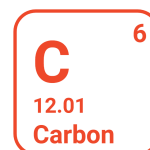


Hour of Science • Carbon

Revised ABC Science scheme of work

The virus that causes COVID-19 couldn't exist without carbon. Neither could plastics, the fossil fuels driving climate change... or you! Carbon is one of the most versatile and important elements on Earth, and this lesson gets pupils investigating why.



THE CENTRAL MYSTERY

Graphite and diamond are made from exactly the same element - carbon - yet one is soft, dark and conducts electricity, while the other is transparent, extraordinarily hard and does not conduct electricity. How can the same atoms make materials that behave so differently?

The learning journey

5 min	Elements, Periodic Table, carbon and particles
5 min	Carbon allotropes + soot/fingerprint teacher demo
5 min	Atomic structure: why arrangement matters
15 min	Graphite 'wires' investigation
10 min	Heating carbon-containing materials
5 min	Carbon cycle, fossil fuels and climate
5 min	Carbon quiz
Extension	CO ₂ teacher demo + carbon projects

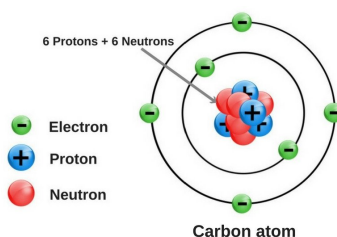
Atoms, elements and carbon

Foundations • approximately 10 minutes

Introduction to particle ideas

Everything around us is made from atoms. An element is a substance containing only one type of atom. The identity of an element is determined by the number of protons in its atoms.

Carbon has atomic number 6, so every carbon atom has six protons. A neutral carbon atom also has six electrons. Different isotopes of carbon can contain different numbers of neutrons.



Pure carbon can exist in several structural forms called allotropes. Familiar examples are graphite and diamond; others include graphene and fullerenes. Coal and soot are carbon-rich materials rather than pure allotropes.

WONDER QUESTION

If graphite and diamond contain only carbon atoms, why do they look and behave so differently?

Teacher demonstration • Reveal a fingerprint with soot

A candle flame can produce soot when combustion is incomplete. The black deposit is carbon-rich. The teacher collects a small amount on foil or a metal spoon, transfers it to a soft brush and gently dusts a fingerprint on paper.



Safety

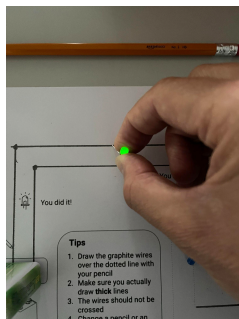
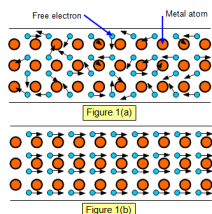
Teacher demonstration only. Stable candle/heatproof mat; hair tied back; pupil exclusion zone; allow metal/foil to cool; avoid inhaling or dispersing soot. Follow the school's activity-specific risk assessment.

Same atoms - different structures

Graphite, diamond and electrical conductivity

The mischievous mystery

Show pupils a pencil and an image/sample of diamond. Tell them both contain carbon. Ask them to vote: Which one will conduct electricity? The apparently ordinary pencil wins.



WOW → WONDER → QUESTION

WOW: graphite conducts; diamond does not. WONDER: but they're both carbon! QUESTION: can the arrangement and bonding of identical atoms change a material's properties?

Experiment 1 • Draw graphite wires

An electric current is a flow of electric charge. In metals such as copper, and in graphite, electrons are able to move through the material and carry charge. In diamond the electrons are held within a different bonding structure, so diamond does not conduct electricity in the same way.

1. Draw a thick continuous graphite track using a soft pencil (for example 2B-6B).
2. Use a school-approved low-voltage circuit with suitable current limiting.
3. Test the graphite track, then change one variable: length, width, pencil grade or number of layers.
4. Repeat and decide which graphite track conducts best. Explain using evidence.

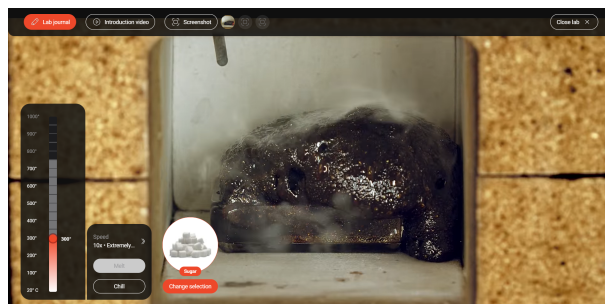
Equipment update

The original draft used a bare 9 V battery and LED. Use a tested, school-approved low-voltage arrangement with appropriate current limiting. This improves reliability and protects the LED.

Materials containing carbon

Heating, decomposition and combustion • approximately 10 minutes

When carbon-containing materials are heated, different things can happen. Some melt, some decompose, some burn in oxygen, and some can leave a black carbon-rich residue. These are not all the same process.



PREDICT

Which sample will melt first? Which will burn? Which might char or leave a dark residue? What observations distinguish a physical change from a chemical change?

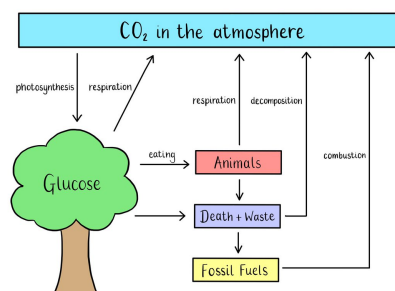
One useful combustion equation

Complete combustion of carbon



Carbon cycle connection

Plants remove some carbon dioxide from the atmosphere during photosynthesis and use its carbon to make sugars and other organic molecules. Carbon then moves through food webs, respiration, decomposition and combustion. Human activities are releasing fossil carbon dioxide faster than natural land and ocean processes can remove it, so atmospheric CO_2 concentrations are increasing.



Carbon and the environment

Climate, combustion and responsible choices

Carbon is essential to life. The problem is not 'carbon' itself: it is the rapid movement of large amounts of carbon from long-term fossil stores into the atmosphere as carbon dioxide. Human activities - particularly burning coal, oil and natural gas - release tens of billions of tonnes of CO₂ each year. The increase in greenhouse gases is causing Earth to warm and changing the climate.



Don't muddle these two

Carbon dioxide (CO₂) is a greenhouse gas. Carbon monoxide (CO) is a poisonous air pollutant formed by incomplete combustion. They are both carbon compounds, but create different environmental and health problems.

Pupil enquiry / discussion

- What human activities transfer carbon from fossil stores into the atmosphere?
- Where can carbon dioxide go after entering the atmosphere?
- Why does planting vegetation help but not make unlimited fossil-fuel emissions harmless?
- Which actions could reduce fossil-fuel use, waste or unnecessary plastic consumption in our school?

Current classroom figure

For primary teaching, it is reasonable to say that carbon dioxide makes up about 0.04% of the atmosphere. Despite being a small fraction, changes in its concentration have an important effect on climate.

Carbon quiz

Five questions • easy to challenging



1. Diamond and graphite are both forms of carbon. Which of these materials are carbon-rich or contain carbon? Coal • pencil 'lead' • glass • graphite • charcoal • lava
2. What is the chemical symbol for carbon? Cn Ca Cr C Cm
3. Carbon can be found in trees, fish, insects, plastics and people. What does that tell you about carbon?
4. True or false? Even if humans stopped burning fossil fuels and firewood, natural processes such as respiration, decomposition and volcanoes would still release some CO₂.
- 5a. A bedroom has a volume of 45 m³. Suppose 0.04% of the air is CO₂. Estimate the volume of CO₂ in the room.
- 5b. Challenge: use a supplied density value to estimate its mass.
- 5c. Explain why CO₂ can rise overnight in an occupied bedroom if ventilation is limited.

Teacher note

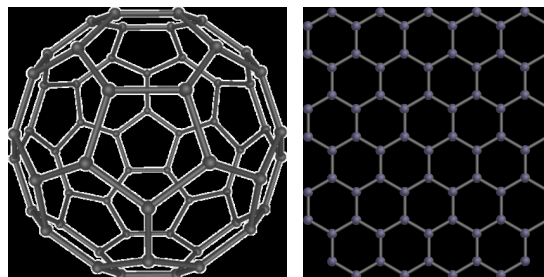
The original draft asked pupils to calculate CO₂ mass without supplying its density. This revision separates the accessible volume calculation from the mass extension. Supply an agreed density value for part 5b.

Extensions and science projects

Carbon facts worth wondering about

Forms of carbon

Diamond and graphite have been known for a very long time; more recently scientists have explored forms such as fullerenes and graphene. Their dramatically different properties come from how carbon atoms are arranged and bonded.



Plant composition

A striking fact: roughly half of a plant's dry mass can be carbon. Most of that carbon ultimately came from carbon dioxide in the air. Ask pupils: Where does the mass of a growing tree actually come from?

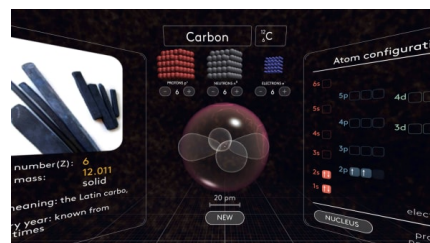


INVESTIGATE

Grow matched seedlings under controlled conditions, measure changes in mass/height/leaf area, and use the results to discuss what plants take in from air, water and soil. This is a superb bridge between chemistry and biology.

Carbon atom extension

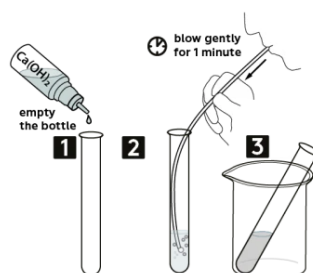
Use a physical or digital atom model to assemble carbon atoms. Keep the key idea precise: the number of protons defines the element; changing the neutron number produces different isotopes.



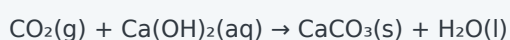
Teacher demonstration • Testing for carbon dioxide

Revised from the original pupil limewater activity

Carbon dioxide reacts with calcium hydroxide in limewater to form insoluble calcium carbonate, making the liquid appear cloudy.



Chemical equation with symbols of state



Teacher demonstration procedure

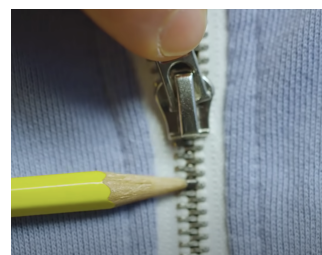
1. Place a small quantity of prepared limewater in a labelled test tube or clear demonstration vessel.
2. Generate or collect carbon dioxide using a school-approved method. Do not ask pupils to blow through limewater.
3. Pass the carbon dioxide through the limewater using suitable tubing/apparatus while pupils observe from a safe distance.
4. Record the change from clear to cloudy and explain what it provides evidence for.
5. Compare with a control where appropriate.

Safety and scope

Teacher demonstration only. Wear eye protection and use prepared, suitably dilute limewater under the school's chemical risk assessment. The former suggestion that pupils make calcium oxide by strongly heating calcium carbonate has been removed.

Demonstration 2 • Graphite as a lubricant

Graphite's layers can slide over one another, helping explain why it feels slippery and can act as a dry lubricant. Rub pencil graphite onto the teeth of a stiff zipper and investigate whether movement becomes easier. Link this back to the central mystery: structure determines properties.



Experiment 1 pupil template

Can a pencil line act like a wire?

CENTRAL INVESTIGATION

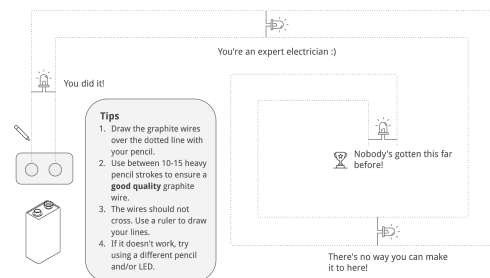
Can graphite conduct enough electric current to affect an LED or sensor - and which kind of graphite track works best?

Plan

Choose one variable: track length, width, pencil grade or number of graphite layers.

Keep the power supply, contacts, paper and testing method the same.

Repeat measurements where possible and record evidence.



Investigation record

Change	Track length / width / pencil grade / layers
Measure / observe	LED response, sensor reading or teacher-approved indicator
Keep the same	Supply, contacts, paper, module, testing method
Repeats	At least 3 where measurements allow
Prediction	I predict... because...

Explain your result

Graphite contains carbon atoms arranged in layers. Some electrons are able to move through the structure, so graphite can conduct electricity. Diamond contains the same element, but its carbon atoms are bonded in a different three-dimensional structure; its electrons are not free to carry charge in the same way.

Teacher resource note: revised scientific wording, updated carbon/climate explanations, safer low-voltage graphite investigation and teacher-only limewater demonstration. Original lesson graphics have been reused where they support the revised activity.