Hydrocarbon fuels: oxygen and products

Student activity • observation and reasoning

YEAR 11 / LESSON 75 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How does oxygen availability change combustion products?

Use balanced equations and atom counters to compare complete and incomplete combustion. Connect carbon monoxide formation to reduced blood oxygen transport.

Equipment

• Booklet, pencil, periodic table and optional molecular model kit

Desk activity only; keep small model pieces away from mouths.

Course coverage: Shared core: 4.11–4.13. Written combustion models only; no carbon monoxide is generated.

Plan, model or apparatus sketch

Draw a labelled structure or model to explain your reasoning for this lesson.

Method and reasoning

Read the whole sequence before starting

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1. Define a fuel in terms of useful heat released when it burns.

2. Balance methane combustion to carbon dioxide and water with sufficient oxygen.

3. Model two incomplete-combustion possibilities: carbon monoxide plus water, and carbon plus water.

4. Compare the oxygen coefficients and explain why a real flame can form a mixture rather than one exclusive carbon product.

5. Explain why carbon monoxide is dangerous even when no visible smoke is present.

6. Correct the claim that a hydrocarbon contains oxygen because its combustion products contain oxygen.

Cleanup

- Return shared equipment and retain corrected reasoning.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Written models: $CH_4 + O_2 \rightarrow CO_2 + H_2O$; $CH_4 + O_2 \rightarrow CO + H_2O$; $CH_4 + O_2 \rightarrow C + H_2O$. Balance each before comparison. Real combustion can produce mixtures of CO_2, CO, soot and unburned fuel. Carbon monoxide is colourless and odourless; appearance cannot establish its absence.

Task	My structure / working	Reason / correction
Complete combustion		
Incomplete: CO		
Incomplete: soot		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Balance complete combustion of methane.

2. Balance methane combustion to carbon monoxide and water.

3. Balance methane combustion to carbon and water.

4. Why can smoke appearance not prove that CO is absent?

5. Explain CO toxicity in terms of oxygen transport.

6. Where do the oxygen atoms in combustion products originate?