2018 O level P2

1

(a) (2018/O/GCSE/P2/01) Use the list of substances to answer the questions.

Carbon dioxide
Diamond
Lead (II) nitrate
Ammonia
Silicon dioxide

(i) Which two substances exist as simple molecules?

[1]

(ii) Which substance is a compound with a giant molecular structure?

[1]

(iii) Which substance does not contain an element from Group IV of the Periodic Table?

[1]

(iv) Which substance is ionic?

[1]

(v) Which substance is displaced from its salts in alkaline conditions?

[1]

(b) Which of the statements about sulfur dioxide are true and which are false? Put a tick (√) in one box in each row.

	True	False
It is an amphoteric oxide.		
It is a pollutant which leads to the erosion of buildings.		
It is released from volcanoes.		
It changes the colour of potassium manganate(VII) from colourless to purple.		

[2]

2 (2018/O/GCSE/P2/02) The table shows information about the electrolysis of some substances. Complete the table by filling in the missing information.

substance	**electrodes used**	**product of reaction at positive electrode**	**product of reaction at negative electrode**
concentrated aqueous copper(II) chloride	carbon		copper
dilute aqueous copper(II) sulfate	copper	Copper(II) ions	
	Platinum	Chlorine	sodium

[3]

3 (2018/O/GCSE/P2/03) The table shows information about the preparation of pure samples of solid salts. Complete the table by filling in the missing information. Include state symbols with any formulae.

formula of salt	**formulae of reagents used**	**method used**
$CuCl_2$(s)	_____ HCl(aq)	addition of excess solid to acid filtration evaporation and crystallisation
_____	KOH(aq) HNO_3(aq)	 evaporation and crystallisation
$PbSO_4$(s)	_____	

[4]

4 (2018/O/GCSE/P2/04) Metals and solutions of ionic compounds conduct electricity differently.

(a) Describe how metals and solutions of ionic compounds conduct electricity differently.

[2]

(b) Conduction of electricity can have a different effect on metals and on solutions of ionic compounds. Describe this difference.

[1]

5 (2018/O/GCSE/P2/05) Helium is a gas with many uses. It is needed for technical equipment, such as MRI scanners. MRI scanners are used in hospitals to produce detailed images of the body. Helium is also used to fill party balloons.
In 2016, a large underground deposit of helium was discovered in Tanzania. Scientists were delighted with the discovery because helium is a finite resource. Scientists cannot get helium back after it is released into the atmosphere.

The table shows some information about helium and some gases in dry air.

Gas	**density of pure gas at room temperature and pressure in g/dm^3**	**percentage volume composition of dry air**
helium	0.17	0
nitrogen	1.17	
oxygen	1.33	
argon		<1

(a) Complete the last column of the table.

[1]

(b)

(i) Suggest why helium cannot be recovered if it is released into the atmosphere.

[1]

(ii) Calculate the density of pure argon at room temperature and pressure in g/dm^3.

[1]

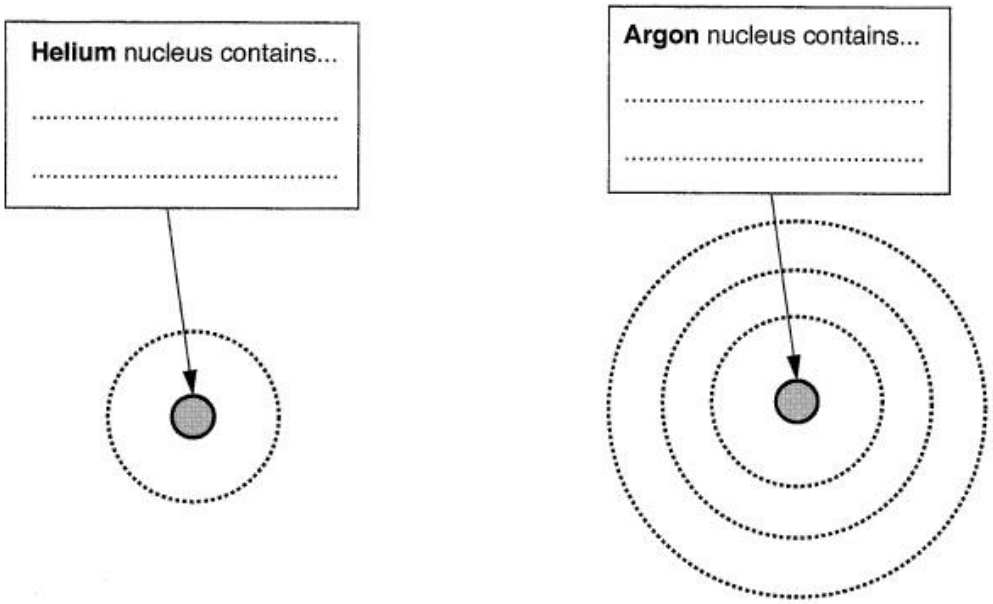
(iii) Some people think that the use of helium to fill party balloons should be discouraged. Explain why they think this.

[2]

(c) Helium and argon are chemically similar.

(i) Complete the diagrams of atoms of helium and argon to show:

- The names and numbers of each particle in the nucleus
- The arrangement of the electrons.



(ii) Use your diagrams to explain how and why helium and argon are chemically similar.

[2]

6 (2018/O/GCSE/P2/06) The process of making ammonia from raw materials has several stages. The equations show two stages in the process.

Stage 1: Methane reacts with steam to make hydrogen.

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ $\quad \Delta H = +210\,kJ/mol$

Conditions:
30 atm
nickel oxide catalyst
800 °C

Stage 2: The hydrogen formed reacts with nitrogen to make ammonia in a reactor.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\quad \Delta H = -92\,kJ/mol$

Conditions:
25–150 atm
iron catalyst
450 °C

(a) Less energy is needed to maintain the temperature for stage 2 than is needed for stage 1. Suggest two reasons why the reaction in stage 2 requires less energy.

[2]

(b) The gases from stage 1 are separated. The waste gas produced in stage 1 is burned as a fuel. Explain why it is important that this gas is collected and burned.

[2]

(c) In stage 2, nitrogen and hydrogen are mixed in definite proportions before they enter the reactor. The table shows the percentages of each gas in the mixture by volume and by mass.

	Nitrogen	hydrogen
percentage by volume	25	75
percentage by mass	82	18

(i) Explain why these percentages by volume are chosen.

[2]

(ii) Explain why the percentages of the gases are different when they are measured by volume and when they are measured by mass.

[1]

(iii) The gases leaving the reactor contain unreacted nitrogen and hydrogen and about 15% ammonia by volume. Unreacted nitrogen and hydrogen are fed back into the reactor in stage 2. Give two reasons why the unreacted gases are fed back into the reactor.

[2]

(d) In stage 1, methane and steam are reacted in the presence of a nickel oxide catalyst. The methane contains compounds of sulfur as impurities. It is important that these impurities are removed because they form a coating on the surface of the catalyst.

(i) One impurity has the formula CH3SH. Draw a 'dot-and-cross' diagram to show the bonding in CH_3SH. Show outer shell electrons only.

[1]

(ii) State how a coating on a catalyst affects the reaction.

[1]

7 (2018/O/GCSE/P2/07) Some versions of the Periodic Table place hydrogen in Group I (Fig. 7.1). Other versions place hydrogen alone and not with any other group (Fig. 7.2).

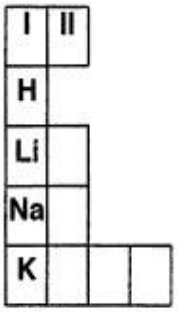


Fig. 7.1

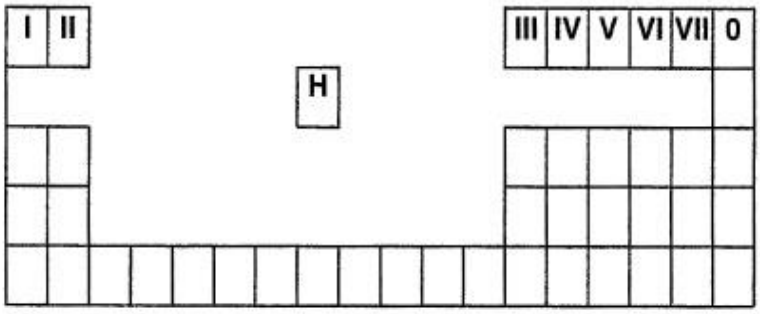


Fig. 7.2

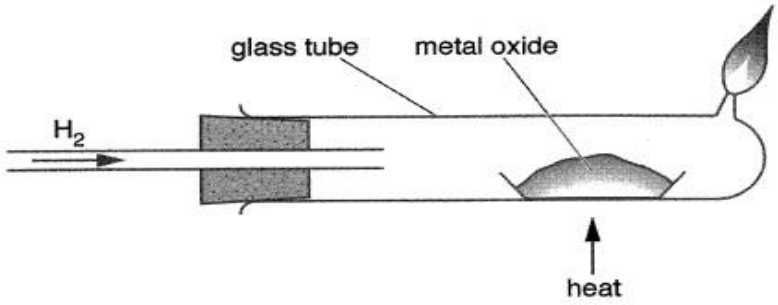
(a) Give two similarities between hydrogen and the elements in Group I.

[2]

(b) Give two properties of hydrogen that do not fit with the properties of the elements in Group I.

[2]

(c) Hydrogen is passed over a heated metal oxide in a glass tube. The unreacted hydrogen gas is burned as it leaves the tube.



(i) The experiment uses silver (I) oxide. The reaction forms liquid silver in the hot tube. Write an equation, with state symbols, for this reaction.

[2]

(ii) The changes that happen during the experiment involve both reduction and oxidation. What is reduced and what is oxidised during the experiment? Explain your reasoning

[3]

(iii) In two separate experiments, hydrogen was passed over heated magnesium oxide and heated copper (II) oxide. Describe the changes, if any, you would expect to see in each experiment. Explain your reasoning.
Observations

Reasons

[3]

Section B

8 (2018/O/GCSE/P2/08) Instrumental techniques in analysis

Flame tests for Group I elements

Flame tests were used in the 18S0s. Robert Bunsen developed the Bunsen burner and used it to show that many metals give characteristic colours when they are heated in the flame. The colour comes from light emitted by individual atoms when they become very hot. For example, sodium gives a very intense yellow-orange colour. The table shows the flame colours of Group I elements.

element	**flame colour**
lithium	red
sodium	yellow-orange
potassium	pale violet
rubidium	red-violet
Caesium	blue-violet

Group I element emission spectra

Bunsen realised that, in practice, it was difficult to use flame tests to identify elements in mixtures. In the 1860s, Bunsen worked with fellow scientist, Gustav Kirchhoff. They used a spectroscope to split the colours of the flames into individual lines. They found that atoms of an element each give a characteristic pattern of lines which is known as an emission spectrum. Fig. 8.1 shows the emission spectra of some Group I elements.

Emission spectra from elements can be used as a reference. They can be compared with the emission spectrum of a mixture so that individual elements in the mixture can be identified.

This technique is used today to analyse light from stars to work out which elements are present in the star.

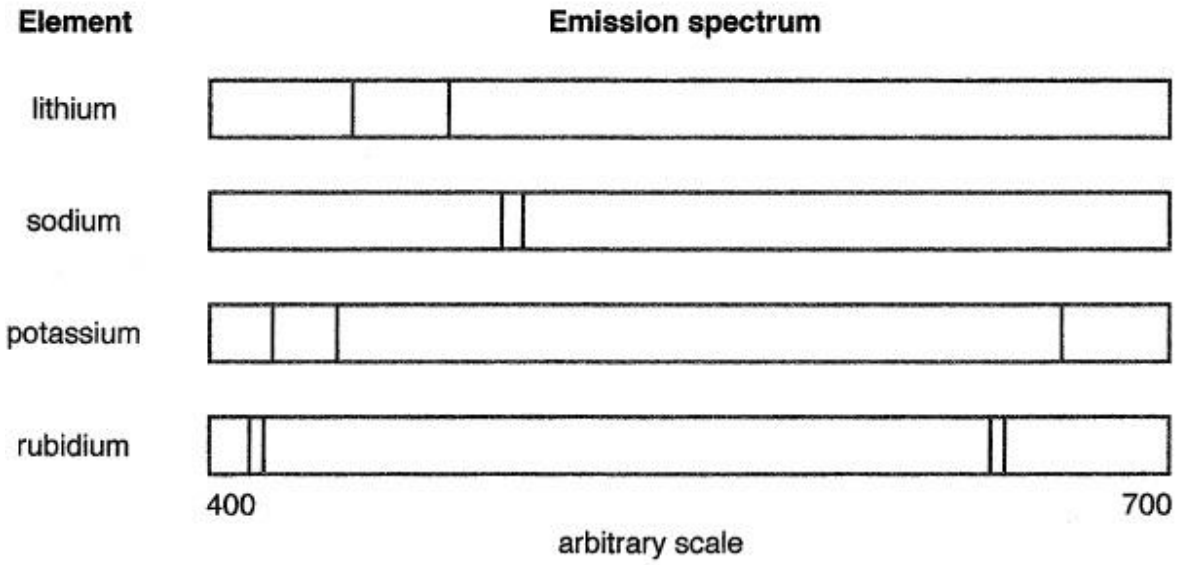


Fig. 8.1

Ion chromatography of a sample of water

In the 19S0s, ion chromatography was developed. This technique involves passing a sample through a chromatography column. Different ions travel through the column at different speeds. A detector is attached to the end of the column. The results are printed out as a graph. The retention time is the time it takes each ion to travel through the column. Ions can be identified by their retention times. The position of the peaks show the retention time of each ion.

The height of each peak (relative intensity) is proportional to the relative amount of each ion in the sample.

Ion chromatography can be used to identify any ion, even those which contain multiple atoms, such as the sulfate ion.

The ion chromatography analyses of a sample of water from a natural source are shown in Fig. 8.2 and Fig. 8.3.

Fig. 8.2 shows the ion chromatogram of positive ions in a sample of water.

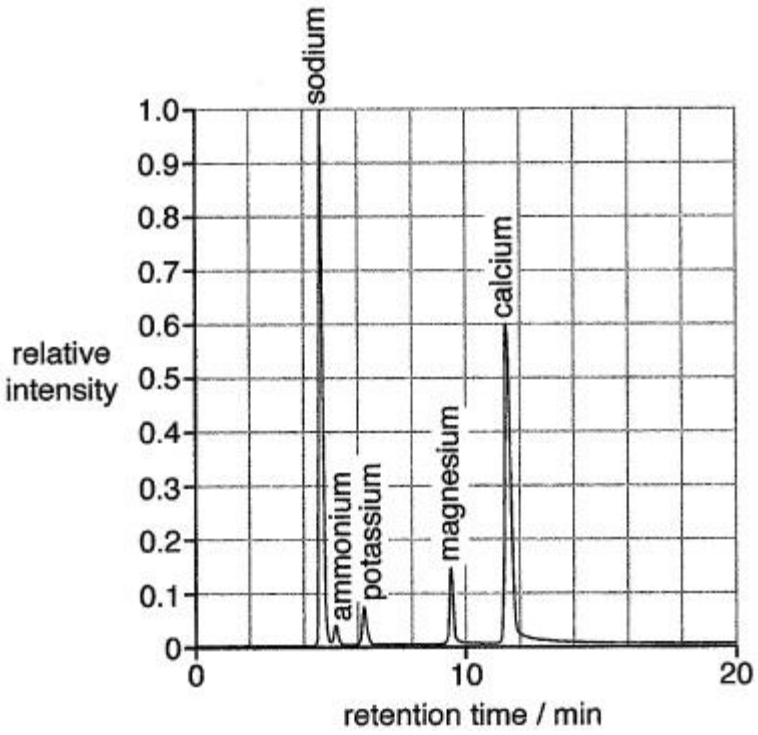


Fig. 8.2

Fig. 8.3 shows the ion chromatogram of negative ions in a sample of water.

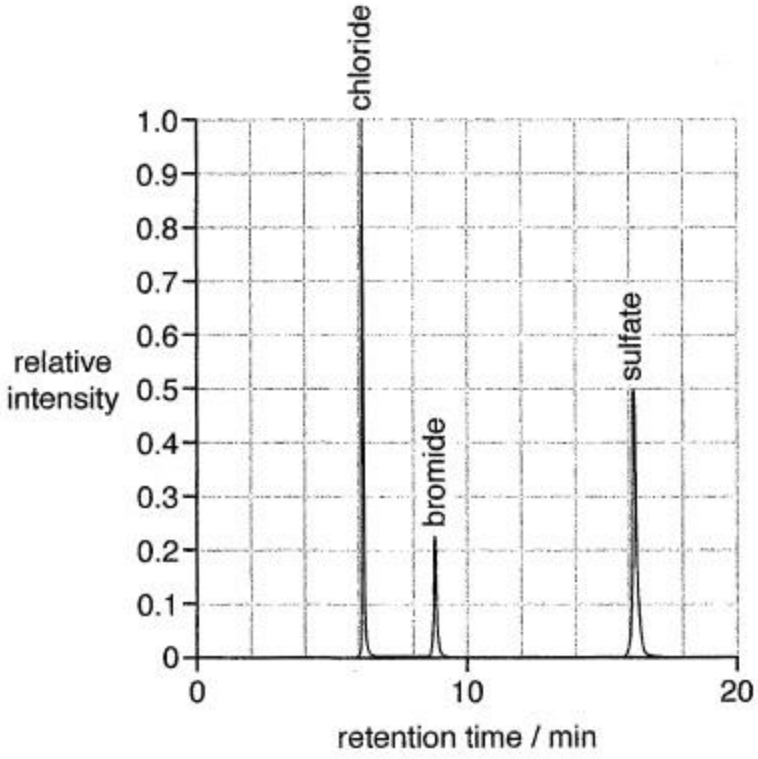
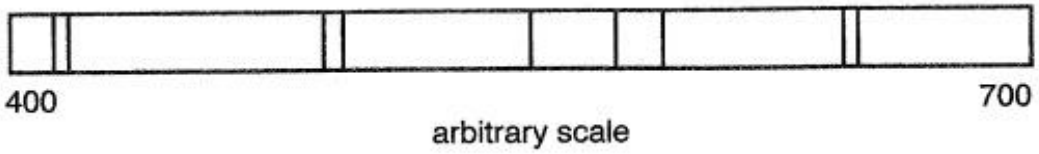


Fig. 8.3

(a) Bunsen said that it is difficult to use flame tests to identify elements in mixtures. Explain why it is difficult to use flame tests to identify which Group I elements are in a mixture.

[2]

(b) This is the emission spectrum from a mixture.



(i) What conclusions can you make about which Group I elements this mixture does and does not contain? Explain your reasoning.

[3]

(ii) What additional information would you need so that you could use the spectrum to identify all of the elements in the mixture?

[2]

(c) Further analysis of the same sample of water that was tested by ion chromatography was done.

(i) The sample was analysed to find out the concentration of sodium ions. The first stage was to crystallise solid salts from the water. Give the formulae of three different sodium salts which could crystallise from the water sample.

Salt 1

Salt 2

Salt 3

[2]

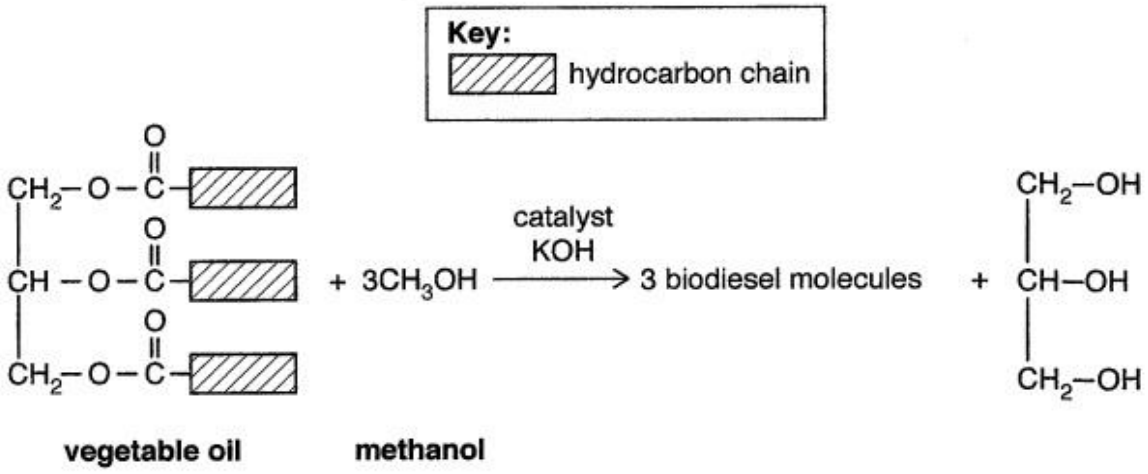
(ii) The concentration of calcium ions in the water is 0.00420mol/dm^3.Calculate the concentration of magnesium ions and the concentration of sodium ions in the water.

[2]

(d) A student comments that the ion chromatograms give more information about mixtures than the emission spectrum. Give reasons to support his idea.

[2]

9 (2018/O/GCSE/P2/09) Vegetable oils that have been used for cooking can be reacted to make biodiesel for fuel. Vegetable oils are tri-esters with long hydrocarbon chains.
Vegetable oils react with methanol.
The reaction uses a potassium hydroxide catalyst.
The diagram shows the structures of some of the molecules involved in the reaction.



(a) Suggest why vegetable oils are called tri-esters.

[1]

(b) One molecule of vegetable oil reacts to form three molecules of biodiesel. Biodiesel is an ester. Suggest the structure of one molecule of biodiesel.

Use  to represent the hydrocarbon chain.

[2]

(c) Vegetable oils that have been used for cooking contain acids. The oils must be treated to neutralise the acids before they can be used in the reaction to make biodiesel. Using untreated oils affects the rate of the reaction. Explain how and why using untreated oils affects the rate of the reaction.

[2]

(d) Before using the oil to make biodiesel, a titration is used to find out how much potassium hydroxide needs to be added to each kg of oil to neutralise the acids. 10.0g of oil is titrated with aqueous potassium hydroxide with a concentration of 1.00g/dm^3.

Results

	Rough	**titration 1**	**titration 2**
final burette reading/cm^3	22.00	43.50	21.60
initial burette reading/cm^3	0.00	22.00	0.00
volume of KOH used/cm^3	22.00	21.50	21.60

Use the titration results to calculate the mass (in grams) of potassium hydroxide that needs to be added to neutralise the acid in 1 kg of oil.

[3]

EITHER

10 (2018/O/GCSE/P2/10) Haematite and coke are used to make iron in the blast furnace.

(a) Explain, with the help of equations, why coke is essential to the process of making iron from haematite.

[4]

(b) Iron from the blast furnace contains carbon and silicon as impurities.

(i) What is the source of silicon impurities in the blast furnace?

[1]

(ii) The impurities change the properties of the iron. Explain, with reference to the arrangement of the atoms, how the presence of impurities affects the properties of iron. You may use diagrams to support your answer.

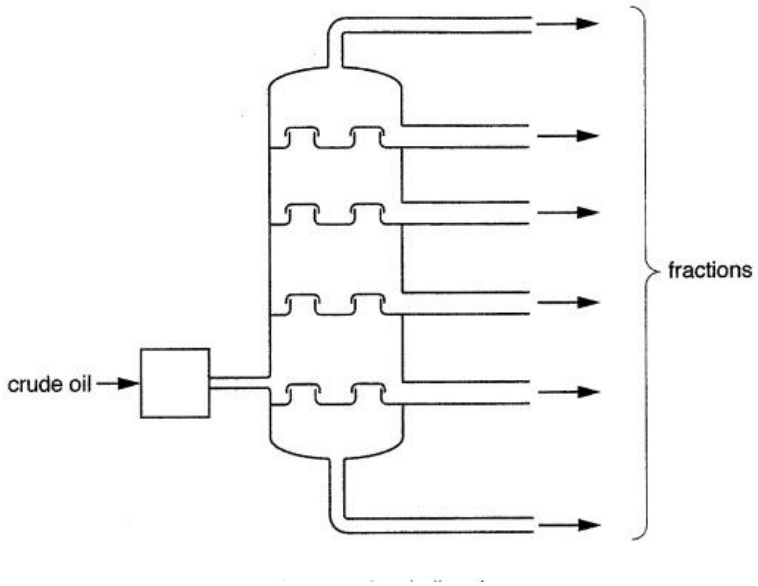
[3]

(c) Hot, molten iron from the blast furnace is used to make steel. Scrap steel is added to the iron during the process. Give reasons why it is important to use scrap steel to make new steel.

[2]

OR

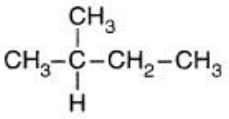
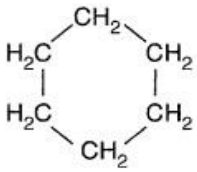
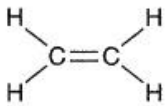
11 (2018/O/GCSE/P2/10) Crude oil contains a mixture of hydrocarbons. In a petrol refinery, fractional distillation is used to separate crude oil into fractions.



(a) Within each fraction the molecules are of a similar size. Describe and explain how the process of fractional distillation separates crude oil into fractions

[5]

(b) After fractional distillation, some molecules undergo further processes, A, B and C, in the refinery. Each process forms a range of different products. The table shows some molecules used in each process with an example of a product formed.

process	molecule used in process	example of product formed in process
A	$CH_3-CH_2-CH_2-CH_2-CH_3$ **pentane**	
B	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$ **hexane**	
C	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$ **heptane**	

One of the processes is cracking.
Another process forms isomers of the molecules that are used in the process. This is called isomerization.

(i) Identify and explain which process in the table is cracking, which is isomerization and which process is neither. Include references to molecular formulae, where relevant, in your answer.

[4]

(ii) Give a reason why cracking is important to the oil industry.

[1]