# Topic 8 Fuels and Crude Oil, Alkanes and Alkenes

## PAPER 3

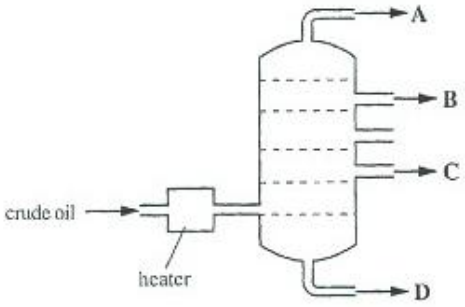
### MULTIPLE-CHOICE QUESTIONS

***For each question, there are four possible answers. Choose the one you consider correct and record your choice (A, B, C or D) in the brackets provided.***

1. The diagram shows a fractionating column.

   From which level of the column is the substance used for making roads obtained?

   (2011/P3/Q18)

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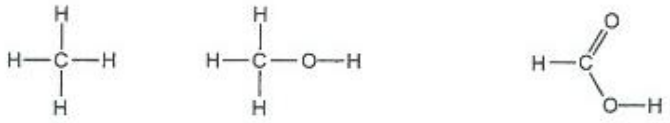
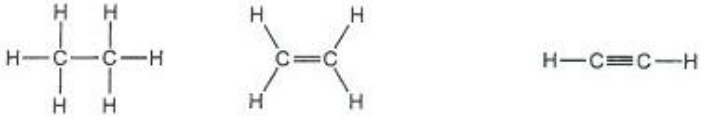
2. Which set of diagrams shows three substances that are all in the same homologous series?

   (2011/P3/Q19)

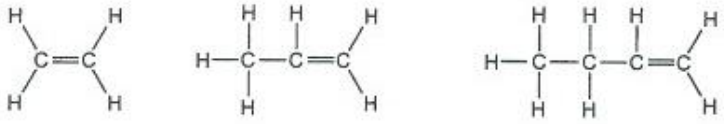
A



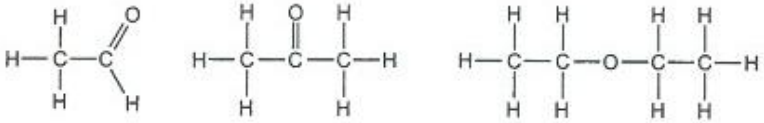
B



C



D



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3. Which reaction is an example of the cracking of an alkane? (2011/P3/Q20 / 2019/P3/Q20)

**A** $3C_2H_4 \longrightarrow C_6H_{12}$ **B** $C_6H_{12} + H_2 \longrightarrow C_6H_{14}$

**C** $C_6H_{14} \longrightarrow 6C + 7H_2$ **D** $C_6H_{14} \longrightarrow C_2H_4 + C_4H_{10}$ ( )

4. Natural gas is mainly methane.

Which products are formed when methane is burned completely? (2012/P3/Q18)

**A** carbon and water **B** carbon dioxide and water

**C** carbon dioxide and hydrogen **D** carbon monoxide and water ( )

5. Which statement describes an homologous series? (2012/P3/Q19)

All the compounds have the same

**A** general formula. **B** physical properties.

**C** relative molecular mass. **D** structural formula. ( )

6. Compound **X** has the formula $CH_3CH_2CH{=}CH_2$.

Which row in the table shows the type of compound **X** and the colour change of aqueous bromine when it is added to compound **X**? (2012/P3/Q20)

| | type of compound | colour change |
|---|---|---|
| **A** | saturated | brown to colourless |
| **B** | saturated | colourless to brown |
| **C** | unsaturated | brown to colourless |
| **D** | unsaturated | colourless to brown |

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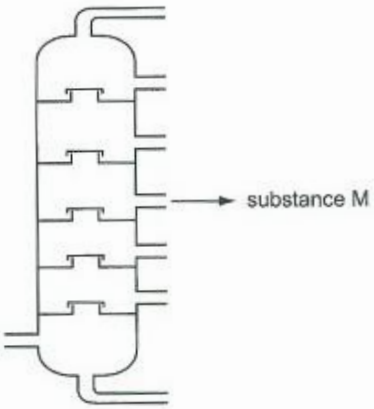
7. The diagram shows an industrial process producing substance M.
Substance M is used as aircraft fuel.



What is the process and what is the substance M? (2013/P3/Q18)

| | process | substance M |
|---|---|---|
| **A** | fractional distillation | paraffin (kerosene) |
| **B** | fractional distillation | petrol (gasoline) |
| **C** | thermal decomposition | paraffin (kerosene) |
| **D** | thermal decomposition | petrol (gasoline) |

( )

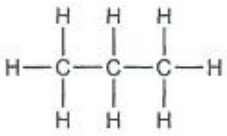
8. Which of the hydrocarbons in the table may be members of the same homologous series? (2013/P3/Q19)

| hydrocarbon | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| state at room temperature | gas | gas | liquid | liquid |
| reaction with oxygen | burns | burns | burns | burns |
| reaction with aqueous bromine | decolourises bromine | no reaction | decolourises bromine | no reaction |

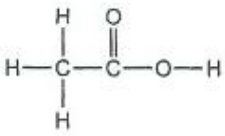
**A** 1 and 2 only **B** 1 and 3 only
**C** 3 and 4 only **D** 1, 2, 3 and 4 ( )

9. Which diagram represents an unsaturated hydrocarbon? (2013/P3/Q20)

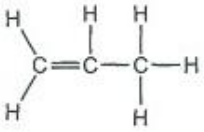
**A**



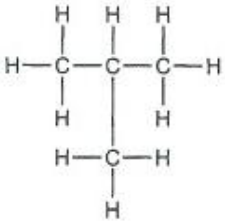
**B**



**C**



**D**



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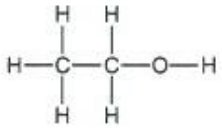
10. A student makes three statements about molecules in food.

    1 The molecules in food contain only carbon atoms.
    2 The molecules in food are hydrocarbons.
    3 The molecules in food contain carbon to carbon double bonds.

    Which of these statements describe a polyunsaturated food? (2014/P3/Q18)

    **A** 1 only **B** 3 only
    **C** 1 and 2 **D** 2 and 3 ( )

11. The structure of compound J is shown.



    Which row describes J? (2014/P3/Q19 / 2018/P3/Q19)

| | saturated | hydrocarbon |
|---|---|---|
| **A** | no | no |
| **B** | no | yes |
| **C** | yes | no |
| **D** | yes | yes |

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12. Which type of hydrocarbon reacts rapidly with bromine and what is the colour change of the bromine? (2014/P3/Q20)

| | type of hydrocarbon | colour change of bromine |
|---|---|---|
| **A** | alkane | brown to colourless |
| **B** | alkane | colourless to brown |
| **C** | alkene | brown to colourless |
| **D** | alkene | colourless to brown |

( )

13. Which fuel is a mixture of hydrocarbons? (2015/P3/Q18)

    **A** coal **B** methane
    **C** petroleum **D** wood ( )

14. Which row describes a polyunsaturated molecule? (2015/P3/Q19 / 2019/P3/Q19)

| | number of double bonds | type of double bond |
|---|---|---|
| **A** | several | carbon to carbon |
| **B** | several | carbon to hydrogen |
| **C** | one | carbon to carbon |
| **D** | one | carbon to hydrogen |

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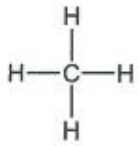
15. The diagram shows an apparatus used to test a gas.

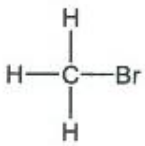

The bromine solution becomes colourless.

What is the structure of the gas? (2015/P3/Q20)

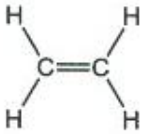
**A**



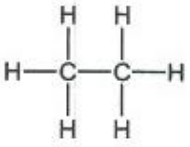
**B**



**C**



**D**



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16. What is formed when ethane burns incompletely but is **not** formed when it burns completely? (2016/P3/Q15)

**A** carbon dioxide
**B** carbon monoxide
**C** ethene
**D** hydrogen

( )

17. The table shows the composition of natural gas.

| gas | % in natural gas |
|---|---|
| R | 93.1 |
| ethane | 3.4 |
| nitrogen | 2.3 |

What is R? (2016/P3/Q17)

**A** ethene
**B** hydrogen
**C** methane
**D** propane

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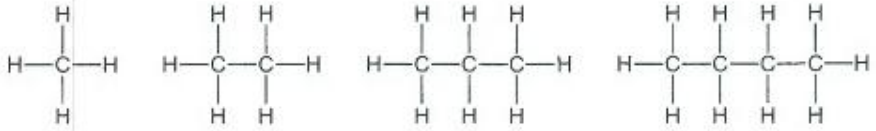
18. The diagram shows the first four members of a homologous series.



What is the difference in molecular formula between one member and the next in the series? (2016/P3/Q18)

**A** CH
**B** $CH_2$
**C** $CH_3$
**D** $CH_4$

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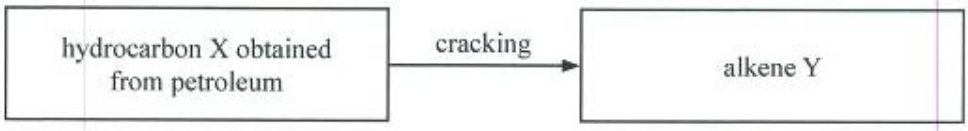
19. Alkenes are manufactured by cracking hydrocarbons obtained from petroleum.




Which row shows the process of cracking? (2016/P3/Q19)

| | size of X molecules | catalyst | temperature | size of Y molecules |
|---|---|---|---|---|
| **A** | large | no | high | small |
| **B** | large | yes | high | small |
| **C** | small | no | low | large |
| **D** | small | yes | low | large |

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20. Margarine is manufactured by passing hydrogen through unsaturated vegetable oils to form a solid product.

Which type of reaction is involved in this process? (2016/P3/Q20)

**A** addition
**B** displacement
**C** neutralisation
**D** substitution ( )

21. Which statement describes the compounds of an homologous series? (2017/P3/Q18)

**A** They have the same general formula.
**B** They have the same physical properties.
**C** They have the same relative molecular mass.
**D** They have the same structural formula. ( )

22. Methane is the first member of the alkane homologous series.

Which row describes the changes in flammability and the size of the molecules in the alkane homologous series from methane to propane? (2017/P3/Q19)

| | flammability | size of molecules |
|---|---|---|
| **A** | decreases | decreases |
| **B** | decreases | increases |
| **C** | increases | decreases |
| **D** | increases | increases |

( )

23. Which change represents the reaction used to manufacture margarine from vegetable oils? (2017/P3/Q20)

**A** $-CH_2-CH=CH-CH_2- + H_2 \rightarrow -CH_2-CH_2-CH_2-CH_2-$
**B** $-CH_2-CH=CH-CH_2- + H_2O \rightarrow -CH_2-CH_2-CH(OH)-CH_2-$
**C** $-CH_2-CH_2-CH_2-CH_2- \rightarrow -CH_2-CH=CH-CH_2 + H_2$
**D** $-CH_2-CH_2-CH(OH)-CH_2- \rightarrow -CH_2-CH=CH-CH_2- + H_2O$ ( )

24. The table shows some fractions obtained from the fractional distillation of petroleum together with some of their uses.

| fractions | uses |
|---|---|
| petroleum gas | cooking |
| gasoline | fuel for cars |
| 1 | making chemicals |
| 2 | fuel for aircraft |
| 3 | making polishes and waxes |
| bitumen | making roads |

Which row identifies fractions 1, 2 and 3? (2018/P3/Q18)

| | 1 | 2 | 3 |
|---|---|---|---|
| **A** | lubricating oil | diesel oil | paraffin |
| **B** | naphtha | paraffin | diesel oil |
| **C** | naphtha | paraffin | lubricating oil |
| **D** | paraffin | naphtha | lubricating oil |

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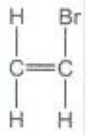
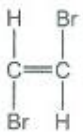
25. Which substance is formed when bromine reacts with ethene? (2018/P3/Q20)

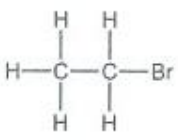
**A**



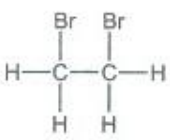
**B**



**C**



**D**



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26. Which is the main source of energy in natural gas? (2019/P3/Q18)

**A** carbon monoxide
**B** ethene
**C** hydrogen
**D** methane

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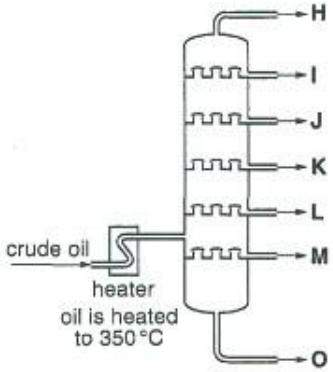
## PAPER 4

### STRUCTURED QUESTIONS

**Section A**

***Answer the following questions.***

1. The diagram shows the fractional distillation of crude oil. The fractions obtained are labelled **H**, **I**, **J**, **K**, **L**, **M** and **O**.




(a) (i) Which of the letters **H** to **O** represents the fraction with the lowest boiling point? [1]

(ii) Suggest **one** compound likely to be present in this fraction. [1]

(b) Decane, $C_{10}H_{22}$, is cracked to produce smaller molecules.
One equation, in which propene is formed by cracking decane, is shown below.

$$\underset{\text{decane}}{C_{10}H_{22}} \rightarrow \mathbf{X} + \underset{\text{propene}}{C_3H_6}$$

(i) What is the molecular formula of compound **X**? [1]

(ii) Draw the structural formula for a molecule of propene. [1]

(2014/P4/Q4)

2. (a) Name the process by which liquids such as petrol and diesel are obtained from crude oil. [1]

(b) Pentane, $C_5H_{12}$, is one of the chemicals obtained from crude oil.

Pentane may be used in the manufacture of other chemicals.

The equation below represents one possible reaction that can occur.

$$C_5H_{12} \xrightarrow[\text{catalyst}]{\text{heat}} C_3H_6 + \mathbf{Y} + H_2$$

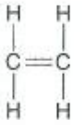
pentane — compound **X** — compound **Y** — hydrogen

(i) Name the process represented. [1]
(ii) Name compound **X**. [1]
(iii) Draw the structural formula of compound **Y**. [1]
(2015/P4/Q3a, bi, ii, iii)

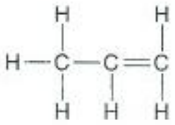
3. The structural formulae of four hydrocarbon compounds **P**, **Q**, **R** and **S** are shown below.

**P**

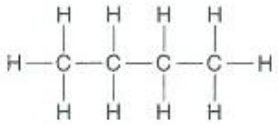
**Q**



**R**



**S**



State which of the compounds **P**, **Q**, **R** and **S**
- are saturated,
- decolourise aqueous bromine,
- take part in addition reactions. [3]

(2016/P4/Q2)

4. The hydrocarbon $C_{15}H_{32}$ is heated strongly in the presence of a catalyst.
The equation for one of the reactions occurring is shown.

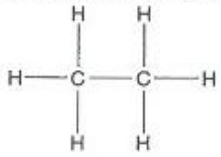
$$C_{15}H_{32} \rightarrow C_8H_{18} + 2C_2H_4 + C_3H_6$$

(a) Name the process represented by this reaction. [1]
(b) Give the names of the products $C_2H_4$ and $C_3H_6$. [1]
(c) Draw the full structural formula for a molecule of $C_3H_6$. Show all atoms and bonds. [2]
(2018/P4/Q2)

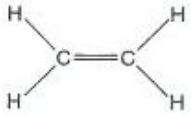
**Section B**

***Answer the following questions.***

1. (a) The structural formulae of ethane and ethene are shown below.



ethane



ethene

(i) Ethane is a saturated hydrocarbon and ethene is an unsaturated hydrocarbon.

Explain what is meant by the terms *saturated* and *unsaturated* when applied to hydrocarbons. [2]

(ii) Name a chemical reagent that can be used to show the difference between a saturated and an unsaturated hydrocarbon.

Describe what you would observe when this reagent is added to separated samples of ethane and ethene. [3]

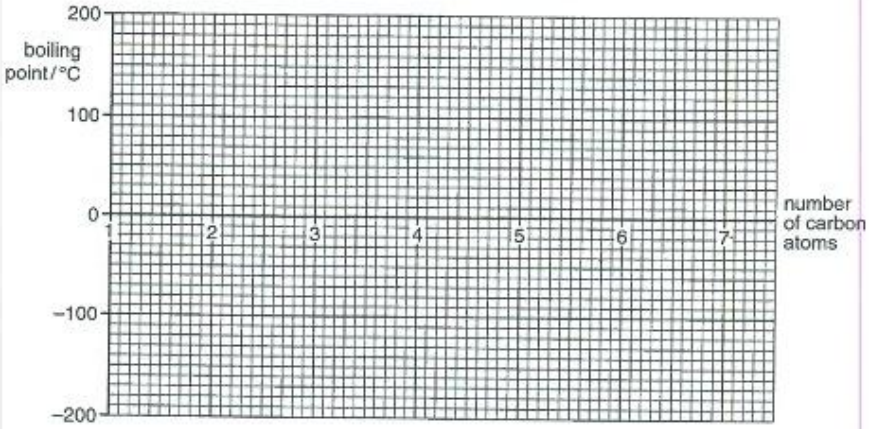
(b) Ethane belongs to a homologous series called the alkanes.

The table shows some of the properties of five members of the alkane series.

| name | formula | number of carbon atoms in one molecule | boiling point / °C |
|---|---|---|---|
| ethane | $C_2H_6$ | 2 | –90 |
| propane | $C_3H_8$ | 3 | –40 |
| butane | $C_4H_{10}$ | 4 | 0 |
| pentane | $C_5H_{12}$ | 5 | 35 |
| hexane | $C_6H_{14}$ | 6 | 70 |

(i) Plot a graph of boiling point against number of carbon atoms for the five alkanes shown, marking each point with a cross (×).

Draw a curved line of best fit.




(ii) Use the graph to predict the boiling point of heptane, which has seven carbon atoms. [3]

(2011/P4/Q4)

2. (a) Crude oil is separated into fractions by the process of fractional distillation.

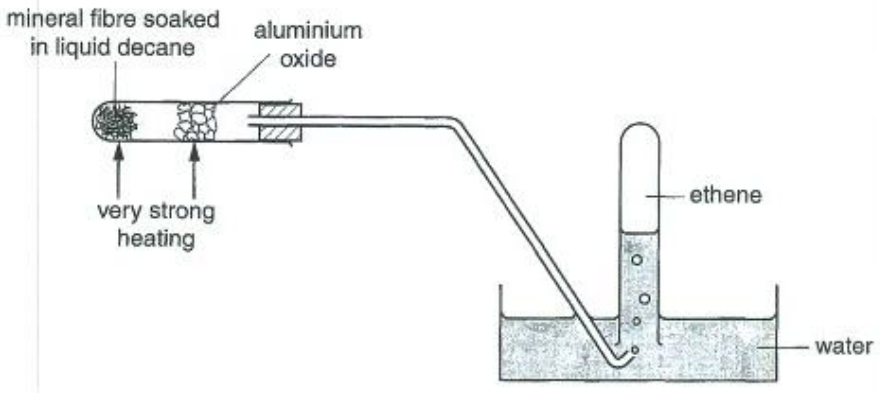
(i) What is the physical property on which fractional distillation depends? [1]

(ii) Name two of the fractions produced by distilling crude oil. [1]

(b) Large hydrocarbon molecules from suitable fractions can be broken down into smaller molecules.

This process can be demonstrated using the apparatus shown below.

The mineral wool is soaked in liquid decane, $C_{10}H_{22}$.



(i) Name the process being demonstrated. [1]
(ii) What is the purpose of the aluminium oxide? [1]
(iii) The equation for one of the reactions occurring is given below.

$$C_{10}H_{22} \longrightarrow \mathbf{X} + C_2H_4$$

What is the molecular formula of **X**? [1]
(iv) In the space below, draw the structural formula of ethene. [1]

(c) A carton of margarine shows the following nutritional information.

| | g per 100g |
|---|---|
| total fat content | 38.0 |
| saturated fat | 11.0 |
| monounsaturated fat | 18.0 |
| polyunsaturated fat | 9.0 |

(i) Explain the meaning of *polyunsaturated*. [1]
(ii) Margarine is made by heating vegetable oils to around 200°C. Hydrogen is bubbled through the oils in the presence of a nickel catalyst. After separation and cooling of the product, solid margarine is formed.

What type of reaction is this? [1]
(2012/P4/Q6)

3. (a) The alkanes are an homologous series of saturated hydrocarbons.
(i) State the general formula of the alkanes. [1]
(ii) Give the formula of the alkane containing 10 carbon atoms. [1]

(b) (i) Name the type of reaction that occurs when an alkane reacts with chlorine. [1]
(ii) Write a balanced chemical equation for the reaction between methane, $CH_4$, and chlorine, $Cl_2$. [1]

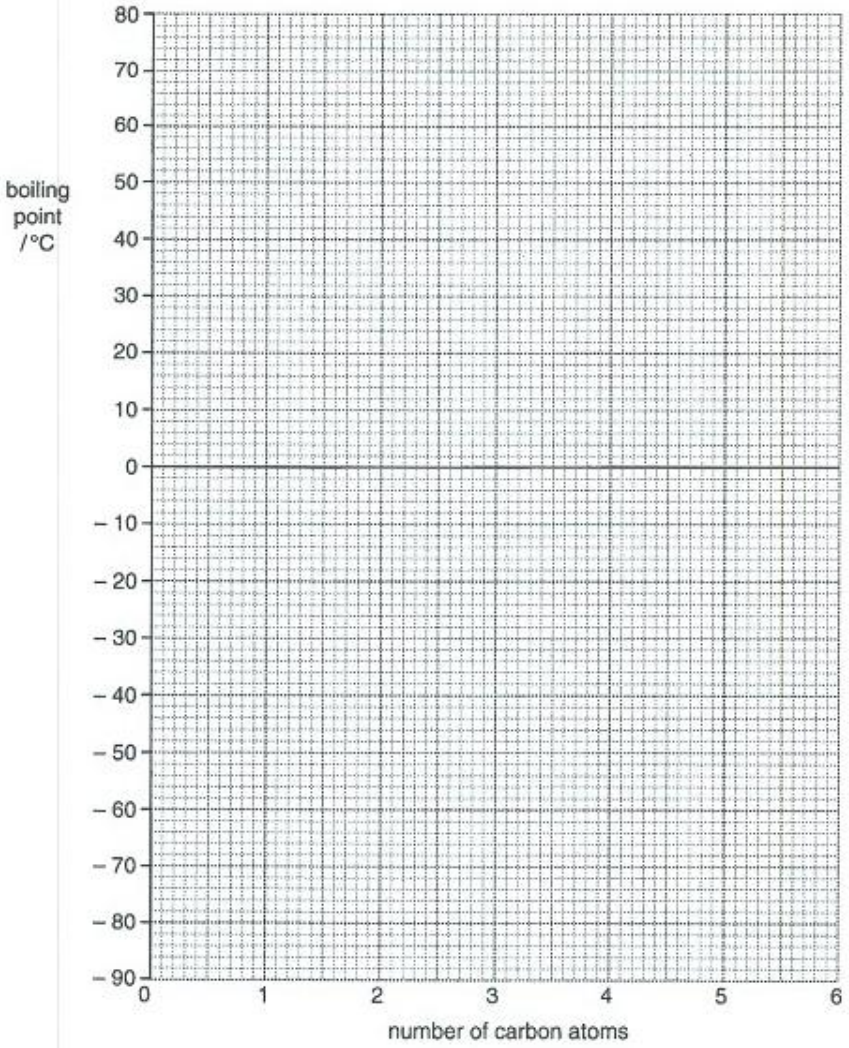
(c) The table below shows the boiling points of some alkanes.

| alkane | number of carbon atoms | boiling point / °C |
|---|---|---|
| ethane | 2 | –88.0 |
| propane | 3 | –42.0 |
| butane | 4 | |
| pentane | 5 | 36.0 |
| hexane | 6 | 69.0 |

(i) Plot a graph of boiling point against the number of carbon atoms.

Mark each point with a cross (×). Draw a curved line of best fit through your plotted points. [2]

(ii) Use the graph to obtain a value for the boiling point of butane. [1]




(d) Large alkane molecules are less useful because of their high boiling points.

Name the chemical process by which large alkane molecules are broken into smaller molecules. [1]

(2013/P4/Q5)

4. (a) The hydrocarbons butene, $C_4H_8$, and pentene, $C_5H_{10}$, are members of the same homologous series.

(i) Explain what is meant by the term *hydrocarbon*. [1]

(ii) State two general properties of an homologous series. [2]

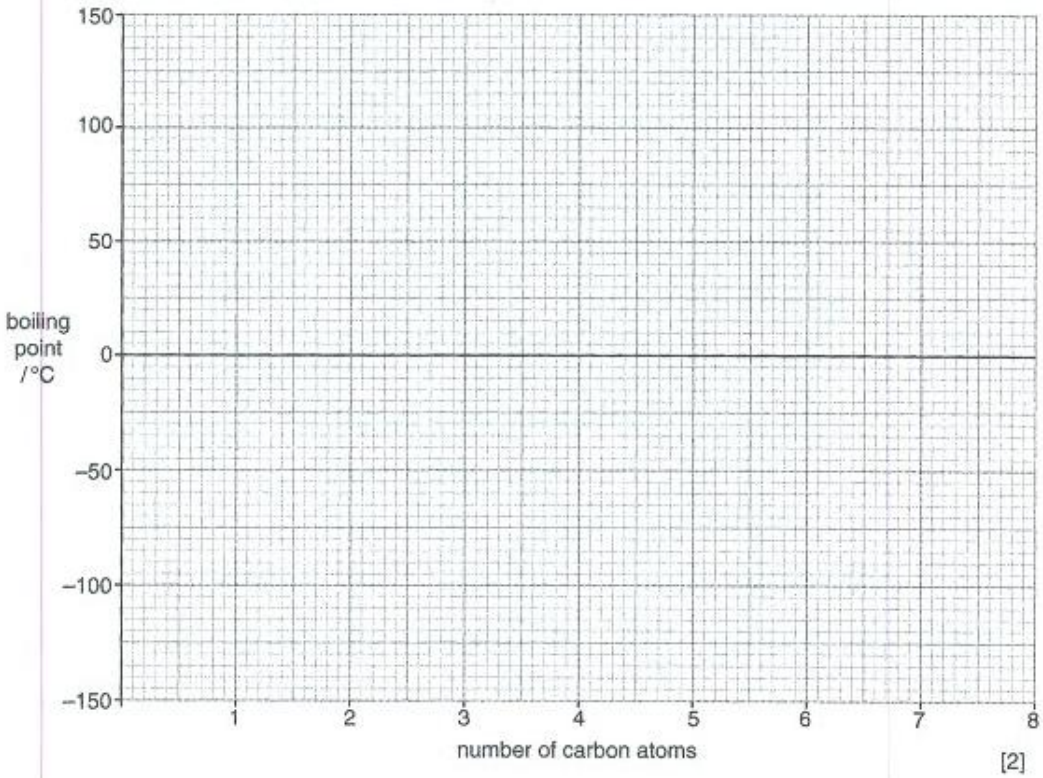
(b) The table shows the boiling points of some members of the homologous series of alkenes.

| formula of alkene | number of carbon atoms | boiling point / °C |
|---|---|---|
| $C_2H_4$ | 2 | –100 |
| $C_3H_6$ | 3 | –50 |
| $C_4H_8$ | 4 | –5 |
| $C_5H_{10}$ | 5 | |
| $C_6H_{12}$ | 6 | 65 |
| $C_7H_{14}$ | 7 | 95 |
| $C_8H_{16}$ | 8 | 120 |

(i) State the general formula for the alkenes. [1]

(ii) Plot a graph of boiling point against the number of carbon atoms, marking each point with a cross (×).

Draw a curved line of best fit for your plotted points.




[2]

(iii) Use your graph to predict the boiling point of the alkene with the formula $C_5H_{10}$. [1]

(iv) Explain the general trend in boiling point shown by your graph. [1]

(2015/P4/Q7)

5. Bromine, another member of Group VII, is used to test for unsaturation in hydrocarbon molecules.

(a) What is the physical state of bromine used in this test? [1]

(b) Describe an observation which would prove that the sample being tested is an unsaturated hydrocarbon. [1]

(c) Name the type of reaction that occurs between bromine and the unsaturated hydrocarbon. [1]

(2017/P4/Q5c)

6. (a) Crude oil is a mixture of different hydrocarbon molecules.

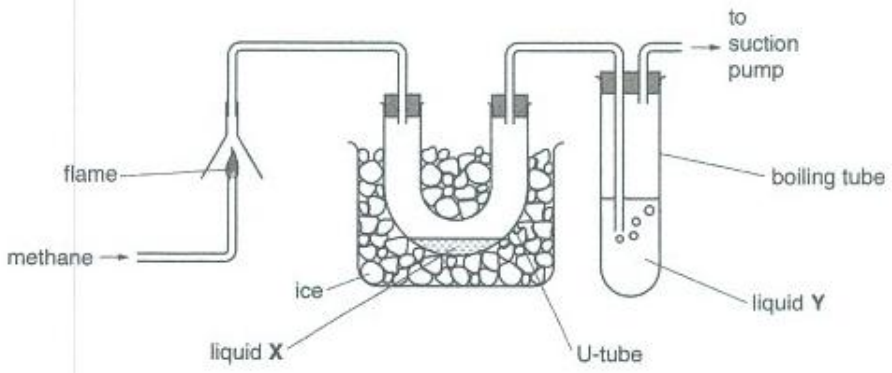
What physical property of the different hydrocarbon molecules in crude oil allows them to be separated by fractional distillation? [1]

(b) Methane, $CH_4$, is the smallest hydrocarbon.

A teacher uses the apparatus to investigate the substances formed when methane burns in air.

At the start of the experiment the U-tube is empty and the liquid **Y** is present in the boiling tube.

The teacher lights a jet of methane and then turns on a suction pump to draw the combustion gases through the apparatus.




(i) Name liquid **X**. [1]

(ii) Liquid **Y** is present in the tube to provide a test for carbon dioxide.
Name liquid **Y** and describe how it would change during the investigation. [1]

(iii) Write a balanced chemical equation for the complete combustion of methane in air. [1]

(c) Cracking is a chemical process used to break down large hydrocarbon molecules into smaller molecules.

State two conditions required for cracking to occur. [1]

(d) The hydrocarbon *dodecane* is present in fuel oils and has the molecular formula, $C_{12}H_{26}$.

(i) Complete the equation below for the cracking of *dodecane* in which propene is produced together with **one** other product.

$$C_{12}H_{26} \rightarrow \text{.....} + \text{.....}$$ [1]

(ii) Draw the full structural formula of propene showing all the atoms and bonds present. [2]

(2017/P4/Q6)

7. The table shows some of the properties of the first seven members of the alkane homologous series.

| name | formula | boiling point / °C | physical state at 20°C |
|---|---|---|---|
| methane | $CH_4$ | –164 | gas |
| ethane | $C_2H_6$ | –89 | gas |
| propane | $C_3H_8$ | –42 | gas |
| butane | $C_4H_{10}$ | 0 | gas |
| pentane | $C_5H_{12}$ | 36 | |
| hexane | $C_6H_{14}$ | 69 | liquid |
| heptane | $C_7H_{16}$ | 98 | liquid |

(a) Write, in the last column, the physical state of pentane at 20°C. [1]

(b) State the general formula for the alkanes. [1]

(c) Write a balanced chemical equation for the complete combustion of heptane. [2]

(d) Margarine is manufactured from polyunsaturated vegetable oils.

(i) State what is meant by the term *polyunsaturated*. [1]

(ii) State the reagent added to vegetable oil to convert it into margarine. [1]

(2018/P4/Q6a, b, d, e)

8. (a) Ethene and propene are both unsaturated hydrocarbons. They belong to the alkene homologous series.

(i) State the general formula of the alkene homologous series. [1]

(ii) One property of a homologous series is that its members have the same general formula.
State **two** other properties of a homologous series. [2]

(iii) Unsaturated hydrocarbons react with bromine water.
Describe what you would observe when bromine water is added to an unsaturated hydrocarbon. [1]

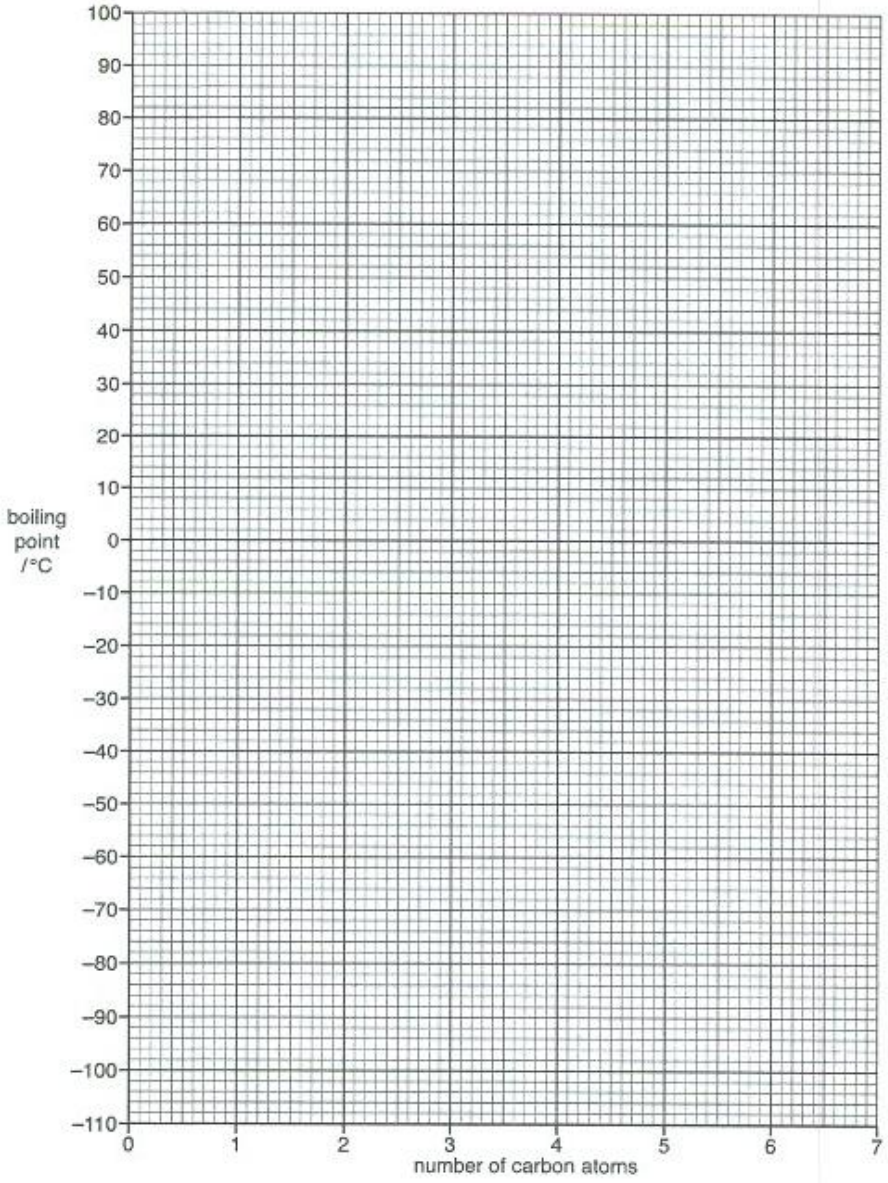
(iv) Write a chemical equation for the reaction of ethene with bromine, $Br_2$. [1]

(b) The table shows some information about the first six members of the alkene family.

| name | number of carbon atoms | boiling point / °C |
|---|---|---|
| ethene | 2 | –104 |
| propene | 3 | –48 |
| butene | 4 | –6 |
| pentene | 5 | |
| hexene | 6 | 63 |
| heptene | 7 | 94 |

(i) Plot a graph of the number of carbon atoms in each alkene against its boiling point. Mark each point with a cross (×). [1]

(ii) Draw a curved line of best fit taking into account all your plotted points. [1]




(iii) From your graph determine the boiling point of pentene. [1]

(2019/P4/Q6)