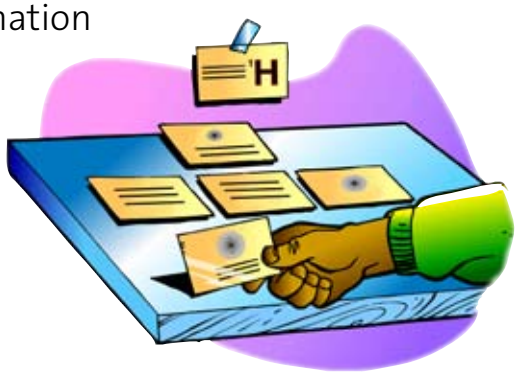
Activity Sheet
Chapter 4, Lesson 3
The Periodic Table and Energy Level Models

Name _____

Date _____

Your group will receive a set of cards with information about the energy levels of a particular atom. Your job is to figure out which atom the card describes and to place it in the area in your classroom for that atom. Use the activity sheet from lesson 2 along with this activity sheet as a reference.



Energy levels

Electrons surround the nucleus of an atom in regions called *energy levels*. Even though atoms are spherical, the energy levels in an atom are more easily shown in concentric circles.

Which atom is this supposed to be?

The larger dot in the center of this atom represents the nucleus, which contains both protons and neutrons. The smaller dots surrounding the nucleus represent electrons. In order to figure out which atom this represents, count up the number of electrons. There are 8 electrons in this atom. Because the number of electrons and protons is the same in an atom, this atom has 8 protons. Look at the chart Periodic Table, Elements 1–20. The number of protons is the same as the atomic number, so this drawing represents an oxygen atom.

ENERGY LEVELS
ELEMENTS 1–20

Complete each energy level model by drawing the correct number of electrons in their corresponding energy levels.

HYDROGEN 1  1.01							HELIUM 2  4.00
LITHIUM 3  6.94	BERYLLIUM 4  9.01	BORON 5  10.81	CARBON 6  12.01	NITROGEN 7  14.01	OXYGEN 8  16.00	FLUORINE 9  19.00	NEON 10  20.18
SODIUM 11  22.99	MAGNESIUM 12  24.31	ALUMINUM 13  26.98	SILICON 14  28.09	PHOSPHORUS 15  30.97	SULFUR 16  32.07	CHLORINE 17  35.45	ARGON 18  39.95
POTASSIUM 19  39.10	CALCIUM 20  40.08						

Additional Teacher Background
Chapter 4 Lesson 3, p. 291

As the note on page 292 points out, there are other ways to model the electron energy levels of atoms. Some middle school texts show the electrons in pairs on an energy level. This pairing of electrons is intended to suggest information about the substructure *within* energy levels. This substructure is made up of regions called *orbitals* which comprise each energy level. The shape and size of the orbital is defined by the space around the nucleus where there is a high probability of finding electrons. There can be a maximum of two electrons in any orbital so showing electrons in pairs on an energy level model is an attempt to suggest information about the orbitals within the level.

In Middle School Chemistry, we chose to spread electrons out evenly on energy levels to indicate only the *number* of electrons on a level and not to suggest anything about the substructure of orbitals *within* energy levels. An understanding that the different energy levels can accommodate a certain number of electrons seems enough for students in middle school. They will see more refined models in high school and college when they learn more details about the orbitals within energy levels.

Some teachers might like to use a different model that shows more details of orbitals because it is more complete, even if they do not intend to explain those aspects of the model in much detail. Another argument is that a model showing paired and unpaired electrons may be useful for certain discussions about bonding. Other teachers may be more comfortable showing a less-detailed model even if it leaves out certain aspects of energy levels because they do not intend to discuss those details and they intend to handle bonding in a more general way. No model can be complete and accurate for all purposes and all have limitations. All models involve aspects of judgment and compromise. A good model focuses on the important points without too much to distract from those main features. The model you choose will have a lot to do with how much you think is important to explain and what the students are able to understand.

Some energy level models you might see and what they represent
For helium (atomic number 2), the energy level model in Middle School Chemistry is:

Helium has two electrons on the first energy level.

Some other middle school texts might show an energy level model for helium like this:

The *first* energy level has only one orbital. This is known as the 1s orbital. The "1" means that it is in the first energy level and the "s" stands for an orbital within that energy level with a particular shape. This 1s orbital can hold up to two electrons. So helium has its two electrons in the 1s orbital. The practice of showing the electrons together or *paired* in an energy level is meant to indicate how many orbitals in that level have been completely occupied by two electrons. For the first energy level, the pairing is not very useful for showing which orbitals are full and which aren't because there is only one orbital. But it becomes more useful for atoms that have more orbitals where some orbitals may be filled and others not.

For boron (atomic number 5), the energy level model in Middle School Chemistry is:

Boron has 2 electrons on the first energy level and 3 electrons on the second level.

Some other middle school texts might show an energy level model for boron like this:

The model shows that boron has two electrons in the 1s orbital of the first energy level which are shown as paired. It also has 3 electrons in the second energy level.

The second energy level is made up of four orbitals. There is a spherical orbital called 2s. The "2" means that it is in the second energy level. It is like the 1s orbital but is further from the nucleus. The second energy level also has 3 other orbitals that are all the same shape and distance from the nucleus but oriented in different directions. These orbitals are called 2p. The "p" orbitals are a different shape than the "s" orbitals. The 2s orbital can hold up to two electrons and each of the 2p orbitals can also hold up to 2 electrons. So the second energy level can hold up to eight electrons in its four orbitals. In this model of boron, two electrons are shown as paired in the 2s orbital and the last electron is shown in one of the 2p orbitals.

Another middle school text might show a model of boron like this:

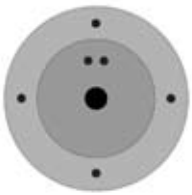
Here, they paired the electrons in the 1s orbital but did not show the detail of pairing the electrons in the 2s orbital of the second energy level. They chose to spread the three electrons out on the second energy level.

For carbon (atomic number 6), the energy level model in Middle School Chemistry is:

Carbon has 2 electrons on the first energy level and 4 on the second. Some other middle school texts might show a model of carbon like this:

This model shows that carbon has two electrons in the 1s orbital of the first energy level which are shown as paired. It also has 4 electrons in the second energy level. In this model, two electrons are shown as paired in the 2s orbital and the other two electrons are shown separately or unpaired. This is done to indicate that each of the electrons is in a separate 2p orbital. One of the details of orbitals is that an electron goes into an empty available orbital of the same type before it goes into an orbital that already has an electron in it.

Another middle school text might show a model of carbon like this:



This model pairs the 1s electrons but spreads out the four electrons in the second energy level regardless of what orbital they are in. This approach would show electrons being paired on the second energy level for the first time in nitrogen.

For oxygen (atomic number 8), the energy level model in Middle School Chemistry is:

Oxygen has 2 electrons on the first energy level and 6 on the second. Oxygen is an interesting example because the other two types of models come out with the same result which looks like this:

Here, the electrons are paired in the 1s orbital. In the second energy level, whether the electrons are paired in the 2s to begin with or whether they are spread out and only paired after placing 1 electron in each of the four orbitals and then adding the last two electrons to make two pairs, the result is the same.

If the energy level models in Middle School Chemistry are different than those in your text book, you can use either one to teach that energy levels only have a certain number of electrons. You could also use the difference to suggest that there is more detail about energy levels that students may learn about later.

