Alkane reactions: combustion and substitution

Student activity • observation and reasoning

YEAR 11 / LESSON 78 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

Why does methane react differently with oxygen and chlorine?

Compare atom-balanced models for combustion and ultraviolet-initiated monosubstitution. Explain the distinct products, conditions and reaction classifications.

Equipment

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

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

Course coverage: Shared core: 4.12 and 4.22. This lesson is included in Double Award; no radical mechanism is required.

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. Balance methane complete combustion and identify the fuel and oxidant.

2. Compare an incomplete-combustion equation producing CO and explain the oxygen limitation.

3. Model $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ under ultraviolet light. Identify the replaced atom and both products.

4. Compare this substitution with an alkene addition model and explain why a saturated alkane does not undergo simple C=C addition.

5. Predict the restricted ethane mono-substitution equation with chlorine and check every atom.

6. Discuss why actual chlorination can form further-substituted products, while this lesson uses only the specified mono-substitution model.

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 examples only. Use methane CH_4, chlorine Cl_2, chloromethane CH_3Cl, ethane C_2H_6 and chloroethane C_2H_5Cl. UV is a reaction condition, not an atom in the equation. Mono-substitution replaces one hydrogen atom; further substitution is possible in practice but is outside the required model.

Task	My structure / working	Reason / correction
Methane + O_2		
Methane + Cl_2 / UV		
Ethane + Cl_2 / UV		

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. Give one incomplete-combustion equation forming CO.

3. State the condition and products for methane mono-substitution with chlorine.

4. Why is this substitution rather than addition?

5. Write ethane mono-substitution with chlorine.

6. Why should the simple equation not be read as a guarantee of one pure organic product?