Allotropes of carbon

Teacher / technician

YEAR 10 / LESSON 24 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Staff preparation and answer guidance. Keep separate from student sheets. Structural models only. No measured conductivity, hardness or phase-change results. Corrects the misleading graphite “upright bond” model.

Coverage and delivery

1.49–1.51: giant covalent structures; diamond, graphite and C_{60} properties; why covalent substances do not usually conduct electricity and the graphite exception.

Allow about 50 minutes. Follow the student sequence and use the answers to check reasoning.

Requisition • class of 30, working in 15 pairs

Item	Per pair / setup	Class total
Student booklet	1 per student	30
Writing tools / blank paper	1 set per student	30 sets
Model nodes / blunt connectors	24 nodes / 30 links	360 nodes / 450 links
Graphite sheet outlines	2 per pair	30
C_{60} and tetrahedral reference	1 teacher display	1 setup

Immediate safety

Desk activity only. Use pre-cut blunt modelling pieces and keep small parts out of mouths. Keep the workspace clear; no chemicals, flames or electrical supply are required.

Preparation and delivery

Read alongside the student method

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1. Per pair supply 24 nodes and 30 blunt connectors, two paper sheet outlines and access to the reference images. Models may be dismantled between tasks. Class of 30: 360 nodes, 450 connectors and 30 sheet outlines; one teacher C_{60} model/image is sufficient.

2. Provide a tetrahedral kit/reference for diamond: a flat four-arm cross is not the 3D geometry. Graphite interior atoms must have three neighbours. Edge atoms in a small fragment are incomplete and should be labelled.

3. Do not install straw uprights as if they were covalent bonds between graphite layers. Separate mats allow sliding; any mechanical supports must be labelled as non-chemical supports.

4. Use 10 minutes for the diamond fragment, 15 for graphite, 10 for C_{60} and 15 for explanations. This is structural modelling, not an actual conductivity, hardness or melting test.

5. Use only pre-cut blunt connectors and reusable modelling material. No sharp spaghetti fragments, carbon powders, heating or mains electricity. Explain pure C_{60} is a poor conductor at this level; avoid claiming all forms or doped materials behave identically.

Close of lesson

• Keep your evidence and corrections. Count and return reusable model pieces; recycle unwanted paper. No chemical waste is produced.

Check before teaching

Check the cards, reference data and quantities against this requisition. Keep the staff answer guide separate until the checking stage. Supplied numerical practice datasets are labelled examples; they are not class measurements.

Answers and teaching notes

Expected explanations • do not give as experimental observations

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• Allotropes are different structural forms of one element. Diamond, graphite and C_{60} all contain carbon atoms but have different arrangements and bonding networks.

• Diamond is hard because strong covalent bonds extend through a rigid 3D network. Disrupting many such bonds needs much energy; do not assign a classroom melting measurement.

• Graphite has strong bonds within each layer and weaker attractions between layers, allowing layers to slide. Its softness does not mean its in-plane covalent bonds are weak.

• Graphite has mobile delocalised electrons along the layers. In ordinary diamond the outer electrons are used in localised bonds, so it lacks comparable mobile charge carriers.

• C_{60} has strong covalent bonding inside each cage, weaker intermolecular attractions between cages and is softer than diamond. C_{60} is molecular, not one continuous giant network; pure C_{60} is a poor conductor compared with graphite.

• Valid limits: not to scale; incomplete edges; rigid/soft materials do not match real bonds; missing electrons; drawings flatten a 3D object; a support stand is not a bond. C_{60} has 12 pentagons and 20 hexagons.

References and provenance

Pearson Chemistry specification

RSC carbon allotropes reference

RSC: working with 2D and 3D models

Prepared 22 November 2026. Original wording, tables and questions. Sources inform the concepts and technique; the lesson scope and classroom quantities are explicitly described here. No laboratory trial or final school risk approval is claimed.