GCSE Chemistry

Fractional Distillation

Question Paper

Time available: 75 minutes
Marks available: 71 marks

1. This question is about hydrocarbons in crude oil.

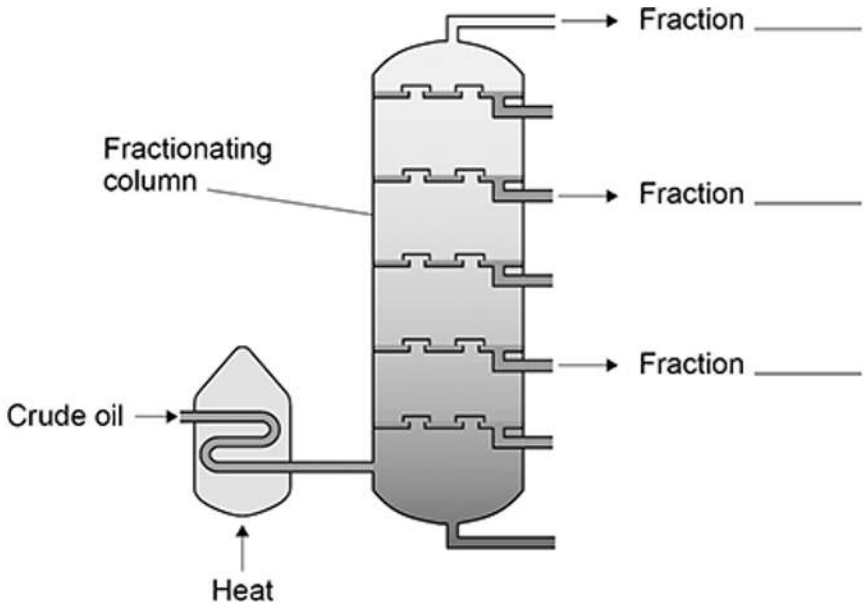
(a) **Table 1** shows information about three fractions obtained from crude oil.

Table 1

Fraction	Boiling point range in °C
A	200–300
B	100–150
C	Below 30

Figure 1 shows the fractionating column used to separate fractions **A**, **B** and **C**.

Figure 1



The temperature of the fractionating column is:

- 30 °C at the top
- 400 °C at the bottom.

Complete **Figure 1** to show where fractions **A**, **B** and **C** are collected.

(1)

(b) **Table 2** shows information about three fractions obtained from crude oil.

Table 2

Fraction	Range of number of carbon atoms in each molecule
Petrol	5–12
Diesel oil	15–19
Heavy fuel oil	20–40

Complete the sentences.

Choose answers from the box.

lower	the same	higher

Compared to petrol, the viscosity of heavy fuel oil is _____.

Compared to petrol, the flammability of diesel oil is _____.

(2)

Table 3 shows the percentage of two fractions obtained from two different sources of crude oil.

Table 3

Source	Percentage (%) of fraction	
	Kerosene	Heavy fuel oil
J	13	30
K	4	44

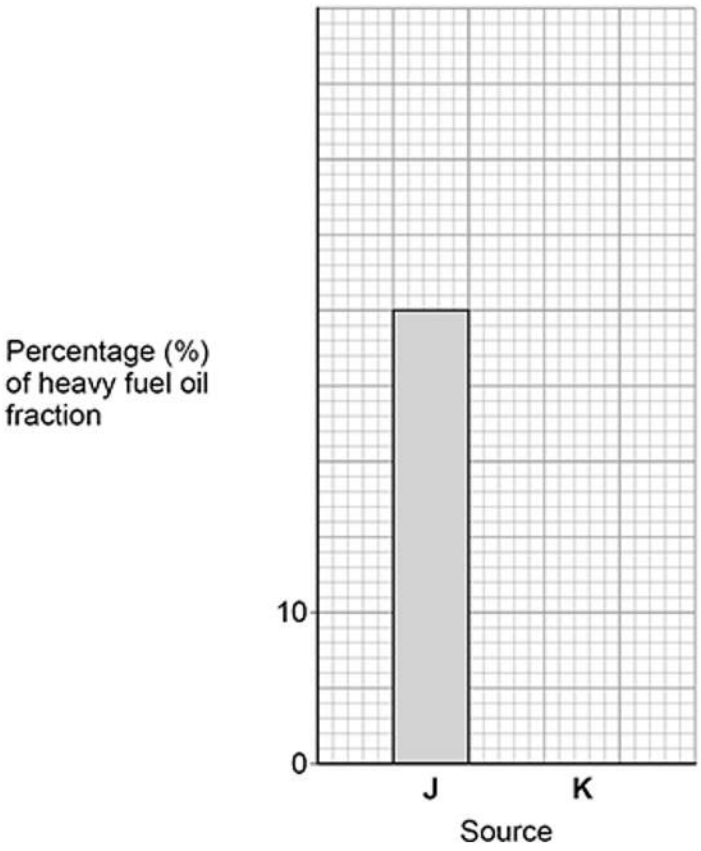
(c) Complete **Figure 2**.

You should:

- complete the *y*-axis scale
- plot the percentage of the heavy fuel oil fraction obtained from source **K**.

Use **Table 3**.

Figure 2



(2)

(d) Kerosene is in higher demand than heavy fuel oil.

Suggest why crude oil from source **J** is in higher demand than crude oil from source **K**.

Use **Table 3**.

_____

_____

(1)

Large hydrocarbon molecules can be cracked to produce smaller hydrocarbon molecules including alkanes.

(e) Which **two** of the following can be used to crack large hydrocarbon molecules?

Tick (✓) **two** boxes.

A catalyst ☐

A fertiliser ☐

Air ☐

Ozone ☐

Steam ☐

(2)

(f) Alkanes have the general formula C_nH_{2n+2}

Complete the formula of the alkane molecule containing 11 carbon atoms.

$C_{11}H$____

(1)

(g) C_2H_6 is an alkane.

Which type of bond is found in a C_2H_6 molecule?

Tick (✓) **one** box.

A double bond between two carbon atoms. ☐

A double bond between two hydrogen atoms. ☐

A single bond between two carbon atoms. ☐

A single bond between two hydrogen atoms. ☐

(1)

(h) Which **two** substances are produced when alkanes completely combust?

Tick (✓) **two** boxes.

Carbon	☐
Carbon dioxide	☐
Carbon monoxide	☐
Hydrogen	☐
Water	☐

(2)

(Total 12 marks)

2. This question is about the fractions obtained from crude oil.

(a) Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 1 shows the boiling point range of these fractions.

Table 1

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

Tick (✓) **two** boxes.

Alloys	☐
Ceramics	☐
Detergents	☐
Fertilisers	☐
Solvents	☐

(2)

Another fraction obtained from crude oil is petrol.

(c) Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

$$C_9H_{20} + \_\_\_\_\_ \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

(2)

(d) Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

_____

_____

_____

_____

(2)

(e) **Table 2** shows information about two more fractions obtained from crude oil.

Table 2

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

_____

_____

_____

_____

(2)

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

(f) Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

Name of process _____

Conditions _____

_____

_____

(3)

(g) Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16} ☐

C_7H_{14} and C_8H_{18} ☐

C_7H_{16} and C_8H_{16} ☐

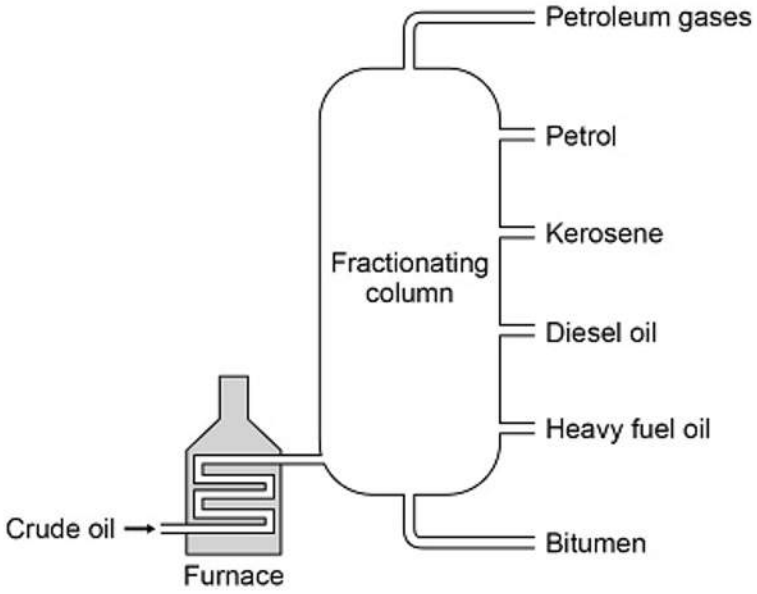
C_7H_{16} and C_8H_{18} ☐

(1)

(Total 16 marks)

3. This question is about crude oil and hydrocarbons.

The figure below shows a fractionating column used to separate crude oil into fractions.



The following table gives information about some of the fractions.

Fraction	**Boiling point range in °C**
Petroleum gases	Below 30
Petrol	40-110
Kerosene	180-260
Diesel oil	260-320
Heavy fuel oil	320-400
Bitumen	400-450

(a) Suggest a suitable temperature for the furnace in the figure.

_____ °C

(1)

(b) Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use the table above.

_____

_____

_____

_____

(2)

(c) Suggest **two** reasons why bitumen is **not** used as a fuel.

1 _____

_____

2 _____

_____

(2)

(d) Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

Tick (✓) **one** box.

C_2H_4 ☐

C_4H_8 ☐

C_6H_{14} ☐

C_8H_{16} ☐

(1)

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

(e) Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

_____

_____

_____

_____

(2)

(f) Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

_____

_____

_____

_____

(2)

(g) Complete the equation for the cracking of $C_{15}H_{32}$

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + \_\_\_\_\_$$

(1)

(Total 11 marks)

4. This question is about alkenes and crude oil.

(a) Pentene is an alkene molecule containing five carbon atoms.

Complete the formula for pentene.

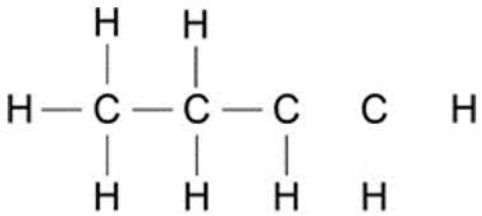
C _____ H _____

(1)

(b) Butene is an alkene molecule containing four carbon atoms.

The diagram shows all of the atoms and some of the bonds in the displayed formula for butene.

Complete the displayed formula by adding the remaining bonds.



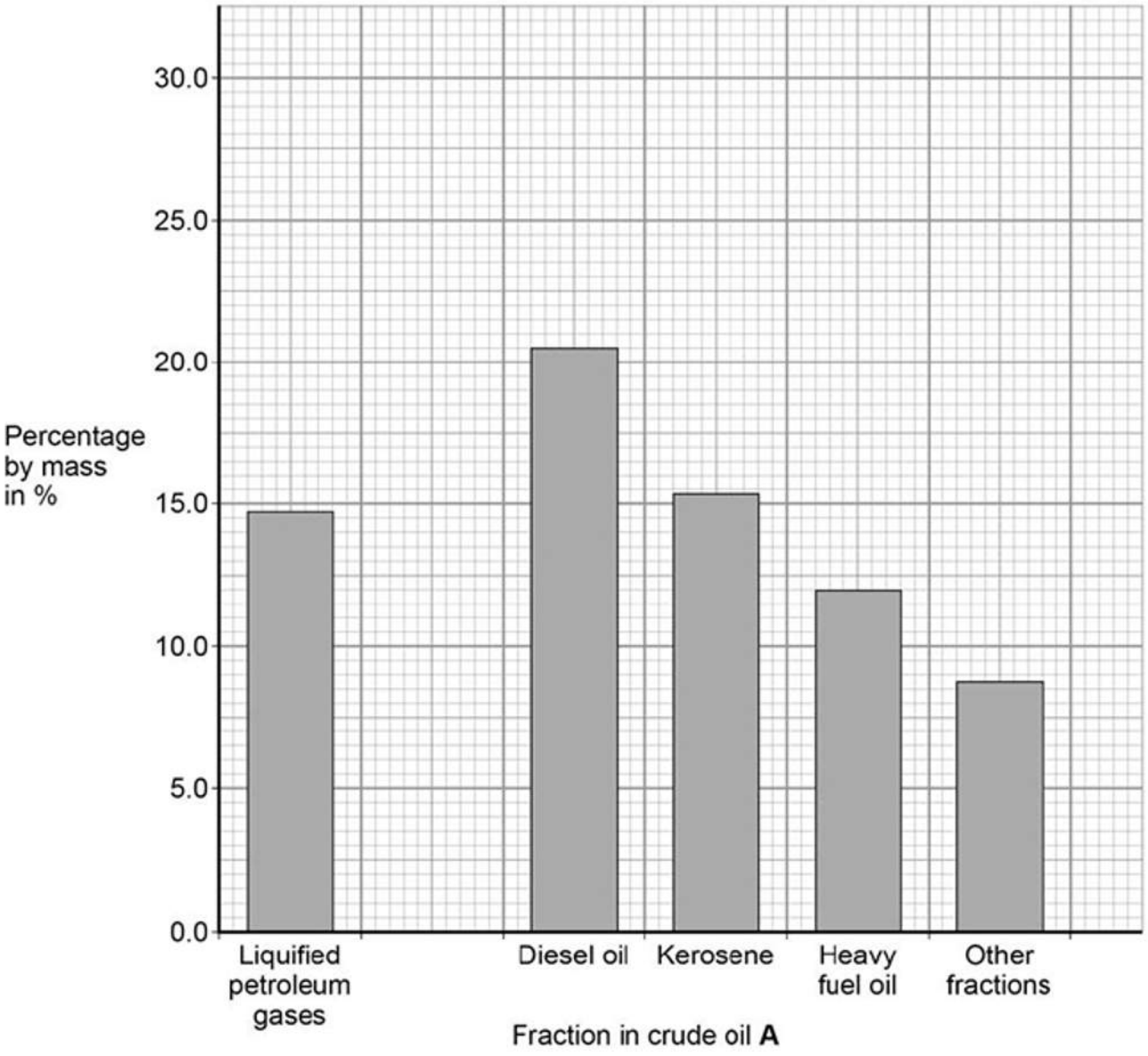
(1)

Pentene and butene are produced from crude oil.

The table shows the percentages of different fractions in two samples of crude oil.

Fraction	**Percentages by mass in %**	
	Crude oil A	**Crude oil B**
Liquefied petroleum gases	14.7	7.1
Petrol	28.6	11.1
Diesel oil	20.5	17.2
Kerosene	15.4	38.5
Heavy fuel oil	12.0	16.0
Other fractions	8.8	10.1

The graph shows the percentages of different fractions in crude oil **A**.



(c) Plot the data for petrol in the table above on the graph.

(1)

(d) What mass of crude oil **A** is needed to obtain 12 tonnes of heavy fuel oil?

Use the table above.

10 tonnes ☐

100 tonnes ☐

1000 tonnes ☐

10 000 tonnes ☐

(1)

(e) Calculate the total mass of car fuel that can be produced from 2000 kg of crude oil **B**.

Use the table above.

_____

_____

_____

_____

Mass of car fuel = _____ kg

(3)

(f) Crude oil **B** is a better source of hydrocarbons for cracking than crude oil **A**.

Suggest why.

Use the table above.

_____

_____

(1)

(g) Alkenes are obtained from crude oil using fractional distillation followed by cracking.

Explain how alkenes are produced using fractional distillation followed by cracking.

(6)

(Total 14 marks)

5. Alkanes are hydrocarbons found in crude oil.

(a) (i) Complete the sentence.

Hydrocarbons contain the elements _____ and _____ only.

(1)

(ii) Ethane is an alkane with the formula C_2H_6

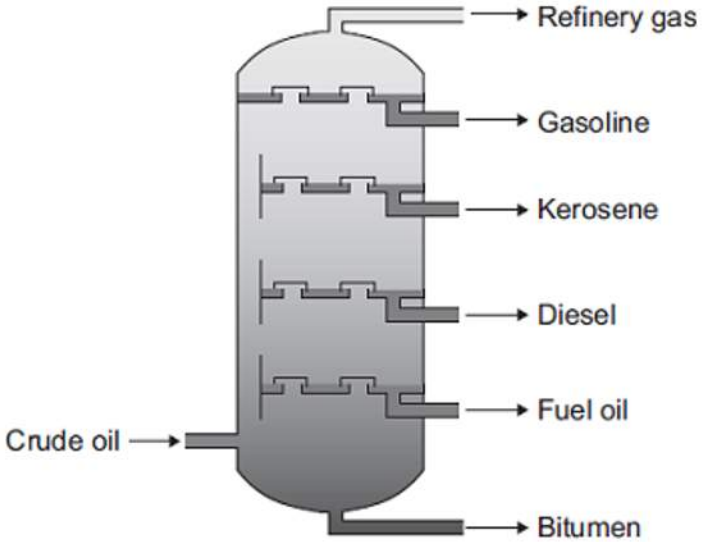
Draw a ring around the correct answer to complete the sentence.

Alkanes are hydrocarbons with the general formula

C_nH_n
C_nH_{2n}
C_nH_{2n+2}

(1)

(b) Crude oil is separated into useful fractions by fractional distillation.



Describe and explain how crude oil is separated into fractions by fractional distillation.

Use the diagram to help you answer the question.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Dodecane ($C_{12}H_{26}$) from crude oil is cracked to produce ethene (C_2H_4).

(i) Complete the equation for this reaction.

$C_{12}H_{26} \longrightarrow 2\ C_2H_4 +$ _____

(1)

(ii) Give **two** conditions needed for cracking.

1. _____

2. _____

(2)

(Total 9 marks)

6. 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.

_____

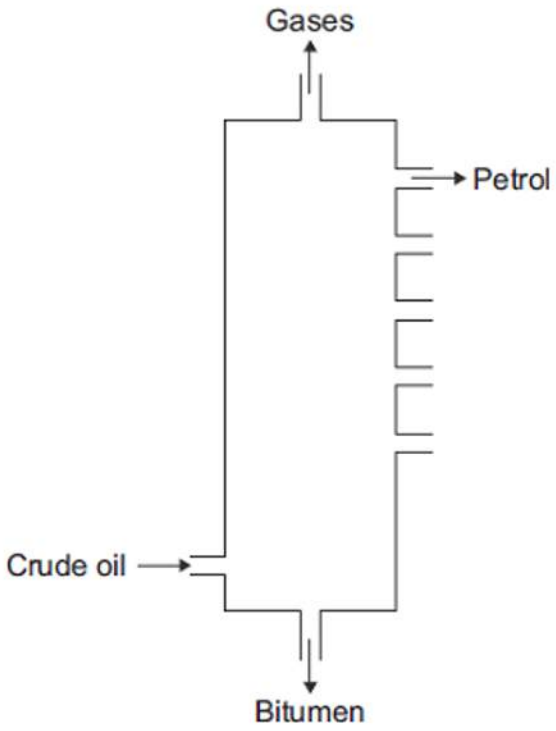
_____

_____

_____

(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)