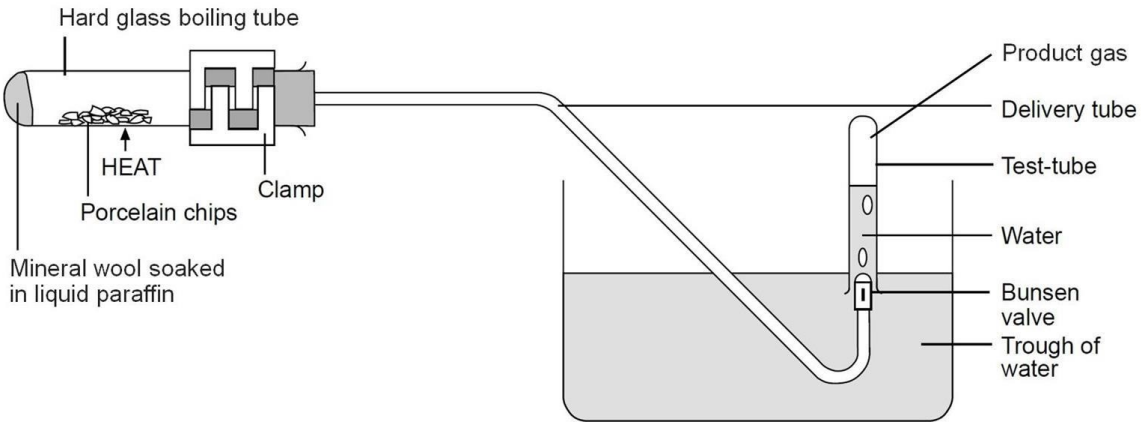
In context

Subject area: Organic chemistry | **Level: 14–16 years (Foundation)**

Topic: Cracking hydrocarbons | **Source: rsc.li/2SCxbLL**

1. A teacher shows a class an experiment in which liquid paraffin is cracked.

Here is a diagram of the equipment used.



Source: Royal Society of Chemistry

a) Suggest what happens to liquid paraffin when it is 'cracked'.

Answer: *The molecules in paraffin are broken down to form smaller molecules.*

b) Porcelain chips are used because they catalyse the reaction.

What is the meaning of the word 'catalyse'?

Answer: *To make the reaction take place at a faster rate.*

c) Using the diagram, what evidence is there that smaller molecules are made in the experiment?

Explain your answer.

Answer: *A product gas is formed from the liquid paraffin.*
The gas has a lower boiling point than the liquid paraffin.
This is because the gas contains smaller molecules.

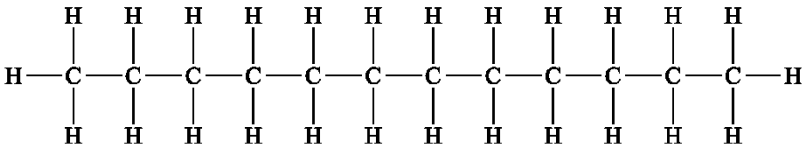
d) Using the diagram, describe how you think the experiment works.

Answer: *Liquid paraffin and porcelain chips are heated with a Bunsen flame.*
The liquid paraffin boils and turns into a vapour.
The paraffin molecules break down due to heat and the catalyst.
The smaller molecules are then collected in the test tube as a gas.

e) What evidence is there from the diagram that the product gas is insoluble in water?

Answer: *The product gas is collected over water, and if it were soluble, it would dissolve.*

Paraffin is a mixture of large molecules.
The structure of one of these molecules is shown below.



f) Which elements are present in the molecule?

Answer: *Hydrogen and carbon.*

g) What is the name of substances containing the elements in part f)?

Answer: *Hydrocarbons.*

h) This molecule is also a member of a homologous series.

What is a homologous series?

Answer: *One in which molecules differ by a CH_2 unit.*
They also contain the same functional group.

i) What is the name of this homologous series?

Answer: *The alkanes.*

j) What is the general formula of the homologous series in part i)?

Answer: $C_nH_{(2n+2)}$

k) The molecule above is called dodecane.

What is the molecular formula of dodecane?

Answer: *$C_{12}H_{26}$*

l) Which of these molecules do not belong to the same homologous series as dodecane?

Write 'Yes' or 'No' into the right-hand column in the table.

Molecular formula of substance	The same homologous series as dodecane ('Yes' or 'No')
C_8H_{16}	***Answer:*** *No.*
$C_{13}H_{28}$	***Answer:*** *Yes.*
C_5H_{12}	***Answer:*** *Yes.*
$C_{23}H_{46}$	***Answer:*** *No.*
$C_{50}H_{102}$	***Answer:*** *Yes.*

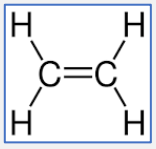
m) The molecules made from cracking long chain molecules can be very useful.

Give a use for these molecules.

Smaller alkanes	***Answer:*** *Petrol.*
Alkenes	***Answer:*** *Polymers / solvents.*

2. When a long chain molecule is cracked, a substance called ethene is normally made.

a) Draw the structure of an ethene molecule.



b) To which homologous series does ethene belong?

Answer: *The alkenes.*

Another molecule that has a similar name to ethene is ethane.

One of these molecules is described as ‘saturated’ and the other as ‘unsaturated’.

c) What is the meaning of each of these terms?

Answer: *Saturated – contains carbon single bonds only.*
Unsaturated – contains one or more carbon double bonds.

d) Write ‘unsaturated’ or ‘saturated’ in the correct spaces next to the names below:

Ethene	***Answer:*** *Unsaturated.*
Ethane	***Answer:*** *Saturated.*

e) Complete the word equation that shows octane being cracked to make ethene.

Write the name of the other product into the space.

Octane → *hexane* + ethene