

TITLE

Build an Atom

AUTHORS

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COURSE

General Chemistry I

TYPE

In-Class Guided-Inquiry Activity

TEACHING MODE

Facilitated Group Inquiry

LEARNING GOALS

Students will be able to:

- Use information about the number of protons, neutrons, and electrons to:
 - Identify an element and its position on the periodic table.
 - Determine whether an atom is neutral or an ion.
 - Predict the charge and determine the mass of an atom or ion.
- Relate the number of protons, neutrons and electrons to representations, including atomic symbols and the symbols found on the periodic table.
- Explain: element symbol, charge, atomic number, mass number, and isotope.

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BUILD AN ATOM

PART I: ATOM SCREEN

Build an Atom simulation (<http://phet.colorado.edu/en/simulation/build-an-atom>)

1. Explore the **Build an Atom** simulation with your group. As you explore, talk about what you find.
2.
 - a) List two things your group observed in the simulation.
 - b) What particle(s) are found in the center of the atom?
3. Play until you discover which **particle(s)** determine(s) the name of the **element** you build. What did you discover?
4. What is the **name** of the following atoms?
 - a) An atom with 3 protons and 4 neutrons: _____
 - b) An atom with 2 protons and 4 neutrons: _____
 - c) An atom with 4 protons and 4 neutrons: _____
5. Play with the simulation to discover which particles affect the **charge** of an atom or ion.
 - a) Fill in the blanks below to show your results:

Neutral atoms have the same number of protons and electrons.

Positive ions have _____ protons than electrons.

Negative ions have _____ protons than electrons.
 - b) Develop a relationship (in the form of a single sentence or equation) that can predict the charge based on the number and types of particle.
6. Play with the simulation to discover what affects the **mass** number of your atom or ion.
 - a) What is a rule for determining the mass number of an atom or ion?
7. Practice applying your understanding by playing 1st and 2nd levels on the game screen.

Commented [TH1]:

This style of question encourages students to complete a full exploration of the sim and to articulate their findings, without needing the teacher to give instructions for each interaction. The teacher could ask students to share out their list with the class.

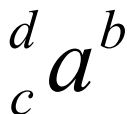
Minimal (or no) instructor introduction is required before students begin the activity and sim exploration.

Commented [TH2]: After a significant portion of the class has completed the first page, or once many of them are engaged with the Game, a class discussion around Part I is suggested.

In the class discussion, focus particular attention on students' answers to questions 5(b) and 6, which allow for a greater diversity of student thinking.

PART II: SYMBOL SCREEN

8. Using the *Symbol* readout box, figure out **which particles** affect each component of the atomic symbol.
- a) In the atomic symbol below, label each letter (*a*, *b*, *c*, and *d*) with:
- the **particle(s)** used to determine the letter, and
 - how** the value of each letter is determined.



9. Create a definition (using a complete sentence) for each of these items based on your labels from the atomic symbol above.
- a) Element Symbol
- b) Charge
- c) Atomic Number
- d) Mass Number
10. Practice applying your understanding by playing the 3rd and 4th game levels. Play until you can get all the questions correct on the 4th level.
11. In addition to atomic symbol, we can represent atoms by name and mass number.
- a) Complete the table below:

Symbol	Name
${}^{12}_{6}\text{C}^{+1}$	Carbon-12
${}^{18}_{9}\text{F}$	
${}^{11}_{5}\text{B}$	

- b) Each representation (Symbol and Name) in the table above provides information about the atom. Describe the similarities and differences between the *Symbol* and *Name* representations.

Commented [TH3]: Part II focuses primarily on student understanding and use of symbolic representations, specifically isotopic symbols.

A facilitated discussion at the end of this section is advised, particularly if students share-out their definitions from question 9 and compare representations as a class.

PART III: ISOTOPES

Commented [YC4]: Part III of the activity extends the use of the sim representations to enable students to construct a definition of isotopes.

12. Play with the simulation to determine:
- Which particles affect the stability of the atom? _____
 - Which particles do not affect the stability of the atom? _____
13. What are the names of the stable forms of oxygen?
- Oxygen-16
 - Oxygen-___
 - Oxygen-___
 - List all of the things that are the same about these atoms (ignore the electrons).
 - List all of the things that are different about these atoms (ignore the electrons).
14. The atoms in the previous question are **isotopes** of each other. Based on this information, list the requirements for two atoms to be isotopes of each other.
15. Test your understanding of isotopes by examining the relationships between the pairs of atoms listed below:

Atom 1	Atom 2	Relationship between atom 1 and atom 2
${}^{12}_{6}\text{C}$	${}^{13}_{6}\text{C}$	<input type="checkbox"/> Isotopes <input type="checkbox"/> Same Atom, Not Isotopes of Each Other <input type="checkbox"/> Different Element
Carbon-12	${}^{12}_{6}\text{C}$	<input type="checkbox"/> Isotopes <input type="checkbox"/> Same Atom, Not Isotopes of Each Other <input type="checkbox"/> Different Element
Argon-40	Argon-41	<input type="checkbox"/> Isotopes <input type="checkbox"/> Same Atom, Not Isotopes of Each Other <input type="checkbox"/> Different Element
${}^{11}_{5}\text{B}$	Boron-10	<input type="checkbox"/> Isotopes <input type="checkbox"/> Same Atom, Not Isotopes of Each Other <input type="checkbox"/> Different Element
An atom with 13 protons and 13 neutrons	An atom with 14 protons and 13 neutrons	<input type="checkbox"/> Isotopes <input type="checkbox"/> Same Atom, Not Isotopes of Each Other <input type="checkbox"/> Different Element

EXERCISES

16. The periodic table has a great deal of information about every atom. Using your periodic table, answer the following questions:

- What is the atomic number of chlorine (Cl)? ____
- What is the atomic number of tungsten (W)? ____
- How many protons are there in any Cl atom? ____
- How many protons are there in any Te atom? ____
- Can you tell from the periodic table exactly how many neutrons are in an atom?

17. Complete the following table:

Name	Symbol	Atomic number	Mass Number	Number of neutrons	Number of Electrons	Charge
hydrogen-2	${}^2\text{H}$	1	2	1	1	0
	${}^3\text{H}$					
sodium-22	${}^{22}\text{Na}^+$				10	
		12	24		12	
		12	25		13	
	${}^{46}\text{Ti}^{-2}$					
	${}^{107}\text{Ag}$					
	${}^{19}\text{F}^{-1}$					
carbon-12					6	
carbon-13					6	
carbon-14					6	
carbon-12					7	
carbon-12					5	
	${}^4\text{He}$					
		8		8	10	
argon-40		18			18	
	${}^{70}\text{Ga}$					
	${}^{70}\text{Ga}^{+3}$					
		4	9		2	
		7		8	8	

18. To test your knowledge of isotopes, draw arrows between all pairs of atoms in the table above that are isotopes of each other.

Commented [TH5]: The exercises on this page may be best left as a homework assignment, as it is difficult to complete this in addition to the rest of the activity during class. Additionally, this section extends to elements outside of the scope of the simulation.