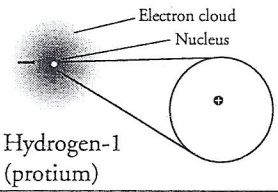
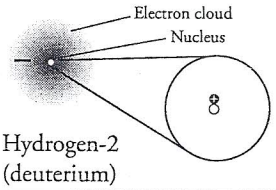
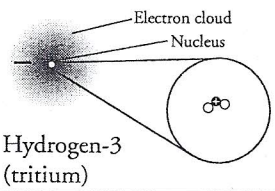
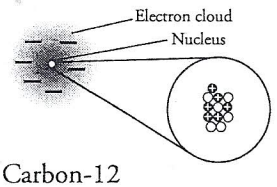
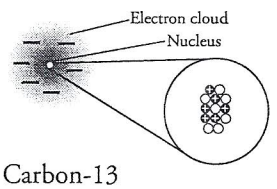
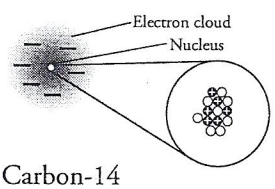
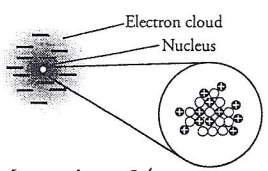
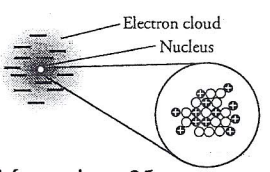
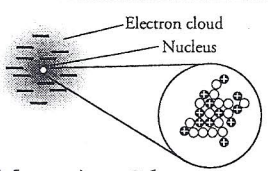
Isotopes

Are all atoms of an element alike?

Why?

The following activity will help you learn the important structural characteristics of an atom. How do we classify atoms? How does the combination of subatomic particles affect the mass and charge of an atom? What are isotopes? This is just a sampling of what we will address. Throughout this activity you will want to keep both Model 1 and a periodic table handy.

Model 1

Isotopes of Hydrogen			
Symbol	$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
Atomic Diagram with Name	 Hydrogen-1 (protium)	 Hydrogen-2 (deuterium)	 Hydrogen-3 (tritium)
Number of Protons ⊕			
Number of Neutrons ○			
Isotopes of Carbon			
Symbol	$^{12}_{6}C$	$^{13}_{6}C$	$^{14}_{6}C$
Atomic Diagram with Name	 Carbon-12	 Carbon-13	 Carbon-14
Number of Protons ⊕			
Number of Neutrons ○			
Isotopes of Magnesium			
Symbol	$^{24}_{12}Mg$	$^{25}_{12}Mg$	$^{26}_{12}Mg$
Atomic Diagram with Name	 Magnesium-24	 Magnesium-25	 Magnesium-26
Number of Protons ⊕			
Number of Neutrons ○			

1. Refer to Model 1. What subatomic particles do the following symbols represent in the Atomic Diagrams?

   ▬ ⊕ ○

2. Complete the table in Model 1 by counting the protons and neutrons in each atomic diagram. Divide the work evenly among group members.

3. Find the three elements shown in Model 1 on your periodic table.

   a. What whole number shown in Model 1 for each element is also found in the periodic table for that element?

   Hydrogen — Carbon — Magnesium — *1*

   b. The whole number in each box of the periodic table is the atomic number of the element. What does the **atomic number** of an element represent?

   c. Refer to the isotope symbols in Model 1. Relative to the atomic symbol (H, C, or Mg), where is the atomic number located in the isotope symbol?

4. Refer to your periodic table.

   a. How many protons are in all chlorine (Cl) atoms?

   b. A student says "I think that some chlorine atoms have 16 protons." Explain why this student is not correct.

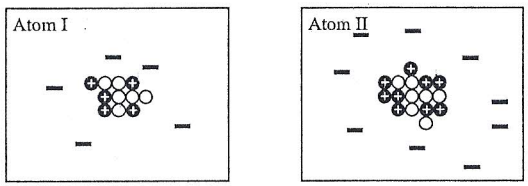
5. Refer again to Model 1. In the isotope symbol of each atom, there is a superscripted (raised) number. This number is also used in the name of the atom (*i.e.*, carbon-12). It is called the **mass number.**

   a. How is the mass number determined?

   b. Why is this number called a "mass" number?

6. Fill in the table for Atom I and Atom II shown below.

	Atom I	**Atom II**
Number of Protons		
Number of Neutrons		
Mass Number		



7. Refer to Model 1.

   a. Which corner of the isotope symbol contains the mass number?

   b. How is the mass number of an isotope expressed in the name of an atom?

8. Write an isotope symbol (similar to those in Model 1) for each of the atoms in Question 6.

9. Write the name of the atom (similar to those in Model 1) for each of the atoms in Question 6.

STOP

10. Fill in the following table.

Isotope Symbol	$^{40}_{19}K$	$^{18}_{9}F$	
Atomic Number			16
Mass Number			
Number of Protons			
Number of Neutrons			15

11. Consider the examples in Model 1.

   a. Do all isotopes of an element have the same atomic number? Give at least one example or counter-example from Model 1 that supports your answer.

b. Do all isotopes of an element have the same mass number? Give at least one example or counter-example from Model 1 that supports your answer.

12. Considering your answers to Question 11, write a definition of **isotope** using a grammatically correct sentence. Your group must come to consensus on this definition.

13. Consult the following list of isotope symbols: $^{204}_{82}Pb$, $^{82}_{35}Br$, $^{78}_{35}Br$, $^{208}_{82}Pb$, $^{204}_{78}Pt$, $^{205}_{82}Pb$.
    a. Which of the atoms represented by these symbols are isotopes of each other?

    b. Which part(s) of the isotope symbol was the most helpful in answering part *a* of this question?

Extension Questions

14. Determine the number of electrons in each of the atomic diagrams in Model 1.
    a. In a neutral atom, how does the number of electrons compare to the number of protons?

    b. Discuss why this relationship is important in making a "neutral" atom.

15. Refer to the hydrogen isotopes in Model 1. Each isotope has a special name derived from Latin (protium, deuterium, and tritium). What structural feature do these names refer to in the atom?

16. Can two atoms with the same mass number ever be isotopes of each other? Explain.

17. All models have limitations. What characteristics of Model 1 are inconsistent with your understanding of what atoms look like?