Name:

Date:

C7 - Test 3

ORGANIC CHEMISTRY

Intermediate

GCSE

CHEMISTRY

AQA - Combined Science

Mark

Grade

Materials

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

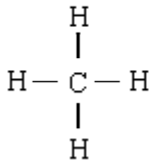
- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

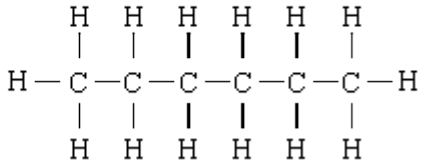
- The marks for the questions are shown in brackets

1. The structural formulae of two saturated hydrocarbons are shown below.

compound A



compound B



Describe **two** ways in which they will differ in their physical properties.

1. _____

_____

2. _____

_____

(Total 2 marks)

2. Petrol burns in oxygen from the air in a car engine.

Two of the gases in the exhaust fumes are carbon dioxide and water vapour.

This indicates that petrol contains the elements _____ and

_____ .

(Total 2 marks)

3. (a) Some hydrocarbons are used as fuels in power stations.

The table gives the boiling points of four hydrocarbons.

Hydrocarbon	Boiling point in °C
W	165
X	–160
Y	–40
Z	180

(i) Which of these hydrocarbons are gases at room temperature (20 °C)?

_____

(1)

(ii) Which of these hydrocarbons has the largest molecules?

_____

(1)

(iii) Which of these hydrocarbons ignites most easily?

_____

(1)

(b) Some hydrocarbons are used to produce polymers.

Which type of hydrocarbons can be converted into polymers?

_____

(1)

(Total 4 marks)

4. Crude oil is a mixture of many different chemical compounds.

(a) Fuels, such as petrol (gasoline), can be produced from crude oil.

(i) Fuels react with oxygen to release energy.

Name the type of reaction that releases energy from a fuel.

_____

(1)

(ii) Fuels react with oxygen to produce carbon dioxide.
The reaction of a fuel with oxygen can produce a different oxide of carbon.

Name this different oxide of carbon and explain why it is produced.

_____

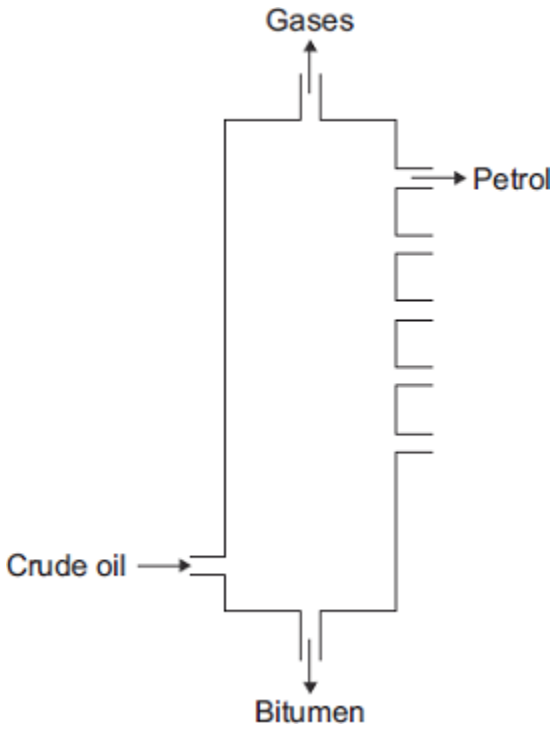
_____

_____

_____

(2)

(b) Most of the compounds in crude oil are hydrocarbons.
Hydrocarbons with the smallest molecules are very volatile.



In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

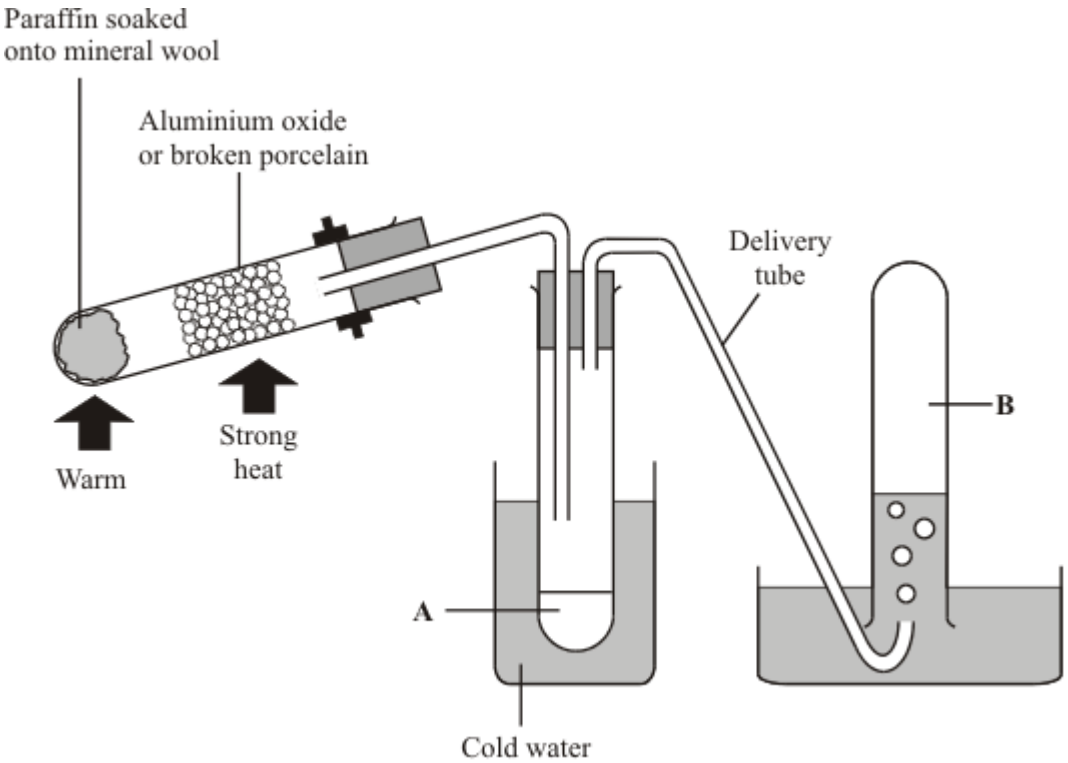
Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

Use the diagram and your knowledge to answer this question.

(6)

(Total 9 marks)

5. The diagram shows an apparatus that can be used to carry out cracking reactions in a laboratory.



(a) Why is aluminium oxide or broken porcelain used?

_____

_____

(1)

(b) Paraffin contains decane. The cracking of decane can be represented by the equation below. A decane molecule is split into two smaller molecules.

Complete the equation by adding the formula of the other product.

$C_{10}H_{22}$ (l) → _____ (l) + C_2H_4 (g)
decane

(1)

(c) Would you expect C_2H_4 molecules to collect at position **A** or **B** shown on the diagram?

Position _____ .

Explain your answer.

_____

_____

(1)

(d) Cracking reactions involve *thermal decomposition*.

What is meant by thermal decomposition?

_____

_____

_____

_____

(2)

(e) Explain, as fully as you can, why cracking is used in the oil industry.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

(3)

(f) The cracking reaction produces a mixture of products. The mixture contains hydrocarbons with different boiling points.

Suggest a method of separating this mixture.

(1)

(Total 9 marks)

6. Crude oil is a mixture of many *saturated hydrocarbons*. They can be separated into *fractions* by the process of fractional distillation.

State what is meant by:

(i) *hydrocarbon*.

(2)

(ii) *saturated*.

(1)

(iii) *fraction*.

(1)

(Total 4 marks)

7. This question is about hydrocarbons.

(a) Most of the hydrocarbons in crude oil are alkanes.

(i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

$$\underset{\text{dodecane}}{C_{12}H_{26}} \longrightarrow \underset{\text{butane}}{C_4H_{10}} + \underset{\text{hexene}}{C_6H_{12}} + \underset{\text{ethene}}{C_2H_4}$$

Give **two** conditions used to crack large alkane molecules.

1. _____

2. _____

(2)

(ii) The products hexene and ethene are alkenes.

Complete the sentence.

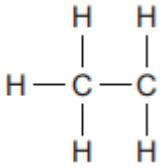
When alkenes react with bromine water the colour changes

from orange to _____ .

(1)

(iii) Butane (C_4H_{10}) is an alkane.

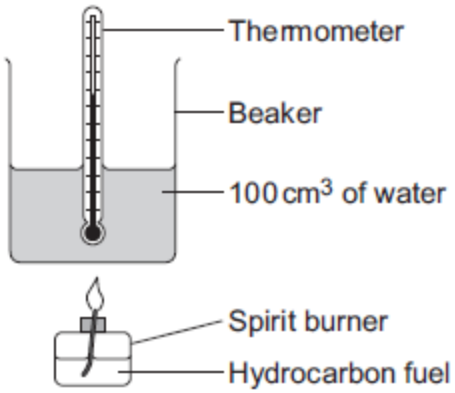
Complete the displayed structure of butane.



(1)

(b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

The diagram below shows the apparatus used.



Each hydrocarbon fuel was burned for two minutes.

Table 1 shows the students' results.

Table 1

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky
Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

(i) Calculate the energy released by 1.0 g of decane in kJ.

_____

_____

Energy released = _____ kJ

(2)

(ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

_____

_____

_____

(2)

(iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

_____

_____

_____

_____

(2)

(iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 2** support this conclusion.

1. _____

_____

2. _____

_____

(2)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 2 shows information about petrol and hydrogen.

Table 2

	Petrol	**Hydrogen**
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen ⟶ carbon dioxide + water	hydrogen + oxygen ⟶ water
Energy released from combustion of 1 g of the fuel	47 kJ	142 kJ

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

(6)

(Total 18 marks)

8. Crude oil is a complex mixture of hydrocarbons, mainly alkanes. The number of carbon atoms in the molecules ranges from 1 to over 100.

(a) How does the boiling point change as the number of carbon atoms in the molecules increases?

_____

_____

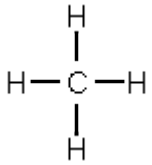
(1)

(b) Name the method used to separate petroleum into fractions.

_____

(1)

(c) The simplest hydrocarbon is methane, CH_4. Its structure can be represented:



Draw the structure of ethane, C_2H_6.

(1)

(Total 3 marks)

9. (a) Crude oil is a mixture of many compounds. Most of the compounds consist of molecules made only of carbon and hydrogen. Choose **one** word from the list below to complete the sentence.

carbohydrates **carbonates** **hydrocarbons** **hydrogencarbonates**

Compounds made only of carbon and hydrogen are called _____

(1)

(b) The fractions contain molecules with similar numbers of carbon atoms. The main fractions are shown in the table below.

NAME OF FRACTION	NUMBER OF CARBON ATOMS IN MOLECULES
petroleum gases	1 to 4
gasoline	4 to 12
naphtha	7 to 14
kerosene	11 to 15
diesel oil	14 to 19
lubricating oil	18 to 30
residue	more than 30

Naphtha burns more easily than diesel oil.
Explain why.

_____

_____

_____

(1)

(Total 2 marks)

10. Crude oil is separated into fractions by fractional distillation.

The table gives information about some of the fractions.

Fraction	Boiling point range in °C	Number of carbon atoms per molecule
Gas	Below 20	1 – 4
Petrol	20 – 100	5 – 10
Paraffin	100 – 250	11 – 15
Diesel	250 – 350	16 – 20
Lubricant	350 – 500	21 – 35
Bitumen	Above 500	Above 35

(a) What is the relationship between the boiling point of a fraction and the number of carbon atoms in its molecules?

_____

_____

(1)

(b) Give **one** further difference, other than boiling point, between diesel and paraffin that also depends on the number of carbon atoms in their molecules.

_____

_____

(1)

(c) All the fractions contain hydrocarbons.

Name the **two** elements in a hydrocarbon.

_____ and _____

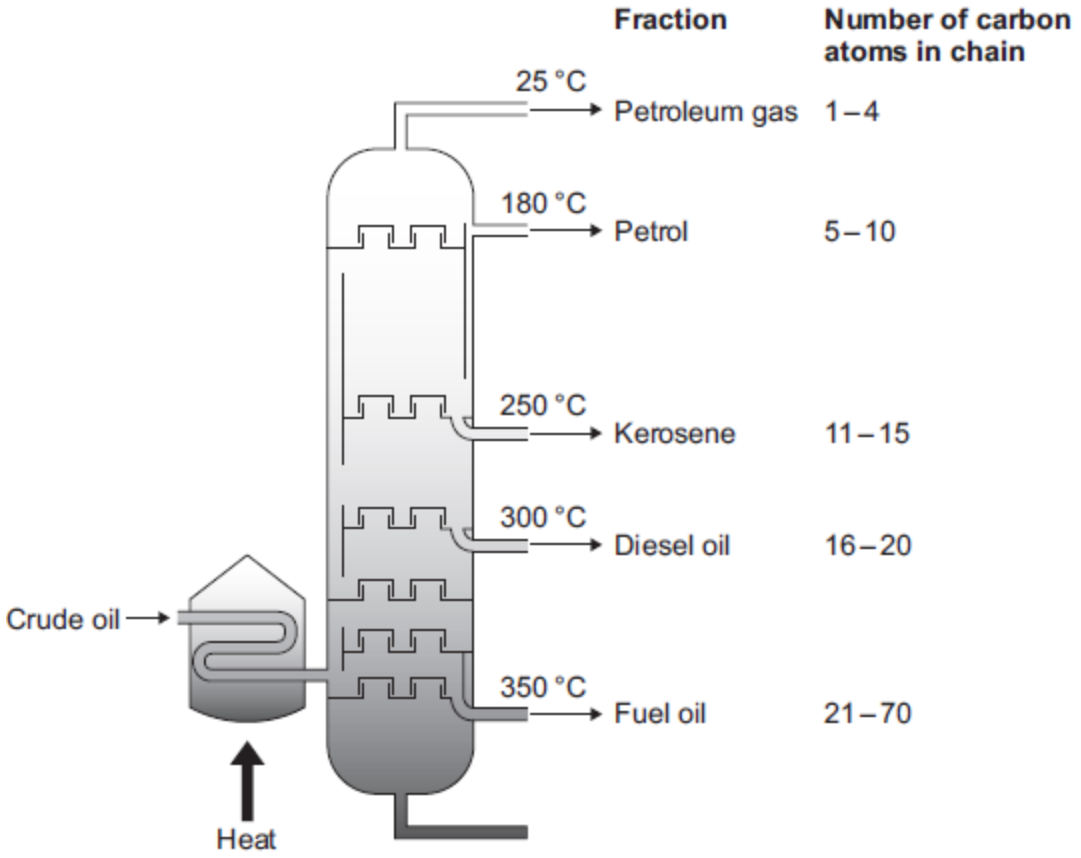
(1)

(Total 3 marks)

11. Many fuels are produced from crude oil.

(a) Crude oil is separated into fractions by distillation in a fractionating column.

A fractionating column is shown below.



(i) Describe how crude oil is separated into fractions by fractional distillation.

(3)

(ii) Some properties of hydrocarbons change as the size of the molecules increases.

Describe the trends in boiling point and viscosity as the number of carbon atoms in the molecule increases.

Boiling point _____

_____

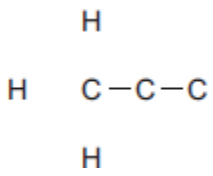
Viscosity _____

_____

(2)

(b) LPG (liquefied petroleum gas) is a fuel. LPG contains propane (C_3H_8).

(i) Complete the displayed (structural) formula for propane.



(1)

(ii) Burning fuels releases energy. Name **two** products formed when LPG is burnt.

_____

_____

(2)

(iii) Some cars are now designed to use LPG as a fuel. LPG is about 50p per litre cheaper than petrol.

Suggest **one** reason why most car owners use cars designed to use petrol and not LPG as a fuel.

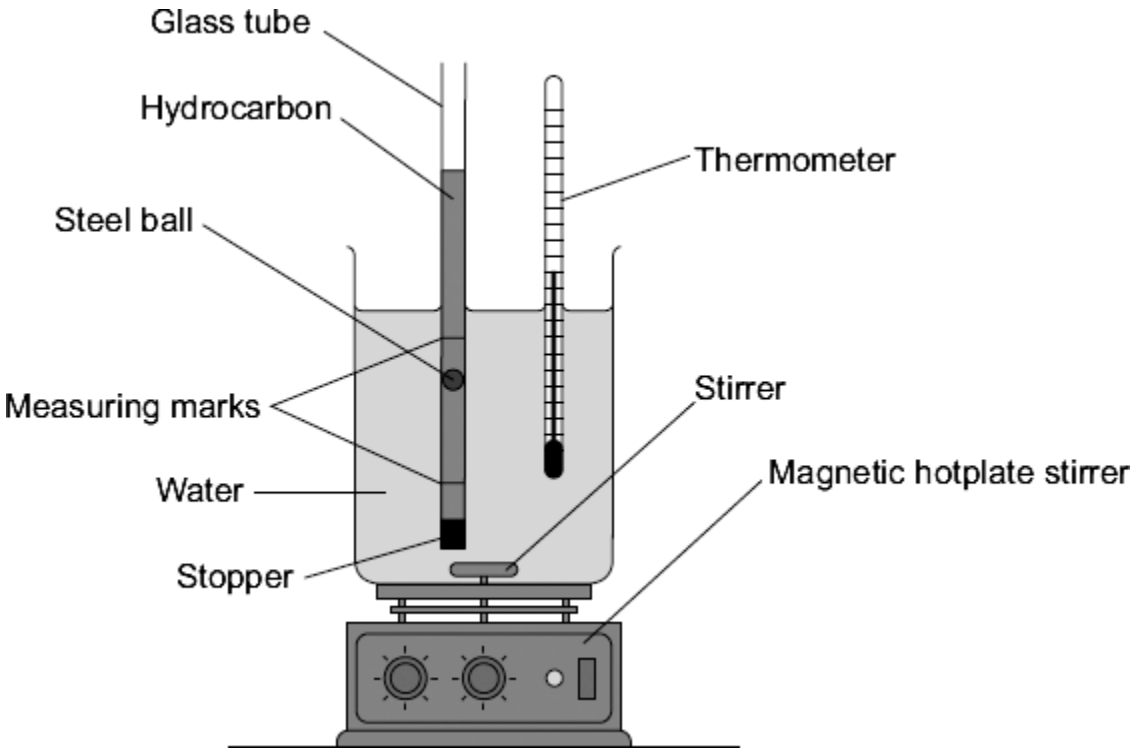
_____

_____

(1)

(Total 9 marks)

12. The diagram shows apparatus used to measure the effect of temperature on the viscosity of two liquid hydrocarbons **A** and **B**.



The time taken for the steel ball to fall between the two measuring marks is recorded for each hydrocarbon at different temperatures.

(a) Using the stirrer improved the accuracy of the results.

Explain how.

_____

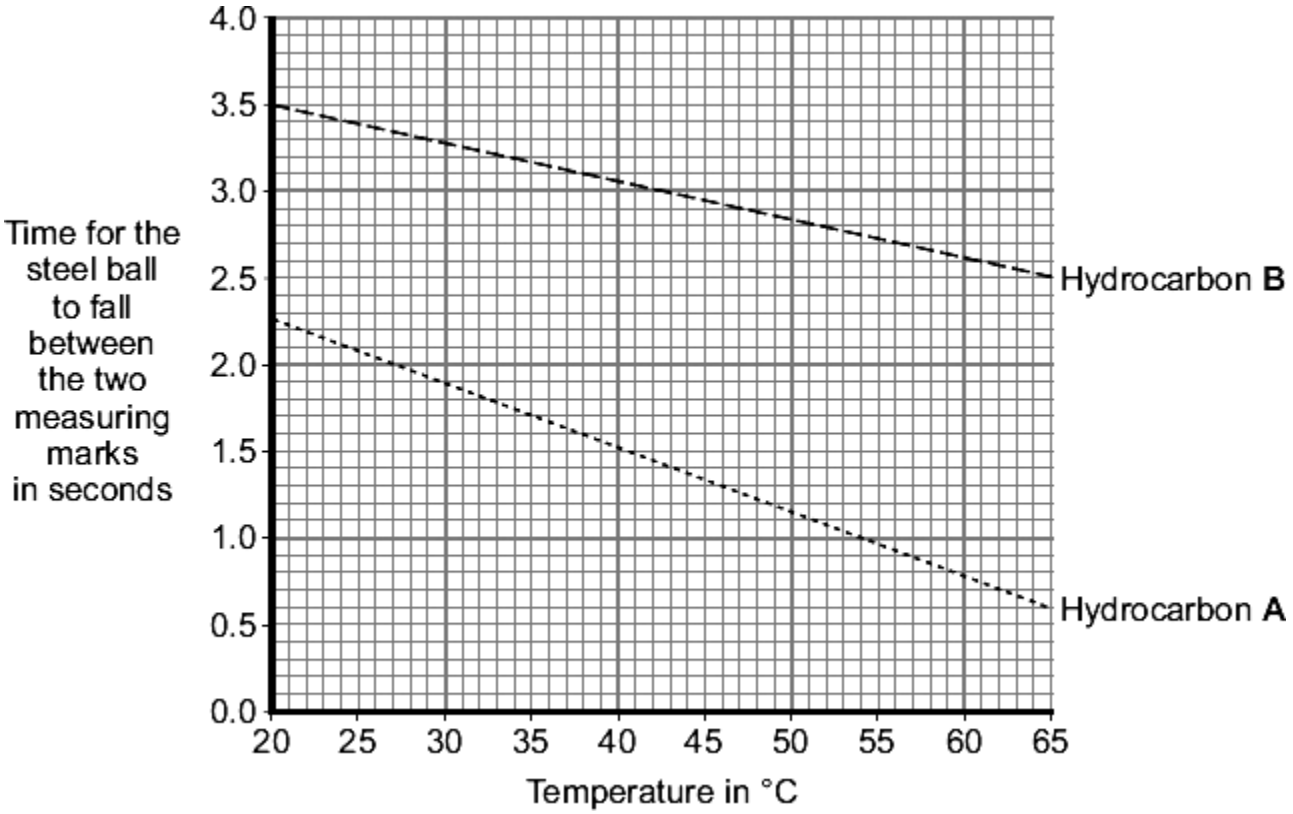
_____

_____

_____

(2)

(b) The graph shows the results of the investigation.



(i) What conclusions can be drawn from the data?

_____

_____

_____

_____

(2)

(ii) Give **one** reason for the difference in the viscosities of hydrocarbon **A** and hydrocarbon **B**.

_____

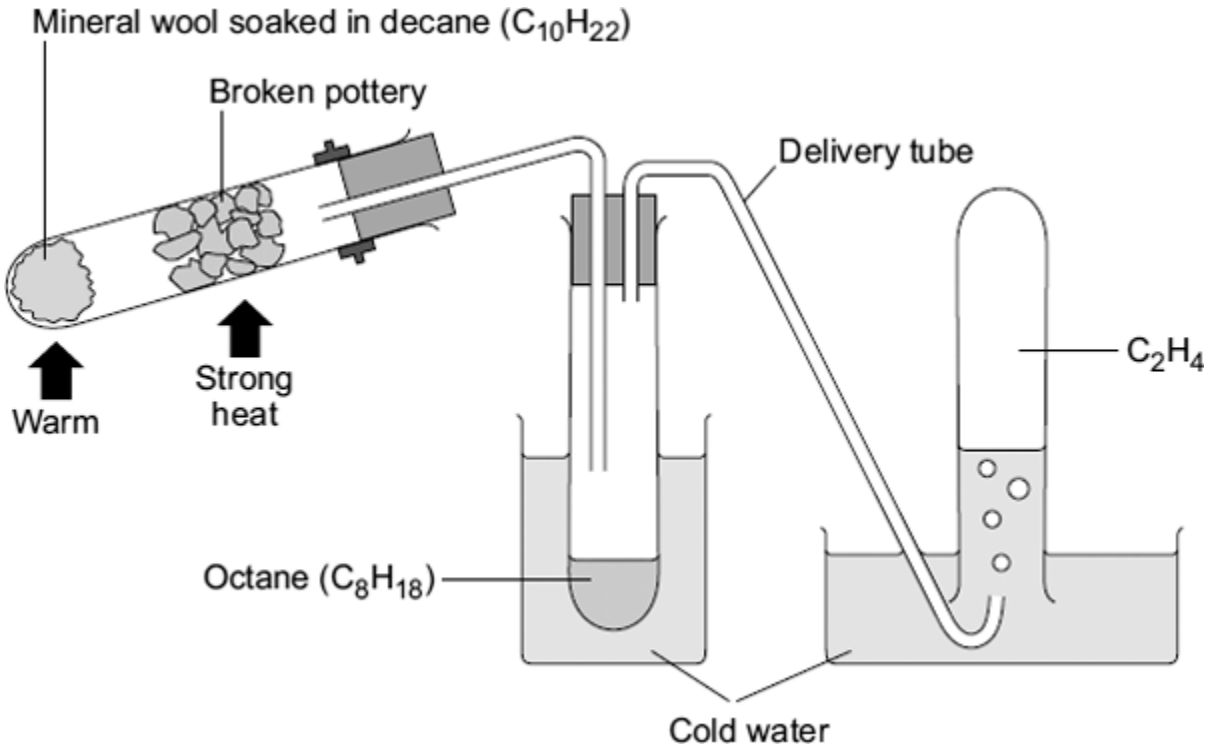
_____

(1)

(Total 5 marks)

13. Hydrocarbons are cracked to produce smaller molecules.

The diagram shows an experiment to demonstrate cracking.



Describe the process of cracking shown in the diagram.

(Total 4 marks)