

## GCE AS / A LEVEL – CHEMISTRY UNIT 2 QUESTION PACK

1092-01 (Legacy CH2) · New spec Unit 2 Topic 2 · AS unit, first sat 2016, 80 marks, 1h 30min paper

**REVISE**.wales

# CHEMISTRY – UNIT 2 · ALKANES, CRACKING & FREE-RADICAL SUBSTITUTION

Topic 2.5 – Alkanes: combustion, fractional distillation, cracking and free-radical substitution

*Properties and reactions of alkanes: complete and incomplete combustion, fractional distillation of crude oil, thermal and catalytic cracking, and the free-radical mechanism for halogenation (initiation / propagation / termination).*

Legacy 2008 specification

**Estimated time for entire question pack: ~5 h 2 min***Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (189 marks over 19 questions).**You are advised to **not** attempt to complete all of this in one sitting.***ABOUT THIS QUESTION PACK**

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC CH2 papers (2008 modular spec, Jan 2010 – Jun 2016) that maps onto the new-spec AS Unit 2 Topic 2.5.

Questions are ordered by source paper date.

**INSTRUCTIONS**

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. You may need the WJEC Periodic Table / Data Booklet.

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Q	Source	Max	Mark	Q	Source	Max	Mark
1	Jun 09 Q7	15		11	Jun 12 Q1	2	
2	Jan 10 Q7	13		12	Jun 12 Q8	9	
3	Jun 10 Q4	2		13	Jan 13 Q9	16	
4	Jun 10 Q5	1		14	Jun 13 Q1	1	
5	Jun 10 Q6	11		15	Jun 13 Q9	13	
6	Jun 10 Q9	12		16	Jan 14 Q12	14	
7	Jan 11 Q10	19		17	Jun 14 Q8	16	
8	Jun 11 Q7	16		18	Jun 15 Q7	1	
9	Jun 11 Q8	13		19	Jun 16 Q5	1	
10	Jan 12 Q9	14					
<b>Total</b>						<b>189</b>	

# Alkanes, Cracking & Free-Radical Substitution – what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 2: Energy, Rate & Chemistry of Carbon Compounds · Topic 2.5.

## Alkanes – basics

- General formula  $C_nH_{2n+2}$ ; saturated.
- Only single C-C and C-H bonds.
- Boiling temperature  $\uparrow$  with chain length and  $\downarrow$  with branching.
- Sources: fractional distillation of crude oil.

## Combustion

- Complete: alkane +  $O_2 \rightarrow CO_2 + H_2O$  (excess  $O_2$ ).
- Incomplete: produces CO and/or C (soot) – limited  $O_2$ .
- Used as fuels.

## Cracking

- Thermal cracking: high T, high p  $\Rightarrow$  alkanes + alkenes (radical mechanism).
- Catalytic cracking: zeolite catalyst,  $450^\circ C \Rightarrow$  branched / aromatic for petrol.
- Converts long-chain alkanes  $\rightarrow$  shorter useful molecules.

## Free-radical substitution

- Halogenation of alkanes:  $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$  (UV).
- **Initiation:**  $Cl_2 \rightarrow 2Cl\cdot$  (UV / homolysis).
- **Propagation:**  $Cl\cdot + CH_4 \rightarrow HCl + CH_3\cdot$ ; then  $CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot$ .
- **Termination:** two radicals combine.

# Alkanes, Cracking & Free-Radical Substitution in one page

Quick-reference notes – revisit before each question.

## General formula

$C_nH_{2n+2}$ . Methane  $CH_4$ , ethane  $C_2H_6$ , ...  
decane  $C_{10}H_{22}$ .

## Fractional distillation

Crude oil heated → vapour rises up column; cooler at top ⇒ lighter fractions (LPG, petrol, kerosene, diesel, fuel oil, bitumen).

## Cracking

Long alkane → shorter alkane + alkene.  
Thermal: 700-1000°C, high p. Catalytic: zeolite, 450°C, lower p.

## Complete combustion

$C_xH_y + (x + y/4)O_2 \rightarrow xCO_2 + (y/2)H_2O$ .  
Strongly exothermic.

## FRS mechanism

I:  $Cl_2 \xrightarrow{[UV]} 2Cl\cdot$   
P1:  $Cl\cdot + CH_4 \rightarrow CH_3\cdot + HCl$   
P2:  $CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot$   
T:  $2Cl\cdot \rightarrow Cl_2$ ;  $CH_3\cdot + Cl\cdot \rightarrow CH_3Cl$

## Multiple substitution

Excess  $Cl_2$  gives  $CH_2Cl_2$ ,  $CHCl_3$ ,  $CCl_4$  –  
mix of products is FRS's main drawback.

7. (a) (i) Petroleum (crude oil) is largely a mixture of alkane hydrocarbons. The first stage of the refining process is fractional distillation. State what is meant by fractional distillation. [1]

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- (ii) One of the alkane hydrocarbons has the skeletal formula shown below.



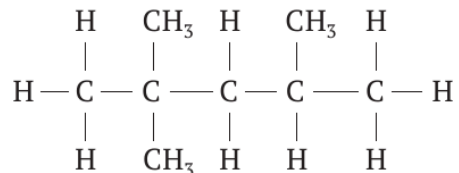
Give the molecular formula of this hydrocarbon. [1]

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- (iii) The next stage of petroleum refining is the cracking of some fractions. State what is meant by the term cracking and explain why this is done. [2]

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- (iv) For effective combustion of petrol in motor vehicles, branched chain isomers are needed. One of these is 2,2,4-trimethylpentane.



Write the displayed formula (showing all the bonds) for the straight chain isomer of 2,2,4-trimethylpentane. [1]

(b) Dichloromethane,  $\text{CH}_2\text{Cl}_2$ , has been an important material in many paint strippers.

(i) Describe how it can be made from chloromethane and chlorine in the presence of ultraviolet light.

Your answer should include:

- the type of bond fission occurring in the initiation stage;
- a description of the initiation stage including an equation;
- two equations representing the propagation stage;
- an equation for the termination stage giving dichloromethane.

[6]

(QWC) [1]

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(ii) The mass spectrum of the products obtained by making dichloromethane in (i) shows a molecular ion peak at  $m/e$  98. The compound giving this molecular ion contains two  $^{35}\text{Cl}$  atoms in each molecule.

Suggest a molecular formula and a displayed (structural) formula for this compound, explaining how it might be formed.

[3]

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Total [15]

Examiner  
only

**SECTION B**

Answer **all** the questions in the spaces provided.

7. Petroleum, which is a mixture of hydrocarbons, is an important source of chemicals. These chemicals can be obtained by fractional distillation and further processing such as cracking and isomerisation.

(a) During fractional distillation, explain why hydrocarbons containing few carbon atoms distil at lower temperatures than hydrocarbons with many carbon atoms. [3]  
QWC [1]

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(b) Pentane is one of the hydrocarbons obtained from petroleum.

(i) Name the homologous series of which pentane is a member. [1]

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(ii) Pentane has two structural isomers.

I. Explain the meaning of the term *structural isomer*. [2]

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II. Draw the displayed formulae of the **structural isomers** of pentane and name them. [4]

Isomer 1

Isomer 2

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Examiner  
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(c) State what is meant by the term **cracking** and explain why this process is important. [2]

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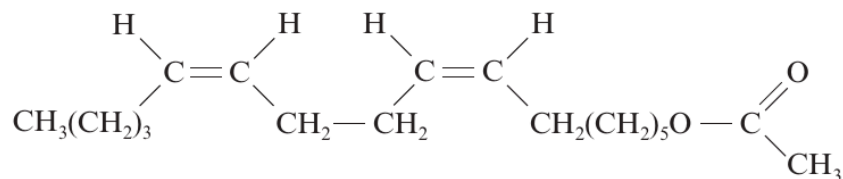
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Total [13]

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3. The formula for an attraction pheromone for the pink bollworm is shown below.



- (i) State a suitable catalyst for the hydrogenation of the  $\begin{array}{c} \diagdown \\ \text{C} = \text{C} \\ \diagup \end{array}$  bonds present. [1]
- (ii) This pheromone molecule contains two  $\begin{array}{c} \diagdown \\ \text{C} = \text{C} \\ \diagup \end{array}$  bonds which both have the Z (cis) configuration.  
Explain why an alkene can exist as either an E (trans) or a Z (cis) isomer. [1]
4. The relative molecular mass of a **branched-chain** alkane is 72.  
Alkanes have the general formula  $\text{C}_n\text{H}_{2n+2}$ .
- (i) State the **molecular** formula of the alkane. [1]
- (ii) Draw one **displayed** formula of this alkane. [1]

5. Use the words 'increases' or 'decreases' to complete the sentence below. [1]  
**Each word can be used once, more than once or not at all.**

As the hydrocarbon chain length in carboxylic acids increases, the boiling temperature ..... and the solubility in water .....

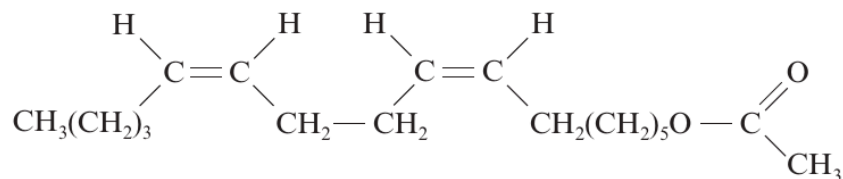
6. State the type of reaction occurring during this chemical change. [1]



**Total Section A [10]**

**Turn over.**

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- (i) State a suitable catalyst for the hydrogenation of the  $\begin{array}{c} \diagdown \\ \text{C} = \text{C} \\ \diagup \end{array}$  bonds present. [1]
- .....
- (ii) This pheromone molecule contains two  $\begin{array}{c} \diagdown \\ \text{C} = \text{C} \\ \diagup \end{array}$  bonds which both have the Z (cis) configuration. Explain why an alkene can exist as either an E (trans) or a Z (cis) isomer. [1]
- .....
- .....
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**Each word can be used once, more than once or not at all.**

As the hydrocarbon chain length in carboxylic acids increases, the boiling temperature ..... and the solubility in water .....

6. State the type of reaction occurring during this chemical change. [1]

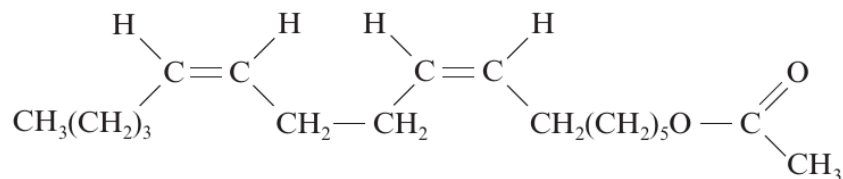


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**Total Section A [10]**

**Turn over.**

Examiner  
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- (i) State a suitable catalyst for the hydrogenation of the  $\begin{array}{c} \diagdown \\ \text{C} = \text{C} \\ \diagup \end{array}$  bonds present. [1]
- .....
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- .....
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**Each word can be used once, more than once or not at all.**

As the hydrocarbon chain length in carboxylic acids increases, the boiling temperature  
..... and the solubility in water .....

6. State the type of reaction occurring during this chemical change. [1]



Total Section A [10]

Turn over.

Examiner  
only

9. (a) Methane reacts with gaseous chlorine giving chloromethane and hydrogen chloride.



In a report of this reaction, a student came across a number of terms. Illustrating your answer with an equation in **each** case, state what is meant by

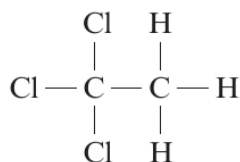
- (i) homolytic fission, [2]

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- (ii) a propagation stage. [2]

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- (b) Ethane reacts with chlorine in a similar way to methane. One of the products is 1,1,1-trichloroethane.



- (i) The manufacture and use of 1,1,1-trichloroethane is now restricted because of its adverse effects on the ozone layer. However, the corresponding fluoro-compound 1,1,1-trifluoroethane does not cause environmental problems in the ozone layer.

Explain why only the chloro-compound has these adverse effects. [2]

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Examiner  
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(ii) A sample of 1,1,1-trichloroethane is reacted with an excess of sodium hydroxide solution and then acidified.

I. One of the organic products of this reaction is liquid **R**, whose mass spectrum shows a molecular ion at  $m/z$  60.

The infrared spectrum of **R** shows characteristic absorption frequencies at  $1725\text{ cm}^{-1}$  and  $2500\text{--}3500\text{ cm}^{-1}$ .

Use this information, showing your working, to suggest a structural formula for liquid **R**. [4]

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II. Chloride ions are also produced when 1,1,1-trichloroethane reacts with aqueous sodium hydroxide. The products of the reaction are then acidified with nitric acid and the mixture tested for the presence of chloride ions.

State the reagent(s) used and the observations when the mixture was tested for chloride ions. [2]

*Reagent(s)* .....

*Observations* .....

Total [12]

Examiner  
only

10. The reaction of methane with chlorine gives a wide array of products including chloromethane, dichloromethane, trichloromethane, tetrachloromethane and ethane. Most of these products are liquids, with the boiling temperatures increasing as the number of chlorine atoms increases. This reaction only occurs in the presence of ultraviolet light.

(a) Give a balanced equation for the initiation stage of this reaction. [1]

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(b) Suggest a suitable method for separating the liquid mixture formed in this reaction to isolate pure samples of the separate products. Explain why you have chosen this method. [2]

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(c) Under similar conditions, pentane can be used to produce 1-chloropentane.

(i) Explain how decane,  $C_{10}H_{22}$ , could be produced as one of the products of this reaction. [2]

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(ii) Warming 1-chloropentane with aqueous sodium hydroxide produces pentan-1-ol. Use the infrared absorption frequencies given in the data sheet to explain how you could check spectroscopically that this reaction had converted **all** the 1-chloropentane into pentan-1-ol. [2]

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Examiner  
only

- (d) The boiling temperatures of 1-chloropentane, pentan-1-ol and propan-1-ol are given below.

Compound	Boiling temperature / °C
propan-1-ol	97
1-chloropentane	107
pentan-1-ol	138

- (i) Explain why the boiling temperature of pentan-1-ol is higher than that of 1-chloropentane. [2]

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- (ii) Explain why the boiling temperature of pentan-1-ol is higher than that of propan-1-ol. [2]

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- (iii) State which one of the three compounds in the table above is likely to be the most soluble in water. Explain your answer. [3]

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- (e) It is possible to test for the presence of halogen atoms in a halogenoalkane by hydrolysing the molecule and testing for the halide ions released, using silver nitrate solution. This is a nucleophilic substitution reaction with the nucleophile attacking the  $C^{\delta+}$  of the C-halogen bond. In each case, a precipitate is formed.

The hydrolysis of three compounds was performed under identical conditions, and the time required for a precipitate of silver halide to form was measured. The results were as follows:

Compound	Time for precipitate to form / minutes
1-chloropentane	17
1-bromopentane	4
1-iodopentane	Less than 1

The carbon-halogen bond energies and the electronegativity differences for each bond are given below.

Bond	Average bond enthalpy /kJ mol <sup>-1</sup>	Electronegativity difference
C—Cl	338	0.61
C—Br	276	0.41
C—I	238	0.11

Examiner  
only

Use both tables to comment on the factors that affect the rate of reaction. Your answer should discuss:

- The trend in relative bond strengths for the halogenoalkanes;
- The trend in the rate of reaction expected if bond strength is the main factor affecting the ease of hydrolysis in these compounds;
- The trend in size of the  $\delta^+$  charges on the carbon atoms of each halogenoalkane;
- The trend in the rate of reaction expected if dipole size is the main factor affecting the ease of hydrolysis in these compounds. [4]

QWC [1]

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Total [19]

## SECTION B

Answer **all** questions in the spaces provided.

7. Petroleum is a mixture of saturated hydrocarbons, some of which are structural isomers of one another. These are separated into fractions by distillation. Some of these fractions are used to make important chemicals such as ethene while others are used as fuels.

(a) Explain what is meant by a *saturated* hydrocarbon. [1]

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(b) Propane and heptane,  $C_7H_{16}$ , are two of the hydrocarbons obtained from petroleum.

(i) Write a balanced equation for the complete combustion of propane. [2]

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(ii) 3-Ethylpentane is a structural isomer of  $C_7H_{16}$ .  
Draw the **skeletal** formula of this isomer. [1]

(c) Name and briefly describe the process by which ethene is produced from a petroleum fraction. [2]

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Examiner  
only

(d) Describe the structure of and bonding in an ethene molecule.

[3]  
QWC [1]

You may use a diagram in your answer.

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(e) Name the type of reaction mechanism occurring when ethene reacts with aqueous bromine and draw the displayed formula of the product formed. [2]

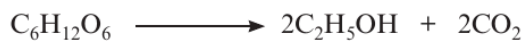
Type of reaction mechanism .....

Displayed formula

(f) Ethene can be used as the starting material in the industrial preparation of ethanol. The conditions for the reaction are a temperature of 300°C and a pressure of 60-70 atm.

Name the catalyst used in this reaction. [1]

(g) Another way to prepare ethanol is by the fermentation of glucose.



Calculate the minimum mass of glucose required to give 230 g of ethanol. [3]

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Total [16]

**Turn over.**

1092  
010007

Examiner  
only

8. (a) Chloroalkanes such as 1-chlorobutane are used in the synthesis of many organic compounds.

1-Chlorobutane can be formed from butane and chlorine in a similar way to the formation of chloromethane from methane and chlorine.

Describe the reaction of butane and chlorine to form 1-chlorobutane.

Your description should include:

- an overall equation for the reaction;
- the conditions required for the reaction to take place;
- full details of the reaction mechanism.

[6]  
QWC [1]

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(b) Give the equation for the reaction between 1-chlorobutane and aqueous sodium hydroxide and name the type of reaction mechanism occurring. [2]

Equation .....

Type of reaction mechanism .....

(c) A compound is known to be either 1-chlorobutane or 1-bromobutane. Describe a test, giving any reagents used and observations, to show that the compound is 1-chlorobutane. [3]

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Examiner  
only

- (d) Chlorofluorocarbons were used at one time as refrigerants in air-conditioning systems in cars and buildings. However, due to leakage over time, their use for this purpose is being phased out.

State the environmental consequence of leakage of chlorofluorocarbons. [1]

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Total [13]

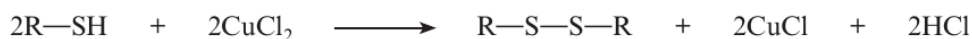
9. During 2010 a serious leak of petroleum (crude oil) occurred in the Gulf of Mexico. This loss of millions of litres of petroleum caused an environmental and ecological disaster.

(a) Petroleum consists largely of a mixture of alkanes that do not dissolve in sea water but form a surface layer. The main reason that these alkanes cannot dissolve in water is because they are unable to hydrogen bond with water. Explain what is meant by *hydrogen bonding* and use this to explain why alkanes do not dissolve in water. [4]

QWC [1]

(b) (i) Some of the leaking oil was collected by tankers and taken to oil refineries. The petroleum was then separated into fractions by the process of fractional distillation. Describe what is meant by *fractional distillation*. [2]

(ii) One of the fractions was then further refined into fuel for vehicles. During refining, most of the sulfur compounds present in the fuel are removed in order to reduce the amount of oxides of sulfur released in exhaust gases. One stage in the process is to convert unpleasant-smelling thioalcohols (R—SH) into disulfides (R—S—S—R) using copper chloride, CuCl<sub>2</sub>.

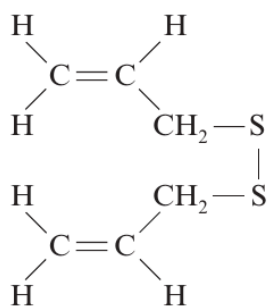


Explain, using the oxidation states (numbers) of copper, why copper chloride, CuCl<sub>2</sub>, is reduced in this reaction. You should assume that the oxidation state of chlorine is -1. [2]

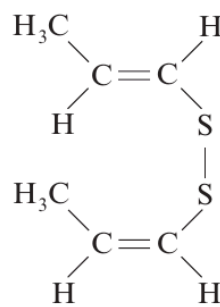


Examiner  
only

(c) Compounds **A** and **B** are organic compounds of sulfur found naturally in some foods.



compound **A**  
found in garlic



compound **B**  
produced on cooking onions

- (i) These two compounds are structural isomers. State what is meant by the term *structural isomer*. [1]

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- (ii) Explain why only compound **B** can exist as E-Z isomers. Your answer should comment on the atoms/groups involved and the reason why these give rise to E-Z isomerism. [2]

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- (iii) Compound **A** is sold by the chemical suppliers at £48.00 for 100 g. The material sold is only 73% pure but this is satisfactory for the purposes needed. Calculate the cost of 1 mol of compound **A**, which has a molecular formula  $\text{C}_6\text{H}_{10}\text{S}_2$ . [2]

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Total [14]

Turn over.



Examiner only

8. (a) Compound X is a straight-chain hydrocarbon that consists of 85.7% carbon by mass.

(i) Find the **empirical** formula of compound X. [3]

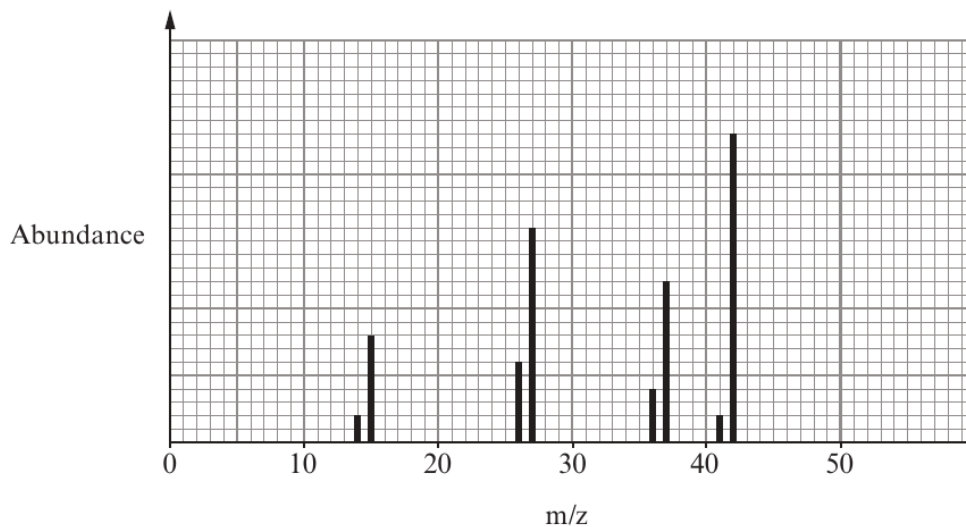
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(ii) Some peaks from the mass spectrum of X are shown below.



Use the empirical formula and the mass spectrum to find the molecular formula of X. Show your workings. [2]

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(iii) Suggest what information the presence of the peak at m/z 15 gives about the structure of X. [1]

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Examiner  
only

- (b) Butene,  $C_4H_8$ , is an alkene. Draw **displayed** formulae for three **straight-chain** isomers of  $C_4H_8$ . [3]

Total [9]

1092  
010009

Examiner  
only

9. Chloromethane can be produced by the chlorination of methane gas.

(a) During the initiation stage of this process, chlorine free radicals are produced.

(i) Give the condition(s) required for this initiation stage. [1]

(ii) State what is meant by a *free radical*. [1]

(b) Write the equation(s) for the propagation stage(s) to produce chloromethane starting with methane and chlorine free radicals. [2]

(c) Apart from chloromethane, a range of other compounds are produced in small amounts during the reaction.

(i) One of the compounds produced in the reaction is ethane. Show how this compound is produced. [1]

(ii) Another of the compounds produced contains 24.3% carbon, 4.1% hydrogen and 71.6% chlorine by mass. Calculate the **empirical** formula of this compound. [2]

Empirical formula .....



0 8

Examiner  
only

(d) Chloromethane can be converted into methanol by reaction with hydroxide ions.

(i) Classify the mechanism of this reaction. [1]

(ii) The boiling temperatures of chloromethane and methanol are given in the table below.

Compound	Boiling temperature / K
chloromethane, CH <sub>3</sub> Cl	249
methanol, CH <sub>3</sub> OH	338

Explain why the boiling temperature of methanol is higher than the boiling temperature of chloromethane. [3]

(iii) Methanol can then be converted to methanoic acid. Give the reagent(s) and condition(s) required for this reaction. [2]

Reagent(s) .....

Condition(s) .....

1092  
010009

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Examiner  
only

- (e) CFCs are another class of organic compounds. They contain chlorine, fluorine and carbon. These compounds once had a range of uses, however their use is now avoided due to their effect on the ozone layer which is part of the **upper** atmosphere.

The table shows the lifetime of some compounds in the **lower** atmosphere and their relative ozone depletion potential (RODP), taking  $\text{CCl}_3\text{F}$  as having a value of 1.0. The RODP is measured by mixing a compound with ozone in a laboratory experiment.

Compound	Formula	Lifetime in the lower atmosphere	Relative ozone depletion potential (RODP)
<b>A</b>	$\text{CHF}_3$	243 years	0.01
<b>B</b>	$\text{CCl}_2\text{F}_2$	20 years	0.86
<b>C</b>	$\text{CCl}_3\text{F}$	75 years	1.00
<b>D</b>	$\text{CBrClF}_2$	120 days	10.00

By referring to this table, explain why CFCs **B** and **C** are far more harmful than compounds **A** and **D**.

Your answer should explain how and why CFCs affect the ozone layer.

[3]

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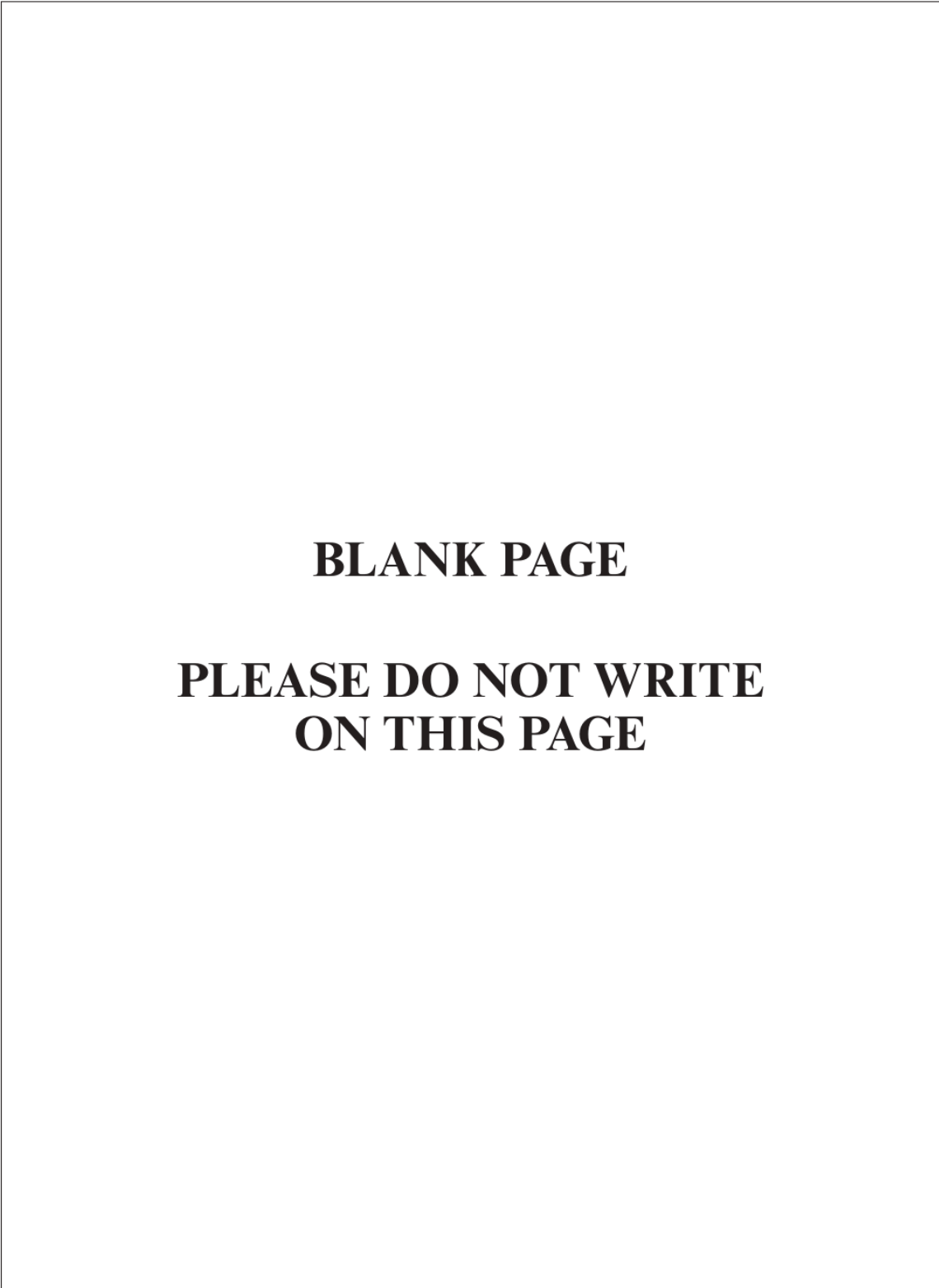
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Total [16]



1 0



1 1

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only

## SECTION A

*Answer all questions in the spaces provided.*

1. State which **one** of the following formulae represents an **alkane**. [1]



2. In order to form a magnesium atom, a magnesium ion must: [1]

A gain one electron

B gain two electrons

C lose two electrons

D lose two protons

3.

ammonium nitrate	calcium chloride	magnesium carbonate
potassium hydroxide	sodium sulfate	

From the list of compounds above choose one that

(a) gives a brick-red flame test, [1]

.....

(b) is insoluble in water, [1]

.....

(c) in solution forms a white precipitate with aqueous barium chloride. [1]

.....



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9. (a) Petroleum is one of the most important resources in the world. It is estimated that we consume about 88 million barrels each day. Describe the general chemical composition of petroleum. [1]

.....  
.....

- (b) Butane is a useful fuel obtained from petroleum. Write an equation for the complete combustion of butane. [1]

.....

- (c) Another fuel is methane. Give the  $\text{H}-\hat{\text{C}}-\text{H}$  bond angle in a methane molecule. [1]

.....

- (d) Explain why the  $\text{H}-\hat{\text{O}}-\text{H}$  bond angle in water is less than the  $\text{H}-\hat{\text{C}}-\text{H}$  bond angle in methane. [3]

QWC [1]

.....  
.....  
.....  
.....  
.....



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(e) Covalent compounds like methane and butane are gases at room temperature, however metals are generally solids with high melting temperatures.

(i) State, giving a reason, whether you would expect butane to have a higher or lower boiling temperature than methane. [1]

.....  
.....  
.....

(ii) Describe briefly the nature of metallic bonding and use this to explain why metals are malleable (can be hammered into shape) and conduct electricity. [4]

*QWC* [1]

.....  
.....  
.....  
.....  
.....  
.....  
.....

Total [13]



12. (a) Petroleum (crude oil) is separated into useful parts by fractional distillation.

(i) Briefly describe how *fractional distillation* can be carried out. [2]

.....

.....

.....

(ii) A fraction is treated further to give a **branched-chain** alkane. The mass spectrum of this alkane shows a molecular ion,  $M^+$ , at  $m/z$  72.

Use this information to give the molecular formula and then suggest a displayed formula for this alkane. [2]

(b) Cracking is a process that is used in the petroleum industry to obtain smaller alkanes and alkenes from larger alkanes.

(i) State why this process of making smaller molecules is carried out. [1]

.....

.....

(ii) Methane is one of the products when nonane,  $C_9H_{20}$ , is cracked. The other products are butane and butadiene,  $C_4H_6$ .  
Give an equation that represents this reaction. [1]

.....

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(c) Methane reacts with chlorine in a substitution reaction.

(i) The first stage of the reaction is as follows.



State an essential condition for this stage.

[1]

(ii) State what is meant by the term *propagation stage*.

[1]

(iii) Write an equation that represents a propagation stage of this reaction.

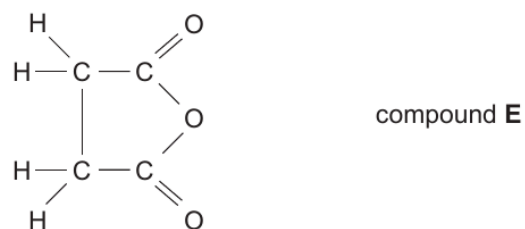
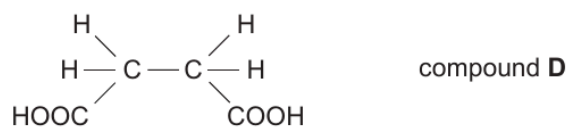
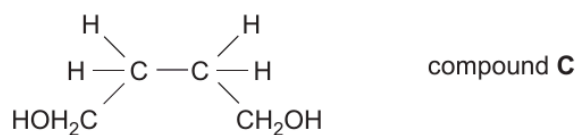
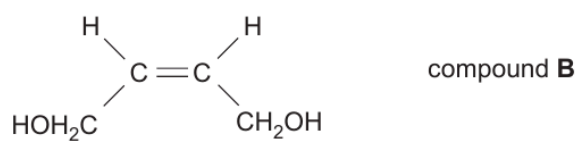
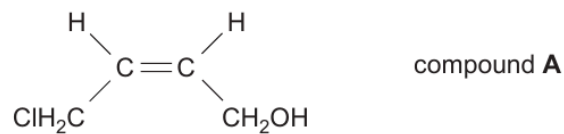
[1]

**QUESTION CONTINUES ON PAGE 18**

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(d) Study the reaction sequence below and then answer the questions that follow.



- (i) Compound **A** is a (*Z*)-isomer.

Write the displayed formula of the (*E*)-isomer of compound **A**.

[1]

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- (ii) State the name of reagent **W** and the solvent in which it is dissolved.

[1]

- (iii) State the name of a catalyst used in the hydrogenation of compound **B** to produce compound **C**.

[1]

- (iv) The infrared spectra of compounds **D** and **E** are taken.

Use the Data Sheet to explain how the infrared spectra can be used to distinguish between compounds **D** and **E**.

[2]

Total [14]

**Total Section B [70]**

**END OF PAPER**





**GCE AS/A level**

1092/01-A

**CHEMISTRY – DATA SHEET  
FOR USE WITH CH2**

A.M. THURSDAY, 16 January 2014

**Infrared Spectroscopy characteristic absorption values**

<b>Bond</b>	<b>Wavenumber / cm<sup>-1</sup></b>
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C=C	1620 to 1670
C=O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

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8. Crude oil is a complex mixture of hydrocarbons, with samples from different locations in the world having different compositions. The table below gives the composition of crude oil from two locations.

Fraction	Percentage by mass	
	Brent Crude	Gulf of Suez
petroleum gases	2.4	1.2
naphtha	19.1	13.6
kerosene	14.2	12.7
gas oil	20.9	18.7
residue	43.4	53.8

- (a) The different fractions are separated by fractional distillation. Explain why the different fractions have different boiling temperatures. [2]

.....

.....

.....

.....

- (b) The petroleum gases produced from crude oil can contain both propane and butane.

- (i) A barrel of Gulf of Suez crude oil has a mass of 145 kg. Assuming all the petroleum gas released from the oil is butane, calculate the volume that this gas would occupy at 1 atmosphere pressure. [3]  
 [1 mol of gas occupies 24.0 dm<sup>3</sup> under these conditions]

Volume = ..... dm<sup>3</sup>

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010009



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(ii) Propane can be chlorinated by a similar method to methane.

I Give the condition(s) required for the chlorination of propane. [1]

.....

II Write an equation for the initiation stage of the chlorination of propane. [1]

.....

III The chlorination of propane also produces hexane as a minor product. Explain how this compound forms. [2]

.....

.....

.....





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5. State the reagent(s) used and the colour change seen when a primary alcohol is oxidised to give a carboxylic acid. [2]

Reagent(s) .....

Colour change from ..... to .....

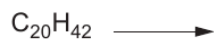
6. State the systematic name of the compound shown below. [1]



.....

7. On cracking, one molecule of  $\text{C}_{20}\text{H}_{42}$  can produce one molecule of pentene, one molecule of hexene and one molecule of another product.

Complete the equation for this reaction. [1]



8. Draw the repeat unit of the polymer formed from the monomer  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ . [1]

**Total Section A [10]**

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4. (a) Place the following elements in order of their increasing first ionisation energy. [1]

sodium      magnesium      aluminium      silicon      chlorine

Lowest ..... Highest

(b) Place the following elements in order of their increasing melting temperature. [1]

sodium      magnesium      aluminium      silicon      chlorine

Lowest ..... Highest

5. Decane (C<sub>10</sub>H<sub>22</sub>) may be used to produce ethene in a cracking reaction. Write an equation for this process. [1]

.....

6. Give the reagent(s) required for the oxidation of ethanol to form ethanoic acid. [1]

.....

7. A saturated solution of calcium sulfate at 20 °C was cooled to 0 °C and 0.11 g of solid calcium sulfate was obtained. Use the data below to calculate the volume of the calcium sulfate solution. [2]

Temperature / °C	Solubility of CaSO <sub>4</sub> / g dm <sup>-3</sup>
0	2.10
20	2.39

Volume = ..... dm<sup>3</sup>

**Total Section A [10]**

**END OF QUESTION PACK**

19 questions · 189 marks · ~5 h 2 min  
Source: WJEC CH2 (2008 modular spec, Jan 2010 – Jun 2016)  
Curated for WJEC Chemistry 2015 spec AS Unit 2 – Topic 2 (2.5)

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