



1.

This question is about fuels.

Octane ( $C_8H_{18}$ ) is a hydrocarbon in petrol.

(a) Cracking breaks down large hydrocarbon molecules into smaller hydrocarbon molecules.

Which hydrocarbon molecule can be cracked to produce octane,  $C_8H_{18}$ ?

Tick **one** box.

$C_4H_8$

$C_4H_{10}$

$C_8H_{16}$

$C_{12}H_{26}$

(1)

(b) What type of carbon compound is octane,  $C_8H_{18}$ ?

Tick **one** box.

Alcohol

Alkane

Carboxylic acid

Ester

(1)

(c) Oxygen is needed to burn fuels.

Name the source of the oxygen needed to burn fuels.

---

---

(1)



(d) Particulates and sulfur dioxide are pollutants produced when some fuels burn.

Draw **one** line from each pollutant to the polluting effect.

Pollutant	Polluting effect
	Acid rain
Particulates	Global dimming
	Global warming
Sulfur dioxide	Landfill
	Sewage sludge

(2)

(e) Which **two** gases are produced when fuels burn in car engines?

Tick **two** boxes.

- Ammonia
- Carbon dioxide
- Carbon monoxide
- Nitrogen
- Oxygen



(f) Vehicles produce most of the atmospheric pollution in cities.

How could the atmospheric pollution in cities be reduced?

Tick **two** boxes.

Build more roads in cities

Build new car factories

Develop fuel efficient engines

Make car tax cheaper

Use electric cars

**(2)**  
**(Total 9 marks)**



2. This question is about hydrocarbons.

The table gives information about four hydrocarbons.

The hydrocarbons are four successive members of a homologous series.

Hydrocarbon	Formula	Boiling point in °C
A	$C_4H_{10}$	0
B		36
C	$C_6H_{14}$	69
D	$C_7H_{16}$	98

(a) What is the formula of hydrocarbon B?

Tick (✓) **one** box.

$C_4H_{12}$

$C_5H_{12}$

$C_5H_{12}$

$C_6H_{12}$

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon A?

Ratio = 2 : \_\_\_\_\_

(1)

(c) Which hydrocarbon is a gas at room temperature (25 °C)?

Tick (✓) **one** box.

A

B

C

D

(1)



(d) Which hydrocarbon is most flammable?

Tick (✓) **one** box.

A       B       C       D

(1)

(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air?

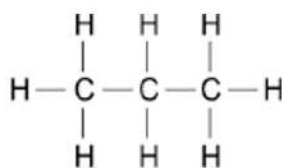
Tick (✓) **two** boxes.

Carbon	<input type="checkbox"/>
Carbon dioxide	<input type="checkbox"/>
Hydrogen	<input type="checkbox"/>
Sulfur dioxide	<input type="checkbox"/>
Water	<input type="checkbox"/>

(2)



The diagram shows the displayed structure of a hydrocarbon molecule.



(f) What is the name of the hydrocarbon in the diagram above?

Tick (✓) **one** box.

Butane

Ethane

Methane

Propane

(1)

(g) Calculate the relative formula mass ( $M_r$ ) of the hydrocarbon in the diagram above.

Relative atomic masses ( $A_r$ ): H = 1 C = 12

---

---

Relative formula mass ( $M_r$ ) = \_\_\_\_\_

(2)

(Total 9 marks)

3.

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 \_\_\_\_\_

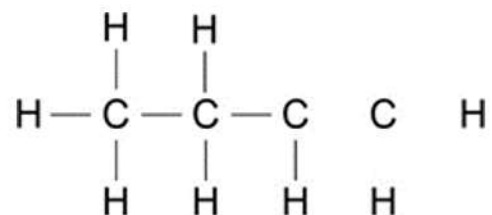
(1)



(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.



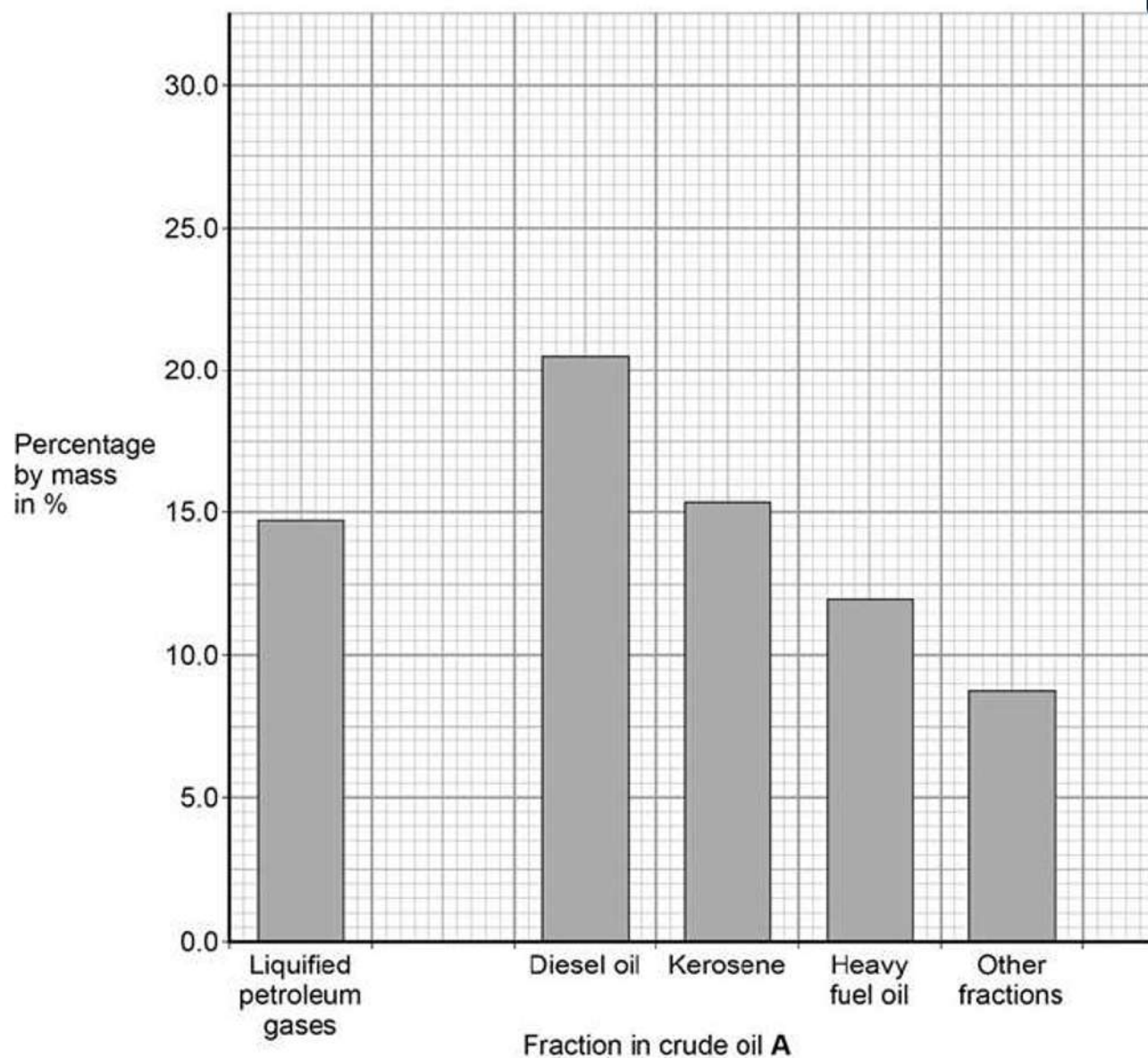
(1)

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

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)



4.

This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane	$C_2H_6$
Propane	$C_3H_8$
Butane	$C_4H_{10}$

The next member in the series is pentane.

What is the formula of pentane?

---

(1)

(b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols	<input type="checkbox"/>
Alkanes	<input type="checkbox"/>
Alkenes	<input type="checkbox"/>
Carboxylic acids	<input type="checkbox"/>

(1)

(c) Propane ( $C_3H_8$ ) is used as a fuel.

Complete the equation for the complete combustion of propane.



(2)

(d) Octane ( $C_8H_{18}$ ) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

---

---

(2)



(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	Relative amounts of pollutants		
	Oxides of Nitrogen	Particulate matter	Carbon dioxide
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

---

---

---

---

---

---

---

(3)



(f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant	Environmental impact caused by the pollutant
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

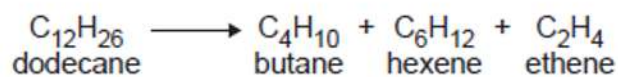
(2)  
(Total 11 marks)

**5.** 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.



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

1. \_\_\_\_\_
2. \_\_\_\_\_

(2)



- (ii) The products hexene and ethene are alkenes.

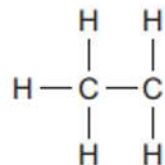
Complete the sentence.

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.

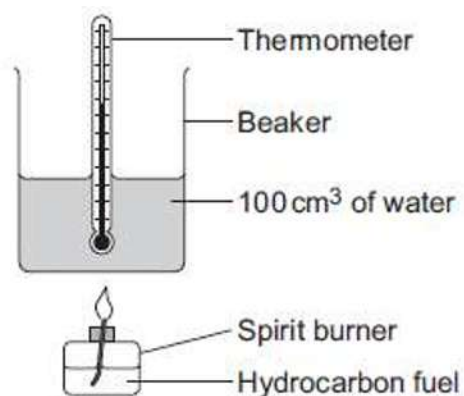


(1)



- (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**

Name and formula of hydrocarbon fuel	After two minutes			Energy released by 1.0 g of fuel in kJ	Relative amount of smoke in the flame
	Mass of fuel used in g	Temperature increase of water in °C	Energy released by fuel in kJ		
Hexane, C <sub>6</sub> H <sub>14</sub>	0.81	40	16.80	20.74	very little smoke
Octane, C <sub>8</sub> H <sub>18</sub>	1.10	54	22.68	20.62	some smoke
Decane, C <sub>10</sub> H <sub>22</sub>	1.20	58	24.36		smoky
Dodecane, C <sub>12</sub> H <sub>26</sub>	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.

	<b>Petrol</b>	<b>Hydrogen</b>
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen $\rightarrow$ carbon dioxide + water	hydrogen + oxygen $\rightarrow$ 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)