AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.7.3 SYNTHETIC AND NATURALLY OCCURRING POLYMERS

SCORE	PERCENTAGE
/270	%

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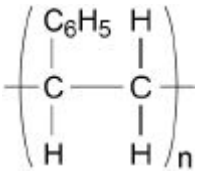
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Q1.

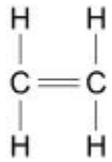
Disposable cups are made from coated paper or poly(styrene).

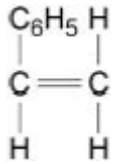
The diagram below represents the structure of poly(styrene).

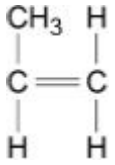


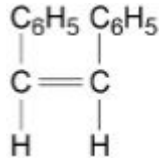
(a) Which small molecule is used to produce poly(styrene)?

Tick **one** box.

 ☐

 ☐

 ☐

 ☐

(1)

(b) Which process is used to make poly(styrene) from small molecules?

Tick **one** box.

Cracking ☐

Distillation ☐

Fermentation ☐

Polymerisation ☐

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(1)

(c) Complete the sentences.

Choose answers from the box.

ceramics	**composites**	**four**	**many**
monomers	**polymers**	**two**	

Poly(styrene) is produced from small molecules called _____

When poly(styrene) is made, _____styrene molecules join to form large molecules.

These large molecules are called _____ .

(3)

(d) The table below gives some information about disposable cups.

	Coated paper cups	**Polystyrene cups**
Source of raw materials	Wood	Crude oil
Energy to make 1 cup in arbitrary units	550	200
Biodegradable	Yes	No
Recyclable	No	Yes

Compare the advantages and disadvantages of using coated paper and poly(styrene) to make disposable cups.

Use the table above and your knowledge and understanding of life cycle assessments (LCAs).

_____

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(4)

(Total 9 marks)

Q2.

This question is about polymers.

(a) Polyesters are produced when monomers join together and lose a small molecule.

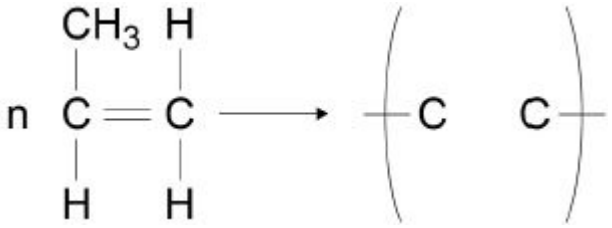
Name the small molecule lost.

_____

(1)

(b) Poly(propene) is produced from propene.

Complete the structure of poly(propene) in the equation.



(3)

(c) Carpets are made from:

- poly(propene)
- wool
- a mixture of poly(propene) and wool.

Poly(propene) wears out more slowly than wool.

A mixture of poly(propene) and wool to make carpets is more sustainable than using just poly(propene) or just wool.

Suggest why.

_____

_____

_____

_____

(2)

Polymer fibres are used to make firefighter uniforms.

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The table below shows some properties of two polymer fibres.

	Polymer fibres	
Property	**Poly(propene)**	**Polyester**
Density in g/cm^3	0.90	1.38
Melting point in °C	165	260
Flame resistance	Poor	Good
Water absorption	Low	High

(d) Evaluate the suitability of poly(propene) and polyester for firefighter uniforms.

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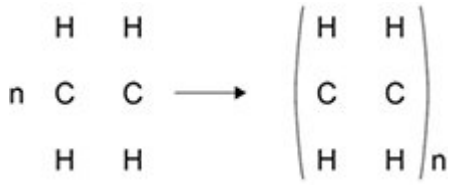
(4)

(Total 10 marks)

Q3.

Ethene is used to produce poly(ethene).

(a) Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.

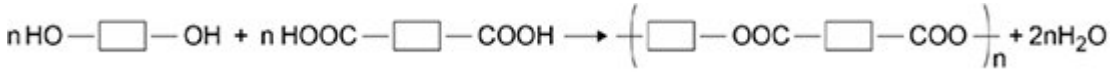


(2)

(b) Polyesters are made by a different method of polymerisation.

The equation for the reaction to produce a polyester can be represented as:

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Compare the polymerisation reaction used to produce poly(ethene) with the polymerisation reaction used to produce a polyester.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)

Q4.

This question is about polymers.

(a) The polymer polyvinyl chloride (PVC) is non-biodegradable.

Give **one** problem caused by non-biodegradable polymers.

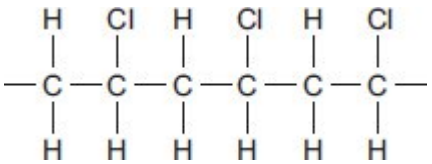
_____

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(1)

(b) **Figure 1** shows a short section of a PVC molecule.

Figure 1



PVC is produced from a monomer that contains two carbon atoms.

Complete the structure of the monomer.

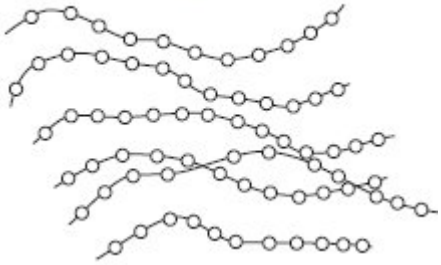
C C

(2)

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(c) **Figure 2** represents a few short chains of PVC molecules.

Figure 2



Explain why PVC softens and melts when heated.

Use **Figure 2** and your knowledge of structure and bonding to help you to answer the question.

_____

_____

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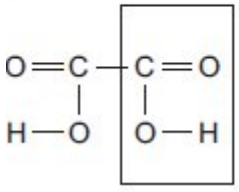
(3)

(d) Monomer **A** and monomer **B** react to form polymer **C**.

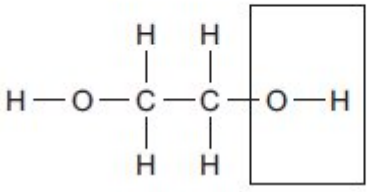
The displayed structures of monomer **A**, monomer **B** and a short section of polymer **C** are shown in **Figure 3**. The functional group of each structure is shown in a box.

Figure 3

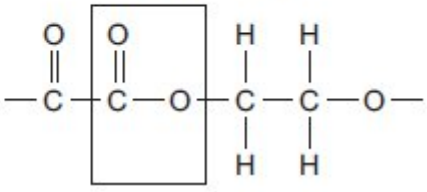
Monomer A



Monomer B



Polymer C



Complete the **Table** below below by writing the names of the functional groups for monomer **A** and polymer **C**.

Table

	Name of functional group
Monomer **A**	_____

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Monomer **B**	alcohol
Polymer **C**	_____

(2)
(Total 8 marks)

Q5.

Crude oil is a fossil fuel.

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

_____

_____

_____

_____

_____

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_____

_____

(3)

(c) Some fractions from crude oil contain large hydrocarbon molecules.

(i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

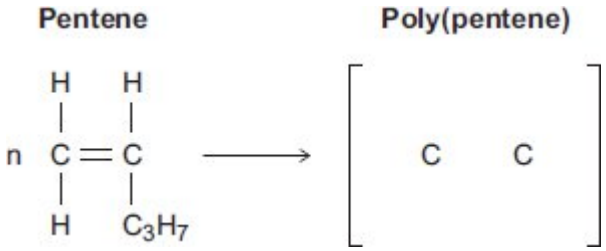
$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ _____

decane pentene propane

(1)

(ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).



(3)

(iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

_____

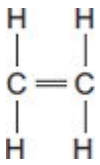
_____

(1)

(Total 12 marks)

Q6.

A molecule of ethene (C_2H_4) is represented as:



(a) A sample of ethene is shaken with bromine water.

Complete the sentence.

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The bromine water turns from orange to _____ .

(1)

(b) Most ethene is produced by the process of cracking.

(i) Complete the sentence.

Cracking is a type of thermal _____ .

(1)

(ii) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

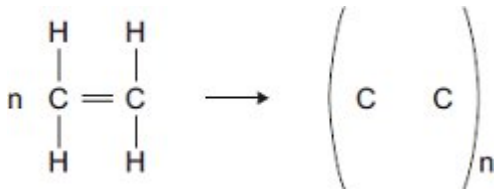
Complete the equation to show the formula of the other product.

$C_{10}H_{22} \longrightarrow C_2H_4 +$ _____

(1)

(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



(2)

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

_____

_____

_____

_____

(2)

(Total 7 marks)

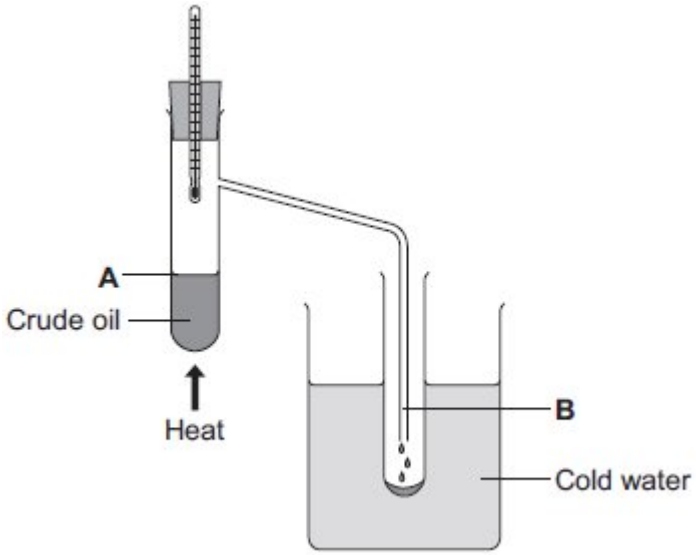
Q7.

Crude oil is a mixture of a very large number of compounds.

Figure 1 shows a laboratory experiment to separate crude oil.

Figure 1

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(a) Complete the sentence.

The name for compounds that contain only hydrogen and

carbon is _____ .

(1)

(b) Use the correct word from the box to complete each sentence.

condensation	**decomposition**	**distillation**
	evaporation	**reduction**

(i) The process of separating crude oil is fractional _____ .

(1)

(ii) The process taking place at **A** is _____ .

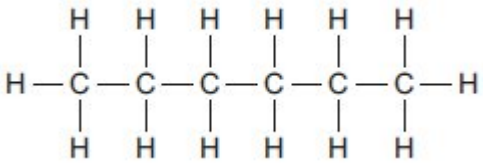
(1)

(iii) The process taking place at **B** is _____ .

(1)

(c) One of the compounds in crude oil is hexane. The displayed structure of hexane is shown in **Figure 2**.

Figure 2



Complete the sentences.

(i) Each line between the atoms in hexane represents a covalent

_____ .

(1)

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(ii) Complete the chemical formula for hexane.

$C_6H__$

(1)

(iii) Hexane can be broken down into smaller molecules by a process called

_____ .

(1)

(d) Small molecules, called alkenes, are used to make polymers.

(i) Name the polymer made from butene.

_____ .

(1)

(ii) Incinerators are used to burn waste polymers, such as plastic bags.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of burning plastic bags.

	Advantage Tick (✓)	**Disadvantage Tick (✓)**
Energy is released.		
More recycling is needed.		
Carbon dioxide is produced.		

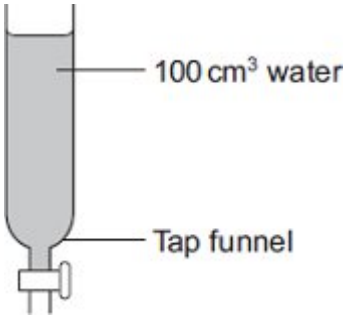
(2)

(Total 10 marks)

Q8.

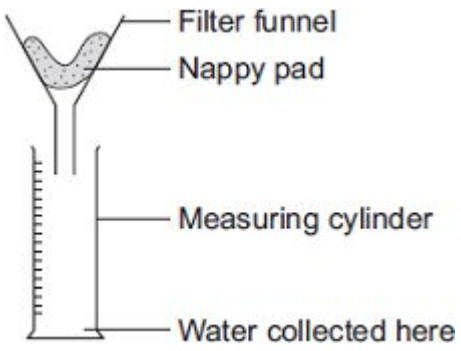
Disposable nappies for babies need to absorb as much water as possible.
Disposable nappies have a pad containing a special polymer called a hydrogel.
Hydrogels absorb water.

A company called Aqanaps compared the water absorption of its nappy pads with nappy pads made by other companies.



- A scientist from Aqanaps poured 100 cm^3 of water onto the pad of one of their nappies.
- He measured the volume of water that passed through.
- He did the test three times using a new nappy pad for each test.
- The scientist then repeated the procedure using the nappy pads from three other companies, **A**, **B** and **C**.

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The results are shown in the table.

Company	Volume of water collected in cm^3		
	Pad 1	**Pad 2**	**Pad 3**
Aqanaps	55	57	55
A	47	46	39
B	65	63	64
C	38	39	38

(a) (i) Choose **one** result in the table that should be tested again.

Result: Company _____ Pad _____

Explain why you chose this result.

_____

_____

_____

(2)

(ii) Suggest **one** variable that should be controlled in this investigation.

_____

_____

(1)

(iii) Suggest **one** possible cause of error in this investigation.

_____

_____

(1)

(b) (i) The Aqanaps company studied the results. The company concluded that it should increase the amount of hydrogel used in its nappy pads.

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Give **two** reasons why the company decided to increase the amount of hydrogel used in its nappy pads.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** disadvantage for the company if it increases the amount of hydrogel used in its nappy pads.

_____

_____

(1)

(Total 7 marks)

Q9.

(a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

(i) Describe how ethene forms poly(ethene).

_____

_____

_____

_____

(2)

(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

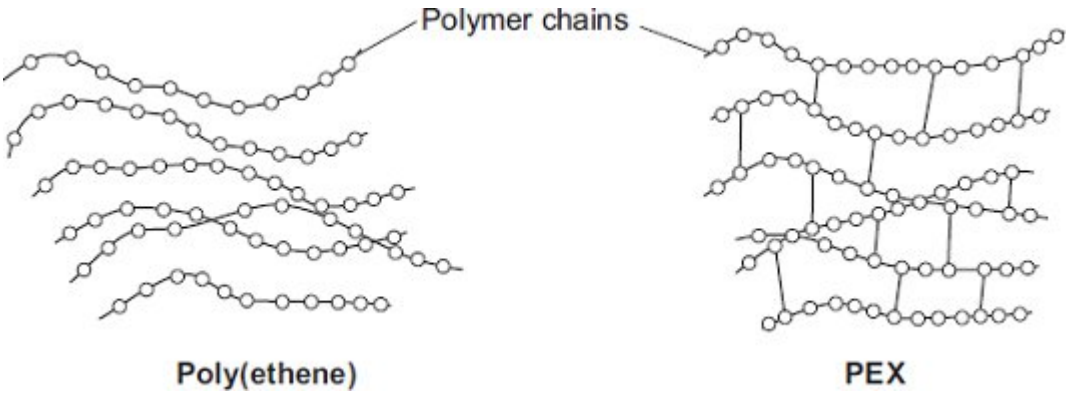
_____

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(1)

(iii) The simplified structures of poly(ethene) and PEX are shown.

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Poly(ethene) is a thermoplastic that softens easily when heated.
Suggest and explain how the structure of PEX changes this property.

_____

_____

_____

_____

_____

_____

(3)

(b) Copper is a suitable material to use for hot water pipes.
PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

1 The low-grade copper ore is powdered and concentrated.

2 The concentrated powdered copper ore is blown into a furnace with air to produce impure, molten copper. (This furnace is heated to 1100 °C using a hydrocarbon fuel.)

3 Oxygen is blown into the impure, molten copper to remove any sulfur. The molten copper is cast into rectangular slabs.

4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes:

- fractional distillation of crude oil
- cracking of naphtha fraction
- polymerisation of ethene
- conversion of poly(ethene) into PEX.

Use the information above and your knowledge and understanding to suggest possible environmental advantages of using PEX instead of copper for hot water pipes.

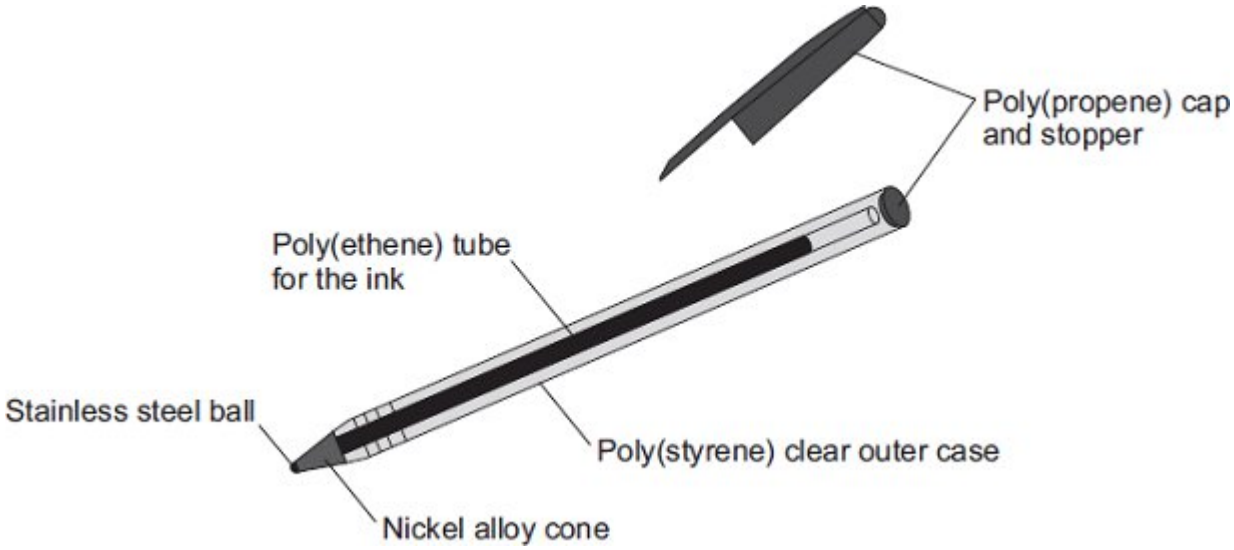
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(4)

(Total 10 marks)

Q10.

The diagram shows a ballpoint pen.



(a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

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_____

(2)

(b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

_____

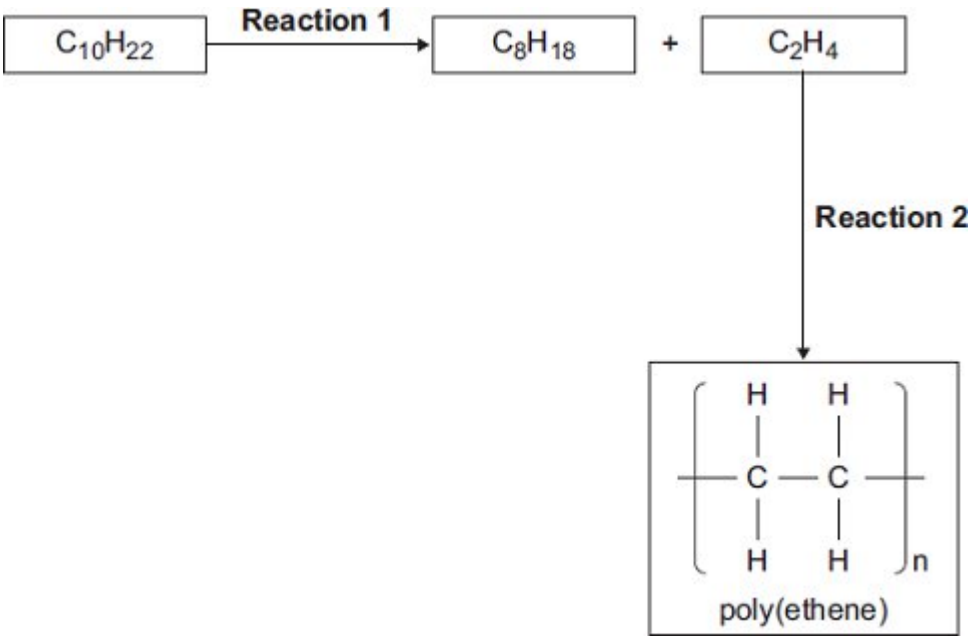
_____

_____

_____

(2)

(c) Decane ($C_{10}H_{22}$) can be used to produce poly(ethene).



(i) Describe the conditions needed for **Reaction 1**.

_____

_____

_____

_____

(2)

(ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2**.

_____

_____

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_____

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(2)

(d) Complete the displayed structure of the product in the equation.



styrenepoly(styrene)

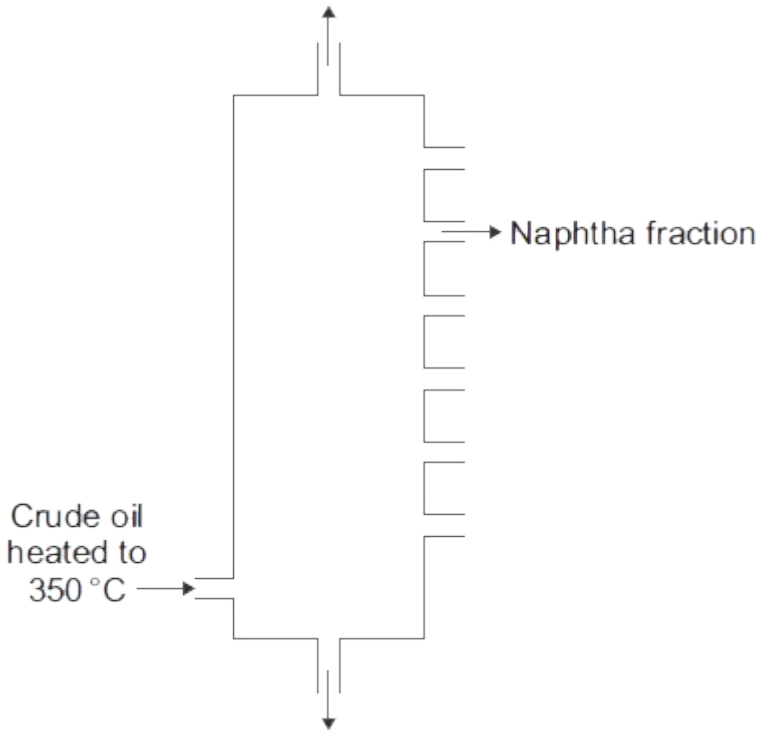
(2)

(Total 10 marks)

Q11.

Crude oil is used to produce poly(ethene).

(a) Fractional distillation is used to separate crude oil into fractions.



(i) Write a number, **2**, **3**, **4** or **5**, next to each stage so that the description of fractional distillation is in the correct order. Numbers **1** and **6** have been done for you.

Number	Stage
1	The crude oil is heated to 350 °C.
	When a fraction in the vapours cools to its boiling point, the fraction condenses.
	Any liquids flow down to the bottom of the column and the hot

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	vapours rise up the column.
6	The condensed fraction is separated and flows out through a pipe.
	When the hot vapours rise up the column, the vapours cool.
	Most of the compounds in the crude oil evaporate.

(2)

(ii) The naphtha fraction is cracked to produce ethene (C_2H_4).
Ethene is used to make the polymer called poly(ethene).

Name **two** substances produced when poly(ethene) burns in air.

1. _____

2. _____

(2)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Each year in the UK, billions of plastic bags are given free to shoppers. These bags are made from poly(ethene) and are often used only once.
After being used many of these plastic bags are either thrown away as litter or buried in landfill sites.

In 2006 over 10 billion of these plastic bags were given free to shoppers.
In 2009 the number of plastic bags given to shoppers had decreased to 6.1 billion.
One reason for the decrease was because some supermarkets made people pay for their plastic bags.

From 2011 a new type of plastic shopping bag made mainly from poly(ethene) had a use-by date of only one year printed on the bag.

Use the information above and your knowledge and understanding to describe advantages and disadvantages of using plastic shopping bags made from poly(ethene).

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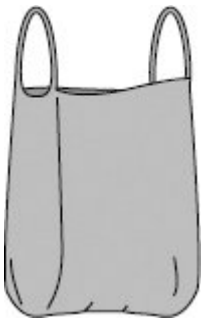
_____

(6)

(Total 10 marks)

Q12.

The plastic used for shopping bags is made from crude oil.



(a) Complete each sentence.

(i) The compounds of hydrogen and carbon

in crude oil are called _____

(1)

(ii) Crude oil is separated into fractions, such as naphtha, using

fractional _____

(1)

(b) Plastics are made from alkenes.
The alkenes are made from naphtha.

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

(i) First the liquid naphtha is made into a gas. This process is called

distilling.
filtering.
vaporising.

(1)

(ii) The naphtha gas is then passed over a hot catalyst.

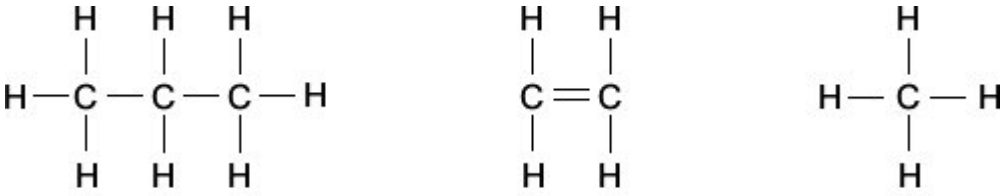
boiling.

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This process is called | bonding. / cracking.

(1)

(c) The displayed formulas of three molecules are:



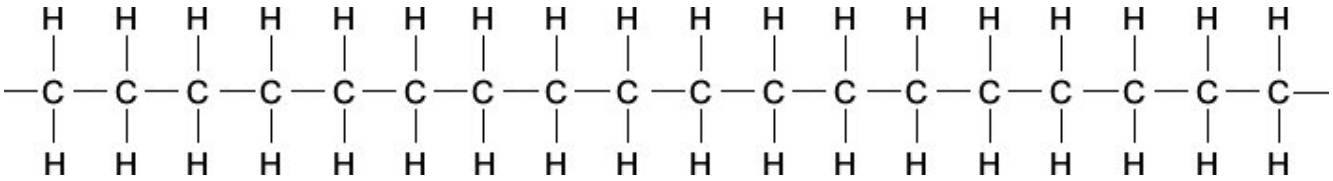
Molecule A **Molecule B** **Molecule C**

Which molecule, **A**, **B** or **C**, is an alkene? ☐

(1)

(d) The plastic for the bag is made when many alkene molecules are joined together to make the polymer called poly(ethene).

Part of a very large poly(ethene) molecule is shown below.



After plastic bags have been used for shopping, the bags can be reused, recycled, buried in landfill sites or burned.

(i) Reusing and recycling used plastic bags is good for the environment because this conserves crude oil.

Tick (✓) another reason why recycling used plastic bags is good for the environment.

Reason	Tick (✓)
energy is used to transport and melt the used plastic bags	
new plastic products are made from the used plastic bags	
new plastic bags made from crude oil are cheap to produce	

(1)

(ii) Complete the sentence.

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One reason why burying used plastic bags in landfill sites is not good for the environment is that poly(ethene) _____

(1)

(iii) Some statements about burning used plastic bags are given below.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of burning used plastic bags.

	Advantage Tick (✓)	**Disadvantage Tick (✓)**
new plastic bags can be produced		
carbon dioxide is produced		
water is one of the products		
energy is released		

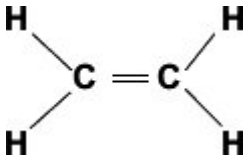
(2)

(Total 9 marks)

Q13.

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers.
Plastic bags are made from a polymer.
The polymer is made from ethene.

The structural formula of ethene is shown.



Ethene is made by cracking hydrocarbons.
These hydrocarbons come from crude oil.

(a) Complete these sentences about ethene.

(i) Ethene is a hydrocarbon because it contains only _____ and _____

(2)

(ii) Ethene is unsaturated because it has a _____ bond.

(1)

(b) Tick (✓) the name of the polymer formed when many ethene molecules join together.

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Name of polymer	Tick (✓)
poly(chloroprene)	
poly(ethene)	
poly(propene)	

(1)

(c) Suggest **two** reasons why supermarkets should stop giving plastic bags to customers.

1. _____

_____

2. _____

_____

(2)

(Total 6 marks)

Q14.

The raw materials used to make the polymer polyvinyl chloride (PVC) are crude oil and sea salt (sodium chloride).

(a) There are three main stages in the production of PVC.

(i) **Stage 1** Cracking of hydrocarbons from crude oil produces ethene, C_2H_4

$$C_{10}H_{22} \longrightarrow C_8H_{18} + C_2H_4$$

How are hydrocarbons cracked?

_____

_____

_____

_____

(2)

(ii) **Stage 2** Electrolysis of sodium chloride solution produces chlorine.
Ethene from **Stage 1** is then reacted with this chlorine.
One of the hydrogen atoms in each ethene molecule is replaced by a chlorine atom to produce vinyl chloride.

Complete the chemical equation by writing in the formula of the product vinyl chloride.

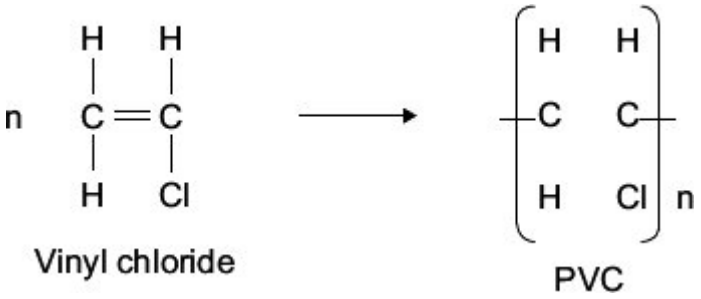
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C_2H_4 + Cl_2 ⟶ _____ + HCl

(1)

(iii) **Stage 3** Polymerisation of vinyl chloride produces polyvinyl chloride (PVC).

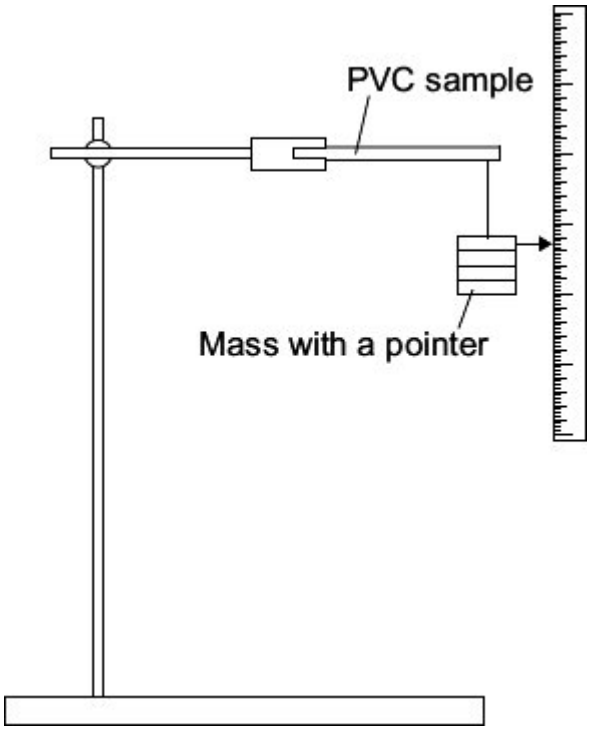
Complete the chemical equation by drawing in the missing bonds of the product, PVC.



(1)

(b) Unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.
PVC with a plasticiser added is used to make cling film for wrapping food.
A plasticiser is a chemical compound.

A student investigated how the percentage of plasticiser added to PVC affected its flexibility.
The student measured the bending of PVC samples when a mass was added.



The student's results are shown in the table.

Sample of PVC	Percentage (%) of plasticiser	Bending of PVC sample in mm

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	added	Test 1	Test 2	Test 3	Test 4	Mean
A	**0**	2	3	3	4	3
B	**5**	22	15	23	24	
C	**10**	27	27	29	29	28
D	**15**	34	35	35	36	35

(i) Each PVC sample should be the same size to make it a fair test.
Explain why.

_____

_____

(1)

(ii) The student repeated the test four times for each sample.
Explain why.

_____

_____

(1)

(iii) Calculate the mean value for sample **B**.

_____

_____

_____

_____

(2)

(iv) Each of the samples bent the most in test **4**.
Suggest a possible reason for this.

_____

_____

(1)

(c) Suggest why unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.

_____

_____

(1)

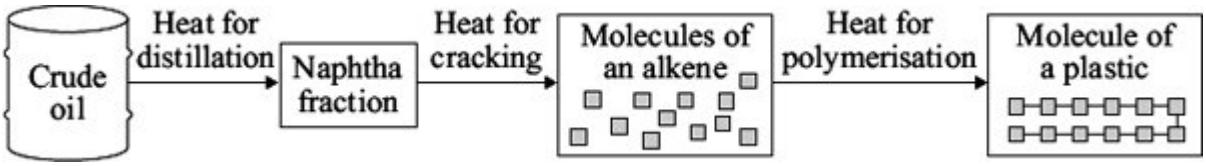
(Total 10 marks)

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Q15.

Crude oil is used to make plastics.

(a) To make a plastic from crude oil involves many processes.



(i) How do alkene molecules form a molecule of a plastic?

_____

_____

(1)

(ii) Suggest **one** of the main costs of making a plastic from crude oil.

_____

_____

(1)

(iii) Suggest **two** problems caused by the disposal of plastics in landfill sites.

1. _____

_____

2. _____

_____

(2)

(b) Some companies are using bio-plastics made from plants such as corn.
Less fossil fuel is used to make bio-plastics than is used to make plastics from crude oil.

Plastics made from plants would be more environmentally friendly than plastics made from crude oil.

Explain why.

_____

_____

_____

_____

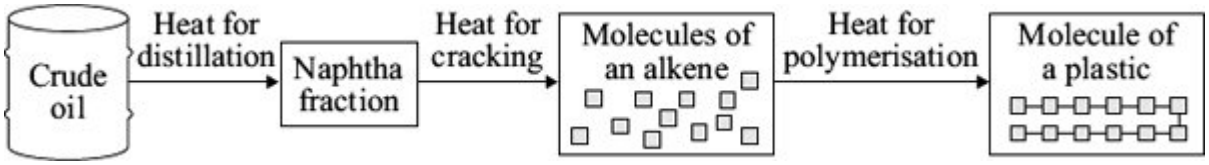
(2)

(Total 6 marks)

Q16.

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To make a plastic, such as poly(ethene), from crude oil involves many processes.



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

_____

_____

_____

_____

_____

(2)

(b) Ethene is produced by cracking the hydrocarbons in the naphtha fraction.

(i) Balance the symbol equation for this reaction.

$C_{10}H_{22}$	→	C_4H_{10}	+	C_2H_4
decane		butane		ethene

(1)

(ii) Describe how cracking is carried out.

_____

_____

_____

_____

_____

(2)

(c) Alkanes, such as butane (C_4H_{10}), do **not** form polymers.

Alkenes, such as ethene (C_2H_4), do form polymers.

Explain these statements.

_____

_____

_____

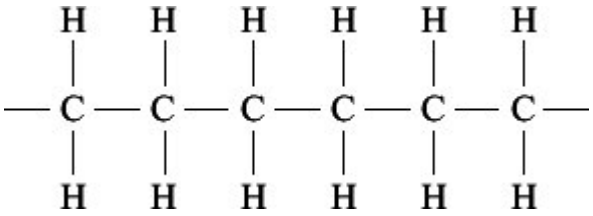
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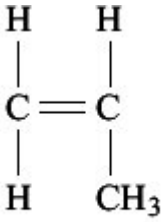
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(2)

(d) Ethene molecules form the polymer poly(ethene). One molecule in poly(ethene) will contain thousands of carbon atoms. The diagram represents part of a poly(ethene) molecule.



Propene molecules form the polymer poly(propene).



Propene molecule

Draw a diagram to represent part of a poly(propene) molecule.

(2)
(Total 9 marks)

Q17.

Water sold in plastic bottles has a high 'carbon cost'.

The 'carbon cost' depends on the amount of carbon dioxide emitted in making and transporting the product.

The more carbon dioxide emitted, the higher the 'carbon cost'.

(a) Plastic water bottles are made from a polymer.
The polymer is made from ethene.
Ethene is made by cracking hydrocarbons.

(i) Name the polymer made from ethene.

_____

(1)

(ii) Ethene can be made by cracking the hydrocarbon pentane, C_5H_{12}.

$$C_5H_{12} \rightarrow C_2H_4 + C_3H_8$$

Explain why there is a 'carbon cost' for the process of cracking a hydrocarbon.

_____

_____

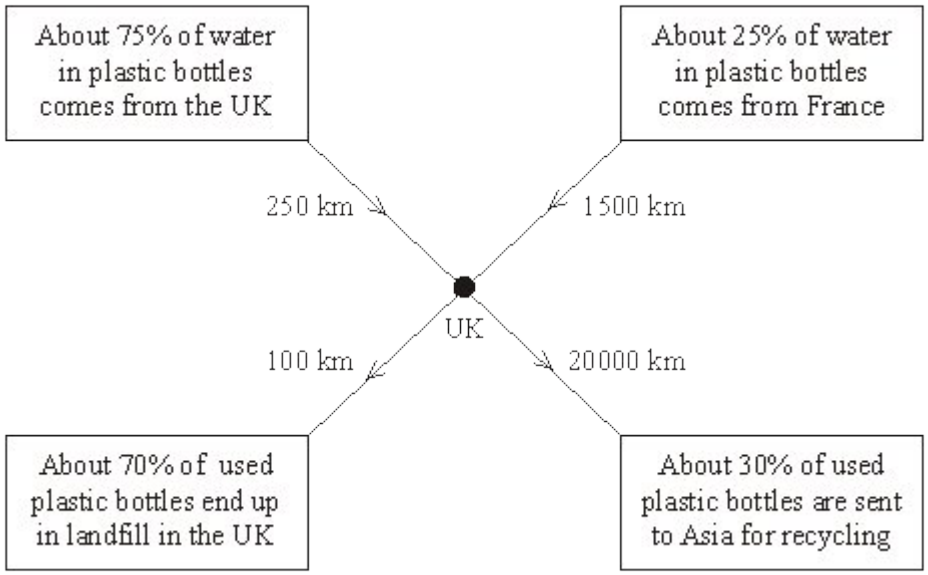
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_____

_____

(2)

(b) The diagram shows information about water sold in plastic bottles in the UK.
The diagram also shows the average distances that water and plastic bottles are transported.



Suggest how the high 'carbon cost' of water sold in plastic bottles could be reduced.

_____

_____

_____

_____

_____

_____

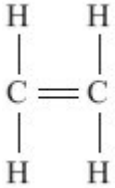
(3)

(Total 6 marks)

Q18.

Crude oil is used to make useful substances such as alkenes and plastics.

(a) The alkene shown is ethene.



(i) Tick (✓) the correct formula for ethene.

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Formula	(✓)
CH_4	
C_2H_4	
C_2H_6	

(1)

(ii) Tick (✓) the name of the plastic formed when many ethene molecules join together.

Name of plastic	(✓)
Poly(ethene)	
Poly(ethanol)	
Poly(propene)	

(1)

(b) Read the article about plastics and then answer the questions.

THE PROBLEM WITH PLASTIC WASTE

The UK produces about 3 million tonnes of plastics from crude oil every year.

Most of the litter found on UK beaches is plastic waste.

80% of the plastics produced end up in landfill sites.

The UK recycles only 7% of plastic waste.

(i) Draw a ring around the correct answer in the box to complete the sentence.

Litter that is plastic waste needs to be removed from beaches

because it [decomposes / is flammable / is not biodegradable] .

(1)

(ii) Suggest a problem caused by 80% of the plastics going to landfill sites.

_____

_____

(1)

(iii) The UK government has set a target to recycle 30% of plastic waste.

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How are resources saved by recycling more plastics?

_____

_____

(1)

(Total 5 marks)

Q19.

(a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

(i) Describe how ethene forms poly(ethene).

_____

_____

_____

_____

(2)

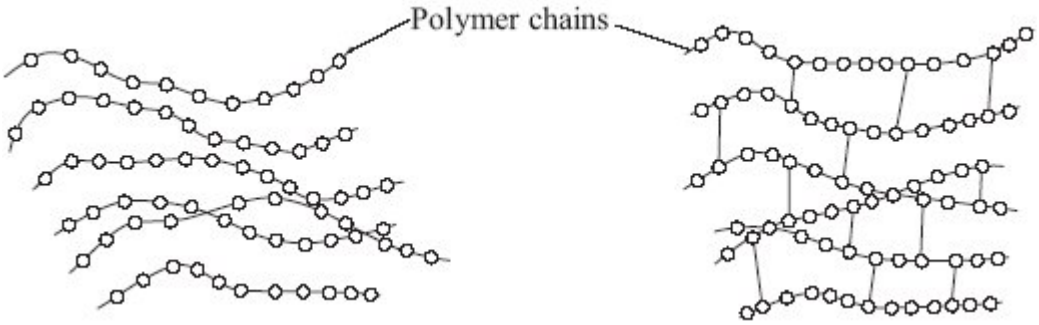
(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

_____

_____

(1)

(iii) The simplified structures of poly(ethene) and PEX are shown.



Poly(ethene) **PEX**

Poly(ethene) is a thermoplastic that softens easily when heated.

Suggest and explain how the structure of PEX changes this property.

_____

_____

_____

_____

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_____

(3)

(b) Copper was considered to be the most suitable material to use for hot water pipes. PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

1 The low-grade ore is powdered and concentrated.
2 Smelting is carried out in an oxygen flash furnace. This furnace is heated to 1100 °C using a hydrocarbon fuel. The copper ore is blown into the furnace with air, producing impure, molten copper.
3 Oxygen is blown into the impure, molten copper to remove any sulfur. The copper is cast into rectangular slabs.
4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes.

1 Fractional distillation
2 Cracking
3 Polymerisation
4 Conversion of poly(ethene) into PEX

Suggest the possible environmental advantages of using PEX instead of copper for hot water pipes.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

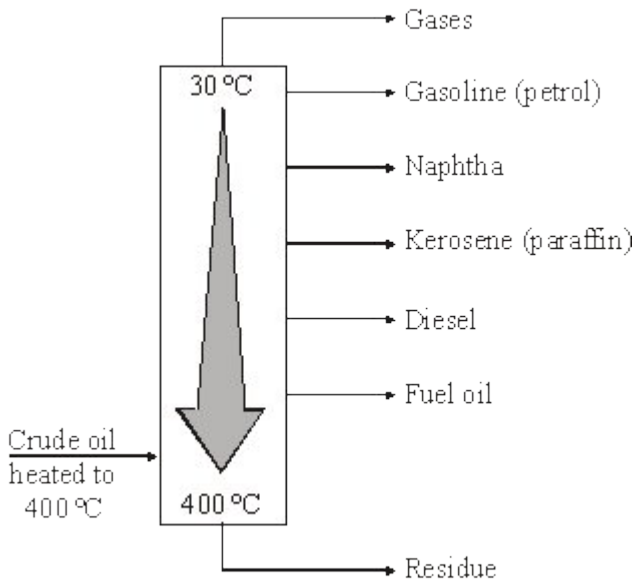
(4)

(Total 10 marks)

Q20.

Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.

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(a) Describe how the naphtha fraction separates from the other fractions.

_____

_____

_____

_____

(2)

(b) The naphtha fraction is often used to make other useful materials.

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22}$ → C_6H_{14} + C_2H_4

(i) Balance the symbol equation given above.

(1)

(ii) Describe how cracking is carried out.

_____

_____

_____

(2)

(iii) Why does ethene have different chemical properties from decane and hexane?

_____

_____

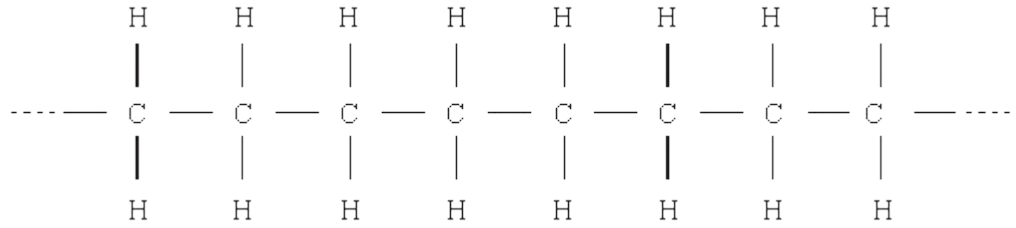
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_____

_____

(2)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.

H H

C C

H H

(1)

(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

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You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

_____

_____

_____

_____

_____

_____

_____

_____

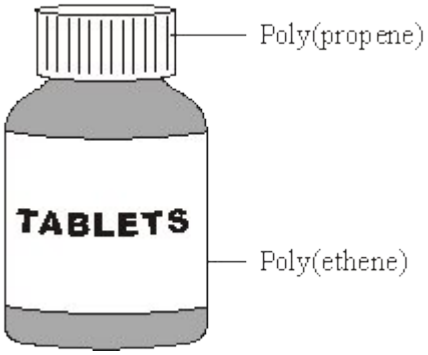
_____

(4)

(Total 12 marks)

Q21.

Tablet containers are often made from two different polymers.



(a) Ethene, C_2H_4, and propene, C_3H_6, can be made from crude oil.

(i) Complete the following sentence.

Ethene and propene are called hydrocarbons because they are made up of carbon and _____ atoms only.

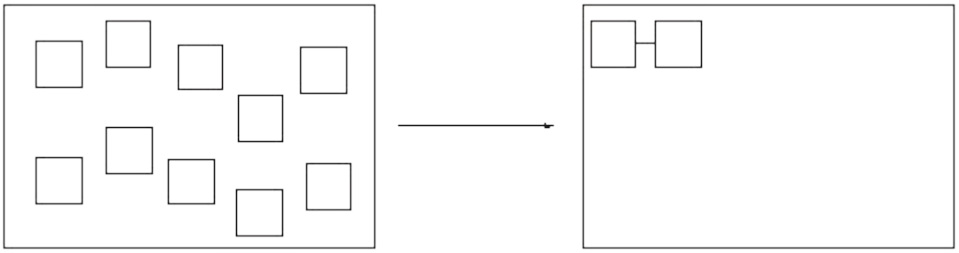
(1)

(ii) Ethene molecules are used to form poly(ethene) molecules.

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Complete the diagram to show the poly(ethene) molecule.

Ethene molecules **Poly(ethene) molecule**



(2)

(b) The tablet containers could be disposed of in a landfill site or could be recycled.

(i) Suggest **two** reasons why disposing of the tablet containers in a landfill site could cause problems.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** reason why recycling the tablet containers would be difficult.

_____

_____

(1)

(Total 6 marks)

Q22.

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

(a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmospheres of Mars and Earth as they are now.

Mars		**Earth**	
nitrogen	3%	nitrogen	78%
oxygen	trace	oxygen	21%
water	trace	water	trace
carbon dioxide	95%	carbon dioxide	trace

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Average surface temperature –23 °C	Average surface temperature 15 °C

Suggest what has caused the main gases in the Earth's atmosphere of millions of years ago to change to the present-day atmosphere.

_____

_____

_____

_____

(2)

(b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth's, contains mainly nitrogen. Methane is the other main gas.

Main gases in Titan's atmosphere	**Percentage (%)**	**Boiling point in °C**
Nitrogen	95	–196
Methane	5	–164
Average surface temperature –178 °C		

When it rains on Titan, it rains methane! Explain why.

_____

_____

_____

(2)

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene and propene, from methane in Titan's atmosphere.

(i) Draw the structure of propene, C_3H_6, to show the covalent bonds.

(1)

(ii) Explain how propene molecules form a polymer. You should name the polymer formed.

_____

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_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q23.

Polymers are used to make many materials that people need.

(a) Plastic bags are used to carry, protect and store food. Plastic bags are made from polymers.



Plastic bag made from a polymer

(i) Ethene is the small molecule (the monomer) used to make the polymer for this plastic bag.

Name the polymer that is made from ethene.

_____

(1)

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

condensing	corroding	cracking

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules by a process called _____

(1)

(iii) The hydrocarbon ethene has the formula C_2H_4

Complete the sentence about ethene.

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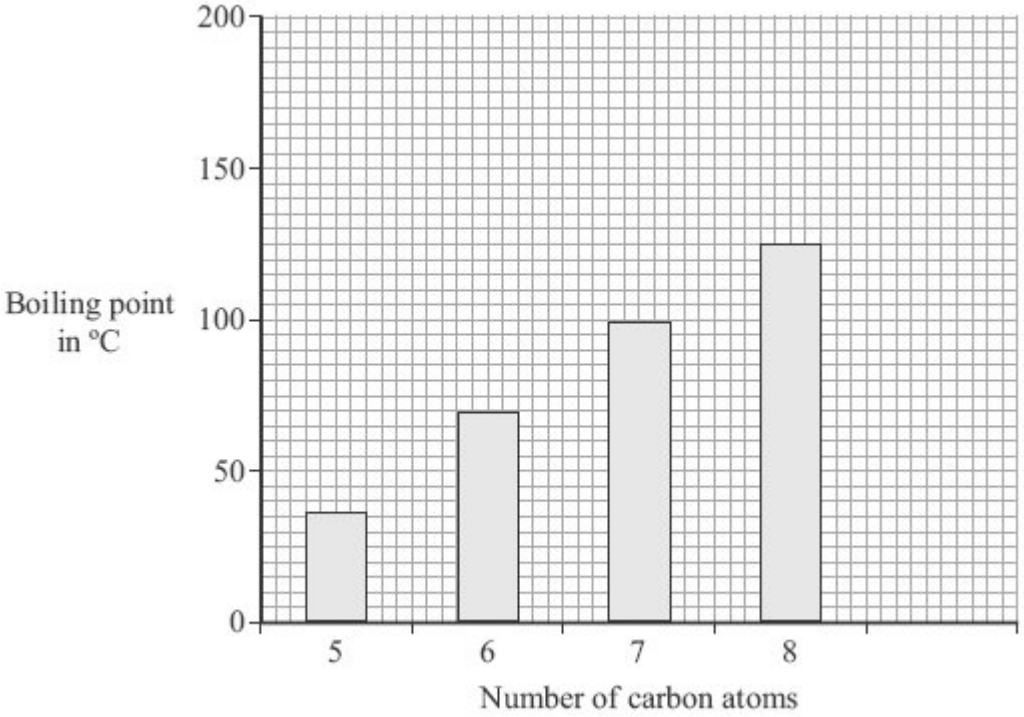
Ethene is a hydrocarbon made up of carbon and _____ atoms.

(1)

(b) The hydrocarbons used to make ethene come from crude oil. The properties of hydrocarbons are linked to the number of carbon atoms in their molecules.

Number of carbon atoms	5	6	7	8	9
Boiling point in °C	36	69	99	125	151

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



(2)

(ii) What happens to the boiling point of a hydrocarbon as the number of carbon atoms increases?

_____

(1)

(iii) All the hydrocarbons in the table are found in petrol. Petrol is one of the fractions separated from crude oil.

Describe how the fractions are separated from crude oil.

_____

_____

_____

_____

_____

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(2)

(c) Most plastic bags that are made of hydrocarbons are not biodegradable.

Used plastic bags can be:

- dumped into large holes, which is called landfill
- burned to give out heat energy, which would produce large amounts of gases.

Would burning used plastic bags be better for the environment than dumping them in landfill?

Explain your answer.

_____

_____

_____

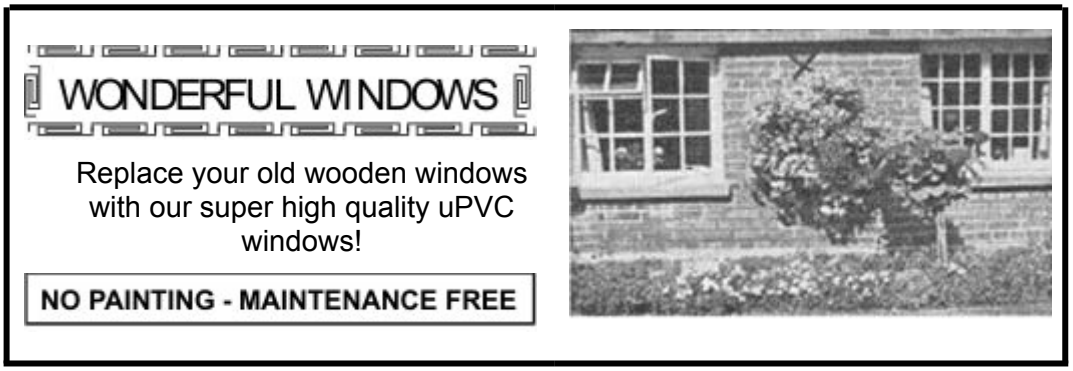
_____

(2)

(Total 10 marks)

Q24.

Modem window frames are often made from uPVC which contains the plastic poly(chloroethene).



(a) State why plastic window frames need no painting or maintenance.

_____

_____

(1)

(b) Poly(chloroethene) is a polymer formed by the *addition polymerisation* of chloroethene.

(i) Chloroethene is an unsaturated molecule. Why is this molecule said to be unsaturated?

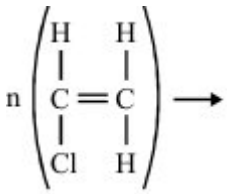
_____

_____

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(1)

(ii) Complete the diagram to represent how poly(chloroethene) is formed from chloroethene.



(3)

(iii) Explain what is meant by the term *polymerisation*.

_____

_____

_____

_____

(2)

(iv) Why is this an *addition polymerisation*?

_____

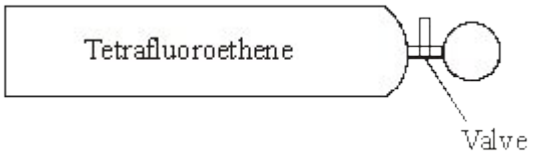
_____

(1)

(Total 8 marks)

Q25.

In 1939 Roy Plunkett opened the valve on a new cylinder of tetrafluoroethene gas. No gas came out!



He cut the cylinder open and found that the gas had changed into a white solid. This solid was an addition polymer.

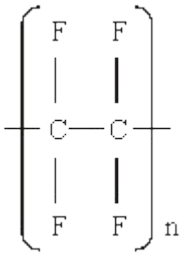
(a) Give the name of the addition polymer that formed inside the cylinder.

_____

(1)

(b) The structure of this polymer can be represented by the diagram below.

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Draw the structure of the monomer, tetrafluoroethene, from which it is formed.

(2)

(c) Describe how this addition polymer forms from monomers.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q26.

(a) Alkenes can be made by cracking large alkane molecules.

(i) Explain how the cracking process is carried out.

_____

_____

_____

_____

(2)

(ii) Give a chemical test which would show the difference between an alkene and an alkane.

Test _____

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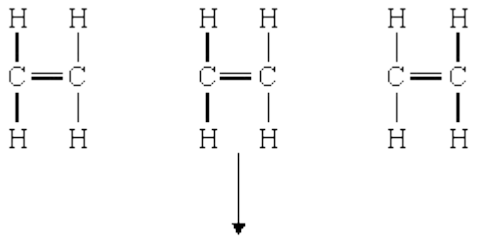
Result of test _____

_____

(2)

(b) Alkenes, such as ethene, can be made into polymers.

(i) Complete the following to show how the ethene molecules bond to form part of a polymer.



(1)

(ii) Name the polymer formed from ethene.

_____

(1)

(iii) Explain **one** important problem caused by the everyday use of this polymer.

_____

_____

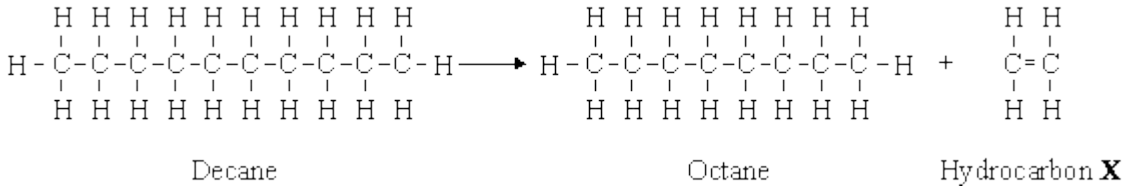
_____

(2)

(Total 8 marks)

Q27.

The high demand for petrol (octane) can be met by breaking down longer hydrocarbons, such as decane, by a process known as cracking.



Decane Octane Hydrocarbon **X**

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(a) Apart from heat, what is used to make the rate of this reaction faster?

_____

(1)

(b) Octane is a *hydrocarbon.*

(i) What does *hydrocarbon* mean?

_____

_____

(1)

(ii) Give the molecular formula of octane.

_____

(1)

(c) The hydrocarbon **X** is used to make poly(ethene).

(i) What is the name of **X**?

_____

(1)

(ii) What is the name of the process in which **X** is changed into poly(ethene)?

_____

(1)

(Total 5 marks)

Q28.

One reason the oil industry is important is that it uses crude oil to produce many of the plastic materials we use in everyday life.

(a) The first stage in the formation of a plastic material is called cracking. Butane (C_4H_{10}), a hydrocarbon in crude oil, can be cracked to produce two different hydrocarbons, ethane (C_2.4) and ethene (C_2H_4)

(i) For cracking to happen what needs to be done to the hydrocarbon?

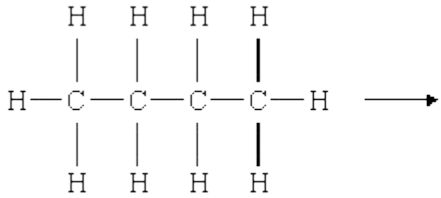
_____

_____

(2)

(ii) Complete the equation for the cracking of butane using displayed formulae.

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Butane (C_4H_{10}) Ethane (C_2H_6) + Ethene (C_2H_4)

(2)

(iii) Complete the balanced chemical equation far the complete combustion of ethane in oxygen.

_____$C_2.4(g)$ + _____(g) → _____(g) + _____(l)

(3)

(b) The second stage is the formation of the plastic material by polymerisation.

Describe how ethene (C_2H_4) forms poly(ethene). You do not need to give the reaction conditions or the names of catalysts.

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q29.

This question is about hydrocarbons.

(a) Use **two** of the words in the box to complete the sentence.

air	finite	organic	renewable	sediment	water

Crude oil is a mixture of hydrocarbons. It was formed from

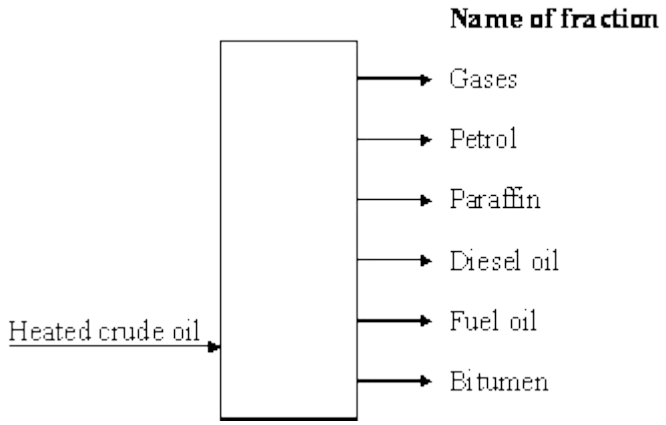
_____ materials that were trapped in

_____ over a very long period of time.

(2)

(b) Petrol is separated from crude oil by fractional distillation.

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(i) Which fraction has the lowest boiling point?

_____

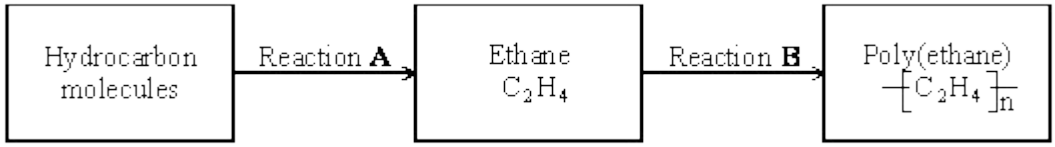
(1)

(ii) Which fraction has the highest density?

_____

(1)

(c) Some of the fractions containing larger hydrocarbon molecules are used to make plastics, such as poly(ethene).



(i) What type of chemical change is Reaction **A**?

_____

(1)

(ii) Explain what happens in Reaction **B**.

_____

_____

_____

_____

(2)

(d) Natural gas contains the hydrocarbon called methane. Some water heaters use methane as a fuel. People could die from breathing the fumes produced by heaters that have not been checked and serviced. Explain how these fumes are produced and why they are dangerous.

_____

_____

_____

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_____

_____

_____

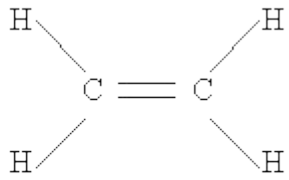
_____

(3)

(Total 10 marks)

Q30.

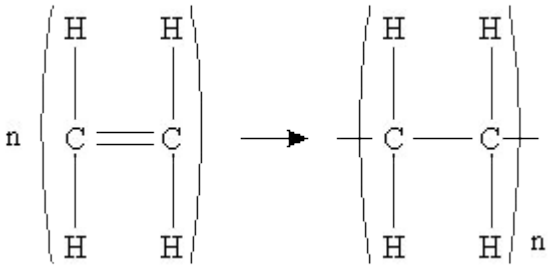
Propane and ethene are both important hydrocarbons.

	propane	ethene
formula	C_3H_8	
structure		

(a) **Complete the table** by adding the formula of the ethene molecule and the structure of the propane molecule.

(2)

(b) Ethene can be changed into a plastic. The equation shown below represents the reaction in which ethene is polymerised.



(i) What is the name of the plastic formed in this reaction?

_____

(1)

(ii) What type of polymerisation reaction is shown in the equation?

_____

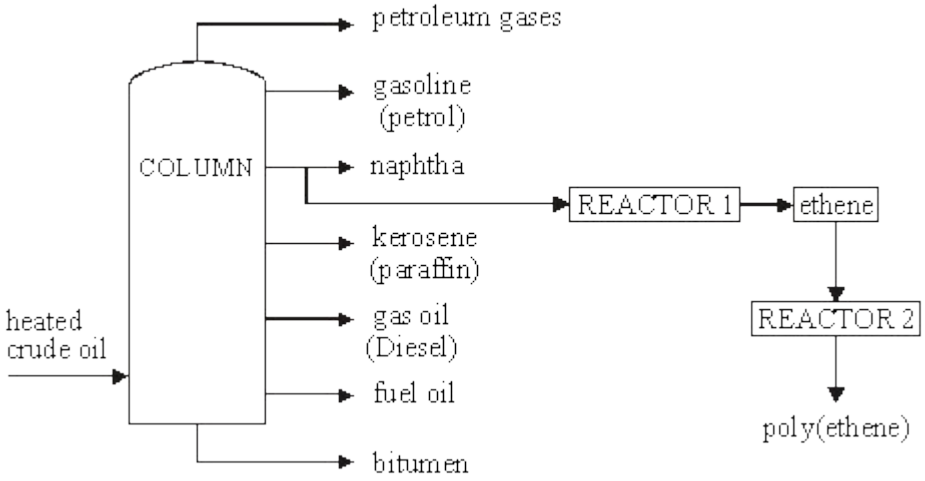
(1)

(Total 4 marks)

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Q31.

Crude oil is a mixture of many compounds. The diagram below shows some of the processes that take place in a petrochemical plant.



(a) Name the process which takes place in the COLUMN.

_____

(1)

(b) Name the type of reactions which take place in:

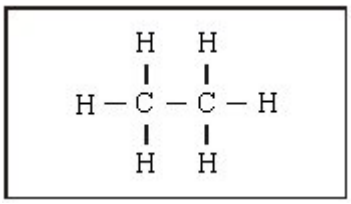
(i) REACTOR 1 _____

(ii) REACTOR 2 _____

(2)

(c) The petroleum gases contain ethane, C_2H_6 and propane, C_3H_8.

The structure of a molecule of ethane can be represented as:



ethane

Draw the structure of a molecule of propane in the space below.



propane

(1)

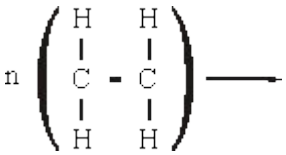
(d) Ethane and propane are said to be *saturated* hydrocarbons.
What does *saturated* mean when used to describe hydrocarbons?

(1)

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(e) Many molecules of ethene join together to form poly(ethene) in REACTOR 2.

Complete the diagram below to show the formation of poly(ethene).

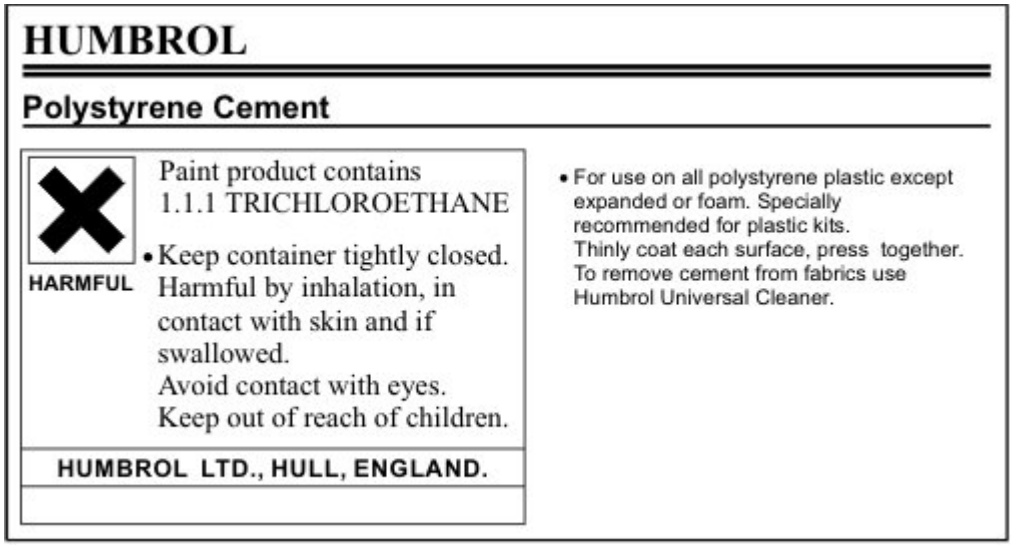


(2)

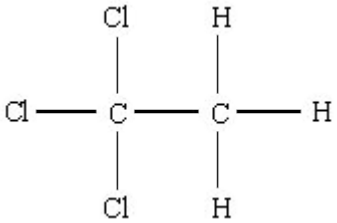
(Total 7 marks)

Q32.

The label has been taken from a tube of *Humbrol Polystyrene Cement*, a glue used in model making.



(a) The solvent used is 1,1,1-trichloroethane. The structural formula of this molecule is:



(i) What do the lines between the atoms represent?

_____

(1)

(ii) State whether 1,1,1-trichloroethane is saturated or unsaturated. Give **one** reason for your answer.

_____

_____

_____

(1)

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(iii) 1,1,1-trichloroethane is being replaced in favour of a 'better' solvent. Use information on the label to help you to suggest why.

_____

_____

(1)

(b) Polystyrene is a plastic. Plastics are polymers which are made by the process of polymerisation.

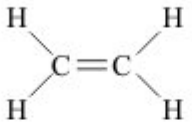
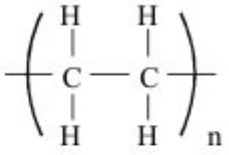
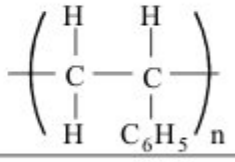
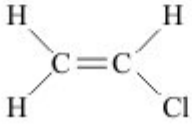
(i) What is meant by polymerisation?

_____

_____

(2)

(ii) The table gives information about monomers and the polymers made from them.
Complete the table.

MONOMER		POLYMER	
name	formula	name	formula
ethene			
styrene		polystyrene	
chloroethene		poly(chloroethene)	

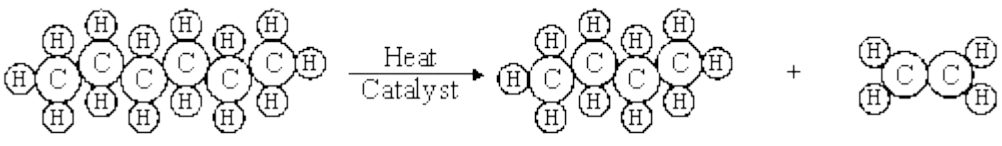
(3)

(Total 8 marks)

Q33.

The many hydrocarbons in crude oil are separated into fractions.

(a) Some of the larger hydrocarbon molecules can be broken down to produce smaller, more useful hydrocarbon molecules.



Hexane Butane Ethene

Hexane and butane are alkanes. Describe the structure of alkanes.

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_____

_____

_____

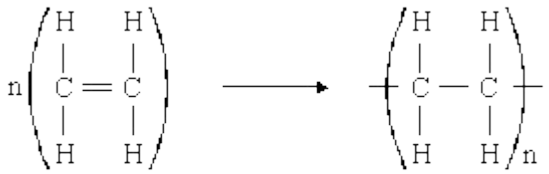
_____

_____

_____

(3)

(b) Ethene is used to make poly(ethene).



Ethene Poly(ethene)

This process is called polymerisation. Explain what is meant by polymerisation.

_____

_____

_____

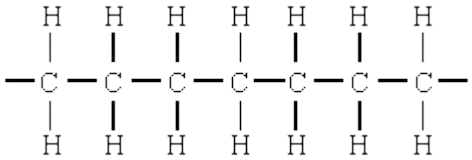
_____

(2)

(Total 5 marks)

Q34.

Poly(ethene) is a long-chain saturated hydrocarbon. The formula for part of the polymer chain is:



(a) Write the structural formula of the small molecule from which poly(ethene) is made.

(2)

(b) Saturated hydrocarbons, such as propane, are fuels.

Write a balanced equation for the complete combustion of propane, C_3H_8.

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_____ + _____ → _____ + _____

(3)

(Total 5 marks)

Q35.

(a) The hydrocarbon $C_{16}H_{34}$ was heated strongly in the absence of air.

This is one of the reactions which took place:

$C_{16}H_{34}$ ⟶ C_6H_{14} + C_6H_{12} + $2C_2H_4$

This type of reaction is carried out because there is a greater demand for the products than for the original hydrocarbon.

Suggest **two** reasons for this.

1. _____

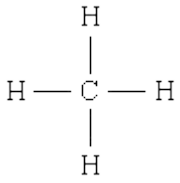
_____

2. _____

_____

(2)

(b) A molecule of the compound methane, CH_4, can be shown like this:

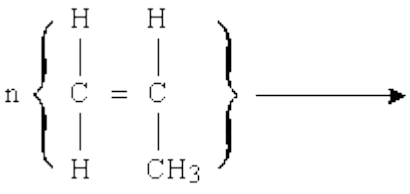


Draw a molecule of the compound ethene, C_2H_4.

(2)

(c) Small molecules of substances called monomers can be joined together in polymerisation, eg. ethene poly ⟶ (ethene).

(i) COMPLETE THE EQUATION BELOW TO SHOW FORMATION OF THE POLYMER FROM THE MONOMER PROPENE.



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(1)

(ii) Suggest the name of the polymer formed.

_____

(1)

(Total 6 marks)

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