The Properties of Matter Lesson Plan is for a 9th grade Physical Science Class and can be used with or without the Bridge Building Activity. The focus of this lesson is how structure and shape of materials affect its properties. Diamonds and graphite are both made of Carbon, but have very different properties. The Bridge project enforces this idea because the geometry of the structure will play a large part on the load it will carry. Class time can be dedicated to the Bridge project or it can be given as a take home assignment. The materials can also be altered.

Georgia Performance Standards:

**SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.**
- a. Exhibit the above traits in their own scientific activities.
- b. Recognize that different explanations often can be given for the same evidence.
- c. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.

**SCSh6. Students will communicate scientific investigations and information clearly.**
- a. Write clear, coherent laboratory reports related to scientific investigations.
- b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
- c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
- d. Participate in group discussions of scientific investigation and current scientific issues.

**SPS5. Students will compare and contrast the phases of matter as they relate to atomic and molecular motion.**
- a. Compare and contrast the atomic/molecular motion of solids, liquids, gases and plasmas.
Graphite (your pencil “lead”) and diamonds are both forms of the same element. Even though they are made out of the exact same material they look very different and have very different properties.

1) What element are graphite and diamonds made out of?

2) Name at least three differences between graphite and diamonds.
   a.
   b.
   c.

3) Why do you think graphite and diamonds are so different physically?

4) Investigation:

**Materials:** 2 pipe cleaners

**Directions:** You will have 7 minutes to create an object using your pipe cleaners. Remember this is an individual assignment and the pipe cleaners are all you may use.

**Extension:** look up the term grapheme and write a short paragraph about it. Compare graphene with diamond and graphite.
Graphite (your pencil “lead”) and diamonds are both forms of the same element. Even though they are made out of the exact same material they look very different and have very different properties.

1) What element are graphite and diamonds made out of?

Carbon

2) Name at least three differences between graphite and diamonds.

   Even though they are made of the same element they have very different properties. Because of this reason they are called polymorphs.

   a. Graphite: sheets of carbon; each carbon is bonded to 3 adjacent carbon atoms; Diamond: crystal structure; each carbon is strongly bonded to 4 adjacent carbon atoms.

   b. Graphite: metallic and opaque    Diamond: brilliant and transparent

   c. Graphite: soft (1-2 on Mohs Hardness Scale)    Diamond: extremely hard (10 on Mohs Hardness Scale – scale runs 1 -10)

   d. Optional: Graphite: free e- that move through the molecule

       Diamond: no free e- and therefore make great insulators

3) Why do you think graphite and diamonds are so different physically?
This is due to their structure

4) Investigation:

Materials: 2 pipe cleaners

Directions: You will have 7 minutes to create an object using your pipe cleaners. Remember this is an individual assignment and the pipe cleaners are all you may use.

After the time is up have the students hold up their pipe cleaner objects. All of them should be different (it helps if they all have the same color pipe cleaner but this may not be possible). Have them understand that even with the same materials the end product can be different.

Extension: look up the term graphene and write a short paragraph about it. Compare graphene with diamond and graphite.

Graphene is an allotrope (different structural modifications of an element) of carbon. The carbon atoms are arranged in a regular hexagonal pattern. It is usually a one atom layer thick layer of graphite. It has really strong mechanical, thermal and electrical properties and is being studied in labs throughout the world. You may also have them look up carbon nanotubes and buckyballs.

PHYSICAL SCIENCE EXTENSION: THE RELATIONSHIP BETWEEN PROPERTIES AND SHAPE

OBJECTIVE: To design a bridge that has the greatest ratio of load mass to the mass of the bridge (the strongest).

TIME: 1 ½ class periods for construction; another class period for testing and voting

GROUPS: You may work in a group with no more than three (3) other people. All group members are equally responsible for the final grade. If there is a problem within the group this must be resolved before the testing date.

MATERIALS: Toothpicks, glue, ruler, scissors, and cardboard (for base). You may not use excessive glue to coat the materials – the glue should only be used to connect the materials together.

DIRECTIONS FOR MODEL:

1. The bridge must be made only out of the specified materials.

2. The bridge must be freestanding and must span two level surfaces 20 cm apart. (This means that your bridge should be longer than the 20 cm so it can sit on the tables).

3. No portion of the bridge can be below the plane (the table).

4. The maximum height of the bridge is 50 cm. The maximum width of the bridge is 10 cm.

5. A weight tied to a dowel should be able to be placed from the center of the bridge. If decking is used a 4 cm by 4cm hole must be cut out for the load.

6. When your bridge is tested, it “fails” when the bridge breaks, or flexes more than 3 cm.

7. Your bridge must support 200 g (0.2 kg).

8. Your bridge will also receive an “efficiency” rating, calculated as follows:

   Efficiency = mass supported (kg) / mass of the bridge (kg)

It should be apparent that the more mass your bridge will hold, the better, but the mass of your bridge will also count so do not use too many materials.
QUESTIONS:

1. Describe the roles of each member of the group for the project and relate those roles to one of the following job descriptions: General Manager, Engineer, or Construction.

2. How did you come up with the initial design for your bridge? Did your design change as you built your bridge? Why or why not?

3. What are some considerations that must be made when designing a bridge in real life?

4. Which geometric shapes are used in your bridge? Why?

5. How does the bridge design project relate to the structures of graphite and diamonds?

COMPETITION:

**Bonus points will be awarded to the most innovative and most efficient designs.**