Acid rain: trace the chemical pathway

Student activity • observation and reasoning

YEAR 11 / LESSON 76 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How do fuel impurities and hot air become acidic deposition?

Trace sulfur and nitrogen from sources to atmospheric reactions and environmental effects. Compare prevention at the source with treatment after deposition.

Equipment

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

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

Course coverage: Shared core: 4.14–4.16. Distinguish sulfur impurity combustion from nitrogen/oxygen reaction at high engine temperatures.

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. Draw a sulfur pathway from an impurity in fuel to sulfur dioxide during combustion. Balance $S + O_2 \rightarrow SO_2$.

2. Draw a separate pathway in which nitrogen and oxygen from air react at high engine temperatures. Use $N_2 + O_2 \rightarrow 2NO$ and subsequent oxidation to NO_2.

3. Explain how these oxides react further with atmospheric water and oxygen to form acidic substances.

4. Link deposition to one aquatic and one building-material effect. Avoid claiming identical effects in all environments.

5. Compare removing sulfur from fuel, controlling nitrogen-oxide emissions and adding alkali to an affected lake. Identify prevention versus treatment.

6. Distinguish acid rain from ordinary rain’s natural weak acidity and from greenhouse warming.

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

Use $S + O_2 \rightarrow SO_2$; $N_2 + O_2 \rightarrow 2NO$ at high temperature; $2NO + O_2 \rightarrow 2NO_2$. The atmospheric chemistry has multiple further reactions producing sulfuric and nitric acids; no one-step universal equation is required. No gases, acids or environmental samples are used in this activity.

Task	My structure / working	Reason / correction
Sulfur pathway		
Nitrogen pathway		
Response and limitation		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Where does sulfur in SO_2 from fuel combustion originate?

2. How can a sulfur-free fuel still be associated with nitrogen oxides in an engine?

3. Balance oxidation of NO to NO_2.

4. Explain how acid deposition can damage limestone.

5. Compare one prevention measure and one treatment measure.

6. Is all naturally acidic rain caused by industrial SO_2? Explain.