Crude oil: separating a mixture

Student activity • observation and reasoning

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The question

How can a column separate molecules without changing them?

Use a temperature-gradient model to explain evaporation and condensation. Treat a fraction as a mixture with a boiling range rather than a pure compound.

Equipment

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

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

Course coverage: Shared core: 4.7–4.8. Industrial fractional-distillation model; no school distillation of flammable liquids.

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 crude oil as a mixture containing many hydrocarbons and distinguish mixture from compound.

2. Draw a fractionating column with a hotter base and cooler top; add heated feed, rising vapour and liquid outlets.

3. Use the invented model boiling points 40, 150 and 300 °C. Starting in sufficiently hot vapour, decide which condenses lower and which can rise higher as temperature falls.

4. Explain condensation in terms of intermolecular attractions, without breaking carbon–carbon covalent bonds.

5. Group nearby boiling ranges into fractions. Explain why a fraction contains several substances rather than one exact molecular formula.

6. Contrast this physical separation with cracking, which changes molecules; identify one limitation of the simple three-component 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

Invented model components A, B and C have boiling points 40, 150 and 300 °C at a common pressure. These are simplified teaching values, not refinery cut temperatures or class measurements. The real column has many components and overlapping ranges; the least volatile residue remains near the bottom and very volatile gases can leave at the top.

Task	My structure / working	Reason / correction
Column model		
40 / 150 / 300 °C		
Fraction versus pure compound		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why is crude oil a mixture?

2. Describe the column temperature gradient.

3. Which model component condenses lowest and why?

4. What is meant by a fraction?

5. Are covalent bonds broken during fractional distillation? Explain.

6. Give one limitation of the three-component model.