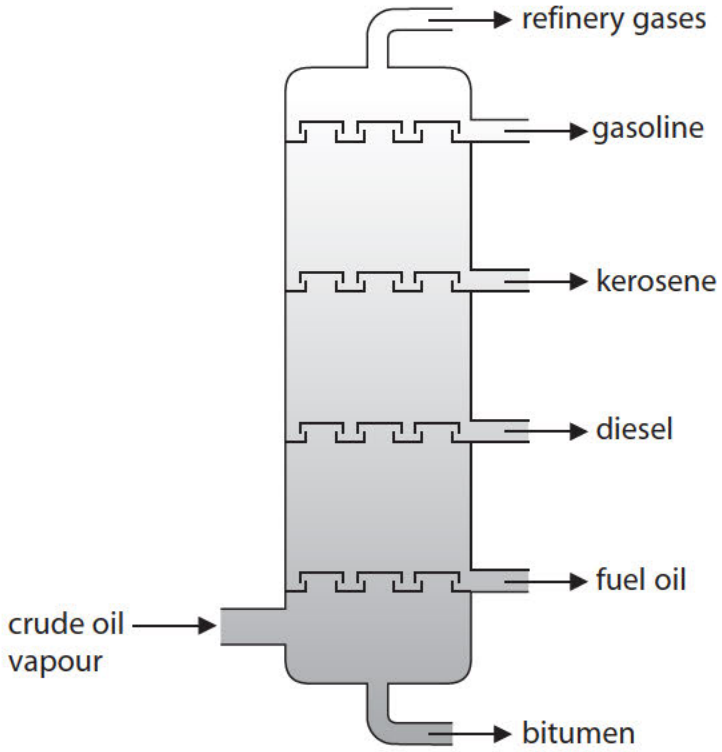
1 Crude oil is a complex mixture of organic compounds called hydrocarbons. It is separated into fractions using a fractionating tower.



(a) Which fraction has the lowest boiling point?

(1)

.....

(b) Which fraction is the most viscous?

(1)

.....

(c) (i) Some fractions containing long-chain hydrocarbons are cracked. The cracking of octadecane, ($C_{18}H_{38}$), produces octane, (C_8H_{18}), and one other product.

Write a chemical equation for this cracking reaction.

(1)

.....

(ii) Explain why it is important to crack long-chain hydrocarbon fractions.

(2)

.....

.....

.....

.....

(d) Octane is one of the hydrocarbons in the petrol used in cars.

The equation for the complete combustion of octane is

$$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$$

The incomplete combustion of octane produces a poisonous gas that reduces the capacity of blood to carry oxygen.

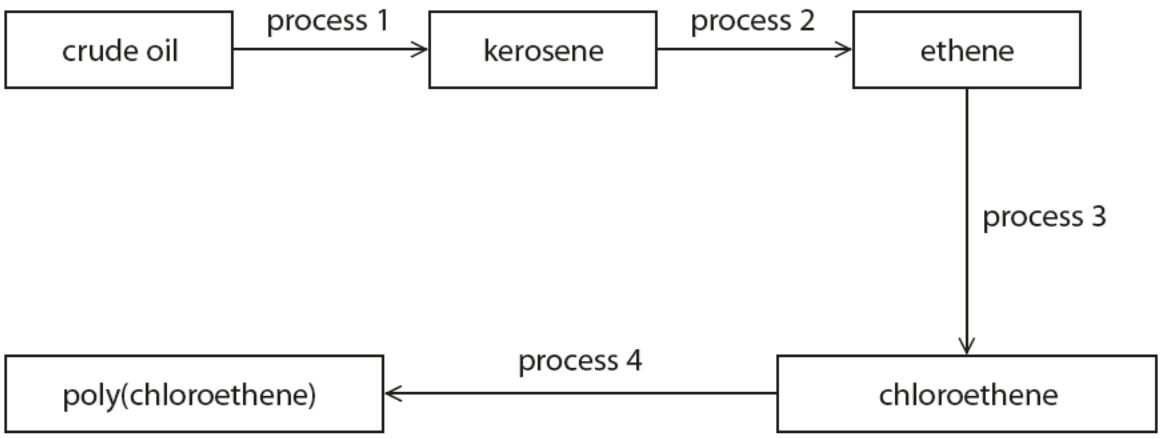
Write a chemical equation for this incomplete combustion of octane.

(2)

.....

(Total for Question 1 = 7 marks)

2 The diagram shows some important conversion processes used in the oil industry.



(a) Process 1 is called

(1)

- ☒ **A** catalytic cracking
- ☒ **B** condensation polymerisation
- ☒ **C** fractional distillation
- ☒ **D** thermal decomposition

(b) Describe the differences between crude oil and kerosene. In your answer you should refer to

- the average size of the molecules in the two liquids
- the covalent bonding in the molecules
- the viscosities of the two liquids

(3)

(c) The equation for one reaction that could occur in process 2 is

$$C_xH_y \rightarrow C_5H_{12} + 2C_2H_4$$

(i) Deduce the formula of C_xH_y

(1)

.....

(ii) Give the name of the compound C_5H_{12}

(1)

.....

(iii) Draw the displayed formula of C_2H_4

(1)

(d) The structural formula of chloroethene formed in process 3 is $CH_2{=}CHCl$

The polymer formed in process 4 is poly(chloroethene).

Draw the **displayed** formula for the repeat unit of poly(chloroethene).

(2)

(e) Poly(chloroethene) is formed by addition polymerisation.

Nylon is formed by condensation polymerisation.

(i) How does condensation polymerisation differ from addition polymerisation?

(1)

.....

.....

(ii) Poly(chloroethene) and nylon do not biodegrade easily.

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

(2)

.....

.....

.....

.....

(iii) What feature of addition polymers makes it difficult for them to biodegrade?

(1)

.....

.....

(Total for Question 2 = 13 marks)

3 The table shows percentage by mass of the fractions obtained from a sample of crude oil and the percentage market demand for these fractions.

Fraction	Percentage by mass in crude oil	Market demand (%)
refinery gases	3	5
gasoline	12	28
kerosene	9	20
diesel	15	25
fuel oil	51	20
bitumen	10	2

(a) Why is the market demand for the gasoline fraction greater than that for the fuel oil fraction?

(1)

.....

.....

.....

(b) Cracking is used to make long-chain hydrocarbon molecules into shorter-chain hydrocarbon molecules.

(i) Complete the equation to show the other hydrocarbon molecule formed when $C_{20}H_{42}$ is cracked.

(1)

$$C_{20}H_{42} \rightarrow C_{16}H_{34} + \text{.....}$$

(ii) Give the name of a catalyst used in industry to crack long-chain hydrocarbons and state a temperature at which cracking is carried out.

(2)

Catalyst .....

Temperature .....

(c) Ethene (C_2H_4) can be produced by cracking long-chain hydrocarbon molecules obtained from crude oil. The ethene produced can then be used to make ethanol.

Ethanol can also be made by the fermentation of sugars.

(i) Give **two** advantages of making ethanol from ethene, rather than by fermentation.

(2)

1 .....

.....

2 .....

.....

(ii) Suggest **two** reasons why ethanol is sometimes made by fermentation, rather than from ethene.

(2)

1 .....

.....

2 .....

.....

(Total for Question 3 8 marks)

4 (a) Plastic bags used to store food are made from a polymer.

Ethene is the monomer used to make the polymer for some plastic bags.

(i) Name the polymer that is made from ethene.

(1)

.....

(ii) Use a word from the box to complete the sentence about ethene.

chromatography	ondensing	ing	ystallising

(1)

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules, using a process called .....

(b) The hydrocarbons used to make ethene are called alkanes.

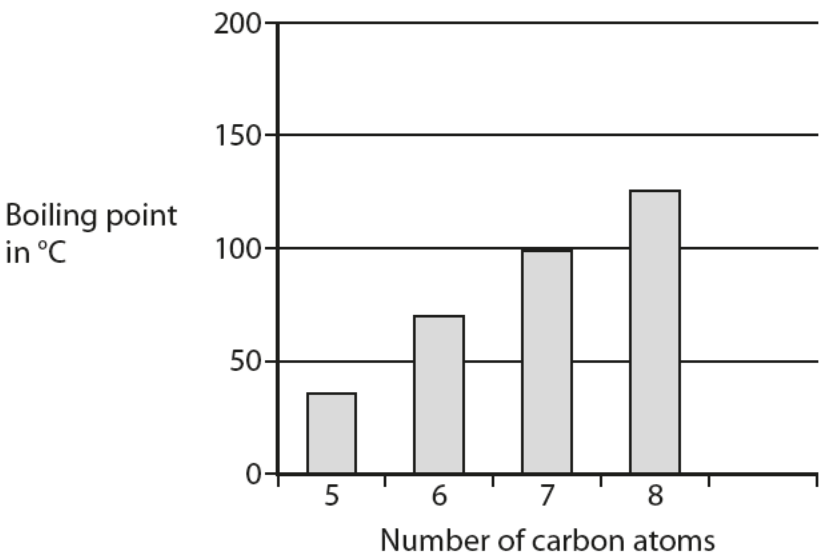
They are obtained from crude oil.

The boiling point of an alkane is related to the number of carbon atoms in the molecule.

Number of carbon atoms in molecule	5	6			
Boiling point in °C	36	69	99	125	151

(i) Use the data in the table to complete the bar chart.

(2)



(ii) What is the relationship between the boiling point of an alkane and the number of carbon atoms in its molecule?

(1)

.....

.....

.....

.....

(c) Many plastic bags are not biodegradable.

Used plastic bags can be

A buried underground, which is called landfill

or

B burned to release energy, which also produces large amounts of gases.

Suggest which of these methods of disposal is better for the environment, giving two reasons for your choice.

(2)

Choice .....

Reason 1 .....

.....

.....

.....

Reason 2 .....

.....

.....

.....

(Total for Question 4 = 7 marks)