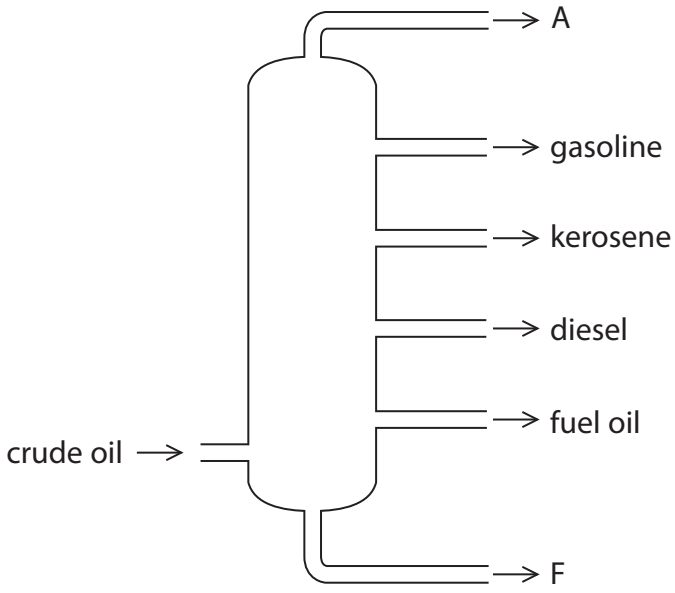
1 The diagram shows a typical fractionating column used to separate crude oil into fractions.



(a) The diagram shows the names of some of the fractions.

State the name of fraction A and the name of fraction F.

(2)

fraction A .....

fraction F .....

(b) Most compounds in crude oil are hydrocarbons.

State the meaning of the term **hydrocarbons**.

(2)

.....

.....

(c) Describe how the boiling point, colour and viscosity of the fuel oil fraction differ from those of the gasoline fraction.

(3)

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(d) Some fuel oil undergoes catalytic cracking. This involves the conversion of long-chain alkanes into alkenes and short-chain alkanes.

(i) A temperature of about 650 °C is used in this process.

Identify a catalyst that is used.

(1)

.....

(ii) The alkane tridecane can be cracked to produce octane and two different alkenes.

Complete the equation to show the formulae of the two alkenes.

(2)

$C_{13}H_{28} \rightarrow C_8H_{18}$ + ... + ...

(e) When hydrocarbons undergo incomplete combustion, a poisonous gas can form.

(i) State the condition that causes incomplete combustion.

(1)

.....

(ii) Identify the poisonous gas.

(1)

.....

(iii) Explain why this gas is poisonous.

(1)

.....

.....

.....

(f) Another problem with using hydrocarbon fuels is the formation of substances that cause an environmental problem. This sequence of equations shows how one of these substances forms.

$S + O_2 \rightarrow SO_2$

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

(i) State the name of the product of each of these reactions.

(2)

SO_2 .....

SO_3 .....

H_2SO_4 .....

(ii) Describe one environmental problem caused by the H_2SO_4 formed.

(2)

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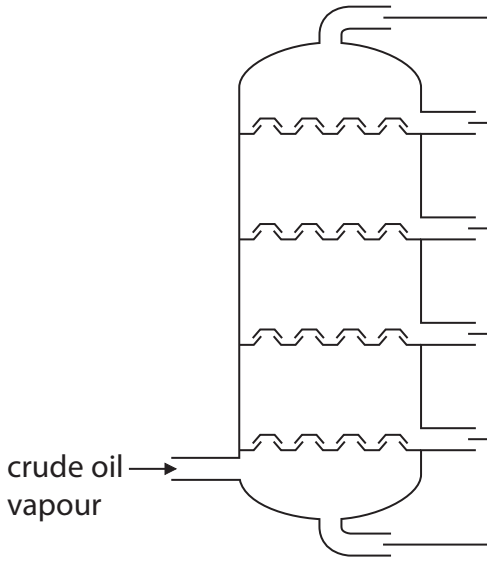
(Total for Question 1 = 17 marks)

2 The diagram shows the separation of crude oil into fractions.



Fraction	Typical number of carbon atoms per molecule
A	1 – 4
B	5 – 10
C	11 – 16
D	17 – 20
E	21 – 30
F	more than 30

(a) What is the name of this method of separation?

(1)

.....

(b) Complete the table by giving the correct fraction, A, B, C, D, E or F, for each description.

You may use each letter once, more than once or not at all.

(3)

Fraction	Description
	contains only gases
	is the most viscous
	contains bitumen

(c) State the relationship between the number of carbon atoms per molecule and the boiling point of the fraction.

(1)

.....

.....

(Total for Question 2 = 5 marks)

3 Crude oil is a mixture of substances.

(a) Which word best describes the main substances in crude oil?

(1)

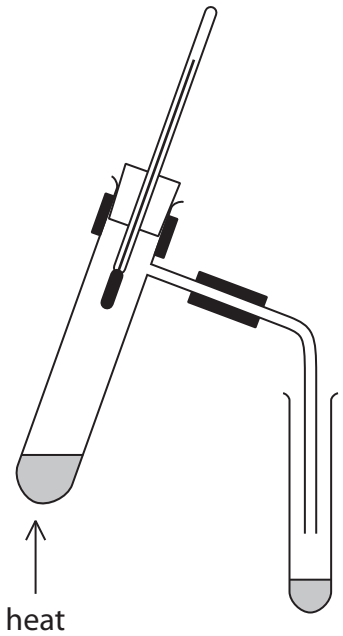
☒ **A** bases

☒ **B** carbohydrates

☒ **C** elements

☒ **D** hydrocarbons

(b) This apparatus can be used to separate the substances present in a sample of crude oil into several fractions.



These sentences describe the steps in the method for separating the substances into fractions, but the steps are in the wrong order.

R Connect a delivery tube to the boiling tube.

S Pour crude oil into a boiling tube.

T Collect each fraction in a different test tube.

U Fit a thermometer into the boiling tube.

V Heat the crude oil gently at first, then more strongly.

Put a letter in each box to show the correct order. One has been done for you.

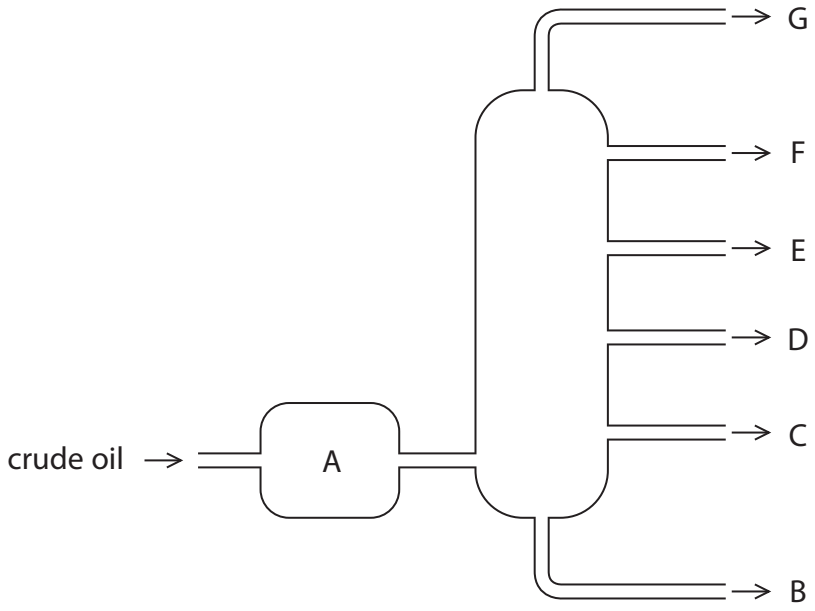
(2)

	U			

(Total for Question 3 = 3 marks)

4 Crude oil is an important source of organic compounds.

(a) The diagram shows how crude oil is separated into fractions in the oil industry.



(i) What happens to the crude oil in A?

(1)

.....

.....

.....

(ii) Most of the compounds in crude oil are hydrocarbons.

What is meant by the term **hydrocarbons**?

(2)

.....

.....

(iii) Compare the hydrocarbons in fractions D and F in terms of

- boiling point
- size of molecules
- viscosity

(3)

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(b) Some of the fractions are catalytically cracked. The general equation for some reactions in this process is

$$\text{alkane} \rightarrow \text{alkane} + \text{alkene}$$

(i) State two conditions used in catalytic cracking.

(2)

1 .....

.....

2 .....

.....

(ii) How does the bonding in an alkene molecule differ from the bonding in an alkane molecule?

(1)

.....

.....

(iii) The chemical equation for one cracking reaction is

$$C_{16}H_{34} \rightarrow C_8H_{18} + 2C_3H_6 + \text{compound Q}$$

Deduce the molecular formula of Q.

(1)

.....

(c) The compound with molecular formula C_3H_6 can be used to make a polymer.

(i) Give the name of the compound C_3H_6

(1)

.....

(ii) Complete the table of information about this compound.

(3)

Type of formula	Formula
molecular	$_3H_6$
	C_nH_{2n}
	CH_2
displayed	

(iii) Complete this structure to show the part of the polymer formed from two molecules of C_3H_6

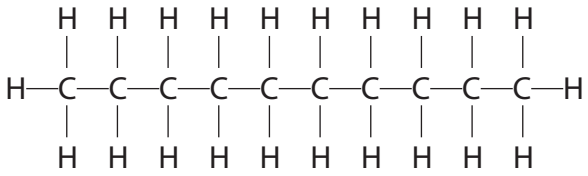
(2)

——C——C——C——C——

(Total for Question 4 = 16 marks)

5 Decane is a hydrocarbon found in crude oil.

The diagram shows the structure of a decane molecule.



(a) (i) Explain why decane is described as a hydrocarbon.

(2)

.....

.....

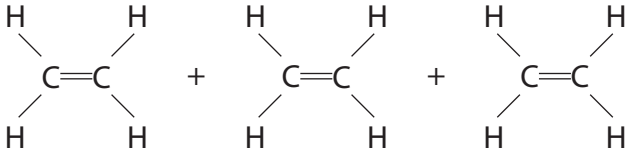
(ii) Give the molecular formula for decane.

(1)

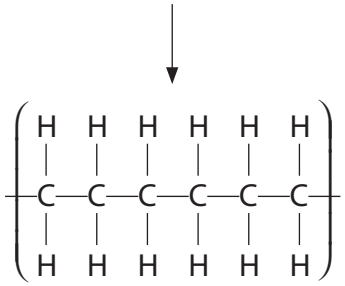
.....

(b) Decane and ethene, C_2H_4, are produced during the cracking of eicosane, $C_{20}H_{42}$

Ethene is used to make poly(ethene).



ethene



poly(ethene)

(i) What is the name given to this type of polymerisation?

(1)

.....

(ii) Use the diagram to state **two** changes that occur during the formation of poly(ethene).

(2)

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(c) Explain why cracking is an important process in the oil industry.

(4)

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(Total for Question 5 = 10 marks)

6 The alkanes are a homologous series of hydrocarbons obtained from the fractions in crude oil.

(a) Describe how crude oil is separated into fractions in industry.

(4)

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(b) (i) State the general formula of the alkanes.

(1)

.....

(ii) State two characteristics, other than having the same general formula, of members of a homologous series.

(2)

1 .....

.....

2 .....

.....

(c) Propane is an alkane used as a fuel.

Balance the equation for the complete combustion of propane.

(1)

$$C_3H_8 + \ldots\ldots O_2 \rightarrow \ldots\ldots CO_2 + \ldots\ldots H_2O$$

(d) Incomplete combustion of propane leads to the formation of a poisonous gas.

(i) Identify this gas.

(1)

.....

(ii) Explain why the gas is poisonous.

(1)

.....

.....

(iii) During the combustion of propane at high temperatures, gases represented by the formula NO_x can form.

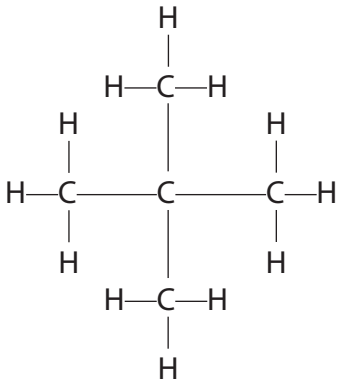
Which two elements combine to form these gases?

(1)

..... and .....

(e) The alkane C_5H_{12} has three isomers.

The displayed formula of one of these isomers is



Draw the displayed formulae of the other two isomers.

(2)

(f) Methane is used in many countries as a fuel in houses. It has no smell, so substances are mixed with it to allow any leaks to be identified.

One of these substances is compound X which has this composition by mass.

C = 53.3%, H = 11.1% and S = 35.6%

(i) Use this information to calculate the empirical formula of X.

(3)

empirical formula of X.....

(ii) The relative formula mass of X is 90

What is the molecular formula of X?

(1)

molecular formula of X.....

(Total for Question 6 = 17 marks)