Diamond and Graphite Molecular Structures

Grade Range: Middle School
Lesson Time: 40 minutes

Key Terms
- Atom
- Bond
- Carbon
- Diamond
- Graphite
- Molecule

Materials and Resources
- Photos or samples of graphite and diamonds

Activity Overview
The element carbon is found in all organic material due to its ability to form a variety of bonds. Diamonds and graphite are both made entirely of carbon atoms, though they look and feel completely different! Students will observe two minerals, diamond and graphite. They will consider the similarities and differences between these minerals, and then explain why these minerals are different even though they have the same composition.

Essential Questions
1. How are structures and functions related in nature?
2. How do temperature and pressure affect an object?

Objectives
- Compare the molecular structures of diamond and graphite
- Explain why these minerals are different

Introduction
Begin the activity by showing pictures of diamonds and graphite or passing around actual minerals. Ask the students these questions: “Have you ever held a piece of diamond or graphite? How do they look and feel?” Explain to the students that diamonds and graphite are both made entirely of carbon atoms, even though they look completely different! Then tell the students that they will observe the molecular structures of these two minerals and then explain why they are different even though they have the same composition.
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Activity Questions Provided in Studio

Answers may vary. Sample answers are provided below.

1. Diamonds are beautiful minerals that are commonly displayed as jewelry. Did you know that diamonds are billions of years old and the hardest natural substance? Look at this diamond molecule. What atoms make up this molecule? What do you observe about the physical structure of diamonds?
   Answers will vary. Sample Answer: Carbon atoms compose diamonds. The atoms bond to form hexagonal formations. Each formation is connected to another, creating a pyramid-type structure.

2. Many of us use graphite every day. It is the “lead” in our pencils. In fact, the word graphite is actually derived from the Greek word grephein, which means to draw or to write. Look at this graphite molecule. What atoms make up this molecule? What do you observe about the physical structure of graphite?
   Answers will vary. Sample Answer: Carbon atoms compose graphite. The atoms bond to form hexagonal formations. The hexagons connect to form sheet-like layers.

3. You have observed that graphite and diamonds are both made up entirely of carbon atoms. Compare the two molecular structures. What do they have in common? What are some differences?
   Answers will vary. Sample Answer: They both have hexagonal formations, connecting six carbon atoms. The biggest difference is how the carbon atoms are bonded. In the graphite molecule, the carbon bonds in a 2-dimensional, hexagonal pattern that creates sheet-like formations. In the diamond molecule, the bonds form a 3-dimensional tetrahedron pattern. This creates a crystal-like formation.

Closing

Questions for Discussion

1. How does the formation of carbon atoms impact the physical composition of a mineral?
   The sheets in the graphite molecule are stacked on top of one another and can easily slide over each other, which makes it soft. However, in a diamond, the atoms are tightly locked, making diamonds incredibly hard.

2. What are the processes of graphite and diamond formation?
   Diamonds form about 100 miles below Earth’s surface under extreme pressure and heat. They are then carried to Earth’s surface by deep volcanic eruptions. Graphite is found close to the Earth’s surface in veins of metamorphic rock.

Extension Activity: Students could touch a diamond and graphite in order to observe and document their texture, hardness, density, color, luster, streak, and cleavage/fracture

Extension Activity: Students could research different minerals and draw their molecular structures

Extension Activity: Students could research what bonds are and explain how they work or form

Differentiation

- Group students heterogeneously to allow students with a strong command of the English language to assist in reading or interpreting questions
- Provide paper copies of diagrams for students to use as a reference
- Allow students to provide answers that are handwritten, typed, or verbal
- Have students work as partners or in small groups (younger children could partner with older buddies)
- Use text-to-speech if needed
- Enrichment: Students could work on the discussion questions and lead the class discussion
- Enrichment: Students could research similar topics and create presentations
- Enrichment: Students could build a model of a key concept