Student Lab Sheets:

Carbon Structures Lab **Name_____________________________**

Period ____ Date _________________

Introduction:

As you know from watching the video thus far, carbon atoms can join together to make more than one substance of pure carbon. The two we will be looking at today are graphite and diamond. One is a very soft mineral that breaks roughly in layers. Its most common uses are as a lubricant and for pencil lead.
Diamonds are the world's hardest natural substance.

If both of these substance are made of carbon atoms, what causes the vast difference? Can it be the number of atoms joined together? Is it how they are arranged? These questions are for you to answer as you "create" graphite and diamond models in this activity.

Your job in this lab is to discover how the changes in structure effect the physical properties of the compound.

Materials:
(per group of 4 students)
52 toothpicks
32 large marshmallows/preferably stale

if using GeoMags or Magnetix
52 magnetic bars
24 steel balls

Procedure Written for use with GeoMags:
(use marshmallows in place of balls and toothpicks in place of bars)

1. Divide the materials evenly among the members of your group. Each member should be able to build one carbon octahedron or one carbon chain ring.
2. First have every one build a carbon chain by alternating a ball (the carbon atom) and a bar magnet so that you have a long chain of ball-bar-ball-bar-ball-bar-ball-bar-ball-bar-ball-bar. See picture 1 at the right. Now carefully bend the long chain around to connect the two ends making a carbon ring structure.

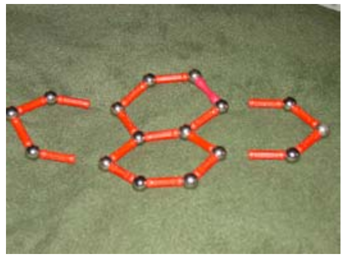
Picture 1

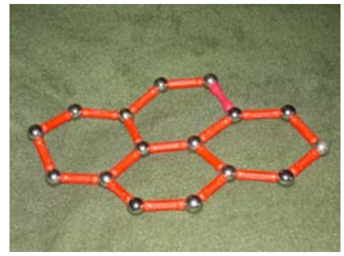
Picture 2

Your structure should look like the picture 2 above.
3. The bars represent bonds between atoms. Count the number of balls and write this in the data table provided in this lab.

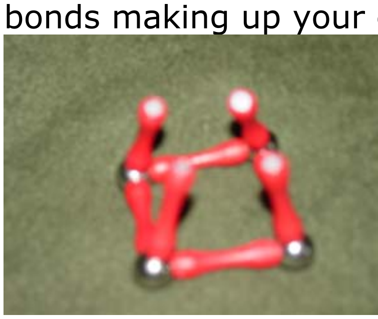
4. Now you need to join the rings together. In doing the joining you will notice that you are removing bars and balls (atoms of carbon as they rearrange to make what is called a sheet structure. This is the basic structure of the mineral graphite. See pictures 3, 4, and 5 below. Again, after joining the rings, you need to count the total number of "atoms" (the balls) in your sheet structure and the total number of "bonds" (the bars).


Picture 3


Picture 4


Picture 5

5. Carefully pick up the ringed sheet structure. Describe its relative "stiffness" and/or the ease you have in reshaping it without breaking any bonds. Stack several sheets on top of each other to see how they are found in nature. The "weak bonds" between the sheets allow them to slide past or break away from each other.
6. Carefully dismantle your sheet and make sure that everyone has at least 6 balls and 12 magnets. You are going to form a new set of structures called octahedrons. First make a square using four bars for the sides and a ball at each corner. Now attach one bar straight up from each corner. Move the upright bar ends in toward each other and join them together with one ball. You should now have something that looks like a four sided (square-based) pyramid. See picture 6 below. Carefully turn your pyramid over so that you can repeat the addition of four bars and one ball to this side of the base. When you have completed adding the last ball to the structure it should look like picture 8 below. This is an octahedron. Count the number of atoms and bonds making up your octahedron. Record this information in the data table.

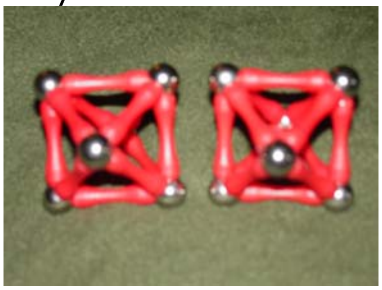

Picture 6

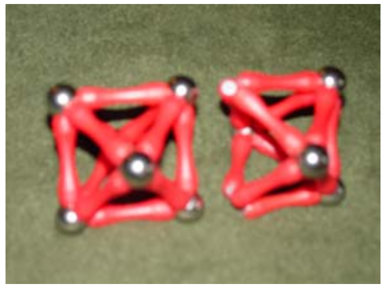

Picture 7

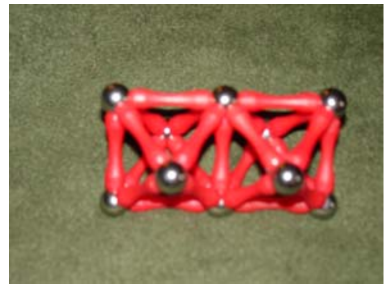

Picture 8

7. Pick up your octahedron and gently tug on any ball to see what happens. Try pulling gently on two balls at the same time. Write your observation in the data table in the space for single octahedron.
8. You are now ready to join octahedrons to start a chain. Pair up with a member of your group and place your octahedrons side by side so that any two corners touch two corners of the octahedron next to it. Notice that you have too many balls and bars to allow the easy joining of the two octahedra. Carefully remove the two balls and the connecting bar from one side of the square on one octahedron. (see picture 10) Now place the two octahedral

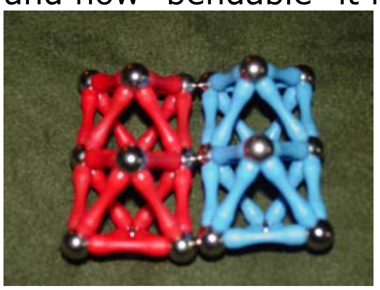
together to form a chained structure. (See picture 11.) Count the atoms and bonds and record your answers in the table, along with any observations you may make for this form.

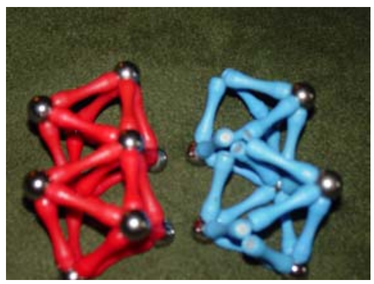

Picture 9


Picture 10


Picture 11

9. Repeat the joining process to join single chain side by side with another single chain. This will make a square double chained structure. See pictures 11,12, and 13. Count the atoms and bonds and record in your table. Make your observations about the relative strength of the bonds in this new structure and how "bendable" it is.

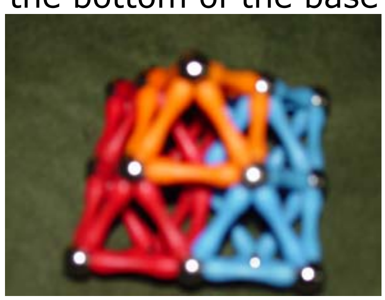

Picture 11

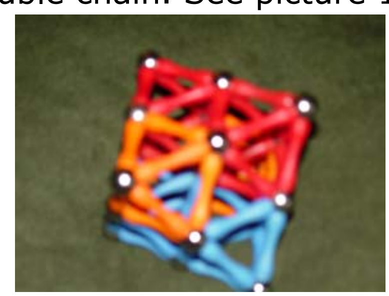

Picture 12


Picture 13

10. Join with two other students from another group. They will each be adding their single octahedron to your square double chain, by using the four atoms on the top as the square base of their octahedron. See pictures 14 and 15. Repeat this process on the bottom of the base double chain. See picture 16.


Picture 14


Picture 15


Picture 16

You have now created the smallest network solid. (A diamond is a network solid!) Count the atoms and bonds. Record your observations about the stability of this structure.

11. When you have finished, carefully take your models apart and return the correct number and color of bars and balls to each lab group kit. Place in the large Ziploc baggie and turn them in to your instructor.

Analysis and Conclusions:

1. **Describe what happens to the ratio of atoms to bonds as you made each progressive structure from the top to the bottom of the data table.**

2. **Relate the "pull-strength" of the bonds to the change in ratios. Write a simple statement explaining the change.**

3. **Look carefully at the network solid you built. Can you find the hexagonal ring structure from the sheet anywhere in the solid? Describe how this could have gotten this way in nature.**

4. **Think back to the required conditions for the formation of a diamond as explained in the video. Relate the conditions to the changes you see in the structures you have built in this lab.**

Data Table

Name of Structure	# of Carbon atoms (balls)	# of bonds between atoms (bars)	Ratio Atoms:Bonds	Observations
Single Carbon Chain Ring				
5 Carbon Ring Sheet				
Single Carbon Octahedron				
Two Octahedron Chain				
Four Octahdron Double Chain				
Network Solid				