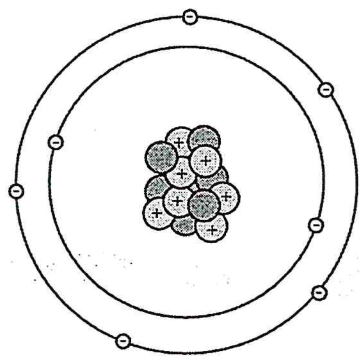
There have been a number of different models of the atom over the years to help us understand and explain how an atom is put together and how the parts of an atom relate to one another. The most commonly used model is called the Bohr model of the atom. In the Bohr model, an atom is made up of smaller pieces that are arranged similarly to a solar system. In a solar system, the large sun is in the middle, and the smaller planets go around the sun in circular orbits. In an atom, the large **nucleus** is in the middle, and the tiny **electrons** whiz around it in spherical orbits called **energy levels.** A solar system has only one planet per orbit, but in an atom there can be multiple electrons in one energy level.

The nucleus in the center of the atom is made up of two different kinds of particles: **protons** and **neutrons**. Protons and neutrons have about equal masses, but protons have a +1 charge and neutrons have zero charge. The electrons orbiting the nucleus have a –1 charge, and have much less mass than a proton or neutron. If a proton weighed the same as a car, an electron would weigh as much as a can of beans. When the numbers of protons and electrons are equal, the atom has no overall charge. If the atom gains electrons, it will have more negative electrons than positive protons, and will be negatively charged. If the atom loses electrons, it will have more protons than electrons and will be positively charged. An atom whose protons and electrons are out of balance like this is called an **ion**.

All of the elements are organized into a chart called the **periodic table**. The way the elements in the periodic table are arranged, you can tell different things about each element just by where it is in the table, so you don't have to memorize a lot of information. Each element is given a symbol that represents its name, and is assigned a number called the **atomic number**. The atomic number tells you how many protons are in the nucleus of atoms of that element. Since the atomic number of carbon is 6, that means all carbon atoms have six protons in their nucleus, and any atom that has six protons is a carbon atom. Neutral atoms have the same number of electrons as they do protons, so carbon's atomic number of 6 also tells you that a neutral carbon atom has six electrons. The unusual shape of the periodic table is because the row and column assigned to each element is based on the position of the electrons in that element's atoms. The Build an Atom simulation doesn't go into detail on the arrangement of electrons, so we won't go into detail here. The simulation simply shows the first two energy levels, which correspond to the first two rows of the periodic table.



Bohr Model of Nitrogen

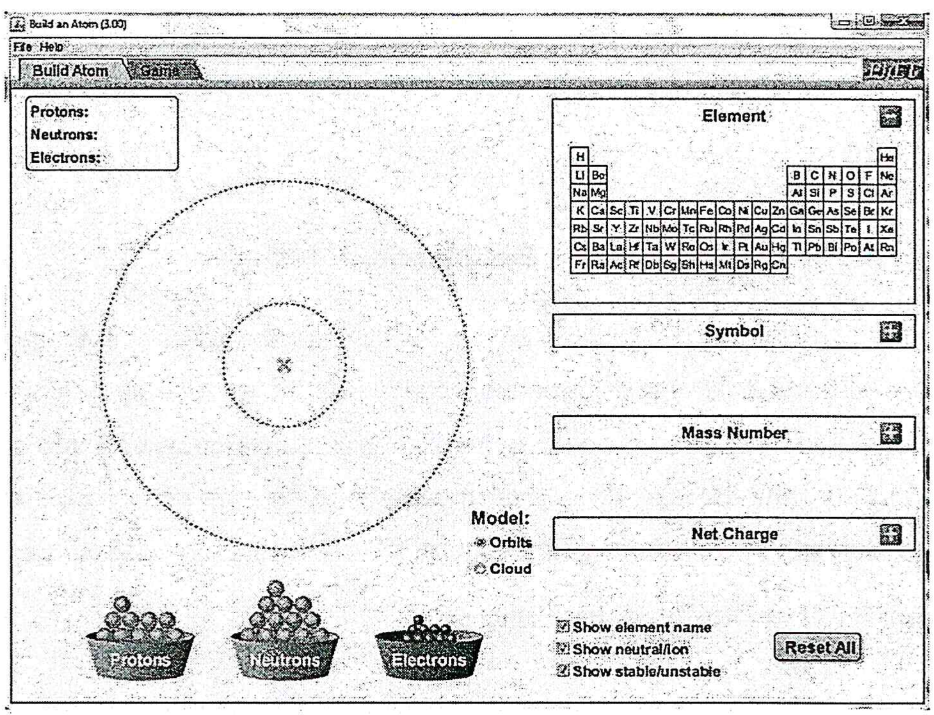
When textbooks show a picture of a solar system, the sizes and distances of the planets are never to scale, because if they were the smaller planets would just be dots. Pictures of atoms are also never shown to scale because the distance between the nucleus and the electrons is far greater than the size of the nucleus itself. To understand the proportions of the size of the nucleus to the size of the overall atom, imagine a housefly sitting on the 50-yard line of a football field. If that housefly was an atomic nucleus, the electrons would be as far away as the end zone. If you shrink that model down small enough to fit into a textbook, the nucleus would be too small to see. The pictures you see in a textbook or online show the nucleus and the electrons much bigger and much closer together than they really are.

Procedure

1) Go to www.google.com and type in: **phet Build an Atom**
2) Click on the 1st link

   (Direct link for this website: http://phet.colorado.edu/en/simulation/build-an-atom)
3) Click: **Run Now!**

   Upon clicking this, you will be taken to the program that is seen on the following page.



4) Click on one of the protons in the bin and drag it to the nucleus of the atom, represented by the **X** in the middle.

   a. What element was created?

   b. Is this element **stable** or **unstable**? ______________________________

5) Right now, the element is a **positive ion** because it has more protons than electrons. In order to make this element **neutral**, the number of protons and electrons must be equal. Drag an electron to the atom. What element is this?

6) Drag another electron to the atom. What type of ion is made now? Why is this?

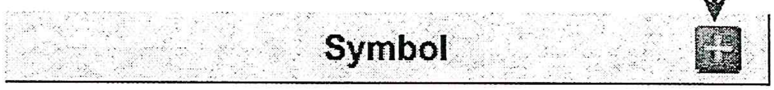
7) Click "**Reset All**" on the bottom right corner.

8) Click on a **neutron** and drag it to the atom. What happens?

9) What can you do to make this atom stable?

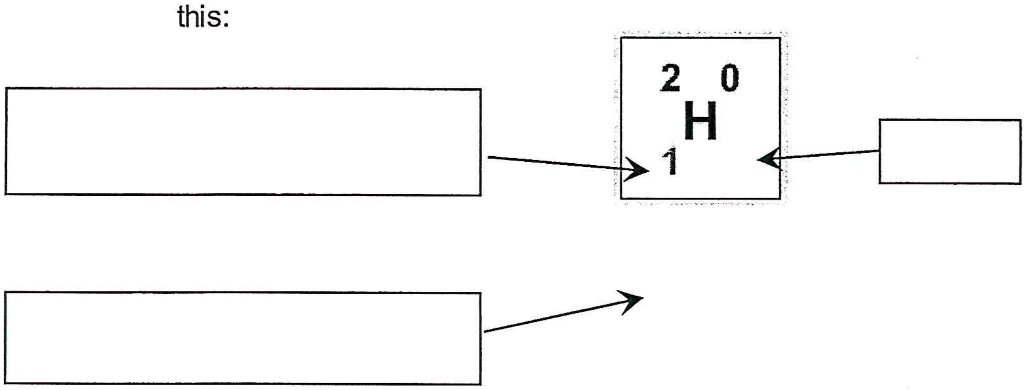
10) Click "**Reset All**" on the bottom right corner.

11) Click the + sign next to "**Symbol**"



12) Drag one proton, one neutron, and one electron to the atom.

Under "Symbol," you should have something that looks like this:



13) Add another proton. You will see that both numbers on the left increased by one.

14) Add another neutron. What happened to the numbers when you did this?

15) The table below will tell you how many **protons, neutrons,** and **electrons** to add to the atom. After you have added these subatomic particles, fill in the rest

of the chart. Click "**Reset All**" after each. (For charge, say if it is **positive**, **negative**, or **neutral**)

# Protons	# Neutrons	# Electrons	Element Name	Stable/Unstable	Charge
6	6	4			
3	2	3			
7	5	7			
1	1	1			
2	2	2			
4	2	2			
9	4	6			
1	2	2			
5	5	5			
7	7	6			
10	13	10			

16) If you finish early, you can click on "Game" at the top of the window. This game is challenging, especially the higher levels. Do your best and push yourself!