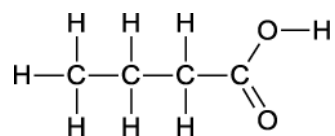


1. Look at the displayed formula of an organic compound.



What is the name of this compound?

- A butanoic acid
- B butanol
- C propanoic acid
- D propanol

Your answer

[1]

2. DNA is a condensation polymer made from monomers called nucleotides.

How many different nucleotides are used to make DNA molecules?

- A 2
- B 3
- C 4
- D 5

Your answer

[1]

3. A student bubbles ethene gas into bromine water.

What is observed?

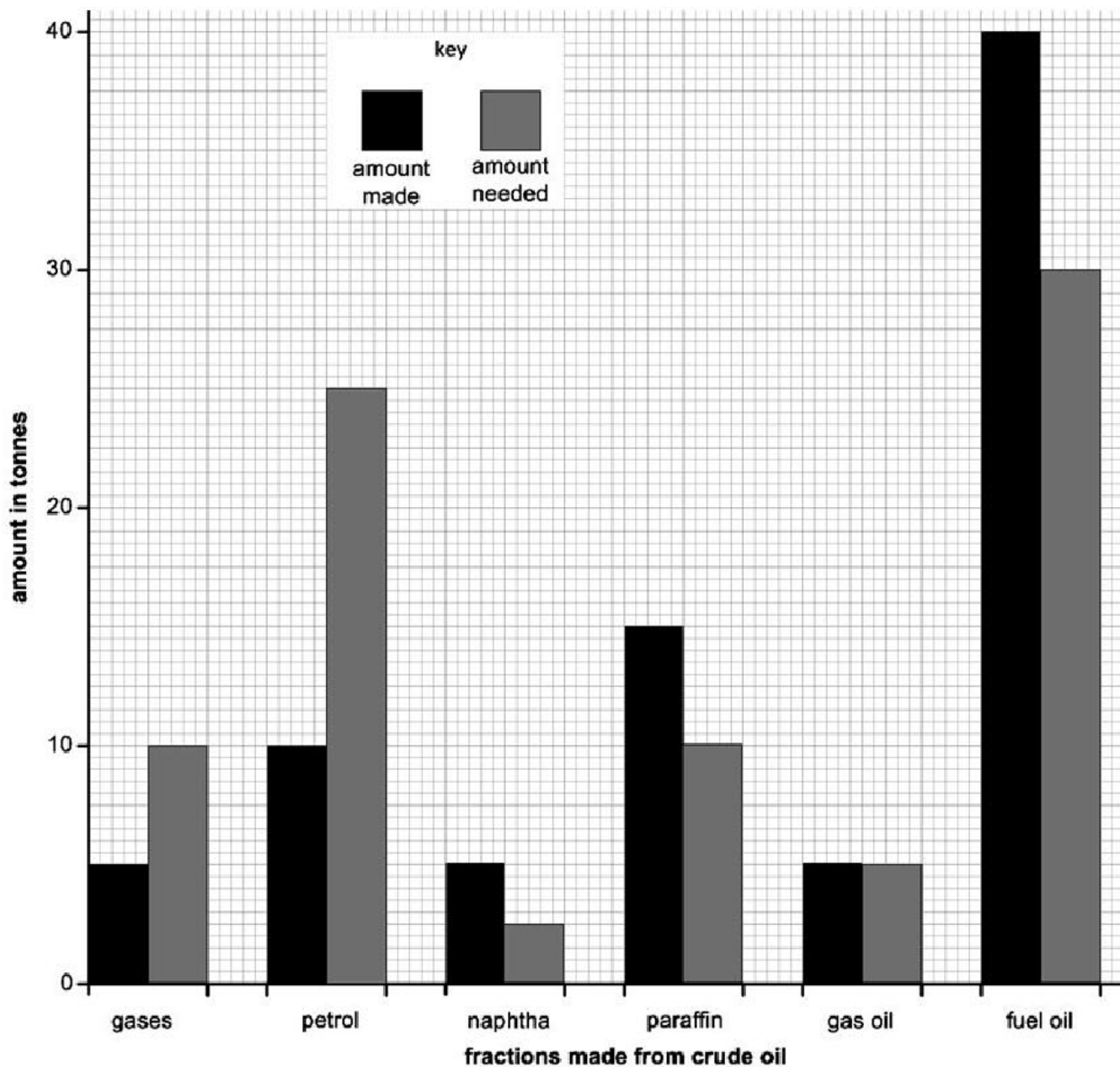
- A colour change from blue to colourless
- B colour change from colourless to orange
- C orange precipitate is made
- D colour change from orange to colourless

Your answer

[1]

4. The bar chart shows the amount of some of the fractions made from 100 tonnes of crude oil by fractional distillation.

It also shows the amount of each fraction needed for everyday uses.



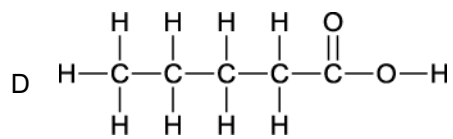
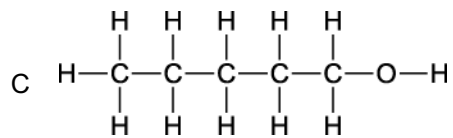
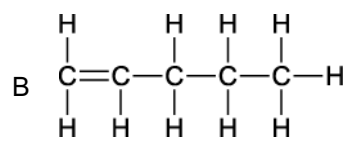
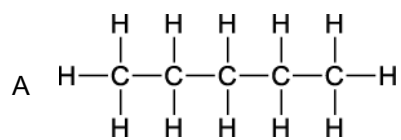
Cracking converts large molecules into smaller more useful molecules to make the supply match the demand. Which fractions are most likely to be cracked to make the supply match the demand?

- A gas oil and fuel oil
- B gas oil and petrol
- C naphtha, paraffin and fuel oil
- D petrol and gases

Your answer

[1]

5. Which displayed formula includes the functional group of an alcohol?

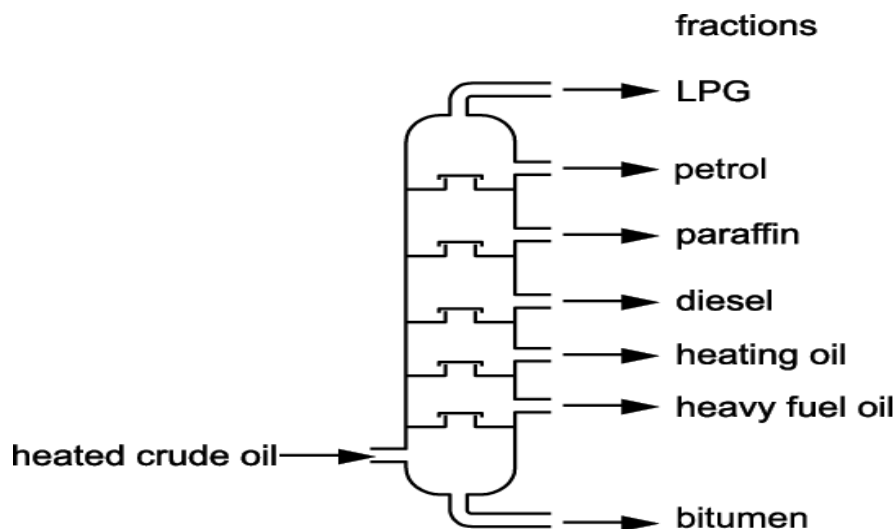


Your answer

[1]

6(a). Crude oil is used as a source of fuels. It is separated into many fractions by fractional distillation.

The diagram below shows a fractionating column.



Crude oil contains a mixture of hydrocarbons that boil at different temperatures.

Describe **how** crude oil can be separated using a fractionating column.

[4]

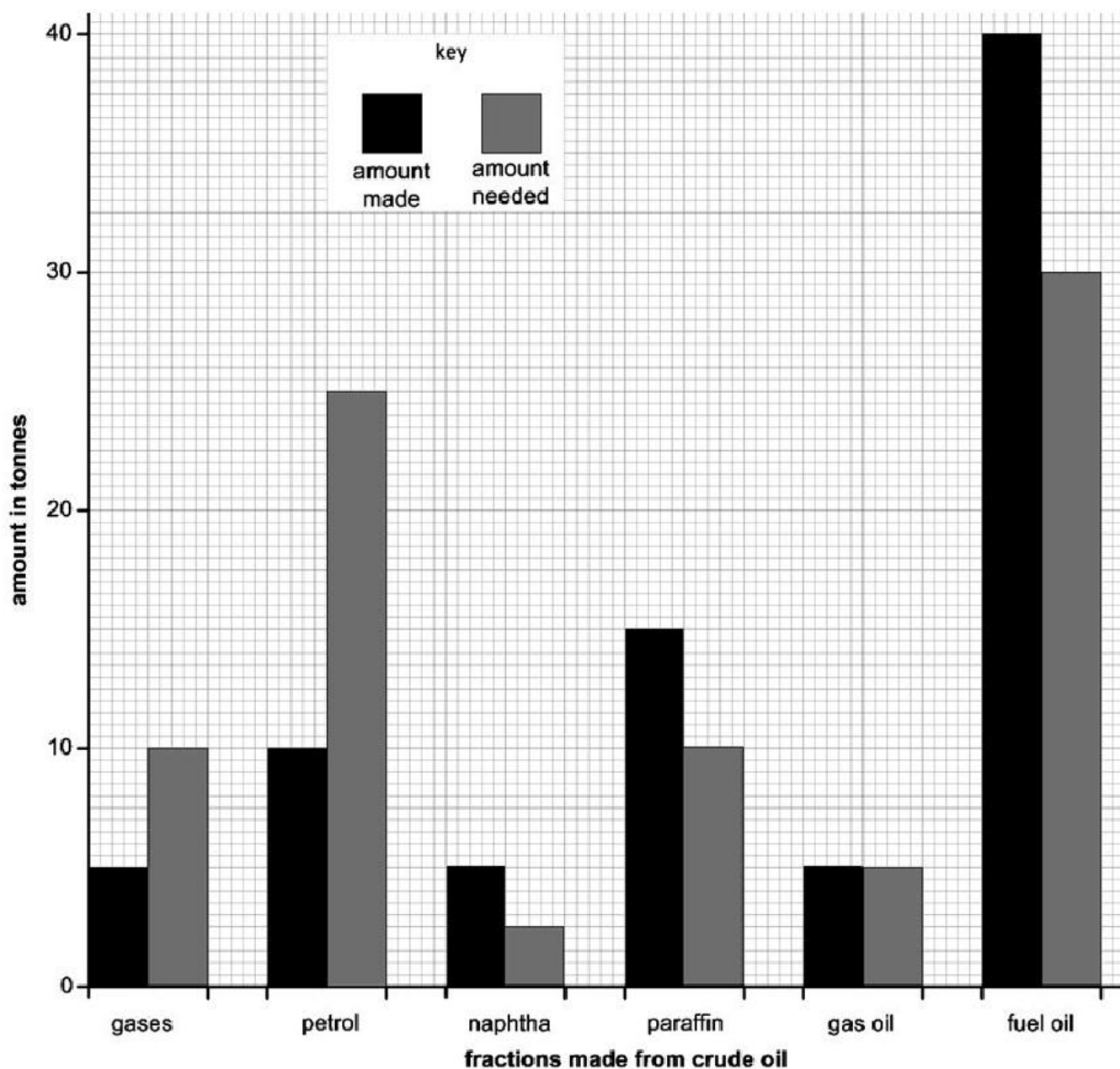
(b). The alkane, $C_{15}H_{32}$, is cracked to make an alkene, C_6H_{12} and an alkane, C_3H_8 .

Construct the **balanced symbol** equation for this reaction.

[1]

7. The bar chart shows the amount of some of the fractions made from 100 tonnes of crude oil by fractional distillation.

It also shows the amount of each fraction needed for everyday uses.



Cracking converts large molecules into smaller more useful molecules to make the supply match the demand.

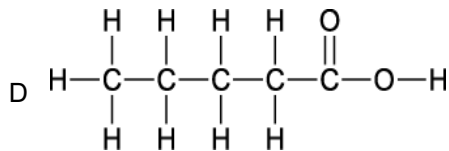
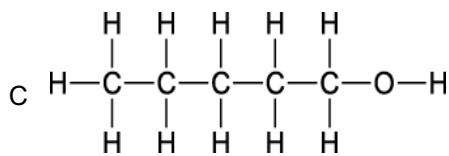
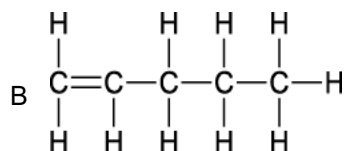
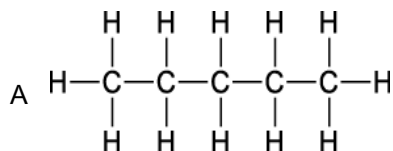
Which fractions are most likely to be cracked to make the supply match the demand?

- A gas oil and fuel oil
- B gas oil and petrol
- C naphtha, paraffin and fuel oil
- D petrol and gases

Your answer

[1]

8. Which displayed formula includes the functional group of an alcohol?

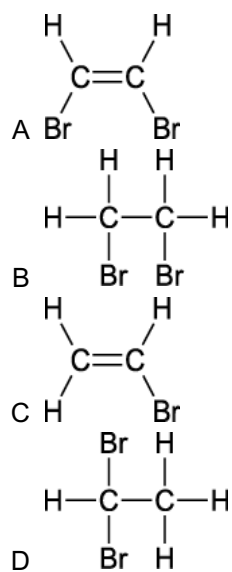


Your answer

[1]

9. A student bubbles ethene gas into bromine water.

Which displayed formula shows the product of this reaction?

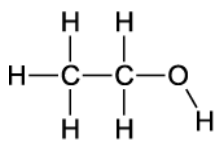


Your answer

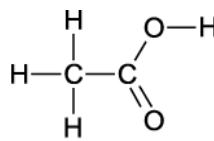
[1]

10. A student heats compound X with acidified potassium manganate(VII) solution.

The product of the reaction is compound Y.



X



Y

What is the colour change seen during this reaction?

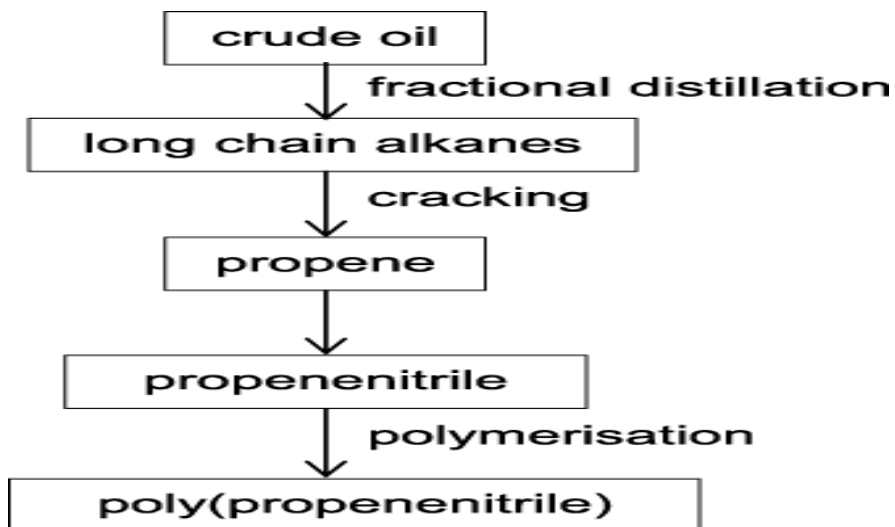
- A colourless to orange
- B colourless to purple
- C orange to colourless
- D purple to colourless

Your answer

[1]

11(a) Poly(propenenitrile) is an addition polymer.

Look at the flow chart. It shows how poly(propenenitrile) is made from crude oil.



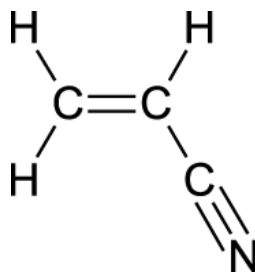
Crude oil is a complex mixture of hydrocarbons.

Fractional distillation separates this mixture.

Explain, in terms of intermolecular forces, fractional distillation.

[2]

(b). Look at the displayed formula for propenenitrile.



Propenenitrile is an unsaturated compound.

How you can tell from the displayed formula?

----- [1]

12. Perfumes, flavourings and nail varnish remover all contain an ester.

Esters are flammable.

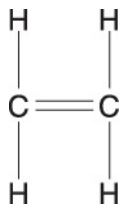
Describe how to do a simple experiment to make an ester including an explanation of the safety precautions you should take.



The quality of written communication will be assessed in your answer to this question.

----- [6]

13(a) Look at the displayed formula of ethene.



Why is ethene described as **unsaturated**?

----- [1]

(b). Bromine water is used to test for an alkene.

Ethene decolourises bromine water.

(i) What type of reaction is this?

----- [1]

(ii) What type of compound is formed in this reaction?

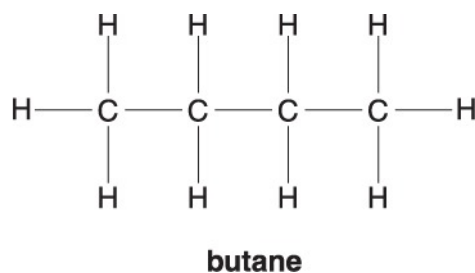
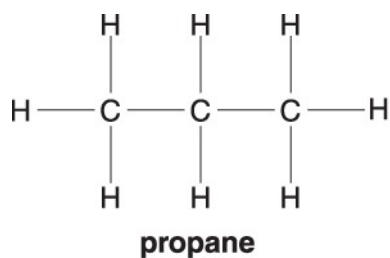
----- [1]

14. Ethene is used to make a **polymer**.

Write down the name of this polymer.

----- [1]

15(a) LPG contains propane and butane.



(i) Write down the **molecular formula** of butane.

answer _____

[1]

(ii) Look at the displayed formulas of propane and butane.

Propane and butane are **hydrocarbons**.

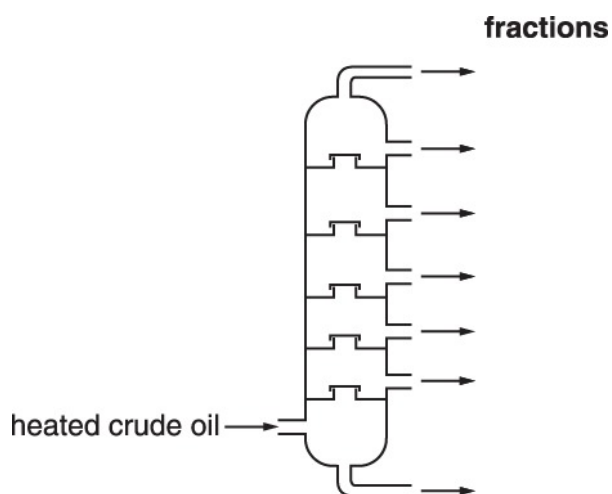
They are also **alkanes**.

Explain why they are both hydrocarbons and alkanes.

[3]

(b). Crude oil is separated into many fractions by fractional distillation.

The diagram shows a fractionating column.



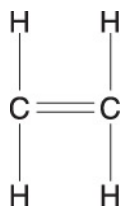
Look at the table. It shows the boiling point range for some of the fractions.

Fraction	Boiling point range in °C
bitumen	above 350
heating oil	240 to 350
paraffin	120 to 240
petrol	20 to 70
LPG	-160 to 20

Write down the name of the fraction which 'exits' from the **bottom** of the fractionating column.

----- [1]

16. Look at the displayed formula of ethene.



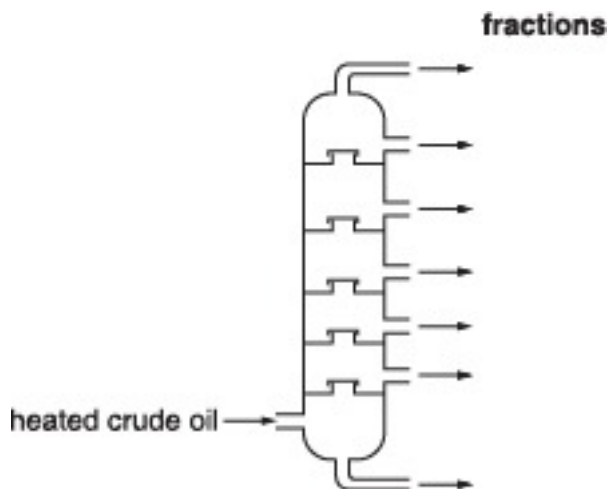
Poly(ethene) is used to make plastic bags.

Draw the displayed formula of poly(ethene).

[2]

17(a) Crude oil is separated into many fractions by fractional distillation.

The diagram shows a fractionating column.



Look at the table. It shows the boiling point range for some of the fractions.

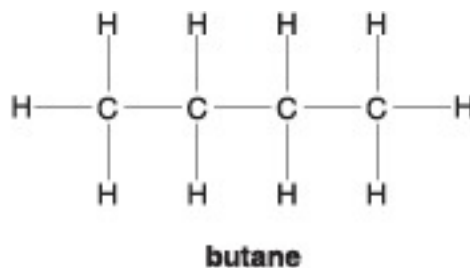
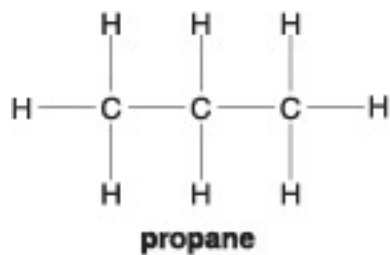
Fraction	Boiling point range in °C
bitumen	above 350
heating oil	240 to 350
paraffin	120 to 240
petrol	20 to 70
LPG	?160 to 20

Write down the name of the fraction which 'exits' from the **bottom** of the fractionating column.

Explain your answer.

[2]

(b). LPG contains propane and butane.



(i) Write down the **number of atoms** in a molecule of **butane**.

answer _____

[1]

(ii) Look at the displayed formulas of propane and butane.

Propane and butane are **hydrocarbons**.

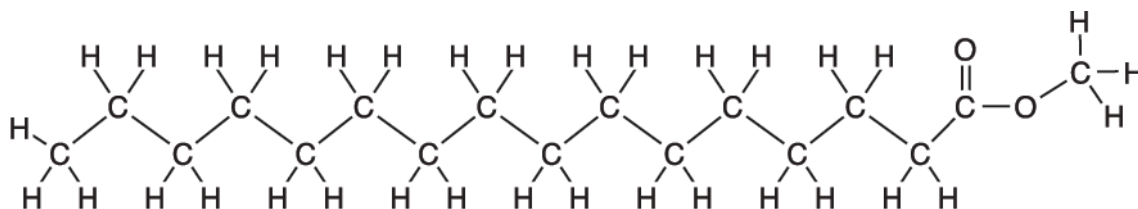
They are also **alkanes**.

Explain why they are both hydrocarbons and alkanes.

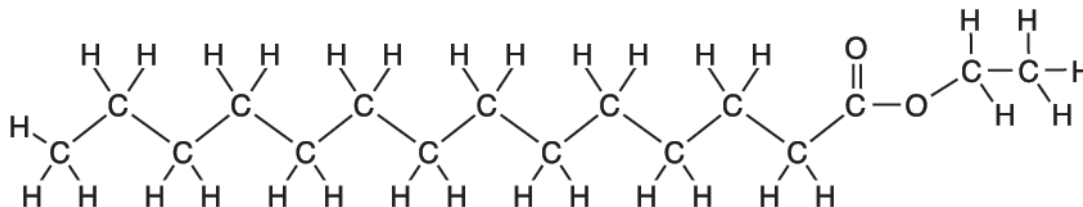
[3]

18. Look at the diagrams. They show the displayed formulas of some fats and oils.

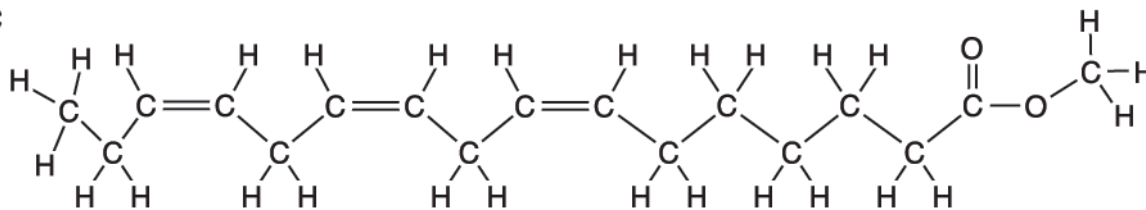
Formula A



Formula B



Formula C



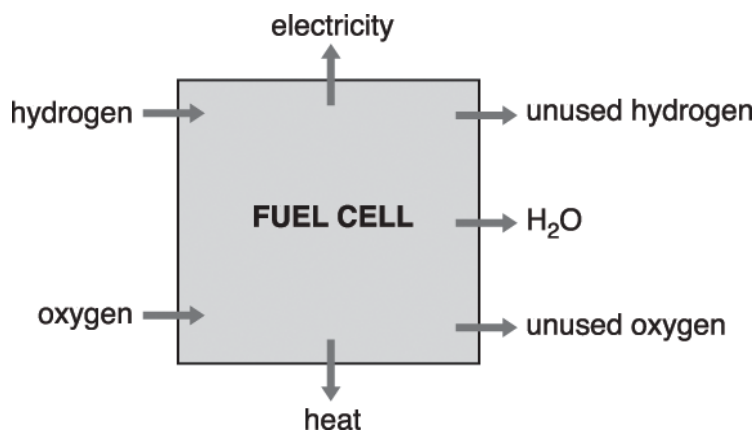
Which formula is **unsaturated**?

Explain your answer.

[2]

19(a) Fuel cells are used to make electricity.

Look at the diagram. It shows what happens in a fuel cell.



What is the name of the fuel used in this fuel cell?

----- [1]

(b). In this fuel cell, hydrogen, H_2 , reacts with oxygen, O_2 . Water, H_2O , is made.

Write a **balanced symbol** equation for this reaction.

----- [2]

(c). The burning of fossil fuels makes waste products that cause pollution.

This fuel cell does **not** make waste products that cause pollution.

Explain why.

----- [1]

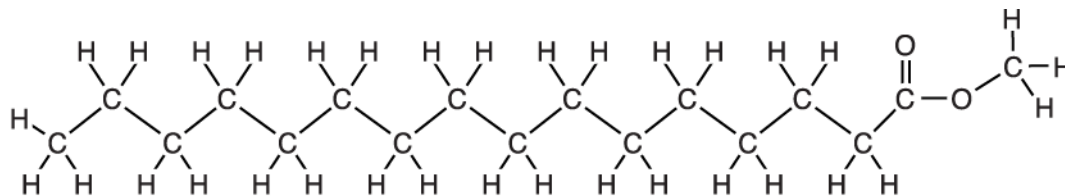
(d). Fuel cells are used to provide electrical energy in spacecraft.

Write down one **other advantage** of using fuel cells in spacecraft.

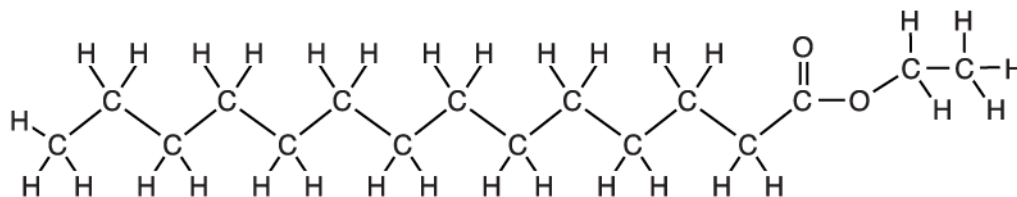
----- [1]

20. Look at the diagrams. They show the displayed formulas of some fats and oils.

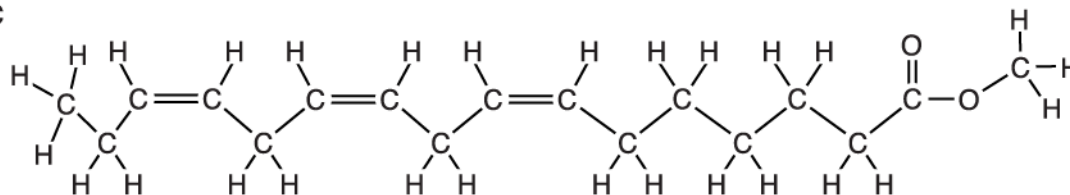
Formula A



Formula B



Formula C



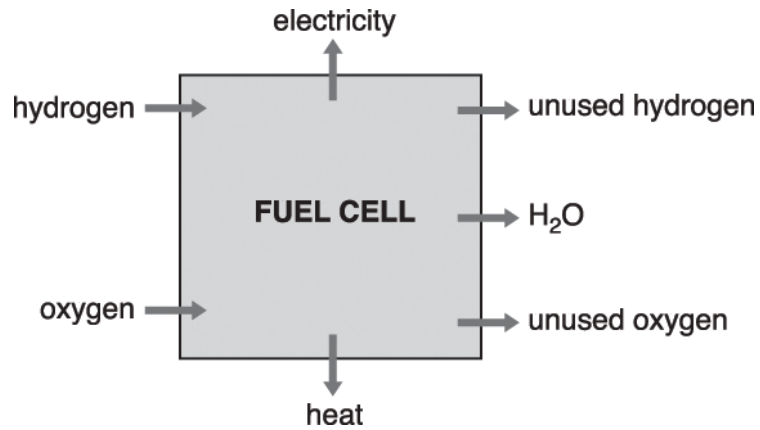
Which formula is **unsaturated**?

Explain your answer.

[2]

21. Fuel cells are used to make electricity.

Look at the diagram. It shows what happens in a fuel cell.



Hydrogen-oxygen fuel cells produce water.

Water is not a pollutant.

Fuel cells still cause pollution.

Write down two ways that fuel cells can cause pollution.

1

2

[2]

22. Some fats are **unsaturated**.

Describe a chemical test to show that a fat is unsaturated.

test -----

result -----

[2]

23(a) Glucose reacts to make carbon dioxide and ethanol.

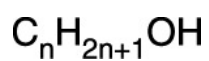
Look at the formulas.

Substance	Formula
glucose	$C_6H_{12}O_6$
carbon dioxide	CO_2
ethanol	C_2H_5OH

Write down the **balanced symbol** equation for this reaction.

----- [2]

(b). The general formula for an alcohol is



Propanol contains three carbon atoms.

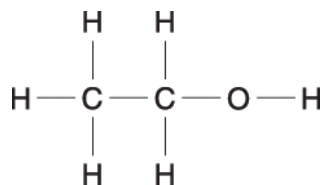
(i) Write the formula for propanol.

----- [1]

(ii) Draw the **displayed formula** of propanol.

24. Ethanol, propanol and butanol are alcohols.

Look at the displayed formula of ethanol.



Alcohols have the general formula $\text{C}_n\text{H}_{2n+1}\text{OH}$.

(i) A molecule of propanol has 3 carbon atoms.

Write the formula of propanol.

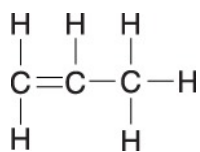
----- [1]

(ii) Draw the **displayed** formula of butanol, $\text{C}_4\text{H}_9\text{OH}$.

[1]

25. Poly(propene) is a polymer made from propene.

Look at the displayed formula for propene.

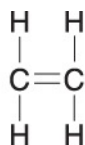


Draw the displayed formula for poly(propene).

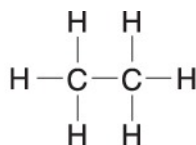
[2]

26(a) This question is about compounds containing carbon.

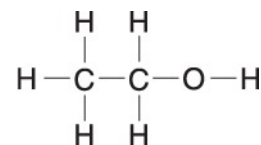
Look at the displayed formulas of some compounds.



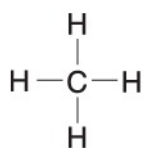
compound **A**



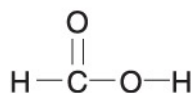
compound **B**



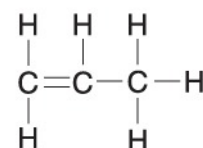
compound **C**



compound **D**



compound **E**



compound **F**

Two compounds are **unsaturated**.

Which two?

----- and -----

[1]

(b). Explain why compound **B** is a hydrocarbon but compound **C** is not a hydrocarbon.

[3]

(c). What is the **molecular formula** for compound **B**?

[1]

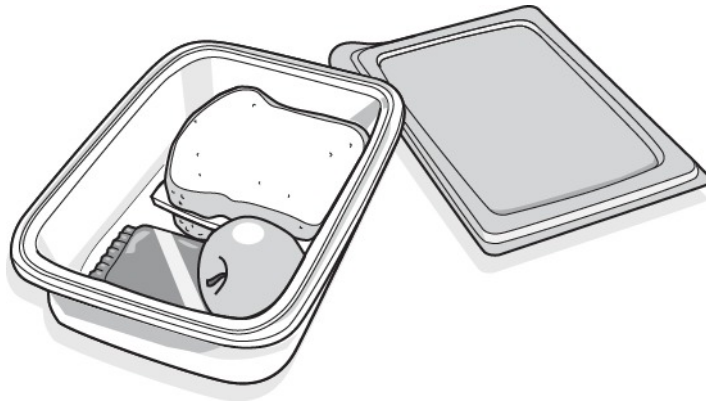
27. A power station burns methane, CH₄.

Construct a **balanced symbol** equation for the complete combustion of methane.

----- [2]

28. Poly(propene) is used to make sandwich boxes.

Look at Anna's sandwich box. It contains the sandwiches for her lunch.



One of the properties of poly(propene) is that it is flexible.

Explain **why** poly(propene) is flexible and suggest, with reasons, two **other** properties needed by poly(propene) to be suitable for making a sandwich box.



The quality of written communication will be assessed in your answer to this question.

----- [6]

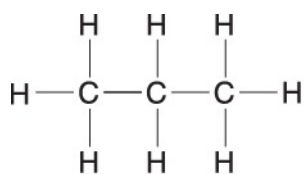
29. The LPG fraction of crude oil contains propane gas, C_3H_8 .

Write a **balanced symbol** equation for the **incomplete** combustion of propane in oxygen, O_2 .

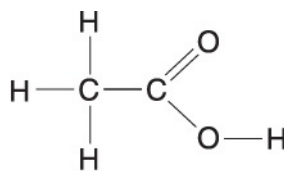
Only carbon monoxide, CO , and water are made.

----- [2]

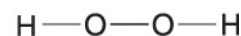
30(a) Look at the displayed formulas of some compounds.



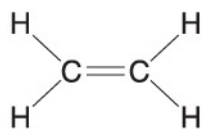
compound **A**



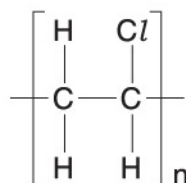
compound **B**



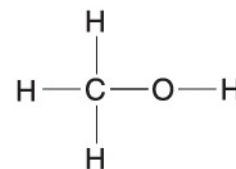
compound **C**



compound **D**



compound **E**



compound **F**

Compound **F** is **not** a hydrocarbon.

Explain how you can tell from the displayed formula.

----- [1]

(b). Which compound is an **unsaturated** hydrocarbon?

Choose from **A, B, C, D, E** or **F**.

[1]

(c). Which compound is a **polymer**?

Choose from **A, B, C, D, E** or **F**.

[1]

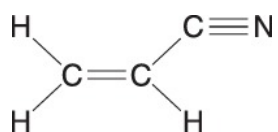
(d). Compound D makes an addition polymer.

Draw the **displayed formula** of this addition polymer.

31. Stowmarket Synthetics is a chemical company that makes polymers.

[1]

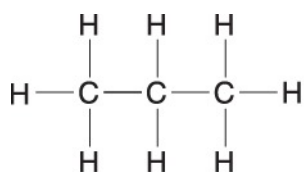
They make a polymer from a monomer called propenenitrile.



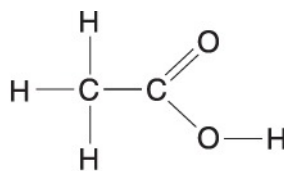
What is the name of the polymer made from propenenitrile?

----- [1]

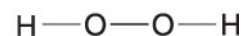
32(a) Look at the displayed formulas of some compounds.



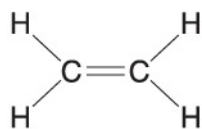
compound **A**



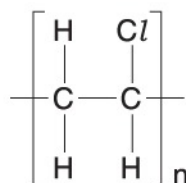
compound **B**



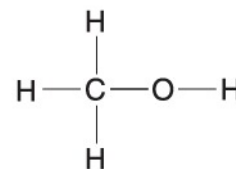
compound **C**



compound **D**



compound **E**



compound **F**

Write down a compound that is a **hydrocarbon**.

Choose from **A, B, C, D, E** or **F**.

[1]

(b). Look at the displayed formula for compound **B**.

How many **different elements** are in compound **B**?

[1]

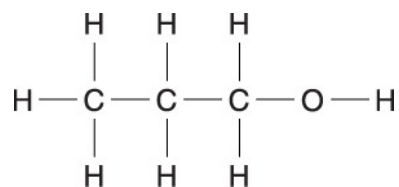
(c). Compound **E** is a polymer called poly(chloroethene).

Write down the name of the **monomer** that poly(chloroethene) is made from.

----- [1]

33(a) Propanol and ethanol are alcohols.

Look at the displayed formula of propanol.



Propanol is not a hydrocarbon. Explain why.

----- [2]

(b). Ethanol can be made from ethene.

Look at the word equation.



Write down the name of this type of reaction.

Choose from the list.

displacement

electrolysis

hydration

galvanising

answer ----- [1]

34. Fractional distillation separates crude oil into useful fractions.

Look at the table.

It shows some information about fractions obtained from crude oil.

Fraction	Boiling temperature in °C
bitumen	above 350
LPG	less than 40
fuel oil	300 – 350
heating oil	250 – 300
petrol	40 – 200
paraffin	200 – 250

Write about how fractional distillation separates crude oil into fractions and list the fractions in the position, from top to bottom, that they ‘exit’ the fractionating column.



The quality of written communication will be assessed in your answer to this question.

[6]

35. Hexane burns in a limited supply of oxygen.

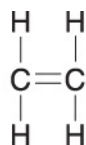
Incomplete combustion happens.

Write a **word equation** for the **incomplete** combustion of hexane.

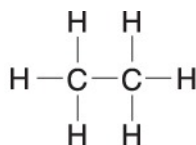
[1]

36(a) This question is about compounds containing carbon.

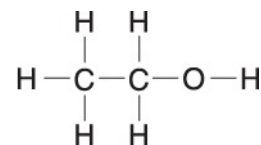
Look at the displayed formulas of some compounds.



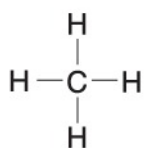
compound **A**



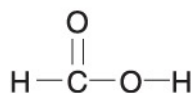
compound **B**



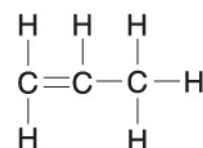
compound **C**



compound **D**



compound **E**



compound **F**

Two compounds have molecules that contain only **five** atoms.

Which two?

----- and -----

[1]

(b). Two compounds decolourise bromine water.

Which two?

----- and -----

[1]

(c). Explain why compound **B** is a hydrocarbon but compound **C** is not a hydrocarbon.

[3]

37. Crude oil is a mixture of hydrocarbons.

Crude oil is separated into useful fractions.

Which of these mixtures of substances could be in a fraction from crude oil?

A C_2H_4 , C_4H_{10} , $C_4H_{10}O$

B C_2H_4 , C_2H_3Br , C_4H_{10}

C C_2H_6 , C_3H_8 , C_4H_{10}

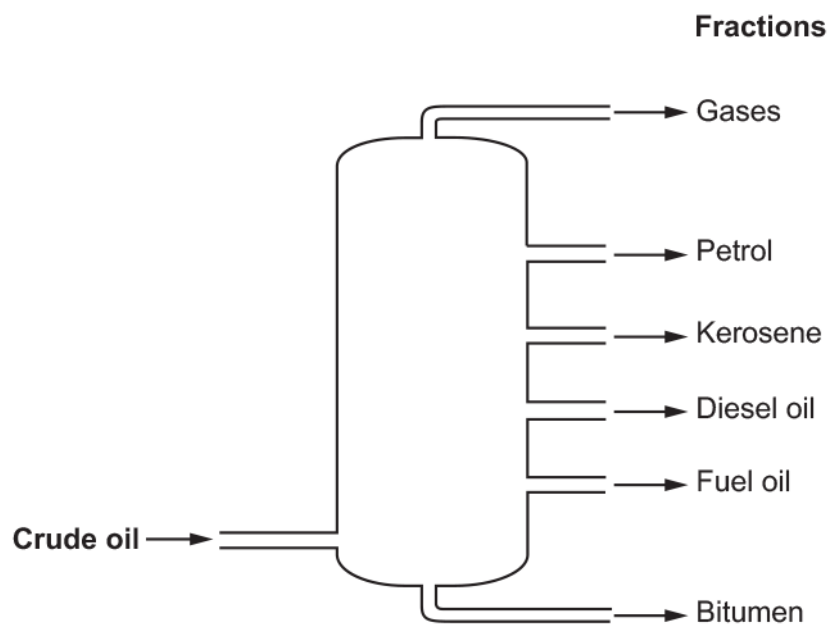
D C_2H_6 , C_2H_3Br , $C_4H_{10}O$

Your answer

[1]

38. Crude oil is separated into useful fractions by fractional distillation.

The diagram shows the useful fractions made in fractional distillation.



Which of these fractions has the **weakest** intermolecular forces?

- A Bitumen
- B Diesel oil
- C Gases
- D Petrol

Your answer

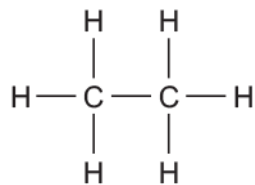
[1]

39(a) Ethane belongs to the **homologous series** called the alkanes.

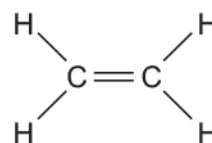
What is the name of the homologous series that **ethene** belongs to?

----- [1]

(b). A student has two test tubes. One contains **ethane** and one contains **ethene**.



Ethane



Ethene

The student added **bromine water** to each test tube.

Describe what she observes.

Ethane -----

Ethane -----

[2]

(c). This question is about hydrocarbons.

The table shows some information about alkanes.

Name of alkane	Molecular formula	Structure
Methane	CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
Ethane	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
.....	C ₄ H ₁₀

Complete the table.

[3]

(d). Ethane is a **saturated hydrocarbon**.

Explain why ethane is called both a hydrocarbon **and** saturated.

----- [2]

40. What type of reaction takes place between an alkene and hydrogen?

- A Addition
- B Dehydration
- C Neutralisation
- D Thermal decomposition

Your answer

[1]

41(a) Crude oil is separated into useful fractions using fractional distillation.

The table shows the percentages of crude oil fractions from different oil wells.

Fraction	Percentage of fraction in crude oil		
	Oil well X	Oil well Y	Oil well Z
LPG	2	7	10
Petrol	3	10	25
Paraffin	6	15	20
Diesel	7	11	15
Fuel oil	26	29	28
Bitumen	56	28	2

Which oil well contains the highest percentage of low boiling point fractions?

Tick (✓) **one** box.

X

Y

Z

[1]

(b). A barrel of crude oil from oil well Y has a mass of 139 kg.

Calculate the mass of **fuel oil** in this barrel.

Mass = kg [2]

(c). Fractions from crude oil contain alkanes.

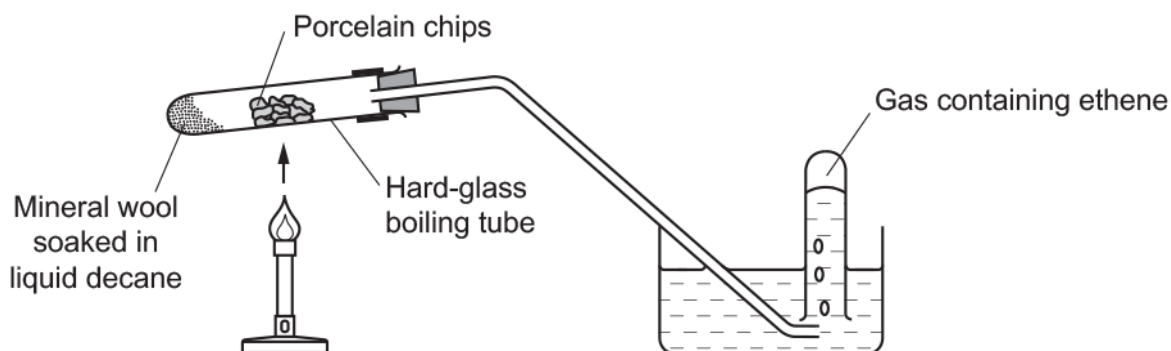
Alkanes have the general formula C_nH_{2n+2} .

Write the formula of hexadecane, the alkane with 16 carbon atoms.

[1]

(d). A sample of decane was cracked.

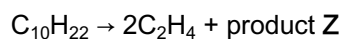
Look at the diagram of the apparatus used.



(i) Describe how this apparatus is used to produce ethene from decane.

[2]

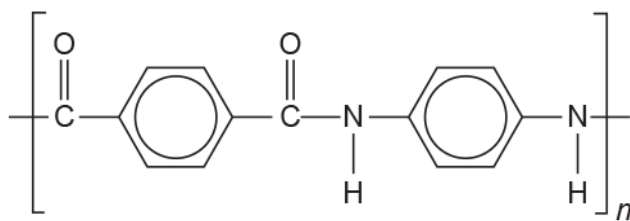
(ii) One molecule of decane, $C_{10}H_{22}$, produced two molecules of ethene, C_2H_4 , and one molecule of product Z.



Write the formula for product Z.

[1]

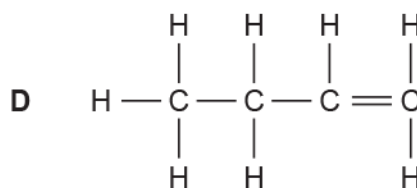
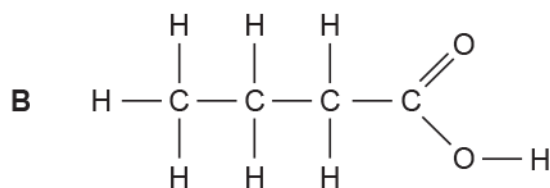
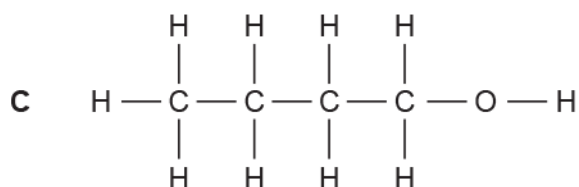
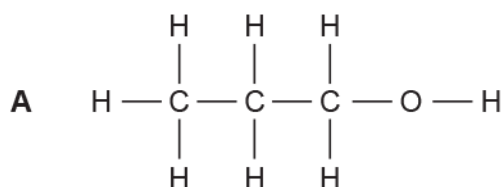
42. Look at the structure of Kevlar®.



What type of molecule is Kevlar®?

[1]

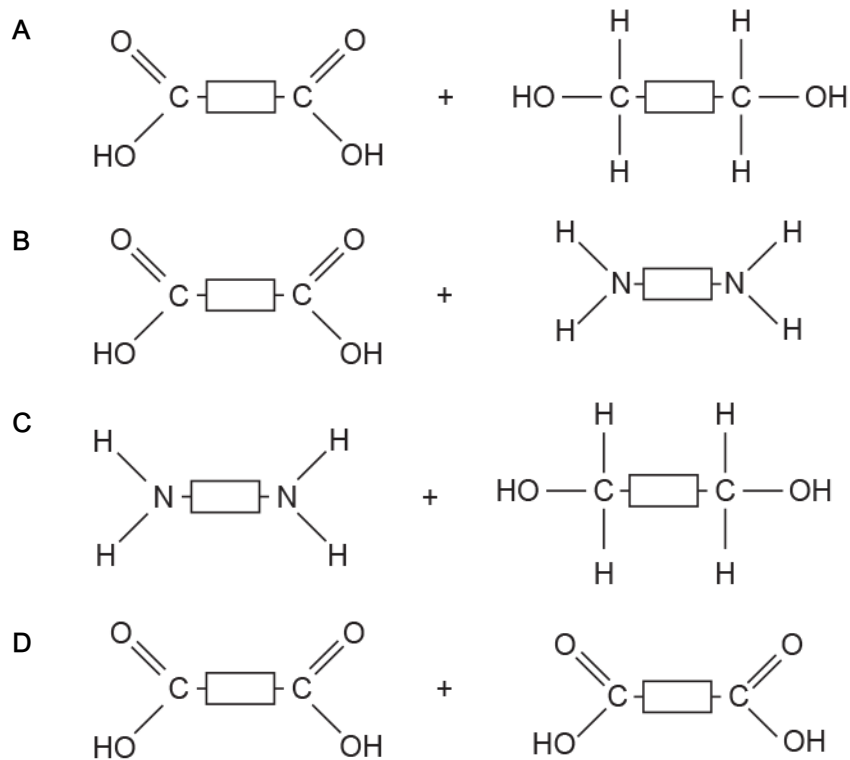
43. Which displayed formula shows butanol?



Your answer

[1]

44. Which pairs of molecules would react to form a polyester?



Your answer

[1]

45. Which statement explains why polyamides are condensation polymers?

- A A molecule of water forms each time a hydroxyl link forms.
- B A molecule of water forms each time an ester link forms.
- C A molecule of water forms each time an amine group reacts with a carboxylic acid group.
- D A molecule of water forms each time an alcohol group reacts with a carboxylic acid group.

Your answer

[1]

46(a) Look at the monomers shown in the table.

Monomer	Structure
Ethene	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$
Ethane-1,2-diol	$\begin{array}{ccccccc} & & \text{H} & & \text{H} & & \\ & & & & & & \\ \text{H} & - & \text{O} & - & \text{C} & - & \text{C} & - & \text{O} & - & \text{H} \\ & & & & & & \\ & & \text{H} & & \text{H} & & \end{array}$
Ethanedioic acid	$\begin{array}{c} & & \text{O} & & \\ & & & & \\ \text{HO} & - & \text{C} & - & \text{C} & - & \text{OH} \\ & & & & \\ & & \text{O} & & \end{array}$

Two of the monomers from the table react to form a polymer which is a **polyester**.

Explain, using the appropriate monomers from the table, how the polyester is formed.

Include the **type of polymerisation** and an **equation for the reaction** in your answer.

[4]

(b). An alcohol, X, has the formula C_3H_7OH .

Alcohol X can be oxidised to a compound, Y, with the molecular formula $C_3H_6O_2$.

(i) Compound Y is **not** an alcohol but is a member of another homologous series.

Write down the name of this homologous series.

----- [1]

(ii) Draw the **displayed formula** of a molecule of alcohol X and of a molecule of compound Y.

Show all the covalent bonds.

Alcohol X

Compound Y

[2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			A	1	
			Total	1	
2			C	1	
			Total	1	
3			D	1	
			Total	1	
4			C	1	
			Total	1	
5			C	1	
			Total	1	
6	a		Tall column with condensers coming off at different heights (1) Column heated at the bottom so hot at the bottom and cool at the top (1) Substances with high boiling points condense at the bottom (1) Substances with low boiling points condense at the top (1)	4	
	b		$C_{15}H_{32} \rightarrow 2C_6H_{12} + C_3H_8$ (1)	1	ALLOW any correct multiple
			Total	5	
7			C	1	
			Total	1	
8			C	1	
			Total	1	
9			B	1	
			Total	1	
10			D	1	
			Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
11	a	Fractions have different boiling points (1) Idea that larger molecules have stronger intermolecular forces (1)	2	Answer must be comparative ALLOW ORA
	b	Has a carbon-carbon double bond (1)	1	ALLOW has C=C ALLOW answer indicated on the displayed formula Has a double bond is not sufficient
		Total	3	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
12	<p>[Level 3] Answer describes how an ester is made in a laboratory, including that the reactants must be mixed or heated together AND applies knowledge of safety and risk assessment to give at least two safety precautions used in the preparation of an ester, one involving the problems of heating a flammable liquid. Quality of written communication does not impede communication of science at this level.</p> <p style="text-align: right;">(5–6 marks)</p> <p>[Level 2] Candidates recall the names of both reactants AND applies knowledge of safety and risk assessment to give two safety precautions used in the preparation of an ester. Quality of written communication partly impedes communication of science at this level.</p> <p style="text-align: right;">(3–4 marks)</p> <p>[Level 1] Candidates recall the name of one reactant used to make an ester OR applies knowledge of safety and risk assessment to give at least one safety precaution used in the preparation of an ester. Quality of written communication impedes communication of science at this level.</p> <p style="text-align: right;">(1–2 marks)</p> <p>[Level 0] Insufficient or irrelevant science such as repeating the question. Answer not worthy of credit.</p> <p style="text-align: right;">(0 marks)</p>	6	<p>This question is targeted up to grade C</p> <p>Indicative scientific points may include:</p> <ul style="list-style-type: none"> • safety precautions include use of safety glasses, gloves, safety screen, fire extinguisher, water bath, laboratory coats etc • reagents are heated together in a beaker or in a test tube in a water bath • reagents are heated together • the reagents are mixed together • alcohols react with acids to make ester • higher level answers may refer to methods that use refluxing and distillation • sulfuric acid added as a catalyst to the reaction mixture • reaction mixture is added to sodium carbonate solution <p>Use the L1, L2, L3 annotations in scoris. Do not use ticks.</p> <p>Examiner's Comments</p> <p>Candidates often found this question about the preparation of esters challenging.</p> <p>Many candidates knew the word equation, or the reactants, but some confused the acid with a mineral acid and the experiment with neutralisation by titration. A considerable number of candidates did not refer to making an ester at all. A common misconception was to describe the safety precautions associated with the use of perfumes rather than during the preparation of an ester.</p>
	Total	6	

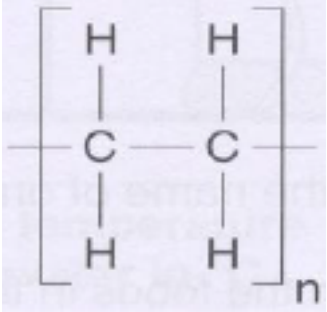
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a		contains a double bond (between carbon atoms) (1)	1	<p>not double bond between carbon molecules ignore does not have the maximum amount of hydrogen atoms</p> <p>Examiner's Comments</p> <p>This question focused on the chemistry of ethene.</p> <p>Many candidates recognised the importance of the double bond.</p>
	b	i	addition reaction (1)	1	<p>allow bromination</p> <p>Examiner's Comments</p> <p>Were challenging and only a small proportion of the candidates described the addition reaction and named the compound type correctly.</p>
		ii	a dibromocompound (1)	1	<p>allow saturated / halogenocompound</p> <p>Examiner's Comments</p> <p>Were challenging and only a small proportion of the candidates described the addition reaction and named the compound type correctly.</p>
			Total	3	
14			poly(ethene) (1)	1	<p>allow polythene (1) allow polyethene (1)</p> <p>Examiner's Comments</p> <p>About half of all candidates correctly named polyethene. 'Nylon', 'polystyrene' and 'polyethane' were the most common incorrect responses.</p>
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	C ₄ H ₁₀ (1)	1	<p>not C₄H₁₀ / C⁴H¹⁰ allow H₁₀C₄</p> <p>Examiner's Comments</p> <p>Candidates were often able to write the molecular formula and only a small proportion of the candidates used superscripts rather than subscripts.</p>
		ii	<p>propane and butane contain carbon and hydrogen (atoms) (1) only (1)</p> <p>has (carbon to carbon) single bonds only / contains single (covalent) bonds only (1)</p>	3	<p>not is a mixture of carbon and hydrogen (only) not contains carbon and hydrogen molecules</p> <p>Only must be linked to first marking point and is not independent</p> <p>allow has no (carbon to carbon) double bonds (1) allow they are saturated compounds (1) allow has general formula C_nH_{2n+2} (1) ignore has the maximum amount of hydrogen atoms</p> <p>Examiner's Comments</p> <p>Candidates were often able to write the molecular formula. Many candidates could explain why propane and butane are hydrocarbons but were often not able to explain why these hydrocarbons are alkanes. A common misconception was that the molecules had single bonds between molecules rather than between the carbon atoms. Other candidates gave imprecise answers and did not refer to the molecules only having single bonds.</p>
	b		bitumen (1)	1	<p>allow phonetic spelling</p> <p>Examiner's Comments</p> <p>Many candidates could interpret the data in the table.</p>
			Total	5	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
16	 <p>correct repeat unit drawn with open bonds at both ends (1)</p> <p>correct use of brackets and n (1)</p>	2	<p>second mark is dependent on first mark</p> <p>allow multiples of this structure eg $?(CH_2CH_2CH_2CH_2)_n$ for two marks</p> <p>allow one mark for a section of the polymer that has at least two repeat units with open ends at both ends</p> <p>Examiner's Comments</p> <p>Many candidates correctly drew the displayed formula of poly(ethene). Common errors were drawing a double bond between the carbon bonds or omitting the open bonds at one or both ends of the monomer unit.</p>
	Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance	
17	a	bitumen (1) (bitumen) has the highest boiling point (range) (1)	2	<p>allow phonetic spelling</p> <p>this mark is dependent on the correct fraction being chosen</p> <p>allow hottest boiling point (1)</p> <p>allow needs the highest temperature to be boiled (1)</p> <p>allow its boiling point is above 350oC (1)</p> <p>allow it's the highest temperature at the bottom (1)</p> <p>ignore it's the hottest</p> <p>Examiner's Comments</p> <p>Most candidates scored 1 mark, usually for the idea that non-renewable fuels are finite. Fewer gained the second mark for taking a long time to form. The main error was candidates who stated 'it can't be used again'.</p>	
	b	i	14 (1)	<p>Examiner's Comments</p> <p>Was well answered by most candidates.</p>	
		ii	propane and butane contain carbon and hydrogen (atoms) (1) only (1) has (carbon to carbon) single bonds only / contains single (covalent) bonds only (1)	3	<p>not is a mixture of carbon and hydrogen (only)</p> <p>not contains carbon and hydrogen molecules</p> <p>Only must be linked to first marking point and is not independent</p> <p>allow has no (carbon to carbon) double bonds (1)</p> <p>allow they are saturated compounds (1)</p> <p>allow has general formula C_nH_{2n+2} (1)</p> <p>Examiner's Comments</p> <p>Differentiated well. Most candidates stated that hydrocarbons contain carbon and hydrogen for 1 mark. The addition of 'only' gained the second mark. The third mark was the most challenging, with candidates needing to state that alkanes contain single bonds only.</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	6	
18			formula C (1) because it contains (a) carbon to carbon double bond(s) (1)	2	<p>allow contains C=C (double bonds) (1)</p> <p>must be clear it is a carbon-carbon double bond and not a carbon-oxygen double bond</p> <p>ignore carbon double bond / double carbon bond</p> <p><u>Examiner's Comments</u></p> <p>Almost half of candidates could identify formula C as unsaturated. Far fewer could explain their selection by talking about carbon to carbon double bonds. Many just stated 'C has double bonds without realising there were carbon to oxygen double bonds in all the molecules. Statements such as carbon double bond or double carbon bond were insufficient to score the second mark.</p>
			Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
19	a	hydrogen (1)	1	<p>allow H or H₂ (1) not hydrogen and oxygen or hydrogen / oxygen</p> <p>Examiner's Comments</p> <p>Only about a quarter of candidates correctly stated hydrogen from the diagram. 'Coal' and 'petrol' were commonly stated.</p>
	b	<p>2H₂ + O₂ ? 2H₂O</p> <p>correct formulae (1)</p> <p>balancing (1) balancing mark is conditional on correct formulae</p>	2	<p>allow any correct multiple e.g. 4H₂ + 2O₂ ? 4H₂O (2)</p> <p>allow = or ? for arrow not 'and' or & for + allow one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. 2h₂ + O² ? 2H₂o</p> <p>Examiner's Comments</p> <p>The equation was generally well answered with stronger candidates scoring both marks for a fully correct equation and others 1 mark for the correct formulae for reactants and product. Weaker candidates often wrote H₂O₂ rather than H₂O.</p>
	c	idea that water is the only product (and is non polluting) (1)	1	<p>allow does not make carbon dioxide / does not make greenhouse gases (1) allow water and unused hydrogen and oxygen (1)</p> <p>Examiner's Comments</p> <p>Only better candidates scored this mark. They recognised that water was the product. Weaker candidates thought that hydrogen or oxygen were the products and failed to score.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d	provides water that astronauts can use / light / lightweight / low density / compact / no moving parts (1)	1	<p>allow idea that makes a usable product i.e. water (for astronauts) / can be used as drinking water</p> <p>ignore efficient / reliable</p> <p>Examiner's Comments</p> <p>The most common answers were that the astronauts could drink the water and that the fuel cell was compact. Answers such as 'efficient' or 'reliable' were insufficient to score.</p>
		Total	5	
20		<p>formula C (1)</p> <p>because it contains (a) carbon to carbon double bond(s) (1)</p>	2	<p>allow contains C=C (double bonds) (1)</p> <p>must be clear it is a carbon-carbon double bond and not a carbon-oxygen double bond</p> <p>ignore carbon double bond / double carbon bond</p> <p>?Examiner's Comments??</p> <p>Many candidates recognised that fat C was unsaturated however not all were able to explain precisely why this was so. Answers had to refer to the presence of carbon-carbon double bonds not just double bonds since the molecule also contained a carbon-oxygen double bond.</p>
		Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
21		<p>idea that fuel cells contain poisonous catalysts (which need to be disposed of) (1)</p> <p>(idea of pollution) from the burning of fossil fuels associated with fuel cell production or manufacture of raw materials (1)</p>	2	<p>allow catalyst could be pollutants (when disposed of) / contain harmful catalysts ignore dangerous catalysts</p> <p>allow makes waste when they are thrown away</p> <p>allow mining for some of the materials used in a fuel cell (will cause pollution)</p> <p>?Examiner's Comments??</p> <p>The most common answer referred to the poisonous catalyst although many candidates gave vague answers relating to manufacture and/or disposal.</p>
		Total	2	
22		<p>test - add bromine (water) (1)</p> <p>result - idea that bromine water loses its colour (1) – this mark is dependent on the correct reagent or a near miss e.g. bromide</p>	2	<p>allow Br₂ (1)</p> <p>allow decolourised / loses its colour / goes colourless (1) not goes clear / discoloured ignore initial colour of bromine</p> <p>Examiner's Comments</p> <p>A significant proportion of the candidates misinterpreted this question and described how to test for a fat rather than how to test for unsaturation. Those candidates that did chose bromine often gave the correct result for an unsaturated fat and the number of candidates using clear rather than colourless has reduced from previous sessions.</p>
		Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance	
23	a	$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ formulae (1) balancing – dependent on correct formulae (1)	2	allow C_2H_6O as formula for ethanol allow any correct multiple e.g. $2C_6H_{12}O_6 \rightarrow 4CO_2 + 4C_2H_5OH$ allow = or ? for arrow not “and” or & for + allow one mark for correct balanced equation with minor errors of case, subscript or superscript e.g. $C^6H^{12}O^6 \rightarrow 2CO_2 + 2C_2H_5OH$ Examiner's Comments Many candidates could construct the balanced equation. Only a small proportion of the candidates changed the formulae of either the reactant or the product.	
	b	i	C_3H_7OH / C_3H_8O (1)	1	Examiner's Comments Many candidates could use the general formula to calculate the formula for propanol.
		ii	$ \begin{array}{ccccccc} & H & H & H & & & \\ & & & & & & \\ H & -C & -C & -C & -O & -H & \\ & & & & & & \\ & H & H & H & & & \end{array} $ (1)	1	allow $ \begin{array}{ccccccc} & H & H & H & & & \\ & & & & & & \\ H & -C & -C & -C & -O & & \\ & & & & & & H \\ & H & H & H & & & \end{array} $ allow $ \begin{array}{ccccccc} & H & H & H & & & \\ & & & & & & \\ H & -C & -C & -C & -OH & & \\ & & & & & & \\ & H & H & H & & & (1) \end{array} $ (1) allow displayed formula for propan-2-ol Examiner's Comments Candidates often drew a correct displayed formula. The mark scheme allowed candidates to write the –O–H group as –OH but Centres should advise candidates that a proper displayed formula shows all of the bonds. Some candidates included pentavalent carbon atoms and others had oxygen atoms with a double bond. Another misconception was to have the –OH bond in the wrong order having C–H–O.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	4	
24		i	C ₃ H ₇ OH (1)	1	<p>allow C₃H₈O allow any order of atoms</p> <p>Examiner's Comments</p> <p>Candidates could use the general formula to calculate that the formula of propanol is C₃H₇OH.</p>
		ii	<p>correct displayed formula (1)</p> $ \begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ & & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{O} & - \text{H} \\ & & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & & \end{array} $	1	<p>allow displayed formula for methylpropan — 1 — ol or methylpropan — 2 — ol or butan-2-ol</p> <p>allow OH in displayed formula with no bond between O and H</p> <p>Examiner's Comments</p> <p>Some candidates could draw the displayed formula for butanol. Almost all displayed formula drawn were of the straight chain primary alcohol.</p>
			Total	2	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
25	<p>correct atoms and bonds without the double bond (1)</p> <p>brackets and n (1)</p>	2	<p>second marking point is dependent on the first</p> <p>allow more than 1 repeat unit</p> <p>allow round brackets</p> <p>allow</p> <p>Examiner's Comments</p> <p>Many candidates drew the displayed formula for poly(ethene), rather than for poly(propene). To score the marks candidates needed to draw the basic covalent structure of the polymer, including the correct use of brackets and 'n' to indicate many repeat units. Credit was also given to candidates who drew 2 or more repeat units. Candidates need to ensure that they include the bonds at the side in the polymer structure to gain credit. Structures containing double bonds or only 3 bonds on carbon atoms did not gain marks.</p>
	Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
26	a	A and F (1)	1	<p>both needed</p> <p>Examiner's Comments</p> <p>A and F were usually correct.</p>
	b	<p>B contains carbon and hydrogen (1) only / AW (1)</p> <p>C contains oxygen / has oxygen in the formula / does not contain only carbon and hydrogen (1)</p>	3	<p>allow (formula) has only (1) H and C (1) the only is not an independent mark and must be linked to the carbon and hydrogen</p> <p>not contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen</p> <p>not hydro atoms but ignore for the third marking point</p> <p>allow C has three elements / C has three different atoms (1)</p> <p>not C contains oxygen molecules</p> <p>Examiner's Comments</p> <p>Most candidates explained that compound B is a hydrocarbon as it contains carbon and hydrogen only. They appreciated that compound C was not a hydrocarbon as it contained an oxygen atom. When candidates did not gain credit it was usually because they referred to B containing 'only carbon and hydrogen <i>molecules</i>'.</p>
	c	C ₂ H ₆ /H ₆ C ₂ (1)	1	<p>the numbers must clearly be subscripts</p> <p>not C²H⁶/C2H6</p> <p>Examiner's Comments</p> <p>The molecular formula for compound B was usually correct.</p>
		Total	5	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
27		$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ correct reactants and products (1) balancing – dependent on correct reactants and products (1)	2	<p>allow any correct multiple, including fractions allow = / ? instead of ? not and / &</p> <p>balancing mark is dependent on the correct formulae but allow 1 mark for a balanced equation with minor errors in subscripts / formulae e.g. $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$</p> <p>Examiner's Comments</p> <p>This question required candidates to write a balanced symbol equation for the complete combustion of methane in oxygen. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they wrote an incorrect formula for water, e.g. H_2, or failed to balance the oxygen atoms on the left hand side of the equation.</p>
		Total	2	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
28	<p>Level 3 Two properties needed by the plastic are explained AND the flexibility of poly(propene) is explained in terms of the structure and bonding. Quality of communication does not impede communication of science at this level. (5–6 marks)</p> <p>Level 2 The flexibility of poly(propene) is explained in terms of the structure and bonding OR two properties needed by the plastic are explained OR one property of the plastic is explained and an attempt to explain why poly(propene) is flexible. Quality of written communication partly impedes communication of the science at this level. (3 - 4 marks)</p> <p>Level 1 One property needed by the plastic is explained OR an attempt to explain why poly(propene) is flexible. Quality of communication impedes communication of the science at this level. (1 - 2 marks)</p> <p>Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A⁺</p> <p>Indicative scientific points for level 3 may include:</p> <ul style="list-style-type: none"> • Poly(propene) molecules are attracted to one another by weak intermolecular forces or bonds that are easy to overcome • Poly(propene) molecules need very little energy to be separated • Poly(propene) molecules can slide over each other • Poly(propene) has atoms held together by strong covalent bonds <p>Indicative scientific points for all levels may include:</p> <ul style="list-style-type: none"> • Non-biodegradable so the plastic does not rot or decay • Insoluble in water or waterproof so that the sandwich box can be washed clean / so it will not dissolve / so moist foods can be stored • Non-toxic material so it will not contaminate the food or make the food dangerous to eat • Non-reactive or inert so will not react with chemicals in the food • Non-permeable so water doesn't reach the food <p>ignore references to can be coloured / is strong / tough / durable / light or lightweight / ard / easily moulded / insulator / does not melt (in hot water)</p> <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks</p> <p>Examiner's Comments</p> <p>This 6 mark question was targeted at all grades up to, and including, grade A⁺ and discriminated well. At level 3 (5-6 marks)</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					all aspects of the question needed to be addressed and candidates were required to explain why poly(propene) is flexible and suggest and explain two other properties needed by a plastic used to make a lunchbox. When candidates did not gain full credit it was usually because they gave properties of the plastic which were not relevant or did not fully explain the flexibility of poly(propene) in terms of weak intermolecular forces that are easy to overcome, allowing the polymer chains to slide over each other.
			Total	6	
29			$C_3H_8 + 3\frac{1}{2}O_2 \rightarrow 3CO + 4H_2O$ formulae (1) balancing (1)	2	<p>allow any correct multiple, including fractions allow = / ? instead of ? not and / &</p> <p>balancing mark is dependent on the correct formula but allow 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc eg $C_3H_8 + 3\frac{1}{2}O_2 \rightarrow 3CO + 4H_2O$</p> <p>Examiner's Comments</p> <p>This question required candidates to write a balanced symbol equation for the incomplete combustion of propane in oxygen. This was a challenging equation for candidates. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they wrote an incorrect formula for carbon monoxide, e.g. CO_2, or failed to balance the oxygen atoms on the left hand side of the equation.</p>
			Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
30	a	(formula) does not contain only carbon and hydrogen / (formula) does contain oxygen (1)	1	<p>not (formula) contains an oxygen molecule</p> <p>Examiner's Comments</p> <p>Most candidates appreciated that compound F was not a hydrocarbon as it contained an oxygen atom.</p>
	b	D (1)	1	<p>Examiner's Comments</p> <p>D was usually correct.</p>
	c	E (1)	1	<p>Examiner's Comments</p> <p>E was usually correct.</p>
	d	$\left[\begin{array}{cc} \text{H} & \text{H} \\ & \\ -\text{C} & - & \text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right]_n$ <p style="text-align: center;">(1)</p>	1	<p>allow</p> $\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ -\text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ <p>or other carbon chain with even number of CH₂ units</p> <p>Examiner's Comments</p> <p>Many candidates drew the correct displayed formula for poly(ethene). To score the mark candidates needed to draw the basic covalent structure of the polymer, including the correct use of brackets and 'n' to indicate many repeat units. Credit was also given to candidates who drew 2 or more repeat units. Candidates need to ensure that they include the bonds at the side in the polymer structure to gain credit. Structures containing double bonds or only 3 bonds on carbon atoms did not gain marks.</p>
		Total	4	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
31		poly(propenenitrile) (1)	1	<p>allow polypropenenitrile</p> <p>Examiner's Comments</p> <p>This question was about polymers and plastics and included a question that assessed the quality of written assessment.</p> <p>Only a small proportion of candidates could name the polymer formed. The most common answers were propene or poly(propene). A significant proportion of the candidates did not attempt this question.</p>
		Total	1	
32	a	A / D (1)	1	<p>allow correct formula ticked, circled or underlined if answer line is blank</p> <p>Examiner's Comments</p> <p>Was well answered.</p>
	b	3 / three (1)	1	<p>Examiner's Comments</p> <p>Was well answered.</p>
	c	chloroethene (1)	1	<p>Examiner's Comments</p> <p>Candidates found it more difficult to identify the monomer that poly(chloroethene) is made from.</p>
		Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
33	a	<p>any one from:</p> <p>contains oxygen (1)</p> <p>has other elements other than hydrogen or carbon / has atoms besides hydrogen and carbon (1)</p> <p>does not contain just carbon and hydrogen (1)</p>	1	<p>allow has O in the formula</p> <p>allow hydrocarbons contain hydrogen and carbon only</p> <p>Examiner's Comments</p> <p>This was well answered. A few candidates incorrectly wrote about the lack of a double bond.</p>
	b	hydration (1)	1	<p>allow other ways of indicating correct response eg ringing or ticking the correct answer but answer line takes precedence</p> <p>Examiner's Comments</p> <p>Many candidates chose 'hydration' as the correct description of the reaction.</p>
		Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
34		<p>Level 3 (5-6 marks) Describes the process of fractional distillation and lists the fractions in correct order. Quality of written communication does not impede communication of the science at this level.</p> <p>Level 2 (3-4 marks) Describes the process of fractional distillation, but answer may be simplistic and lacking in detail</p> <p>OR lists the fractions in the correct order. Quality of written communication partly impedes communication of the science at this level.</p> <p>Level 1 (1-2 marks) Appreciates that fractional distillation works because of differences in boiling point. Quality of written communication impedes communication of the science at this level.</p> <p>Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.</p>	6	<p>This question is targeted at grades up to C.</p> <p>Indicative scientific points at levels 2 and 3 may include:</p> <ul style="list-style-type: none"> • crude oil is heated • fractionating column has temperature gradient (cold at top and hot at bottom) • fractions containing mixtures of hydrocarbons are obtained • order of fractions, from top, is LPG, petrol, paraffin, heating oil, fuel oils, bitumen. <p>allow higher level answers in terms of intermolecular forces and molecular size linked to boiling point</p> <p>Use the L1, L2, L3 annotations in scoris, do not use ticks.</p> <p>Examiner's Comments</p> <p>Many candidates could place the fractions in order of their boiling point and scored 4 marks. Fewer candidates considered the temperature gradient in the column and that the crude oil has to be heated.</p>
		Total	6	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
35		hexane + oxygen ? carbon + water or hexane + oxygen ? carbon monoxide + water or hexane + oxygen ? carbon + carbon monoxide + water (1)	1	<p>allow correct formula instead of names C_6H_{14}, O_2, C, H_2O and CO</p> <p>allow mix of names and correct formulae symbol equation, if given, does not need to be balanced</p> <p>ignore soot</p> <p>not '+ carbon dioxide' in products not '+ energy'</p> <p><u>Examiner's Comments</u></p> <p>Many candidates appreciated that incomplete combustion produces carbon monoxide and/or carbon in addition to water. Candidates who failed to gain credit usually included carbon dioxide as a product or used the word 'fuel' instead of hexane.</p>
		Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
36	a	D and E (1)	1	<p>both needed</p> <p><u>Examiner's Comments</u></p> <p>Many candidates could interpret the displayed formulae and recognise that D and E both had five atoms in a molecule.</p>
	b	A and F (1)	1	<p>both needed</p> <p><u>Examiner's Comments</u></p> <p>Candidates found this question much more demanding than (a) and did not recognise that the molecules had to contain a carbon-carbon double bond. Only a small proportion of the candidates wrote A and F.</p>
	c	<p>B contains carbon and hydrogen (1) only / AW (1)</p> <p>C contains oxygen / has oxygen in the formula / does not contain only carbon and hydrogen (1)</p>	3	<p>allow (formula) has only (1) H and C (1) the only is not an independent mark and must be linked to the carbon and hydrogen</p> <p>not contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen</p> <p>not hydro atoms but ignore for the third marking point</p> <p>allow C has three elements / C has three different atoms (1)</p> <p>not C contains oxygen molecules</p> <p><u>Examiner's Comments</u></p> <p>Candidates often gave very good explanations as to why B was hydrocarbon and C was not. The idea that hydrocarbons contain only hydrogen and carbon was well known. A common misconception was to refer to the presence of carbon and hydrogen molecules in a hydrocarbon.</p>
		Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37			C ✓	1(AO 2.1)	<p><u>Examiner's Comments</u></p> <p>Higher ability candidates tended to recognise that option C was the only option to consist solely of hydrocarbons. For the others, choices were fairly evenly split between options A, B and D although, interestingly, far fewer went for option D.</p>
			Total	1	
38			C ✓	1(AO 1.1)	<p><u>Examiner's Comments</u></p> <p>Higher ability candidates realised that gases would have the weakest intermolecular forces, with the most popular alternative being bitumen.</p>
			Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance												
39	a	Alkene(s) ✓	1(AO 1.1)	<p><u>Examiner's Comments</u></p> <p>The term alkenes was well known.</p>												
	b	Ethane – bromine water remains orange / orange-brown ✓ Ethene – bromine water is decolourised / turns colourless ✓	2(AO 2.2)	<p>IGNORE No change</p> <p>IGNORE turns clear / disappears</p> <p><u>Examiner's Comments</u></p> <p>Very few candidates knew what happens when bromine water is added. 'Water fizzes and bubbles with ethene' was a common incorrect response</p>												
	c	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="text-align: left;">Name of alkane</th> <th style="text-align: left;">Molecular formula</th> <th style="text-align: left;">Structure</th> </tr> </thead> <tbody> <tr> <td>Methane</td> <td>CH₄</td> <td> $\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$ </td> </tr> <tr> <td>Ethane</td> <td>C₂H₆ ✓</td> <td> $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$ </td> </tr> <tr> <td>Butane ✓</td> <td>C₄H₁₀</td> <td> $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} \quad \checkmark$ </td> </tr> </tbody> </table>	Name of alkane	Molecular formula	Structure	Methane	CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	Ethane	C ₂ H ₆ ✓	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	Butane ✓	C ₄ H ₁₀	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} \quad \checkmark$	3(AO 1.1)	<p><u>Examiner's Comments</u></p> <p>Molecular formula and structure were both exceptionally well done, with the most common mistake being to write the structure as an incorrect version of cyclobutane.</p> <p>Naming was much more problematic. Most candidates assumed that alkane would be propane. A few realised that it would start with 'b' but wrote bromine. There was the usual crop of minor misspellings.</p>
Name of alkane	Molecular formula	Structure														
Methane	CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$														
Ethane	C ₂ H ₆ ✓	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$														
Butane ✓	C ₄ H ₁₀	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array} \quad \checkmark$														

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d	<p>Hydrocarbon because contains only carbon and hydrogen ✓</p> <p>Saturated because contains single (covalent) bonds <u>only</u> / AW ✓</p>	2(AO 2.1)	<p>ALLOW fits the general formula C_nH_{2n+2} ALLOW has only H and C ✓</p> <p>DO NOT ALLOW contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen</p> <p>ALLOW does not have a double bond IGNORE 'saturated because not an alkene / because all its carbons have 4 bonds</p> <p>Examiner's Comments</p> <p>Almost all candidates saw that there were two parts to this question and tried to answer both. Hydrogen and carbon were quoted by many, and a small minority went on to say 'only' and so gained credit.</p> <p>Very, very few could explain what 'saturated' meant. Sometimes candidates got part way there with 'it contains single bonds' but again did not add the word 'only' which would have made it complete. 'Because it only contains two carbons' was not an uncommon incorrect response.</p>
		Total	8	
40		A ✓	1(AO 1.2)	<p>Examiner's Comments</p> <p>Addition reactions were not well known. Most candidates assumed that the reaction would be a neutralisation.</p>
		Total	1	



Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
41	a	Z ✓	1(AO 2.1)	<p>Examiner's Comments</p> <p>Higher ability candidates often realised that well Z had the lowest boiling point fraction but most candidates saw the largest number in the table and went for X.</p>
	b	<p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 40.31(kg) award 2 marks</p> $\frac{29}{100} \times 139 \checkmark$ $= 40.31(\text{kg}) \checkmark$	2(AO 2.2)	<p>ALLOW 40.3 / 40 ✓✓</p> <p>ALLOW ecf for one mark if 26% or 28% used (=36.14 or 38.92) ✓</p> <p>Examiner's Comments</p> <p>Marks gained tended to be 2 or 0. Higher ability candidates answered correctly, many others added all the figures in the 'Oil Y' column to get, unsurprisingly, 100, then either calculated 139/100 or 139-100.</p>
	c	$\text{C}_{16}\text{H}_{34} \checkmark$	1(AO 2.1)	<p>ALLOW $\text{H}_{34}\text{C}_{16}$</p> <p>Examiner's Comments</p> <p>Higher ability candidates handled the formula with ease. Other candidates showed clear partial understanding with answers such as $\text{C}_{16}\text{H}_{2n+2}$ or $\text{C}_{16}\text{H}_{32+2}$.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	d i	<p>Any two from:</p> <p>idea that decane boils / evaporates / turns into gaseous decane ✓</p> <p>Idea that decane (vapour or gas) reacts / breaks down as it comes into contact with the porcelain chips ✓</p> <p>Idea that large molecules of decane produce smaller molecules like ethene ✓</p>	2(AO 1.2)	<p>ALLOW passed over hot catalyst</p> <p>ALLOW liquid decane reacts with chips</p> <p>BOD</p> <p>Examiner's Comments</p> <p>This is another question where candidates were expected to explain a practical application, and few appeared comfortable with the task. The most common incorrect responses included 'decane reacts with the water and makes ethene', 'the porcelain turns into ethene', and 'the chips melt / give off a gas'.</p>
	ii	C ₆ H ₁₄ ✓	1(AO 2.2)	<p>ALLOW H₁₄C₆</p> <p>ALLOW if the candidate tries to write an (erroneous) equation for cracking and gives it as a product</p> <p>Examiner's Comments</p> <p>Again, higher ability candidates handled this formula with ease. Others got most of the way there and gave answers such as C₆H₁₈ or C₈H₁₈.</p>
		Total	7	
42		(Condensation) polymer ✓	1(AO 1.1)	<p>ALLOW polyamide / polypeptide</p> <p>DO NOT ALLOW addition polymer</p> <p>DO NOT ALLOW chain</p> <p>Examiner's Comments</p> <p>Candidates found this question challenging with only some of the higher ability candidates appreciating that Kevlar is a polymer molecule. Some others were heading more in the right direction when they suggested that it might be a giant structure. There was a wide variety of incorrect answers to this question with 'nanoparticle' being one of the more commonly seen responses.</p>
		Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
43		C ✓	1(AO 1.1)	<p><u>Examiner's Comments</u></p> <p> Misconception</p> <p>A and B were both common misconceptions in this question.</p>
		Total	1	
44		A ✓	1(AO 1.1)	<p><u>Examiner's Comments</u></p> <p> Misconception</p> <p>B and D were both common misconceptions in this question.</p>
		Total	1	
45		C ✓	1(AO 1.1)	
		Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
46	a	<p>Type of polymerisation – condensation (polymerisation) ✓</p> <p>Correct choice of ethane-1,2-diol and ethanedioic acid ✓</p> <p>Equation:</p> $ \begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{H} & \text{H} \end{array} + \begin{array}{c} \text{O} \\ \\ \text{HO}-\text{C} & -\text{C}-\text{OH} \\ \\ \text{O} \end{array} \rightarrow \begin{array}{c} \text{O} & \text{O} & \text{H} & \text{H} \\ & & & \\ -\text{C} & -\text{C}-\text{O} & -\text{C} & -\text{C}-\text{O}- \\ & & & \\ & & \text{H} & \text{H} \end{array} + \text{H}_2\text{O} $ <p>Correct ester (link) formed ✓</p> <p>Water molecule eliminated ✓</p>	<p>4(AO1 × 1.1)</p> <p>(AO1 × 3.1a)</p> <p>(AO2 × 2.1)</p>	<p>ALLOW mark for correct choice of monomers from correct reactant structures in an equation</p> <p>ALLOW mark for 'water' from an equation, even if incorrect</p> <p>Examiner's Comments</p> <p>Good responses to this question described the reaction of ethanedioic acid with ethane-1,2-diol in a condensation polymerisation reaction to form an ester and water. Many candidates gained 3 marks, but the fourth mark for drawing the correct ester link was less frequently given.</p> <p>Choosing ethene as one of the monomers was a common error.</p>
	b	i	Carboxylic acids ✓	<p>1(AO 1.1)</p> <p>IGNORE carboxyl group</p> <p>Examiner's Comments</p> <p>Alkanes, amines and esters were common errors in this question.</p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
ii	<p>Alcohol X</p> <pre> H H H H - C - C - C - O - H H H H </pre> <p style="text-align: right;">✓</p> <p>Compound Y</p> <pre> H H O // H - C - C - C \ H H O - H </pre> <p style="text-align: right;">✓</p>	2(AO 2.1)	<p>ALL covalent bonds must be shown in both displayed formulae BUT ALLOW 1 mark if both displayed formulae are correct, but show '-OH' without covalent bond</p> <p><u>Examiner's Comments</u></p> <p>More candidates were able to correctly draw the structure of alcohol X than compound Y. Many candidates did not gain the mark for the displayed formula of the alcohol because they lacked the O-H bond. The question stated 'show all the covalent bonds'. Lower ability candidates did not recall the carboxylic acid functional group, -COOH. Often the diagrams had two C-O bonds drawn (the oxygens had no other bonds). Other diagrams included C=OH or more than one C=O within the structure.</p>
	Total	7	