions for students: A popular chemistry joke asks, “Why can you never trust an atom?” The answer, “Because they make up everything.” To understand almost any natural phenomena, scientists must start with the basic knowledge of the building blocks of matter, atoms. Atoms with a specific number of protons are known by an element name, like “oxygen” or “hydrogen.” Atoms exist in nature as either neutral elements or as ions, depending on the surrounding atoms and other physical conditions. There are also multiple versions of atoms of the same element that exist in nature in varying abundances, called isotopes.

In this activity, you’re going to explore a simple simulation to define and understand elements, ions and isotopes. You will then explore the *Science News* journalism archive to find current science research examples that apply these concepts.

Read and watch

Before you begin to explore the simulation, check out a *Science News* article about microwaving grapes and the related video: www.sciencenews.org/article/grapes-spark-microwave-plasma. Scientists have recently gained insights into why microwaved grapes make plasma fireballs. While there are many concepts involved, at the most basic level, scientists have to understand atoms and ions to understand plasma formation. And, so we start with learning the basics of atoms, ions and isotopes.

Now explore the simulation

1. Download and open the PhET Interactive Simulation titled Build an Atom. Next click on “Atom,” and allow the simulation to load. Now click on the “+” sign for both “Net Charge” and “Mass Number” to open those windows.

2. Atoms make up everything, but first we’ll explore what makes up an atom. Before you start adding subatomic particles to create an atom, name those particles using the table below. Note that the “x” in the middle of the Bohr atomic model onscreen in the simulation represents the nucleus. The dashed lines represent electron orbitals. Move the subatomic particles into and out of the atomic model and watch how it changes the values in the “Net Charge” and “Mass Number” windows. Fill in the table below based on what you learn, then answer the question that follows.

Subatomic particle name	**Charge** (include the magnitude of the charge per subatomic particle and whether it is a + or – charge)	**Location in atom**	**Mass** (amu)

How would you define an atom?

3. Atoms of different elements are different. We're going to use lithium (Li) and carbon (C) to explore how. Use the simulation to build a Li atom and then a C atom. Figure out which subatomic particle you need to manipulate to create the atoms, then write the correct number of that subatomic particle in the table below. Note the following abbreviations: proton (p+), neutron (n^0) and electron (e^-). If you did not need to manipulate a subatomic particle to create the atom, write an "X" in the table. Finally, answer the questions below the table before moving on.

Element	**Li**	**C**
# of p^+		
# of n^0		
# of e^-		

You created a Li atom and a C atom, two different elements. How are the atoms of these two elements different?

Based on this exercise, how would you define an element?

4. Using the "Net Charge" window as a guide, figure out which subatomic particle you need to manipulate to create a neutral Li atom and then a neutral C atom, then write the correct number in the table below. If you did not need to manipulate other subatomic particles, write an "X" in the table. Answer the questions below the table before moving on.

Element	**Li**	**C**
# of p^+		
# of n^0		
# of e^-		

What does it mean for an atom to be neutral? How do the number of subatomic particles compare?

What does it mean if an atom is not neutral? How do the number of subatomic particles compare?

These types of atoms are called ions. How would you define an ion?

5. Next we will explore what gives ions a specific charge. Create the ions listed below by manipulating the necessary subatomic particles, and write the number of each particle in the table. If you did not need to manipulate a subatomic particle, write an “X” in the table. Write a formula, described below the table, before moving on. Note that the charge on an atom is always written to the upper right of an element’s symbol.

Element	**Li^{+} (same as Li^{1+})**	**C^{4-}**
# of p^{+}		
# of n^{0}		
# of e^{-}		

Write a general formula for determining the charge from the number of subatomic particles.

Charge on an ion =

5. Check the box in the simulation that says “Stable/Unstable” so your atom’s stability appears onscreen. Figure out which subatomic particle you need to manipulate to create a stable, neutral Li atom and then a stable, neutral C atom, and write the correct number of that subatomic particle in the table below. Use the “Mass Number” window to write down the mass of each stable, neutral element. Write a formula, described below the table, before moving on.

Element	**Li**	**C**
# of p^{+}		
# of n^{0}		
# of e^{-}		

Mass number		

Write a general formula for determining an atom's mass from the number of subatomic particles.

Atomic mass (or mass number) =

6. Atomic symbols are often used to clarify an atom's mass number. The symbols use the format below, where "X" is the element symbol (as shown on the periodic table), "A" is the atomic mass (or mass number) and "Z" is the number of protons (or the atomic number). Note that the "Z" is not always written, because the element symbol defines the number of protons that an atom has.

General format of an atomic symbol:

$${}^{A}_{Z}X$$

Write an atomic symbol for the stable, neutral Li atom.

Write an atomic symbol for the stable, neutral C atom.

7. Use the simulation to fill out the table below. Then answer the related questions below the table.

Atomic symbol	^{12}C	^{13}C	^{14}C
Atomic mass			
# of p^+			
# of n^0			
# of e^-			
Stable or unstable?			

Do atoms have to have the same number of protons and neutron to be stable? Why do you say that?

What do all of the atoms listed in the table have in common? How are they different?

8. These atoms are examples of isotopes. Most elements exist in nature as multiple types of isotopes. For example, ^{12}C and ^{13}C are the most abundant isotopes in nature, but ^{14}C also exists. Because ^{14}C isn't stable, it breaks down or decays very slowly over time.

Define an isotope.

9. Think back to the grape plasma article and video that you watched at the beginning of the lesson, rereading and rewatching if necessary.

How does a concept you learned today explain something about the grape plasma production?

10. Now that you've created your general definitions, let's take a little time to explore how current research applies the concepts of atoms, ions and isotopes. In your groups, choose one of the articles listed below that interests you (most relate to lithium or carbon atoms, ions or isotopes), or do your own search in the *Science News* journalism archive to find an article related to the concepts learned today. Answer the prompts below.

Environmental science: "As ice retreats, frozen mosses emerge to tell climate change tale"

Chemistry: "The search for new geologic sources of lithium could power a clean future"

Physics: "Scientists seek materials that defy friction at the atomic level"

Astronomy: "Competing ideas abound for how Earth got its moon"

Biology/health: "Small intestine is the first stop for fructose"

Summarize which concept is applied in the current research described in the article and explain how a scientist or technology mentioned in the article applies the concept.

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