

Carbon Allotropes: Diamond and Graphite

Simulation: edtechsims.com/allotropes-of-carbon

Name: _____ Class: _____ Date: _____



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Instructions

- 1) Visit <https://edtechsims.com/allotropes-of-carbon/>
- 2) Explore the various models to learn more about graphite and diamond.
- 3) Complete this worksheet.

Section 1: Warm-up / Definitions

1. Define the term **allotrope**.

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2. State the element in which diamond and graphite are both allotropes of.

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Section 2: Structure Identification & Diagrams

3. In the space below, sketch the atomic arrangement of **diamond**.

4. In the space below, sketch the atomic arrangement of **graphite**. Label one layer clearly.

5. Fill in the blanks with the number of covalent bonds formed by each carbon atom:

Diamond: _____ Graphite: _____

Section 3: Guided Observation (using the interactive model)

6. Click **"Show When Force Is Applied"** on the Graphite view. Describe what happens to the layers. Why does this happen?

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7. Click **"Show In Electric Field"** on the Graphite view. What do the blue spheres represent, and in which direction do they move when the field is switched on?

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Section 4: Property Explanation

8. Why is diamond very hard, but graphite is soft and slippery?

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9. Why does graphite conduct electricity, but diamond does not?

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10. Why is graphite used as a lubricant?

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Section 5: Comparison Table

Complete the table below to compare diamond and graphite. Some of the cells have been filled in for you.

Feature	Diamond	Graphite
Bonds per carbon atom	4	
Structure type		Giant covalent, layered hexagonal structure
Electrical conductivity	Poor (no free electrons)	
Hardness		Soft, layers slide easily
One real-world use	Cutting tools / drill tips / jewellery	

Section 6: True or False

Circle **True** or **False** for each statement. Explain your answer if the statement is false.

11. Diamond and graphite are different forms of the same element, carbon, making them allotropes.

True / False

Reason:
.....

12. In diamond, each carbon atom forms three covalent bonds, resulting in its excellent electrical conductivity.

True / False

Reason:
.....

13. The layers in graphite can easily slide past each other because of weak forces of attraction between the layers.

True / False

Reason:
.....

14. Diamond is a poor electrical conductor because all valence electrons of each carbon atom are involved in covalent bonding.

True / False

Reason:
.....

15. When force is applied to graphite, the layers deform permanently rather than sliding against each other.

True / False

Reason:
.....

Section 7: Other Allotropes (Bonus)

Carbon also exists as **fullerenes** and **nanotubes** — you can explore these in the interactive model too.

16. Fullerenes can be used to carry drug molecules inside their hollow cage structure. Suggest **one** advantage this could have in medicine.

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17. Carbon nanotubes are very strong and can conduct electricity. Suggest **one** possible application of nanotubes based on these properties.

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ANSWER KEY

Section 1: Warm-up / Definitions

1. An allotrope is a different structural form of the same element, in the same physical state, where atoms are arranged or bonded differently.

2. Carbon.

Section 2: Structure Identification & Diagrams

3. Diamond: each carbon atom bonded to four other carbon atoms arranged in a tetrahedral shape, with a bond angle of 109.5° , extending in a giant 3D network.

4. Graphite: carbon atoms arranged in flat hexagonal (six-sided) rings, forming layers. Layers are stacked with larger gaps between them.

5.

Structure Number of bonds formed by each carbon atom

Diamond 4

Graphite 3

Section 3: Guided Observation

6. The layers slide past each other in different directions. This happens because there are only weak forces of attraction between the layers (no covalent bonds between layers), so applying a force can easily separate/slide them without breaking the strong covalent bonds within each layer.

7. The blue spheres represent **delocalised electrons**. When the electric field is switched on, they move toward the **positive end** of the field.

Section 4: Property Explanation

8. Diamond is hard because every carbon atom is joined to four others by strong covalent bonds in a rigid 3D network, requiring a large amount of energy to break. Graphite is soft because although the covalent bonds within each layer are strong, the forces between layers are weak, allowing the layers to slide over one another easily.

9. Graphite conducts electricity because each carbon atom uses only 3 of its 4 valence electrons for covalent bonding, leaving one delocalised electron per atom free to move along the layers and carry charge. Diamond does not conduct because all 4 valence electrons of every carbon atom are used in covalent bonding, leaving no free/delocalised electrons to move.

10. Graphite works as a lubricant because its layers can slide over each other easily (due to weak forces between layers), reducing friction between surfaces.

Section 5: Comparison Table (Suggested Answers)

Feature	Diamond	Graphite
Bonds per carbon atom	4	3
Structure type	Giant covalent, 3D tetrahedral network	Giant covalent, layered hexagonal structure
Electrical conductivity	Poor (no free electrons)	Good (delocalised electrons present)
Hardness	Very hard	Soft, layers slide easily
One real-world use	Cutting tools / drill tips / jewellery	Pencil "lead" / lubricant / electrodes

Section 6: True or False — Answers

11. True — Diamond and graphite are both allotropes of carbon.

12. False — In diamond, each carbon atom forms **four** covalent bonds. It is a poor conductor, not a good one, because all electrons are used in bonding.

13. True — Weak forces between graphite layers allow them to slide easily, which is why graphite is soft and used as a lubricant.

14. True — All four valence electrons of each carbon atom in diamond are used in covalent bonding, leaving none free to conduct electricity.

15. False — Graphite layers **slide** against each other when force is applied; this is not permanent deformation.

Section 7: Other Allotropes (Bonus) — Sample Answers

16. Fullerenes could deliver drugs directly to a specific target site in the body (e.g. a tumour), which may reduce side effects on healthy cells compared to drugs that spread throughout the whole body. (Any reasonable, sensible answer accepted.)

17. Possible applications include: reinforcing materials to make them stronger and lighter (e.g. sports equipment, aircraft parts), or use in tiny electronic circuits/wires due to their electrical conductivity. (Any reasonable, sensible answer accepted.)